XVI Congresso Nazionale di Scienze Planetarie

Book of Abstracts

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Programma

3 Febbraio

09.15

- welcome
- **09.30** Inizio corso per giornalisti
- **11.30** coffe break
- **12.00** Saluto autorita'
- **12.30** relazioni programmatiche

    - Barbara Negri ASI
    - Francesca Esposito INAF
    - Luigi Colangeli ESA

- **13.30** Pranzo

15.00

- **Tavola Rotonda: le prospettive future per la nostra comunità**
- **16.30** Coffe break
- **17.00** *Piccoli Corpi*: 5 presentazioni chair: **Davide Perna**

    - Alessandro Rossi, YORP-Yarkowski evolution of asteroid families
    - Giovanni Valsecchi, Collisions vs. ejections in the outer planetary region
    - Elisabetta Dotto, LICIACube: the Light Italian Cubesat for Imaging of Asteroids
    - Giovanna Rinaldi, Dust properties in the innermost coma of comet 67P/Churyumov-Gerasimenko from VIRTIS-M spectra
    - Stavro Lambrov Ivanovski, Modelling of rotating non-spherical dust dynamics at cometary and asteroid environments

- **18.15** fine sessione

Concerto al Conservatorio Pollini alle 19.00
(organizzato e offerto dal prof. F.Seno, Direttore del DFA)

4 Febbraio

09.00

- *Piccoli Corpi*: 7 presentazioni chair: **Monica Lazzarin**

    - Alessandro Rossi, Exploiting orbital resonances for the disposal of objects from Low Earth Orbit
    - Gabriele Cremonese, First interstellar comet, 2I/Borisov: TNG observations
    - Gianrico Filacchione, Colour cycling on 67P/CG coma and nucleus
    - Pamela Cambianica, Time Evolution of Dust in the Hapi Region of Comet 67P/Churyumov-Gerasimenko
    - Fiorangela La Forgia, Visible and near-IR spectroscopic characterization of different dynamical classes of comets

- Vito Mennella, An evidence of a link between primitive solar system bodies and interstellar dust through the 3.2 μm band of 67P/CG
- Elisabetta Dotto, The EU H2020 programme NEOROCKS

- **10.45** coffee break
- **11.15** inizio sessione
- *Piccoli Corpi*: 4 presentazioni chair: **Maria Cristina De Sanctis**

  - Batiste Rousseau, Ceres surface spectral properties through the VIR/Dawn visible data
  - Davide Perna, Near-Earth small body nodal encounter mission opportunities
  - Linda Dimare, In-orbit fragmentation characterization and parent bodies identification by means of orbital distances
  - Andrea Raponi, Ceres as seen by VIR/Dawn in the 0.4 – 4.1 μm range: spectral modeling and VIS-NIR/Raman spectroscopy on laboratory analogues suggest altered and pristine silicates within carbon chemistry.

- *Pianeti Marte*: 3 presentazioni chair: **Davide Grassi**

  - Giacomo Carrozzo, TGO/NOMAD nadir observations of Mars during years 2018- 2019
  - Fabrizio Oliva, Vertical distribution of dust in the Martian atmosphere from OMEGA-MEx observations
  - Simone Silvestro, Aeolian processes on Mars: bed form analysis and implications for climate

- **13.00** Pranzo

14.30

- **Invited: M.T.Capria, La Società Italiana di Scienze Planetarie**
- **15.00** *Pianeti Marte*: 4 presentazioni chair: **Matteo Massironi**

  - Paola Manzari, Investigation on the absorption bands around 3.3 micrometers in CRISM data
  - Maurizio Pajola, Inverted fluvial features in NE Eridania basin, Mars. Origin and timing of fluvial activity
  - Giovanni Munaretto, First CaSSIS observations of Martian recurring slope lineae: implications for their origin and evolution
  - Riccardo Pozzobon, Salt tectonics in Arabia Terra bulged craters? Hints from geological mapping, structural analysis and 3D geomodelling of the Crommelin Crater (Mars)

- **16.00** coffee break
- **16.30** inizio sessione
- *Pianeti Mercurio*: 3 presentazioni chair: **Valeria Mangano**

  - Valentina Galluzzi, Asymmetric magnetic anomalies over two young impact craters on Mercury
  - Stavro Lambrov Ivanovski, Magnetic Reconnection Modelling at the Mercury's Magnetopause in Preparation for BepiColombo/SERENA Experiment

- Valeria Mangano, Synergies between the ground-based and space-based observations of the Na exosphere of Mercury

- *Pianeti Esterni*: 3 presentazioni

  - Davide Grassi, On the spatial distribution of minor species in Jupiter's troposphere as inferred from Juno JIRAM data
  - Alessandra Migliorini, JIRAM observation of H3+ and CH4 distributed along the disc of Jupiter
  - Federico Tosi, Compositional and thermal mapping of Io obtained with Juno/JIRAM

- **18.00** fine sessione

Cena Sociale al Pedrocchi alle 19.30 (https://www.caffepedrocchi.it)

6 Febbraio

09.0

- *Strumentazione e Laboratorio*: 2 presentazioni chair: **Riccardo Claudi**

  - Maria Cristina De Sanctis, Ma_Miss on Exo Mars 2020: ready to launch
  - Francesco Sauro, Geological contribution to ESA Analog1 experiment

- *Esopianeti e Sistemi Planetari*: 4 presentazioni

  - Luca Malavolta, The Italian contribution to field of exoplanets: results and perspectives
  - Francesco Marzari, Dust distribution in circumstellar disks with two giant planets in resonance.
  - Francesco Marzari, A violent dance of giant planets and planetesimals in circumstellar disks
  - Luis Diego Pinto, Young Protoplanetary disks evolving in open clusters: SPH treatment with radiative transfer formalism

- **10.30** coffee break
- **11.00** inizio sessione
- *Esopianeti e Sistemi Planetari:* 5 presentazioni chair: **Nadia Balucani**

  - Angelo Zinzi, Exo-MerCat inclusion in ExoplAn3T: a new way of exploring large exoplanetary databases
  - Antonio Garrido Rubio, Study of the Balmer Lines on the exoplanetary atmospheres of Kelt-9b through Transmission Spectroscopy
  - Cecilia Lazzoni, Looking for binary planets, satellites and disks around exoplanets
  - Silvano Desidera, Young planets at close separations
  - Claudia Toci, The fate of rings in protoplanetary discs: giant planets in action

- *Astrobiologia:* 2 presentazioni

- Alessandro Frigeri, Geologic fieldwork supporting ESA ExoMars' MA_MISS experiment
- Teresa Fornaro, Laboratory Analog Studies for Supporting Detection of Molecular Biosignatures on Mars

- **12.45 Invited: M.Cirasuolo**, *the Extremely Large Telescope and the future of European ground-based astronomy*
- **13.15** Pranzo

14.30

- Sessione poster 2
- **15.15**Astrochimica chair: **Maria Teresa Capria**

  - **Invited: E.Bianchi**, *The astrochemical link between Sun-like protostars and Solar System comets*
  - **Invited: L.Podio**, *The chemical content of planet-forming disks: towards a comparison with the Outer Solar System Objects and the exoplanets*

- **16.15** coffee break
- **16.45** inizio sessione
- *Astrobiologia*: 7 presentazioni chair: **John Brucato**

  - Nadia Balucani, Formation of nitriles and other N-containing organic molecules in the upper atmosphere of Titan
  - Maria Angela Corazzi, Thermal desorption process of formamide ice
  - Francesco Ferlin, Experimental Solubility Determination of Organic Compounds in Simulated Titan's Methane Lakes
  - Vito Squicciarini, Searching for the oxygen footprint of light-harvesting organisms
  - Maria Cristina De Sanctis, Hydrated sodium chloride on Ceres from recent ascending salty fluids
    Andrea Meneghin, ABCS: a CubeSat for space environment astrobiology experiments
  - Claudio Maccone, A mathematical model for Evolution of Life on Earth and Exoplanets (Evo-SETI)

- **18.30** fine sessione

7 Febbraio

09.00

- *Meteore, Meteoriti e Polvere interplanetaria*: 6 presentazioni chair: **Cristian Carli**

  - Luigi Folco, Thirty years of Antarctic meteorite research by the Italian Programma Nazionale delle ricerche in Antartide (PNRA)
  - Jacopo Nava, New perspectives into outburst and sublimation on minor bodies and comets inferred from laboratory experiments on carbonaceous chondrites.
  - Oliver Christ, Origin of diamond and graphite in ureilites: a timely topic in planetary geology
  - Anna Barbaro, Study of carbon phases in the Yamato 74123 and Kenna ureilites

- Mara Murri, Multi-methodological approach to quantify hexagonal stacking in natural impact diamonds
- Giovanni Poggiali, Laboratory spectroscopic properties of carbonaceus chondrites and minerals at cryogenic temperatures in support of OSIRIS-REx.

- **10.30** coffee break
- **11.00** inizio sessione
- *Meteore, Meteoriti e Polvere interplanetaria*: 5 presentazioni chair: **Giovanni Pratesi**

  - Jacopo Nava, Composition of C-type asteroids inferred from Antarctic fine-grained micrometeorites showing the 3 μm band
  - Luigi Folco, The extraterrestrial dust flux: size distribution and mass contribution estimates inferred from the Transantarctic Mountain micrometeorite collection
  - Lidia Pittarello, Pallasites and mesosiderites: a petrologic approach
  - Fabrizio Campanale, Impact coesite: formation and survival
  - Cristian Carli, OLivine-Bearing ungrOuped achonDrItES: OL-BODIES
  - Lorenzo Cibin, ASTROCAD – The Astronomic CCD Camera for the ESA NEO Survey Telescope.

- **12.30** Pranzo

Alessio Aboudan

Affiliazione: CISAS G. Colombo, Università di Padova

Contributi Proposti

Title: Analysis of planetary rotational state using spaceborne images

Authors: Alessio Aboudan, CISAS Università di Padova; Giacomo Colombatti, CISAS Università di Padova; Vincenzo Della Corte, IAPS INAF; Stefano Debei, CISAS Università di Padova; Pasquale Palumbo, Università di Napoli Parthenope

Abstract: Bodies of our solar system such as Mercury, Ganymede, Europa, Callisto, will be targeted by ESA missions in the next ten years. The thickness of their outer shell, distribution of internal layers and in some cases a sub-surface ocean as well as the details about their interior have not been well constrained yet. Direct measurements of their rotational state, when compared with the predictions of available geophysical models, will be useful to better characterise the sub-surface structure of such bodies. In the near future BepiColombo HRIC and Juice JANUS cameras are expected to provide high-resolution images of both Mercury and Ganymede. Tracking surface landmarks and measuring their longitudinal shift it will be possible to estimate obliquity, librations and other motion parameters. Goal of this work is to define an error budget for such kind of measurements, investigate to which extent the libration shift can be detected and design a rigorous statistical methodology to compare different interior models and to select which one better fits the observed data. This will support both the preparation of data processing tools and the definition of the observational strategies that could be used for such analysis.

Thematic section: Pianeti e satelliti

Title: Learning to detect geologic features on spaceborne images. The case of boulders detection on Oxia Planum.

Authors: Alessio Aboudan, CISAS Università di Padova; Mattia Mazuccato, CISAS Università di Padova; Stefano Debei, CISAS Università di Padova

Abstract: This work presents a methodology to automatically detect geological features on spaceborne images, leveraging on the recent advances in the field of computer vision and machine learning. The proposed detector is based on a modified version of single shot YOLO convolutional neural network algorithm properly tailored to process single channel images. The algorithm is fully integrated into a GIS software and it is intended to provide a tool for producing features distribution maps on large spatial scales, with beneficial outcomes for both scientists and engineers. As a case study, this work focuses in mapping rocks on the martian region of the Oxia Planum, which was recently invested with a great deal of interest for the landing site selection in the context of ExoMars 2020 mission. The detector is trained on HiRISE images using about 8000 hand labeled boulders with a diameter greater than 1.25 m. Then the detection performances are evaluated on an extensive mapping task. The method is very general because the convolutional neural network can be trained to cope with images of different geological units or with different features only extending the training set. Furthermore, since the detector can run in near real-time it may be an effective tool to support hazard evaluation during probes landing phases and rover surface navigation.

Thematic section: Pianeti e satelliti

Tommaso Alberti

Affiliazione: INAF - Istituto di Astrofisica e Planetologia Spaziali

Contributi Proposti

Title: Interplanetary effects on planetary environments: Earth, Venus, and Mercury

Authors: Tommaso Alberti (INAF-IAPS); Anna Milillo (INAF-IAPS); Monica Laurenza (INAF-IAPS); Valeria Mangano (INAF-IAPS); Stefano Massetti (INAF-IAPS); Christina Plainaki (ASI); Alessandro Mura (INAF-IAPS); Elisabetta De Angelis (INAF-IAPS); Rosanna Rispoli (INAF-IAPS); Stavro Ivanovski (INAF-OATs); Stefano Orsini (INAF-IAPS)

Abstract: The interplanetary and planetary environments are characterized by several intrinsic and induced properties as magnetic fields, waves and instabilites, boundaries, and ionizing radiation components. These features usually evolve on timescales ranging from seconds up to years, mainly controlled by the solar activity. BepiColombo and Solar Orbiter flybys will offer an interesting opportunity to investigate the dynamical features of both magnetic fields and particle populations when passing from the interplanetary to the planetary environments, thus allowing us to properly characterize different regions of the interplanetary and planetary space. This contribution discusses some outstanding features of planetary environments (Earth, Venus, and Mercury) when they interact with the interplanetary medium by considering data coming from in-flight space missions as ACE, MESSENGER, and Venus Express. Moreover, a special attention will be devoted to BepiColombo flybys which will be helpful for deeper investigations.

Thematic section: Pianeti e satell

Nadia Balucani

Affiliazione: DCBB - Università degli Studi di Perugia

Contributi Proposti

Title: Formation of nitriles and other N-containing organic molecules in the upper atmosphere of Titan

Authors: D. Marchione; L. Mancini; N. Balucani; D. Skouteris; F. Ferlin; L. Vaccaro; G. Vanuzzo; P. Casavecchia; M. Rosi - DCBB, Università degli Studi di Perugia

Abstract: Titan, the massive moon of Saturn, is a planetary-scale laboratory for the study of prebiotic chemistry under conditions that resemble, in many aspects, those of primitive Earth. After the large amount of data provided by the Cassini-Huygens mission on the composition of the atmosphere of Titan, new data are provided by remote detection with ALMA. We now know the Titan has the richest atmospheric chemistry of the entire Solar System. Photochemical models that simulate the rich atmospheric chemistry of Titan require the characterization in laboratory experiments of the elementary reactions that dominate the chemical evolution of this complex medium. In our laboratory, we have performed a systematic investigation of reactive processes leading to imines or nitriles, that is, the molecular species that are alleged to be responsible for the formation of the N-rich organic polymers constituting the orange haze that surrounds the moon. In this contribution, new results on the reactions of nitrogen atoms and cyano radicals with common hydrocarbons and other N-containing organic molecules are presented. We have used a combined experimental and theoretical approach. In particular, the reactions involving cyanoacetylene, a molecular species detected on Titan, will be discussed. The Authors wish to thank the Italian Space Agency for co-funding the Life in Space project (ASI N. 2019-3-U.0)

Thematic section: Astrobiologia, Pianeti e satelliti, Planetologia sperimentale e di laboratorio

Anna Barbaro

Affiliazione: University of Pavia

Contributi Proposti

Title: Study of carbon phases in the Yamato 74123 and Kenna ureilites

Authors: Anna Barbaro 1; Oliver Christ 2; Mara Murri 1; Ludovic Ferrière 3; Lidia Pittarello 3; Cyrena A. Goodrich 4; Maria C. Domeneghetti 1; Anna M. Fioretti 5; Matteo Alvaro 1; Frank E. Brenker 6; Fabrizio Nestola 2,6; 1 Department of Earth and Environmental Sciences, University of Pavia, Pavia I-27100; 2 Department of Geosciences, University of Padova, Padova I-35131; 3 Natural History Museum Vienna, Department of Mineralogy and Petrography, Vienna 1010; 4 Lunar and Planetary Institute, USRA, Houston, Texas 77058; 5 CNR Institute of Geosciences and Earth Resources, Padova I-35131; 6 Geoscience Institute, Goethe-University Frankfurt, Frankfurt 60323;

Abstract: Ureilites are primitive achondrites, the second largest group of achondritic meteorites after the HED meteorites. They commonly contain significant amounts of interstitial carbon-rich material, which occur as diamond, graphite (and its polytypes), and hydrocarbons. We examined diamond and graphite in two ureilitic fragments of the Yamato 74123 and Kenna meteorites, using a multimethodological approach, including scanning electron microscopy, micro-Raman spectroscopy, and X-ray diffraction. The aim of this study is to shed light on the origin of ureilites and on the geological processes that have affected their parent body. The studied ureilite fragments show a mixture of nanodiamonds with stacking disorder, nanographite grains, and micro-diamonds. These type of association between micro/nano diamonds and graphite are consistent with those produced with experimental results from detonation experiments (e.g., Efremov 2018, 2019a, 2019b). Detonation experiments offer a close approximation of impacts events and shock processes. These results further confirm what was previously observed in Almahata Sitta and NWA 7983 (Nestola et al. submitted), in which it was proposed that ureilitic diamonds likely form due to shock through the conversion of precursor carbon compounds, rather than under high static pressure in a large planetary body (Nabiei et al. 2018). AB, MM, MCD, MA and FN have been funded by the PNRA 2018 to F. Nestola. AB, MM, MCD and MA have been funded by the MIUR FARE 2016 IMPACt project (R164WEJAHH) to M. Alvaro; CG is funded by the NASA EW program. References V. P. Efremov, E. I. Zakatilova, I. V Makalashova, N. V Shevchenko, J. Phys. Conf. Ser. 946, 1–8 (2018a). V. P. Efremov, E. I. Zakatilova, I. V Maklashova, N. V Shevchenko, Nanotechnologies Russ. 13, 11–17 (2018b). V. P. Efremov, E. I. Zakatilova, J. Phys. Conf. Ser. 1238, 1–6 (2019). F. Nabiei, et al., Nat. Commun. 9, 1–6 (2018). F. Nestola et al. Submitted (PNAS).

Thematic section: Meteore, meteoriti e polvere interplanetaria

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Title: LUNATIC: the crowdfunding project to implement with lunar samples a collection of meteorite thin sections

Authors: Anna Barbaro1; Matteo Alvaro 1; Giovanni Pratesi 2; Marco Morelli 3; Vanni Moggi Cecchi4; Daniela Faggi 3; Mara Murri 1; M. Chiara Domeneghetti 1; 1 Department of Earth and Environmental Sciences, University of Pavia; 2 Department of Earth Sciences, University of Florence; 3 Museum of Planetary

Sciences of Prato; 4 Museo di Storia Naturale - Sistema Museale di Ateneo, University of Florence;

Abstract: The Apollo 11 Moon landing was one of the most important events among the entire scientific community and even for the mankind. But what about lunar samples? The Apollo missions allowed sampling the Moon by collecting about 384 kg of lunar rocks in the surroundings of the landing site. Between 1970 and 1976, the Soviet Union successfully executed three robotic sample return missions (total weight of the samples 326 g) as part of the Cold War competition with the United States. Moreover, the Chinese probe Chang'e-5, scheduled for 2020, will collect and return samples from Mons Rümker is a large volcanic complex in Oceanus Procellarum. Nonetheless, there is also another way to sample the Moon, much less expensive and much less areal limited. This sampling is that offered by lunar meteorites, rocks that escaping from the Moon, travel in the space and then fall on Earth. Here we present the crowdfunding project “LUNATIC” that was selected by the crowdfunding platform of the University of Pavia (universitiamo.eu) in honor of the 50th anniversary of the Apollo 11 Moon landing. The aim of LUNATIC is to get funds for implementing with lunar samples a collection of meteorites thin sections which is in preparation thanks to the collaboration with the Museum of Natural History of the University of Florence and the Museum of Planetary Sciences of Prato. Once complete it will represent an important thin section reference collection available with educational purposes for the Italian universities in which Planetary Sciences are taught for promoting the study of meteorites and their parent bodies. The project funding may also allow young researchers to participate in meteorite research expeditions.
Acknowledgements The authors thank universitiamo.eu (The University Crowdfunding Platform by UNIPV) for the support of the crowdfunding campaign.

Thematic section: Meteore, meteoriti e polvere interplanetaria

Lorenzo Biasiotti

Affiliazione: Università degli Studi di Padova

Contributi Proposti

Title: Search and characterization of exoplanets within the habitable zone of M dwarfs found by TESS

Authors: Lorenzo, Biasiotti, Università degli Studi di Padova; Giampaolo, Piotto, Università degli Studi di Padova; Valerio, Nascimbeni, INAF

Abstract: The statistics of planetary systems discovered by the Kepler/K2 mission suggest that terrestrial-sized planets should be common around M-type main-sequence stars. Following the success of Kepler, NASA's Transit Exoplanet Survey Satellite (TESS) has been launched in 2018 to monitor a large sample of nearby and bright stars (typically 30-100x brighter than average Kepler targets) covering the entire sky during its 2-year nominal mission. According to Turbet et al. (2016), a significant number of them could have the ideal conditions to develop a planetary biosphere. In the near feature, M stars represent the best opportunity to find potentially habitable planets in the Sun neighbourhood. A new global tool, known as “General Circulation Model” (GCM; Yang et al. 2014) becomes essential to define the Habitable Zone (HZ), which is traditionally defined as the circumstellar region in which a terrestrial-mass planet with a N_2-CO_2-H_2_O atmosphere can sustain liquid water on its surface (Kasting et al. 1993; Kopparapu et al. 2013). I applied these 3-D GCMs and other 1-D climate models to the current list of TESS planetary candidates to identify those that potentially lie within the HZ. My results suggest that five candidate exoplanets (TOI-256b, TOI-715b, TOI-700c, TOI-176b, TOI-793b) are located within the HZ boundaries according to all models and should be regarded as high-priority targets for a follow-up survey, which I am currently planning. Two of them are also probably locked in synchronous rotation with respect to their host star due to tidal interactions. Moreover, seven additional TESS candidate exoplanets with an Earth-like radius (<~2 R_earth) are found nearby the HZ boundaries. Follow-up observations with radial velocity surveys are required to confirm the planetary nature of these candidates and to derive their masses, and therefore their bulk densities.

Thematic section: Pianeti e sistemi extrasolari

Pamela Cambianica

Affiliazione: INAF- Padova

Contributi Proposti

Title: Time Evolution of Dust in the Hapi Region of Comet 67P/Churyumov-Gerasimenko

Authors: P. Cambianica (1); M. Fulle (2); G. Cremonese (3); E. Simioni (3); G. Naletto (1, 4, 5); M. Massironi (6, 1); L. Penasa (1); A. Lucchetti (3); M. Pajola(3); I. Bertini (7); D. Bodewits (8); C. Ceccarelli (9); F. Ferri (1); S. Fornasier (10); E. Frattin (7); C. Güttler (11); P. J. Gutiérrez (12); H. U. Keller (13, 14); M. Küppers (15); F. La Forgia (7); M. Lazzarin (7); F. Marzari (4); S. Mottola (14); H. Sierks (11); I. Toth (16); C. Tubiana (11); J.-B. Vincent (14) (1) Center of Studies and Activities for Space (CISAS) "G. Colombo", University of Padova, via Venezia 15, 35131 Padova, Italy (2) INAf Astronomical Observatory of Trieste, via Tiepolo 11, 38121 Trieste, Italy (3) INAF Astronomical observatory of Padova, Vicolo dell'Osservatorio 5, 35122 Padova, Italy (4) Department of Physics and Astronomy "Galileo Galilei", University of Padova, Via Marzolo 8, 35131 Padova, Italy (5) CNR-IFN UOS Padova LUXOR, via Trasea 7, 35131 Padova, Italy (6) Department of Geosciences, University of Padova, Via Giovanni Gradenigo 6, 35131 Padova, Italy (7) Department of Physics and Astronomy "Galileo Galilei", University of Padova, Vicolo dell'Osservatorio 3, 35122 Padova, Italy (8) Physics Department, Allison Laboratory, Auburn University, Auburn AL 36849, USA (9) University Grenoble Alpes, CNRS, IPAG, F-38000 Grenoble, France (10) LESIA, Observatoire de Paris, PSL Research University, CNRS, Univ. Paris Diderot, Sorbonne Paris Cite', UPMC Univ. Paris 06, Sorbonne Universités, 5 place Jules Janssen, 92195 Meudon, France (11) Max Planck Institute for Solar System Research, Justusvon-Liebig-Weg 3, 37077, Göttingen, Germany (12) Instituto de Astrofísica de Andalucía (CSIS), c/Glorieta de la Astronomia s/n, 18008 Granada, Spain (13) Insitut für Geophysik und extraterrestrische Physik, Technische Universität Braunschweig, Mendelssohnstraße 3, 38106 Braunschweig, Germany (14) Deutches Zentrum für Luft- und Raumfahrt (DLR), Institüt für Planetenforschung, Rutherfordstraße 26, 12489 Berlin, Germany (15) Operations Department, European Space Astronomy Center/ESA, Camino bajo del Castillo S/N, 28692 Villanueva de la Canada (Madrid), Spain (16) Konkoly Observatory, PO Box 67, 1525 Budapest, Hungary

Abstract: To investigate the nucleus of comet 67P Churyumov-Gerasimenko, the Optical, Spectroscopic, and Infrared Remote Imaging System - OSIRIS (1) onboard the Rosetta spacecraft was designed. The observations revealed that the northern regions of the comet are fully covered by dust. On the contrary, equatorial regions look different. In these regions, dust deposits appeared to have been replaced by consolidated and coarse terrains (2). Due to the inclination of the axis of rotation, the comet experiences strong seasons, resulting in significant differences in insolation between the northern and southern hemispheres. This strong dichotomy is reflected in the morphology between the two hemispheres, and the dust cover in the northern regions can be the result of transport mechanisms of particles from the southern hemisphere during the southern summer (3). We developed a tool to quantify the seasonal erosion and deposit/accretion in the Hapi region. The tool is based on the monitoring of the time evolution of boulders height,

defined as the difference between the top of the boulders and the surrounding pebble deposit surface. This technique has led to measure the seasonal evolution of the deposit erosion/accretion of the Hapi region with a vertical accuracy of 0.2 m. Acknowledgments OSIRIS was built by a consortium of the Max-Planck- Institut für Sonnensystemforschung, in Göttingen, Germany, CISAS-University of Padova, Italy, the Laboratoire d'Astrophysique de Marseille, France, the Instituto de Astrofísica de Andalucia, CSIC, Granada, Spain, the Research and Scientific Support epartment of the European Space Agency, Noordwijk, The Netherlands, the Instituto Nacional de Tecnica Aeroespacial, Madrid, Spain, the Universidad Politechnica de Madrid, Spain, the Department of Physics and Astronomy of Uppsala University, Sweden, and the Institut für Datentechnik und Kommunikationsnetze der Technischen Universität Braunschweig, Germany. The support of the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB), and the ESA Technical Directorate is gratefully acknowledged. We thank the ESA teams at ESAC, ESOC and ESTEC for their work in support of the Rosetta mission.

Thematic section: Piccoli Corpi
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Fabrizio Campanale

Affiliazione: Dipartimento di Scienze della Terra, Università di Pisa, Italy; Center for Nanotechnology Innovation@NEST, Istituto Italiano di Tecnologia, Italy

Contributi Proposti

Title: Impact coesite: formation and survival

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Abstract: This is an overview of the results of our ongoing research (Folco et al., 2018; Campanale et al., 2019; Glass et al., 2019) aiming at better understanding of the formation and survival of impact coesite - a debated issue in impact cratering and shock metamorphism studies. Impact coesite occurs in the form of nanometre-sized grains with polysynthetic twinning on (010) grains, typically embedded in silica glass. Its presence in rocks that experienced shock conditions beyond the stability field is an intriguing and controversial issue. Models, widely accepted since its discovery in 1960 (Chao et al., 1960), predict that coesite forms during crystallization from highly densified silica melts (Stöffler and Langenhorst, 1994; Fazio et al., 2017) or from diaplectic glass (Stähle et al., 2018) during shock unloading, when the decompression path intersects the coesite stability field (pressure 3–10 GPa, temperature <3000 K). In contrast to these mechanisms, we show electron diffraction (ED) evidence of subsolidus direct quartz-to-coesite transformation in quartzose impactites from different geological contexts (i.e. Kamil Crater, Egypt, and Australasian tektite/μtektite strewn field), including a plausible mechanism for this polymorphic transformation. These results have implications on the reconstruction of the P-T-t paths experienced by target rocks and on the definition of impact scenarios. Furthermore, this work shows the potential of the emerging three-dimensional ED method for the structure characterization of materials available only as sub-micrometre-sized grains (Gemmi et al., 2019), thereby opening a new perspective in shock metamorphic studies and planetary science, given the typical micro-to-nanometre scale of shock metamorphic features and their defective nature. Interestingly, by using very mild illumination conditions, complete and high-resolution data can be collected on phases that normally deteriorate rapidly in high resolution TEM mode (such as high pressure SiO2 phases and nucleation seeds in amorphous areas). Likewise, the TEM-based phase/orientation mapping using precession-assisted crystal orientation mapping (PACOM) technique enables reliable data with a spatial resolution down to 2 nm when used with a field emission gun. Also, whilst yielding less precise orientation measurements when compared with Kikuchi lines in EBSD, spot diffraction patterns are less affected by the distortion induced by high dislocation densities (Viladot et al., 2013). Therefore, PACOM is particularly suited for investigating strongly plastically deformed materials like the shocked silica ejecta studied here. Campanale F. et al. (2019) Geochim. Cosmochim. Acta 264, 105-117. https://doi.org/10.1016/j.gca.2019.08.014 Chao E. C. T. et al. (1960) Science 132, 220–222. https://doi.org/10.1126/science.132.3421.220 Fazio A. et al. (2017)

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Thematic section: Meteore, meteoriti e polvere interplanetaria

Maria Teresa Capria

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: Comet Interceptor, the new ESA F-class mission

Authors: Maria Teresa Capria (1); Alessandra Rotundi (2); Vincenzo Della Corte (1); Vania Da Deppo (3); Ivano Bertini (2); Monica Lazzarin (4); Andrea Longobardo (1,2); Alessandra Migliorini (1); Claudio Pernechele (5); Vladimir Zakharov (2) (1) INAF-IAPS, Rome, Italy (2) Parthenope University, Naples, Italy (3) CNR, Institute for Photonics and Nanotecnologies, Padua, Italy (4) DFA, Padua University, Padua, Italy (5) Padua Observatory, Padua, Italy

Abstract: Comet Interceptor is the mission selected by ESA on June 2019 as its first F-class mission, and is also the first mission that will have as a primary target an encounter with a long-period comet, possibly a dynamically new one. A newly discovered interstellar object would also be considered as a target. The launch, in 2028, will be shared with the Ariel exoplanet telescope. All the nuclei explored so far belong to Jupiter-family or Halley-type dynamical classes, and are orbiting in the inner Solar System. Their surface can by no means be defined as being pristine, and surely most, if not all, of the geomorphological features and characteristics we have seen on them are due to the activity. A dynamically new comet is a long-period comet that has been displaced from the Oort cloud and is entering the inner Solar System for the first time. DNCs are a class of cometary nuclei never explored before. After the launch, Comet Interceptor will wait at the stable Lagrange point L2 for up to 2-3 years for the discovery of a suitable new comet, then will leave L2 to intercept the path of the comet close to the ecliptic plane. The mission has a multi-spacecraft architecture: after the departure from L2 the three small spacecrafts will separate and proceed towards their target. As for the onboard payload, Italy contributes to the Dust, Field and Plasma package (DFP) with the Dust Impact Sensor and Counter (DISC) and to Italy contribution to the all-sky multispectral and polarimetric imager EnVisS (Entire Visible Sky).

Thematic section: Piccoli Corpi

Cristian Carli

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: OLivine-Bearing ungrOuped achonDrItES: OL-BODIES

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Abstract: Sample return missions are at present one of the primary goals of Solar System exploration. Different missions addressing that goal are ongoing (e.g. Hayabusa 1 and 2; OSIRIS-REx). Nevertheless, a natural sampling of our Solar System bodies are meteorites that provide important information about their parent bodies, spanning from the most primitive, associated with the origin of our Solar System, to the most evolved ones. Among meteorites, those that have experienced a process of differentiation are achondrites, and they can span from primitive to highly differentiated. They are mainly composed of mafic minerals and feldspar. Within mafic minerals olivine is considered a paradox, as being a mineral forming the mantle of differentiated bodies, it would be expected to be present in a larger number of asteroids than it has been observed. We will present a project to investigate a set of ungrouped achondrites with variable amounts of olivine and other phases. Reflectance spectra obtained from the selected samples will allow us to associate them with their parent bodies family. Characterization by a multi-disciplinary approach of the other phases (e.g. pyroxene, graphite, spinel), when present, will help to constrain the genesis of the meteorites and the evolution of their parent bodies. We will show the preliminary results from the first samples studied, beginning with the Al Huwaysah 010 meteorite that is characterized by high abundance of olivine and augitic pyroxene, the spectral features document the mafic mineralogy, and the low visible-near-infrared spectral reflectance is in accordance with the reported presence of opaque phases like chromite, fine-grained graphite, and/or metals dispersed in the sample. The authors acknowledge financial contribution from the agreement ASI-INAF n.2018-16-HH.0

Thematic section: Meteore, meteoriti e polvere interplanetaria, Piccoli Corpi, Planetologia sperimentale e di laboratorio

Filippo Giacomo Carrozzo

Affiliazione: IAPS-INAF

Contributi Proposti

Title: TGO/NOMAD nadir observations of Mars during years 2018- 2019

Authors: Giancarlo Bellucci; Filippo Giacomo Carrozzo; Fabrizio Oliva ; Emiliano D'Aversa; Francesca Altieri; Ozgur Karatekin; Ann Carine Vandaele; José Juan López-Moreno; Manish Patel; Frank Daerden; Cédric Depiesse; Jason Mason; Bojan Ristic; Ian Thomas; Yannick Willame; Marilena Amoroso

Abstract: The NOMAD (Nadir and Occultation measurements for Mars Discovery) spectrometer suite onboard the joint ESA-Roscosmos ExoMars Trace Gas Orbiter mission is mapping the composition and distribution of Mars; atmospheric trace species in unprecedented detail. The instrument is a combination of three channels, covering a spectral range from the UV to the IR, and can perform solar occultation, nadir and limb observations. In this work we present an analysis of data acquired by the nadir channel of the Nadir and Occultation for MArs Discovery spectrometer, onboard the ExoMars Trace Gas Orbiter (TGO) spacecraft currently orbiting Mars. The data cover the period before-during and after the global dust storm event occurred in 2018 and 2019. We have developed some spectral indexes to quantify the dust loading of the atmosphere and the CO2/H2O ices presence. NOMAD is able to follow the development of global dust storm between latitudes -70° and 70°. It also observes the sublimation of meridional seasonal cap as predicted by the general circulation models. Acknowledgements: The NOMAD experiment is led by the Royal Belgian Institute for Space Aeronomy (IASB-BIRA), assisted by Co-PI teams from Spain (IAA-CSIC), Italy (INAF-IAPS), and the United Kingdom (Open University). This project acknowledges funding by the Belgian Science Policy Office (BELSPO), with the financial and contractual coordination by the ESA Prodex Office (PEA 4000103401, 4000121493), by Spanish MICINN through its Plan Nacional and by European funds under grant ESP2015-65064-C2-1-P (MINECO/FEDER), as well as by UK Space Agency through grants ST/R005761/1, ST/P001262/1, ST/R001405/1 and ST/R001405/1 and Italian Space Agency through grant 2018-2-HH.0.

Thematic section: Pianeti e satelliti

Mauro Ciarniello

Affiliazione: IAPS-INAF

Contributi Proposti

Title: Compositional gradients among Saturn's icy moons and rings

Authors: Mauro, Ciarniello, IAPS-INAF; Gianrico, Filacchione, IAPS-INAF; Andrea, Raponi, IAPS-INAF; Fabrizio, Capaccioni, IAPS-INAF; Emiliano D'Aversa, IAPS-INAF; Priscilla, Cerroni, IAPS-INAF; Christina, Plainaki, ASI;

Abstract: The Cassini mission ended in September 2017, after orbiting for almost thirteen years in the Saturn's system. Among the twelve experiments on-board the orbiter, the VIMS (Visible and Infrared Mapping Spectrometer) instrument [1], performed an extensive observation campaign of Saturn's rings and icy moons, providing a complete characterization of their spectrophotometric properties in the VIS-IR wavelength interval (0.35-5.1 μm). This huge dataset revealed surface compositions dominated by water ice, mixed with chromophores (e.g. tholins and iron oxides) and darkening compounds (e.g. carbonaceous materials, silicates, iron, and sulfides). However, the final nature of the non-icy contaminants is still debated [2,3,4,5,6]. Until now, spectral properties of selected targets, as the main rings (A, B and C) and the major icy moons (Tethys, Enceladus, Mimas, Rhea, and Dione) have been studied separately, using spectral indicators [4,7] and analytical and numerical radiative transfer models [2,4,8], to investigate the surface composition of these targets and provide quantitative characterization of contaminant abundances, their mixing modalities with water ice and regolith grain size. In this work, we integrate and harmonize the results of these previous studies. In particular, we refine the present spectral modeling of the icy moons, after the application of recently developed photometric models [9,10] to VIMS data, aimed at minimizing spectrophotometric effects induced by observation geometries and isolate the intrinsic albedo properties of the surface (bond albedo). A similar outcome has been previously produced for the main rings, by performing photometric modeling through Monte Carlo ray-tracing simulations [8,11]. The derived bond albedo is then modeled by means of Hapke's theory [12], using as input the optical properties of several compounds of interest (crystalline water ice, carbon, iron, amorphous and crystalline silicates, tholins, sulfides, iron oxides) and simulating different mixing modalities (areal, intimate, intra-particle). We obtain the best match for the VIS-IR spectral properties of the icy moons and rings with an intimate mixture of a darkening material (amorphous carbons or amorphous silicates) and water ice embedding tholin, in variable amounts. We will present the derived compositional gradients across the main rings and major moons and discuss how they are affected by the interaction of the target surface with the Saturn's environment (flux of charged particle from Saturn's magnetosphere, flux of icy grains from E-ring) and possible exogenous sources (meteoritic bombardment). References: [1] Brown, R. H., et al., 2004. Space Sci. Rev., 115 (1-4), 111–168. [2] Ciarniello, M., et al., 2011. Icarus 214, 541–555. [3] Clark, R. N., et al., 2012. Icarus 218, 831–860. [4] Filacchione, G., et al., 2012. Icarus 220 (2), 1064–1096. [5] Hendrix, A. R., et al., 2017. Icarus, Volume 300, p. 103-114. [6] Buratti, B. J., et al., 2019. Science 364, 6445, eaat2349. [7] Filacchione, G., et al. 2013. Astrophys. J. 766, 76–80 (2013). [8] Ciarniello, M., et al., 2019. Icarus 317, 242–265. [9] Filacchione, G., et al. 2018. Geophys. Res. Lett., 45:2184–2192. [10]

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Thematic section: Pianeti e satelliti

Riccardo Claudi

Affiliazione: INAF - Astronomical Observatory of Padova

Contributi Proposti

Title: Ozone in Super-Earths

Authors: Claudi, R., INAF-OAPD; Alei, E., INAF-OAPD, ETH Zurich Pawlowski, D., University of Michigan Squicciarini V., Università di Padova, dip. Fisica e Astronomia

Abstract: In order to characterize a planetary atmosphere and its potential habitability, it is necessary to look for particular absorption features in the detected spectrum. On Earth, some atmospheric species that result from biological activity exhibit noticeable spectral features: the main ones are O2, O3, CH4 and N2O in visible and infrared electromagnetic ranges. Considering only carbon-based life forms, one should expect some analog features in planetary spectra also: these are commonly known as biosignatures. Their detection is essential for the search of life in the universe. We developed a Python code whose aim is to study the photochemical production of ozone (from O2) depending on the incoming star radiation and the atmospheric composition. By changing stellar and planetary radii, planetary masses, distances, stellar temperatures, p-T profiles and molecular oxygen volume mixing ratios, it is possible to solve the ODE system for the Chapman ozone cycle, some N2-based reactions, and Br/Cl catalytic cycles retrieving the corresponding ozone abundance profile. We were thus able to model the ozone abundance for some currently known Super-Earths, supposing many different atmospheric combinations. This study allowed us to retrieve important information concerning the minimum ozone abundance that allows its spectral feature to be correctly interpreted as a biosignature on an observed atmosphere.

Thematic section: Astrobiologia, Pianeti e sistemi extrasolari

Maria Angela Corazzi

Affiliazione: University of Florence; INAF OAA

Contributi Proposti

Title: Thermal desorption process of formamide ice

Authors: Maria Angela Corazzi(1, 2); John Robert Brucato (2); Davide Fedele (2); Giovanni Poggiali (1, 2) (1)Department of Physics and Astronomy, University of Florence, via Sansone 1, 50019 Sesto Fiorentino, Italy (2)INAF-Astrophysical Observatory of Arcetri, L.go E. Fermi 5, 50125 Firenze, Italy

Abstract: Today thanks to the advent of large telescopes, an increasing number of gas phase complex molecules is observed in star forming regions, prestellar dense cores, circumstellar disks and winds [1, 2, 3]. Planets are formed in protoplanetary disks during the first millions of years of stellar evolution. Thus, it is important to understand if iCOMs (interstellar complex organic molecules) observed in gas phase, are already available in the solid phase adsorbed on the surface of dust and which fraction of them will end up in protoplanetary disks in newly formed planetesimal. Among these molecules formamide (HCONH2) can play a key role. Formamide is considered a plausible pathway in the synthesis of biomolecules under prebiotic conditions. It was initially detected in the gas phase in two high-mass star forming regions: Orion-KL and SgrB2 [4]. In the last years, it was also observed in two types of low-mass star formation environments: shocked regions by protostellar jets [5] and hot corinos [6]. Interesting, formamide was not revealed in protostars that do not contain hot corino [7, 8]. In these high temperatures regions, thermal desorption is responsible for sublimation of frozen mantles into the gas phase. In laboratory through Temperature Programmed Desorption analysis, we are studying the thermal desorption process of formamide from dust grains of various minerals. These studies will support the interpretation of formamide observations in star forming regions and hot corinos with the goal of understanding the role of grain surface in driving chemistry of iCOMs in space. [1] Beltrán, M. T. et al. 2009, The Astrophysical Journal Letters, Vol. 690 [2] Rivilla, V. M. et al. 2017, Astronomy & Astrophysics, Vol. 598 [3] Codella, C. et al. 2015, Mon. Not. R. Astron. Soc., Vol. 449 [4] Nummelin, A. et al. 1998, The Astrophysical Journal Supplement Series, Vol. 117 [5] Codella, C. et al. 2017, A&A;, Vol. 605 [6] Lòpez-Sepulcre, A. et al. 2015, Mon. Not. R. Astron. Soc., Vol. 449 [7] Sakai, N. et al. 2013, Chemical Reviews, Vol. 113 [8] Lòpez-Sepulcre, A. et al. 2019, Earth and Space Chemistry, Vol. 3

Thematic section: Astrobiologia

Gabriele Cremonese

Affiliazione: INAF-Padova

Contributi Proposti

Title: First interstellar comet, 2I/Borisov: TNG observations

Authors: G. Cremonese, P.Cambianica, M.T.Capria, M.Fulle, F.La Forgia, M.Lazzarin, A.Migliorini, G. Munaretto, W.Boschin

Abstract: On 30 August 2019 the amateur Borisov discovered a new comet; after few days it was clear from the characteristics of its orbit (eccentricity > 3 and high hyperbolic excess velocity) that the second interstellar object had been detected and the object received the name of I2/Borisov. It appears to be very different from 1I/'Oumuamua and can be considered as the first interstellar comet. According to the first observations the comet should have a nucleus with a radius of few km and a dust coma and tail due to the activity started in June 2019 (Jewitt et al., 2019). The first spectra showed a clear CN emission in the near-UV region and no other emissions have been detected, included the common cometary lines due to C2 (Fitzsimmons et al., 2019). At the beginning of October we have decided to ask for the Discretionary Director Time (DDT) to the TNG in order to monitor the comet. We have been awarded of the observation time during 1 night per week, on the November and December months to perform, low resolution spectroscopy and R images with Dolores. The required period includes the perihelion passage on 8 December. We will show the preliminary results from the spectra and the dust size distribution and production from the images, applying the Fulle et al (2010) dust model. The 2I dust tail is best fit by the dust environment measured by Rosetta in 67P. In particular, during November 2019, the dust loss rate was 35 kg/s, the dust ejection velocity of mm-sized particles was 3 m/s and Afrho was 0.6 m. The onset of the activity building-up the dust tail occurred at 4 au from the Sun, so that dust ejection is probably driven by water-ice sublimation. SIMBIO-SYS is the suite of three remote sensing instruments on board the ESA-JAXA mission BepiColombo, that will provide high resolution images (HRIC), the 3D (STC) and spectral (VIHI) global mapping of Mercury. The design of SIMBIO-SYS is enriched of new technologies that allowed to realize a really compact instrument, having a total mass of 14.5 kg. The Near Earth Commissioning has been successfully completed, but we have to wait for 7 years before getting the first data on Mercury. In the meantime we have to prepare the observing strategy, according to revised scientific objectives taking into account the MESSENGER observations, and the target list. The innovative design of SIMBIO-SYS make it small and light, but allowing good performances that may be challenging even for the exploration of other bodies. Recently we have started to think about having SIMBIO-SYS on board a spacecraft around the Moon, applying minor changes to the design it is possible to collect unprecedented data, as for instance searching for water on the polar regions. We will describe the present performances of the instrument and how they can be interesting even for the Moon.

Thematic section: Piccoli Corpi

Fabrizio De Marchi

Affiliazione: Università "La Sapienza" Roma

Contributi Proposti

Title: Observability of Ganymede’s gravity anomalies related to surface features by the 3GM experiment onboard European Space Agency (ESA) JUpiter ICy moons Explorer (JUICE) mission

Authors: Fabrizio De Marchi - Dip. di Ingegneria meccanica e aerospaziale, Univ. Roma "La Sapienza"; Gaetano Di Achille - INAF Università d'Abruzzo; Giuseppe Mitri - Scuola internazionale di scienze planetarie Univ. d'Annunzio; Paolo Cappuccio - Dip. di Ingegneria meccanica e aerospaziale, Univ. Roma "La Sapienza"; Ivan di Stefano - Dip. di Ingegneria meccanica e aerospaziale, Univ. Roma "La Sapienza"; Luciano Iess - Dip. di Ingegneria meccanica e aerospaziale, Univ. Roma "La Sapienza";

Abstract: The Geodesy and Geophysics of Jupiter and the Galilean Moons (3GM) experiment aboard the JUpiter ICy moons Explorer (JUICE) will estimate the gravity fields of Europa, Callisto and Ganymede. For Ganymede, a 9-months orbital phase is planned, divided in a 5-month elliptical phase and a 4-month circular orbit. This latter will allow to obtain the first orbital gravity data for Ganymede, enabling the estimation of Ganymede’s gravity field up to degree 30-40 of the spherical harmonics expansion. Moreover, the collected data will allow the identification of regional (hundreds of km) surface structures. Ganymede’s icy surface shell is characterized by the presence of dark and bright terrains: evidence of older, dirty ice, and younger, clean ice, respectively. In this work we investigate the possibility to detect gravity anomalies related to the surface distribution of bright and dark terrains using the 3GM data. To this aim, we simulate the expected gravity field as it would be reconstructed by JUICE by assuming: i) a range of reasonable density contrasts and thicknesses for the dark and bright terrains; ii) a set of models for the surface topographies based on Galileo probe images (e.g. Golombek, 1982; Parmentier et al., 1982; Squyres, 1981; Giese et al., 1998; Schenk et al., 2001); iii) a multi-layered internal structure model (Hemingway & Matsuyama, 2017) assuming isostatic compensation; iv) a conductive heat transfer model for the icy shell, the ocean and the sub-oceanic high-pressure icy layers (Mitri et al., 2010). Our results show that 3GM data may allow to discriminate and separate the gravitational contributions from the deep interior and the surface distribution of dark and bright terrains. Moreover, we show that the presence of a deep ocean below the ice shell could be inferred from a peculiar profile of the power spectrum of the measured gravity signal.

Thematic section: Pianeti e satelliti

Maria Cristina De Sanctis

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: Ma_Miss on Exo Mars 2020: ready to launch

Authors: M.C. De Sanctis (1), F. Altieri (1), E. Ammannito (2), S. De Angelis (1), M. Ferrari (1), S. Fonte (1), A. Frigeri (1), R. Mugnuolo (2), S. Pirrotta (2), and the Ma_MISS team. (1) Institute for Space Astrophysics and Planetology, IAPS-INAF, Rome, Italy (mariacristina.desanctis@inaf.it),(2) Italian Space Agency, ASI, Italy.

Abstract: Ma_MISS (Mars Multispectral Imager for Subsurface Studies) experiment is the Visible and Near Infrared miniaturized spectrometer in the drill system of the ExoMars 2020 rover (De Sanctis et al.,2017, Vago et al., 2017). The main goal of the Ma_MISS instrument is to study the Martian subsurface environment. Access to the Martian subsurface is crucial to constrain the nature, timing and duration of alteration and sedimentation processes on Mars, as well as habitability conditions. Subsurface deposits likely host and preserve water ice and hydrated materials diagnostic for understanding the water geochemical environment (both in the liquid and solid state) at the landing site. Ma_MISS will perform infrared spectral reflectance investigations in the 0.5-2.3 μm range to characterize the mineralogy of Martian subsurface at different depths (up to 2 m). Making use of the drill's movement the instrument slit can scan rings and column building up hyperspectral images of the borehole, with a spectral sampling of 20 nm and spatial resolution over of 120 μm. Results obtained in the lab on mineral/rock samples confirm that the Ma_MISS spectrometer has a spectral range, resolution and imaging capabilities suitable for the Mars subsurface characterization (De Sanctis et al., 2017, De Angelis, 2017). The spectra acquired with the Ma_MISS fine spatial resolution (120 μm) show minerals that are not recognizable at coarser resolution. Ma_MISS is the only instrument in the rover's Pasteur payload able to analyze subsurface material in its natural condition (in situ), prior to extracting samples for further analysis. After a successful calibration and testing campaign, the instrument has been integrated into the Drill and into the Exo Mars rover. In these last months, the integrated instrument has been subject to several tests in different conditions. The results are satisfactory and the instrument is ready to be launched. This work is supported by ASI: Accordo ASI INAF n. 2017-48-H.0 Vago et al., ASTROBIOLOGY, Volume 17, Numbers 6 and 7, 2017, 471-510. De sanctis et al., ASTROBIOLOGY, Volume 17, Numbers 6 and 7, 2017, 612–620. De Angelis et al. (2017): PSS, 144, DOI: 10.1016/j.pss.2017.06.005

Thematic section: Astrobiologia, Pianeti e satelliti, Strumentazione

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Title: Hydrated sodium chloride on Ceres from recent ascending salty fluids

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Abstract: Data returned by Dawn's mission found that Ceres appears to be

sculpted by the action of water(1,2), indicating the presence of substantial subsurface ice (3) and isolated surface ice exposures(4,5). Ahuna Mons and other domical mountains were interpreted as the expression of potential cryovolcanism(6,7). Similarly, cryovolcanism was suggested as a possible explanation of the sporadic observations of water emission from Ceres(8). The data also provided evidence of a global process of aqueous alteration (2), indicating the existence of an ocean in the past(1,2). However, it is not clear if part of this ocean is still present as a relic of the past and residual fluids are still circulating in its interior. The most promising site to verify the occurrence of present fluids at Ceres', is Cerealia Facula in Occator crater (9). The young facula exhibits minerals relatively rare in our solar system (10,11), whose formation requires the presence of liquid water in combination with hydrothermal activity. The last data acquired by Dawn permitted the identification of hydrous sodium chloride on Cerealia Facula (12). The newly identified chloride salts are concentrated on the top of the tholus, close to a system of radial fractures. The observed distribution coupled with the hydrous phase, suggests that chloride salts are the solid residue of deep brines that reached the surface only recently, or are still ascending. These salts are able to maintain warm the Ceres internal temperatures and to lower the eutectic of the brines, in which case ascending salty fluids may exist in Ceres today. 1. E. Ammannito et al. Distribution of phyllosilicates on Ceres, Science, 353, aaf4279 (2016). 2. M.C. De Sanctis et al. Ammoniated phyllosilicates with a likely outer Solar System origin on (1) Ceres, Nature, 528, 241–244 (2015). 3. T. H. Prettyman et al., Extensive water ice within Ceres' aqueously altered regolith: Evidence from nuclear spectroscopy, Science, 355, 55-59, DOI: 10.1126/science.aah6765 (2017). 4. J.-Ph., Combe et al. Detection of local H2O exposed at the surface of Ceres, Science, 353, 10.1126/science.aaf3010 (2016) 5. Raponi, et al. Variations in the amount of water ice on Ceres' surface suggest a seasonal water cycle , Sci. Adv., 4, eaao3757 (2018). 6. M.M. Sori, et al. Cryovolcanic rates on Ceres revealed by topography. Nat Astron 2, 946–950 (2018) 7. O. Ruesch, et al. Cryovolcanism on Ceres, Science, 353, 1005. (2016) 8. M., Küppers, et al. Localized sources of water vapour on the dwarf planet (1)Ceres. Nature, 505(7484), 525– 527 (2014). 9. J.E.C. Scully et al. Synthesis of the special issue: The formation and evolution of Ceres' Occator crater, Icarus, 320, 213-225 (2019) 10. M.C. De Sanctis et al. Bright carbonate deposits as evidence of aqueous alteration on (1) Ceres, Nature, 536, 54–57 (2016) 11. Raponi et al. Mineralogy of Occator crater on Ceres and insight into its evolution from the properties of carbonates, phyllosilicates, and chlorides, Icarus, 320, 83-96 (2019) 12. De Sanctis et al., Fresh emplacement of hydrated sodium chloride on Ceres from ascending salty fluids, Nature Astronomy, 2020.

Thematic section: Astrobiologia, Piccoli Corpi, Strumentazione

Silvano Desidera

Affiliazione: INAF-OAPD

Contributi Proposti

Title: Young planets at close separations

Authors: Silvano Desidera, INAF-OAPD; Serena Benatti, INAF-OAPA, & GAPS Team

Abstract: The origin of the observed diversity of the exoplanetary systems architectures can be investigated thanks to a statistically significant sample of planets around young stars when the early stages of planet formation and evolution can be observed. Some results in recent literature suggest an higher fraction of hot Jupiters around very young stars with respect to the old ones, but only a handful of systems is known so far, in most cases not confirmed by independent investigations. A crucial contribution to the young planets detections will be provided by the NASA Transiting Exoplanet Survey Satellite (TESS), which is surveying the 85% of the sky searching for short period transiting exoplanets. In this talk, I will present two radial velocity surveys focused on the detection, validation and characterisation of close-in planets at young ages. The first one is performed in framework of the GAPS (Global Architecture of Planetary Systems) project using TNG instrumentation, the second one is ongoing on souther emisphere using ESO instrumentation. We present the preliminary results of these projects, including retraction and confirmation of young planets published in the literature, new detections and the confirmation of the first young planet detected by TESS, which is orbiting the main component of the binary system DS Tucanae, a 40 Myr G6 star, in 8.14 days. Our analysis suggests that this planet could be considered inflated: the planetary radius is 5.6 R_Earth, while the expected mass is lower than 20 M_Earth. This condition makes DS Tuc A b particularly suitable for atmospheric characterisation through transmission spectroscopy and, more in general, the properties of the system allow us to use different investigation methodologies to study its evolution.

Thematic section: Pianeti e sistemi extrasolari

Title: The frequency of planets in binary systems

Authors: Silvano Desidera, INAF-OAPD; Mariangela Bonavita, Univ. Edinburgh., UK

Abstract: The frequency of planets in binaries is an important issue in the field of extrasolar planets studies, because of its relevance in the estimate of the global planet population of our Galaxy and the clues it can give to our understanding of planet formation and evolution. Here we present an update of the frequencies of giant planets around single stars and binaries at various separations, exploting Gaia results and recent literature results. We confirm and better quantify the paucity of planets around components of close binaries while components of wide binaries have similar frequencies of planets with respect to single stars.

Thematic section: Pianeti e sistemi extrasolari

Barbara De Toffoli

Affiliazione: Università degli studi di Padova

Contributi Proposti

Title: Fluid circulation in the upper Martian crust, Arcadia Planitia (Mars)

Authors: Barbara De Toffoli, Università degli studi di Padova; Andrea Bistacchi, Università degli studi di Milano Bicocca; Francesco Mazzarini, INGV, Pisa; Matteo Massironi, Università degli studi di Padova

Abstract: We previously reported on evidence for fluid circulation in the upper crust of Mars, which could create environments favorable for life and its development. We investigated the nature of the thumbprint terrains covering part of Arcadia planitia in the Martian northern hemisphere and we were able to ascribe these morphologies to sedimentary volcanism involving a feeding network of fractures reaching the base of the clathrate-rich cryosphere, where lies the contact with the theoretical underlying hydrosphere. Based on this evidence we are now pursuing a further study to identify the possible trigger to the sediment/water emissions. Accordingly, we enhanced the dataset by enlarging the study area starting from the sample region used in the previous work and then analyzed the spatial distributions of vents and fractures among the new thumbprint terrains population to infer subsurface extension of these fracture networks. We detected a maximum extension of the fracture networks consistent with the ones previously published and identified a formerly unknown shallow rheological discontinuity just a few kilometers underneath the surface. Thanks to this new data load we are producing a more precise picture of the Martian subsurface that will allow us to produce a model displaying how the Martian crust would locally behave under the diverse drives, which would be affected by rheological differences and ice content. This work is part of a project supported by the European Union's Horizon 2020 research and innovation program under grant agreement N°776276 (PLANMAP).

Thematic section: Pianeti e satelliti

Gaetano Di Achille

Affiliazione: INAF - Osservatorio Astronomico d'Abruzzo

Contributi Proposti

Title: Mercury’s gravity field and geology after MESSENGER: the Mercury Orbiter Radio-Science Experiment (MORE) perspective

Authors: Gaetano, Di Achille, INAF - Astronomical Observatory of Abruzzo; Fabrizio, De Marchi, Sapienza University of Rome, Italy; Ivan, Di Stefano, Sapienza University of Rome; Antonio, Genova, Sapienza University of Rome; Luciano, Iess, Sapienza University of Rome.

Abstract: The NASA MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission returned a wealth of data for the geophysical characterization of Mercury and its internal structure. The Mercury Laser Altimeter (MLA) and the Radio Science (RS) system were fundamental for the determination of the planet topography, gravitational field, rotation, and tides (e.g. Genova et al., 2019). Particularly, the radio science data combined with the topography allowed to derive global gravity field maps. Because of the high eccentricity of MESSENGER’s orbit, the gravity field was estimated up to the degree and order 80 of spherical harmonic expansion for the regions with latitude > 67 N. This has been possible thanks to the lower altitudes reached during the last phase of the mission (up to 25 km). For the same reasons the resolution in the southern regions is much lower, rarely exceeding degree 12. A comparison between maps of gravity anomalies, topography, and surface features shows that the gravity field is overall well correlated with topography. Large positive gravity anomalies are associated with major impact basins (e.g. Caloris and Sobkou) while negative anomalies correlate with smaller impact craters (e.g. Rachmaninoff crater), especially in the northern polar regions. Another large positive anomaly is associated with the Northern Rise (a regional uplift located toward the northern pole). The origin of the latter geologic feature (and the associated gravity anomaly) is still debated and it remains one of the main open question in Mercury’s geophysics. The northern polar regions, characterized by the emplacement of young smooth volcanic units, are well correlated with negative gravity values. Finally, while the regions at latitudes > 15 S have a good coverage of gravity data, it is difficult to make specific assumptions on the gravity field associated to morphotectonic structures located in the southern hemisphere. The ESA BepiColombo mission has been successfully launched in October 2018 and is currently cruising toward Mercury with another radio science experiment onboard: the Mercury Orbiter Radio-Science Experiment (MORE). This experiment will provide a uniform coverage of the hermean gravity field, filling the gap inherent in the MESSENGER determinations. Indeed, the nearly circular orbit of BepiColombo will allow to reach the degree 50 of spherical harmonic expansion in the southern hemisphere of Mercury, shedding new lights on the geophysics of this region of the planet. Among the other interesting features located toward the southern pole, the Enterprise Rupes, dislocating the northwestern rim of the Rembrandt impact basin, is a regional, about 1000-km-long, tectonic feature showing up to 2-3 km elevation drops across. The emplacement of the latter contractional feature might have resulted into a local significant thickening of the lithosphere, which is one of the most interesting targets for the geophysics of the southern hemisphere. Here, using MESSENGER

topography, the Mission Analysis, Operations, and Navigation Toolkit Environment (MONTE) for BepiColombo mission simulation, and a series of geological assumptions, we derive the MORE expected results in terms of gravitational field maps. Our results confirm that MORE will improve the resolution and accuracy of the Mercury's gravity field, especially for the southern hemisphere, allowing the correlation between gravitational anomalies and regional morphotectonic structures, including the Enterprise Rupes, whose putative gravity anomaly should be detectable by BepiColombo.

Thematic section: Pianeti e satelliti

Alessandra Di Cecco

Affiliazione: Agenzia Spaziale Italiana

Contributi Proposti

Title: Evaluating the astronomical seeing of the Matera Space Geodesy Center

Authors: Alessandra Di Cecco (ASI HQ, viale del Politecnico snc 00133 Roma; ASI CGS Contrada Terlecchia 75100 Matera); Cosimo Marzo (ASI CGS, Contrada Terlecchia 75100 Matera); Domenico Iacovone (E-Geos, Contrada Terlecchia 75100 Matera); Ettore Perozzi (ASI HQ viale del Politecnico snc 00133 Roma; ASI CGS Contrada Terlecchia 75100 Matera); Giuseppe Bianco (ASI CGS, Contrada Terlecchia 75100 Matera)

Abstract: The Matera Space Geodesy Center (CGS) is a facility of the Italian Space Agency (ASI), with a long-standing tradition of optical observations, focused on lunar and satellite laser-ranging. Since 2016, CGS has been involved in space debris observations supporting the UE Space Surveillance and Tracking (SST) Project and is likely to host temporarly the ESA Fly-Eye telescope, devoted to NEO detection whitin the framework of the Space Situational Awareness (SSA) Programm. Because of this, the quality of the sky at CGS has been constatly monitored over the years, thus providing a large dataset of in-situ seeing values. In particular, we are analysing a data campaign that spans almost 600 nights, having acquired more than 110,000 seeing measurements. We present the analysis of this dataset, by evaluating a robust statistical estimate of the Matera CGS seeing. The results are discussed in relation of different obvervational activities.

Thematic section: Dinamica dei corpi celesti naturali e artificiali, Piccoli Corpi, Strumentazione

Alessio Di Iorio

Affiliazione: Alma Sistemi SRL

Contributi Proposti

Title: InTime project developments: towards and in-situ dating instrument

Authors: A. Di Iorio; L. Marinangeli; F. Coccaro; I. Di Pietro; N. Schetakis, M. Pondrelli, V. Pascucci

Abstract: As the ongoing robotic exploration has made some tantalizing discoveries, the next major step [1] should be retrieving samples from Mars in order to be analysed in detail in terrestrial laboratories. However, an in-situ dating of rock and sediment samples would allow quick tests to select meaningful return samples enabling a cost-effective mission's approach. To do this, there is a need to identify a scientific rationale and to develop new instruments. We believe that luminescence-based techniques hold the potential to gain interesting insight in modern surfaces processes. On Mars, the chronology has a very poor temporal resolution [2,3,4]; therefore, deposits reflecting recent short-term climate changes are difficult to be correlated and dated since there are few or none large craters at their individual stratigraphic scale. Consequently, luminescence may become the key to understand the evolution of the most recent Mars geological processes and, eventually, to narrow uncertainties in ages. The MEPAG report lists the determination of the absolute age as high priority measurements of the surface and accessible crustal layers [1]. In order to achieve the best possible scientific outcome, absolute dating should retrieve ages from a stratigraphic succession of rocks/sediments, constraining and quantifying the processes through which they formed and dating the bounding surfaces. This would allow: i) to reconstruct the local geological evolution of the study area and ii) provide a tool for lateral correlation between deposits that reflect the same recent geological processes and/or climatic events. The latter point implies that this information is extended over a much larger area. This approach would increase exponentially the benefits in terms of scientific results of luminescence measurements. The laboratory working prototype has been developed and shows promising performances with K-feldspar samples. Furthermore, a new prototype designed to match the SAMPLE PREPARATION AND DISTRIBUTION SYSTEM's (SPDS) interface is described and the project is now moving towards analogue test campaign that will address both the instrument performances and the luminescence properties of Martian-like samples. The instrument is a miniaturized, portable tool for in-situ examination and assessment based on the luminescence method. It is a standard technique with many successful applications [2,3,4]. New techniques and procedure are now available and the feasibility of a luminescence-based approach to dating of soil simulants and sediments analogues to Martian deposits has been showed [5,6]. The one and only direct mineralogical analysis -performed by Curiosity at Gale crater- showed a high percentage of K-rich deposits in an area where satellite images did not previously display significant presence of K-feldspar. This implies and highlights even more the need of a deeper geological reconstruction to better constrain the source area of recent deposits to be dated, exponentially increasing the scientific results of IN-TIME and the overall knowledge of Mars surface. [1] R. Johnson, 2018 MEPAG [2] Hartmann, W. K., and G. Neukum, 2001, Space Sci. Rev.,96, pp. 165–194 [3] Ivanov, B. A., 2001, Space

Sci. Rev., 96, 87–104 [4] Doran, Peter T., et al., 2004, , Icarus, 147, 433 – 443 [5] Detschel, M.J., et al., 2009. Journal of Luminescence [6] Jain, M., et al, 2007. NIMPS

Thematic section: Planetologia sperimentale e di laboratorio, Strumentazione

Linda Dimare

Affiliazione: Space Dynamics Services s.r.l.

Contributi Proposti

Title: In-orbit fragmentation characterization and parent bodies identification by means of orbital distances

Authors: Linda Dimare, Space Dynamics Services s.r.l.; Stefano Cicalò, Space Dynamics Services s.r.l.; Alessandro Rossi, IFAC-CNR; Elisa Maria Alessi, IFAC-CNR; Givanni Battista Valsecchi, IFAC-CNR and INAF-IAPS.

Abstract: Once a potential fragmentation event has been detected by the Space Surveillance Network of sensors, it is necessary to confirm and characterize it. Typically, the network is observing a number of fragments crossing their field of view and a fundamental step for the analysts is the identification of the parent body (or bodies) of the observed fragments. We propose a new approach to correlate fragments with known orbits to parent objects, using the definition of a suitable orbital similarity function in the space of orbital elements. The method can be used both if a short time has passed from the instant of breakup and if a long time has already elapsed. Orbital similarity functions defined in the space of Keplerian coordinates are commonly used to find the origin of meteor streams and to investigate the common origin of two or more asteroids. The scientific literature on this subject is rich. Historically, the first of this kind of functions was the D-criterion introduced by Southworth and Hawkins in 1963 (Smithsonian Contributions to Astrophysics, Vol. 7) with the objective to identify meteor streams. Afterwards, the same D-criterion was applied for the identification of asteroid families, using proper-elements (see for example the work by Lindblad in Asteroids, Comets, Meteors 1991). Other similar criteria were introduced for meteor streams identification respectively by Drummond (Icarus, Vol. 45, 1981) and Jopek (Icarus, Vol. 106, 1993). The above mentioned three criteria were considered to be used to study clouds of Earth orbiting objects, with the objective to identify their origin. In this context, we concentrated on the identification of the breakup time and of the parent body (or bodies) of a fragmentation detected by the Space Surveillance Network of sensors, given that the orbits of some of the fragments are known. The idea is that the fragmentation should have happened at the time corresponding to the minimum of the mutual orbital distances of the known fragments, which is our candidate breakup time. In the same way, to find the parent among the known satellite orbits, we search the catalog for the minimum of the distance of any satellite from the fragments at the time of breakup. In addition to the D-criteria, we considered also the Minimal Orbital Intersection Distance (MOID) and the nodal distance to measure the similarity between two orbits. The MOID gives the absolute minimum of the distance between two osculating ellipses, while the nodal distance is their distance along the intersection of the orbital planes. For the computation of the MOID we used the algorithm by Gronchi (Celestial Mechanics and Dynamical Astronomy, Vol. 93, 2005). We implemented five different algorithms, differing only in the orbital similarity function, and tested them on simulated and real fragmentation clouds. The performance of the different algorithms was evaluated and the benefits and issues related to each one were examined. The distance criterion by Southworth and Hawkins and the one proposed by Jopek proved to be the most suitable ones for our purposes. Indeed,

contrary to the other functions, they allowed us to find both the right breakup time and the right parent body in all the tested cases. Nonetheless, the availability of other criteria improves our capability to handle and characterize different types of events. Part of this work was performed under a contract with the Italian Space Agency (ASI).

Thematic section: Dinamica dei corpi celesti naturali e artificiali

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Title: Use of the semilinear method to predict the impact corridor on ground

Authors: Linda Dimare, Space Dynamics Services s.r.l.; Alessio Del Vigna, Space Dynamics Services s.r.l.; Davide Bracali Cioci, Space Dynamics Services s.r.l.; Fabrizio Bernardi, Space Dynamics Services s.r.l.

Abstract: We propose an adaptation of the semilinear algorithm for the prediction of the impact corridor on ground of an Earth-impacting asteroid. The semilinear algorithm was first introduced by Milani in 1999 (Icarus, Vol. 137) for the recovery of lost asteroids. The method is general and we applied it to the case of an impact prediction. Our algorithm starts from a least squares orbit for which an impact on Earth is possible at some epoch in the future, thus with a positive impact probability, as provided by the main impact monitoring systems CLOMON-2 and Sentry, developed respectively by the University of Pisa and NASA-JPL. Since the impact probability is greater than zero, there exists a connected set of orbits compatible with the observations and leading to an impact at a certain date, a so called virtual impactor. The impact region on the Earth's surface is obtained through the propagation of the intersection of the orbital uncertainty region with the region of orbits leading to the impact. The target impact surface can be defined at different altitudes on ground. The union of the boundaries of the impact regions at different altitudes provides the impact corridor, a curved tube inside which the asteroid falling trajectory will lie with a certain likelihood. We can associate an impact probability with each impact region, giving a measure of the confidence that the real asteroid trajectory will actually be inside the corridor. Our adaptation of the semilinear algorithm to the impact prediction permits to compute the boundary of the impact region on ground with a comparatively smaller number of propagations with respect to Monte Carlo approaches. Indeed, it samples a 1-dimensional curve instead of a region in the 6-dimensional orbital elements space. We have implemented the algorithm within the OrbFit 5.0 (http://adams.dm.unipi.it/orbfit/) software used by the online information systems NEODyS and AstDyS. This code is not distributed. The algorithm was tested using the real observations of the past impacted objects 2008 TC3 , 2014 AA, 2018 LA and 2019 MO. It was applied also to the asteroid Apophis, but using only the observations available on 27 December 2004, before that pre-discovery observations were found. This situation corresponds to a possibility of impact in 2029 with a probability of about 2.4%, as computed by the last version of OrbFit, version 5.0. For 2008 TC3 and Apophis the predicted impact regions on ground are in good agreement with the Monte Carlo predictions by the JPL-NASA system. The semilinear prediction is especially good for 2008 TC3, for which the predicted thin impact corridor along the ground track passes through the region of recovered meteorites. For 2018 LA and 2019 MO, the predicted semilinear impact regions contain the locations of the observed fireballs, even if very few observations are available. Only the case of 2014 AA reveals some limitations of the method. In this case the non-linearity causes the propagated uncertainty ellipse to twist on itself, so that the drawn boundary of the impact region does not encompass the inner points, and it provides incomplete and misleading information. A part from the 2014 AA exception, the implemented algorithm revealed to be useful for imminent impactors, for which the software takes between 30 and 50 seconds of runtime to compute a single impact region,

with fixed altitude and sigma, without the need of parallelisation.

Thematic section: Piccoli Corpi

Elisabetta Dotto

Affiliazione: INAF-Osservatorio Astronomico di Roma

Contributi Proposti

Title: The EU H2020 programme NEOROCKS

Authors: E. Dotto(INAF-OAR); E. Perozzi(ASI); on behalf of the NEOROCKS team* *The NEOROCKS team is composed by: Istituto Nazionale di Astrofisica (I) – coordinating partner; Agenzia Spaziale Italiana (I); University of Padova (I); LESIA – Observatoire de Paris (F); Observatoire de la Cote d'Azur (F); University of Edimburgh (UK); Astronomicky Ustav AV CR (CZ); Instituto de Astrofisica de Canarias (S); Space Dynamics Services s.r.l. (I); DEIMOS Space s.l.u. (S); DEIMOS Space s.r.l. (RO); DEIMOS Castilla La Mancha sl (S); NEOSPACE Spolka z Ograniczona Odpowiedzialnoscia (PL); Resolvo s.r.l. (I)

Abstract: In the last years the research about Near Earth Objects (NEOs) has been a major topic in planetary science, also in view of the potential hazard some of them pose to human beings and, more in general, to life on our planet. Moreover, the physical characterization of NEOs allows us to put constraints on the material in the protoplanetary nebula at different solar distances, and can give us insights into the early processes that governed the formation and the evolution of planets, including the delivery of water and organics to Earth. The "NEOROCKS - The NEO Rapid Observation, Characterization and Key Simulations" Collaborative Research Project has been recently approved to address the topic c) "Improvement of our knowledge of the physical characteristics of the NEO population" of the call SU-SPACE-23-SEC-2019 from the Horizon 2020 - Work Programme 2018-2020 Leadership in Enabling and Industrial Technologies – Space. The aims of NEOROCKS are: • to develop and validate advanced mathematical methods and innovative algorithms for NEO orbit determination and impact monitoring; • to organize follow-up astronomical observations of NEOs efficiently, in order to obtain high-quality data to derive their physical properties, giving priority to timely addressing potentially hazardous objects; • to improve dramatically statistical analysis, modelling and computer simulations aimed to understand the physical nature of NEOs, focussing on small size objects, which are of uttermost importance for designing effective mitigation measures in space and on the ground; • to ensure maximum visibility and dissemination of the data beyond the timeline of the project, by hosting it in an existing astronomical data center facility; • to foster European and international cooperation on NEO physical characterization, providing scenarios and roadmaps with the potential to scale-up at a global level the experience gained during the project; • to apply and guarantee continuity of educational and public outreach activities needed to improve significantly public understanding and perception of the asteroid hazard, counteracting the spreading of fake news and unjustified alarms. Programme team and strategy will be presented and discussed.

Thematic section: Piccoli Corpi

Title: LICIACube: the Light Italian Cubesat for Imaging of Asteroids

Authors: E. Dotto1, V. Della Corte2, M. Lavagna3, P. Tortora4, S. Pirrotta5, M. Amoroso5, V. Di Tana6, E. Mazzotta Epifani1, A. Rossi7, J.R. Brucato10, S.L. Ivanovski8, G. Cremonese9, A. Lucchetti9, A. Capannolo3, M. Zannoni4, I. Gai4,

F. Miglioretti6, S. Simonetti6 1.INAF-Osservatorio Astronomico di Roma, 2. INAF-Istituto di Astrofisica e Planetologia Spaziali, Roma 3.Politecnico di Milano 4.Università di Bologna 5.Agenzia Spaziale Italiana, Roma 6.Argotec, Torino 7.IFAC-CNR, Firenze 8.INAF-Osservatorio Astronomico di Trieste 9.INAF-Osservatorio Astronomico di Padova 10.INAF-Osservatorio Astrofisico di Arcetri, Firenze

Abstract: “LICIACube – the Light Italian Cubesat for Imaging of Asteroids” is a space mission of the Italian Space Agency, based on a 6U cubesat that will take part in the NASA DART mission, with the aim to enhance the information gained from the main probe impact on the secondary member of the (65803) Didymos binary asteroid system and to allow dedicated scientific investigations. The cubesat will be launched in mid 2021 and hosted by the DART probe as piggyback during the 16 months of interplanetary cruise, then released five days before the impact so that several unique images of the effects on the asteroid can be collected and transmitted towards Earth. LICIACube is an ASI project, whose design, integration and test has been assigned to the aerospace company Argotec. The scientific team is led by National Institute of Astrophysics (OAR, IAPS, OAA, OAPd, OATs) with the support of IFAC-CNR, and it is enriched by University of Bologna team, for orbit determination and satellite navigation, and Polytechnic of Milan, for mission analysis and optimization. LICIACube will be the first Italian autonomous mission in deep space: the whole project and its present status-of-the-art will be presented and discussed together with the in situ observing strategy and the expected performances.

Thematic section: Piccoli Corpi

Mayssa El Yazidi

Affiliazione: Università degli studi di Padova

Contributi Proposti

Title: Structural analysis of grabens, Pit chains and rifting in Noctis Labyrinthus (Mars) based on Data derived from HRSC and MOLA

Authors: Mayssa El Yazidi, Riccardo Pozzobon, Luca Penasa,Stefano Debei, Matteo Massironi.

Abstract: Noctis Labyrinthus is a region in Mars, located at the western part of Valles Marineris, where the topography shows a complex interconnected canyons and branched network of faults and graben. With the current work, which is part of PLANMAP project, a large fraction of faults and grabens was studied in Noctis Labyrinthus for length and displacement greater than 800m and 40m respectively, with the aim to understand the mechanism of formation and evolution of this area. By means of orthoimages derived from HRSC (High Resolution Stereo Camera on board Mars Express) bearing a resolution of 12.5 m/pixel and DEM from MOLA (Mars Orbiter Laser Altimeter on board Mars Global Surveyor) with resolution of ~ 460 m/pixel, we mapped faults at different scales and we analyzed their relationship with pit chains by using Length-Displacement and a cumulative Length-Frequency diagrams. Our results show two main directions of fault and grabens population, which are ENE-WSW, with a cross-cutting relationship of one direction over the other. The distribution of the maximum displacement vs. length, shows a large scattering of values, implies the relation expressed by D=Ɣ.L (Cowie and Scholz, 1992; Clark and Cox, 1996).The negative power law for the cumulative frequency plot seems to support the presence of homogenous basalts , while the D/L diagram shows a large scatter of values that could be interpreted by the growth of faults by segment linkage. However, we infer that a Volcano-tectonic activity represented by a regional stress field (Early bidirectional extension) and a magmatic activity are likely the main driving processes for the formation, evolution and the frequent surface interconnection between grabens and pit chains.
Keywords: Noctis Labyrinthus, extension, magma chamber, pit chains.

Thematic section: Pianeti e satelliti, Pianeti e sistemi extrasolari

Francesca Esposito

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: The characterization of Martian atmospheric dust with the MicroMED sensor on-board the ExoMars 2020 Surface Platform

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Abstract: The ESA-Roscosmos ExoMars program consists of two space missions: the first one has been successfully launched in 2016 and included the Trace Gas Orbiter (TGO) and the Entry Descent and Landing Demonstrator Module Schiaparelli. This last unfortunately crashed on Mars during the descent phase, while TGO entered successfully in Martian orbit. The second mission is planned to be launched in July 2020 and includes a European rover and a Russian led Surface Platform. The main scientific objectives of ExoMars program are the search for signs of extant or extinct life, the investigation of water and geochemical environment and of Martian atmospheric trace gases and their sources. The specific goals of the Surface Platform are: 1) Context imaging, 2) Long-term climate monitoring and atmospheric investigations, 3) Atmosphere/surface volatile exchange, 4) Studies of subsurface water distribution at the landing site, 5) Monitoring of the radiation environment, 6) Geophysical investigations of Mars' internal structure. The Dust Complex, is one of the instruments on the Surface Platform devoted to the atmospheric investigations. It is a suite of sensors for the monitoring of dust dynamics close to the surface. It consists of the following sensors: two impact detectors, MicroMED, Mast with electrostatic detector, conductivity sensor. MicroMED is an optical particle counter developed by INAF Naples in collaboration with Politecnico of Milan, the Instituto Nacional de Técnica Aeroespacial (INTA) in Madrid and the Russian Space Research Institute (IKI) in Moscow. MicroMED is an Aerosol Particle Counter. It has been designed to measure, for the first time directly and in situ, the size distribution and number density vs size of dust particles suspended into the atmosphere of Mars, close to the surface. This information represents a key input in different areas of interest: 1) to improve knowledge on airborne mineral dust in terms of physical properties and lifting mechanism, 2) to improve climate models and 3) to address potential hazards for future landed Martian exploration missions. MicroMED is a miniaturized/optimized version of the MEDUSA instrument, which was selected by ESA for the ExoMars Humboldt Payload, now cancelled. MicroMED has a mass of 509 g (as measured) and an average power consumption of 5 W. MicroMED is a lighter and simplified version of the instrument MEDUSA, previously selected by ESA for being accommodated on the Humboldt payload of the ExoMars mission.

MicroMED is able to measure the size of single dust grains entering into the instrument from 0.4 to 20 μm radius, giving as products the dust size distribution and abundance. It analyses light scattered from single dust particles. A pump is used to sample the Martian atmosphere, generating a flux of gas and dust across the instrument trough the inlet. When the dust grains reach the Optical Sensor, they cross a collimated IR laser beam emitted by a laser diode. The light scattered by the grains is detected by a photodiode, which is amplified by the Central Electronics Unit. The detected signal is related to the size of sampled dust particle. MicroMED Proto-Flight Model has been delivered to TAS and is now going to be integrated on the Surface Platform.

Thematic section: Strumentazione

Francesco Ferlin

Affiliazione: Universita degli Studi di Perugia

Contributi Proposti

Title: Experimental Solubility Determination of Organic Compounds in Simulated Titan's Methane Lakes

Authors: Francesco Ferlin; Luigi Vaccaro; Nadia Balucani - DCBB, Universitá degli Studi di Perugia

Abstract: As revealed by the Cassini-Huygens mission, Titan, the largest moon of Saturn, is characterized by an active hydrological cycle where light hydrocarbons can precipitate forming pluvial valley, channels and lakes. Titan’s hydrologic cycle is much more complex than the terrestrial one, since there might be multiple materials that compose the fraction of the surface liquids on Titan, among which nitrogen, methane, ethane, and propane. Nitrogen and methane are the dominant components of Titan’s atmosphere. Under Titan’s temperatures regime, methane could cycle between hemispheres on a seasonal timescale while ethane does the same at epochal timescale. In addition, a plethora of organic compounds have been also detected on Titan, including, among others, benzene, acrylonitrile and cyanoacetylene. These compounds are probably photogenerated in the atmosphere and subsequently precipitate on the surface of the moon. A possible chemical evolution of these organic compound strongly depends on their solubility in Titan’s liquid surfaces. Formation of evaporite deposits could take place in dry lake beds followed by volatile removal. Alternatively, materials with even lower solubility, may remain as a lag deposit after more soluble materials have dissolved and washed away. For this reason, it is of great interest to characterize the solubility of common organic compounds in liquid methane and ethane. Because of the characteristics of methane phase transitions, these data are not available in the literature. To fill this gap, we have implemented a laboratory set-up to determine the solubility of organic compounds in a simulated liquid Titan environment. Preliminary data have been collected by screening different organic compound (benzene, toluene, acrylonitrile and acetonitrile) at 143 K and 15 bar of pure methane in liquid phase. The Authors wish to thank the Italian Space Agency for co-funding the Life in Space project (ASI N. 2019-3-U.0)

Thematic section: Astrobiologia, Pianeti e satelliti, Planetologia sperimentale e di laboratorio

Marco Ferrari

Affiliazione: Istituto di Astrofisica e Planetologia Spaziali - INAF

Contributi Proposti

Title: Testing the scientific performance of the Ma_MISS instrument

Authors: Marco, Ferrari, Istituto di Astrofisica e Planetologia Spaziali-INAF; Simone, De Angelis, Istituto di Astrofisica e Planetologia Spaziali-INAF; Maria Cristina, De Sanctis, Istituto di Astrofisica e Planetologia Spaziali-INAF; Francesca, Altieri, Istituto di Astrofisica e Planetologia Spaziali-INAF; Eleonora, Ammannito, ASI - Agenzia Spaziale Italiana; Alessandro, Frigeri, Istituto di Astrofisica e Planetologia Spaziali-INAF

Abstract: Laboratory measurements were performed on different inorganic and organic compounds with the aim of characterizing the scientific performance of the Ma_MISS (Mars Multispectral Imager for Subsurface Studies) instrument onboard the ExoMars2020 “Rosalind Franklin” rover [1]. Ma_MISS is the Visible and Near Infrared (0.5-2.3 μm) miniaturized spectrometer hosted in the drill system of the ExoMars2020 rover that will characterize the mineralogy and stratigraphy of the excavated borehole wall at different depths (<2 m) [2]. The main scientific objectives of the ESA ExoMars2020 mission are searching for signs of past and/or present life on Mars and characterizing the subsurface geochemical environment as a function of depth. The rover payload consists of a suite of nine instruments that will provide information about the geological and geochemical environment of the surface and subsurface of selected landing site (i.e. Oxia Planum) [3]. Remote sensing measurements performed by OMEGA and CRISM [4] suggest that the mineralogy of exposed rocks on the surface of Oxia Planum is dominated by the widespread presence of Fe-/Mg-smectites, Al-clays and more generally, the presence of OH-bearing silicates confirm the interaction between water and the parent rocks. In this framework, we performed several spectroscopic measurements of minerals (Fe, Mg and Al clays, sulphates, zeolites, and hydroxides), perchlorate salts and organic compounds using the laboratory model of the Ma_MISS instrument (breadboard [5]) at the Institute for Space Astrophysics and Planetology – INAF. Our results show that mineral mixtures and mm-sized layered rocks can simulate stratigraphy of excavation inside regolith or mounds and outcrops of sedimentary origin. Analyses of layered rocks showed that spectral/mineralogical differences are discernible for millimetre-sized layering. Infrared reflectance spectra of the selected analogue minerals in the range of the Ma_MISS spectrometer show the typical hydration features due to structural OH, bound H2O, and adsorbed H2O. The spectral response of these hydration features is highly dependent on the sample environment and on the nature of the H2O/OH in the minerals. The spectra obtained on the mixtures between silicates and organic compounds have proved useful for testing the ability of the Ma_MISS instrument to be supportive in the detection of biosignatures, even though the spectral features of the organic compounds are out of the instrument spectral range. Spectroscopic analysis performed on Martian analogues shows that the Ma_MISS instrument has a spectral range, resolution, and imaging capabilities suitable for the characterization of subsurface environments. Measurements of these type of samples can be also used to develop the operational strategies that Ma_MISS will adopt during the scientific phase of the mission. Acknowledgements:

This work is supported by ASI: Accordo ASI-INAF n. 2017-48-H.0 References: [1] Vago J.L. et al. (2017) Astrobiology, 17, 6, 7. [2] De Sanctis M.C. et al. (2017) Astrobiology, 17, 6, 7. [3] Quantin C. et al. (2016) #2863, 47th LPSC, Houston, TX. [4] Carter J. et al. (2013) JGR Planets, 118, 4, 831-858. [5] De Angelis S. et al. (2014) PSS, 101, 89-107.

Thematic section: Planetologia sperimentale e di laboratorio

Sabrina Ferrari

Affiliazione: CISAS - Università degli Studi di Padova

Contributi Proposti

Title: Laboratory reflectance and emissivity spectra of sulfide- and carbon-bearing samples: new constraints for the surface of Mercury.

Authors: Sabrina, Ferrari, CISAS, University of Padova, Italy; Cristian, Carli, IAPS-INAF, Rome, Italy; Alessandro, Maturilli, DLR, Berlin, Germany; Giovanna, Serventi, Department of Chemistry, Life Science and Environmental Sustainability, Parma University, Italy; Maria, Sgavetti, Department of Chemistry, Life Science and Environmental Sustainability, Parma University, Italy; Arianna, Secchiari, Department of Chemistry, Life Science and Environmental Sustainability, Parma University, Italy; Alessandra, Montanini, Department of Chemistry, Life Science and Environmental Sustainability, Parma University, Italy; Joern, Helbert, DLR, Berlin, Germany.

Abstract: The overall analysis of MESSENGER data suggested that the surface of Mercury is Mg-richer and Al-, Ca- and Fe-poorer than the surface of the Moon and of the Earth, and that the planet is enriched in volatiles and alkalis as well. As regards future BepiColombo targets, reflectance and emissivity spectra of suitable amorphous and crystalline silicates need to be acquired in laboratory. In these specific case studies, we used Mg-rich glasses and multimineral mafic aggregates mixed with non-silicate materials to shed light on the contribution of peculiar components to the spectra of Mercury-like regolith. Here we propose spectra of particulate mixtures of Mg-rich gabbronorite and Ca-sulfide, and of Mg-rich glass and carbon measured in the reflectance Visible-Mid Infrared (VIS-MIR) range and in the emissivity Thermal Infrared (TIR) range at the Planetary Spectroscopy Laboratory of the German Aerospace Center (DLR, Berlin). We prepared mixtures reduced at a fine grain size (<63 μm) with increasing sulfide abundances (20, 40 and 60 wt.%, respectively) and increasing carbon abundances (2, 5 and 10 wt.%). Samples were characterized by chemical analyses and reflectance VIS-MIR spectroscopy at room temperature. Since the daily range of surface temperature of Mercury can cause important variations on spectra (Helbert et al. 2013a, b, Ferrari et al. 2015), emissivity spectra were acquired at different temperature between 400 and 700K. This work aim to define indicators useful to analyse remote sensing data for the future BepiColombo mission where both VNIR reflectance and TIR emittance will be measured by VIHI (Visible and Infrared Hyperspectral Imager) and MERTIS (Mercury Radiometer and Thermal Imaging Spectrometer) respectively. This activity were founded by Europlanet 2020 RI from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654208.

Thematic section: Pianeti e satelliti, Planetologia sperimentale e di laboratorio

Francesca Ferri

Affiliazione: Università degli studi di Padova - CISAS

Contributi Proposti

Title: The atmospheric structure of the Ice Giant planets from in situ measurements by an entry probe

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Abstract: An atmospheric entry probes offer a unique opportunity for sounding atmospheric regions not reachable from remote sensing observations. The case for an entry probe at the Ice Giants has been investigated in the context of international cooperation [1, 2] and resulted in several NASA and ESA mission studies [3,4] and proposals [5, 6]. In situ measurements during the entry and descent allow for investigating the atmospheric composition, structure and dynamics down deep into the atmosphere (e.g. Galileo probe at Jupiter [7], Huygens probe at Titan [8]) in order to constrain the interior and possibly offer insights on the origin and evolution of the Ice planets also in connection with exoplanets of similar type. In the framework of the opportunity for a NASA-ESA joint mission to Uranus, Neptune and their moons, we are proposing an Atmospheric Structure Instrument (ASI) for an entry probe at the Ice Giant planets. On the heritage of the Huygens ASI experiment at Titan [9,10], the Ice Giant ASI will consist of a multi sensor package designed to measure the physical quantities characterizing the Uranus’ or Neptune’s atmosphere during the entry and descent of the probe into the planet. The key measurements will be acceleration, pressure, temperature and electrical properties all along the probe descent down deep into the atmosphere in order to investigate the atmospheric structure, dynamics and electricity. The atmospheric profile along the probe trajectory is retrieved by the measurements of the deceleration of the probe and by direct measurements of the pressure and temperature during the descent under parachute. The resulting atmospheric thermal structure constrains the atmospheric stability, dynamics and its effect on the atmospheric chemistry. The variations in the density, pressure and temperature profiles provide information on the atmospheric stability and stratification, on the presence of wind, thermal tides, waves and turbulence in the atmosphere. The estimation of the temperature lapse rate can be used to identify the presence of the condensation and aerosols and cloud layers, to distinguish between saturated and unsaturated, stable and conditionally stable regions. Measurements of the atmospheric electrical properties along the descent could contribute to the study of the moist convective processes, clouds formation and characterization, and allow for detection of possible electrical discharges, i.e. lightnings. IG-ASI data will contribute also to the analysis of the atmospheric composition and the study of the vertical distribution of volatile gases and their condensed phases. The scientific objectives, sensors, measurements and expected results for an Atmospheric Structure Instrument (ASI) for an entry probe at the Ice Giant planets will be presented and discussed in the framework of the

opportunity for an NASA-ESA joint mission to the Ice Giants. References: [1] Mousis, et al. 2018 Planet. Space Scie. 155 [2] Hofstadter, et al. 2019 Planet. Space Scie 10.1016/j.pss.2019.06.004. [3] Ice Giants Pre-Decadal Study Final Report, JPL D-100520, June 2017 https://www.lpi.usra.edu/icegiants/mission_study/Full-Report.pdf [4] ESA M* Ice Giant CDF study http://sci.esa.int/future-missions-department/61307-cdf-study-report- ice-giants/ [5] Arridge et al. 2014 Planet. Space Scie. 104, 10.1016/j.pss.2014.08.009 [6] Mousis et al. 2019, In situ Exploration of the Giant Planets ESA Voyage 2050 White paper [7] Seiff et al. 1996 Science, 272 [8] Lebreton et al. 2005 Nature, 438 [9] Fulchignoni et al. 2002 Space Scie. Rev. 104

Thematic section: Pianeti e sistemi extrasolari, Strumentazione

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Title: AMELIA: the ExoMars Entry, Descent and Landing Science. Atmospheric Mars Entry and Landing Investigations & Analysis (AMELIA) by ExoMars 2016 Schiaparelli and 2020 Entry Descent Modules

Authors: F. Ferri1; A. Aboudan1; G. Colombatti1; C. Bettanini1; S. Debei1; O. Karatekin2; S. Lewis3; F. Forget4; 1Università degli Studi di Padova, Centro di Ateneo di Studi e Attività Spaziali “Giuseppe Colombo” (CISAS), Padova, Italia; 2Royal Observatory of Belgium (ROB), Brussels, Belgium; 3School of Physical Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK; 4Laboratoire de Météorologie Dynamique, UPMC BP 99, 4 place Jussieu, 75005, Paris, France

Abstract: The ExoMars program, with the Schiaparelli Entry Demonstrator Module (EDM) in 2016 and the entry module containing the Kazachov Surface Platform and Rosalind Franklin Rover in 2020 provides the rare (one-per-mission) opportunity for new direct in situ measurements over a wide altitude range and with resolution not achievable over the full altitude range by remote sensing observations. The Atmospheric Mars Entry and Landing Investigations and Analysis (AMELIA) experiment aims at exploiting the engineering measurements of the Entry Descent and Landing System (EDLS) for scientific investigations of Mars’ atmosphere and surface. The data recorded during the different phases can be used for an accurate trajectory and attitude reconstruction and for the retrieval of atmospheric vertical profile to study the atmospheric structure, dynamics and static stability and to characterize the landing site context. On October 19th 2016, Schiaparelli, the Entry Demonstrator Module (EDM) entered into the martian atmosphere. Although it did not complete a safe landing on Mars, it transmitted data though its descent to the surface until the loss of the signal at 1 min before the expected touch-down on Mars’ surface. The flight data received from Schiaparelli, although more limited than expected, were essential to investigate the anomaly that caused the crash landing and for the achievement of the AMELIA experiment. From the flight data we reconstruct the actual dynamics of the vehicle during the descent towards Mars’ surface and retrieved the atmospheric profile, in terms of density, pressure and temperature, along its trajectory. The analysis of the Schiaparelli data and the results on the assessment of the atmospheric science will be reported and put into perspectives for the ExoMars 2020 mission.
Acknowledgements This work was supported by Italian Space Agency (ASI) in the framework of the ExoMars2016 mission EDL science – AMELIA experiment (ASI, grant n. 2017-03-17 and n. I/018/12/3)

Thematic section: Pianeti e satelliti

Gianrico Filacchione

Affiliazione: INAF-IAPS, Roma

Contributi Proposti

Title: Colour cycling on 67P/CG coma and nucleus

Authors: Gianrico Filacchione, Fabrizio Capaccioni, Mauro Ciarniello, Andrea Raponi, Giovanna Rinaldi, Maria Cristina De Sanctis, Dominique Bockelèe-Morvan, Stèphane Erard, Gabriele Arnold, Vito Mennella, Michelangelo Formisano, Andrea Longobardo, Stefano Mottola

Abstract: We report about the observation of two opposite seasonal colour cycles developing in the coma dust particles and on the surface of comet 67P/CG (Churyumov-Gerasimenko) as observed by VIRTIS onboard Rosetta spacecraft during its perihelion passage in 2015. Mie scattering theory has been applied to grains of different composition, including amorphous carbon, Mg-rich silicate, troilite, water ice, organic matter and with variable size distributions (radii from 0.1 to 50 μm) to simulate VIRTIS coma observations acquired with scattering angles ranging between 60° and 150°. Spectral analysis indicates an enrichment of submicron grains made of organic material and amorphous carbon in the coma as the cause of the escalating colour reddening observed during the perihelion passage. At the same time, the progressive removal of dust from the nucleus causes the exposure of more pristine and bluish icy layers on the surface. Far from the Sun, we find that the abundance of exposed water ice on the nucleus is reduced due to the redeposition of dust and/or dehydration of the surface layer while water ice contribute to less-red coma's colours. Apart daily and seasonal cycles of volatile species previously observed on the nucleus' surface, also the coma shows a seasonal cycle giving a further confirmation that the solar heating is the major engine driving the cometary evolution.

Thematic section: Piccoli Corpi

Title: VIS-IR Albedo and Spectral Indicators Maps of Saturn's Icy Satellites Surfaces by Cassini/VIMS

Authors: Gianrico Filacchione, Mauro Ciarniello, Emiliano D'Aversa, Fabrizio Capaccioni, Priscilla Cerroni, Bonnie J. Buratti, Roger N. Clark, Katrin Stephan, Jonathan I. Lunine, Christina Plainaki

Abstract: With the aim to explore surface composition and properties of Saturn's icy satellites, a protocol able to produce photometric-corrected maps of Cassini-VIMS disk-resolved data has been developed and tested. The method allows to correct reflectance spectral data for the illumination and viewing geometry of a given observation to retrieve albedo, a quantity directly correlated with surface composition and physical properties. We adopt the photometric correction proposed by Shkuratov et al. (2011) to derive equigonal albedo maps of Mimas, Enceladus, Tethys, Dione and Rhea. Equigonal albedo is modeled at null incidence and emission angles from observations acquired at phase angle ≥10°. The equigonal albedo is in general lower than the geometric albedo because it do not includes the opposition effect surge. The full dataset returned by VIMS is exploited with the aim to maximise the spatial coverage and resolution for each satellite. After having applied a similar methodology to Dione's (Filacchione et al.,

2018°) and Tethys' data (Filacchione et al., 2018b), we report about the main results for the remaining satellites. Photometric parameters are computed at at 65 wavelengths between 0.35 and 5.047 μm. Cylindrical maps of equigonal albedos and spectral indicators (visible slopes, water ice band depths) are rendered at 0.5°x 0.5° angular resolution in latitude and longitude following the method presented in Filacchione et al. (2016). This mapping method results to spatial resolutions (at equator) of 1.7 km/bin on Mimas, 2.2 km/bin on Enceladus, 4.7 km/bin on Tethys, 4.5 km/bin on Dione and 6.7 km/bin on Rhea. The maps are built by mining the full VIMS dataset to maximize spatial coverage by select only pixels having incidence and emission angles ≤80° acquired from distances ≤100.000 km. A synergic study of the 0.35-0.55 and 0.55-0.95 μm spectral slopes together with the water ice 1.5-2.0 μm band depth maps allow 1) to trace the leading-trailing hemisphere dichotomy visible on many regular satellites of Saturn (Schenk et al., 2011); 2) to constrain the shape and dimensions of the equatorial lenses generated by the bombardment of high energy magnetospheric electrons on Mimas' and Tethys' leading hemispheres (Filacchione et al., 2018b); 3) to detect the more fresh material on the floors and ejecta of many impact craters (Stephan et al., 2012) and 4) to trace water ice and dark materials distribution on Dione's (Clark et al., 2008) and Rhea's (Stephan et al., 2012) whispy terrains. A comparison between average equigonal albedo and disk-integrated reflectance spectra of Saturn's satellites (Filacchione et al., 2007, 2010, 2012; Hendrix et al., 2018) will be discussed.

Thematic section: Pianeti e satelliti

Luigi Folco

Affiliazione: Università di Pisa - Dip Scienze della Terra

Contributi Proposti

Title: The extraterrestrial dust flux: size distribution and mass contribution estimates inferred from the Transantarctic Mountain micrometeorite collection

Authors: L. Folco, (luigi.folco@unipi.it) Dipartimento di Scienze della Terra, Università di Pisa, 56126 Pisa, Italy M.D. Suttle Dipartimento di Scienze della Terra, Università di Pisa, 56126 Pisa, Italy

Abstract: This study explores the long-duration (0.8-2.3Ma), time-averaged micrometeorite flux (mass and size distribution) reaching Earth, as recorded by the Transantarctic Mountain (TAM) micrometeorite collection. We investigate a single sediment trap (TAM65), performing an exhaustive recovery and characterization effort and identifying 1643 micrometeorites (between 100-2000μm). Approximately 7% of particles are unmelted or scoriaceous, of which 75% are fine-grained. Among cosmic spherules, 95.6% are silicate-dominated S-types, and further subdivided into porphyritic (16.9%), barred olivine (19.9%), cryptocrystalline (51.6%) and vitreous (7.5%). Our (rank)-size distribution is fit against a power law with a slope of -3.9 (R2=0.98) over the size range 200-700μm. However, the distribution is also bimodal, with peaks centered at ~145μm and ~250μm. Remarkably similar peak positions are observed in the Larkman Nunatak data. These observations suggest that the micrometeorite flux is composed of multiple dust sources with distinct size distributions. In terms of mass, the TAM65 trap contains 1.77g of extraterrestrial dust in 15kg of sediment (<5mm). Upscaling to a global annual estimate gives 1,555 (±753) t/yr – consistent with previous micrometeorite abundance estimates and almost identical to the previous South Pole Water Well flux estimate (~1,600 t/yr) and potentially suggesting minimal variation in the background cosmic dust flux over the Quaternary. The greatest uncertainty in our mass flux calculation is the accumulation window. A minimum age (0.8Ma) is robustly inferred from the presence of Australasian microtektites, while the upper age (~2.3Ma) is loosely constrained based on 10Be exposure dating of glacial surfaces at Roberts Butte (6km from our sample site).

Thematic section: Meteore, meteoriti e polvere interplanetaria

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Title: Thirty years of Antarctic meteorite research by the Italian Programma Nazionale delle ricerche in Antartide (PNRA)

Authors: L. Folco, (luigi.folco@unipi.it) Dipartimento di Scienze della Terra, Università di Pisa, 56126 Pisa, Italy

Abstract: I will briefly provide an overview of twenty years of Antarctic meteorite research by the Italian Programma Nazionale delle Ricerche in Antartide (PNRA) with particular emphasis on its contribution to meteoritics and planetary sciences. Since 1990 several blue ice fields along the Transantarctic Mountains have been have been visited by our research group and led to the collection of over 1400 meteorite specimens. Among them many remarkable findings of interest for recent and future space missions including two lunar meteorites, several differentiated meteorites belonging to the HED and mesosiderites related to the Vesta asteroid family, and many carbonaceous chondrites related to primitive asteroids. In 2003

we discovered the largest and oldest (fossil micrometeorites are excluded) known accumulation of micrometeorites on Earth on the summit plateaus of the Transantarctic Mountain. The Transantarctic Mountain micrometeorite collection sample the flux of cosmic dust falling to Earth over significant timescales (~1-2 Myrs). Such an extraordinarily long collection time has resulted in the accumulation of many thousands of individual particles. This includes an abundance of otherwise rare giant micrometeorites (orders of magnitude larger than previously found in other collections) which are thus suitable for multi-analytical investigations. This collection provides insights into the composition of the near Earth cosmic dust complex, expand the composition of the solar system material, new information on the geology of dust priducing bodies of the solar system and estimates of the flux of extraterrestrial matter accreting by the Earth. All this material is available for research through the Museo Nazionale dell'Antartide.

Thematic section: Meteore, meteoriti e polvere interplanetaria

Teresa Fornaro

Affiliazione: INAF-Osservatorio Astrofisico di Arcetri

Contributi Proposti

Title: Laboratory Analog Studies for Supporting Detection of Molecular Biosignatures on Mars

Authors: Teresa Fornaro, INAF-Osservatorio Astrofisico di Arcetri; John R. Brucato, INAF-Osservatorio Astrofisico di Arcetri; Giovanni Poggiali, INAF-Osservatorio Astrofisico di Arcetri.

Abstract: One of the primary goals of current and future exploration missions to Mars concerns the search for traces of past or present life. In particular, detection of molecular biosignatures in the martian soil is highly desirable because they provide more directly observable evidence of biogenicity than other categories of biosignatures for which biological production is only inferred. The next NASA and ESA rovers that will be sent to Mars, i.e. Mars 2020 and ExoMars 2020, respectively, are specifically equipped with instruments suitable for identifying this kind of biosignatures by using infrared and Raman vibrational spectroscopies, laser desorption ionization- and gas chromatography- mass spectrometry. Interpreting data acquired by these instruments is, however, a big challenge. The molecular features observable by the instruments, indeed, change depending on a variety of factors, such as specific molecule-mineral interactions, molecular concentration, mineral grain size, pH and ionic strength of the original aqueous environment, and so on. Molecules might have been altered by UV irradiation processing, presence of oxidants, or variations of temperature and pressure through time. Hence, analog studies on Earth are essential to interpret space mission data on actual martian unknown samples. Specifically, laboratory studies simulating the martian environment provide a reference dataset to deconvolve complex features of martian samples and distinguish the contribution of each factor or combination of factors to the overall signals. Here we present laboratory activities in support to ExoMars 2020 and Mars 2020 space missions, pertaining to: 1) preparation of Mars soil analog samples through equilibrium adsorption of different classes of organic compounds, including plausible molecular biosignatures, on minerals representative of the martian regolith, with and without perchlorates; 2) characterization of Mars soil analogs through various techniques to investigate molecule-mineral interactions and test detectability/sensitivity of some of the techniques employed by space flight instruments; 3) UV-irradiation processing of the Mars soil analogs under Martian-like conditions, in order to develop models for molecular degradation in the martian geological record. These studies turn out to be key for: (i) validating the potentialities of flight instruments and developing life detection strategies through their coordinated activity; (ii) helping interpretation of data collected on the ground during mission operative periods; (iii) defining more accurately the molecular targets for life detection missions, depending on the products of transformation of possible biomarkers; (iv) identifying mineral deposits with highest preservation potential, which helps to select the most interesting samples to analyze in situ or/and collect for sample return. References: Fornaro T. et al. (2018) Life, 8, 56. Fornaro T. et al. (2018) Icarus, 313, 38-60. Fornaro T. et al. (2018) Astrobiology, 18(8), 989-1007. Fornaro T. et al. (2013) Icarus, 226, 1068-1085. Fornaro T. et al. (2013) IJA, 12(1), 78-86.

Fornaro T. et al. (2013) PSS, 86, 75-79.

Thematic section: Astrobiologia

Alessandro Frigeri

Affiliazione: IAPS / INAF

Contributi Proposti

Title: Geologic fieldwork supporting ESA ExoMars' MA_MISS experiment

Authors: Alessandro Frigeri, IAPS; Maria Cristina De Sanctis, IAPS ; Francesca Altieri, IAPS; Marco Ferrari, IAPS ;Simone De Angelis, IAPS ; Eleonora Ammannito, ASI

Abstract: Comparative studies in planetary science allow understanding more by looking at common characteristics and processes shared by different planetary bodies and atmospheres rather than by studying extra-terrestrial bodies as unrelated systems. When applied to the planetary surfaces, this concept translates into the study of the geologic evolution of distant bodies through, for example, the analogy with materials and processes we can directly access on planet Earth. Ma_MISS (Mars Multispectral Imager for Subsurface Studies) is the spectrometer integrated within the shaft of the drill on board the ExoMars 2020 rover Rosalind Franklin, which will explore the martian subsurface, contributing to the mission's main goal which is looking for signs of past and present life (Vago et al., 2017). The spectrometer will investigate the borehole wall rocks in the spectral range of 0.5-2.3 micrometers to a depth of up to 2 meters (De Sanctis et al., 2017). The scientific team of Ma_MISS is based at IAPS-INAF in Rome and is currently involved in the preparation of the operative phases of the rover mission which is planned to land on Mars on March 2021. Part of the activity of the scientific team is focused on the characterization of the spectral response of rocks which we expect to observe on the surface of Mars, at the landing site located at Oxia Planum (see Ferrari et al., this conference). The orbital spectrometers OMEGA and CRISM have observed basalts and various types of hydrated minerals on Oxia Planum, where the morphology suggests the presence of clays emplaced in fluvio-lacustrine environment (Quantin-Nataf et al.,2017; Carter et al., 2013). In the last two years, we have introduced geologic fieldwork in the scientific activity of Ma_MISS. This allows collecting not only the rock samples to be analyzed in the laboratory but also their geologic context. Within this extended view, we are able also to include specimen within the stratigraphic sequence, analyzing, for example, the evolution of fluvial-lacustrine processes from a spectroscopic perspective. Our work is based on traditional geologic field investigation, oriented to sample collection. The outcrop where the sample is going to be picked is accurately located geographically (by GPS/Galileo) on a medium to large scale geologic map (1:50k to 1:10k), photographed and described. The rock sample is labeled and any original layering or texture orientation is recorded. We are registering samples by International Geo Sample Number (IGSN), which provides long term preservation and discoverability of the metadata via the internet. In this work we will present the main sample campaigns made so far, describing our workflow from planning to fieldwork to analyses and results. Bibliographic references: Carter J. et al. (2013) JGR Planets, 118, 4, 831- 858. De Sanctis M.C. et al. (2017) Astrobiology, 17, 6, 7. Ferrari M. et al. (2020) this conference Quantin-Nataf C. et al. (2017) LPSC #2863 Vago J.L. et al. (2017) Astrobiology, 17, 6, 7.

Thematic section: Astrobiologia, Pianeti e satelliti, Planetologia sperimentale e di laboratorio

Valentina Galluzzi

Affiliazione: INAF, IAPS

Contributi Proposti

Title: Asymmetric magnetic anomalies over two young impact craters on Mercury

Authors: Valentina, Galluzzi, INAF Istituto di Astrofisica e Planetologia Spaziali di Roma; Joana S., Oliveira, ESA/ESTEC SCI-S Noordwijk NL and CITEUC University of Coimbra PT; Jack, Wright, School of Physical Sciences The Open University UK; Lon L., Hood, LPL University of Arizona USA; David A., Rothery, School of Physical Sciences The Open University UK.

Abstract: In the last months of its mission, MESSENGER was able to obtain measurements at low altitude (< 120 km). This has made it possible to measure small magnetic field signals, probably of crustal origin (Johnson et al, 2015). Maps of the crust signatures at 40 km altitude were produced by Hood (2016) and Hood et al. (2018), showing that the strongest anomalies are about 14 nT in the Caloris basin. Some of the anomalies are associated with impact craters, and it has been demonstrated that this is not a coincidence (Hood et al., 2018). It is believed that these anomalies are the result of impactor materials rich in magnetic carriers (e.g., metallic iron) that were incorporated on the surface acquiring remanent magnetic fields during the cooling of the material. We intend to analyze whether the anomalies of the crustal field are related to geological characteristics by examining two Hermean craters in order to test this impactor hypothesis. Anomalies associated with Rustaveli and Stieglitz craters are slightly or totally asymmetric with respect to the crater center. We analyze the shape of the anomalies and the impact crater morphologies to understand whether there is any connection between the impactor and the anomalies. The morphology and geological setting of these two fresh impact craters that still maintain a well-preserved ejecta blanket and visible secondary crater chains are investigated to constrain the overall impact dynamics. Both impact angles were likely > 40°. In both cases, slight asymmetries in the morphology and ejecta distribution show that the magnetic anomalies correlate well with the location of impact melt. For the large basin Rustaveli, the melt emplaced SE in the downrange direction, whereas in the case of the smaller crater Stieglitz, downrange direction remains uncertain; in one scenario the melt naturally migrated to the northern topographic lows away from a SW downrange direction, while in the other the downrange direction corresponds to the location of the melt to the north. Rustaveli is associated with a ~5 nT crustal magnetic anomaly centered close to the crater's midpoint, although offset ~20 km east-southeast. This offset is somewhat consistent with the downrange direction implied by Rustaveli's impact melt and crater chains distribution. For Stieglitz, all anomalies are offset from the crater's center. An anomaly larger than 3 nT includes most of the ejecta melt locations towards southwest. The ejecta melt cluster to the north of the crater corresponds to an anomaly of ~5 nT, while the largest anomaly of ~7 nT is found further north and closely corresponds to the crater's deepest chain, making the second scenario of a N downrange direction more realistic. For both craters, the melt likely recorded the prevailing magnetic field of Mercury after quenching. For Stieglitz, also some solid impactor fragments likely contribute to the anomaly. Hence, both impactors brought magnetic carriers to the surface that could record the past magnetic field of Mercury. Acknowledgements: The authors

gratefully acknowledge funding from the Italian Space Agency (ASI) under ASI-INAF agreement 2017-47-H.0. References: Hood, J. Geophys. Res. Planets 121, 2016; Hood et al., J. Geophys. Res. Planets 123, 2018; Johnson et al., Science 348, 2015.

Thematic section: Pianeti e satelliti

Antonio Garrido Rubio

Affiliazione: INAF

Contributi Proposti

Title: Study of the Balmer Lines on the exoplanetary atmospheres of Kelt-9b through Transmission Spectroscopy

Authors: Antonio Garrido Rubio, INAF; Francesco Borsa, INAF; Giusi Micela, INAF; Antonino Petralia, INAF; Jesus Maldonado, INAF; Antonio Maggio, INAF

Abstract: When the exoplanet passes in front of its host star, part of the star's light passes through the upper layers of the exoplanet's atmosphere allowing the study of its atmospheric chemistry and the physics through transmission spectroscopy. We have developed a method that allows to extract the transmission spectrum of the exoplanet's atmosphere, which can be studied as the spectra of stars without planets. These studies have resulted in the first observation of the Atmospheric Rossiter-McLaughlin effect (Borsa et al. 2019), and the extraction of the Balmer lines from the atmosphere of the exoplanet Kelt-9b allowing a direct measurement of the exoplanet's high atmosphere temperature through the measurement of the FWHM (Garrido Rubio et al., in prep.).

Thematic section: Pianeti e sistemi extrasolari

Livia Giacomini

Affiliazione: Istituto Nazionale di Astrofisica (INAF)- IAPS

Contributi Proposti

Title: Europlanet Society and the Italian Hub

Authors: Maria Cristina, De Sanctis, INAF-IAPS, Istituto di Astrofisica e Planetologia Spaziali di Roma; Maria Teresa, Capria, INAF-IAPS, Istituto di Astrofisica e Planetologia Spaziali di Roma; Valentina, Galluzzi, INAF-IAPS, Istituto di Astrofisica e Planetologia Spaziali di Roma; Laura, Gatti, Thales Alenia Space; Livia, Giacomini, INAF-IAPS, Istituto di Astrofisica e Planetologia Spaziali di Roma; Stavro, Ivanovski, INAF-Osservatorio Astronomico di Trieste: Alice, Lucchetti, INAF-OAPD, Osservatorio Astronomico di Padova. (1) (2) Thales Alenia Space (3) INAF-Osservatorio Astronomico di Trieste (4) INAF-OAPD, Osservatorio Astronomico di PadovaStavro Ivanovski, INAF- Osservatorio Astronomico di Trieste

Abstract: The Europlanet Society was officially announced on 20th September 2018 at the European Planetary Science Congress (EPSC) in Berlin and is a membership organisation that aims to promote the advancement of European planetary science and support a diverse and inclusive planetary science community across Europe. The Society builds on the heritage of 15 years of Europlanet projects funded by the European Commission, and its concept particularly evolved during the current Europlanet-2020-RI project. The Europlanet Society is managed by an elective Board, voted and established during the European Planetary Science Congress (EPSC) 2019 in Geneva. The Society is also responsible for the next European Planetary Science Congresses. The Society is structured in regional hubs, physically located on the territory. Each hub, including the Italian, has a committee reporting to the EPSC board. The main aims of the hub within the Society are the following: • To promote, foster and support planetary science and related activities within the designated Hub region • To promote, encourage and support the Constitution of the Europlanet Society and meet Europlanet's commitment to diversity within the Hub region • To provide guidance and make recommendations to the Europlanet Executive Board on regional issues, including where action is needed • To support the practical delivery of activities to build and sustain the Europlanet Society within the academic, industrial, policy, outreach and education communities at a regional level • To review, report on, share and exchange good practice within and outside the Society Here we will report about the main initiatives of the Hub and the Society and we will collect inputs from the National community.

Thematic section: Pianeti e satelliti, Pianeti e sistemi extrasolari, Planetologia sperimentale e di laboratorio

Davide Grassi

Affiliazione: INAF-IAPS

Contributi Proposti

Title: On the spatial distribution of minor species in Jupiter's troposphere as inferred from Juno JIRAM data

Authors: Davide Grassi (INAF-IAPS); Alberto Adriani (INAF-IAPS); Alessandro Mura (INAF-IAPS); Sushil K. Atreya (U. Michigan); Leigh N. Fletcher (U. Leicester); Jonathan I. Lunine (Cornell U.); Glenn S. Orton (JPL); Scott Bolton (SwRI); Christina Plainaki (ASI); Giuseppe Sindoni (ASI); Francesca Altieri (INAF-IAPS); Andrea Cicchetti (INAF-IAPS); Bianca Maria Dinelli (CNR-ISAC); Gianrico Filacchione (INAF-IAPS); Alessandra Migliorini (INAF-IAPS); Maria Luisa Moriconi (CNR-ISAC); Raffaella Noschese (INAF-IAPS); Angelo Olivieri (ASI); Giuseppe Piccioni (INAF-IAPS); Edoardo Rognini (ASI-SSDC); Roberto Sordini (INAF-IAPS); Stefania Stefani (INAF-IAPS); Federico Tosi (INAF-IAPS); Diego Turrini (INAF-IAPS)

Abstract: The spatial distribution of water, ammonia, phosphine, germane and arsine in the Jupiter's troposphere has been inferred from the JIRAM-Juno data. Measurements allow us to retrieve the vertically-averaged concentration of gases between ~3-5 bars from infrared-bright spectra. Results were used to create latitudinal profiles. The water vapor relative humidity varies with latitude from <1% to over 15%. At intermediate latitudes (30°-70°) the water vapor maxima are associated with the location of cyclonic belts, as inferred from mean zonal wind profiles (Porco et al., [2003]). The high-latitude regions (beyond 60°) are drier in the north (mean relative humidity around 2-3%) than the south, where humidity reaches 15% around the pole. The ammonia volume mixing ratio varies from 1×10-4 to 4×10-4. A marked minimum exists around 10°N, while data suggest an increase over the equator. The high-latitude regions are different in the two hemispheres, with a gradual increase in the south and more constant values with latitude in the north. The phosphine volume mixing ratio varies from 4×10-7 to 10×10-7. A marked minimum exists in the North Equatorial Belt. For latitudes poleward 30°S and 30°N, the northern hemisphere appears richer in phosphine, with a decrease toward the pole, while the opposite is observed in the south. JIRAM data indicate an increase of germane volume mixing ratio from 2×10-10 to 8×10-10 from both poles to 15°S, with a depletion centered around the equator. Arsine presents the opposite trend, with maximum values of 6×10-10 at the two poles and minima below 1×10-10 around 20°S.

Thematic section: Pianeti e satelliti

Stavro Lambrov Ivanovski

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: Modelling of rotating non-spherical dust dynamics at cometary and asteroid environments

Authors: Stavro L. Ivanovski, GIADA team* and LICIACube** team *Co-authors from GIADA scientific team Vladimir Zakharov (2,3), Vincenzo Della Corte (2,3), Alessandra Rotundi (3,2) and Marco Fulle (1), **Co-authors from LICIACube team E. Dotto (4), V. Della Corte (2), M. Lavagna (5), P. Tortora (6), S. Pirrotta (7), M. Amoroso(7), V. Di Tana (8), E. Mazzotta Epifani (4), A. Rossi (9), J.R. Brucato (10), G. Cremonese(11), A. Lucchetti(11), A. Capannolo (5), M. Zannoni(5), I. Gai(6), F. Miglioretti (8) and S. Simonetti (8) (1) INAF – Osservatorio Astronomico di Trieste (2) INAF-Istituto di Astrofisica e Planetologia Spaziali, Roma (3) DIST-Università Parthenope, Centro Direzionale, Isola C4, 80143, Napoli (4) INAF-Osservatorio Astronomico di Roma, (5) Politecnico di Milano (6) Università di Bologna (7) Agenzia Spaziale Italiana, Roma (8) Argotec, Torino (9) IFAC-CNR, Firenze INAF-Osservatorio Astronomico di Padova (10) INAF-Osservatorio Astrofisico di Padova (11) INAF-Osservatorio Astrofisico di Arcetri, Firenze

Abstract: Dust dynamics present at different small bodies and belonging to different astrophysical phenomena will be reviewed. First, we will outline the state-of-the-art achievements with the non-spherical 3D+t dust model [1-4] applied to multi-instrument Rosetta data collected at 67P/Churyumov-Gerasimenko. Secondly, we will discuss the application of this updated model for simulating the dust plume evolution just after the NASA Double Asteroid Redirection Test (DART) impact on the asteroid 6583 Didymos system. How the knowledge on cometary dust dynamics acquired through Rosetta data can be properly applied to other comets remains a question of outstanding scientific interest. The irregular dust shape leads to changes in the particle motion (with respect to a spherical particle) due to addition of the transversal forces and rotational motion governed by the aerodynamic force. This leads to different terminal velocities of particles with the same mass, but different in shape. In a series of works based on Rosetta data and calibrated with Rosetta/GIADA[5] data we derived the rotational frequencies and velocities of the non-spherical particles in the vicinity of 67P [1-4]. Real dust grains have arbitrary shapes and it is not possible to treat each particular grain individually. We highlight the major results applying the model to multi-instrument Rosetta data, aiming at constraining (and where possible determining) the main parameters capable to represent the key processes acting on dust in cometary atmospheres. The second study addresses one of the main scientific objectives of the ASI Light Italian Cubesat for Imaging of Asteroids (LICIACube) mission. i.e. to study the observation of the slow plume ejecta (< 5 m/s) evolution just after the NASA Double Asteroid Redirection Test (DART) impact occurrence and to investigate the plume density structure and evolution. We only focus on the plume evolution with dust dynamical simulations with an updated 3D+t non-spherical dust model [1] considering two main forces (gravity and solar radiation pressure) and assuming initial velocity of the particle after the DART impact. Using different target material cases (Table 2, [6]) and 6583 Didymos system parameters [7] we performed simulations with different dust physical and dynamical parameters of the

plume. The dust dynamics of irregular shapes can lead to different optical thickness of the plume. The optical thickness of the plume can vary not only due to the size distribution but also due to particle shapes and orientation. In case of strong solar radiation pressure, if a particle has initial torque and rotate during the plume evolution then its speed will be different than the non-rotating one of the same mass, shape and size. Solar radiation pressure will mainly affect the plume motion at large distances. In the end, we shortly address at what distance particles achieve their terminal velocities or eventually stop to accelerate/decelerate. [1] Ivanovski, S. et al. (2017), Icarus 282, 333-350; [2] Ivanovski, S. et al. (2017), MNRAS, 469, S774-S786; [3] Fulle, M. et al. (2015) A&A;, 583, A14; [4] Rinaldi et al. (2017), MNRAS 481, 1, 1235–1250; [5] Della Corte V. et al. (2014) JAI 1350011-1350022; [6] Cheng et al. 2016, PSS,121; [7] Yu et al. 2017, Icarus, 282, 313-325

Thematic section: Piccoli Corpi

Title: Magnetic Reconnection Modelling at the Mercury's Magnetopause in Preparation for BepiColombo/SERENA Experiment

Authors: Stavro L. Ivanovski (1), Anna Milillo (2), Monio Kartalev (3), Stefano Massetti (1), Stefano Orsini (2), Valeria Mangano (2), Christina Plainaki (4), A. Kazakov (2), Alessandro Mura (2), Roberto Sordini (2), Elisabetta De Angelis(2), R. Rispoli(2), F. Lazzarotto (5), A. Aronica(2), R. Noschese(2) and T. Alberti(2). (1) INAF - Osservatorio Astronomico di Trieste, via Giambattista Tiepolo, 11, 34143 Trieste, Italy, (stavro.ivanovski@inaf.it) (2) INAF-IAPS, via Fosso del Cavaliere 100, 00133 Rome, Italy; (3) Geospace Consult Ltd, Institute of Mechanics, Bulgarian Academy of Sciences, G. Bontchev St., bl 4, 1113 Sofia, Bulgaria (4) ASI - Italian Space Agency, Via del Politecnico snc, 00133 Rome, Italy (5) INAF-Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio, 5, 35122 Padova, Italy

Abstract: Five of the six flybys that BepiColombo will perform during the cruise phase at Mercury will be in close vicinity of the planet allowing measurements of the magnetosphere crossings. To prepare for taking full advantage of these observations we model the development of MHD instabilities that can provide an estimation on the magnetic reconnection phenomena at Mercury's magnetopause. Based on a flexible numerical incompressible magnetohydrodynamic (MHD) approach utilized for studying a coupled Kelvin-Helmholtz (KH) and tearing mode (TM) instabilities [1], we investigate the magnetic reconnection rates under the identified high-shear and low-shear IMF conditions in the MESSENGER data [2, 3]. We determine a threshold value of the magnetic reconnection rate when the MHD instabilities are present based on the reconnection rates derived from MESSENGER data [2]. We study in which of the eight Highly Compressed Magnetospheric Events at Mercury analysed in [2], KHTM instabilities could possibly develop. Then we are able to address questions whether MHD instabilities are triggered for low reconnection rate cases, when the size of the magnetosphere is largely controlled by induction effects [2] or this is only valid in case of high reconnection rates when the induction-driven shielding and reconnection-driven erosion seems balance each other. We will also discuss how occurrence of such instabilities at the flanks of the magnetosphere can suggest a plausible explanation of the KHTM vortex asymmetry and how this study can support the SERENA experiment [4,5] onboard BepiColombo deciphering the complex Mercury system surface-exosphere-magnetosphere. [1] Ivanovski et al. 2011, JTAM, vol. 41, No. 3, pp. 31–42; [2] DiBraccio et al. 2013, JGR, 118, 997-1008; [3] Jia et al. 2019, JGR Space Physics, https://doi.org/10.1029/2018JA026166; [4] Milillo et al. 2005, SSR; Orsini, S. et al. 2010, BepiColombo Special Issue on Planetary and Space

Science, doi:10.1016/j.pss.2008.09.012, 58, 166-181

Thematic section: Pianeti e satelliti

Fiorangela La Forgia

Affiliazione: University of Padova

Contributi Proposti

Title: Visible and near-IR spectroscopic characterization of different dynamical classes of comets

Authors: Fiorangela La Forgia (Uni Padova); Monica Lazzarin (Uni Padova); Alessandra Migliorini (IAPS-INAF); Ivano Bertini (Uni Parthenope); M. Cristina De Sanctis (IAPS-INAF)

Abstract: Taxonomic classification of comets based on their volatile chemical composition suggests that comets are different depending on their formation zone (A'Hearn et al., 1995 and Fink, 2009). These classifications indicate globally two major compositional classes of comets: usual comets and carbon-depleted comets. Fink et al. (2009) concluded that comets formed in the Saturn and Uranus region, and scattered in the Oort cloud (i.e. Halley type comets) shows no C2 depletion, while object originating in the Neptune region show a mixture of typical and C2 depleted objects, while comets originating in the classical Kuiper belt form the C2 depleted group. However, these classifications were limited to the volatile content in the visible range. Recent Solar System formation models (Brasser and Morbidelli, 2013) suggest that comets formed all in the same region before being scattered to the in the two reservoirs of the Oort cloud and the Scattered Disk. If this scenario is confirmed, the observed chemical diversity might be interpreted as evolutionary, rather than primordial. A large-scale study of heterogeneities within comets of various dynamical classes is therefore crucial to test this model. New comets are frequently inserted into instable orbits and pass close to the Sun (and Earth) giving the possibility to investigate an increasing sample of comets to study their heterogeneities and compare them with short-period comets. Short-period comets, on the other hand, are periodically observable and spectroscopic measures allow comparison with previous apparitions. Significant changes in the volatile content with time (and apparition) would indirectly yield a confirmation to the recent dynamical models. We acquired visible and near-IR spectra of 24 comets observed with TNG telescope in La Palma in the Canary Islands and 21 comets observed with VLT-ESO telescope in Chile of various dynamical classes. Most of the observed comets are dynamically new comets but we also observed Jupiter Family comets, Halley-type, and long-period comets. We will present the preliminary results of the characterization of this set of comets, possibly including molecular abundances and production rates. This study will allow us to test some of the recent dynamical models and help in understanding if the observed heterogeneities are primordial or evolutionary.

Thematic section: Piccoli Corpi

Francesco Lazzarotto

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: High Quality Software for Planetary Science from Space

Authors: Francesco Lazzarotto, INAF Padova; Gabriele Cremonese, INAF Padova; Pamela Cambianca, UniPD & INAF Padova; Alice Lucchetti, INAF Padova; Giovanni Munaretto, UniPD & INAF Padova; Cristina Re, INAF Padova; Emanuele Simioni, INAF Padova; Maurizio Pajola, INAF Padova;

Abstract: Planetary science space missions need high quality software ed efficient algorithms in order to extract innovative scientific results from flight data. Reliable and efficient software technologies are increasingly vital to improve and prolong the exploiting of the results of a mission, to allow the application of established algorithms and technologies also to future space missions and for the scientific analysis of archived data. Below will be given an in-depth analysis study accompanied by implementation examples on ESA and ASI missions and some remarkable results fruit of decades of important experience reached by space agencies and research institutes in the field.

Thematic section: Planetologia sperimentale e di laboratorio, Strumentazione

Cecilia Lazzoni

Affiliazione: OAPD-INAF

Contributi Proposti

Title: Looking for binary planets, satellites and disks around exoplanets

Authors: Cecilia Lazzoni OAPD-INAF ; Alice Zurlo Universitas Diego Portales; Silvano Desidera OAPD-INAF; SPHERE Team

Abstract: In the past decades the exoplanets hunting has improved so much that thousands of planets have been confirmed and partially characterized. Both indirect and direct detecting techniques have filled this huge sample, from the terrestrial to the gas giant and brown dwarf regime. One further step would be to detect exomoons and disks/rings around exoplanets, that we expect to be there taking as a model our Solar System. We will show how this goal is, however, a really challenging one and which estimates we can obtain from the present instrument and data. In particular, we developed a technique based on the PSF subtraction to deeply investigate the neighborhoods of exoplanets detected with the direct imaging technique in order to look for further companions and circumplanetary disks.

Thematic section: Pianeti e satelliti, Pianeti e sistemi extrasolari

ALICE LUCCHETTI

Affiliazione: INAF - OAPD Astronomical Observatory of Padova

Contributi Proposti

Title: Unveiling the subsurface from icy fractured surface

Authors: A. Lucchetti (1); F. Mazzarini (2); R. Pozzobon (3); M. Baroni (4); M. Pajola (1); G. Cremonese (1); M. Massironi (3). (1) INAF-OAPD Astronomical Observatory of Padova, Italy (alice.lucchetti@inaf.it). (2) Istituto Nazionale di Geofisica e Vulcanologia, Pisa, Italy. (3) Dept. of Geosciences, University of Padova, Italy. (4) Dept of Physics and Astronomy, University of Padova, Italy

Abstract: The investigation and analysis of size and spatial distribution of fracture systems in icy bodies may provide new insights into the surface and subsurface evolution that cannot be gained by other techniques, hence focusing on the depth where a liquid water ocean and/or reservoir might be. Indeed, high-resolution observations have revealed that liquid water and other trace chemicals may be erupting onto the surfaces of icy satellites (e.g. Miyamoto et al., 2005; Prockter and Schenk, 2005) supporting the hypothesis that a conduit must exist between a subsurface reservoir and the surface itself. Those fractures able to penetrate the entire thickness of the shell may serve as fluid pathways connecting the subsurface to the surface. In this context, by applying the fractal analysis to the study of some of the main characteristics of fracture populations, such as length and spatial? clustering, it is possible to infer the depth at which fractures penetrate the icy crust (e.g., Mazzarini and Isola, 2010; Mazzarini et al., 2013). This well-known methodology has been already applied on Enceladus (Lucchetti et al., 2017) demonstrating the prevalence of fractal populations of faults and providing thickness estimates of Enceladus' brittle ice crust in multiple regions. We propose to apply this analysis to icy bodies that are considered to host and/or have hosted a liquid (Jupiter's satellites, Ganymede and Europa) or frozen water ocean/pockets (Ceres) underneath their surfaces. We will use the data coming from past space missions depending on the icy bodies under study, such as Dawn for Ceres, Galileo for Jupiter's Satellites (Europa and Ganymede). In particular, we will exploit the data coming from the cameras in order to identify and map the fractures and/or vents (i.e. points of gas and/or fluid emission) that will be later on investigated by the fractal method. Through the fractal analysis, we will be able to give an estimate of the thickness of the ice brittle layer and the depth at which subsurface reservoirs should be. Acknowledgments: The activity has been realized under the ASI-INAF contract 2018-25-HH.0. References: Lucchetti A., et al., (2017). Brittle ice shell thickness of Enceladus from fracture distribution analysis. Icarus, 297, 252-264. Mazzarini F., Isola I., (2010). Monogenetic vent self-similar clustering in extending continental crust: examples from the East African Rift system. Geosphere 6, 567–582. Mazzarini F., et al., (2013). Spatial relationship between earthquakes and volcanic vents in the central-northern Main Ethiopian Rift. J. Volcanol. Geotherm. Res. 262, 123–133. Miyamoto, H. et al., (2005). Putative ice flows on Europa: Geometric patterns and relation to topography collectively constrain material properties and effusion rates. Icarus, 177(2), 413-424. Prockter, L., & Schenk, P. (2005). Origin and evolution of Castalia Macula, an anomalous young depression on Europa. Icarus, 177(2), 305-326.

Thematic section: Pianeti e satelliti

Erica Luzzi

Affiliazione: Jacobs University

Contributi Proposti

Title: Hydrothermal deposits associated with volcano-tectonic structures, south of Aureum Chaos (Mars)

Authors: Erica Luzzi, Jacobs University Bremen Angelo Pio Rossi, Jacobs University Bremen Francesca Altieri, Inaf-IAPS, Rome Cristian Carli, Inaf-IAPS, Rome

Abstract: Volcano-tectonic structures are widespread in Mars' chaotic terrains. Those structures include collapsed lava conduits, radial and concentric fractures, y-shaped junctions, fissure vents associated to lava flows, and pit chains. Between the southern edge of Aureum Chaos and the northeastern edge of Arsinoes Chaos, we observed a mineralogical variation in a small light-toned deposit in proximity of volcano-tectonic structures. The appearance of this light-toned deposit is different from the light-toned deposits hosted inside the nearby chaotic terrains, that appear instead layered, sulfate-bearing and that are located in closed basins, suggesting a possible lacustrine/evaporitic depositional environment. In this case the deposit is not located in a basin, does not show internal layering nor the presence of ulfates. The extent of the deposit is limited at ~ 1.3 km, but other patches are visible in the area, suggesting that perhaps the hydrothermal deposits have been exhumed locally but are still buried for most of their extent. CRISM data were analysed using the summary products for a first identification of hydrated minerals. The band depth at 1.9 μm has significant values in correspondence of the light-toned deposit, suggesting occurrence of hydrated minerals (Viviano-Beck et al., 2014). The spectral analysis allowed a clear distinction between the basaltic bedrock hosting pyroxenes and the light-toned deposit where Fe-Mg phyllosilicates were identified. In particular, the absorption at 2.28 μm was interpreted as belonging to smectite, since the other Fe-Mg phyllosilicates have absorptions shifted at 2.3 μm having more Fe than Mg (Clark et al., 1990). The occurrence of smectite and the location of the deposit nearby a system of deep fractures and collapsed lava conduits suggest that the light-toned deposit could represent the result of hydrothermal deposition and alteration of the basaltic bedrock (Inoue, 1995). The complex web of grabens, fissures and fractures could have been a preferential path for circulating hot fluids at the late volcanic stage of the area. The whole region surrounding Valles Marineris was already considered by Schulze-Makuch et al. (2016) as a possible hydrothermal target on Mars, given the magmatic-driven tectonism affecting the area and the occurrence of hydrated minerals. We propose this relatively small deposit as a hydrothermal target.

Thematic section: Pianeti e satelliti

Claudio Maccone

Affiliazione: INAF Osservatorio di Cagliari

Contributi Proposti

Title: KLT is a better algorithm than FFT

Authors: Claudio Maccone, INAF Cagliari; Nicolo` Antonietti, INAF-IRA Bologna; Matteo Trudu, INAF Cagliari; Andrea Melis, INAF Cagliari

Abstract: Abstract. The Karhunen-Loève Transform (hereafter abbreviated KLT, please see the following site for more mathematical details https://en.wikipedia.org/wiki/Principal_component_analysis, and, in Italian, please see the site https://it.wikipedia.org/wiki/Analisi_delle_componenti_principali) is a more advanced method than the Fast Fourier Transform (FFT) to extract very weak signals out of background noise of whatever kind. In Italy, the KLT was introduced by this author and Stelio Montebugnoli back in the 1990's at the Medicina radio telescopes. As of 2020, a school of KLT experts has been flowering at Cagliari since 2013, when the 64-meter Sardinia radio telescope was opened. We also exported our KLT expertise to the SETI community worldwide, particularly to the Berkeley SETI Group, who absorbed our KLT works eagerly. It's high time for the Italian scientific community to extensively use this powerful mathematical tool, that goes under the generic name of "principal component analysis" in different applications of statistics to all the sciences: not only SETI (as we do), but also astrobiology, engineering, finances, and more. In this presentation: 1) the KLT basics will be presented by Claudio Maccone. 2) the cosmological KLT, good for analysis of distant targets like FRBs and Re-Ionization-Age objects, will be presented by Nicolo` Antonietti. 3) Finally, Andrea Melis and Matteo Trudu will describe their practical implementations of the KLT codes for SETI and Astrobiology (pre-biotic molecules in space), as they are now doing at the Sardinia Radio Telescope.

Thematic section: Pianeti e sistemi extrasolari, Strumentazione

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Title: A mathematical model for Evolution of Life on Earth and Exoplanets (Evo-SETI)

Authors: Claudio Maccone (INAF Cagliari)

Abstract: Abstract. The discovery of a larger and larger number of Exoplanets raises a question: where does a newly-discovered Exoplanet stand in its capability to develop Life as we know it on Earth? Our tentative answer to this question is our Evo-SETI Theory, a mathematical model aiming at casting Cladistics and the Evolution of Life on Earth over the last 3.5 billion years in terms of a few simple statistical equations. The novelty is that these simple statistical equations are based on lognormal probability distributions in the time, rather than in the amounts of something else. The first new notion is that of a b-lognormal, i.e. a lognormal probability density function (pdf) starting at time b rather than at time zero. In other words, the lifetime of any living form may then be expressed as a b-lognormal starting at b, reaching puberty at the ascending inflexion point a ("adolescence (end)"), raising up to the peak time p, then starting to decline to the descending inflexion point s ("senility") and finally going down along a straight line up to the intercept with the time axis, that is the "death" of the individual. Based on all this,

the author was able to derive several mathematical consequences like the Central Limit Theorem of Statistics re-cast in the language of Evo-SETI theory: from the lifetime of each individual to the lifetime of the "big b-lognormal" of the whole population itself to which the individual belongs ("E-Pluribus-Unum Theorem"). This author also discovered his "Peak-Locus Theorem" translating Cladistics in term of Evo-SETI Theory: each SPECIES created by Evolution over 3.5 billion years is a b-lognormal whose peak lies on the exponential in the number of living Species. More correctly still, this exponential is not the exact curve telling us exactly how many Species there were on Earth at a given time in the past: the exponential actually is the mean value of a stochastic process called "Geometric Brownian Motion" (GBM) in the mathematics of Finances, so that also the Mass Extinctions of the past are incorporated in Evo-SETI Theory as all-lows of the GBM. Then what is the Shannon entropy of each b-lognormal representing a Species? Answer: the Shannon entropy (with a reversed sign) is the measure of how evolved that Species was when compared to other Species of the past and of the future. That means MEASURING THE PACE OF EVOLUTION: our EvoEntropy is just a number in bits, typical of Shannon's Information Theory, rather than a mountain of describing words! And what is the equivalent of the MOLECULAR CLOCK in Evo-SETI Theory? Answer: it is the STRAIGHT LINE behavior in time of the Shannon Entropy if (and only if) an exponential is the enveloping curve of all the b-lognormals representing the various Species. We were also able to generalize his Peak-Locus Theorem from the exponential case to the general case when the mean-value-envelope is an arbitrary curve that one may chose at will: for instance, this curve is a polynomial of the third degree in the time in the Korotayev-Markov (2007) model of evolution, leading then to a non-linear EvoEntropy. Finally, the Evo-SETI UNIT of evolution turns out to equal 25.575 bits, if life on Earth started exactly 3.5 billion years ago: this is our suggested unit to measure the evolution of life in the Universe, both on Earth and on Exoplanets.

Thematic section: Astrobiologia

VALERIA MANGANO

Affiliazione: INAF-IAPS

Contributi Proposti

Title: Synergies between the ground-based and space-based observations of the Na exosphere of Mercury

Authors: Valeria Mangano, INAF-IAPS; Anna Milillo, INAF-IAPS; Stefano Orsini, INAF-IAPS; Stefano Massetti, INAF-IAPS; Alessandro Mura, INAF-IAPS

Abstract: An Earth-based campaign to observe Mercury's thin collisionless atmosphere (exosphere) is performed at THEMIS by using the THEMIS telescope in the Canaries (Spain). THEMIS is a solar telescope that, thanks to its characteristics of very low diffuse light, is resulted to be very well suited to perform daylight observations of the exosphere of Mercury. In addition, the MTR spectrograph has a very high spectral resolution (ranging from 220,000 to 400,000) and offers the multiline mode, with two different cameras observing the Na D1 and D2 lines at the same time. After adaptive optics implementation, this year THEMIS is open again, and new Mercury exosphere observations were performed. The analysis of the wide database collected, evidenced the peculiar morphology and high variability on different timescales (ranging from 'seasonal', daily, hourly …down to 10-15 minutes) of the exospheric Na emission. The comparison with devoted models of the exosphere and of the planetary magnetosphere interactions with the solar wind magnetic field, put constraints on the morphology pattern and on the processes responsible of exosphere generation and dynamics. The contemporary analysis with the in-situ magnetic field and energetic particles populations by MAG and FIPS onboard MESSENGER, allowed deeper analysis of the evident but still not explained relationship between Mercury's exosphere and the inner heliosphere environment. A brief overview of the results obtained will be presented.

Thematic section: Pianeti e satelliti

Paola Manzari

Affiliazione: Agenzia Spaziale Italiana

Contributi Proposti

Title: Investigation on the absorption bands around 3.3 micrometers in CRISM data

Authors: Paola Manzari, Agenzia Spaziale Italiana, Roma, Italia; Cosimo Marzo, Agenzia Spaziale Italiana, Matera, Italia; Eleonora Ammannito, Agenzia Spaziale Italiana, Roma, Italia

Abstract: In the last years, several instruments both orbiting and onboard rovers have detected methane on Mars surface. However, a distinction has to be made for what concerns methane detection on Mars: background detections and detection of “spikes” of methane which differ by orders of magnitude. Background detections at the surface range up to 0.05 ppbv to 0.2-0.6 ppbv. Spikes detections range up to 21 ppbv at Gale at the surface (NASA Announcement, June 2019), to 40 ppbv from ground telescopes. Summarizing the results of the previous observations, the source of Mars methane should be spatially restricted but also temporarily restricted with potential sources in form of seepages. With these premises we investigated on the chance to localize methane spikes in CRISM data. CRISM data used for this work have a spatial resolution of 19 m/pixel, a spectral range between 0.4 and 3.9 μm and a spectral resolution of 6.55 nm. This IR range of CRISM would potentially allow the detection of the 3.3 μm methane band. We investigated CRISM observations on three sites: Gale crater, Nili Fossae and Oxia Planum: area of Gale crater in which the increase of methane was proven from the PFS orbiter and on ground by SAM-TLS onboard Curiosity; area of Nili Fossae in which the mineralogy is compatible with methane formation and in which the greater abundance 40 ppbv of methane was estimated from ground telescopes and area of Oxia Planum, in the view of the upcoming Exomars 2020 mission, to have a chance to compare the results of this work with data collected on ground. We analyzed the 3.3 μm band absorption to be sure it was not an artifact and then we have studied it in the light of the mineralogical association occurring. To avoid false positive, we studied the noise to decide a threshold on the absorption depth. Then, we used the Planetary Spectrum Generator to simulate CRISM spectra of the different chosen sites, with different concentration of CH4 spikes found in literature. The results of these simulations were compared with the band absorptions at 3.3 μm found in CRISM data. The final goal of this work is the processing of several images that could potentially help in the research of methane macro-seepages on Mars surface.

Thematic section: Pianeti e satelliti

Title: Handheld Laser-Induced Breakdown Spectroscopy (LIBS) instrumentation as a valuable tool for terrestrial in field search for meteorites

Authors: Giorgio S. Senesi, CNR - Istituto per la Scienza e Tecnologia dei Plasmi (ISTP), Bari, Italia; Ahmed A. Touchnt, Department of Physics and Earth Sciences, Università di Ferrara, Ferrara, Italia; Paola Manzari, Agenzia Spaziale Italiana, Roma, Italia; Abderrahmane Ibhi, Petrology, Metallogeny and Meteorites Laboratory, University of Ibn Zohr, Agadir, Morocco; Olga De Pascale, CNR - Istituto per la Scienza e Tecnologia dei Plasmi (ISTP), Bari, Italia.

Abstract: Mineralogy, chemistry and isotopic compositions of meteorites can provide unique information on the materials that formed the solar system and the processes that occurred during and after accretion into asteroids. Visual and magnetic methods are not exhaustive for an unequivocal identification to ascertain the extra-terrestrial origin of suspected, especially iron, meteorites, which requires an adequate laboratory analysis. In the last decade Laser-Induced Breakdown Spectroscopy (LIBS) has been shown to be a very promising technique for meteorite analysis and identification [1]. With respect to the various destructive and expensive traditional analytical techniques generally used, the elemental determination performed by LIBS shows significant advantages, including sensitivity to light elements, versatility, minimal destructivity, rapidity, relatively low operating costs and the possibility of in-field operations [1]. Recently, portable handheld LIBS instruments have become increasingly common for the rapid in situ measurement of most major and trace elements in a broad variety of minerals, which cannot be achieved by the use of other field portable instruments. In particular, this type of instrument allows to obtain a preliminary chemical identification and classification of metallic objects of extraterrestrial origin, i.e. meteorites, with respect to human artifacts and to recognize mislabelled/unlabelled and dubious meteorite specimens in the field and in museums and private collections. Very recently, a handheld LIBS instrument has been used for the first time [2] to identify the qualitative differences in the elemental composition among a certified iron meteorite named Agoudal, a suspected meteorite fragment and a pig iron product. [1] G.S. Senesi, Earth Sci. Rev. 139, (2014), 231-267. [2] G.S. Senesi, et al., Geostand. Geoanal. Res. 42, (2018), 607-614.

Thematic section: Meteore, meteoriti e polvere interplanetaria

Elena Martellato

Affiliazione: Universita' degli Studi di Napoli Parthenope, Napoli, Italy

Contributi Proposti

Title: Cratering Record and Age Dating of the Galilean Satellites

Authors: Elena, Martellato, Universita' degli Studi di Napoli Parthenope Napoli Italy; Valentina, Galluzzi, INAF - Istituto di Astrofisica e Planetologia Spaziali Roma Italy; Simone, Marchi, Southwest Research Institute Boulder CO USA; Pasquale, Palumbo, Universita' degli Studi di Napoli Parthenope Napoli Italy; Alessandra, Rotundi, Universita' degli Studi di Napoli Parthenope Napoli Italy; Vincenzo, Della Corte, INAF - Istituto di Astrofisica e Planetologia Spaziali Roma Italy

Abstract: Impact craters are one of the most important landforms on planetary surfaces. Crater morphology and excavated materials provide important constraints to crustal stratigraphy, and variations of rheology with depth. In addition, the degree of crater morphological freshness can be useful to derive relative ages of the considered terrains. Statistical analysis of impact crater populations is recognized as the most used tool to derive absolute dating of planetary and small body terrains. One of the most commonly used chronological model was initially developed for the Moon and is based on relating crater counts at the Apollo landing sites to radiometric ages of the collected samples. This is then extrapolated to other planetary bodies, including the Galilean satellites, by making a number of assumptions including the source of the projectile population. Specifically for the Galilean satellites, other chronologies based on current estimates of the impact flux have been derived. These chronologies, however, suffer from a limited understanding of the variation of the impact flux with time. We present here a preliminary work on crater counts performed on Ganymede. By using the existing global geological maps, we performed further cartographic refinement of the geological units in order to select suitable and uniform areas for the crater counts. Each impact structure is selected by means of photo-interpretation (e.g., primary vs secondary, degradation degree, peculiar morphology, ejecta blanket, etc.) within the limits imposed by the available basemap resolution (~ 1 km/pixel), and, where available, by higher resolution Galileo SSI mosaics. In addition, we aim at deriving a revised chronology for the Galilean satellites using the most updated understanding on the current and historical impact flux resulting from recent dynamical models. This crater database and the new chronology model will improve our understanding of the geological evolution of the Galilean satellites, and lead the way to future investigations of the Jupiter System by the ESA JUICE mission.

Thematic section: Pianeti e satelliti

Francesco Marzari

Affiliazione: Dipartimento di Fisica, Università di Padova.

Contributi Proposti

Title: Dust distribution in circumstellar disks with two giant planets in resonance.

Authors: F. Marzari, DFA Università di Padova, G. Picogna, Ludwig-Maximilians-Universität München, DE; G. D'Angelo, Los Alamos National Laboratores, USA.

Abstract: Two giant planets in resonance alter the dust distribution in circumstellar disks due to the common gap they create in the gas. The peaks at the border of the gap act as dust traps and the dust density significantly grows. In addition the inward/outward migration enhances the dust accumulation of the borders of the gap causing also a decoupling between the gas gap and the dust gap (which becomes wider). By exploting the numerical algorithms RADMC-3D and CASA we translate the outcome of numerical simulations of the dust evolution into synthetic images to test whether the dust accumulation at the borders of the gap is a visible effect. We probe the observability of different mean motion resonances (MMR), by first post-processing the hydrodynamical simulation with the RADMC3D radiative transfer code, and then testing several configurations of the Atacama Large Millimeter/Submillimeter Array (ALMA) using the CASA software. This study can help us to understand whether we can deduce the presence of two migrating planets trapped in resonance directly from the signatures they leaves on the dust distribution.

Thematic section: Pianeti e sistemi extrasolari

Andrea Melis

Affiliazione: INAF - Osservatorio Astronomico di Cagliari

Contributi Proposti

Title: The Sardinia Radio Telescope: a general purpose facility for the study of exoplanets

Authors: Andrea Melis, INAF - Osservatorio Astronomico di Cagliari; Marta Burgay, INAF - Osservatorio Astronomico di Cagliari; Raimondo Concu, INAF - Osservatorio Astronomico di Cagliari; Emilio Molinari, INAF - Osservatorio Astronomico di Cagliari; Alessandro Navarrini, INAF - Osservatorio Astronomico di Cagliari, Maura Pilia, INAF - Osservatorio Astronomico di Cagliari; Delphine Perrodin, INAF - Osservatorio Astronomico di Cagliari

Abstract: The Sardinia Radio Telescope (SRT) is a 64-m antenna, currently fully operational; a third call for proposals has recently been published, offering a total of 1500 hours from January until June 2020. SRT is a general-purpose facility, used 80% of the time for radio astronomy but also used for spacecraft tracking (20% of the telescope time is used by the Italian Space Agency, ASI), as well as other applications like space debris mapping. Among these, we have been recently investigating the suitability for the Search for ExtraTerrestrial Intelligence (SETI) as a possible new activity. In particular, we are now collaborating with the Breakthrough Listen (BL) Initiatives program. Very recently, a press release announced an agreement between BL and the Transiting Exoplanet Survey Satellite (TESS), which is the planet-hunting successor to the Kepler Space Telescope, and SRT is fully involved in this: up to 12 TESS targets will be followed-up from the beginning of 2020. The radio observations of known exoplanets can also give signals of the star-planet interaction (SPI), as a tracer of mass transfer between the two, giving rise to synchrotron emission at low frequencies. We give here an overview of the SRT, its new upgrade to a wider range of frequencies, recently funded by Italian ministry under EU PON framework, and how we are getting involved in the exoplanets studies in this pilot phase.

Thematic section: Strumentazione

Andrea Meneghin

Affiliazione: INAF - Osservatorio Astrofisico di Arcetri

Contributi Proposti

Title: ABCS: a CubeSat for space environment astrobiology experiments

Authors: Andrea Meneghin, INAF – Osservatorio Astrofisico di Arcetri; John Robert Brucato, INAF – Osservatorio Astrofisico di Arcetri; Simone Pirrotta, ASI; Alessia Sabatini, ASI; Gabriele Impresario, ASI; Claudia Pacelli, ASI;Daniele Paglialunga, INAF – Osservatorio Astrofisico di Arcetri; Augusto Nascetti, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Gianluca Fiacco, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Stefano Carletta, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Luigi Schirone, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Pierpaolo Granello, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Matteo Ferrara, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Paolo Teofilatto, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Maurizio Parisse, Scuola di Ingegneria Aerospaziale, Università Sapienza di Roma; Lorenzo Iannascoli, Dipartimento di Ingegneria dell'Informazione, Elettronica e Telecomunicazioni, Università Sapienza di Roma; Domenico Caputo, Dipartimento di Ingegneria dell'Informazione, Elettronica e Telecomunicazioni, Università Sapienza di Roma; Giampiero de Cesare, Dipartimento di Ingegneria dell'Informazione, Elettronica e Telecomunicazioni, Università Sapienza di Roma; Laura Anfossi, Dipartimento di Chimica, Università di Torino; Mara Mirasoli, Dipartimento di Chimica, Università di Bologna; Liyana Popova, Kayser Italia S.r.l.

Abstract: AstroBio CubeSat (ABCS) is an Italian Space Agency (ASI) 3U CubeSat (100x100x340 mm) selected by European Space Agency (ESA) to be launched with the Vega C qualification maiden flight, as piggy back of the ASI LARES2 main satellite, during summer 2020. ABCS will be deployed in an approximately circular orbit, with about 5900km altitude and 70° of inclination. It implied that ABCS will spend a significant part of the orbital period within the internal Van Allen belt, close to its maximum. Coinsidering the extremely harsh space conditions, the estimated mission lifetime useful to perform the payload experiments should be defined in 3 months. The Project is funded and managed by ASI in cooperation with INAF-Astrophysical Observatory of Arcetri (INAF, I), that will coordinate the scientific and engineering team. Partners of the projects are the School of Aerospace Engineering of Sapienza University of Rome (UNIROMA1, I), the University of Bologna (UNIBO, I) the University of Torino (UNITO, I), and SME Kayser Italia. ABCS will host a mini laboratory payload based on an innovative lab-on chip technology suitable for research in astrobiology. The objective is to test in space environments an automatic laboratory able to provide a highly integrated in-situ multiparameter platform that uses immunoassay tests exploiting chemiluminescence detection. The experiment will consist in a set of lateral flow immunoassays (LFIA) on nitrocellulose support where target biomolecules are immobilized in specific test areas. Reagents are deposited in a non-permanent fashion and in a dry form in the initial part (starting area) of the microfluidic path. When the reagents-delivery-system provides a volume of liquid reagent to the starting pad, capillary forces will guide the reagents through the LFIA microfluidic pathway. During the flow, liquid reagents will solubilize and transport along the

path the deposited reagents, triggering specific reactions. The small device will be based on the strong heritage gained by the research team with the ground validation of the PLEIADES (Planetary Life Explorer with Integrated Analytical Detection and Embedded Sensors) instrument, an R&D; ASI project recently concluded. The experiment aims at evaluating the functionality of the device and the stability of chemicals and biomolecules employed. The in-orbit validation of the proposed technology would represent a significant breakthrough for autonomous execution of bio-analytical experiments in space with potential application in planetary exploration for biomarkers detection, astronauts' healthcare, space stations' environmental monitoring and more. In this work an overview of the main aspects of the experiment and payload definition of ABCS is presented.

Thematic section: Astrobiologia

Vito Mennella

Affiliazione: INAF- Osservatorio di Capodimonte Napoli

Contributi Proposti

Title: An evidence of a link between primitive solar system bodies and interstellar dust through the 3.2 μm band of 67P/CG

Authors: V. Mennella; F. Capaccioni; M. Ciarniello; G. Filacchione; C. Popa; A. Raponi; T. Suhasaria

Abstract: The VIRTIS spectrometer aboard Rosetta has shown that a broad absorption band between 2.8 and 3.6 centred at 3.2 μm characterizes the nucleus surface of comet 67P/CG (Capaccioni et al. 2015). Ammonium (NH4+) salts (such as ammonium formate, sulphate, citrate), water ice and carboxylic acids or alcohol inserted in a macromolecular organic solid have been proposed as carrier of the broad 3.2 μm feature (Quirico et al. 2016, Poch et al. 2019). Hydroxylated Mg-rich amorphous silicates can also contribute to the broad cometary feature (Mennella et al. 2019). Their presence on the cometary surface suggests an evolutionary link between primitive objects of the solar system and dust in the interstellar medium (ISM). This evolutionary link is further supported by the recent identification of aliphatic materials, of possible interstellar origin, through the presence of sub-features at 3.38, 3.41 and 3.46 μm on the broad 3.2 cometary band (Raponi et al. 2019). Here we discuss the results of experimental works aimed at simulating the evolution of dust grains (carbonaceous and siliceous), determined by their interaction with ions, atoms and UV photons, during their journey from birth-sites around evolved stars to our Solar System. References: Capaccioni et al. 2015.Science, 347, aaa0628. Mennella et al. 2019, in preparation. Poch et al. 2019, Science, submitted. Quirico et al. 2016, Icarus, 272, 32. Raponi et al. 2019, Nature Astronomy, in press

Thematic section: Piccoli Corpi, Planetologia sperimentale e di laboratorio

Alessandra Migliorini

Affiliazione: IAPS-INAF

Contributi Proposti

Title: JIRAM observation of H3+ and CH4 distributed along the disc of Jupiter

Authors: A. Migliorini (IAPS-INAF); A. Altieri (IAPS-INAF); B.M. Dinelli (ISAC-CNR); M. Moriconi (ISAC-CNR); A. Adriani (IAPS-INAF); A. Mura (IAPS-INAF); F. Tosi (IAPS-INAF); R. Sordini (IAPS-INAF); R. Noschese (IAPS-INAF); G. Piccioni (IAPS-INAF); D. Grassi (IAPS-INAF); C. Plainaki (ASI); G. Sindoni (ASI); and the JIRAM/Juno Team

Abstract: The Jovian Infrared Auroral Mapper (JIRAM) is the IR imager and spectrometer on board the Juno mission, designed to investigate Jupiter's atmosphere. A key objective of JIRAM is the investigation of the minor species, such as CH4 and H3+, which have strong emission lines in the 3.3-3.8 micron spectral range. These can be observed with the L-band imager filter (bandpass from 3.3 to 3.6 micron), and the spectrometer, which covers the 2-5 micron band with a spectral sampling on average of 9 nm. In this study, we discuss the spatial distribution of methane in the auroral region, both in the North and South hemispheres and its variation from orbit to orbit, observed with JIRAM during orbits 1 and 4 (August 2016-December 2016). The vertical distribution of CH4 and H3+ is investigated through limb measurements, acquired by both the L band imager and spectrometer, in the period May 2018-February 2019. The observations focus on mid-equatorial latitudes. Although the methane spectral radiance is quite low and the scattered radiation makes direct retrieval difficult from observations in the limb viewing mode, the vertical distribution of the observed radiances shows that CH4 is localized around 200 km above the 1-bar level, while a distinct layer due to H3+ is observed around 500-600 km (0.04-0.016 microbar).

Thematic section: Pianeti e satelliti

Anna Milillo

Affiliazione: INAF/IAPS

Contributi Proposti

Title: SERENA role in investigating Mercury’s environment with the two-spacecraft BepiColombo mission

Authors: Anna Milillo (1); Elisabetta De Angelis (1); Stavro L. Ivanovski (2); Monica Laurenza (1); Valeria Mangano (1); Stefano Massetti (1); Alessandro Mura (1); Stefano Orsini (1); Christina Plainaki (3); R. Rispoli(1); Tommaso Alberti(1); Alessandro Aronica (1); Adrian Kazakov (1); Francesco Lazzarotto (4); Raffaella Noschese (1); Fabrizio Nuccilli (1); Roberto Sordini (1); Nello Vertolli (1); and the BepiColombo Hermean Environment Working Group (1) INAF-IAPS; via Fosso del Cavaliere 100, 00133 Rome, Italy; (2) INAF-Osservatorio Astronomico di Trieste, via Giambattista Tiepolo, 11, 34143 Trieste, Italy, (3) ASI - Italian Space Agency, Via del Politecnico, 00133 Rome, Italy (4) INAF-Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio, 5, 35122 Padova, Italy

Abstract: The ESA-JAXA BepiColombo mission will provide simultaneous measurements from two spacecraft, offering an unprecedented opportunity to investigate the magnetospheric and exospheric dynamics at Mercury as well as their interactions with solar wind, radiation, and interplanetary dust. Many scientific instruments onboard the two spacecraft will be completely, or partially, devoted to studying the near-space environment of Mercury as well as the complex processes that govern it. Many issues remain unsolved even after the MESSENGER mission that ended in 2015. The specific orbits of the two spacecraft, MPO and Mio, and the comprehensive scientific payload allow a wider range of scientific questions to be addressed than those that could be achieved by the individual instruments acting alone, or by previous missions. These joint observations are of key importance because many phenomena in Mercury’s environment are highly temporally and spatially varying. MPO/SERENA particle sensors package has a key role in this aspect since this experiment is specifically devoted to investigate the planetary response to external conditions. Examples of possible coordinated observations will be described, analysing the required geometrical conditions, pointing, resolutions and operation timing of different BepiColombo instruments.

Thematic section: Pianeti e satelliti

Giuseppe Mitri

Affiliazione: IRSPS, InGeo, Università d'Annunzio

Contributi Proposti

Title: Possible explosion crater origin of small lake basins with raised rims on Titan

Authors: Jonathan I. Lunine; Marco Mastrogiuseppe; Valerio Poggiali

Abstract: The Cassini mission discovered lakes and seas comprising mostly methane in the polar regions of Titan. Lakes of liquid nitrogen may have existed during the epochs of Titan’s past in which methane was photochemically depleted, leaving a nearly pure molecular nitrogen atmosphere and, thus, far colder temperatures. The modern-day small lake basins with sharp edges have been suggested to originate from dissolution processes, due to their morphological similarity to terrestrial karstic lakes. Here we analyse the morphology of the small lake basins that feature raised rims to elucidate their origin, using delay-Doppler processed altimetric and bathymetric data acquired during the last close flyby of Titan by the Cassini spacecraft. We find that the morphology of the raised-rim basins is analogous to that of explosion craters from magma-water interaction on Earth and therefore propose that these basins are from near-surface vapour explosions, rather than karstic. We calculate that the phase transition of liquid nitrogen in the near subsurface during a warming event can generate explosions sufficient to form the basins. Hence, we suggest that raised-rim basins are evidence for one or more warming events terminating a nitrogen-dominated cold episode on Titan.

Thematic section: Pianeti e satelliti

Enrico Mugnaioli

Affiliazione: Istituto Italiano di Tecnologia

Contributi Proposti

Title: 3D electron diffraction for the mineralogical characterization of micro-meteorites and impact micro-ejecta

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Abstract: The investigation of cutting-edge topics in Earth and planetary sciences often requires the study of cryptocrystalline polyphasic materials, typically characterized by nano-scale mineral intergrowths associated with high-pressure/high-temperature transformations, fast and non-equilibrium processes and small amounts of available specimens. Conventional optical imaging and X-ray crystallographic tools may be not sufficient for the proper characterization of such samples. The development of efficient probes able to investigate the nanoworld is therefore crucial to further our understanding of the mineralogical and geochemical processes that regulate Earth and extraterrestrial environments. Over the last ten years, electron diffraction (ED) evolved from a qualitative method restricted to few TEM users, to a robust protocol for phase identification and ab-initio structure determination. Such changes have been possible due to the development of automatic and semi-automatic routines for 3D data collection (Gemmi et al., 2019). This methodology is in principle equivalent to single-crystal X-ray diffraction, but can be performed on crystals 10 to 1000 times smaller. In this contribution, we show recent applications of ED in planetary sciences. In particular, how ED allowed the mineralogical screening of the carbonaceous chondrite CM Paris (Pignatelli et al., 2018) and of a hydrated chondritic micrometeorite (CP94-050-052) through the polytypic description of sub-micrometric phyllosilicate grains. Moreover, we will present an extensive petrographic and crystallographic study of quartz-coesite mineralogical association in impact ejecta from Kamil Crater, Egypt (Folco et al., 2018), and from the Australasian tektite strewn field (Campanale et al., 2019). We believe that the extensive application of modern ED techniques on micro-to-nanometer extraterrestrial samples has the potential for significant breakthroughs in our understanding of the Solar System’s formation and evolution. Also, it will allow the thorough exploitation of the evidence already enclosed in the micrometeorite collection recovered within the Progetto Nazionale Ricerche in Antartide (PNRA) and in the forthcoming European space missions. ED will also significantly support other sources of information based on remote sensing and spectroscopy and will therefore ensure better constraints in numerical modeling studies. Campanale F., Mugnaioli E., Folco L., Gemmi M., Lee M.R., Daly L. & Glass B.P. Evidence for subsolidus quartz-coesite transformation in impact ejecta from the Australasian tektite strewn field. Geochimica et Cosmochimica Acta, 2019, 264, 105-117. Folco L., Mugnaioli E., Gemelli M., Masotta M. & Campanale F. Direct quartz-coesite

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Thematic section: Meteore, meteoriti e polvere interplanetaria

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Contributi Proposti

Title: First CaSSIS observations of Martian recurring slope lineae: implications for their origin and evolution

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Abstract: Recurring Slope Lineae (RSL) are narrow, dark features that appear to initiate at bedrock outcrops and incrementally lengthen down steep warm Martian slopes [1]. In general, most RSL form when temperatures are warm (typically in local spring and summer), fade in cold seasons when temperatures drop, and recur annually [1]. Multiple models have been proposed to explain their origin, but a definitive explanation is still missing. The temperature dependence of RSL activity and their spatial correlation with multi-scale fractures [4] suggests that they are liquid triggered flows [1-6] associated with groundwater sources [4,6,7], while other studies favour dry granular flows [7-11]. The Colour and Surface Stereo Imaging System (CaSSIS, [12]) on board the ESA ExoMars Trace Gas Orbiter mission (TGO) provides images of the Martian surface in four bands at a resolution of 4.6 m. The 74° inclined orbit of TGO allows CaSSIS to image a given location of Mars at different local times, providing the unique opportunity of imaging RSL sites in the morning. These observations are of pivotal importance in understanding the nature of RSL. Indeed, if these features are related to liquids (i.e. via deliquescence), then they should be more stable in the morning and we should see increased RSL activity at these times. Alternatively, no differences between morning and afternoon observations would be expected for dry granular flows. In this study we present the first observations of RSL at Hale crater, Mars, performed by CaSSIS during local morning and compare them with HiRISE observations acquired during local afternoon. We search for any difference in global activity and RSL relative albedo [11,13] between morning and afternoon. We use the model of [14] to study the thermal environment of the surface and assess whether temperatures allowed either melting of brines or deliquescence of salts at the time of the CaSSIS observations. Acknowledgments: The authors wish to thank the spacecraft and instrument engineering teams for the successful completion of the instrument. CaSSIS is a project of the University of Bern and funded through the Swiss Space Office via ESA's PRODEX programme. The instrument hardware development was also supported by the Italian Space Agency (ASI) (ASI-INAF agreement no.I/018/12/0), INAF/Astronomical Observatory of Padova, and the Space Research Center (CBK) in Warsaw. Support from SGF (Budapest), the University of Arizona (Lunar and Planetary Lab.) and NASA are also gratefully acknowledged. The study has been supported by the Italian Space Agency

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Thematic section: Pianeti e satelliti

Title: Topographic correction of HiRISE and CaSSIS images

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Abstract: The topographic correction of satellite images can be exploited to disentangle albedo features from illumination effects induced by topography and to perform spectrophotometric studies based on multi-wavelengths datasets. The reflectance of a surface at a given wavelength depends on the scattering properties of the material of which it is made of [2]. This dependence is usually modelled by three observation angles: the incidence, phase and emission (or emergence) angles [2]. We will consider four simple photometric models that are widely used in planetary photometry: the Lambert [3] (i.e. a cosine correction), the Lommel-Seeliger [4], the Akimov [5] and the Minnaert models [2,3,6]. The aim of this work is to test and evaluate the performance of these photometric models at removing the topographic shading from High Resolution Imaging Science Experiment (HiRISE, [7]) and Colour and Surface Science Imaging System (CaSSIS, [8]) images at a resolution of 0.3 m and 4.6 m, respectively. We use digital terrain models (DTMs) of the surface to compute incidence and emission angles for every pixel of the image, following the methodology described in [2]. These angles are then used as inputs for the photometric models to remove the topographic shading. As a result, for each model we obtain a topographically corrected image. All corrected images are then compared to assess which model explains better the observed dependency between the reflectance of the surface and the observation angles. In particular, since in our case the phase angle is constant all over the image and the effect of the emission angle is negligible, the main dependency is from the incidence angle. We find that in multiple cases the Minnaert model achieves the best correction, producing images in which the effect of topography on the reflectance of the surface is reduced. The method is validated by reproducing the measurements of [7] and will be applied in future to investigate albedo features on HiRISE and CaSSIS colour observations. In particular, it will be applied to photometrically study the temporal evolution of Recurring Slope Lineae on Mars [9], extending the study of [7] to other regions and different spectral bands.

Acknowledgments: The study has been supported by the Italian Space Agency (ASI-INAF agreement no.2017-03-17). References: [1] S. Walter et al., 2011, EPSC-DPS2011-648, 2011 [2] Hapke, B., 1993. Theory of Reflectance and

Emittance Spectroscopy. CUP [3] McEwen, S. A., 1991, Icarus 92, 2,298-311 [4] Fairbairn, M.B, 2005 Journal of the Royal Astronomical Society of Canada,99,3,92 [5] Akimov, L.A., 1976. Sov. Astron. 19(3), 385-388. [6] Minnaert, M.,1941, ApJ 93, 403-410. [7] Schaefer, E. et al. (2019) Icarus 317, 621-648. [7] McEwen, A. S., et al., 2007, J.G.R., 112,E05S02 [8] Thomas, N. et al., 2017, Space Science Reviews, 212,1897–1944 [9] [1] McEwen, A.S. et al., 2011. Science, 333, 740-743

Thematic section: Pianeti e satelliti

Mara Murri

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Contributi Proposti

Title: Multi-methodological approach to quantify hexagonal stacking in natural impact diamonds

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Abstract: Impact diamonds often exhibit structural disorder in the form of complex combinations of cubic and hexagonal stacking motifs (e.g. Németh et al. 2014, Salzmann et al. 2015, Jones et al. 2016). The structural characterization of such diamonds remains a challenge. Moreover, investigation of mineral structures retrieved from their host rocks (e.g. meteorites, planetary bodies and target rocks) provides fundamental information on planetary-scale geological processes including impact cratering processes. Impact diamonds from the Popigai impact site (Siberia, Russia) containing hexagonal features in their X-ray diffraction patterns were studied to develop a systematic protocol for understanding and assigning specific hexagonality attributes to the mineral designated as "lonsdaleite" (Bundy & Kasper 1967) among natural, artificially shocked and synthetic samples with only sp3-bonded carbon atoms. Their hexagonal features interpreted as a deviation from the standard cubic structure of diamond were characterized using multiple techniques (i.e. high-resolution X-ray diffraction, high-resolution transmission electron microscopy, micro Raman spectroscopy and density functional theory calculations) in order to also understand how the deviatoric stresses deform the crystallographic structures during catastrophic impact events (Murri et al. 2019). Acknowledgements MM, MA and MCD were supported by the IMPACt project (R164WEJAHH) to MA. MM and MA were also funded by the European Research Council (ERC) under the European Union’s Horizon 2020 Research and Innovation Programme (grant agreement 714936) for the project TRUE DEPTHS to MA. MM, MA FN and MCD were also funded by PNRA 2018 grant to FN, and MM received support from the Barringer Family Fund for Meteorite Impact Research. PN acknowledges financial support from the Hungarian NRDIO project NKFIH_126502 and the János Bolyai Research Scholarship. The authors thank the UK Royal Society for a University Research Fellowship to CGS (UF150665), the UCL Chemistry Department for a DTP studentship (RLS), and the Advanced Characterization of Materials CDT (EPSRC EP/L015277/1) for a PhD studentship to MH. References Bundy, F. P. & Kasper, J.

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Thematic section: Meteore, meteoriti e polvere interplanetaria, Planetologia sperimentale e di laboratorio

Jacopo Nava

Affiliazione: Università di Padova

Contributi Proposti

Title: New perspectives into outburst and sublimation on minor bodies and comets inferred from laboratory experiments on carbonaceous chondrites.

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Abstract: Outbursts can be generated by cryovolcanism on different planetary bodies such as asteroids and satellites [1 to 5] and by irradiation and sublimation on cometary nuclei [6-7]. Cryovolcanic activity and ice-rock interaction are poorly understood [8-9]. To shed light on these mechanisms we made some experiments in laboratory with Carbonaceous Chondrites (CCs) and ices to simulate cryovolcanic processes and study outbursting products. We powdered 5 CCs samples (FRO99040, FRO90006, FRO95002, DEW14001 and DaG521) and individually mixed them with deionized or ammoniated waters and subsequently froze them at -80°C. Once frozen the mixtures were put in a vacuum chamber and heated from ~ -195°C up to ~ 100°C. The powders started sublimating fine particles at around -40°C and between -20 °C and -10°C a violent outburst occurred. We divided the sublimated powders from the ejected powders during the outburst and we acquired IR reflectance spectra of the resulting powders. The spectra have been than compared with the original powders. In the ejected powders the 3.4 μm and 3.5 μm bands of aliphatic hydrocarbons appeared in four samples, in the sublimated powders these features were found in two samples while in the original powders they were not present. Gas chromatography analyses showed that in the sublimated powders new n-alkanes in the C11-C22 range formed and in the ejected powders these n-alkanes were found in much higher abundances with respect to the sublimated and original powders. We found out that aliphatic hydrocarbons can form in presence of ice during short-duration sublimation-outburst at temperature at least as low as -40°C. Our results can explain the organic-rich composition of bodies like Ceres and Themis and implies that cometary activity is capable of creating new organic materials. Our results can also explain the high organic matter abundances in micrometeorites if we consider sublimation-outburst as of their possible delivery mechanism. Acknowledgments: Europlanet 2020 RI has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654208. Samples loaned from MNA (Museo Nazionale dell'Antartide, Italy). [1] Ruesch et al., 2016. Science. [2] Quick et al., 2017. Icarus. [3] Postberg et al., 2009. Nature. [4] Head et al., 2002. Geophysical Research Letters. [5] Desch and Neveu, 2017. Icarus. [6] Miles, 2016. Icarus. [7] Vincent et al., 2016. Monthly Notices of the Royal Astronomical Society. [8] Kargel et al., 1991. Icarus. [9] Neveu et al., 2015. Icarus.

Thematic section: Meteore, meteoriti e polvere interplanetaria, Piccoli Corpi, Planetologia sperimentale e di laboratorio

Title: Composition of C-type asteroids inferred from Antarctic fine-grained micrometeorites showing the 3 μm band

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Abstract: Many C-type asteroids are characterised by an IR reflectance spectra showing a 3 μm band with its centre varying between 3 to 3.15 μm [1]. The nature of this band is still debated and among meteorites only one sample showing the 3 μm band has been found [2], for this reason we studied several Fine-Grained micrometeorites (Fg-MMs). Among the studied samples we found 3 particles showing a 3 μm band I.e. TAM5.29, TAM18c.11 and TAM18c.13. TAM5.29 is a CV-like minimeteorite characterised by a matrix of Fe-rich olivine largely altered into iddingsite, and clasts of andradite surrounded by diopside-jarosite-phyllosilicates assemblages [3]. TAM18c.11 and TAM18c.13 are very similar in composition and both suffered a very strong alteration in Antarctica that replaced almost all the crystals with ammonium-jarosite. The band centre of the 3 μm absorption of these samples varies between 3.07 μm up to 3.15 μm. The 3.15 μm band is found in TAM5.29 and is associated with Fe-rich hydrous phases suggesting a close relationship with Fe-OH bonds as already suggested by [4]. In a localized spot in TAM5.29 and in TAM18c.11 the 3 μm band is found at around 3.07 μm. In the case of TAM5.29 particle is found together with the 3.4 and 3.5 μm absorptions of aliphatic hydrocarbons, while in TAM18c.11 is found scattered around the ammoniumjarosite-rich matrix. These results suggest that at shorter wavelengths (3.07 μm) the 3 μm band is indicative of organic matter, most likely CH and NH functional groups (as suggested by [5]), while at longer wavelength (3.15 μm) this band is related to Fe-rich hydrated minerals. With these observations we infer that Europa-like asteroids (with a band centre at 3.15 μm) are Fe-rich hydrous worlds, while Ceres-like bodies (with a band centre at 3.05 ± 0.01) are organic rich worlds. Furthermore both Europa and Ceres-like bodies underwent an extensive period of hydrothermal alteration and a second period of low-temperature aqueous alteration. [1] Takir and Emery, 2012. Icarus. [2] Takir et al., 2019. Icarus. [3] Nava et al., 2019. 82nd Annual Meeting of The Meteoritical Society. [4] Rivkin, et al., 2006. Icarus. [5] De Sanctis et al., 2015. Nature.

Thematic section: Meteore, meteoriti e polvere interplanetaria, Piccoli Corpi

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Contributi Proposti

Title: Origin of diamond and graphite in ureilites: a timely topic in planetary geology

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Abstract: In this study we investigated diamonds in three carbon bearing samples from AhS 209b, AhS 72 and NWA 7983 meteorites, by scanning electron microscopy, X-ray diffraction, micro-Raman spectroscopy and transmission electron microscopy. Almahata Sitta (AhS) fragments show a mixture of nano-diamond (with stacking disorder of diamond) and nano-graphite, while in NWA 7983 the simultaneous presence of micro- and nano-diamonds associated with nano-graphite was detected. A recent study has proposed the formation of diamond in ureilites at static pressures >20 GPa in a large planetary body with size similar to Mars or Mercury (Nabiei et al. 2018), like typical lithospheric diamonds formed in the Earth's mantle. In NWA 7983 we found an unprecedented occurrence of coexisting nanodiamonds (between about 9 and 50 nm), large monocrystalline diamonds (up to at least 100 μm), nanographite, and nanometric grains of metallic iron, cohenite, troilite and likely schreibersite. We argue that diamonds and graphite within NWA 7983 ureilite (as well as the two Almahata Sitta fragments) were formed during an impact shock event characterized by peak pressures of ~ 15 GPa, consistent with the shock level recorded by the silicates. This is supported by experimental evidence that detonation processes can produce a similar association of micro- and nano-diamonds (Efremov et al. 2018a, 2018b, 2019). There is no evidence that formation of micrometer(s) sized diamonds or associated Fe-S-P phases in ureilites require high static pressures and long times for formation. It is highly unlikely that any of the diamonds in ureilites formed in bodies as large as Mars or Mercury (Nabiei et al. 2018). AB, MCD, FN, MA have been funded by the PNRA 2018 to F. Nestola. AB, MM, MCD and MA have been funded by the MIUR FARE 2016 IMPACt project (R164WEJAHH) to M. Alvaro; CG is funded by the NASA EW program. References F. Nabiei, et al., Nat. Commun. 9, 1–6 (2018). V. P. Efremov, E. I. Zakatilova, I. V Makalashova, N. V Shevchenko, J. Phys. Conf. Ser. 946, 1–8 (2018a). V. P. Efremov, E. I. Zakatilova, I. V Maklashova, N. V Shevchenko, Nanotechnologies Russ. 13, 11–17 (2018b). V. P. Efremov, E. I. Zakatilova, J.

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Thematic section: Meteore, meteoriti e polvere interplanetaria

Fabrizio Oliva

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Contributi Proposti

Title: Vertical distribution of dust in the Martian atmosphere from OMEGA-MEx observations

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Abstract: The OMEGA spectrometer on board Mars Express acquired several observations of the Martian limb that are still largely unexploited. Here, we explore the information content of these data in terms of density and size of the dust suspended in the Martian atmosphere. An accurate measurement of the Martian dust distribution is essential for the understanding of the physical processes driving the dynamics and energy balance of the atmosphere, and represents an important input for the atmospheric models (e.g Kahre et al. 2008). For the first time, we approach the quantitative retrieval of dust-related quantities by applying a full spherical multiple scattering Monte Carlo (MC) 1D radiative transfer code (MYSTIC, Mayer 2009), to selected case studies. The OMEGA data in the 0.5-2.5 μm spectral range, covered by two the instrument channels VNIR and SWIR, is used to derive dust effective radii and number density variation with altitude in ranges of altitude between about 5 and 50 km, with variable spatial resolution. Water ice has not been included in the simulations and the spectra in the OMEGA LWIR channel (2.7-5 μm) range, which include the most diagnostic spectral features of water ice, have been used as a proxy for selecting limb observations with a pure dust composition. The complex radiative transfer in limb geometry is modeled in a spherical shells MC scheme in order to fully take into account multiple scattering effects, which are very significant in this spectral range at altitudes below 20-30 km. We also included an improved treatment of the atmosphere illumination from the surface (surface-shine), by reconstructing the variation of the surface reflectivity in the actual geometry of the limb observation, by taking advantage of OMEGA nadir surface measurements and NAIF-SPICE library. We will show the vertical profiles of dust properties compatible with OMEGA data and their implication, as well as the related issues, either due to instrument features and to intrinsic limitations of the methodology. References Kahre, Melinda A., Jeffery L. Hollingsworth, Robert M. Haberle, and James R. Murphy. 2008. "Investigations of the Variability of Dust Particle Sizes in the Martian Atmosphere Using the NASA Ames General Circulation Model." Icarus 195 (2): 576–97. Mayer, B. 2009. "Radiative Transfer in the Cloudy Atmosphere." The European Physical Journal Conferences 1 (February): 75–99.

Thematic section: Pianeti e satelliti

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Contributi Proposti

Title: The Lermontov crater on Mercury: morphology, age determination and spectrophotometry

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Abstract: The Lermontov crater is a 166-km size crater located at 15.24°N, 48.94°W in the Kuiper quadrangle of Mercury. This crater was first identified in Mariner 10 images thanks to its particularly bright floor characterised by smooth plains [1]. The bright behaviour of the crater was first explained as the result of fumarolic alteration along floor fractures [2]. Nevertheless, since the crater floor appears to have a lower crater density than the surroundings and its northeast part has irregular rimless pits (this is indicative of endogenic modification [3]), [4] proposed that the bright floor deposit might have been emplaced by pyroclastic activity. By means of MESSENGER flybys 1-3 images, the Lermontov floor deposit was eventually identified as one of the 35 pyroclastic deposits observed on Mercury [5]. In particular, the pit associated with the Lermontov NE pyroclastic deposit is morphologically similar to the one associated with the lunar pyroclastic deposit Sulpicius Gallus [6,7], where a non-circular shape, rimless margins and lack of ejecta deposits is evident [5]. In this multidisciplinary work we use the MESSENGER-Mercury Dual Imaging System Narrow Angle Camera (MDIS-NAC, [8]) 35 m-resolution images to prepare the first high-resolution geological map of the crater and its closest surroundings, distinguishing seven different units and four linear features. Among the several features identified, the crater floor appears strongly affected by hollow-related morphologies and deposits, which cover almost entirely the flat area inside the crater, and also some portions of the crater wall and ejecta (in the northern sector). Through the crater counting technique, the derived modelled age ranges between 3.84 and 3.74 Ga [9,10]. This age is older than the Mansurian one previously suggested for Lermontov [11], hence dating back the emplacement of the crater into the Calorian age. On the photometrically corrected MDIS-Wide Angle Camera (WAC) multiband dataset, we apply an unsupervised spectral clustering K-means technique [12,13] that separates the different deposits located both inside and outside the Lermontov crater. We identify that the pyroclastic deposits located on the crater’s floor have a steep, red spectral behaviour. On the contrary, the vents’ rims are characterised by several hollows whose spectral slope is bluer that the pyroclastic deposits themselves and the absorption bands are similar to those identified inside hollows located far away from the vents. Eventually, the mineralogical analysis of the derived spectra is presented. This activity has been realized under the BepiColombo ASI-INAF

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Thematic section: Pianeti e satelliti

Title: Inverted fluvial features in NE Eridania basin, Mars. Origin and timing of fluvial activity

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Abstract: The Eridania paleolakes system is located along the 180° meridian between Terra Cimmeria and Terra Sirenum: it is considered to be one of the largest lacustrine environments that were once present on Mars [1]. Eridania’s body of water, 562000 km3, exceeded the volume of all other lakes on Mars combined [2], but due to the lack of major tributaries flowing into this basin, its existence is interpreted to be related to groundwater springs, with a minor contribution from surface runoff [3]. Several sedimentological and mineralogical records have supported evidence for: i) a low-energy and long-lasting depositional environment characterized by the presence of ponding water and ii) a warm paleoclimate with a stable highland water table more than 3.5 Ga ago [1,5,6]. In this work we focus on the N-E side of Eridania Basin, over an area located between 181°E and 182°E longitude and 29°30’S - 31°30’S latitude. This location shows well-preserved sinuous ridges associated with fan-shaped deposits that are now topographically inverted. The western end is currently buried beneath basaltic lavas that cover the vast majority of the Eridania basin [6]. To the east, such feature extends up to a low-lying area, where several sediments spread. The length of the inverted feature’s course is at least 38 km and its thickness does not exceed 20 m, despite the fact that it may have been eroded to an unknown extent. In this study, we interpret these features to be remnants of fluvial activity based on their morphological setting and sedimentary structures that offer layering and cross-bedding in a few parts. The source of this system is not clear but it seems to have sedimented deposits in a relatively small and closed basin with a presumed delta fan. Such sediments spread over an area of 9.08 x 102 km2, locally showing evidence of layering, testifying the occurrence of multiple phases of sedimentation. The catchment of the ancient riverbed and its drainage basin is unclear, since

volcanic capping units completely cover the area to the west; nevertheless, the occurrence of a channel and possible delta over this location is of particular importance because it may highlight the presence of a late-stage fluvial activity while the full body of water in Eridania was vanishing. The presumed delta fan itself is topographically open towards lower elevation inside the E-SE basin and its elevation suggests the presence of paleolake with a minimum depth of about 20 m. Over the full study area, the high-albedo patches of Fe and Mg clays [6] deposited on the ancient Eridania seafloor intermix with the dark deposits brought inside the late stage paleolake. New CaSSIS images taken in 2019 [7] reveal the strong color differences among those distinct units. By using the CTX 5.5 m resolution images covering the area [8] we counted all craters situated on such deposits and estimated a modeled age of 3.45 +0.03/-0.04 Ga ago. This should point out to the final timing when the late stage body of water vanished from this basin. This study has been supported by the Italian Space Agency (ASI-INAF agreement no.2017-03-17). [1] Irwin III, R.P. et al., 2002. Science 296 (5576), 2209-2212. [2] Fassett C.I. & Head J.W., 2008. Icarus 198, 37-56. [3] Andrews-Hanna J.C. et al., 2007. Nature 446, 163-166. [4] Adeli S. et al., 2012. EPSC Congress 2012, 7, p 291. [5] Pajola M. et al., 2016. Icarus 275, 163-182. [6] Michalski J.R. et al., 2017. Nat. Comm., 8:15978. 2017. [7] Thomas N. et al., 2017. Space Sci. Rev., 212(3-4), 1897-1944. [8] Malin M.C. et al., 2007. J. Geophys. Res. 112, E05S04.

Thematic section: Pianeti e satelliti

Maria Pedone

Affiliazione: Agenzia Spaziale Italiana (ASI)

Contributi Proposti

Title: Study of freezing and upwelling processes of brines under Ceres' surface: some clues about thermodynamic and kinetic differences

Authors: Maria Pedone; Eleonora Ammannito; Christina Plainaki. Agenzia Spaziale Italiana, Rome, Italy

Abstract: On Ceres' surface, VIR spectrometer's data [1] suggested a different style of aqueous alteration occurred locally [2]. Spectral analysis of Juling and Kupalo craters, selected for this work, evidences the existence of water ice and carbonates; nevertheless, some substantial compositional differences have been identified too. At first, we used FREZCHEM code [3] to infer the initial speciation of aqueous solutions under the both craters. In the code, we selected fractional crystallization pathway by changing temperature values from 273 K to 243 K, close to eutectic. We simulated freezing processes under three different values of initial total pressure in which the starting solutions have cooled to precipitate the solids characterizing the surface. Then, we compared the results of the applied code with our chemical equilibria calculations to understand the equilibrium state for each precipitated mineral, during cooling process, related to the activities of solutes and the ionic strength of solutions. Decreasing temperature caused, at first, the precipitations of carbonates (thermodynamically favorited), followed by the formation of sulphates and, later, of Cl-bearing salts from more saline brines. Solids precipitation feeds cooling process, changing the velocity/density ratios of aqueous solutions that would have arrived at surface erupting with a velocity of ~8·10-5 m/s, after they moved upward in a cylindrical conduit with a presumed radius of 1 km. Our models [4] suggest that Na-Cl-enriched (Kupalo-like) solutions could freeze at a lower temperature with respect to Na-Cl-depleted (Juling-like) solutions, and confirm the endogenous origin of solid compounds observed on Ceres' surface. These solids deposited during the brines freezing in the subsurface and, possibly, in terms of salinity, density, and volatiles solubility, these brines have reached the surface from below. Moreover, some molecules' formation is highly pressure-dependent, as for sodium-salts. Beneath Kupalo, at specific pressure condition, some kinetics-dependent molecules could form, suggesting that aqueous solutions plausibly were affected by cooling processes slower than the nearby Juling. Revealing the details of the freezing processes within the Solar System will be an important step for future investigations aiming at the understanding of the planetary bodies' evolution. [1] De Sanctis M.C. et al., Sci Rev, 163, 329-369, 2011. [2] Carrozzo F.G. et al., Sci Adv 4, doi: 10.1126/sciadv.1701645, 2018. [3] Marion G.M. et al., Computers & Geosciences, 36, 10-15, 2010. [4] Pedone M. et al., JGR: Planets, under review, https://www.essoar.org/doi/10.1002/essoar.10501116.1.

Thematic section: Pianeti e satelliti, Piccoli Corpi

Luca Penasa

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Contributi Proposti

Title: The origin of cliffs on comet 67P

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Abstract: Cliffs on comet 67P are ubiquitous features whose size distribution has been linked to the amount of processing a comet have been subject to: pristine comets would present both large and small cliffs, while older and processed nuclei would have lost most of the small cliffs due to erosional processes (Vincent et al. 2017). A satisfying explanation about how cliffs might have been formed in first instance was never discussed in depth though it is fundamental for a thorough understanding of the morphological features observed on the nucleus. Previous investigations suggested that they might be the result of a selective erosional process associated to the presence of layers (Massironi et al. 2015). Although viable, this hypothesis is in contrast with the observation that sublimation tend to produce smoother nuclei (and not vice-versa), hence other formation mechanisms should be investigated. Furthermore the large amount of missing materials suggested by recent studies (Franceschi et al. 2019) is hard to be accounted for with loss of mass by sublimation only. We made use of latest 3D shape models (Preusker et al. 2017) to analyse the distribution of the local orientations of the cliffs (Vincent et al. 2017). We used a “polar” model to measure the orientation of cliffs in local reference frames: provided an imaginary axis passing trough the comet and two poles at the intersection between the axis and the nucleus surface, it is possible to define parallels and meridians for the whole cometary body. We then used the reference frame provided by these imaginary lines to measure the degree of correlation between cliff orientations and meridians or parallels. In the case of randomly distributed orientations we expect to not find any preferential orientation. With this technique we demonstrate that the cliffs are indeed non-randomly distributed and are statistically aligned to the imaginary parallels associated to the long axis of the comet (the lobe’s junction axis, which is almost perpendicular to the rotational axis). This evidence, together with previous investigations regarding the layered nature of 67P lobes (Massironi et al. 2015; Penasa et al. 2017) and their deformations (Franceschi et al. 2019), suggests that the collisional event that brought together the two cometesimals might have had a role in the process of shaping the morphology of 67P: layers might have worked as large-scale detachment surfaces on which fractures would have propagated. To explore this hypothesis a series of simulations based on the Discrete Element method (Wang and Mora 2009) was set up to reproduce the process of layer-driven detachment during the collision of the lobes. Although preliminary and

limited our results show that under specific circumstances it is indeed possible to generate extended curved fractures that could detach large portions of the external layered shells. Cliffs orientation and simulations of layered impactors strongly suggest that cliffs might have been originated as the result of the lobe-merging impact rather than sublimation processes acting on layers of different susceptibility to erosion. The peculiar morphology observed on comet 67P, might indeed be dominated by the effects of the impact of two layered bodies, while the activities related to sublimation might have had a minor impact than previously thought. Cliff-height distribution might indeed be used as a valid proxy for the amount of processing the nucleus underwent, but only provided that some other process previously created them.

Thematic section: Piccoli Corpi

Title: Three dimensional geological modelling in the context of the PLANMAP project

Authors: Luca Penasa (1), Riccardo Pozzobon (1), Marco Franceschi (2), Barbara De Toffoli (1), Matteo Massironi (1), and the PLANMAP team 1) Dipartimento di Geoscienze, Università degli studi di Padova, Padova, Italy 2) Department of Mathematics and Geosciences, via Weiss, Trieste, Italy

Abstract: Three dimensional geological modelling (Wellmann and Caumon 2018) is widely employed in the mining and oil industry for creating 3D geometrical representations of geological structures (sedimentary bodies, faults, folds etc...), which can then be used as a sound basis for performing any kind of physical simulations, as for example modelling fluid-flow in porous media. The applicability of these techniques have been for long restricted to studies on Earth because of the sparsity of surface and subsurface data available for small bodies and solid planets. This perspective has been progressively improving during the last years thanks to an overall increase in quality and variety of products that have become available, suggesting that, not only it is now possible to approach geological studies in a more detailed manner, but also that 3D modelling techniques might soon become a valuable tool for developing and refining the conceptual models behind the formation and the evolution of geological features. In this perspective, the PLANMAP project is exploring the application of three dimensional geological modelling in the context of planetary sciences, trying to extend surface information to the subsurface. Both implicit and explicit modelling approaches have been evaluated in real scenarios via open source tools and proprietary software on the Moon by using Chang'e III Yutu's rover GPR data (Xiao et al. 2015), on Mars by exploiting SHARAD radargrams (Putzig et al. 2018) and structural data on the Crommelin crater (Pozzobon et al. 2019), on comet 67P where only surface information was used to produce a comprehensive model of the inner layering (Penasa et al. 2017), and on Mercury in the Rembrandt basin (Semenzato et al. 2018). Results of this preliminary investigation show that these techniques can indeed be applied also in the planetary context. Although the resulting models suffer of several limitations due to the scarcity of observations, they provide a way of visualizing the structures undergoing investigation with a numerical representation that is inherently coherent in all the directions. The models make it possible to extract additional quantities related to the involved volumes or other geometrical parameters. Inferring the subsurface from an extremely limited set of observations is a challenging task for the planetary scientists. Any three dimensional model of a geological body not only is required to honour measurable constraints but should also to respect all the previous geological knowledge about the formation and evolution of the body under study. The development of such conceptual models and their subsequent integration into three dimensional

representations cannot be decoupled. Such approach will be one of the key by which our understanding of geological processes on solid planets and small bodies will improve.

Thematic section: Pianeti e satelliti

Davide Perna

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Contributi Proposti

Title: Near-Earth small body nodal encounter mission opportunities

Authors: Davide Perna, INAF-OAR; Lorenzo Casalino, Politecnico di Torino; Ettore Perozzi, ASI; Elisabetta Dotto, INAF-OAR; Elena Mazzotta Epifani, INAF-OAR

Abstract: In recent years the discoveries of near-Earth asteroids (NEAs) are exponentially growing in number, mainly concerning very small bodies, down to meter-sized ones (i.e., orders of magnitude smaller than those already visited by space missions). Investigating the physical properties of asteroids with diameters up to some tens of meters -- and in particular checking whether they are solid blocks or aggregates -- can tell us crucial information on how cohesion works in such a low-gravity environment, which was also experienced by planetesimals of this size during planetary formation. Furthermore, it will be essential to assess the potential exploitation of the asteroidal mineral resources in the near future, as well as to increase our capacity of mitigating the asteroid threat of collision with the Earth. A spacecraft travelling in an orbit very similar to that of the Earth could encounter several small NEAs at their orbital nodes. E.g., rendez-vous with 3 asteroids could be feasible with total deltaV of about 2.5 km/s and total transfer time of about 2 years. Fly-by encounters would allow much smaller propellant consumption, or alternatively to visit more asteroids with deltaV being equal. This mission concept will be presented and discussed.

Thematic section: Piccoli Corpi

Ettore Perozzi

Affiliazione: Agenzia Spaziale Italiana

Contributi Proposti

Title: The Accessibility of Small Bodies Nearby the Orbit of the Earth

Authors: Ettore Perozzi, Agenzia Spaziale Italiana; Alessandro Rossi, IFAC-CNR; Giovanni B. Valsecchi, INAF-IAPS, Alessio Giunta, ASI Space Science Data Center

Abstract: The new trend in the exploration of the solar system is likely to profit of the development of an increased low-cost access to interplanetary space and of small- to nano- satellites (e.g. cubesats). The possibility of reaching small bodies when they pass close to the orbit of the Earth is therefore more and more appealing, allowing mission scenarios such as multiple flybys and nodal encounters. Within this framework it is worthwhile analysing the flux of small bodies in the vicinity of the orbit of the Earth (asteroids, short and long period comets, interstellar objects) also in view of the operation of the new generation of all-sky surveys (e.g. LSST, Flyeye). The goal is to assess their accessibility and provide inputs for selecting targets for future missions and cruise science opportunities for already planned missions.

Thematic section: Dinamica dei corpi celesti naturali e artificiali

Luis Diego Pinto

Affiliazione: INAF-IAPS Istituto di Astrofisica e Planetologia Spaziali

Contributi Proposti

Title: Young Protoplanetary disks evolving in open clusters: SPH treatment with radiative transfer formalism

Authors: Luis Diego Pinto (INAF-IAPS), Gianfranco Magni (INAF-IAPS), Fabrizio Capaccioni (INAF-IAPS)

Abstract: The recent discoveries of protoplanetary disks (see, e.g., [3], [5]) and planetary systems [4] in Open Clusters provided new perspectives on the models of planet formation: planets can also be formed in a disk affected by the gravitational perturbation of other stars, rather than evolving in an isolated system. Such an idea is applicable also to our Solar System evolution model, too, since there are strong arguments suggesting that the Sun was part of an Open Cluster [6]. New models are thus needed to evaluate the effects of the interactions of the other stars on the matter distribution inside the early protoplanetary disk and the further dynamical evolution of the Solar System. Our SPH model [7] treating the evolution of an early protoplanetary disk around a sun-like star is being improved by the inclusion of a scheme that considers the propagation of the radiation through matter [1], to account in a more realistic context, respect to the classical vertical isothermal approach in which the temperature is only a function of the radial cylindrical distance from the central star, the effects of the disk opacity on the thermal energy. Our lagrangian Smoothed Particle Hydrodynamics (SPH) code [7] assumes a gaseous disk revolving around 1 solar mass star, and accounts for the hydrodynamic evolution and the self-gravity of the gas. Moreover, to simulate the close encounter with a passing-by star, the code integrates the star-star interaction with a 14th order method and couples the stars with the gas by considering their mutual gravitational interaction. Radiative transport plays a fundamental role since the presence of dust makes the disk optically thick, and it thus holds inside its layers a fraction of thermal energy generated by its internal hydrodynamical processes and by the radiation of the central star. This implies, for the disk, a thermal profile which depends on the luminosity of the star, and is completely different from the profile obtained with a simple isothermal law where any input of energy is irradiated outwards immediately and is not considered for the energy balance. Using a well-known radial model for the opacity [2], we can model the radiative transport in the inner zones, where the disk is optically thick, in diffusion regime approximation, for which the motion of photons is schematized as a flux of thermal energy dependent only on the local density and temperature gradient. While in the vertical outer zones, where the mean optical path is higher, the disk is optically thin and the diffusion approximation fails, suitable external boundary conditions must be used. We will discuss the radiative transfer scheme and its effects on the SPH code, by simulating the evolution of an early protoplanetary disk around a sun-like star, by focusing on close fly-bys events, in order to understand the role of such strong perturbations on the mixing of matter. References: [1] Bastien, P., et al. 2004, in Revista Mexicana de Astronomia y Astrofisica Conference Series, Vol. 22, 144-147 [2] Henning, Th., Stognienko, R. 1996, A&A;, 311, 291 [3] Hernández, J., et al. 2010, ApJ, 722, 1226 [4] Malavolta, L., et al., 2016, A&A; 588, A118 [5] Mann, R. K., et al. 2015, ApJ, 802, 77 [6]

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Thematic section: Pianeti e sistemi extrasolari

Lidia Pittarello

Affiliazione: Naturhistorisches Museum Wien

Contributi Proposti

Title: Pallasites and mesosiderites: a petrologic approach

Authors: Lidia Pittarello, 1. Naturhistorisches Museum Wien, Mineralogisch-Petrographische Abteilung, 2. Universitaet Wien, Departement für Lithosphaerenforschung, Vienna, Austria; Seann McKibbin, Geowissenschaftliches Zentrum, Abteilung Isotopengeologie, Georg-August-Universität Göttingen, Goettingen, Germany; and coauthors*

Abstract: Pallasites and mesosiderites are the best known stony-iron meteorites, consisting of a mixture between core material and elements from the mantle or the crust, respectively, of a differentiated planetary body. Their origin is still debated, due to their complex mineralogy and texture. Here, we present a petrologic study of selected meteorites, in the attempt to contribute to understanding their formation process. Sample A 09545, a mesosiderite collected during a joint Belgian-Japanese mission in Antarctica in 2009, was selected for this work because it contains two generations of exsolution lamellae within pyroxene (Pittarello et al. 2019). The study of chemical composition, orientation, and lattice parameters of these lamellae and the application of several geothermometers allowed us to constrain the thermal evolution of the investigated sample. After the formation of the first generation of augite exsolution by cooling through 1000-900 °C, relatively slow cooling through 900-800°C yielded a further exsolution of monoclinic low-Ca pyroxene; finally, at lower temperature, pigeonite transformed from high to low in the host and in the second generation of exsolution lamellae. The occurrence of the lamellae and the unexpected monoclinic crystallography of the low-Ca pyroxene host imply incomplete equilibrium conditions, which resulted in the failed nucleation of orthopyroxene. The preservation of the investigated exsolution lamellae also suggests either a burial depth sufficient to guarantee a relatively slow cooling rate, or only mild reheating by impacts with a peak temperature lower than 570 °C and, or only for a very short duration. As the observed features are quite uncommon in mesosiderites, further crystallographic investigations in mesosiderite would lead to the classification of subgroups and to better understanding of the thermal history and origin of the mesosiderite parent body. In the case of pallasites, the various olivine morphologies are believed to be related to different formation processes. A recently re-investigated sample of the Brahin meteorite was found to contain fragmental, rounded, and angular olivine in the same section, i.e. all morphological types, and this prompted a thorough literature review and additional analyses of other pallasites (McKibbin et al. 2019). The presence of some recurring features allowed us to recognize new subgroups that are important indicators of the formation environments in the main group pallasite (PMG) parent body. In some PMG meteorites, the presence of large (>500 μm in diameter) MnO-poor, rounded olivines together with farringtonite (Mg-phosphate) and phosphoran olivine indicate prolonged interaction between metallic core and silicate mantle. A lack of farringtonite and phosphoran olivine in those PMG containing only angular olivines that are richer in MnO indicate simple mechanical mixing between core and mantle materials, followed by more rapid cooling. Fragmental olivine is a secondary morphology that formed from either

rounded or angular olivine. *Coauthors: Yamaguchi A., Ji G., Schryvers D., Debaille V., Makarona C., Hamann C., Hecht L., Chernonozhkin S.M., Goderis S., and Claeys Ph. Acknowledgements: NIPR, Tachikawa, Japan, and RBINS, Brussels, Belgium for the sample loans. References: McKibbin et al. 2019 Meteoritics & Planetary Science 54:2814-2844. Pittarello et al. 2019 American Mineralogist 104:1663–1672.

Thematic section: Meteore, meteoriti e polvere interplanetaria, Planetologia sperimentale e di laboratorio

Christina Plainaki

Affiliazione: Agenzia Spaziale Italiana

Contributi Proposti

Title: Detection of Ganymede's water vapor environment with MAJIS: preliminary estimations

Authors: Christina Plainaki (1), Giuseppe Sindoni (1), Davide Grassi (2), Luigi Cafarelli (1)(3), Emiliano D'Aversa (2), Stefano Massetti (2), Alessandro Mura (2), Anna Milillo (2), Gianrico Filacchione (2), Federico Tosi (2), Alessandra Migliorini (2), Francesca Altieri (2), Giuseppe Piccioni (2) (1) Italian Space Agency, Rome, Italy (christina.plainaki@asi.it) (2) INAF - Institute of Space Astrophysics and Planetology, Rome, Italy (3) University of Tor Vergata, Rome, Italy

Abstract: The characterization of Ganymede's exosphere is of key importance to achieve a full understanding of the ice alteration processes induced by the radiation environment. Several scientific instruments that will operate on board the upcoming Jupiter Icy Moons Explorer (JUICE) mission, selected by ESA in the context of its Cosmic Vision programme, have the potential to study Ganymede's environment. Among them, the Moons And Jupiter Imaging Spectrometer (MAJIS) will have the chance to investigate the composition of the moon's exospheric components and the emission of the water molecules. The exospheric water density profile, as obtained from current models, is a crucial parameter for the estimation of the expected signal to noise ratio related to the actual measurement. In lack of an adequate number of Ganymede's observations from past missions, there is a general difficulty in constraining current exosphere models which are based, in general, on different scenarios and considerations and often show large discrepancies in the estimated spatial distribution of the neutral environment. In this work, we make a preliminary estimation of the expected IR emission from exospheric water molecules, using different modelled density profiles, and we speculate on its detection possibilities with JUICE/MAJIS. An estimation of the potential plume detection capabilities of the same instrument is also performed. The first necessary step for performing these calculations is a rough comparison of the existing models of Ganymede's water vapor exosphere. We discuss the characteristics of the neutral environment as derived from different exospheric models available in literature and the related implications also in view of future observations. The role of the ion-surface interactions is also discussed. We then use the model outputs to estimate different scenarios for the expected non-Local Thermal Equilibrium (non-LTE) emission from these molecules. Our results can be of help during the JUICE observation planning phase.

Thematic section: Pianeti e satelliti

Title: Planetary Space Weather science possibilities in the near future

Authors: Christina Plainaki Italian Space Agency, Rome, Italy (christina.plainaki@asi.it)

Abstract: With increasing efforts in solar system exploration, there is an urgent need for an in depth understanding of space environments around planetary bodies other than Earth. An interdisciplinary approach is required to provide environmental specification for the design and maintenance of spacecraft, payload

instruments and systems in space, guaranteeing as far as possible their normal function under a wide range of external conditions. Feedback obtained from past and ongoing space exploration missions can enrich our knowledge of the so called planetary Space Weather. Revealing the physics of the various mechanisms underlying planetary Space Weather phenomena is the first step towards mitigation of their impact on technology. Nowadays, understanding planetary Space Weather in the inner solar system is a scientific challenge. Data from numerous past and ongoing missions can be of paramount importance in this effort, especially within a comparative planetology framework: in particular, investigating the physical processes of space-environment interactions at different distances from the Sun can help to better constrain current models and make more accurate predictions of the behaviour of the physical quantities of interest. In this talk, some of the main scientific aspects of planetary Space Weather in the inner Solar System will be discussed. Since solar flares, CMEs and, to a lesser extent, solar wind stream interactions are the main drivers of Space Weather in the inner Heliosphere, our discussion will be focused on the interplay between solar activity and the environments of rocky planets, in particular Mercury and Venus. Understanding the properties of the intense radiation environment in the Heliosphere is one of the key science challenges of planetary Space Weather science also in view of human and robotic exploration in space. Indeed, our ability to predict the fluxes of energetic particles that can be detected when a shock passes by a spacecraft will allow the development of possible mitigation strategies to be followed during the mission. Therefore, based on data obtained from different missions over a long period of time, the development of a multi-year environment variability model driven by the solar activity patterns becomes a major scientific challenge of significant value also for operations and technology design. Synergies between the Heliophysics, planetary and stellar communities can improve our ability to predict also extreme Space Weather in the Solar System.

Thematic section: Pianeti e satelliti

Giovanni Poggiali

Affiliazione: University of Florence, INAF-Arcetri

Contributi Proposti

Title: Laboratory spectroscopic properties of carbonaceus chondrites and minerals at cryogenic temperatures in support of OSIRIS-REx.

Authors: Giovanni, Poggiali, Department of Physics and Astronomy University of Firenze - INAF-Astrophysical Observatory of Arcetri; John Robert, Brucato, INAF-Astrophysical Observatory of Arcetri; Elisabetta, Dotto, INAF-Astronomical Observatory of Roma; Maria A, Barucci, LESIA Observatoire de Paris CNRS - Universite Pierre et Marie Curie 92195 Meudon Principal Cedex Paris France; Maurizio, Pajola, INAF-Astronomical Observatory of Padova; Victoria E, Hamilton, Southwest Research Institute Boulder CO USA; Philip R, Christensen, Arizona State University Tempe AZ USA; Amy A, Simon, NASA Goddard Space Flight Center Greenbelt MD USA; Dennis C, Reuter, NASA Goddard Space Flight Center Greenbelt MD USA; Salvatore, Ferrone, Ithaca College Ithaca NY USA; Beth E, Clark, Ithaca College Ithaca NY USA; Dante S, Lauretta, Lunar and Planetary Laboratory University of Arizona Tucson AZ USA

Abstract: Interpretation of spectroscopic data from the OVIRS (1) and OTES (2) instruments onboard NASA's OSIRIS-REx spacecraft (3) depends on the spectroscopic properties, particle size, and temperature of materials present on Bennu's surface (4,5). Spectral indices of silicates, carbonates, sulfates, oxides, and chemicals available in public databases are commonly obtained at room temperature and pressure. To date (6), few studies have been performed analysing the effects of space environmental conditions such as low pressure and temperature, on spectroscopic features of minerals. In detail, the effects of temperature on spectral properties of minerals such as the peak emissivity position, band area, and shape have been questioned decades ago, but today a systematic laboratory study on such effects is still missing. Other changes in spectral features are strictly related to particle size distribution. Thus, it is important to acquire spectra in vacuum, at various temperatures and with variable particle sizes for better simulating space environmental conditions. Our experimental setup at the INAF-Astrophysical Observatory of Arcetri allows reflectance measurements in an extended spectral range from VIS to far IR and at temperatures from 64 to 500 K with temperature stability ±0.1 K. The temperature range explored in the laboratory was chosen to be wider than that measured on Bennu's surface during the OSIRIS-REx encounters (about 180 to 380 K). By interfacing an Oxford Instruments cryostat with a Bruker FT-IR interferometer we are able, through the proper mirror geometry, to acquire reflectance spectra of different powdered samples. The cold finger of the cryostat with its sample holder is placed in vacuum (10 -6 mbar) inside a micro tail equipped with different windows that are transparent at each spectral range analysed. Among the many mineral phases expected on Bennu, we focused on pyroxene, olivine, and antigorite. Simultaneously, in the quest for a Bennu analogue, we studied three meteorites: Orgueil (CI), Tagish (C2-ungrouped) and the recently fallen Aguas Zarcas (CM2). Samples were prepared in two different ranges of particle sizes: less than 200 microns and between 200 and 500 microns. Spectroscopic changes were observed in the VIS-NIR-MIR range and in the full range of temperatures studied,

64 to 500 K. Our results show that different temperatures induce peak position shift and mineral band areas modification with a bell-shaped profile. Laboratory data are encouraging to infer physical and compositional properties of Bennu's surface, especially when compared with day/night observations or perihelion/aphelion observations when the temperature variations on Bennu are largest.
Acknowledgements: This work is support by the Italian Space Agency, grant ASI/INAF n.2017-37-H.0. The participation of U.S. OSIRIS-REx team members is supported by NASA under Contract NNM10AA11C issued through the New Frontiers Program. We are grateful to the entire OSIRIS-REx Team for making the encounter with Bennu possible.
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Thematic section: Meteore, meteoriti e polvere interplanetaria, Piccoli Corpi, Planetologia sperimentale e di laboratorio

Ciprian Popa

Affiliazione: INAF-OAC

Contributi Proposti

Title: Possible identification issues related to metasomatic rock alteration using near infrared diffuse reflectance: implications for carbonate remote sensing detection

Authors: Ciprian Popa (INAF – Osservatorio Astronomico di Capodimonte, Napoli, Italy); Francesca Esposito; Vito Mennella

Abstract: Near infrared spectroscopy is a useful tool for the identification of minerals in remote sensing applications. Water bearing minerals are identifiable from orbit using this analytical method either on Earth or Mars. It is though often difficult to infer the geological depositional environment from these measurements. Carbonate dominated rocks can be identified in a similar manner using in orbit sensors, due to their intense NIR stretching bands. There are recent claims of localized carbonate orbital findings on Mars thought to be related to sedimentary deposition of carbonates [1,2,3]. Here we show that many of the identified carbonate bearing outcrops on Mars could be easily misinterpreted with common metasomatic (hydrothermal) alterations acting on igneous rocks of mafic to intermediary compositions. Namely, we present examples of alterations in the low metamorphic facies that can either mimic the spectral response of carbonates. These alteration cases can be used to understand the way water interacted with the pristine rocks on other celestial bodies (e.g. Mars, Ceres etc.).

Thematic section: Pianeti e satelliti, Planetologia sperimentale e di laboratorio

Luca Porcelli

Affiliazione: INFN-LNF

Contributi Proposti

Title: Laser Retroreflectors for Exploration, Planetary and Gravity Sciences

Authors: S. Dell'Agnello 1; G.O. Delle Monache 1; L. Porcelli 1,2; M. Tibuzzi 1; L. Salvatori 1; C. Mondaini 1; M. Muccino 1; M. Di Paolo Emilio 1; R. March 1; L. Ioppi 1; O. Luongo 1; G. Bianco 1,3; D. G. Currie 4; R. Vittori 1,5; C. Benedetto 3; F. Pasquali 3; M. Petrassi 1; L. Filomena 1; L. Mauro 1; L. Rubino 1; G. Moretti 1; V. Sanclimenti 1, 1 Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati (INFN-LNF), Via E. Fermi 40, 00044, Frascati, Italy (luca.porcelli@lnf.infn.it); 2 Dipartimento di Fisica, Università della Calabria (Unical), Via P. Bucci, 87036, Arcavacata di Rende, Italy; 3 Agenzia Spaziale Italiana - Centro di Geodesia Spaziale "Giuseppe Colombo" (ASI-CGS), Località Terlecchia, 75100, Matera, Italy; 4 University of Maryland (UMD) at College Park, MD, USA; 5 Italian Air Force, Rome, Italy, ASI and Embassy of Italy in Washington DC.

Abstract: We describe several payload models of next-generation laser retroreflectors that we developed for the diverse exploration, planetary and gravity sciences of: Asteroids and Comets, the Phobos-Deimos system, NASA's CLPS program (Commercial Lunar Payload Services), the Earth-Moon Lagrangian point L1 and cislunar orbits, including applications to the LOP-G (Lunar Orbital Platform and Gateway). Specific payload design, prototyping and space qualification activities were completed in the last years by INFN-LNF (Frascati) and ASI-CGS (Matera), in the framework of the: Joint Laboratory between INFN-LNF and ASI-CGS; Affiliation of INFN to NASA/SSERVI (Solar System Exploration Virtual Institute); Association of ASI to SSERVI; activities funded by the INFN National Science Committees n. 5 (CSN5 - Technology Research) and n. 2 (CSN2 - Space Sciences). These payloads are summarized in the following. * COSPHERA = COmet/asteroid SPHerical laser Retroreflector Array. This payload is intended for observation from the proposed ESA Hera mission (evolution of the AIM, Asteroid Impact Mission) to the Didymos double asteroid. The Hera design includes a lidar capable of laser-ranging/altimetry. For Hera we have designed and built multiple Italy-branded miniaturized payloads, COSPHERA and others. These payloads inherit from the already space qualified technologies for ASI, ESA and NASA-JPL for the Martian microreflectors onboard the ESA ExoMars missions, and the NASA InSight and Mars 2020 missions. * PANDORA = Phobos ANd DeimOs laser Retroreflector Array. This payload is intended for observation from orbiters capable of laser-ranging/altimetry in the Mars systems, like the Martian Moons eXploration (MMX) mission of the Japan Aerospace Exploration Agency (JAXA). * MoonLIGHT-100/NGLR = Moon Laser Instrumentation for General relativity High accuracy test (INFN-LNF)/Next Generation Laser Retroreflector (UMD). This 100 mm single, solid, large reflector is intended for direct lunar laser ranging from stations in USA, Italy (ASI-CGS) and France (Grasse). Its main applications are the Lunar Geophysical Network (LGN) and precision tests of General Relativity and new theories of fundamental relativistic gravity. * LaGrEx = Lagrangian point Gravity Explorer. This 75 mm single, solid, medium-large laser retroreflector is a reduced mass/volume backup payload for CLPS landings and is designed for

accurate laser positioning in the Earth-Moon Lagrangian point L1.
Thematic section: Strumentazione

Riccardo Pozzobon

Affiliazione: Dipartimento di Geoscienze, Università degli Studi di Padova

Contributi Proposti

Title: Salt tectonics in Arabia Terra bulged craters? Hints from geological mapping, structural analysis and 3D geomodelling of the Crommelin Crater (Mars)

Authors: Riccardo Pozzobon, Dipartimento di Geoscienze, Università degli Studi di Padova; Dario Pesce, Dipartimento di Geoscienze, Università degli Studi di Padova; Matteo Massironi, Dipartimento di Geoscienze, Università degli Studi di Padova

Abstract: Arabia Terra is a region of Mars that displays widespread and pervasive water interaction and possibly even fluid resurgence within impact craters. This is testified by light-toned fine layers (informally named ELDs), small spring mounds/mud volcanoes, and sulphate-bearing minerals [1–5]. ELDs can be found both inside impact craters but also outside in the surrounding plateaus ranging from tens of meters up to km-thick sequences. Peculiar geometries of these layered sequences have been identified at places[2]. Crommelin, a 90 km-wide crater, presents an elliptic bulge of 50x30 km with widespread ELDs in its surroundings that appear slightly tilted and folded [4]. We produced a geological and structural map (1:160.000), on a mosaic of CTX stereo DTMs (18m grid size) and a seamless controlled mosaic of CTX orthoimages at 6 m/pixel obtained with ISIS3 and ASP [6, 7]. The stratigraphic sequence derived from the geologic mapping evidenced that the bulge occupies a lower stratigraphic position than the surrounding folded ELDs, which appear to be draping the bulge itself. The structural mapping highlighted the presence of at least two folding events in the ELD unit: km-size symmetric folds are visible in the western sector, whereas more pronounced NW-verging asymmetric folds are present in the NW sector. The Southern part presents elliptical basins with fine concentric stratification that were previously interpreted as desiccation ponds (4). From the structural analysis, on the contrary they appear perfectly coherent with a dome and basin interference folding pattern, with major axis concentric to the bulge and the minor radial to it. A similar pattern is visible on the northern sector on the opposite side of the crater, partially obliterated by the ejecta of a nearby impact crater. The structural setting and fold patterns were modelled in 3D MOVE, using 21 cross sections perpendicular to the folding both on the western (11) and southern sectors (10). Using continuous strata banks as markers, we interpolated them and reconstructed the subsurface with 3D meshes representing the folded strata. The 3D reconstruction confirms the structural interpretation of two interacting folds systems that can be explained with a long-lasting uplift of a buried diapiric body in correspondence of the bulge after the deposition of the surrounding ELDs giving origin to the identified deformation patterns. This research was supported by European Union’s Horizon 2020 under grant agreement No 776276- PLANMAP. 1. R. Pozzobon et al., Fluids mobilization in Arabia Terra , Mars : Depth of pressurized reservoir from mounds self-similar clustering. Icarus. 321, 1–22 (2019). 2. M. Pondrelli et al., Groundwater control and process variability on the Equatorial Layered Deposits of Kotido crater, Mars. J. Geophys. Res. Planets (2019), doi:10.1029/2018je005656. 3. J. Flahaut et al., Embedded clays and sulfates in Meridiani Planum, Mars. Icarus. 248, 269–288 (2015). 4. F. Franchi, a.

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Thematic section: Pianeti e satelliti

Title: Geologic map and landing site selection on Copernicus Crater (Moon)

Authors: Riccardo Pozzobon, Dipartimento di Geoscienze, Università degli Studi di Padova; Filippo Tusberti, Dipartimento di Geoscienze, Università degli Studi di Padova; Maurizio Pajola, INAF - Osservatorio di Padova; Matteo Massironi, Dipartimento di Geoscienze, Università degli Studi di Padova

Abstract: Copernicus Crater is a relatively young impact crater of ~800 Ma with a diameter of ~100 km and it is located on the lunar near side. Developed within the PlanMap project, we hereby present two geologic maps, at a broad and local scale, and the technical evaluation as a landing site with possible traverse paths and sampling sites. The scientific rationale guiding this study is that Copernicus is pivotal to refine the lunar time scale and because of its particular composition. Sample returns could provide absolute ages useful to improve both the lunar crater chronology and, by extrapolation, that of other inner solar system terrestrial bodies. Moreover, olivine spectral signature was detected [1], and this can provide information about the lunar crust and mantle. The whole central peak represents exhumed deep olivine-rich troctolite [1] We performed a geologic mapping on the basis of the merged DEM of LOLA+Kaguya at 59 m of grid spacing and LROC WAC 100m/pixel mosaic. We also integrated spectral observations in order to recognize lithological variations and to better define the geologic units. Cementine UVVIS color ratio mosaic was used: the band ratios combined in an RGB mosaic were used to determine the relative abundance in titanium, mafic minerals, and volcanic glasses. In order to assess the possibility of landing in Copernicus we mapped in higher detail landforms that would be suitable as scientific stops in a rover traverse as well as to define possible obstacles and hazards, we produced a second geologic map at higher resolution (1:100.000) by means of a mosaic of LROC NAC images resampled at 5 m/pixel. The NW quadrant of Copernicus was chosen: it is the smoothest with relatively low number of obstacles and significant hazards. Three different landing ellipses were selected: sizes were derived from the NASA Mars rovers MSL Curiosity and Mars2020, since to date no constraints are available for the Moon. Hazards related to rock abundance was also investigated according to [2] within the landing ellipses as well as for small impact craters together with overall surface slope. Following the constraints defined for Schrödinger crater exploration in the HERACLES program [3] six traverses were defined: three long and three short traverses, of 32 and 16 km respectively. The sampling sites/stops for analyses were chosen to maximise the scientific return, following the future science goals in in situ lunar exploration [4]. This research was supported by European Union’s Horizon 2020 under grant agreement No 776276-PLANMAP. 1) Liu, F., Yang, R., Zhang, Y., Qiao, L., Wang, S., Yang, Y., & Wang, X. (2011). Distribution of olivine and pyroxene derived from Clementine data in Crater Copernicus. Journal of Earth Science, 22(5), 586-594. https://doi.org/10.1007/s12583-011-0209-2 2) Pajola, M., Rossato, S., Baratti, E., Pozzobon, R., Quantin, C., Carter, J., & Thollot, P. (2017). Boulder abundances and size-frequency distributions on Oxia Planum-Mars: Scientific implications for

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Thematic section: Pianeti e satelliti

Andrea Raponi

Affiliazione: IAPS - INAF

Contributi Proposti

Title: Ceres as seen by VIR/Dawn in the 0.4 – 4.1 μm range: spectral modeling and VIS-NIR/Raman spectroscopy on laboratory analogues suggest altered and pristine silicates within carbon chemistry.

Authors: Andrea, Raponi, IAPS-INAF; Marco, Ferrari, IAPS-INAF; Maria Cristina De Sanctis, IAPS-INAF; Batiste, Rousseau, IAPS-INAF; Mauro, Ciarniello, IAPS-INAF; Simone, De Angelis, IAPS-INAF; Eleonora, Ammannito, ASI; and the Dawn/VIR Team

Abstract: The infrared average spectrum of Ceres (1.0 – 4.1 μm) as seen by VIR onboard Dawn [1] has already been the subject of previous works which derived an aqueously altered, volatile rich, and carbon-rich composition [2, 3]. Those results have taken advantage of an inflight calibration of the infrared channel [4]. Here we refined this calibration on the base of the observation of the stars by VIR, compared with ground observations. Moreover, we add the spectral range covered by the visible channel, taking advantage of a new correction for instrumental effects [5]. We produced an average reflectance of Ceres in the spectral range 0.4 – 4.1 μm combining the visible and infrared channels to perform spectral modeling with Hapke theory [6]. The simulated composition makes use of endmembers in intimate mixture, similarly to [2] and [3], to fit the IR features at 2.72, 3.06, and 3.95 μm, respectively attributed to Mg-phyllosilicates, NH4-phyllosilicates and Mg-carbonates. The novel introduction of the visible spectral range adds new constrains in the fitting procedure: the steep slope in the 0.4 – 0.6 μm range resembles that of spectra of carbonaceous chondrites, showing that a similar material is likely present on the surface. The small absorption centred at 0.72 μm, also present on CM chondrite spectra [7], would be attributed to Fe2+-Fe3+charge transfer in iron-bearing minerals. The broad absorption centred at 1.2 μm, has been attributed to Fe2+, in dark phases like meteorite MAC87300 and/or magnetite, as suggested by [8]. However, mixing with high concentration of Fe would not match elemental composition derived by GRAND [3]. We obtained an alternative best fit including a spectrum of lizardite heated in vacuum at 600 °C [9]. A laboratory activity was undertaken in order to test the possibility that the 1.2 μm band and the emergence of a blue slope longward of 0.77 μm could be linked to an incomplete serpentinization process on the Ceres surface that left remnants of primary phases (e.g. olivine). Powdered samples of three different serpentine rocks from geologically well documented location have been heated at 500, 600, 700 and 800 °C, and for every temperature step their VIS-NIR and Raman spectra have been collected. Raman data show that prograde reactions transformed the serpentine to olivine passing from the incipient crystallization of intermediate talc-like phases and amphibole [10, 11]. VIS-NIR spectra collected on serpentine show systematic changes as the temperature increases: the bands near 1.4, 1.9 and 2.3 μm decrease while a wider absorption band near 1 μm increases due to the crystallization of higher temperature phases. This experiment uses high-temperature prograde reactions, which, on Earth are linked to the thermal metamorphism to explain the inverse process of the partial serpentinization that on the average spectrum of Ceres could be responsible for the presence of 0.77 and

1.2 μm spectral features. References: [1] De Sanctis M.C. et al., SSR 163, 2011. [2] De Sanctis M.C. et al., Nature 528, 2015. [3] Marchi S. et al., Nat. Astron., 3, 2019. [4] Carrozzo, F. G., Rev. Sci. Instrum., 87, 2016. [5] Rousseau et al., Rev. Sci. Instrum., in press. [6] Hapke B., Cambridge Univ. Press., 2012. [7] Takir D. et al., MAPS, 48, 2013. [8] Rivkin A. S., Space Sci Rev, 163, 2011. [9] Hiroi T., and Zolensky E., Antarct Meteorite Res, 12, 1999. [10] Trittschack R. et al Am. Min. 97, 2012. [11] Rinaudo C. and Croce A. Appl. Sci. 9, 3092, 2019.

Thematic section: Pianeti e satelliti, Piccoli Corpi, Planetologia sperimentale e di laboratorio

Cristina Re

Affiliazione: INAF- Osservatorio Astronomico Padova

Contributi Proposti

Title: A simulator for HYPSOS – the next generation stereo camera

Authors: Cristina, Re, INAF Osservatorio Astronomico di Padova; Nicolò, Borin, Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" (CISAS); Francesco, Lazzarotto, INAF Osservatorio Astronomico di Padova; Gabriele, Cremonese, INAF Osservatorio Astronomico di Padova; Giampiero, Naletto, Dipartimento di Fisica e Astronomia "Galileo Galilei"; Massimiliano, Tordi, EIE Group; Stefano, Debei, Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" (CISAS)

Abstract: HYPSOS (Hyperspectral Stereo Observing System) is a novel concept of hyperspectral-stereo camera that combines the 3D information attainable by a couple of stereo images, with the fine spectral sampling of a spectrograph. The HYPSOS concept has obtained an Italian patent in 2016 and planetary remote sensing represents an interesting future application field for the idea in development. The concept at the basis merges two different approaches for studying the surface of a planet: the morphology of any feature analysed by the geologist through the 3D images, and the composition of the same feature, through the hyperspectral data. Thanks to the integration of these characteristics in a single instrument, with HYPSOS there is no problem of correlating different instrument characteristics, as optical design, resolutions and calibration. In order to derive the best configuration for the stereo-hyperspectral acquisition and to optimise the instrument performances, the development of simulation tools becomes mandatory. The simulation tool that we will adopt is based on the image rendering software SurRender developed by Airbus which addresses the specific challenges of realistic image simulation with high level of representativeness for space scenes. Images are rendered by raytracing, which implements the physical principles of geometrical light propagation. Images are rendered in physical units using a macroscopic instrument model and scene objects reflectance functions. In SurRender environment the virtual camera will be placed, then the satellite constraints, the illumination conditions and a particular 3D-model that emulates the target of a possible mission will be introduced. The simulation results will be used in the validation and to obtain a better knowledge of some important instrument aspects, such as the optical and data-production performances. The simulation work will operate at different levels: simulation of the imaging system, reproduction of the camera characteristics (focal length, optical channels, sensor dimensions, spectral information definition) and of the image acquisition process through the push-broom approach; simulation of possible flight trajectories for a generic spacecraft, including the possible implementation of real or simulated SPICE kernels, allowing to take into account the impact of the attitude on the instrument design and observing strategy; introduction into the scene of 3D-model of planetary bodies reproducing spectral specifications of surface angular reflectance distribution (BRDF) and the use of physically-based material specifications and several illumination conditions. Rendering the virtual scene prescribes a workflow that will be useful to test capabilities both of the instrument and of the tools (algorithms for the surface reconstruction etc.) developed for the data exploitation.

Thematic section: Pianeti e satelliti, Strumentazione

Giovanna Rinaldi

Affiliazione: IAPS-INAF

Contributi Proposti

Title: Dust properties in the innermost coma of comet 67P/Churyumov-Gerasimenko from VIRTIS-M spectra

Authors: Giovanna Rinaldi (1,2), Emiliano D'Aversa (1), Dominique Bockelée-Morvan (3), Andrea Raponi (1), Fabrizio Capaccioni (1), Mauro Ciarniello (1), Gianrico Filacchione (1), Fabrizio Oliva (1), Andrea Longobardo (1,2), Federico Tosi (1), Maria Teresa Capria (1) (1) INAF-IAPS, via Fosso del Cavaliere 100, 0133 Rome, Italy; (2) DIST-Università Parthenope, Centro Direzionale, Isola C4, 80143, Naples, Italy; (3) LESIA, Observatoire de Paris, LESIA/CNRS, UPMC, Universite Paris-Diderot, 92195, Meudon, France

Abstract: The Rosetta/ESA spacecraft followed the comet 67P/Churyumov-Gerasimenko from 2014 August (3.6 au pre-perihelion) to 2016 September (3.6 au post-perihelion). This offered a unique opportunity to analyze the time evolution of the dust properties in the inner coma. Onboard Rosetta, the Visual Infrared and Thermal Imaging Spectrometer (VIRTIS-M) acquired spectra of the dust coma in the spectral range 0.25 to 5 μm (Coradini et al. 2007). We limited our analysis to the pre-perihelion period, due to the malfunction of the IR channel from May 2015 onward, and we present spectral maps of the inner coma collected October 2014 to May 2015 (rh = 3.2–1.7 AU), during the in-bound phase. The 0.25-5 μm radiance spectra taken in the coma contain two contributions: the solar radiation scattered by the dust (0.25 - 3.5 μm) and the dust thermal emission (3.5 - 5 μm). The time evolution of the dust properties is analyzed by fitting the radiance spectra with a single scattering radiative transfer model. The latter assumes a fixed complex refractive index, a dust size distribution with power-law indexes from -4 to -0.1 and particle size intervals between 0.1 and 1000 μm. These quantities are needed to compute dust scattering and thermal emission properties, and a linear least square fitting algorithm is used to invert the observed spectra. Through spectral fitting, we measured the dust spectral slope (1-3 μm), the temperature, dust column density and differential dust size distribution indexes. We studied the temporal and spatial evolution of the dust properties, as well as their dependence on the solar illumination and distance from nucleus. Preliminary results at equinox show a mean dust color of 2%/100 nm and a superheating factor of 1.19, measured at 90° phase angle and consistent with previous VIRTIS-M and H measurements (Rinaldi et al 2016 and Bockelée-Morvan et al. 2017). The application of the algorithm to the measured spectra showed that the coma dust continuum radiation is sensitive to the dust size distribution. A power-law index greater than −3 matches the dust continuum very well. Fitting the thermal part of the spectrum suggests a dust temperature of (210 -270) K and gives a superheat value of S = 1.0 -1.5. The power-law index and the superheat values confirm that the coma of 67P is dominated by particles greater than 10 μm during the inbound equinox. Further results will be presented and discussed.

Thematic section: Piccoli Corpi

Edoardo Rognini

Affiliazione: INAF-OAR; ASI-SSDC

Contributi Proposti

Title: Possible effects of Mercury surface temperatures on the exosphere

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Abstract: The BepiColombo mission is the first European mission to Mercury; the spacecraft will reach its destination in December 2025, and will study in detail the surface, the exosphere and the magnetosphere of the planet. We have developed a thermophysical model with the aim to analyze the dependence of the temperature of the surface and of the layers close to it on the assumptions on the thermophysical properties of the soil. The code solves the one-dimensional heat equation, assumes purely conductive heat propagation and no internal heat sources; the surface is assumed to be composed of a regolith layer with high porosity and density increasing with depth. The illumination conditions are calculated by using a Mercury shape model and the SPICE routines [1]. The model will help us to interpret the data that will be provided by the instruments onboard the BepiColombo mission. Preliminary calculations have been carried out to analyze the thermal response of the soil as a function of thermal conductivity. The model is currently also used to study the sodium content in the planet's exosphere, whose origin is under investigation [2]; the MESSENGER mission has measured the exospheric sodium content as a function of time, detecting an increase at the "cold poles" (so called because of their lower than average temperature). We therefore want to study the effect of surface temperatures on the sodium content in the exosphere; for this purpose, the temperature distribution calculated with the code is used together with an atmospheric circulation model that calculates the exospheric sodium content [3]. A simplified version of the thermophysical code will be made available to the scientific community through MATISSE [4], the software developed at the SSDC in ASI. [1] Acton, C. H. (1996), Planetary and Space Science, 44, 65-70 [2] Cassidy, T., et al. (2016), GRL, 43, 11 121-128 [3] Mura, A., et al. (2009), Icarus, 1, 1-11 [4] Zinzi, A., et al. (2016), Astronomy & Computing, 15, 16-28

Thematic section: Pianeti e satelliti

Title: Inclusion of scientific algorithms in MATISSE

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Abstract: MATISSE (Multi-purpose Advanced Tool for the Solar System Exploration) [1] is a tool that allows the visualization of observations from space missions and datasets derived from these observations on a three-dimensional model of the selected target body. The second version of the tool (named MATISSE 2.0) will, among other things, include algorithms developed by partner research teams; in this work we focalize our attention on the MATISSE inclusion of two codes developed for atmospheric retrieval and thermophysical modeling. The retrieval code is used for the analysis of the spectra provided by the JIRAM instrument (Jovian Infrared Auroral Mapper [2]) onboard the NASA's Juno mission, whose main purpose is the study of the upper regions of Jupiter's atmosphere in the 2-5 μm wavelength range and pressure up to 5-7 bar. The spectra provided by the instrument are processed with the retrieval code that calculates, for each pixel of a hyperspectral image, the chemical and physical parameters in the corresponding points of the atmosphere [3]. The code processes all pixels of a hyperspectral image, so parallelization is convenient in order to reduce the computation time; this is possible by using the Python language tools, which allow the execution of a code written in its own language (FORTRAN in this case) by providing the required parallelization. As a further optimization step, the code has been converted into a Docker image to make it portable and easy to run on heterogeneous architectures. The second code included in MATISSE is a thermophysical model that calculates the surface temperature of airless bodies as function of thermal conductivity [4,5] and other physical properties; the calculated temperature can be compared with the measured ones, if any, in order to retrieve the thermal properties of the soil, or can be used to compute other temperature-dependent quantities. To the moment we are working on Mercury, looking for the effects of the surface temperature on the exosphere sodium content. A version of these codes will be made available through MATISSE 2.0. [1] Zinzi, A., et al. (2016), Astronomy & Computing, 15, 16-28 [2] Adriani, A., et al. (2017), Space Science Reviews, 213, 393-446 [3] Grassi et al. (2010), Planetary and Space Science, 58, 1265-1278 [4] Capria, M. T. et al (2014), Geophysical Research Letters, 41, 1438-1443 [5] Rognini et al., Journal of Geophysical Research, in press

Thematic section: Pianeti e satelliti, Strumentazione

Alessandro Rossi

Affiliazione: IFAC-CNR

Contributi Proposti

Title: YORP-Yarkowski evolution of asteroid families

Authors: F. Marzari, University of Padova, Padova, Italy; A. Rossi, IFAC-CNR, Sesto Fiorentino (FI), Italy; O. Golubov, V. N. Karazin Kharkiv National University, Kharkiv, Ukraine; D.J. Scheeres, University of Colorado, Boulder, USA; P. Paolicchi, University of Pisa, Pisa, Italy; A. Dell'Oro, Osservatorio Astrofisico di Arcetri, Florence, Italy.

Abstract: The orbital evolution of the asteroids within the families is entangled with their spin dynamics since the Yarkovsky effect strongly depends on the obliquity of the body. To have a full picture of this dynamics it is essential to consider, in addition to the 'normal' Yorp (NYORP), also the so-called Tangential YORP (TYORP), caused by asymmetric light emission by boulders or other structures on the surface of an asteroid, and mutual collisions which cause step changes in the spin of asteroids. Introducing these effects in a model which tracks the coupled orbital and rotational evolution of asteroid families, under the action of the Yarkowsky (diurnal and seasonal), YORP and collision effects, we are able to recover the characteristic V-shape configuration in the semimajor axis vs absolute magnitude (H) space. Adding to the complexity of the model, it is observed how the simple NYORP spin dynamic pathway hypothesized by the analytical model by Golubov and Scheeres (The Astronomical Journal, Vol. 157, article id. 105, 2019), is altered by the introduction of TYOPR and collisions. Since TYORP tends to accelerate the asteroid spin rate rather than to decelerate it in all known cases, a number of asteroids is progressively accelerated towards the breakup limit. The smooth YORP cycles coupling the spin axis obliquity and the rotation rate and driving the obliquity back and forth between the extremes of its evolution scale, is futher disturbed by the introduction of the collisions. With collisions at play, the cycles are almost uncorrelated. Even if the initial rotation rates are slow, the objects can be driven close to the rotational breakup. In fact, the collisions not only change the angular momentum vector of the body but can also alter the subsequent YORP evolution by changing the surface properties of the body. First, the time evolution of a number of synthetic families is explored with this model looking in detail at different size regimes. The specific contributions by TYORP and collisions, leading to a larger dispersion of the semimajor axis, through direct and indirect effects can be tracked and understood. Separating the diurnal and the seasonal Yarkowski effects, it is observed how the latter is shifting the family members inwards with some small members drifting significantly far from the initial location. We expect further tests to be able to understand whether these combined effects can erase the initial features of a realistic family, dominating its evolution.

Thematic section: Dinamica dei corpi celesti naturali e artificiali

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Title: Exploiting orbital resonances for the disposal of objects from Low Earth Orbit

Authors: A. Rossi, IFAC-CNR, Sesto Fiorentino (FI), Italy; E.M. Alessi, IFAC-CNR, Sesto Fiorentino (FI), Italy; G. Schettino, IFAC-CNR, Sesto Fiorentino (FI), Italy, G.B. Valsecchi, INAF-IAPS, Roma & IFAC-CNR, Sesto Fiorentino (FI), Italy

Abstract: The steadily growing exploitation of the circumterrestrial space with the significant increase in the traffic launch, mostly related to private sector and associated to the forthcoming advent of the mega-constellations of satellites, calls for a renewed and increased effort towards efficient and effective mitigation measures. The de-orbiting of the spacecraft at the end-of-life, within a given residual orbital lifetime, currently represents a fundamental part of a space mission and an essential step to guarantee the future exploitation of the Earth orbit. In this respect an accurate dynamical characterization of the circumterrestrial region and identify the natural orbital mechanisms that can be exploited to improve the current end-of-life measures. The goal is to identify stable and unstable regions in the phase space where the objects could be moved to exploit either long term "graveyards" or, possibly and preferentially, faster escape routes. To this purpose, the most accurate dynamical mapping of the circumterrestrial space, from the Low Earth Orbit to the Geostationary Orbit, ever performed at this date was realized within the Horizon 2020 project ReDSHIFT (Revolutionary Design of Spacecraft through Holistic Integration of Future Technologies). The underlying idea stems from the asteroid dynamics where small Main Belt bodies are driven towards the inner Solar System by powerful resonances (and non-gravitational forces) which increase their eccentricity leading them to gravitationally interact with the terrestrial planets. Similarly, in the Earth orbit we identified the main resonances, involving the rate of precession of Right Ascension of the Ascending Node, the argument of perigee and the apparent mean motion of the Sun with respect to the ecliptic plane. The long-term effects associated with these resonances that can be used to de-orbiting is indeed a variation in eccentricity, that can become quasi-secular when the effects of the solar radiation pressure is coupled with the planetary oblateness. From the theoretical point of view, the effect was explained by computing the equilibrium points and the corresponding stability of the dynamical system associated with solar radiation pressure and Earth’s oblateness. In particular, it turns out that the natural de-orbiting can occur in two situations, either by following the hyperbolic invariant curves stemming from a saddle equilibrium point or by following a wide enough libration curve in the neighborhood of an elliptic equilibrium point. A thorough characterization of these resonances by means of a frequency analysis was performed too. Finally, by means of long term simulations of the evolution of a sample traffic launch we showed how these resonances can sometimes be exploited as natural reentry corridors (the so-called "de-orbiting highways") to improve the disposal of the spacecraft at the end-of-life and help in stabilizing the space debris population.

Thematic section: Dinamica dei corpi celesti naturali e artificiali

Batiste Rousseau

Affiliazione: INAF - IAPS

Contributi Proposti

Title: Ceres surface spectral properties through the VIR/Dawn visible data

Authors: B. Rousseau, A. Raponi, M. Ciarniello, M. C. De Sanctis, M. Ferrari, A. Frigeri, E. Ammannito, F. G. Carrozzo, F. Tosi

Abstract: The VIR imaging spectrometer (De Sanctis et al., 2011) has been in operation onboard the Dawn (Russel et al., 2007) spacecraft from 2007 to 2018, from the launch to the targets: orbiting Vesta and then orbiting Ceres. Here we focus on Ceres, for which a rich dataset has been produced thanks to the coverage of the surface at several resolutions. After having developed and applied a correction (Rousseau et al., 2019) on the dataset of the visible channel of VIR, which suffered of the CCD temperature variations and of high IR channel temperature, we are able to analyze and interpret the Visible data properly. Here we focus on the global mapping of spectral indicators such as albedo, spectral slopes and band area. Those indicators, determined in the visible range (400-950 nm), provide first-order information on the surface properties and composition. The global visible spectrum of Ceres is characterized by a steep slope in the UV-visible range (between 400nm and 450 nm). This slope is commonly interpreted as a proxy of the absorption induced by the iron charge transfer process, that produces a slope in the UV (Clark 1999, Cloutis et al., 2008). Maps of the spectral slopes calculated between 480-630nm and 630-950nm are similar. In particular, they seem to discriminate the fresh impact craters to the rest of the surface. They also provide indicators on the composition. In particular, the slopes change drastically on the Haulani and Occator crater floors, showing less steep slopes. Conversely, the central dome of the Occator crater and a part of the southeastern crater wall of Haulani exhibit redder spectra. In the same way, the Ernutet region, where organics have been identified (De Sanctis et al., 2017, 2018), is clearly the reddest area of the Ceres surface in these spectral ranges. The global visible Cerean spectrum shows a shallow absorption centered around 720 nm. While still under investigation, this feature is of importance in the understanding of the Ceres surface composition. A feature in this wavelength is normally due to the Fe2+-Fe3+ charge transfer process. This could be due to the iron oxides in phyllosilicates (Vilas and Gaffey 1989), which have been identified on Ceres (De Sanctis et al. 2015, Ammannito et al. 2016). In that case, the link with the aqueous alteration experienced by Ceres surface is high. However, this Fe2+-Fe3+ charge transfer process could also be linked to the presence of other iron-bearing minerals (e.g. magnetite). The global map of the feature observed at 720nm will be also discussed. The correction of the visible data acquired at Ceres by VIR allows us to derive the main spectral properties of the Ceres surface at a global scale. The maps of the albedo, of the spectral slopes, as well as the feature observed at 720nm, will be presented and discussed for the first time. References: 1. M. C. De Sanctis et al., Space Science Reviews 163, 329 (2011) 2. C. T. Russell et al., Earth, Moon, and Planets 101, 65 (2007) 3. B. Rousseau et al., Review of Scientific Instruments, in press 4. R. N. Clark, in Manual of Remote Sensing, Volume 3, Remote Sensing for the Earth Sciences, 3rd Edition (1999) 5. E. Cloutis et al., Icarus 197, 1 (2008) 6. M. C. De Sanctis et al., Science 355, 6326 (2017) 7.

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Thematic section: Piccoli Corpi

Title: Correction of the CCD and IR temperature dependencies in the VIR/Dawn visible data

Authors: B. Rousseau, A. Raponi, M. Ciarniello, E. Ammannito, F. G. Carrozzo, M. C. De Sanctis, S. Fonte, A. Frigeri, F. Tosi

Abstract: [Poster] The VIR imaging spectrometer (De Sanctis et al., 2011) has been in operation onboard the Dawn spacecraft (Russell et al., 2007) from 2011 to 2018, first orbiting Vesta and then orbiting Ceres. A rich dataset has been produced thanks to the coverage of these two bodies at several resolutions. However, the slope of spectra acquired by the visible channel of VIR are affected by the temperature variations of its CCD detector. As a consequence, the higher the temperature, the redder the spectral slope. In addition, a higher IR channel temperature monitored in some periods of observations impacts the visible spectral shape. Acquisitions of the VIR data are organized in sequences made of several hyperspectral cubes acquired one after the other. During a given sequence (lasting several hours), the temperature of the CCD detector increases, and then cools down when the sensor is not operative. The range of temperatures may vary between 168K and 195K depending of the mission phase. On the other hand, the IR channel temperature can be stable at 80-85K or as high as 175K when the cryocooler is switched off. The effect on the spectra of the CCD temperature variation is a change in the spectral slope while a high IR channel temperature implies a distortion of the spectral shape. Both those effects could affect the correct interpretation of the data. A correction is therefore needed to retrieve the real shape of the Ceres spectra. The correction of the spectra requires to define references in terms of CCD and IR temperatures and wavelength. We normalized the correction at 550 nm and we use as a reference the CCD temperature at 177K and the IR channel temperature at 85K as they correspond to the temperature at which an observation of Arcturus has been made by VIR and present a good agreement with ground-based observations. Based on these hypotheses, we compute a correction factor that we apply on the dataset. Such process allows to obtain a globally coherent dataset which is then usable – e.g. for mapping purpose – without instrumental effects. References: 1. M. C. De Sanctis et al., Space Science Reviews 163, 329 (2011) 2. C. T. Russell et al., Earth, Moon, and Planets 101, 65 (2007)

Thematic section: Piccoli Corpi, Strumentazione

Elena Rufini

Affiliazione: Università La Sapienza di Roma

Contributi Proposti

Title: Detection of Biomarkers in Exoplanets' Reflectance Spectra

Authors: Elena Rufini, Università La Sapienza Roma (Italy); Fabrizio Oliva, INAF-IAPS Rome (Italy); Riccardo Claudi, INAF-OAP Padova (Italy); Nicoletta La Rocca, Dip. Biologia - Università degli Studi di Padova (Italy)

Abstract: Authors: E. Rufini, F. Oliva, R. Claudi, N. La Rocca Presentation: Poster TITLE: Detection of Biomarkers in Exoplanets' Reflectance Spectra The focus of the scientific community on exoplanets studies is gradually moving from their discovery to their characterisation. Knowing the composition of these planets' atmosphere is of extreme importance to learn more about how planetary systems form, in which way they evolve and for the assessment of planets habitability. For this reason, many space- and ground-based missions are under construction or are already at work. Most of them are thought to study exoplanetary atmospheres through indirect methods, such as the transmission/emission spectroscopy. In addition, the use of direct techniques to characterise planetary surfaces is now on development, allowing us to gain more and more data from the next generation telescopes. In this work we perform a sensitivity study, focused on the detectability of different surface and cloud spectral endmembers in planetary reflectance spectra, in order to analyse the possibility to detect the presence of particular organisms, called cyanobacteria. By means of a model developed by Oliva et al. (2017), we simulated the observations of planets made of different spectral endmembers (vegetation and/or cyanobacteria, desert, ocean and H2O ice clouds). We then analysed the resulting spectra for the detection of each endmember through the use of spectral indexes. We furthermore investigated the possibility to detect the endmembers at different observing geometries and distances from the target. We deduced that cyanobacteria have spectral signatures that would permit their identification in the reflectance spectra of planets. In particular, the spectral signatures of the studied cyanobacteria allowed the definition of indexes for their clear identification with respect to the terrestrial vegetation when observed at a distance at which the planet is completely resolved on several pixels. These tests succeeded even at greater distances, also at a distance at which a planet is observed as a single pixel. This is a forerunner work for forward works that will take into consideration future high contrast imagers (e.g. METIS and SPHERE) and direct imaging mission like WFIRST CGI, JWST-MIRI and JWST-FGS/NIRISS.

Thematic section: Astrobiologia

Francesco Sauro

Affiliazione: Università di Bologna

Contributi Proposti

Title: Geological contribution to ESA Analog1 experiment

Authors: Francesco Sauro, Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna; Sam Payler, ESA-EAC; Angelo Pio Rossi, Jacobs University; Riccardo Pozzobon, Dipartimento di Geoscienze, Università di Padova; Erica Luzzi, Jacobs University; Nicolas Mangold, CNRS-LPG; Harald Hiesinger, Muenster University; Matteo Massironi, Dipartimento di Geoscienze, Università di Padova; William Carey, ESA-ESTEC.

Abstract: One of the possible scenario of forthcoming Lunar and Mars exploration is defined by human assisted robotic sample return missions. Analog1 experiment was conceived to pave the way to such an exploration strategy by allowing the teleoperation of a rover and its robotic arm for geological sampling purposes. On the 25th of November 2019 Luca Parmitano teleoperated a robot from the International Space Station and successfully accomplished a geological sampling on a simulated environment at ESTEC, while communicating to the science ground hosted at EAC. Planetary geologists had a prominent role on this experiment by characterizing through 3D reconstruction the simulated sampling sites, providing the samples, acting as science ground segment, defining the scientific rationale for each sampling site and providing the evaluation metrics on the degree of success of the experiment. The ESA PANGAEA training course for Astronauts assured also that Luca Parmitano and some engineers involved in the project were clearly aware of the science topics and geological objectives of the experiment and provided the basis without which the communication effectiveness in terms of description of the sites and samples would have not been possible. Finally, geologists have also defined potential traverses on natural environments on Lanzarote for possible future experiments on Earth. In this presentation we will describe how the experiment was carried out focusing on the geological contribution provided by the PANGAEA planetary geologists team.

Thematic section: Pianeti e satelliti

Simone Silvestro

Affiliazione: INAF OACN

Contributi Proposti

Title: Aeolian processes on Mars: bed form analysis and implications for climate

Authors: Simone, Silvestro, INAF OACN; David, Vaz, Università di Coimbra; Ciprian, Popa, INAF OACN; Giuseppe, Mongelluzzo, INAF OACN; Francesca, Esposito, INAF OACN

Abstract: Small-scale aeolian bed forms such as sand ripples are widely studied to constrain the wind environment at the surface of Mars and to interpret its stratigraphic record (1–4). On big advantage for Martian aeolian science is that, due to its “exotic” atmospheric environment, Martian ripples are one order of magnitude larger than their terrestrial counterparts and are thus visible on high resolution orbiter images (5, 6). Thus, the aeolian environment in many areas of Mars can be characterized remotely and key parameters for landscape evolution such as sand flux and erosion rates can be computed (2, 3, 7, 8). On the other hand, with few in situ sedimentological data, the characterization of the bed form covering the surface of Mars is much more challenging. Bright-toned bed forms with wavelength ranging from ~10 to ~100 m and height ~1 to ~14 m were called Transverse Aeolian Ridges (TARs) as their exact nature (ripples or dunes) is debated (Table 1) (9, 10). When found together, TARs are overlaid by dark dunes and, despite checked for activity on 2-3 Mars years paired images by numerous researchers, they have never been observed to migrate (11–13). Thus, TARs have been widely considered to be remnant landforms from a prior climate and obliquity (13–16). In this work, we analyze bed forms located in Nili fossae and McLaughlin Crater that partially overly the TARs wavelength range. The study features are 1-35 meters spaced (5 meters on average) and have albedo in between dark dunes and TARs. For the first time, we characterize the dynamic of these bed forms and we estimate their flux, which is one order of magnitude lower than dunes. In addition, we present preliminary evidence for the presence and orientations of bright-toned megaripples in the ESA ExoMars 2020 landing site in Oxia Planum, giving constrains on the wind-regime in the landing ellipse. 1. M. G. A. Lapotre et al., Large wind ripples on Mars: A record of atmospheric evolution. Science (80-.). 353, 55–58 (2016). 2. S. Diniega et al., Our evolving understanding of aeolian bedforms, based on observation of dunes on different worlds. Aeolian Res. 26, 5–27 (2017). 3. M. E. Banks et al., Patterns in Mobility and Modification of Middle- and High-Latitude Southern Hemisphere Dunes on Mars. J. Geophys. Res. Planets. 123, 3205–3219 (2018). 4. D. A. Vaz, S. Silvestro, Mapping and characterization of small-scale aeolian structures on Mars: An example from the MSL landing site in Gale Crater. Icarus. 230, 151–161 (2014). 5. M. G. A. Lapotre et al., Geophys. Res. Lett., in press, doi:10.1029/2018GL079029. 6. R. Sullivan et al., Wind-driven particle mobility on Mars : Insights from Mars Exploration Rover observations at ‘“ El Dorado ”’ and surroundings at Gusev Crater. J. Geophys. Res. Planets. 113, 1–70 (2008). 7. N. T. Bridges et al., in 47th Lunar and Planetary Science Conference (2016). 8. M. Chojnacki, M. E. Banks, L. K. Fenton, A. C. Urso, Boundary condition controls on the high-sand-flux regions of Mars. Geology. 47, 1–4 (2019). 9. J. R. Zimbelman, M. C. Bourke, R. D. Lorenz, Recent developments in planetary Aeolian studies and their terrestrial analogs. Aeolian

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Thematic section: Pianeti e satelliti

Vito Squicciarini

Affiliazione: Università di Padova - INAF/OAPD

Contributi Proposti

Title: Searching for the oxygen footprint of light-harvesting organisms

Authors: Vito Squicciarini, Università di Padova - INAF/OAPD; Riccardo Claudi, INAF/OAPD; Nicoletta La Rocca, Università di Padova Eleonora Alei, Università di Padova - INAF/OAPD

Abstract: For the first time in history, we do have the means to scientifically answer a longstanding human question: "Are we alone?". The remote detection of life is based on the idea that its metabolic by-products can, under the right conditions, build up to detectable concentrations. This is the case of Earth's free oxygen, the waste product of photosynthetic activity. While photosynthesis is expected to be a common feature of life, O2 buildup depends on the relation between its sources and sinks: a problem quantitatively assessed in the model presented here. Starting from their present values, analytical forms for their time evolution were searched; the biomass term, in particular, was modelled through the logistic function. Despite many simplifications, the model yielded a close fit to the reconstructed Earth's O2 profile, with four biomass bumps at t=2.3 Gyr, t=720 Myr, t=370 Myr and t=260 Myr ago, compatible to paleontological evidence. After gauging the model to the Earth, an attempt was made to generalise it to exoplanets. Absence of data compulsorily required many assumptions. Since biomass is ultimately limited by the availability of light and nutrients, a clear distinction emerged between nutrient-limited, light-limited and the hybrid chimera worlds. The simulations show that biotic oxygen can accumulate in a wide variety of planetary environments, including light-starving M-star systems, even if an O2-rich atmosphere is not the inevitable outcome of photosynthesis. Atmospheric characterisation of exoplanets by space missions like NASA's JWST and ESA's ARIEL and ground-based facilities like SPHERE@VLT, GPI@GEMINI and PCS@E-ELT, might provide a spectacular confirmation of these claims.

Thematic section: Astrobiologia

Stefania Stefani

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: Planetary Atmosphere Simulation System (PASS), a new experimental set up used to characterize the optical properties of gases at typical planetary conditions

Authors: S.Stefani (iaps-inaf), G.Piccioni (iaps-inaf), M. Snels (isac-cnr), A. Adriani (iaps-inaf) and D. Grassi (iaps-inaf)

Abstract: The laboratory studies of the optical properties of gases at planetary conditions, high/low pressure and high/low temperature, are of major importance to assess the input parameters of any radiative transfer model. In this work we report a new innovative experimental set up designed to measure the optical properties of gases, such as CO2, CH4, H2, H2+He or other combinations, performed in an ample range of pressures and temperatures. The experimental set-up is composed by a special designed chamber, named PASS (Planetary Atmosphere Simulation System), suitable to be coupled to a Fourier Transform-InfraRed (FT-IR) spectrometer, or working as a stand-alone Cavity Ring Down (CRD) system and it is designed to sustain pressures in a range from vacuum up to 70 bars and temperatures ranging from 100 up to 500 K. When coupled with a FT-IR spectrometer, the chamber can be equipped with a Multi Pass (MP) absorption gas cell, characterized by an optical path of about 9 m, mounted internally. The absorption coefficients of the gases can be measured in a wide spectral range (0.4-8 •m) with a spectral resolution pre-set from 0.07 to 10 cm-1. Alternatively, the MP can be replaced by an independent resonant cavity consisting of a quartz tube formed by two highly reflecting plano-concave mirrors (with reflectivity better than 99.98%) which takes advantage of the Cavity Ring Down (CRD) technique. In this case we illuminate the cavity with a tunable laser and, varying the pressure and temperature of the sampled gas, we acquire the loss rate which in turn represents the absorption coefficient of the gas. The CRD can reach an equivalent optical path of about 5km, so that very weak absorptions (about 10-10) can be studied, particularly interesting for the so called ‘’atmospheric windows’’. In this work we present preliminary results of the CO2 Collisional Induced Absorptions (CIA) bands measured in the IR spectral region, at different densities and temperatures.

Thematic section: Planetologia sperimentale e di laboratorio

Giovanni Strazzulla

Affiliazione: INAF_Osservatorio Astrofisico di Catania

Contributi Proposti

Title: Ion implantation in laboratory ices (Waiting for JWST and JUICE)

Authors: Giovanni Strazzulla INAF-Osservatorio Astrofisico, Catania

Abstract: Bombardment by energetic ions that populate the magnetospheres of giant planets drive chemical evolution of the surfaces of their icy satellites. Such a processing is simulated in the laboratory, where pure ices (e.g. H2O, NH3, CO2, SO2 and many others) or mixtures are deposited at low temperature (10-150 K) and irradiated with energetic ions. If the thickness of the target is greater than the ion penetration depth, ions are implanted in the target and if they are reactive (e.g., H+, Cn+, Nn+, On+, Sn+) have a chance, being stopped in the target, to form new species containing the projectile. Here I present some of the most recent results that are relevant to plan and understand the data that will be obtained by future space missions such as JUICE (ESA) and JWST (NASA).

Thematic section: Planetologia sperimentale e di laboratorio

Claudia Toci

Affiliazione: INAF OA Brera

Contributi Proposti

Title: The fate of rings in protoplanetary discs: giant planets in action

Authors: Claudia Toci, INAF OA Brera; Giuseppe Lodato, UNIMI; Davide Fedele, INAF OA Arcetri; Leonardo Testi, ESO; Christophe Pinte, Monash University

Abstract: New generation instruments such as the interferometre ALMA and the telescope SPHERE are more and more delivering astonishing images of protoplanetary discs, showing a large number of gaps and ring-like structures. These structures can be due to the presence of one or more planets embedded in the parental disc. Frontier research is to study the interaction between the disc and the planets that are forming inside, using observational result in synergy with current theoretical models and numerical simulations. Indeed, this has a deep impact on the resulting architecture of exoplanetary systems. I will present a recent analysis of HD 169142, a protostar with a nearly face-on disk. It has been observed with different telescopes and techniques, including the continuum emission of millimetric dust and millimetre gas lines emission of CO and its isotopologues (Fedele et al. 2017, Perez 2019) and infrared polarised scattered light of small size dust (Pohl et al. 2017, Ligi et al.2017,..). Such a large number of observations and the claim of the potential discovery of protoplanets (Biller et al. 2014, Reggiani et al.2014, Gratton et al.2019) makes HD 169142 an ideal case to study the planet-disc interaction during the early phases of planetary formation and evolution. I will show the results of 3D hydrodynamical simulations performed using the SPH code PHANTOM (Price et al. 2018) aimed to model the dust inner ring and gas profile of this disc. I assumed the presence of two giant planets and I followed the time evolution of the system. In particular, I will show that the two planets reach a resonant orbital locking, and can be responsible for the origin of the observed dust inner rings structure, that is actually long lived. At the same time, the gas mass of the disc is accreted onto the star and the planets, emptying the inner region. I will also show that the innermost planet is located at the inner edge of the dust ring, and can generate a signature in the dust ring shape that can be observed in mm ALMA observations. (Toci et al., ApJL 2019).

Thematic section: Pianeti e sistemi extrasolari

Gloria Tognon

Affiliazione: Center of Studies and Activities for Space "G.Colombo" of Padova, University of Padova

Contributi Proposti

Title: Geological characterization of Tsiolkovskiy crater as a possible landing site

Authors: Gloria Tognon, Center of Studies and Activities for Space "G.Colombo" of Padova, University of Padova; Riccardo Pozzobon, Department of Geosciences, University of Padova; Matteo Massironi, Department of Geosciences, Center of Studies and Activities for Space "G.Colombo" of Padova, University of Padova

Abstract: Tsiolkovskiy crater is a late Imbrian elliptical impact crater, with a minor axis diameter of 180 km, located on the far side of the Moon and centered at 20.4° S, 129.1° E in the Feldspathic Highlands Terrane (Whitford-Stark & Hawke, 1982). The crater floor is filled by a particularly dark mare deposit, one of the few exposures of mare basalt on the lunar farside (Pieters & Tompkins, 1999), over which rises a ~3 km-high exclusively bright and well-preserved central peak on which has been defined the presence of anorthosite composed of nearly 100% anorthite, also defined as Purest ANorthosite (PAN) (Ohtake et al., 2009; Lemelin et al., 2015), and olivine (Corley et al., 2018). The above mentioned characteristics and the unusually smooth surface of the crater floor make Tsiolkovskiy crater a scientifically interesting and safe place for a possible landing site. Aiming to focus the strategy of exploration with rovers by means of planned traverses, we are producing geological maps of the site to select locations of high interest for investigations and analysis. The main basemap used to characterize the surface morphology of the impact crater is the LRO-WAC (Robinson et al., 2010) global mosaic with a resolution up to 100 m/pixel along with elevation data derived from the LRO-LOLA and Kaguya TC DEM merge with an horizontal and vertical resolution respectively of about 59 m/pixel and 3-4 m (Barker et al., 2016). The spectral characterization, instead, is being performed on the basis of the ~200 m/pixel false color composite (Red 750/415 nm; Green 750/1000 nm; Blue 415/740 nm) generated using the Clementine UVVIS reflectance (Lucey et al., 2000). The geomorphological mapping, currently delimitated by Tsiolkovskiy's rim, allowed to define six units. In particular, three units are related to the crater floor and correspond to the sharp central peak morphology and to smooth and hummocky materials, distinguished according to the texture differences. The remaining three units, corresponding to the crater rim, scarps steeper than 40° and ponds of smooth material texturally discording with respect to the surrounding rough areas, are related to the crater walls. Differently, the geo-spectral mapping is being performed on the basis of the different color of the units, associated to a different origin and composition of the material. Up to now, have been identified basaltic soils and fresher basalts, correlated to the smooth crater floor unit, together with norites, troctolites and anorthosites, mostly correlated to the steep scarps and the central peak units, lying on top of mature highland soils, basically associated with the smooth ponds present on the crater walls, the crater walls themselves and the hummocky crater floor units. In the immediate future, the geological characterization of Tsiolkovskiy crater will be supported also by an high-resolution mapping of a portion of the crater, selected on the basis of its scientific interest, and by an investigation for the presence of subsurface caves and lava pile

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Thematic section: Pianeti e satelliti

Ilaria Tomasi

Affiliazione: Dipartimento di Geoscienze - Università degli Studi di Padova

Contributi Proposti

Title: Extra-large lava tubes

Authors: Ilaria Tomasi [University of Padua, Department of Geoscience, Italy]; Matteo Massironi [University of Padua, Department of Geoscience, Italy]; Christine Meyzen [University of Padua, Department of Geoscience, Italy]; Riccardo Pozzobon [University of Padua, Department of Geoscience, Italy]; Luca Penasa [University of Padua, Department of Geoscience, Italy]; Francesco Sauro [University of Bologna, Department of Biological, Geological and Environmental Science, Italy]; Jesús Martínez-Frías [Instituto de Geociencias - IGEO (CSIC-UCM), Madrid, Spain] and Elena Mateo Medero [Geopark of Lanzarote, Cabildo Insular, Lanzarote, Spain]

Abstract: Lava tubes, which are typical features of lava fields encountered in intracontinental plateaus and volcanic-shield islands (slopes <2°, e.g. Hawaii and Canaries), constitute among the most efficient thermal structures on Earth, because of their capacity of thermal insulation. In minimizing their heat loss, isolated lava flows can travel over long distances across lava fields. Lava tubes do not only occur in Earth volcanic environment, as open pits and sky-lights, constituting distinctive features of lava tube, have also been recognised on the surface of other rocky bodies of the Solar System (SS) such as Mars and the Moon[1]. Due to the differences in gravity between Earth and other planets and its concurrent influence on the effusion rates, terrestrial pyroducts tend to generally have a smaller width (10–30 m) than those on Mars (250–400 m) and the Moon (500–1100 m)[2].Within this framework, studying the largest lavas tubes on Earth is of interest as they could represent the best planetary analogues. Located in the NE part of Lanzarote(Canary Islands), La Corona lava tube with its 7.6 km length and average width of 30 m [3] is one of the world's largest volcanic cave complex. Canary Islands are located in the Canary Island Seamount Province (CISP) that forms in parallel to the NW African continental margin (Morocco). The CISP has been generated by the extremely slow transit (~8–10 mm/yr) of the African plate over a hotspot for more than 133 Ma[4] and hence represents both long-term and spatially focused volcanic activity over a poorly mobile tectonic plate. For this reason, it constitutes one of the best terrestrial analogue of the Martian one-shell plate volcanism [5]. Therefore, the occurrence of volcanism on an almost stationary plate and the impressive dimensions of La Corona lava tube make it one of the most suitable lava tube for interplanetary analogies. Different field surveys were conducted over the last two years in order to explore its three-dimensional geometry using 3D laser-scan. These data allowed to place constraints on the tube origin (inflation process rather than over-crusting), the involvement of thermal erosional processes (inferred from characteristic morphologies) and to identify a weak pyroclastic level within the tube which might have favoured the inflated tube inception. Studying this exceptional example of terrestrial lava tube will allow to improve our understanding of the formation processes giving rise to analogue features on other bodies of the SS. [1] Haruyama, J. et al. (2012) Trans. JAPAN Soc. Aeronaut. Sp. Sci. Aerosp. Technol. JAPAN 10 [2] Sauro, F., et al. (2018) 49th Lunar Planet. Sci. Conf. 2018 [3] Carracedo, J. C. et al. (2003) Estud. Geol.

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Thematic section: Pianeti e satelliti

Federico Tosi

Affiliazione: INAF-IAPS, Roma

Contributi Proposti

Title: Compositional and thermal mapping of Io obtained with Juno/JIRAM

Authors: F. Tosi1; A. Mura1; A. Adriani1; G. Filacchione1; J. Rathbun2; G. Sindoni3; F. Zambon1; F. Altieri1; M. Ciarniello1; A. Cicchetti1; D. Grassi1; A. Migliorini1; R. Noschese1; G. Piccioni1; C. Plainaki3,1; R. Sordini1; S. Stefani1. 1 INAF-IAPS, Rome, Italy, federico.tosi@inaf.it 2 Planetary Science Institute (PSI), Tucson, USA 3 Agenzia Spaziale Italiana (ASI), Rome, Italy

Abstract: Despite the Jupiter InfraRed Auroral Mapper (JIRAM) onboard the NASA Juno mission [1] is a spectro-imager designed primarily for the study of Jupiter's atmospheric and auroral processes, in the three-year period from the capture orbit until 12 September 2019 JIRAM had the opportunity to observe the Galilean satellites over 5000 times, both through images and spectra. In the best cases, the Galilean satellites were typically observed over 11 to 58 pixels, yielding spatial resolutions between ~54 and ~300 km/px depending on the target (Europa best, Callisto worst), but always at medium-to-high and high phase angle values, given Juno's polar orbit. JIRAM data of Io acquired from orbit 5 to orbit 24 display typical pixel resolutions from about 70 to 150 km/px. In particular, those obtained in orbits: 5, 7, 9, 10, 17, and 18, have already been used to characterize the location, potential morphology and temperature of Io's volcanic thermal sources, as well as to derive average spectra representative of surface composition [2]. In this work, we follow up the analysis of JIRAM spectroscopic data to map the spatial distribution of SO2 frost and other chemical species largely known from literature and revealed in JIRAM spectra [2]. In particular, the mapping of non-SO2 species is an original product that can hardly be obtained from Earth-based observations. The spectral sensitivity range of JIRAM limited to 5 μm and its typical in-flight instrumental noise allow a temperature retrieval only for surface temperature values greater than 170-180 K. Given the low temperatures typical of the surfaces of the Galilean satellites, this means that a reliable temperature retrieval can be attempted only for hot spots, which are revealed in both JIRAM's M-band imagery and spectroscopic datasets, despite their sub-pixel nature. There are indeed several examples of JIRAM radiance spectra showing maxima in the spectral region between 2.5 and 4.0 μm. Assuming that the surface of Io behaves like a black body, according to Wien's law these maxima are indicative of local temperatures exceeding several hundred Kelvin. [1] Adriani, A., et al., 2017. JIRAM, the Jovian Infrared Auroral Mapper. Space Sci. Rev. 213, 393-446. [2] Mura A., et al., 2020. Infrared observations of Io from Juno. Icarus, in press.

Thematic section: Pianeti e satelliti

Diego Turrini

Affiliazione: Istituto Nazionale di Astrofisica (INAF)

Contributi Proposti

Title: A violent dance of giant planets and planetesimals in circumstellar disks

Authors: Diego Turrini (INAF-IAPS); Francesco Marzari (UNIPD); Danae Polychroni; Leonardo Testi (ESO); and the ISSI Team "Vesta, the key to the origins of the Solar System"

Abstract: Planetesimals are the first population of planetary bodies to form from the dust in circumstellar disks, as testified by the radioactive dating of the meteorites collected on Earth. Recent observations of circumstellar disks with ALMA revealed, however, that the formation of giant planets occurs soon after. As soon as giant planets appear, the dynamical evolution of these two classes of planetary bodies becomes closely connected. Disentangling the coupled evolution of giant planets and planetesimals, however, is complicated by the process of orbital migration. While there is consensus that giant planets form at locations different from their observed ones, the different scenarios formulated for the Solar System propose divergent migration tracks. A further complication arises from ALMA's observational campaigns of circumstellar disks, which revealed morphological features (rings and gaps) suggestive of the presence of giant planets at several tens of au from the stars, increasing the range of possible formation regions and migration tracks. A common element to all giant planet formation scenarios, both in case or in absence of migration, is that growing giant planets dynamically excite the planetesimal orbits to large eccentricities and cause a rapid growth of the impact rates across the young planetary system. In this talk I'll show how the constructive and destructive effects of the excited collisional evolution of the planetesimals can be used to investigate the mysterious early phases in the life of planetary systems, both around our Sun and other stars.

Thematic section: Pianeti e sistemi extrasolari

Giovanni Valsecchi

Affiliazione: IAPS-INAf

Contributi Proposti

Title: Collisions vs. ejections in the outer planetary region

Authors: Giovanni B. Valsecchi, IAPS-INAF

Abstract: Close encounters with the giant planets play an important role in the dynamical evolution of objects in planet-crossing orbits. This subject has been most often dealt with using massive numerical integrations; however, some useful insight can be obtained using an analytic approach, at the price of having to treat the problem in a simplified version of the restricted 3-body problem. This presentation is aimed at determining the conditions under which ejections from the Solar System, due to close encounters with an outer planet, prevail over collisions with the same planet.

Thematic section: Dinamica dei corpi celesti naturali e artificiali

Francesca Zambon

Affiliazione: INAF-IAPS

Contributi Proposti

Title: Intergrating morpho-stratigraphic and spectral units on Apollo basin on the Moon.

Authors: F. Zambon (1); C. Carli (1); C. H. van der Bogert (2); C. Pöhler (2); H. Hiesinger (2); F. Altieri (1); M. Massironi (3,4) 1) INAF-Istituto di Astrofisica e Planetologia Spaziali, Via del Fosso del Cavaliere, 100, I-00133 Rome 2) Institut für Planetologie, Westfälische Wilhelms Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany 3) Dipartimento di Geoscienze, Padova University, Padova, Italy 4) INAF - Osservatorio Astronomico di Padova

Abstract: Apollo basin (10°-60°S, 125°-175°W, 492 km diameter) lies within the northeastern edge of the ~2500 km South Pole-Aitken (SPA) basin [1]. Because it is one of the largest and deepest basins within SPA that postdates the formation of SPA, it has been selected as a region of interest for the PLANetary MAPping (PLANMAP - H2020 n°776276) project [2]. Apollo basin has also been investigated as a candidate landing region for robotic and human exploration [3]. GRAIL gravity data reveal an average crustal thickness on the floor of SPA of ~20 km and within the Apollo basin of only ~5 km, meaning that mantle material may be exposed there [4,5]. However unlike the Earth, SPA is not dominated by olivine, but rather by low calcium pyroxenes, suggesting a different composition of the Moon upper mantle [6]. Crater size-frequency distribution studies indicate that Apollo basin is one of the youngest pre-Nectarian basins, with an extimated age of ~3.98 Ga according to [2] and 4.14 Ga following [7]. Models and observational data suggest that the basin was created by an impactor of ~40 km in diameter traveling at 15 km/s into 20–40 km thick crustal material [8]. A morpho-stratigraphic analysis of this region reveals the presence of two main units: cratered terrains and plains-forming materials created by deposition of both volcanic flows and impact melt breccias [2]. To complement this analysis, here, we study the Apollo area from the spectral stand point. We consider the Chandrayaan-1/M3 data to produce hyperspectral maps of the Apollo region to derive proper spectral parameters (e.g. albedo, center and depth of the absorption bands and spectral slopes), useful for identifying spectral units that can augment and improve the morpho-stratigraphic ones defined in [2]. This work is essential not only to identify more detailed geological units – linking compositional and morpho-stratigraphic information – but in a broader view to better understand the origin of this intriguing region of the Moon. This work is funded by the European Union's Horizon 2020 research grant agreement No 776276- PLANMAP. References [1] Garrick-Bethell, I., & Zuber, M. T., 2009, Icarus, 204, 399-408. [2] Ivanov, M.A. et al., 2018, JGR, 123, 2585-2612. [3] Orgel C. et al., 2018, LPSC 49, 1969. https://www.hou.usra.edu/meetings/lpsc2018/pdf/1969.pdf [4] Baker, D.M.H. et al., 2017, Icarus 292, 54-73. [5] Wieczorek, M.A. et al., 2013, Science 339, 671-675. [6] Melosh, H. J. Et al., 2017, Geology, 45 (12), 1063-1066. [7] Orgel et al., 2018, JGR 123. [8] Potter, R.E.K., et al. 2018, Icarus, 306, 139-149.

Thematic section: Pianeti e satelliti

Title: Multi-instrument integrated analysis of regions of interest on Ganymede

Authors: F. Zambon (1); F. Tosi (1), V. Galluzzi (1); G. Piccioni (1); G. Cremonese (2); G. Filacchione (1); A. Lucchetti (2); R. Orosei (3); P. Palumbo (4,1) 1) INAF - Istituto di Astrofisica e Planetologia Spaziali, via del fosso del cavaliere 100, 00133 Roma 2) INAF - Osservatorio Astronomico di Padova, Vicolo Osservatorio 5, 35122 Padova 3) INAF - Istituto di Radio Astronomia, Via P. Gobetti, 101, 40129 Bologna 4) DiST - Università di Napoli "Parthenope", Centro Direzionale, Isola C4, 80143 Napoli

Abstract: The ESA JUpiter ICy moons Explorer (JUICE) mission will enter orbit for the first time around an icy satellite, Jupiter's largest moon Ganymede, in 2032 [1]. Previous investigations carried out by the NASA Voyager and Galileo spacecrafts decades ago were able to image the surface of Ganymede with a spatial resolution (up to 1 km/pixel) adequate enough to undertake geologic mapping, revealing a variety of surface features [2]. The analysis of the Galileo/Solid-State Imager (SSI) data, plus a recent revision of all the literature produced on the basis of Voyager and Galileo imaging data, allowed for a firm identification of seven main geological categories on Ganymede. In decreasing order of geologic priority, these are: 1) Potential cryovolcanic areas, 2) Polar deposits, 3) Craters with dark rays or dark floors, halo craters, 4) Impact crater morphologies (e.g., peaks, pits, domes, pedestals, palimpsest, catenae); 5) Bright ray craters, 6) Bright terrains, and 7) Surface degradation terrains [3]. The Galileo spacecraft also carried onboard a Near-Infrared Mapping Spectrometer (NIMS), meant to identify and map the surface composition of Jupiter and its moons. Unfortunately, the mission profile combined to limited resources in terms of data volume, allowed Galileo/NIMS to cover the surface of Ganymede at generally coarse spatial resolution (50-150 km/px). Only a few local-scale areas (so-called "postage stamps") were observed at a spatial resolution adequate enough (2-10 km/px) to reveal spectral signatures potentially indicative of a class of non-ice materials, which might be endogenic in origin. Here, we show preliminary results of a multisensor analysis carried out for some of these regions of interest, including different geologic categories as defined above, covered by both SSI and NIMS. Among other things, the study of specific regions of interest on Ganymede is key to drive the planning and prioritization of the observations to be carried out by the JANUS imaging system and the MAJIS imaging spectrometer onboard the JUICE mission, especially during the low-altitude Ganymede orbit phase (GCO-500) where global coverage cannot be achieved. This work aims at showing the potential of a multidisciplinary data analysis approach that could be obtained by merging multi- and hyperspectral images in anticipation of the JUICE mission. This work is funded by the INAF Mainstream 2018 research project: "Ganimede dal 2D al 3D: Un approccio multidisciplinare in preparazione a JUICE". References [1] Witasse, O., EPSC-DPS Joint Meeting 2019. [2] Jones, K.B. at al., 2003, Icarus 164 197–212. [3] JUICE Working Group 2 Report: Ganymede/Callisto Target Area Collection, ESA internal document, 2018.

Thematic section: Pianeti e satelliti

Angelo Zinzi

Affiliazione: SSDC-ASI

Contributi Proposti

Title: MATISSE 2.0, the new tool for planetary sciences

Authors: Angelo Zinzi, SSDC-ASI; Marco Giardino, SSDC-ASI; Edoardo Rognini, SSDC-ASI / INAF-OAR; Giuseppe Sindoni, ASI / SSDC-ASI; Maria Teresa Capria, INAF-IAPS; Davide Grassi, INAF-IAPS; Ernesto Palomba, INAF-IAPS; Christina Plainaki, ASI; Alberto Adriani, INAF-IAPS; Alessadnro Mura, INAF-IAPS; Cristina Re, INAF-OAPD; Gabriele Cremonese, INAF-OAPD; Eleonora Ammannito, ASI; Gianluca Polenta, SSDC-ASI

Abstract: A brand new version of the SSDC webtool MATISSE (Multi-purpose Advanced Tool for the Solar System Exploration) is now online in its beta version at https://tools.ssdc.asi.it/Matisse. We decided to make it publicly available as beta version in order to gather feedback and suggestions from the users to be included in the upcoming stable release. This new version, named MATISSE 2.0, is aimed at enlarging the functionalities of the old version (still online at https://tools.ssdc.asi.it/matisse.jsp) and exploiting its potential in order to become a point of reference for the planetary science community. The new, improved, user-friendly interface of MATISSE 2.0 offers the possibility of searching data from maps, loading a series of queries in different tabs, and showing both 2D and 3D outputs in an interactive form directly from the web browser, thanks to the use of Planetary FITS and VTP formats for 2D and 3D, respectively. There is also an important difference in the engine of the two versions of the tool, with MATISSE 2.0 exploiting the GIS suited characteristics of PostegreSQL + PostGIS, rather than the MySQL used in MATISSE 1. Thanks to this solution, MATISSE 2.0 can better manage geospatial data, both by executing more accurate queries and by exploiting the DBMS characteristics to lower the computing resources devoted to spatial interpolation. All these capabilities are already available in the beta version online, together with the Dawn-VIR dataset for Vesta, while other datasets are being implemented and will be available in the very near future (Dawn-VIR Ceres, MRO-CRISM Mars from PlanetServer, VEX-VIRTIS from VESPA, Juno-JIRAM Jupiter). Another noteworthy dataset we are working on for ingestion in MATISSE 2.0 is that relative to CaSSIS (Colour and Stereo Surface Imaging System - Thomas et al., 2017), the high-resolution camera orbiting Mars, with stereo capabilities, whose data analysis would greatly benefit from the online 3D visualization featured in our tool. MATISSE 2.0 will also include algorithms, developed by collaborating research teams, for real time production and visualization of high-level data. As an example we highlight atmospheric retrieval (e.g. Grassi et al., 2010; Sindoni et al., 2017), surface temperature modelling (Capria et al., 2014; Rognini et al., 2019) and Artificial Intelligence / Computer Vision (Zinzi et al., 2019). In addition, MATISSE 2.0 is intended to further extend its capabilities by accepting queries from command line, so that, without being limited by the browser, an experienced user could send very complex queries, thus greatly supporting its research. This invocation technique has been also developed with a micro-service architecture perspective in mind, facilitating any integration of auto-scaling features References Capria et al., 2014, Geophysical Research Letters, 41, 1438-1443 Grassi et al., 2010, Planetary and Space Science, Volume

58, Issue 10, p. 1265-1278 N. Thomas et al., 2017, Space Sci. Rev. 212, 1897–1944 Rognini et al., Journal of Geophysical Research, in press Sindoni et al., 2017, Geophysical Research Letters, Volume 44, Issue 10, pp. 4660-4668 Zinzi et al., 2019, EPSC-DPS Joint Meeting 2019, held 15-20 September 2019 in Geneva, Switzerland, id. EPSC-DPS2019-1278

Thematic section: Pianeti e satelliti, Piccoli Corpi

Title: Exo-MerCat inclusion in ExoplAn3T: a new way of exploring large exoplanetary databases

Authors: Angelo Zinzi, SSDC-ASI; Eleonora Alei, INAF – OAPD / Dipartimento di Fisica e Astronomia Galileo Galilei, Università di Padova; Diego Turrini, INAF-IAPS; Riccardo Claudi, INAF-OAPD; Marco Molinaro, INAF-OATS; Andrea Bignamini, INAF-OATS; Francesco Verrecchia, SSDC-ASI / INAF-OAR

Abstract: ExoplAn3T (Exoplanet Analysis and 3D visualization Tool - https://tools.ssdc.asi.it/exoplanet/) is the SSDC webtool providing access to remote observational databases with an interface designed and optimized for the study of exoplanetary systems as a whole, rather than single exoplanets. To be able to succeed in this operation, the tool makes use of a two-phases approach: first finds all the exoplanets with user-defined characteristics and then finds all the exoplanets in the systems whom the exoplanets in the first query belong. The peculiar characteristic of ExoplAn3T has already demonstrated its usefulness for studies focused on the evolution of planetary systems (e.g., [1]) and, in order to make it of further interest to the scientific community, it is crucial to open it to new databases. In this framework the Exo-MerCat database is of major relevance, since it allows to automatically compare four of the main exoplanetary databases available (e.g., NASA Exoplanet Archive [2, A], Exoplanet Orbit Database [3, B], Exoplanet Encyclopaedia [4, C] and Open Exoplanet Catalogue [5, D]), matching the results and, finally, providing as output a single database. Taking into consideration that every archive considered often has different values for the same exoplanetary measurements (due to database rules, updating frequency and so on), exploiting the capabilities of Exo-MerCat in merging them would be fundamental for ExoplAn3T to provide access to the community to a larger and more complete database. At the present time Exo-MerCat is already available from the ExoplAn3T portal, even if some issues are still open, such as those regarding the speed up of the whole process. ExoMerCat is called by the ExoplAn3T pipeline by means of standard Python commands for Virtual Observatory resources. Once the requested part of the catalogue (including only exoplanets with user-defined characteristics) is made available to the system, ExoplAn3T starts parallel queries to Exo-MerCat to complete the systems as required by its second phase. In the next months the collaboration between the two developing teams is intended to be continued, so that the issues still present both in the Exo-MerCat database and in the way ExoplAn3T calls it could be superseded, thus providing an extremely powerful tool for the scientific community of interest. Websites: [A] www.exoplanetarchive.ipac.caltech.edu [B] www.exoplanets.org [C] www.exoplanet.eu [D] www.openexoplanetcatalogue.com References: [1] Zinzi & Turrini (2017) - A&A;, Volume 605, id.L4, 4 pp. [2] Akeson et al. (2013) - PASP, Volume 125, 989-999. [3] Wright et al. (2011) - PASP, Volume 123, Issue 902, pp. 412. [4] Schneider et al., 2011, A 532, A79. [5] Rein (2012) - arXiv:1211.7121.

Thematic section: Pianeti e sistemi extrasolari

Eleonora Bianchi

Affiliazione: Univ.Grenoble, CNRS, Grenoble, France. INAF-Arcetri

Title: The astrochemical link between Sun-like protostars and Solar System comets

Abstract: How the chemical complexity evolves during the process leading to the formation of a Sun and its planetary system? Is the chemical richness of a Solar-like planetary system (at least partially) inherited from the earliest stages or there is a complete chemical reset? A powerful way to start answering these questions is by comparing the observed astrochemical content in young protostars with that in comets, i.e. with the most pristine known material from which our Solar System formed.

The recent advent of IRAM-NOEMA and ALMA interferometers opened a golden age for astrochemistry, more specifically for the study of the chemical composition of the gaseous component associated with young protostellar disks, i.e. the place where planets are forming. Unprecedented combinations of sensitivity, high-spatial resolution, and huge spectral bandwidth lead to significative steps ahead in the detection of complex organic molecules on a Solar System scale, as well as in the identification of their formation routes. In this context, the on-going analysis of observations in the light of quantum chemistry computations and laboratory experiments is essential. It is time for the Italian communities working on the physical and chemical properties of young protostellar disks and Solar System objects to work in close synergy to ride this scientific wave. An example is provided by the recent comparison of young disks composition with the chemical census obtained towards the comet 67P thanks to the ROSETTA mission. The first comparative studies show striking correlations for the abundance ratios of some complex organic molecules like $HCOOCH_3$, CH_3OCH_3 and C_2H_5OH, suggesting clues of inheritance from the protostellar phase.

These preliminary and fruitful findings point to perspectives, which will be here presented in the context of the synergy between: (1) the first ALMA Large program in astrochemistry (FAUST), dedicated to a systematic (sub-)mm observations of protostellar disks around Sun analogues, (2) complementing pilot projects at cm-wavelengths (preparing the advent of SKA), and (3) forthcoming missions dedicated to study the composition of the outer Solar System objects. An example is represented by the future ESA mission AMBITION, which propose to explore new classes of comets and to collect a cometary nucleus sample.

Linda Podio

Affiliazione: INAF-Arcetri

Title: The chemical content of planet-forming disks: towards a comparison with the Outer Solar System Objects and exoplanets

Abstract: How have planets formed in the Solar System? And what chemical composition they inherited from their natal environment? Is the chemical composition passed unaltered from the earliest stages of the formation of the Sun to its disk and then to the planets which assembled in the disk? Or does it reflects chemical processes occurring in the disk and/or during the planet formation process?

A viable way to answer these questions is to study protoplanetary disks around young Sun-like stars. The impacting images recently obtained by millimetre arrays of antennas such as ALMA provided the first observational evidence of ongoing planet formation in 0.1-1 million years old disks, through rings and gaps in their dust and gas distribution. The chemical composition of the forming planets clearly depends on the location and timescale for their formation and is intimately connected to the spatial distribution and abundance of the various molecular species in the disk. The chemical characterisation of disks is therefore crucial.
This field, however, is still in its infancy, because of the small sizes of disks (~100 au) and to the low gas-phase abundance of molecules (abundances with respect to H_2 down to 10^{-12}), which requires an unprecedented combination of angular resolution and sensitivity. I will show the first pioneering results obtained as part of the ALMA chemical survey of protoplanetary disks in the Taurus star forming region (ALMA-DOT program). We recovered the radial distribution and abundance of diatomic molecules (CO, CS, and CN) as well as of simple organics (H_2CO and CH_3OH), which are key for the formation of prebiotic molecules, at ~20 au resolution. The CS and H_2CO molecules show enhanced emission in the cold outer disk, which suggests efficient formation of organic molecules on the icy mantles of dust grain. This could be the dawn of ice chemistry in the disk, producing more complex organic molecules which still escape our observations.

The next step is the comparison of the molecules radial distribution and abundance gradients in disks with those observed in the Outer Solar System Objects (OSSOs), which are believed to preserve the pristine composition of the protosolar nebula. Further to this, with the advent of JWST and ARIEL it will be possible to characterise the atmospheres of extrasolar planets and to compare them with the chemical diversity observed in disks. Finally, the SKA will open us a new window in the cm to search for heavier molecules and to explore the inner disk regions which are obscured by the dust in the millimetre range covered by ALMA.

Lorenzo Cibin

Affiliazione: OHB Italia SpA

Title: ASTROCAD – The Astronomic CCD Camera for the ESA NEO Survey Telescope

Authors: P.Gregori, M.Chiarini

Abstract: The ESA program for the procurement and deployment of the first NEO Survey Telescope, based on the innovative Fly-Eye technology developed by OHB-Italia, is nearly achieved. In particular the main components of the first NEO Survey Telescope (NEOSTEL) Prototype have been procured and accepted, comprising the Equatorial Mount with all Telescope Optical and Opto-mechanical Subsystems. To populate the extremely vast Field of View of the Fly-Eye Telescope, a series of 16 identical Astronomic grade CCD cameras are needed. To solve this necessity a dedicated ASI/ESA GSTP program has been carried on for the development of a dedicated advanced performances CCD Astronomic Camera, constituting a key element of the Telescopes that will allow to implement the Optical Observation Network for the SSA-NEO Survey activities. The NEOSTED camera is a state-of-the-art astronomical camera that provides low noise capabilities as well as remote control via an EPICS1 protocol over Ethernet Interface. It is equipped with a Scientific Grade 4kx4k high sensitivity (back illuminated) CCD sensor which operates down to -50 °C, in optimal operating conditions, thanks to a dedicated TEC cooling module. The ASTROCAD prototype has been tested by means of advanced EGSE and OGSE apparatuses, allowing to check in detail the obtained performances, and preliminarily tested on field at the Copernico Telescope of INAF Asiago Astronomical site. We present here the results of the ASTROCAD project outcomes with an overview of the development status of the NEO Survey Fly-Eye Telescope Prototype.

Vanni Moggi Checchi

Affiliazione: Università degli Studi di Firenze

Title: Meteorite databases and catalogues: the case of the meteorite collection of the Museo di Storia Naturale dell'Università di Firenze as the first one to be published on the Italian ICCD web site

Authors: V. Moggi Cecchi, G. Pratesi, L.Fantoni, C. Scagliotti

Abstract: Since the first half of the 19th century the scientific community realized the importance of performing a systematic cataloguing of all the known meteorites of the world. The first systematic catalogue (Catalogue of Meteorites) was produced in 1847 and contained the complete list of the meteorite samples deposited at the Natural History Museum of London. Several further editions of this catalogue were published, the last one in 2000. This fifth edition is the first one containing, together with the book, a CD-rom with a database of the officially approved meteorites. An excerpt of the contents of this database is also available at the Natural History Museum of London website. Another product full of information was the software MetBase, a fee- downloadable database provided by a private collector containing basic information, analysis data, repositories, images and literature on meteoritics and planetary sciences. Another interesting tool is the Earth Impact database provided by the PASSC at the University of New Brunswick, Canada, containing information about all the known impact structures of the world. The most updated tool containing basic information about all the officially approved meteorites is the Meteoritical Bulletin database. In this case the search form is rather simple but several information is lacking. As concerns Italy, the recent constrains developed by the Central Institute for Cataloguing and Documentation (ICCD) – after which meteorites are considered natural heritage and therefore placed under the control of the State authority – lead to the creation of a set of cataloguing rules based on the up-to-date scientific information about meteorites. A new, ICCD rules-based cataloguing software named SAMM-2 has been consequently commissioned to a software house by the Museo di Storia Naturale – Sistema Museale di Ateneo dell'Università di Firenze. In 2019 a cataloguing campaign has been performed by the Mineralogy Section of the Museo Storia Naturale dell'Università di Firenze. A set of 120 official numbers has been requested to the ICCD and two main collections have been chosen for testing the cataloguing tool. The first is the historic collection of the Museum, consisting of 68 specimens most of which are meteorites that fell in the 18th and 19th centuries already described in the mid 18th century handwritten catalogue. The other one is a collection of specimens collected during a field campaign carried out in the Lut Desert of Iran in march 2017 by a joint Italian-Iranian expedition. Since all these samples have been classified at the meteorite laboratory of the Museum, these specimens have been registered as type specimens, i.e. new meteorites. All the cards of the meteorites will be published in the official site of the ICCD and will therefore represent the first meteorite collection in Italy to be officially registered in the National General Catalogue of Cultural Heritage. A research tool will then allow to browse the collection and show the consistency of the collection itself. We therefore present the scientific criteria adopted for ICCD cards and the functionality of the SAMM-2 ICCD-tested cataloguing tool.