PROGRAM

Thursday	June 27th
9:00	Introduction (OAPd Director)
9:10 [Grazian]	Vulcani (15’+5’), Moretti (15’+5’), Ciolfi (15’+5’)
10:10	Break
10:40 [Cremonese]	Lucchetti (15’+5’), Re (15’+5’), Simioni (15’+5’), Vallenari (15’+5’)
12:00	Lunch break + Poster Session
14:00 [Lucatello]	Persic (10’+5’), Salasnich (15’+5’), Costa (15’+5’), Pastorelli (15’+5’), Spina (15’+5’)
15:35	End

Friday	June 28th
9:00 [Gratton]	Nascimbeni (15’+5’), Barbato (15’+5’), Desidera (10’+5’), Rigliaco (10’+5’)
10:10	Break
10:30 [Greggio]	Fiori (15’+5’), Grazian (15’+5’), Tomasella (15’+5’), Salmaso/Valerin (25’+5’)
12:00	Lunch break + Poster Session
14:00 [Radhakrishnan]	Marziani (15’+5’), Ballone (15’+5’), Gomes Machado (15’+5’), Cerpelloni/Rebrysh (15’+5’), Arcidiacono/Zaggia (15’+5’)
15:40	End

TALK LIST

> Thursday 27th, 9:10—10:10

- Benedetta Vulcani, Bianca Poggianti, Benedetta Vulcani, Marco Gullieuszik, Mario Radovich, Ariel Werle, Alessandro Ignesti, Eric Giunchi, Giorgia Peluso, Nina Akerman, Daria Zakharova, Peter Watson, Ayan Acharyya

The role of the environment in shaping galaxy properties from Cosmic Noon to Cosmic Dusk

- Alessia Moretti, Bianca Poggianti, Benedetta Vulcani, Marco Gullieuszik, Mario Radovich, Ariel Werle, Alessandro Ignesti, Eric Giunchi, Giorgia Peluso, Nina Akerman

The future of galaxy evolution and environment with incoming facilities

- Riccardo Ciolfi, Andrea Pavan, Matteo Pais, Emma Dreas, Jay Kalinani

Modelling binary neutron star mergers and GRB jets via numerical simulations

> Thursday 27th, 10:40—12:00

- Alice Lucchetti, Luca Penasa, Costanza Rossi, Maurizio Pajola, Filippo Tusberti, Joel Beccarelli, Giovanni Munaretto, Patrizia Borin, Gabriele Cremonese

Small Bodies and Icy Moons of the Solar System

- Cristina Re, Gabriele Cremonese, Emanuele Simioni, Giovanni Munaretto, Maurizio Pajola, Alice Lucchetti, Adriano Tullo, Pamela Cambianica, Riccardo La Grassa, Elena Martellato, Silvia Bertoli, Patrizia Borin, Natalia Amanda Vergara

Exploration of Mercury and Mars

- Emanuele Simioni, Claudio Pernechele, Paolo Martini, Matteo Massironi, Riccardo Pozzobon, Davide Greggio, Luigi Lessio, Wolfgang Erb, Luca Penasa, Gabriele Rodighiero, Lorenzo Paoletti, Pamela Cambianica, Gabriele Cremonese, Alice Lucchetti, Maurizio Pajola, Cristina Re

Beyond the Horizon (applications of the Hyper-Hemisferical Lens)

- Antonella Vallenari, Rosanna Sordo, Marina Dal Ponte, Ioannis Kallimanis, Sara Lucatello, Lorenzo Spina, Diego Bossini

Gaia and follow-up spectroscopic surveys WEAVE, SPA

> Thursday 27th, 14:00—15:35

- Massimo Persic

Relativistic particles in star forming galaxies

- Bernardo Salasnich, Andrea Baruffolo, Daniela Fantinel, Davide Ricci, Andrea Balestra, Elia Costa, Fulvio Laudisio, Salvatore Lampitelli, Chiara Di Prospero, Daphne Diretto, Alessandro Lorenzetto, Rosanna Sordo, Amedeo Petrella, Danilo Selvestrel

Instrumentation control SW group: current projects and involved OAPd people

- Guglielmo Costa, Leo Girardi, Paola Marigo, Alessandro Bressan, Simone Zaggia, Giada Pastorelli, Michele Trabucchi, Diego Bossini, Francesco Addari, Kendall Shepherd, Guglielmo Volpato, Alessandro Mazzi, Chi Thanh Nguyen, Greta Ettorre, Francesco Guerriero

Stellar modeling: evolution with PARSEC and COLIBRI, including variability, asteroseismology, and opacities

- Giada Pastorelli, Leo Girardi, Paola Marigo, Alessandro Bressan, Guglielmo Costa, Simone Zaggia, Michele Trabucchi, Diego Bossini, Francesco Addari, Kendall Shepherd, Guglielmo Volpato, Alessandro Mazzi, Chi Thanh Nguyen, Greta Ettorre, Francesco Guerriero, Yazan Al Momany, Federico di Giacomo

Surveying and modelling resolved stellar populations of nearby galaxies

- Lorenzo Spina, Yazan Al Momany, Angela Bragaglia, Lorenzo Cavallo, Valentina D'Orazi, Sara Lucatello, Laura Magrini, Mario Pasquato, Jose Luis Schiapacasse, Antonella Vallenari, Nagaraj Vernekar

Galactic Archaeology with Machines and Novel Data

> Friday 28th, 9:00—10:10

- Valerio Nascimbeni, Adriana Barbieri, Luca Borsato, Riccardo Claudi, Silvano Desidera, Valentina D’Orazi, Valentina Granata, Pietro Leonardi, Luca Malavolta, Giacomo Mantovan, Domenico Nardiello, Leonardo Pagliaro, Giampaolo Piotto, Monika Beata Stangret, Tiziano Zingales

Transiting exoplanets with space- and ground-based facilities: architecture, dynamics, composition, habitability

- Domenico Barbato, Silvano Desidera, Dino Mesa, Valentina D'Orazi, Elisabetta Rigliaco, Raffaele Gratton, Riccardo Claudi, Francesco Marzari, Valerio Nascimbeni, Cecilia Lazzoni, Alessandro Ruggieri, Gabriele Columba, Domenico Nardiello, Giampaolo Piotto, Luca Malavolta, Luca Borsato, Martina Baratella, Giacomo Mantovan, Tiziano Zingales, Alice Zurlo, Vito Squicciarini

The architecture of planetary systems

- Silvano Desidera, Valentina D'Orazi, Raffaele Gratton, Valerio Nascimbeni, Domenico Nardiello, Luca Malavolta, Martina Baratella, et al.

Stellar chacterization of planet hosts

- Elisabetta Rigliaco, Gratton, Columba

Planet forming disks and the interaction with their environment

> Friday 28th, 10:30—12:00

- Michele Fiori, Luca Zampieri and AQUEYE+/IQUEYE Team

Investigating compact objects at high time resolution in the optical band with AQUEYE+ and IQUEYE

- Andrea Grazian, Carmelo Arcidiacono, Marco Gullieuszik, Elisa Portaluri, Matteo Simioni, Benedetta Vulcani, Anita Zanella

Scientific exploitation of ELT/MICADO/MORFEO

- Lina Tomasella, Enrico Cappellaro, Stefano Benetti, Daniela Fantinel, Thomas Forte, Aldo Frigo, Marco Mosele, Luciano Traverso, Danilo Selvestrel, Luigi Lessio

News from Ekar: the robotisation of the Copernico 1.82m telescope (RoboCop)

- Irene Salmaso, Giorgio Valerin, Stefano Benetti, Enrico Cappellaro, Lina Tomasella, Andrea Pastorello, Nancy Elias-Rosa, Laura Greggio, Andrea Reguitti, Francesco Guidolin, Paolo Ochner

The transient sky in the era of multimessenger astronomy

> Friday 28th, 14:00—15:40

- Paola Marziani, Mauro D'Onofrio, Alberto Floris

Super-Eddington accretion in quasars: the observational viewpoint

- Alessandro Ballone, INAF-Padova Instrumentation and Adaptive Optics Group & Others

MATTO: a future facility for testing Multi-conjugated Adaptive Optics techniques

- Tania Sofia Gomes Machado, INAF-Padova Instrumentation and Adaptive Optics Group & Others

SHARK-NIR: Hunting for Exoplanets and Beyond

- Paolo Cerpelloni, Oleksandra Rebrysh, INAF-Padova Instrumentation and Adaptive Optics Group & Others

MAVIS on the VLT: the cutting-edge MCAO assisted imager and spectrograph for visible observations

- Carmelo Arcidiacono, S. Zaggia, Marco Dima, Matteo Simioni, Marco Gullieuszik, Lina Tomasella

Optical Space Surveillance and Tracking (SST) and Space Situational Awareness (SSA)

POSTER LIST (alphabetical order)

- Ayan Acharyya, Molly S. Peeples, Jason Tumlinson, Brian W. O'Shea, Cassandra Lochhaas, Anna C. Wright, Raymond C. Simons, Ramona Augustin, Britton D. Smith, and Eugene Hyeonmin Lee

Complex and Stochastic Metallicity Gradients at z > 2 seen in FOGGIE simulations

Using high cadence (~few Myr) FOGGIE simulations we demonstrate that galaxies exhibit significant stochasticity and short timescale (~10 Myr) variations in their metallicity gradient evolution, particularly at high-z. This poses a challenge to interpreting upcoming metallicity gradient observations with JWST at high-z, which we investigate.

- Carmelo Arcidiacono, Elisa Portaluri, Anita Zanella, Simone Zaggia, Marco Gullieuszik, Maurizio Pajola, Alice Lucchetti, Matteo Simioni

MORFEO Science Team activities

We present the status of ongoing projects from each MORFEO Science Team Working Groups. Specific contributions from the Padova team span in the main area of:
- Planetary Science: observations and simulations of non-sidereal planetary objects, discussing strategies for high-precision astrometry and photometry. This includes the study and characterization of both small bodies (asteroids and comets) and outer Solar System objects (icy satellites, KBOs and TNOs) and the development of new observational techniques.
- Resolved Stellar Populations: investigations into the metallicity and kinematics of stellar populations in the Milky Way and nearby galaxies. Supported by extensive simulations, their research provides crucial insights into the lifecycle and distribution of stars within these systems.
- Galaxies and AGN: focus on advanced simulations and observational strategies for studying high-redshift galaxies and AGNs. Leveraging the capabilities of MORFEO and MICADO, for understanding formation of star clusters at high redshifts.
- Astrometry: development of methodologies to achieve precise astrometric measurements. Working on simulations to model PSF variability and efforts to improve accuracy, ensuring that MORFEO and MICADO can meet the high standards required for cutting-edge astronomical research.

- Joel Beccarelli, Maurizio Pajola, Giovanni Munaretto, Alice Lucchetti, Giovanni Poggiali, Emanuele Simioni, Costanza Rossi, John Robert Brucato

Analysis of the OMEGA 0.4-2.5 µm Spectra of the Martian satellite Phobos Context and Dataset

Phobos surface can be divided in two main units: the blue and the red one. The first seems to be associated to the Stickney Crater and its spectrum has a higher reflectance in the visible, while the red unit occupies the rest of the surface and has higher reflectance in the IR. A transitional unit made by a mixture of the two may be present. The origin of Phobos is still debated with two main possible scenarios: [i] asteroidal capture and [ii] in situ reaccretion of Martian material. In this work we present a compositional study based on the analysis of four ESA/MeX/OMEGA spectral data-cubes (orbits 0756, 5851, 7926, 8477) in the spectral region 0.4-2.5 µm. The main goal is to find an asteroidal and meteoric analogue for Phobos, revealing its mineralogical composition and formation scenario. Analysis and Comparison. A set of both blue and red unit's spectra have been extracted. The transition from bluer to redder unit has been found to be gradual and not sharp, indicating a possible ejected origin for the first. The 0756 blue unit shows a possible feature at 0.95 µm - 1.05 µm, possibly linked to the presence of pyroxene and olivine. Its nature should be verified with higher resolution images due to the low band depth measured (few %) and presence of gaps in the data. Many comparisons have been attempted with asteroids and meteorites spectra, finding that the most primitive and carbonaceous objects are the best match for Phobos blue unit (Kaidun and the Murchison fusion crust) and red units (Tagish Lake). Also, the comparisons made with asteroids shows a clear correlation with the most carbonaceous objects, in particular D-types for the red unit and T-type for the blue one.

- Pamela Cambianica, Gabriele Cremonese, Emanuele Simioni, Cristina Re, Adriano Tullo, Elena Martellato, Riccardo Pozzobon, Alice Lucchetti, Maurizio Pajola, Matteo Massironi

ANTHELIA: analysis of illumination and thermal environment of lunar pits and lava tubes

Planned space exploration, including human missions to the Moon, aims to enhance our understanding of geological processes on rocky bodies in the Solar System. A key focus is volcanic activity, evidenced by features like lava tubes. Lava tubes, natural conduits formed by flowing lava that solidifies upon contact with low temperatures, could offer shelter for astronauts against meteorite impacts, cosmic radiation, and extreme temperature fluctuations. On airless bodies like the Moon, surface weathering due to solar radiation leads to significant temperature variations, affecting surface materials. Estimating illumination and surface radiative intensity on such bodies is crucial for potential lunar bases. Exploring subsurface lunar bases requires understanding temperature variations to identify optimal conditions (e.g., size, latitude, depth) for a thermally stable environment, beneficial for both human and industrial activities. Missions like LRO and Kaguya have identified potential skylights—collapsed pit features providing access to subsurface voids and potential lava tubes. These skylights, formed by roof collapses due to seismic events or meteoroid impacts, expose stratified lunar crust, offering insights into the Moon's formation and volcanic history. Understanding these conditions can reveal volatile traps and solar wind particles. We developed a ray-tracing illumination and thermal model to characterize the thermal environment of lunar pits and lava tubes. The model uses a 3D Digital Terrain Model (DTM) of specific surface features, updating orbital positions and orientations with respect to the Sun. The 3D thermal model, initialized based on latitude, outputs surface temperatures over time. This data provide inputs for a volatile transport model, calculating volatile loss rates based on pit geometry and latitude. Preliminary results present surface and subsurface temperatures throughout a lunar day for various synthetic 3D pits and cave geometries. The TRANQUILLITATIS pit in Mare Tranquillitatis (8.335°N, 33.222°E, diameter: 84-99 m) was used as a test case, showing a thermal stability around 17°C. This study aims to identify the best geometries for human explorers and lunar outposts.

- Elena Carolo & INAF-Padova Instrumentation and Adaptive Optics Group & Others

Laboratory Facilities in INAF-Padova

The laboratories of Padova welcome different activities and people, from the student to staff, from the on-site workers to team of other observatories and institutes around the world who collaborate on the various projects. The rooms are many and varied, some with optical benches dedicated to specific experiments, others set up with different functions, from the optics laboratory to technical rooms equipped with an overhead crane and a clean room. Over the years, various innovative technologies for cutting-edge astronomical instrumentation have been developed, prototyped, tested and aligned, designed for terrestrial and space missions, some already operational, others in the testing and assembly phase. The laboratories also accommodate tools and equipment that over time have been replaced by more modern and sensitive ones, while still trying to keep the pre-existing machinery operational, there are six optical benches, a Zygo interferometer, a vacuum pump, a portable measuring arm, and much more.

- Emma Dreas, Andrea Pavan, Riccardo Ciolfi, Annalisa Celotti

Afterglow emission from short GRB jets: simulations meet observational data

The observation in 2017 of a binary neutron star (BNS) merger via gravitational waves and electromagnetic (EM) counterparts confirmed that these events can power relativistic jets, and in turn, produce Gamma-Ray Bursts (GRBs). Numerous studies, before and after this event, focussed on the interplay between these jets and their surrounding post-merger environment, which shapes the energy and angular distribution of the emerging outflow, with obvious impact on its observable EM signatures.

Numerical (magneto)hydrodynamic simulations play a central role in this investigation, but in most cases they are limited to less than a few seconds of evolution, while the jet is still accelerating and its angular distribution is still changing. Here, we present the methods and procedure we designed to extend jet simulations up to a nearly ballistic phase, allowing us to extract reliable information to compute the afterglow signal that the given jet would produce via the interaction with the interstellar medium. Starting from the output of the fiducial model of Pavan et al. 2023, representing the first magnetized jet simulation employing a realistic post-merger environment (i.e. directly imported from a BNS merger simulation), we are able to further evolve the system without loss of accuracy up to the time the jet energy is more than 98% kinetic and the angular structure is frozen. For the next step, we are now applying such a procedure to a set of jet simulations performed within our group and combining the outcome with an advanced afterglow model to compute the corresponding afterglow light curves.

- Eric Giunchi, Bianca Poggianti, Marco Gullieuszik, Alessia Moretti, Ariel Werle

Star formation in the clumps of six jellyfish galaxies with HST

RPS galaxies are systems experiencing the ram pressure exerted by the hot and high-pressure intracluster medium (ICM) they are embedded in, after being accreted by the galaxy cluster. As a consequence of this interplay, the galactic interstellar medium (ISM) is stripped out of the galactic disk, forming up-to-100 kpc long tails. The stripped gas eventually collapses and forms compact stellar clumps, observable in H-alpha and optical bands. The study of these clumps can unveil if and how the surrounding environment (the ICM in this case) affects the mechanisms driving star formation and the properties of the clumps. I will present a statistically significant sample of H-alpha and UV clumps and of optical complexes (size 0.1-1 kpc, age 10-400 Myr) in the tails and disks of 6 ram-pressure stripped (RPS) galaxies at z=0.05, using UV- to I-band rest frame HST data. I will characterize the mass function and the star-formation rate surface density (SD(SFR)) of the clumps, treating separately clumps in disks and tails, which demonstrated that turbulence is the main driver for star formation, irrespective of the influence of the RPS and of the environment in general. On the other hand, RPS seems to enhance the SD(SFR) of the clumps, whether they are in disks or tails, most likely as a consequence of gas compression. I will also present a high-resolution multi-wavelength characterization of the morphology of the tail stellar structures, showing how the H-alpha clumps (associated to young stellar populations) are displaced further away from the galactic disk than UV clumps (tracing older stellar populations) on a scale of a few hundreds of parsecs. This configuration is in accordance with the so-called fireball model, which has already been observed in the tails of RPS galaxies and reproduced by simulations. Finally, I will discuss the fate of these clumps, by means of semi-analytic tidal models and comparison with state-of-art simulations, showing under which conditions the clumps remain self-gravitating and/or bound to the parent galaxy or not.

- Tania Sofia Gomes Machado, Roberto Ragazzoni, Elisa Portaluri, Carmelo Arcidiacono, Maria Bergomi, Simone Di Filippo, Marco Dima, Davide Greggio, Dheeraj Malik, Cesar Charles Louis Nesme, Kalyan Radhakrishnan Santhakumari, Valentina Viotto, Federico Battaini, Alessando Ballone, Jacopo Farinato, Luigi Lessio, Demetrio Magrin, Luca Marafatto, Gabriele Umbriaco

Which AO technologies ELT needs to study the deep universe? - The case of the INGOT WFS

Larger apertures and AO systems will provide unparalleled data, making the next-generation class of telescopes the most powerful and coveted instruments. We focus on the development and lab testing of a new class of WFS, called Ingot. It is designed to address the challenges posed by LGSs on the ELT, allowing to fully exploit their extraordinary potential.

- Alessandro Ignesti, Bianca Poggianti, Benedetta Vulcani, Alessia Moretti, Marco Gullieuszik, Mario Radovich, Giorgia Peluso, Ariel Werle, Eric Giunchi

Tracing large-scale gas outflows from spiral galaxies in clusters with radio-continuum observations

In galaxy clusters, we observe that star-forming spiral galaxies can evolve into passive S0 galaxies. One of the main drivers of this ‘environmental processing’ is the ram pressure induced by the relative motion between the galaxies and the intracluster medium (ICM). This process induces large-scale interstellar medium (ISM) outflows, which strip the gas reservoirs of these galaxies and quench their star formation. However, recent observations revealed that the stripped ISM clouds can survive in the hot ICM long enough to collapse into new stars outside the stellar disks. The processes that regulate this phenomenon are still unknown, and radio-continuum observations can shed light on the dynamics and evolution of the stripped ISM clouds. These large-scale outflows transport the magnetic field and the cosmic ray electrons from the stellar disk, thus producing radio-continuum emission at low frequencies via synchrotron. We present a semi-empirical model to constrain the ISM outflow velocity based on the properties of the radio-continuum emission. This model is based on the pure synchrotron cooling of a radio plasma moving along the stripping direction with a uniform velocity, which can reproduce the multi-frequency radio continuum emission of the ram-pressure outflows. I will showcase the results of an exploratory study on seven galaxies in Abell 2255 (z=0.08012) with deep LOFAR and uGMRT observations at 144 and 400 MHz. Our model reproduces the observed properties of the radio-continuum emission with a projected outflow velocity of between 160 and 430 km/s. We can now use this new piece of information to explore the poorly known physics of the interplay between the stripped ISM and the surrounding ICM. This semi-empirical model can be used to expand the use of radio observations of ram-pressure-stripped galaxies in clusters and groups.

- Cecilia Lazzoni, Silvano Desidera, Raffaele Gratton, Valentina D'Orazi

Exomoons and binary planets

New-generation of high contrast instruments (SPHERE/VLT, GPI/Gemini, SCExAO/Subaru) can be used to unveil features, in the form of giant moons or disks, within the Hill radius of directly imaged substellar objects. Following a dedicated study on SPHERE observations, we detected a candidate satellite companion of 1 MJup on a 10 au orbit around the low-mass brown dwarf DH Tau B (10 MJup). More suitable assumptions are needed to model the formation of such giant satellites/planetary pairs, such as gravitational capture. In this scenario, the two planets, which we assume are formed independently in the circumstellar disk via gravitational instability, become a bound pair due to close encounters during which energy is dissipated through tidal interactions. Results show that the formation rate for planet-planet pairs can reach a 14% in the gravitational instability scenario, similar to what was presented by previous works such as in Ochiai+2014 for the core accretion models.

- Antonino Marasco, Bianca Poggianti, Jacopo Fritz, Benedetta Vulcani, Alessia Moretti, Marco Gullieuszik, Andrea Kulier

The morphological transformation of ram pressure stripped galaxies

Cluster galaxies have been subject to a major redistribution of their morphology fractions in the last 6-8 Gyr, with the spiral population steadily fading out in favour of the S0s. The question of what is the primary mechanism responsible for such fast transition has still no answer. In my work, I quantify the effect of stellar "ageing" in driving a morphological transformation in ram-pressure stripped cluster spirals. For this purpose, I use a sample 91 galaxies from the GASP program with known spatially resolved star formation history from MUSE data. I simulate their future evolution assuming outside-in quenching scenarios with different stripping timescales, artificially age their MUSE spectra, produce synthetic multi-band images and infer the variation of their morphology at future times. I find that, in all scenarios considered, the initial population dominated by blue-cloud spirals (~90%) evolves into a mixed population mostly composed by red-sequence spirals (50−55%) and lenticulars (~ 40%). The transformation is completed after just 1.5 − 3.5 Gyr, proceeding faster in more efficient quenching scenarios. These evolutionary paths are then used as an input for a more complex model for the evolution of a realistic cluster population from z=0.6 to z=0 in the LCDM cosmological framework. I will show that the evolution of the morphology fractions observed in clusters can be reproduced only accounting for the transformation of spirals into S0s, occurring with timescales compatible with those found in the previous analysis.

- Elena Martellato, Silvia Bertoli, Pamela Cambianica, Riccardo La Grassa, Cristina Re, Adriano Tullo

Impact cratering on the Solar System

Impact craters are the most widespread landform on rocky bodies. Since they have been collected randomly, their statistical distribution allows to infer stratigraphical relationship between geological processes and thus understand the evolution of planetary surfaces. Craters are the outcome of the impact cratering process, which stands out among other geological processes for its unique conditions — large amount of nearly instantaneous release of energy, in a relatively small area interested by outstanding pressure and temperature conditions. Impact is based on the transfer of the kinetic energy of a projectile to a target body. The cavity resulting from shock-induced growth is unstable, and is modified in a larger and shallower structure, under the interplay of gravity and the target strength. The extent of this modification depends on the crater size. At the smallest sizes, craters are bowl-shaped, but as diameter increases, they develop a more exotic appearance, with flat floor, terraced walls, and central peak, or ring at even further larger dimensions. However, target properties play a major role in shaping crater morphology. Variations in target structure, such as layering, or irregular distribution of rocks with different mechanical properties, or presence of joints, cracks and other planes of weakness, may substantially draw the final outcome of an impact. The recognition of the importance of meteorite impacts has come largely from the study of other planets. Exploration of the Moon and the Solar System by astronauts and robotic spacecraft demonstrates that impact cratering has been, and still is, a major process in the origin and evolution of all the solid bodies of the Solar System, from Mercury to the moons of Neptune. In this work, we present our main projects showing the importance of impact craters, a peculiar tool in planetary sciences.

- Giovanni Munaretto, Gabriele Cremonese, Maurizio Pajola, Silvia Bertoli, Alice Lucchetti, Adriano Tullo, Filippo Tusberti, Cristina Re, Emanuele Simioni, Matteo Massironi, Shane Byrne, Nicolas Thomas

Exploring Mars through geologic time: form past to present and towards the future

The surface of Mars records traces of events dating back to immediately after planetary formation, followed by periods of Earth-like habitable environments that then transitioned to the present-day dry, cold and inhospitable conditions. This makes the Red Planet the only other planetary body in the Solar system beyond Earth with an easily accessible geologic history that was similar to the Earth. Studying its surface is therefore crucial for understanding its past habitability and climatic conditions and how they evolved with time. It is also pivotal for assessing its In Situ Resource Utilization potentials, a crucial aspect for the future human and robotic exploration missions. The planetary science research group at OAPD is actively involved in many research projects on the multidisciplinary analysis of Martian surface landforms, locations and features that record past and/or present-day aqueous or glacial processes. We present a set of published and ongoing studies aimed at investigating a) candidate past & present-day Martian surface features related to the flow of liquid water, b) periglacial landforms, c) new methods to analyze future Martian remote sensing datasets, and d) characterization of Martian locations suitable for a possible human and/or robotic exploration mission.

- Giorgia Peluso, Bianca Poggianti, Benedetta Vulcani, Alessia Moretti, Mario Radovich, Marco Gullieuszik

Gas-phase metallicity in local AGNs in the GASP and MaNGA suvreys

The influence of the large-scale environment on AGN activity has been widely investigated in the past decades. Recent studies reported tentative evidence of a connection between AGN incidence and ram-pressure stripping (RPS) of gas due to the interaction between the intra-cluster medium and the interstellar medium in the galactic disk. The expected link has roots in the fact that the properties of AGN are linked to the conditions of the available gas, which in turn can be strongly affected by RPS. Hydrodynamical simulations showed that RPS can trigger inflows of gas towards the galaxy center by losing angular momentum. Inflows and outflows of gas also accompany often the detection of AGN and strong evidence shows a possible link between the two phenomena, where inflows would trigger the central activity. However, a statistically robust study has never been performed, making it not clear if the link between RPS and AGN is real. We robustly measured, for the first time, the AGN fraction in 115 ram-pressure stripped galaxies located in clusters at low redshifts. To understand if the RPS enhances the AGN activity, we also computed the AGN fraction in normal galaxies, with similar proprieties of the RP stripped sample, but located in the field and presumably not affected by RP. We found statistical evidence that the AGN-RPS connection does exist: our results show that the AGN fraction rises to 51% when ram-pressure stripping is acting, selecting galaxies with $M_* > 10^{10}\ M_\odot$. This fraction is higher than the AGN fraction of 35% in normal galaxies, in the same mass bin. More than that, to further investigate the link between the AGN activity and the RPS phenomenon, we performed a dedicated study of the gas-phase metallicity in the nuclear regions of galaxies hosting an AGN as a function of the environment, along with the scaling relations with the host galaxy stellar mass. To do so, we estimate the gas-phase metallicity of nuclear regions and the mass-metallicity relation of galaxies at $z \leq 0.07$ and with stellar masses $\log M_*/M_\odot \geq 9.0$, either experiencing RPS or not.
Independently of the RPS, we do not find a correlation between stellar mass and AGN metallicity in the mass range $\log M_*/M_\odot \geq 10.4$, while for the star-forming galaxies we observe the well-known mass-metallicity relation (MZR) between $9.0 \leq \log M_*/M_\odot \leq 10.8$ with a scatter mainly driven by the star-formation rate (SFR) and a plateau around $\log M_*/M_\odot \sim 10.5$. The gas-phase metallicity in the nuclei of AGN hosts is enhanced with respect to those of SF galaxies by a factor of $\sim$ 0.05 dex regardless of the RPS. These results suggest that the AGN activity implies higher metallicities in the nuclear regions of galaxies, but that the RPS does not seem to play a key role in modifying this trend.

- Alessia Spolon & ASTRI-SI3 Team

Fast photon counting Stellar Intensity Interferometry: Prospects for the ASTRI Mini-Array

Stellar intensity interferometry is based on the correlation of the light intensity fluctuations of a star detected at two or more telescopes. A measurement of the correlation in "photon-counting" was recently experimented in Asiago and is currently being implemented on the ASTRI Mini-Array."

- Adriano Tullo, Cristina Re, Gabriele Cremonese, Matteo Massironi, Emanuele Simioni, Giovanni Munaretto, Silvia Bertoli, Riccardo La Grassa, Elena Martellato, Amanda Vergara, Pamela Cambianica, Maurizio Pajola, Lorenzo Spina, Patrizia Borin

The colours of Mars: Exploring the red planet with CaSSIS

Onboard the ESA ExoMars Trace Gas Orbiter, the Colour and Stereo Surface Imaging System (CaSSIS) produces high-resolution multispectral stereo images of Mars in four bands, spanning the blue, visible, and near Infrared wavelength ranges. Thanks to its novel rotation mechanism, CaSSIS can acquire images pairs that are stereo-compatible which can be used for three-dimensional surface reconstruction by photogrammetry. Since the beginning of its nominal science operations in April 2018, CaSSIS has provided us the
most advanced colour images of the Martian surface, reaching up to 4.5 m/px in spatial resolution from its 400 km circular orbit and capturing images at various times of day and seasons. The CaSSIS bands allow us to explore Mars; mineralogical diversity and dynamic surface processes such as aeolian, volcanic, dry dust avalanches, dust devils, gullies, Recurring Slope Lineae (RSL) and polar, glacial and periglacial features. INAF is directly involved in the mission and at the forefront of CaSSIS stereogrammetry due to the
development of 3DPD software and photometric corrections. The group is also involved in several image-based geological mapping projects of Mars, such as the characterisation of floor-fractured craters in Terra Sirenum. In addition, with the development of image integration algorithms (Pansharpening) and the use of MRO High Resolution Imaging Science Experiment (HiRISE) that captures detailed images of the data, CaSSIS images can be further improved to a ground spatial resolution up to 25 cm/px, enabling us to observe hitherto unexplored details in color.

- Filippo Tusberti, Maurizio Pajola, Giovanni Munaretto, Luca Penasa, Alice Lucchetti, Joel Beccarelli, Costanza Rossi, Riccardo Pozzobon, Matteo Massironi

Ice Degradation and Boulder Size Frequency Distribution Analysis of the Fresh Martian Crater S1094b

S1094b is the largest (155 m-size) and southernmost known ice-exposing fresh crater discovered so far on Mars, revealing a relatively pure and unstable subsurface ice deposit located at the northern Martian mid-latitudes. In this work, we analyze HiRISE images taken on 27 February 2022 and on 5 December 2022 to perform a multi-temporal analysis of its ice-rich ejecta, combining this analysis
with geologic mapping, the boulder size frequency distribution (SFD) and thermal modeling. The objective is to provide a multidisciplinary characterization of both the impact and subsequent exposed ice sublimation processes. The boulder SFD of both February and December cases show a power-law best fit with indices -4.68 ± 0.15 and -3.47 ± 0.10, respectively. In the same timeframe, the density of boulders per km2 ≥ 1.5 m changes from 3908, to 596. This flattening is mainly due to the sublimation and consequent loss of the smaller-size icy boulders. This is confirmed by the ice volume computation performed on the area, which changed from ~20274 m3 to ~7951 m3 , i.e. a decrease of ~60% in 274 Sols. The thermal models showed that the ice in this region is always unstable, leading to a total of 6504.71 sublimation hours from which we estimated a sublimation rate of ~0.15 mm/h. The presence of this amount of reachable ice at such low latitudes could be a valuable resource for potential future human missions.

- Gabriele Umbriaco Alessandro Ballone, Maria Bergomi, Tania Sofia Gomes Machado, Simone Di Filippo, Federico Battaini, Kalyan Radhakrishnan Santhakumari, Luca Marafatto, Davide Greggio, Elena Carolo

4D Interferometer Lab - Laboratorio di Eccellenza DFA/INAF

The Department of Physics and Astronomy "G. Galilei" (DFA) in the environment of UNIPD/INAF collaboration is internationally recognized for its excellence in research, education, and knowledge transfer in the physics of the Universe. The DFA's "Physics of the Universe" project aims to advance multidisciplinary research through astronomy, astrophysics, cosmology, and fundamental physics. Key initiatives include establishing two new laboratories for optics and sensors, recruiting personnel, and creating a master's program in Astrophysics and Cosmology. The laboratories feature advanced instruments such as a femtosecond pulsed laser source and a 4D interferometer Phasecam 4030. Tests conducted include interferometric optical tests, DM characterization (stroke linearity, aberration control, stability), custom beam expander evaluations and the control of devices by the PLICO system under Python. In the new interferometric lab we characterized various deformable mirrors (e.g., ALPAO DM97-15, DM97-25, DM292) and deformable lenses and a thesis on the characterization of DM292 was carried out.

- Peter J. Watson, Benedetta Vulcani

Unveiling Concurrent Physical Processes on a Cluster Galaxy at z=0.3 Using JWST

Using JWST-NIRISS data from the GLASS survey, and HST and NIRCAM data from UNCOVER/MegaScience, we identify and characterise the concurrent physical processes acting on a potential ram-pressure stripped galaxy in Abell 2744. We show a new method for modelling the continuum of sources in 2D grism data, and the improvement in the resulting emission line maps. We also derive the spatially-resolved non-parametric star-formation history of the galaxy. From this, we discover a compact companion object responsible for a recent interaction, producing a tidal stream, and confirm that the combined interacting system is presently undergoing ram-pressure stripping.

- Ariel Werle, Eric Giunchi, Bianca Poggianti, Marco Gullieuszik, Alessia Moretti, Anita Zanella, Benedetta Vulcani, Nina Akerman

The history of star-forming regions in the tails of jellyfish galaxies

We use HST photometry to model the stellar populations of star-forming clumps in the tails of 6 galaxies undergoing extreme ram-pressure. Clumps detected in narrow-band Hα and in the F275W filter of the WFC3 camera are embedded in larger regions (star-forming complexes) detected in the optical (F606W filter). The median mass-weighted ages are ~27 Myrs for Hα clumps and ~39 Myrs for F275W clumps and star-forming complexes. Stellar masses vary from 103.5 to 107 solar masses, with star-forming complexes being the most massive. As we move further away from the galactic disks, we find clumps to be younger, less massive and less obscured by dust. The difference in the mean age of the stellar populations between the complex and its youngest embedded clump scales with the distance between the clump and the center of the optical emission of the complex, with the most displaced clumps being hosted by the most elongated complexes. This is consistent with a fireball-like morphology, where star-formation proceeds in a small portion of the complex while older stars are left behind producing a linear stellar population gradient. Although the stellar masses of star-forming complexes are consistent with the ones of globular clusters, their stellar mass surface densities are lower by 2 dex, and consistent with the population of low surface brightness dwarf galaxies in clusters.

- Daria Zakharova, Benedetta Vulcani

The role of filaments in cold gas content for galaxies in the Virgo cluster surroundings

One of the main elements regulating the evolution of galaxies is their environment. A number of physical processes (e.g. ram-pressure stripping, tidal interactions, etc.) can significantly affect the properties of galaxies residing in different environments. Using a unique combination of information on the mass of cold gas (both atomic HI and molecular H2) for galaxies in the Virgo cluster and in the surrounding filaments, we study the influence of the environment on regulating the gas content of galaxies. We complement the observational analysis with a comparison to predictions from the Galaxy Evolution and Assembly (GAEA) semi-analytic model, which have explicit prescriptions for partitioning the cold gas content in its atomic and molecular phases. We show that galaxies within filaments divide into two populations: those found in groups and isolated galaxies, which have gas properties similar to galaxies in a field. We also show how the distance to the filament axis or the halo mass affects the gas deficit in galaxies.