# MONTHLY NEWSLETTER

INAF
ISTITUTO NAZIONALE
DI ASTROFISICA

INAF Osservatorio Astrofisico di Arcetri

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## HIGHLIGHTS

## AstroBio-CubeSat: a new tool for astrobiology in space

AstroBio CubeSat (ABCS) is an Italian 3U CubeSat has been launched by ESA VEGA-C Maiden Flight on July 13th, 2022. ABCS hosts a micro laboratory payload for research in astrobiology, life sciences, biotechnology and pharmaceutical technologies. The objective of the project is to test in space environments MEO (within Van Allen belt) an automatic laboratory based on origami lab-on-chip technology, able to provide a highly integrated in-situ multiparameter platform that uses immunoassay tests exploiting chemiluminescence detection.
The experiments will aim at evaluating the functional tests of the device (delivery of reagents, mixing of chemicals, detection of emitted photons, electronics, data storage and transmission) and the stability of chemicals and biomolecules (e.g., immunoassays exploiting chemiluminescence detection) in space conditions for astrobiological investigations.
The Project is supported by ASI in cooperation with INAF, INAF-Osservatorio Astrofisico di Arcetri and School of Aerospace Engineering - Università Sapienza di Roma.

INAF-OAA (science, design, management): **J. Brucato** (PI)

Astrobio Cubesat. Cr: La Sapienza University of Rome

Website: https://sites.google.com/view/astrobiocubesat/home
Media INAF: https://www.media.inaf.it/2022/07/13/lancio-astrobio/

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# OBSERVING PROGRAM

### Atmospheric structure, chemistry and heating processes in the day-side of the hottest gaseous giants with MAROON-X at Gemini-N

Long Term Status

Hours Allocated: 72.5 - PI: L. Pino

Hot and ultra-hot Jupiters (HJs and UHJs) are key targets to study planetary atmospheres in extreme regimes. Due to their high temperatures, they offer the unique opportunity to probe key atmospheric properties through the study of refractory elements, at high signal to noise. We propose the first homogeneous survey of the optical emission spectra of the day-side of 8 HJs and UHJs, to measure: (1) their thermal structures and (2) abundances of atomic and molecular refractory species (e.g. Fe, Fe +, Ti, Ti+, TiO), strong optical absorbers likely responsible of thermal inversions in hot planets. We will cover 2,500 K in planet equilibrium temperature, and 2 orders of magnitude in gravity, looking for trends of our observables along these axes. We will thus tackle outstanding questions on the thermal structures and compositions of hot Jupiters to realize the potential of this class of planets. Ours is one of the first homogeneous surveys of planetary spectra, and the first survey of high spectral resolution, optical emission spectra of HJS and UHJs, and complements space-born efforts with HST and Spitzer to higher spectral resolution and different wavelengths. The legacy of this program is a library of optical spectra, which will complement infrared observations from JWST and form the basis for the interpretation of JWST observations of the hottest giant planets.

# INAF GRANTS

Large Grant: ***The role of MAGnetic fields in MAssive star formation (MAGMA)***

This project joins the efforts of theorists and observers in the Italian community, with solid experience in the field, with the aim of investigating the role of magnetic fields in the formation of stars of all masses, and, in particular, of high-mass stars. For the first time, we will combine thermal (dust and line) and maser emission polarization observations of a statistically significant sample of high-mass star-forming regions.

INAF-OAA: **Beltran** (PI), **Dall'Olio**, **Moscadelli**, **Galli**, **Padovani**, **Bacciotti**, **Cesaroni**

Large Grant: ***The metal circle: a new sharp view of the baryon cycle at high-z with the latest generation IFU facilities***

This project aims to exploit unprecedented datasets to explore the baryon cycle up to z=9 through the study of interstellar medium (ISM) properties and AGN feedback. This is only possible for the unique position of our group, which has access to guaranteed observations exploiting the new forefront IFU instruments in the near-IR (NIRSpec@JWST, ERIS@VLT). These data will enable a transformational view of these processes, up to uncharted redshift ranges.

INAF-OAA: **Cresci** (PI), Amiri, **Belfiore**, Curti, **Mannucci**, Marconi, **Nardini**, Perna, **Spiga**, Tozzi, Venturi.

Large Grant: ***INAF Exploration of Diffuse Galaxies with Euclid: INAF-EDGE***

Euclid will revolutionize the study of low-surface brightness (LSB) galaxies, especially the extreme Ultra-Diffuse dwarf galaxies (UDGs) which are as large as the Milky Way in extent, but more than 100 times less massive. With this proposal, INAF Exploration of Diffuse Galaxies with Euclid (INAF-EDGE), we seek to realize Euclid's potential for LSB science, currently not funded through other agencies.
INAF-OAA: Hunt (PI)

Techno Grant: ***Machine Learning for Spectroscopy***

Machine learning algorithms based on Artificial Neural Networks (ANNs) have been successfully employed in several areas of astrophysics. The goal of this grant is to develop new tools based on ANNs for the analysis of spectra of galaxies, stars and exoplanets to take full advantage of the next generation of spectroscopic facilities.
INAF-OAA: **Sacco** (PI), **Belfiore**, **Magrini**, **Pino**, **Tribioli**, **Zibetti**

Theory Grant: ***Star Clusters As Cosmic Ray Factories***

The origin of Galactic Cosmic Rays is usually attributed to the forward shock of supernova remnants able to accelerate particles from the circumstellar medium. This project aims at exploring a different scenario where CRs are produced by the termination shock of powerful stellar winds in massive star clusters taking advantage of the recent detection of gamma rays from some of these clusters to constraint the theoretical models.
INAF-OAA: **G. Morlino** (PI), **E. Amato**, **N. Bucciantini**, **R. Bandiera**, **B. Olmi**.

Normal GO-GTO Grant: ***ERIS & SHARK GTO data exploitation***

Fundings are requested to support the data reduction and analysis of ERIS at the VLT and SHARK-NIR at LBT. In the context of INAF ERIS GTO (60 nights), we will perform a deep search for protoplanets still embedded in their natal disk. ERIS will allow to peer down in the interior of protoplanetary disks; SHARK-NIR will allow the detection of planets at very short separation from the host star observing in the Y, J and H bands where a better spatial resolution is possible.
INAF-OAA: **D. Fedele** (PI), **C. Codella**, **L. Podio**, **A. Garufi**

Mini Grant: ***Sub-apertures calibration of deformable mirrors***

The size of the ground based telescopes has dramatically increased in the past years thanks to the AO systems. This requires large size test facilities which show several criticalities both from the alignment, stability point of view and from the cost of the opto-mechanical assembly itself. The aim of this project is to calibrate for the first time an AO system via stitching approach. After an initial step concerning simulations, a dedicated optical bench will be set up for the laboratory experiments.
INAF-OAA: **Azzaroli** (PI), **Briguglio**, **Xompero**, **Riccardi**

Mini Grant: ***Towards precision chemical abundances: from the local Universe to Cosmic Noon***

I plan to chart the chemical evolution of the Universe by combining state-of-the-art models with new observational data aimed at deriving accurate gas-phase abundances. In particular, I will leverage observations of samples of HII regions in the local Universe and JWST observations in the early Universe the trace the oxygen abundance over the last 11 Gyr of cosmic history.
INAF-OAA: **Belfiore** (PI), **Mannucci**, Marconi

Mini Grant: ***Numerical Studies of Pulsar Wind Nebulae in The Light of IXPE***

Pulsar Wind Nebulae are the most unique astrophysical environment where high energy processes can be investigated with great detail. X-ray polarimetry could offer us an unprecedented opportunity to do this. The newly operating IXPE satellite will provide us, for the first time, with space-resolved polarimetric imaging of some PWNe. Scope of the project is to develop and investigate turbulent MHD models of PWNe with numerical tools and apply the results to upcoming IXPE data.
INAF-OAA: **Bucciantini** (PI), **Olmi**, **Bandiera**, **Morlino**, **Amato**, Del Zanna.

Mini Grant: ***Support to Mars 2020 Participating Scientist Activities***

This proposal aims to support the Mars 2020 Participating Scientist activity of the PI, which consists in assisting data analysis for the SuperCam and SHERLOC instruments on board the NASA Mars 2020 Perseverance rover by developing proper tools to look for spectroscopic features of high preservation potential minerals and organics, both abiotic and molecular biosignatures, which is key to select the most promising samples to cache for future return to Earth and understand if life ever arose on Mars.
INAF-OAA: **Fornaro** (PI)

Mini Grant: ***The stellar population scaling relations from LEGA-C and their evolution with redshift***

The Large Early Galaxy Astrophysics Census survey has gathered deep spectra for a large and representative sample of galaxies up to redshift z=1. We are leading the effort to infer accurate estimates of stellar population physical properties and assess the stellar populations scaling relations, for galaxies with different star formation activity, and their evolution with cosmic time. These provide constraints to the past star formation and metal enrichment histories of galaxies and their main evolutionary mechanisms.
INAF-OAA: **Gallazzi** (PI), **Zibetti**

Mini Grant: ***Design optimization of aluminum-made secondary mirror in space telescopes***

The use of aluminum substrate for space telescope mirrors is wide spreading in space field. A key advantage of this material choice is to ensure athermal design in aluminum telescope structure. The project baseline purpose is to optimize the design of M2 substrate/support through analysis with finite element methods according to M2 expected performance. The goal of the project would be to manufacture a prototype of M2 to assess flexures effect and finite element analysis correlation.
INAF-OAA: **Iuzzolino** (PI)

Mini Grant: ***CHECS (CHEmical ClockS): Seeking a theoretical foundation for the use of chemical clocks***

Stellar ages are the missing ingredient to complete the portrait of our Galaxy. One of the most promising methods to derive them is based on the relation between stellar chemical composition and age, using the so-called chemical clocks. But how universal are chemical clocks? Can we apply them to all Galactic populations? With this project, we aim at observationally and theoretically investigating the application of chemical clocks to the disc of our Galaxy.
INAF-OAA: **Magrini** (PI)

Mini Grant: ***AGN accretion disks under the X-ray scanner***

The variability on short time-scales (of the order of a few hours) of the emission and absorption features in the X-ray spectra of AGNs, especially in the iron K band, is an invaluable diagnostic of accretion physics. However, the count statistics required by this kind of study often exceeds the capabilities of the current X-ray observatories. Future missions, and in particular Athena, can transform the intriguing but sparse results obtained so far into a brand new field of AGN research with prospective INAF leadership.
INAF-OAA: **Nardini** (PI)

Mini Grant: ***Chemical Origins: linking the chemistry of protoplanetary disks with the fossil composition of the Solar System***

The project is aimed to test whether, and how much, the chemistry of the Solar System (SS) is inherited by the early phases of its formation by comparing the chemistry of protostellar and protoplanetary disks around young Solar analogs with the composition of the primitive bodies in the outer SS.
INAF-OAA: **Podio** (PI)

## REFEREED PUBLICATIONS

**Giulia Carlà, Cédric Plantet, Lorenzo Busoni, Guido Agapito**
***Temporal spectrum of multi-conjugate adaptive optics residuals and impact of tip-tilt anisoplanatism on astrometric observations***
Monthly Notices of the Royal Astronomical Society, in press
https://academic.oup.com/mnras/advance-article/doi/10.1093/mnras/stac2377/6675823

**F. Lelli**, T. A. Davis, M. Bureau, M. Cappellari, L. Liu, I. Ruffa, M. D. Smith, T. G. Williams
***WISDOM Project -- XIII. Feeding molecular gas to the supermassive black hole in the starburst AGN-host galaxy Fairall 49***
Monthly Notices of the Royal Astronomical Society, in press
https://arxiv.org/abs/2209.00363

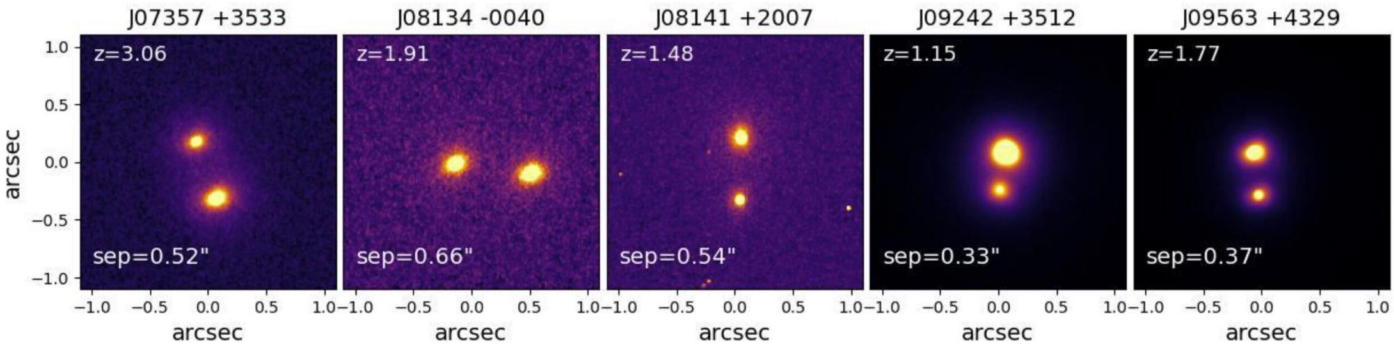
**F. Mannucci, E. Pancino, F. Belfiore,** C. Cicone, A. Ciurlo, **G. Cresci, E. Lusso, A. Marasco, A. Marconi, E. Nardini, E. Pinna,** P. Severgnini, P. Saracco, **G. Tozzi** e S. Yeh

***Unveiling the population of dual and lensed active galactic nuclei at sub-arcsec separations***

Nature Astronomy (in press)

https://www.nature.com/articles/s41550-022-01761-5

Media INAF: https://www.media.inaf.it/2022/08/25/gaia-coppie-buchi-neri/




Cr: Mannucci et al. (2022)

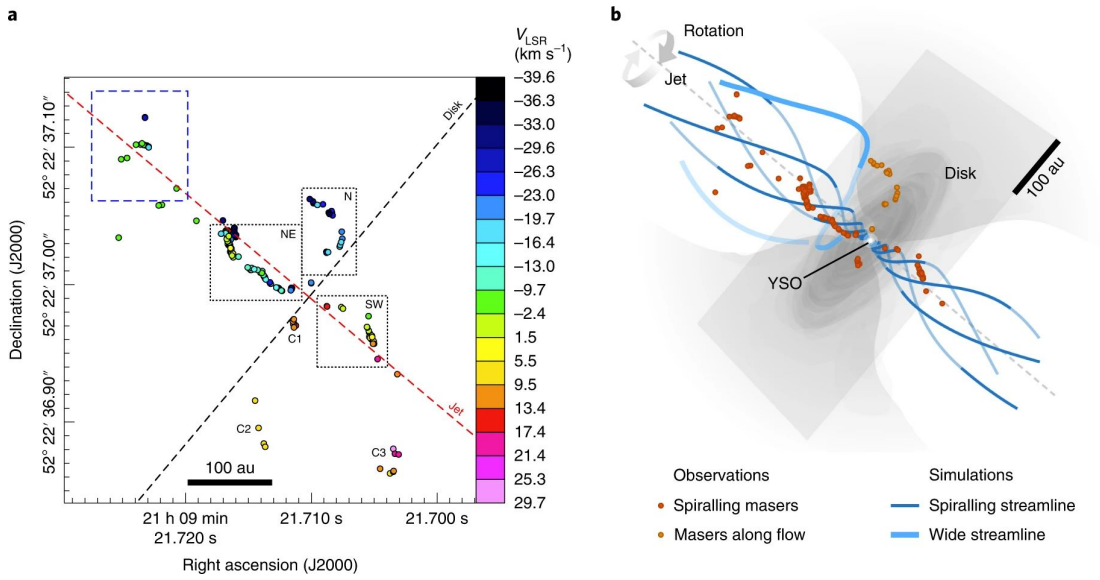
**L. Moscadelli,** A. Sanna, H. Beuther, G.A. Oliva, and R. Kuiper

***Snapshot of a magnetohydrodynamic disk wind***

Nature Astronomy (in press)

https://www.nature.com/articles/s41550-022-01754-4

Media INAF: https://www.media.inaf.it/2022/08/11/istantanea-di-moti-a-spirale/




Cr: Moscadelli et al. (2022)

A.V. Mosenkov, P.A. Usachev, Z. Shakespear, J. Guerrette, M. Baes, **S. Bianchi**, E.M. Xilouris, G.A. Gontcharov, V.B. Il'in, A.A. Marchuk, S.S. Savchenko, A.A. Smirnov

***The distribution of dust in edge-on galaxies: I. The global structure***

Monthly Notices of the Royal Astronomical Society (2022), 515, 4

https://academic.oup.com/mnras/article/515/4/5698/6652508

P. Li, S.S. McGaugh, **F. Lelli**, J.M. Schombert, M.S. Pawlowski

***Incorporating baryon-driven contraction of dark matter halos in rotation curve fits***

Astronomy & Astrophysics, in press

https://arxiv.org/abs/2208.04326

R. Middei, A. Marinucci, V. Braito, S. Bianchi, B. De Marco, A. Luminari , G. Matt, **E. Nardini**, M. Perri, J. N. Reeves, F. Vagnetti

***The lively accretion disc in NGC 2992 - II. The 2019/2021 X-ray monitoring campaigns***

Monthly Notices of the Royal Astronomical Society (2022), 514, 2

https://ui.adsabs.harvard.edu/abs/2022MNRAS.514.2974M/abstract

G. A. Matzeu, M. Lieu, M. T. Costa, J. N. Reeves, V. Braito, M. Dadina, **E. Nardini**, P. G. Boorman, M. L. Parker, S. A. Sim, D. Barret, E. Kammoun, R. Middei, M. Giustini, M. Brusa, J. Pérez Cabrera, S. Marchesi

***A new emulated Monte Carlo radiative transfer disk-wind model: X-Ray Accretion Disk-wind Emulator - XRADE***

Monthly Notices of the Royal Astronomical Society, in press

https://ui.adsabs.harvard.edu/abs/2022arXiv220713731M/abstract

M. Curti, F. D'Eugenio, S. Carniani, R. Maiolino, L. Sandles, J. Witstok, W. M. Baker, J. S. Bennett, J. M. Piotrowska, S. Tacchella, S. Charlot, K. Nakajima, G. Maheson, **F. Mannucci**, S. Arribas, **F. Belfiore**, N. R. Bonaventura, A. J. Bunker, J. Chevallard, **G. Cresci**, E. Curtis-Lake, C. Hayden-Pawson, G. C. Jones, N. Kumari, I. Laseter, T. J. Looser, **A. Marconi**, M.V. Maseda, J. Scholtz, R. Smit, H. Übler, and I. E. B. Wallace

***The chemical enrichment in the early Universe as probed by JWST via direct metallicity measurements at $z \sim 8$***

Monthly Notices of the Royal Astronomical Society, in press

https://arxiv.org/pdf/2207.12375.pdf

G. Gilmore, **S. Randich**, C. C. Worley, A. Hourihane, A. Gonneau, **G.G. Sacco**, J. R. Lewis, **L. Magrini**, P. François, R. D. Jeffries, S. E. Koposov, A. Bragaglia, E. J. Alfaro, C. Allende Prieto, R. Blomme, A. J. Korn, A. C. Lanzafame, **E. Pancino**, A. Recio-Blanco, R. Smiljanic, S. Van Eck, T. Zwitter, T. Bensby, E. Flaccomio, M. J. Irwin, **E. Franciosini**, **L. Morbidelli,** …., **M. Van der Swaelmen,** …., **N. Sanna**, ..., **M. Tsantaki** et al.

***The Gaia-ESO Public Spectroscopic Survey: Motivation, implementation, GIRAFFE data processing, analysis, and final data products***

Astronomy & Astrophysics, in press

https://arxiv.org/pdf/2208.05432.pdf

A. Sacchi, **G. Risaliti**, **M. Signorini**, **E. Lusso**, **E. Nardini**, G. Bargiacchi, S. Bisogni, F. Civano, M. Elvis, G. Fabbiano, R. Gilli, B. Trefoloni, C. Vignali

***Quasars as high-redshift standard candles***

Astronomy & Astrophysics Letters, in press

https://ui.adsabs.harvard.edu/abs/2022arXiv220613528S/abstract

E. Keles, M. Mallonn, D. Kitzmann, K. Poppenhaeger, H. J. Hoeijmakers, I. Ilyin, X. Alexoudi, T.A. Carroll, J. Alvarado-Gomez, L. Ketzer, A. S. Bonomo, F. Borsa, B.S.Gaudi, T. Henning, L. Malavolta, K. Molaverdikhani, V. Nascimbeni, J. Patience, **L. Pino** et al.

***The PEPSI exoplanet transit survey (PETS) I: investigating the presence of a silicate atmosphere on the super-earth 55 Cnc e***

Monthly Notices of the Royal Astronomical Society (2022), 513, 1

https://academic.oup.com/mnras/article/513/1/1544/6555041

D. Sicilia, L. Malavolta, **L. Pino**, G. Scandariato, V. Nascimbeni, G. Piotto, I. Pagano

***Characterization of exoplanetary atmospheres with SLOPpy***

Astronomy & Astrophysics, in press

https://arxiv.org/abs/2208.13045

## OTHER PUBLICATIONS

**E. Nardini**, D.-W. Kim, S. Pellegrini

***The hot interstellar medium***

in the Section "Galaxies" of "Handbook of X-ray and Gamma-ray Astrophysics"

Springer, 2022

https://ui.adsabs.harvard.edu/abs/2022arXiv220502855N/abstract

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