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DI ASTROFISICA

INAF Laboratories @ RSN3
State of art and new perspectives

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Napoli, 18-19 Oct. 2022

RSN3 laboratories: Instrumentation

RSN3 laboratories: people

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RSN3 laboratories: Instrumentation

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RSN5

Forum della Ricerca Sperimentale e Tecnologica in INAF
Bologna, 22-24 giugno 2022

RSN3 laboratory facilities

Instrument development

IAPS: DISC (Dust Impact Sensor and Counter)
IAPS: DUSTER (Dust in the Upper Stratosphere Tracking Experiment and Retrieval)
IAPS: Space Materials Laboratory
OACN: Laboratorio di Fisica Cosmica e Planetologia
OAA: Life Detection Chip

Characterization, processing and astrobiology

OAA: Arcetri Astrobiology Laboratory
OACT: Laboratorio di Astrofisica Sperimentale (LASp)
OACN: Laboratorio di Fisica Cosmica e Planetologia
OAPA: Light Irradiation Facility for Exochemistry (LIFE)
IAPS: The Planetary Mapping and GIS laboratory (GISlab)
IAPS: Laboratorio di Planetologia (Plab)
IAPS: Sample Preparation Facility (SPF)
IAPS: Spectroscopy LABoratory (SLAB)
IAPS: Laboratorio Spettroscopia Superfici (C-Lab)
IAPS: Drill for Analogues and Visible Infrared Spectrometer (DAVIS)

Test and calibration

OACN: Martian Atmosphere and Simulation Chamber
OAPA: X-ray Astronomy Calibration and Testing (XACT)
IAPS: Solar Wind and Ionospheric Plasma Simulation (SWIPS)
IAPS: Ion and Energetic Neutral Atom beam (I-ENA)
IAPS: Laboratorio di Planetologia (Plab)
OAA: Planetary Protection
OATO: Optical Payload Systems (OPSys) Facility & Optical Lab

Laboratory Scientific Activities

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Analog materials
- Silicates
- Carbonaceous materials
- Ices
- Biomolecules
- Atmospheres

Extraterrestrial samples
- Meteorites
- Interplanetary Dust Particles
- Cometary dust (Stardust/Wild2)
- Asteroids (Hayabusa2/Ryugu, *Osiris-Rex/Bennu*)

Analytical techniques
- X-ray - VUV - Vis – IR – mm spectroscopy
- Raman spectroscopy
- Scanning Electron Microscopy + EDX
- Mass spectrometry
- Powder diffraction (XRD)
- Liquid Chromatography Mass Spectroscopy
- Optical Tweezers
- Cartography & Geographic Information Sys.

Processing
- UV photons
- X-rays
- Fast ions (keV-MeV)
- Atoms
- Temperature
- Plasma

Complementary laboratories

Grand Accélérateur National d'Ions Lourds (GANIL), France

Interstellar Energetic Process System (IEPS) at the National Central University, Taiwan
National Synchrotron Radiation Research Center (NSRRC, Taiwan)

etc…

Laboratory Instrument Development

Small Objects
- Microbalances
- Dust Impact Sensors and Counters
- Spectrometers
- Cameras

Planetary Surface
- Spectrometers
- Dust sensors
- Cameras
- Life detection Chip
- Space tweezers

Sun & Planetary atmospheres
- Neutral and ionized particle detector
- Plasma analyzer
- Spectrometers

Future projects

INAF – Grants:

Bando per il Finanziamento della Ricerca Fondamentale 2022 in INAF

- **Large grants:** PRESTIGE (Pristine Returned Sample Testing InvestiGation and Examination) - E. Palomba
- **Grants "Laboratori Spaziali":** Upgrade of Laboratories - G. Baratta, A. Ciaravella, S. De Angelis
- **Mini-grants:** M. Accolla, C. Carli, C. Cecchi-Pestellini, T. Fornaro, G. Franzese, D. Fulvio, A. Jimenez Escobar

Future projects

PNRR: ”Rafforzamento e creazione di Infrastrutture di Ricerca“

Strengthening the Italian Leadership in ELT and SKA (STILES): funds for building an Exo–planetary Atmosphere Laboratory

PNRR: ”PE - Spazio“

Under evaluation

Future projects

Space missions

- **BepiColombo:** launched October 2018 – at Mercury 2025
- **LICIACube-DART:** impact 21 Sept. 2022 on Dimorphos
- **JUICE - JUpiter ICy moons Explorer:** launch 2023 – at Jupiter 2030
- **ASCPIICS/PROBA-3:** launch 2023
- **MMX:** sample return from Phobos, launch 2025
- **MUSE – MUlti-slit Solar Explorer:** launch 2027
- **Comet Interceptor:** launch 2029
- **Ariel:** launch 2029
- **ExoMars:** launch 2030

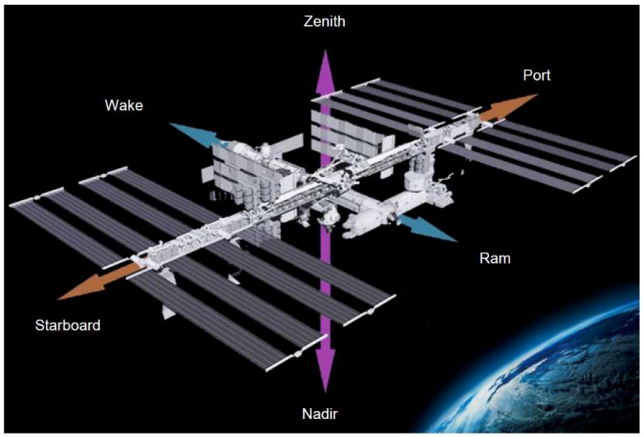
Stratospheric Balloon HEMERA

- **DUSTER**
- **CorMag**

Future projects

International Space Station

- **Material Ageing** launch 2024
- **CODEX NASA coronograph** launch 2023



Future projects

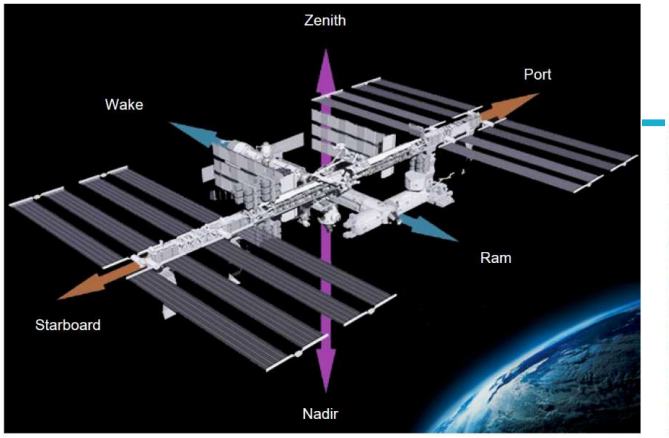
Material Ageing

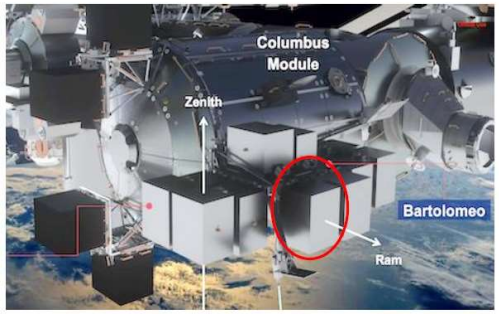
Esperiment on the International Space Station to study the stability of metal thin layers on polymeric substrates

Polymethyl methacrylate (PMMA)

Virgin + 200 keV H^+

Mezzina et al. 2022, Nanomaterials 12, 1992





Euro Material Ageing location outside the ISS

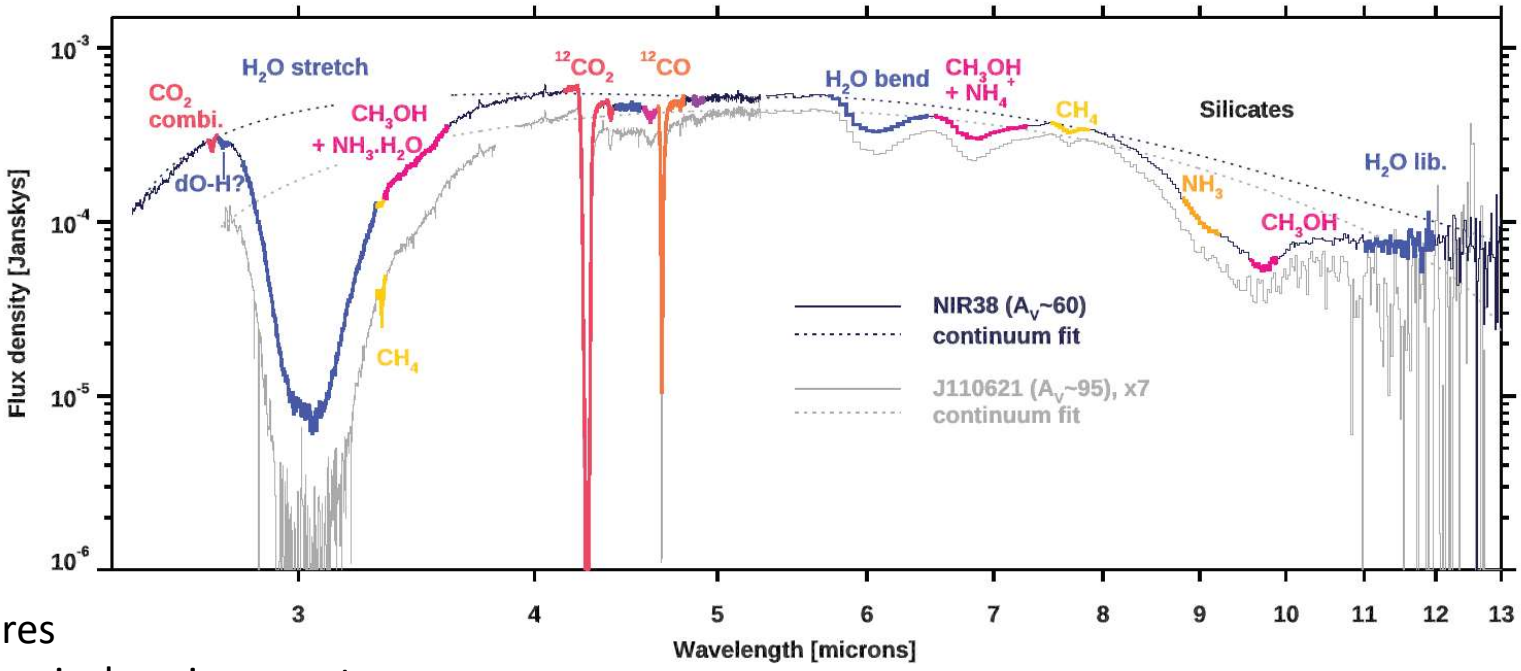
List of projects

Proposal number	Participants	Title of the proposal
AO-2020-EMA-136	DLR	ATOX Resistance of Polysilazane Coatings on Membrane Material for PV Arrays, Drag Sails and Thermal Components
AO-2020-EMA-110	BAM	Metallic glass ageing and rejuvenation in space ("Glassage")
AO-2020-EMA-106	Erich Schmid Institute	Aging of new material systems for flexible optical solar reflectors
AO-2020-EMA-115	ARCEON	Environmentally Stable and Low Thermal Expansion Composites (ESLTEC)
AO-2020-EMA-113	University of Bristol	Determination of the long-term LEO stability of novel carbon fibre reinforced plastics
AO-2020-EMA-121	NEMATX	Nematic 3D Printing of Liquid Crystal Polymers
AO-2020-EMA-105	AAC	Transparent polyimide films for thermo-optical applications
AO-2020-EMA-130	AZIMUT SPACE	BLAST-MA (Black LAser Surface Treatment – Material Ageing
AO-2020-EMA-109	Universita di Catania	Ageing of metal/insulator patterned samples for coatings and printable electronics
AO-2020-EMA-138	LIP INAF	Ageing od Ge/Si and CZT samples for sensors and LAUE lenses of future gamma-ray astrophysics telescopes
AO-2020-EMA-127	HEVS	3D-Printed NiTi
AO-2020-EMA-134	TECHNIKER	Diamond Like Carbon (DLC) and Plasma Electrolytic Oxidation (PEO) for tribology in space
AO-2020-EMA-137	SOTON	Effects of Long duration space environment exposure on additively manufactured metals
AO-2020-EMA-139	EMPA	Materials for device applications in space: Silicon for sensing MEMS and NEMS and BMGs for the storage for mechanical energy – the impact of defects on device performance
AO-2020-EMA-128	ISTEC University Naples	Low Earth orbit environment ageing effect on Ultra-High Temperature Ceramic Matrix Composites (WINTERTIME)

Future projects

James Webb Space Telescope (JWST) observations (interstellar medium, star forming regions, Solar System, exo-planets)

IceAge: DD - ERS #1309
McClure et al.



Laboratory experiments

- Identify absorption features
- Constrain the physico-chemical environment
- Constrain the chemical evolution

Future projects

Ultra-clean laboratory where to analyse samples returned from space missions from Mars, Moon, Phobos, Asteroids and Comets

INAF - Labs

INAF is a multicentre laboratory

Pros	Cons
- Distributed expertise	- Small Labs sizing
- Complementary activities	- Limited interactions
- Local sci & tech impact	- Lack of high impact Inst.
- Strengthens with local small PME	- INAF internal competitions
- Public Outreach and Education	- Lack of common objectives

Criticalities

- Maintenance of available instrumentation
- Need for stable research staff with an interdisciplinary background to maintain the role of excellence in such a long-term program.
- Need for more technical personnel in the laboratories and funds for the maintenance of the facilities, in many cases made through ASI funding, which represent an important asset of INAF.
- To be ready to analyze samples that will be returned to Earth from Mars, Moon, asteroids, and comets.