

ASTROPHYSIQUE@PARIS-SACLAY

SCIENCE THEME I: HOW DOES THE SOLAR SYSTEM WORK?

Journée de lancement de l'axe Astrophysique de la Graduate School de Physique

16 Novembre 2021

MAIN QUESTIONS, MEANS & RESSOURCES

- Sun and Planet formation, physical processes, evolution
 - Conditions for the emergence of life
 - Solar activity and global effects in the Heliosphere
 - Solar Wind interaction with planets, and the interplanetary/interstellar medium
 - Sun-Earth relations: Solar flares and Space Weather surveillance (human/spacecraft/ground system protection)
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- Space missions (remote and in-situ observations): hardware, ground/in-flight calibrations, data analysis
 - Numerical Simulations: support to space missions, databases
 - Laboratory Experiences: simulating physical processes

SOLAR SYSTEM EXPLORATION

ESA/SOHO (1995-)
ESA/Solar Orbiter (2020-)
NASA/ParkerSP (2018-)
JAXA/Solar C (2027)
NASA/SOLARIS (phase A)

ESA/Vex (2005-2014)
ESA/Envision (2031)
NASA/Veritas (2026)
Shukrayaan-I (2024)

ESA/BepiC (2018-)

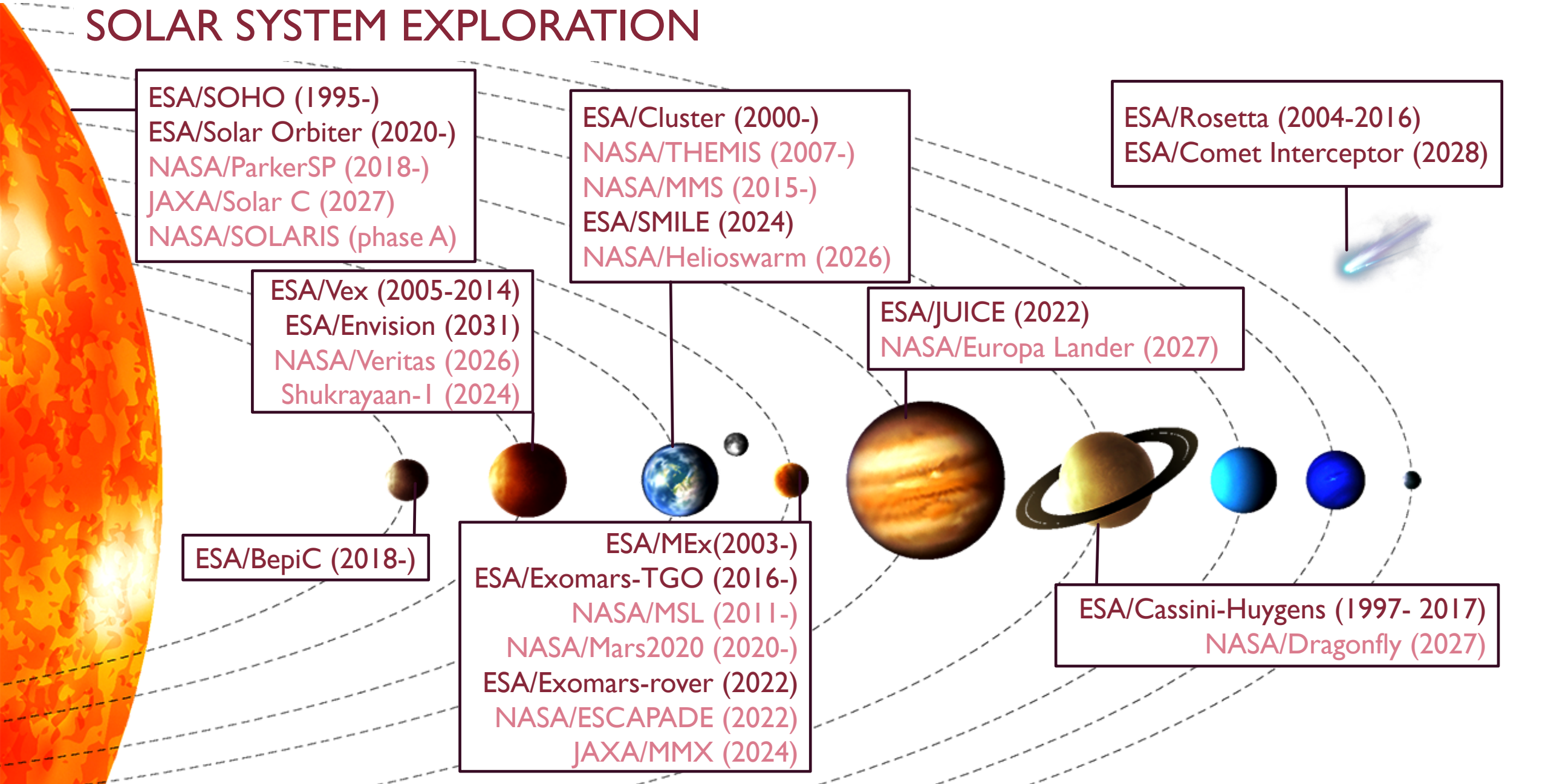
ESA/MEx(2003-)
ESA/Exomars-TGO (2016-)
NASA/MSL (2011-)
NASA/Mars2020 (2020-)
ESA/Exomars-rover (2022)
NASA/ESCAPADE (2022)
JAXA/MMX (2024)

ESA/Cluster (2000-)
NASA/THEMIS (2007-)
NASA/MMS (2015-)
ESA/SMILE (2024)
NASA/Helioswarm (2026)

ESA/JUICE (2022)
NASA/Europa Lander (2027)

ESA/Rosetta (2004-2016)
ESA/Comet Interceptor (2028)

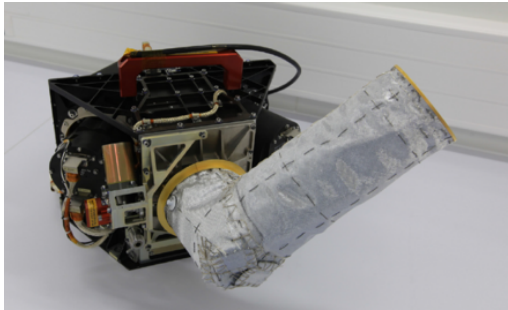
ESA/Cassini-Huygens (1997- 2017)
NASA/Dragonfly (2027)



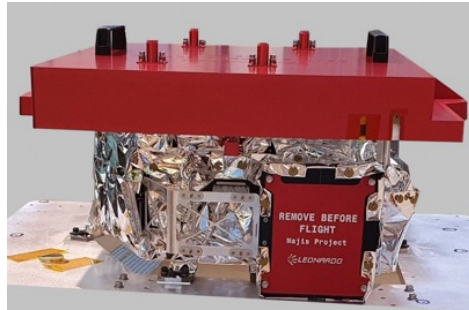
INSTRUMENT EXPERTISE

Orbital Remote sensing (LATMOS, IAS, AIM):

- UV / Visible / IR / X-ray photometers/spectro-imagers : (e.g. SOHO/SWAN, SOHO/EIT, SoHO/EUI, SoHO/STIX, Mex/SPICAM, Vex/SPICAM, MPO/PHEBUS, MPO/SymbioSys, JUICE/MAJIS, EnVision/VenSpec-U)
- Radars/radiometers : (e.g. Cassini, Rosetta)



BepiColombo
MPO/PHEBUS



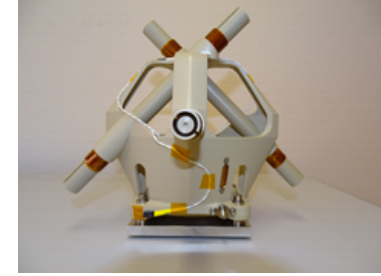
JUICE/MAJIS

In-Situ plasma measurements (LPP):

- Magnetometers/search-coil (e.g. Cluster, MMS, BepiC, Juice)
- Ion/electron mass spectrometers (e.g. Cluster, Cassini, MIO/MSA, Solar Orbiter, ParkerSP, Juice)



BepiColombo,
MIO/MSA



JUICE/search-coil

In-situ planetary landers (LATMOS, IAS):

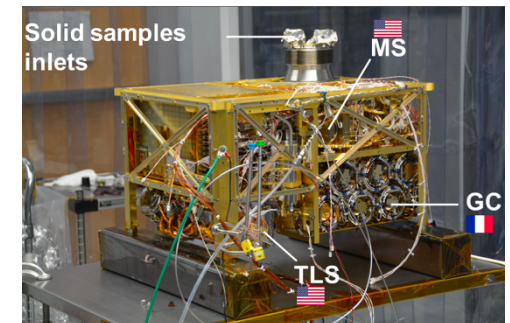
- Gas chromatography (e.g. SAM-Curiosity, MOMA)
- Microscopic spectral IR imagery (e.g. ExoMars/MicrOmega)
- Radar, permittivity probes (e.g. ExoMars/WISDOM, Dragonfly/DIEL)
- Imagery (e.g. Rosetta/CIVA)



WISDOM Antennas



MicrOmega

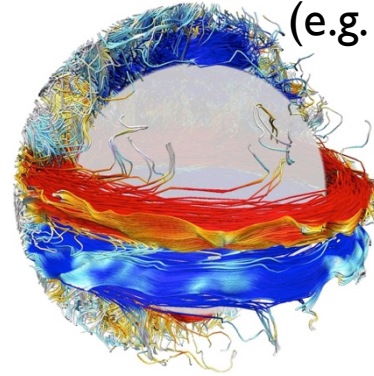
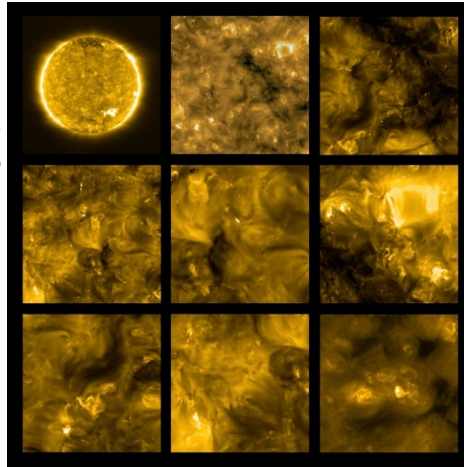


SAM/GC-Curiosity

I. SUN, SOLAR WIND, HELIOSPHERE

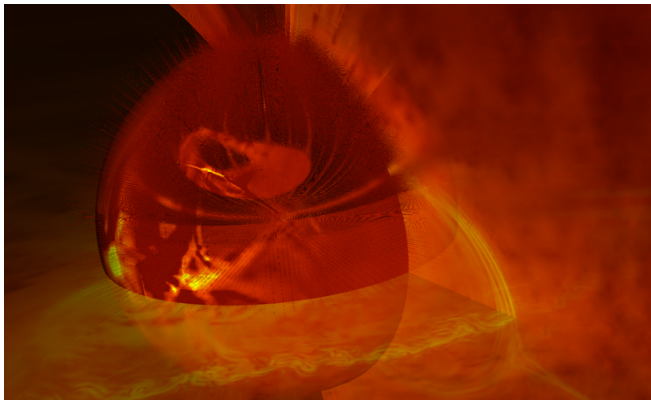
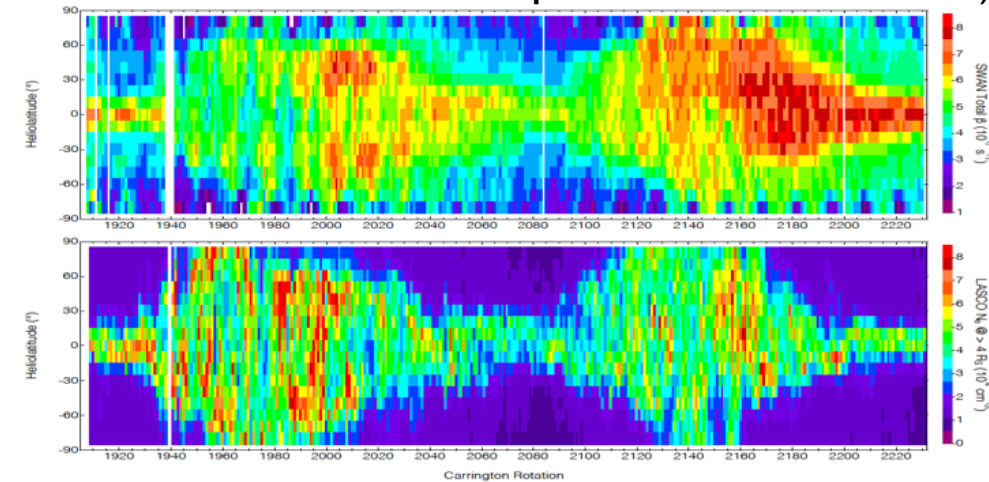
The Sun from the core to the corona
(e.g. ERC Synergy ‘WholeSun’, Brun et al., 2021, AIM)

Solar Orbiter/EUI images
reveal Sun’s “campfires”
(Auch re et al., 2020, IAS)

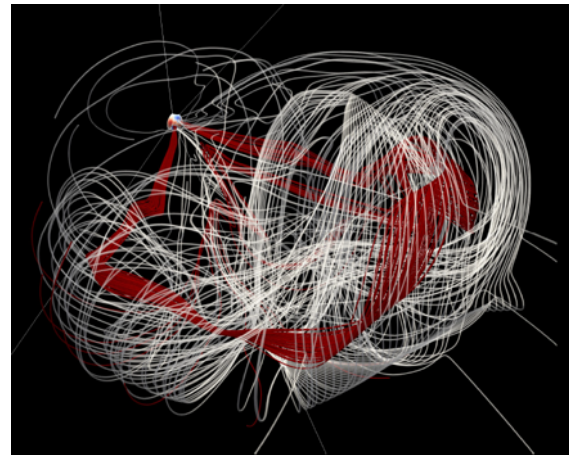


SolO artist impression

Solar Wind 3D distribution in the Heliosphere,
Solar Cycle evolution (e.g. SOHO/SWAN-LASCO,
Qu merais, Koutroumpa et al. 2021 LATMOS)

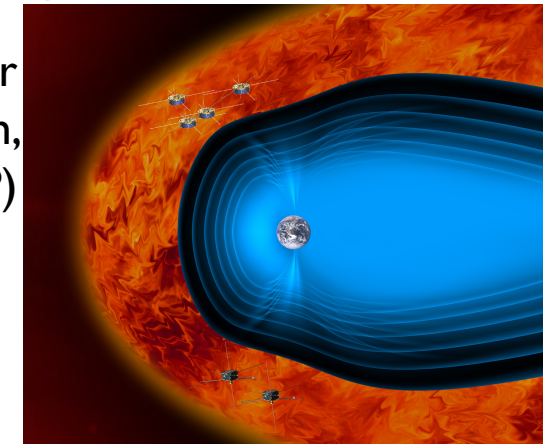


Solar Corona Anatomy: 3D MHD
simulations (1st prize photo
contest, PLAS@PAR, Pellegrin,
Pariat et al., 2021, LPP, LESIA)



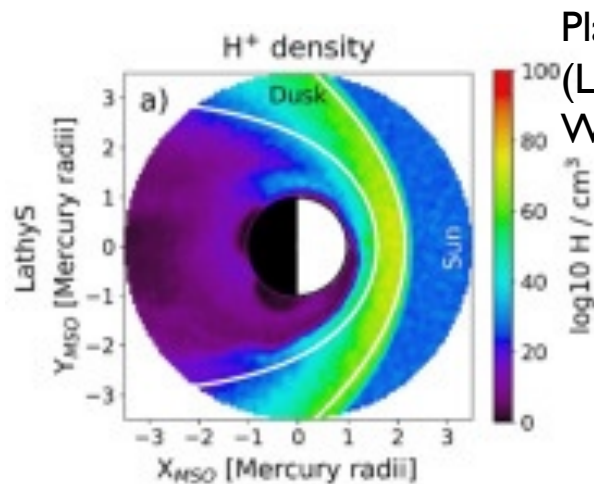
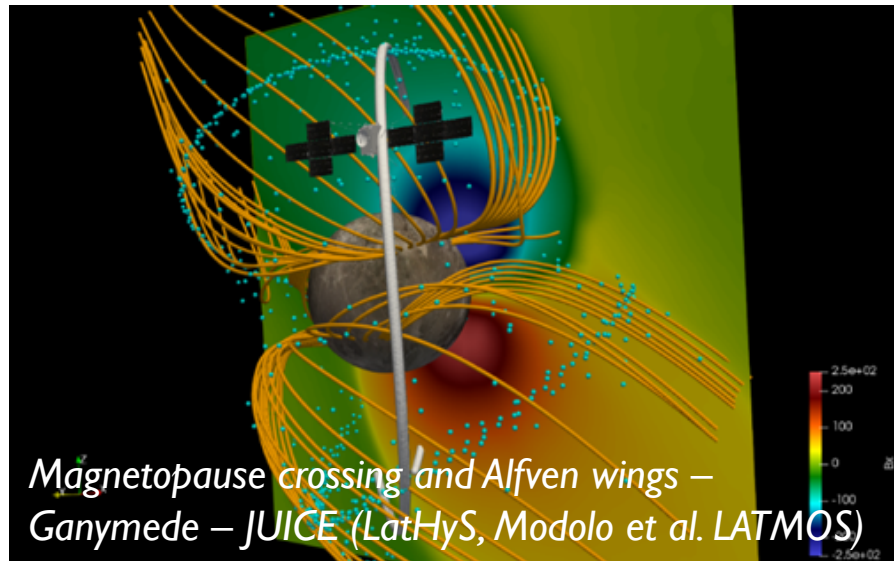
Plasma turbulence (e.g. Cluster
in solar wind / magnetosheath,
Hadid, Sahraoui, et al. LPP)

CME propagation
(e.g. ESA-WindPredict,
Regnault et al., AIM, IAS)



II. SUN – PLANET INTERACTIONS

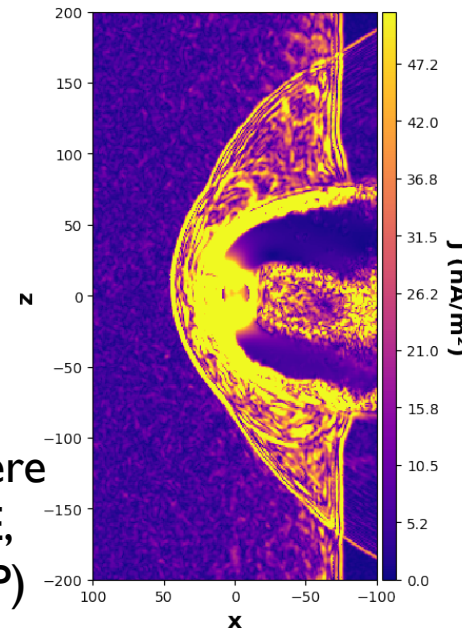
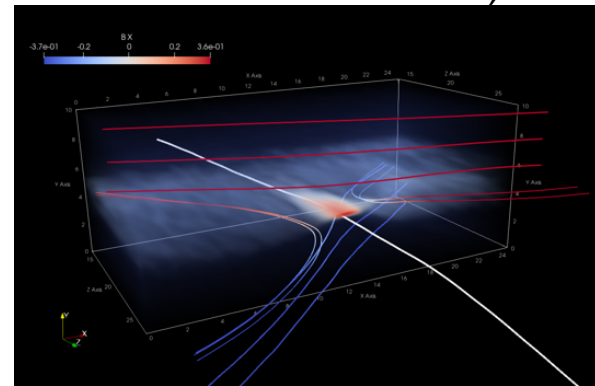
Plasma-Neutral coupling in planetary environments



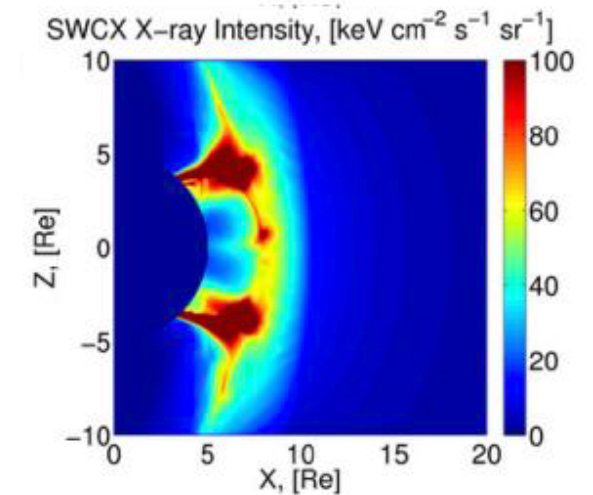
Planetary ions in Mercury
(LatHyS – NASA/MESSENGER,
Werner, Leblanc et al., 2021 LATMOS)

(e.g. IP shock-magnetosphere
interaction, ANR TEMPETE,
LatHyS, Moissard et al., LPP)

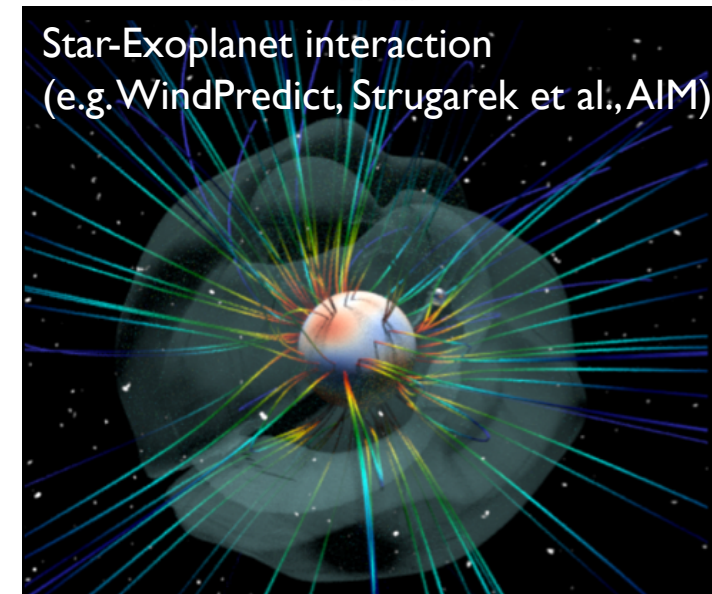
3D Hybrid PIC simulations:
(e.g. magnetic reconnection,
PHARE, Aunai et al., LPP)



X-Ray Imaging of the magnetosphere
(e.g. ESA/SMILE Mod.Work.Group,
Koutroumpa et al. 2021, LATMOS)

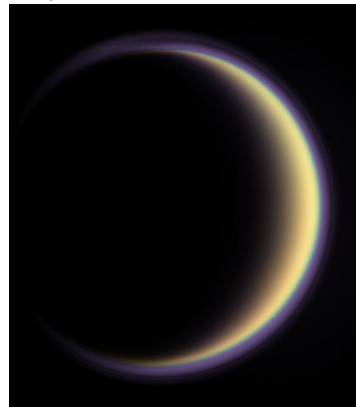
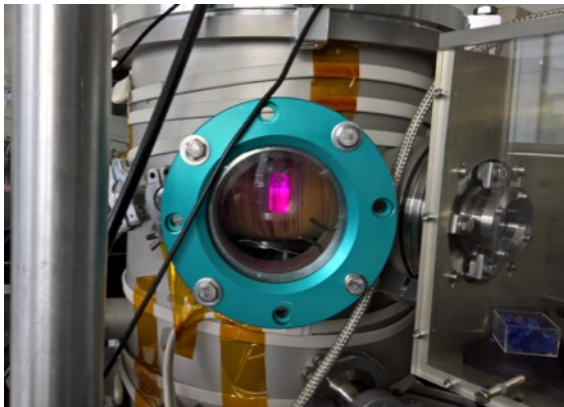


Star-Exoplanet interaction
(e.g. WindPredict, Strugarek et al., AIM)

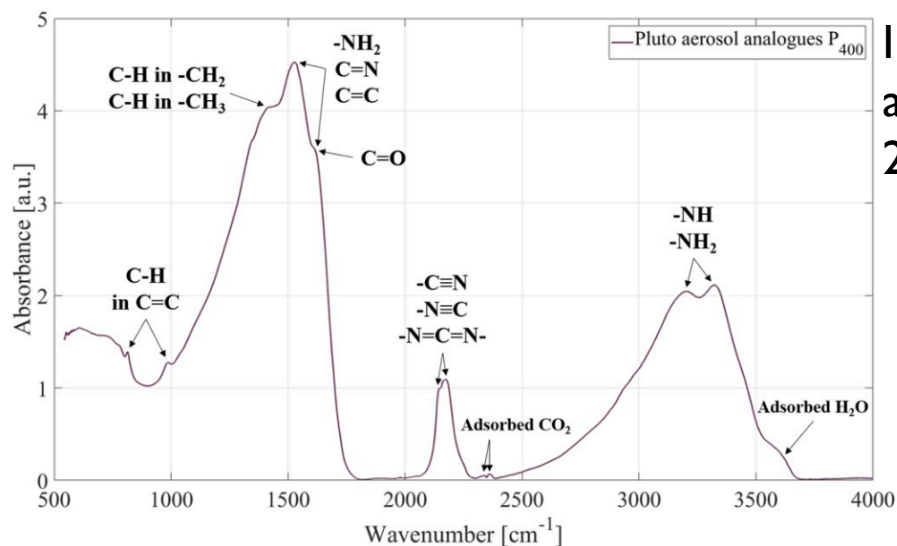
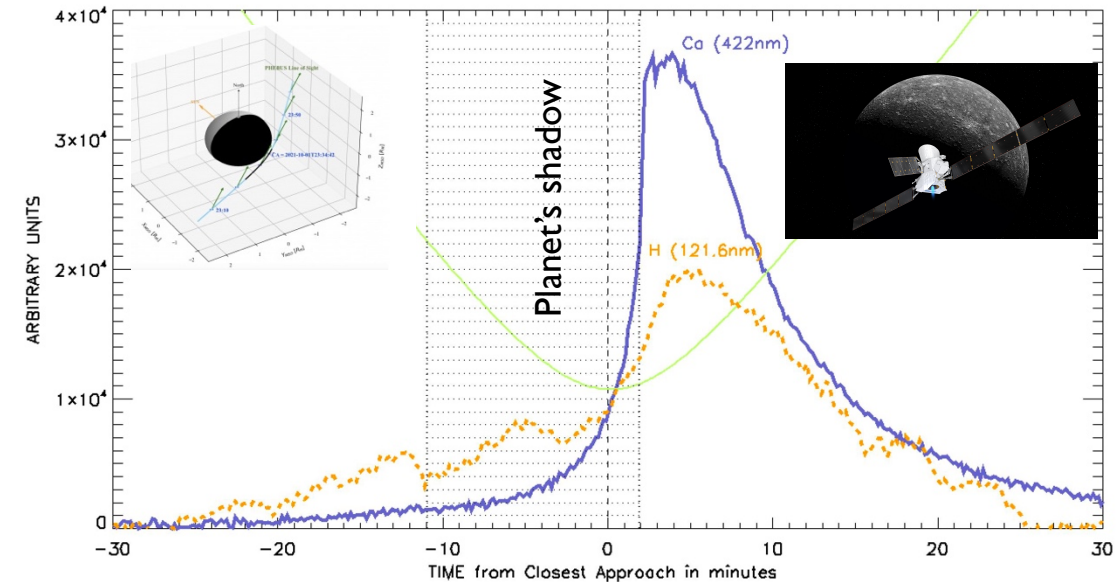


III. PLANETARY ATMOSPHERES

PAMPRE/APSIS Experimental setup (e.g., ERC PrimChem, ANR Tracking Organic Matter in Titan atmosphere, Carrasco, Gautier et al. LATMOS)

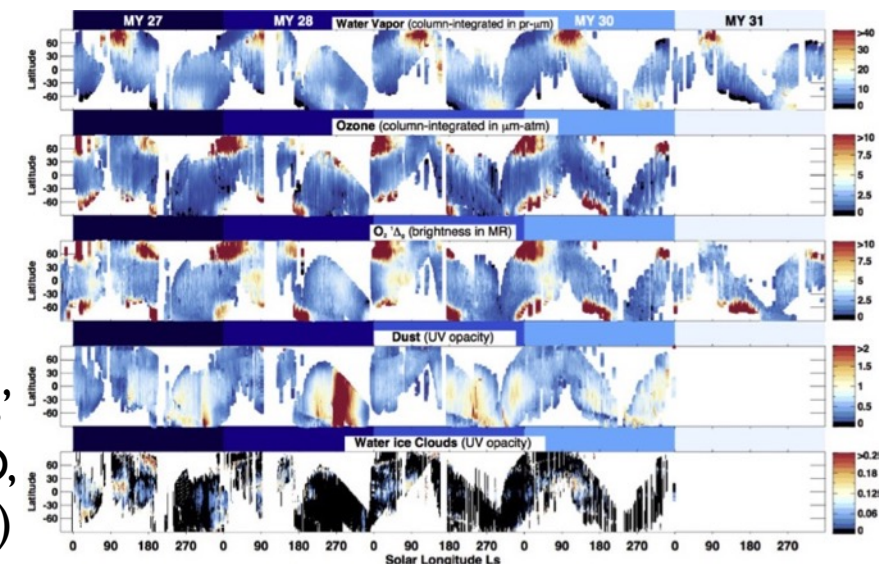


BepiColombo's 1st Mercury Flyby (Oct. 2021): PHEBUS exosphere measurements (Quémerais et al., LATMOS)



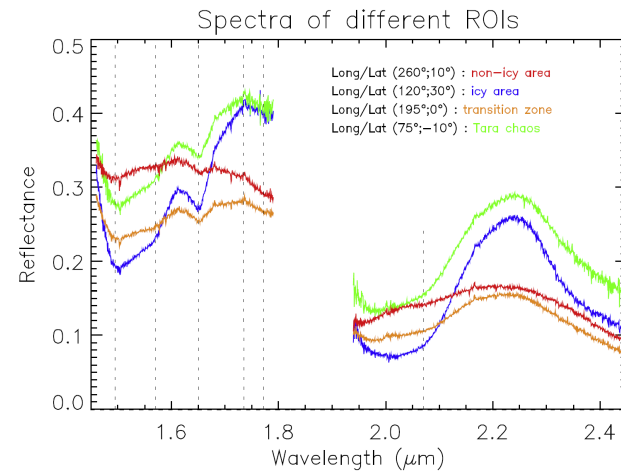
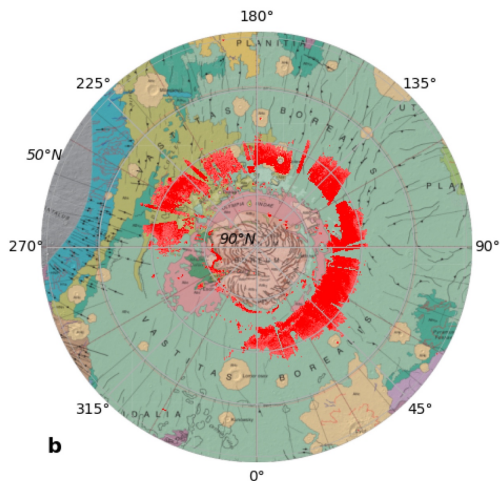
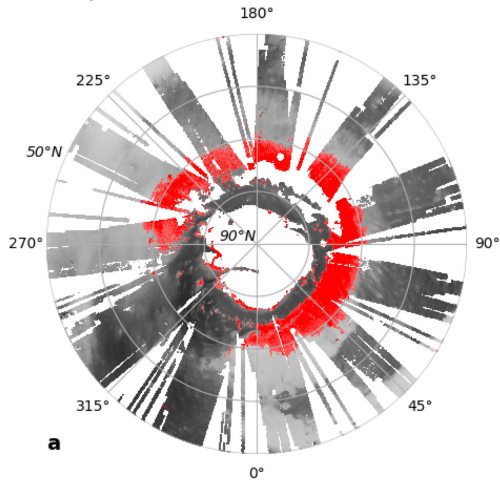
IR spectra of Pluto's aerosol analogues (Jovanovic et al. 2020, LATMOS)

Multiannual monitoring of Mars' atmosphere (e.g. MEx & TGO, Montmessin et al. 2017, LATMOS)



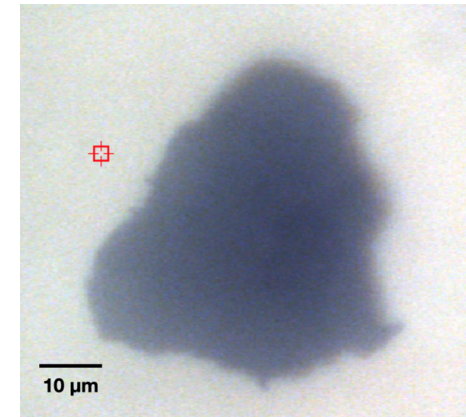
IV. PLANETARY SURFACES

MEx hyperspectral imagery :
surface mineralogy of the north
pole (Stcherbinine et al., 2021, IAS)

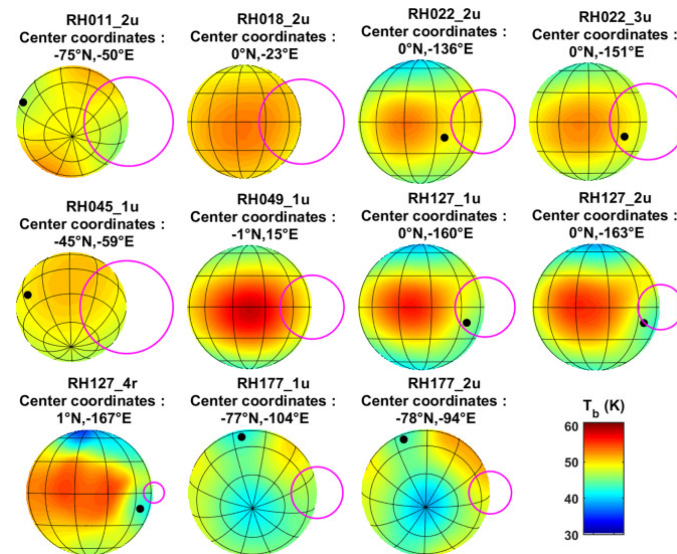


Composition of water
ice and salts on Europa
from NIR spectroscopy
(Ligier et al. 2016, IAS)

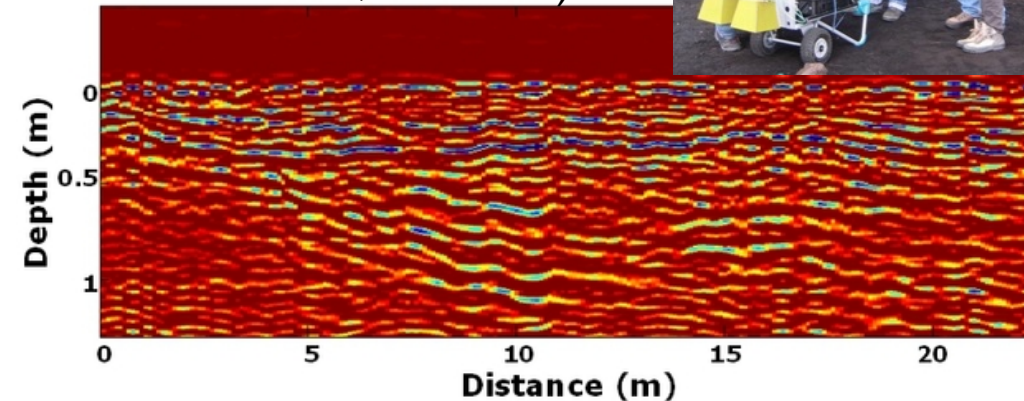
Laboratory measurements of
primitive bodies composition
(e.g. samples return by Hayabusa 2,
Brunetto et al., IAS)



Cassini's Radar: Rhea's surface Temp.
(Bonnefoy et al. 2020, LATMOS)



ExoMars2020/WISDOM:
tests on Etna (e.g., Ciarletti,
Le Gall et al., LATMOS)



COMMUNITY SERVICES & LABORATORY RESOURCES.

IDOC (Integrated Data & Operation Center), IAS:

- MEDOC (Multi Experiment Data & Operation Center – solar physics space data)
- PSuP (Planetary Surfaces Portal)

>15 Primary responsibility & Partnership in SNOs (Service National d'Observation)

SciQlop, LPP: Multi-mission/spacecraft data visualization tool

LatHyS, LATMOS: Simulations database

SMILEI, LPP: open source codes

Synergies with CDDP (Centre de Données de Physique des Plasmas - IRAP)

LATMOS

- PAMPRE & APSIS: Atmospheric Chemistry Simulations (Titan, Pluton, Exoplanets)
- Measurements of dielectric properties of analog materials

OVSQ

- Integration Platform (PIT): integration halls, clean rooms, mechanical/optical/thermal tests
- MIRE immersive platform

IAS

- Calibration station

CEA

- SOLEIL synchrotron

