Voyage2050

Astrochemistry, star formation, and the interstellar medium

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Cycle of the ISM in galaxies
From diffuse clouds to stars and eventually back to diffuse clouds
**White papers, total 9:** 3 UV, 3 FIR, (1+1) THz and 1 in-situ

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A complete census of the gas phases in and around galaxies: far-UV spectropolarimetry as a prime tool for understanding galaxy evolution and star formation

Vianney Lebouteiller et al. & (Ana Inés Gómez de Castro et al.)

FUV (912 - 2000 Å) absorption spectropolarimetry: HI, H₂, D, CO, CH, CII, CII*, OVI...

Large samples of line of sights in the Galaxy, other galaxies and QSO

Chemistry and physics of the diffuse ISM:
• How is the ISM structured? How do phases interact?
• What are the gas ionizing and heating mechanisms?
• What drives the chemistry?

Precision measurement of magnetic field:
• What is the role of magnetic field in the ISM phases and star formation?

The ISM properties in external galaxies and gas flows in the CGM:
• Is there evidence of metal-free gas accretion?
• Does star formation proceed in cold atomic gas in quasi-pristine environments at redshift~0?
• Are there enough CGM clouds to sustain star formation through accretion?
• How are the galactic halos energized?
A complete census of the gas phases in and around galaxies: far-UV spectropolarimetry as a prime tool for understanding galaxy evolution and star formation
  Vianney Lebouteiller et al. & (Ana Inés Gómez de Castro et al.)

Vianney Lebouteiller et al.:  
**Mission:** L-type, Effective area > 40 000 cm$^2$, spatial resolution 10 mas, 
spectropolarimetry capabilities with spectral resolution R > 120000 -200000 
**ESA contribution to LUVOIR.** The POLLUX instrument supported by CNES

Ana Inés Gómez de Castro et al.  
**Mission:** L-type, 6-10 meter telescope with angular resolution 10 mas, 
spectroscopy with R=20,000-100,000, spectropolarimetry, R=80,000, 
Integral field spectroscopy R=500-1000
Massive Stars in Extremely Metal-Poor Galaxies: a Window into the Past UV
Miriam Garcia et al.

Spectroscopy in the 3600-7000 Å with spectral resolving powers of 1000, 8000, 50000
Characterization of a significant sample of XMP massive stars (from galaxies at 1-4 Mpc) with Z < 0.2

Stellar evolution: Breaking the frontier of the SMC metallicity (0.2 Zo)
What are the physics processes in massive stars in pristine systems?
How does the feedback change as a function of metallicity?
• GRBs, SNe, SLSNe progenitors
• Formation of >30M☉ black holes in binary systems (GW150914)?
What is the effect of metallicity in the IMF?

Mission: L_type: 10 m class telescope operating in the UV-optical-NIR
ESA contribution to LUVOIR with a multi-object optical spectrograph with R = 1000, 8000 and 50000.
The Far Infrared Spectroscopic Surveyor
Dimitra Rigopoulou et al.

Large scale mapping in 4 selected far-IR lines (CI, OI, CII and NII) at very high spectral resolution
Galactic plane, nearby Galaxies and blind fields

**How the gas transforms into stars and how their feedback impact the ISM:**
- How does the Interstellar Medium vary with environment?
- How do molecular clouds form?
- What regulates Star Formation in galaxies?
- How much gas is in `CO-dark’ clouds and how does it impact on modes of SF?
- What is the impact of radiative feedback on the ISM?

**Mission:** M-type, 1-2 meter class telescope operating in the 4 bands in the 63 to 370μm range
high resolution spectroscopy with multibeam heterodyne receivers
In-situ Investigations of the Local Interstellar Medium
Robert F. Wimmer-Schweingruber et al.

Measure:
• Composition of the local interstellar medium?
• Properties of the interstellar magnetic field?
• Properties and dynamics of the interstellar neutral component?
• Properties and dynamics of interstellar dust?

How do they relate to the diffuse ISM?

Mission: L type with international collaboration.
TeraHertz Exploration and Zooming-in for Astrophysics (THEZA)
Leonid Gurvits et al.

High resolution imagining (0.01” to 0.1”) of water lines at sub-mm wavelengths

Water in protoplanetary disks:
• ice lines – tracers of dust grains dynamics

Cold water vapour reservoirs:
• understanding the “disk – protoplanet” dynamics

Water in exoplanets:
• from planet formation to biospheres

Mission: L-type, Space interferometer with 2-3 medium size antennas operating from 300 μm to 1.5 mm with heterodyne receivers
Medium-Earth orbits and very high spectral resolution
LUNES: LUNar tErahertz teleScope Expanding the electromagnetic window
Jean-François Lampin

**Observatory on the moon:**
Telescope: > 10 m (target 30m) operating at THz (1-10THz /30-300 μm)
High spectral resolution provided by heterodyne receivers

**Scientific potential:**
*Astrochemistry:* from light hydrides (e.g. H$_2$O, OH+, .) to very complex molecules organic molecules
*ISM:* main coolant lines (CI, CII, OI, OII, NII, ..), CO-dark gas (HD)

Explore a wide range of objects from protoplanetary discs to high-z galaxies