Molecules of astrophysical interest (3 ECTS)

***Teachers**: Géraldine Féraud (MONARIS, SU), Xavier Michaut (MONARIS, SU), Mathieu Bertin (MONARIS, SU)*

Objectives :

The aim of this course is to show how laboratory studies of the interaction between radiation and molecular matter (in gaseous or solid form) are essential for observing and understanding the universe. Using on-board telescopes or on the ground, light analysis enables us to determine the physico-chemical conditions in interstellar environments light-years away from our solar system. Although some of the properties of molecular matter can be determined directly by observation, laboratory experiments are needed to shed light on molecular mechanisms at work in the interstellar medium, which have important consequences for the evolution of interstellar matter.

Contents :

Introduction – The interstellar medium (physical conditions, size and time scales, interstellar medium regions and composition, radiation conditions); Role of molecules and dust in the interstellar medium and their detection

Interaction between gaseous molecules and low-energy radiation - Reminders of rovibrational spectroscopy and radiative transfer in a molecular gas in astrophysics; Observations of CO in space (rotational temperatures, column densities, antenna temperature, Doppler shift); Observations of polyatomic molecules (rovibrational spectroscopy of polyatomic molecules, isomerism and nuclear spin conversion). ;

TP : high-resolution H2O spectroscopy in gas and solid phases in the CoSpiNu experiment.

Interaction between gaseous molecules and more energetic radiation - Electron spectroscopy and laboratory experiments (absorption and fluorescence; Franck-Condon principle; Study of example spectra (CO, H2O, C6H6); Non-radiative processes (introduction to non-radiative transitions, dissociation, isomerization); Application to astrophysical observations (diffuse interstellar bands, aromatic infrared bands);

Molecular solids in astrophysics - Molecular ices in the cold regions of the interstellar medium; Characterization of molecular solids (vibrational spectroscopy of solids, thermal desorption methods, theoretical modeling); Formation and thermal evolution of interstellar ices (catalytic role of grains, diffusion, thermal reactions and desorption, accretion and "snowlines");

TP : experimental simulation of the evolution of a mixed CO:H2O ice in the SPICES experiment.

Place : Jussieu