Unveiling our chemical origins: the composition of planet-forming disks

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Since the discovery of the first exoplanet in 1995 more than 4000 exoplanets have been detected nowadays. This indicates that planet formation is a robust mechanism and nearly every star in our Galaxy should host a system of planets. However, many crucial questions about the origin of planets are still unanswered: How and when planets formed in the Solar System and in extra-solar systems? What is the reason of the huge variety of architectures of extrasolar systems? And what chemical composition do Solar System bodies inherit from their natal environment?

This PhD project is aimed to answer these outstanding questions by studying the planet formation site, i.e. planet-forming disks around young Sun-like stars (i.e. young stars with mass similar to our Sun). The PhD student will analyse observations taken with state-of-the-art interferometers working at millimetre and centimetre wavelengths, such as ALMA and VLA, to detect the emission from gaseous molecules and dust grains in planet-forming disks down to scales of a few au, i.e. comparable to the size of our Solar System (50 au). During the PhD, he/she will use radiative transfer codes to analyse molecular line emission and derive the gas physical conditions and molecular abundances. The spatial distribution and abundance of molecules in disks will be compared with the predictions from thermo-chemical disk models to constrain the formation mechanisms of simple molecules as well as (complex) organics, which are believed to be the building blocks of prebiotic molecules. Finally, the chemical composition of the planet-forming disks will be compared with that observed in comets, which preserve a nearly pristine record of the early Solar System.

The PhD student will benefit from the collaborations with world-recognised expert of astrochemistry, from observations to modelling and quantum chemistry computations, thanks to the team involvement in a number of international collaborations devoted to astrochemistry, such as the H2020 Horizon ITN Marie Curie project ACO (Astrochemical Origins), the PRIN-MUR project BEYOND-2P, as well as in large observational programmes, such as SOLIS (Seeds Of Life In Space), FAUST (Fifty AU Study of the chemistry in the disk/envelope system of Solar-like protostars), and ALMA-DOT (ALMA chemical survey of Disk-Outflow sources in Taurus).