Brand new insights on the jet/disk protostellar systems using interstellar Complex Organic Molecules (iCOMs)
(PhD project)

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SCIENTIFIC BACKGROUND

The birth of a Sun-like star is a complex game played by several participants whose respective roles are not yet entirely clear. On the one hand, the star-to-be accretes matter from a collapsing envelope. The gravitational energy released in the process heats up the material surrounding the protostar, creating warm regions enriched by interstellar complex organic molecules (iCOMs, at least 6 atoms) called hot corinos. On the other hand, the presence of angular momentum and magnetic fields leads to two consequences: (i) the formation of circumstellar disks; and (ii) substantial episodes of matter ejection, as e.g. collimated jets.

THE NOEMA-ALMA SYNERGY

Thanks to the combination of the high-sensitivities and high-angular resolutions provided by the advent of new telescopes such as ALMA and NOEMA, it is now possible to image in details the earliest stages of the Sun-like star formation, thus inspecting the inner (less than 20-50 AU from the driving protostar) jet. At these spatial scales a proper study of jets has to take into account also the effects connected with the accreting disk. In other words, it is time to study the protostellar jet-disk system as a whole. Several still unanswered questions can be addressed. What is the origin of the chemically enriched hot corinos: are they jet-driven shocked regions? What is the origin of the ejections: are they due to disk or stellar winds? How are these phenomena linked? Shocks are precious tool to attack these questions, given they enrich the gas phase with the species deposited onto the dust mantles and/or locked in the refractory dust cores. Basically, we have to deal with two kind of shocks: (i) high-velocity shocks produced by protostellar jets, and (ii) slow accretion shocks located close to the centrifugal barrier of the accretion disks. Both shocks are factories of iCOMs, which can be then efficiently used to follow both the kinematics and the chemistry of the inner protostellar systems. With this in mind, the PhD candidate is expected to analyse and discuss the big dataset obtained in the framework of different Large Programs at mm and sub-mm wavelengths, such as ASAI (complementary IRAM 30-m data), SOLIS (IRAM NOEMA), and enriched by the FAUST NRAO VLA & ESO ALMA Key Program, with C. Codella as co-PI.

PhD ACTIVITY

During the her/his PhD activity, the candidate will acquire experience in reducing and analysing high-spatial NOEMA and ALMA images using the GILDAS and CASA data reduction tools. The candidate will also learn how to manage big data and to interpret the so-called datacubes (4D images) as well as the collected forest of 2D lines thanks to the available spectroscopic catalogues (e.g. JCMT, CDMS). The study of the line profiles will be fundamental to disentangle the different kinematical components playing in the protostellar scenario (disk, jets, outflow cavities, extended envelopes, infalling material). Finally, the candidate will learn how to analyse the data by the light of the state-of-the-art models of shocks and disks with a special attention to the chemical content. The candidate is expected to spend part of her/his PhD activity at International institutes abroad such as: ESO (Graching), IPAG/IRAM (Grenoble) for stages on ALMA/NOEMA data handling.