SOLIS IRAM-NOEMA Large Program (Seeds of Life in Space)

https://solis.osug.fr

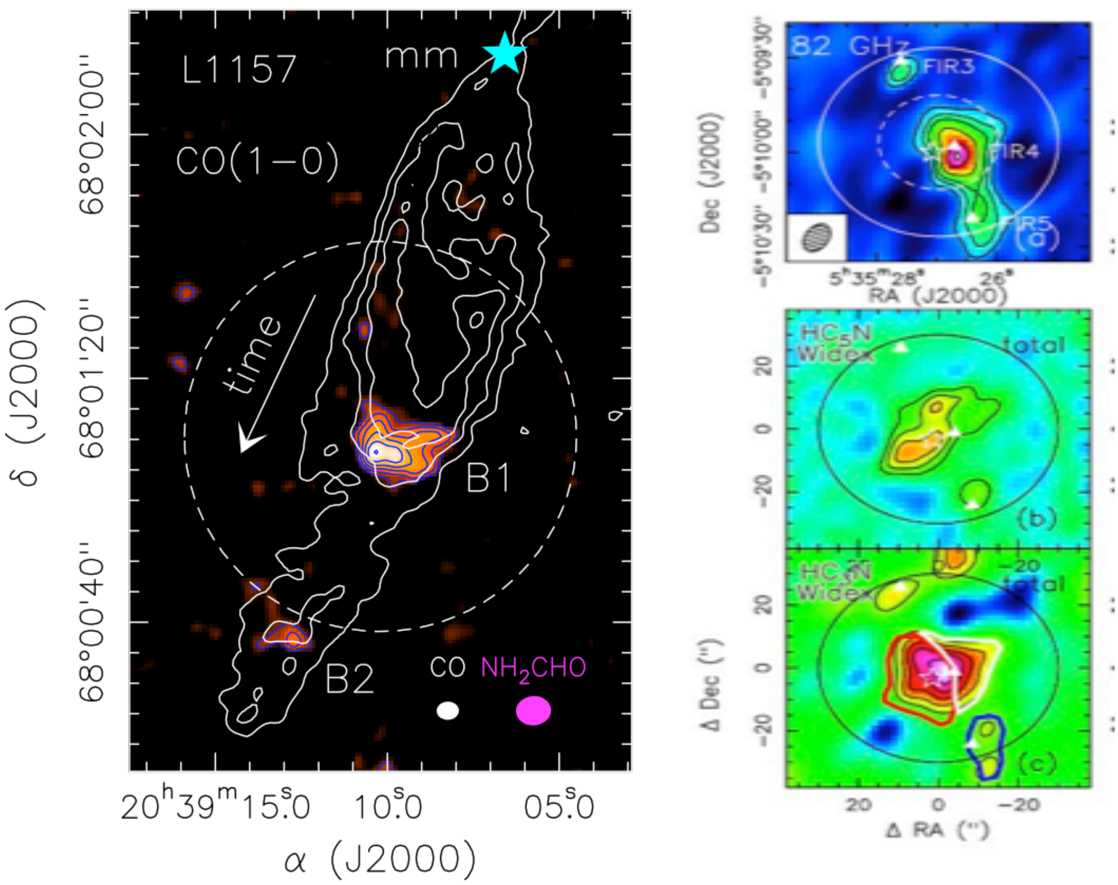
(see Ceccarelli et al. 2017, ApJ 850, 176)

SOLIS is an IRAM/NOEMA Large Program whose two complementary goals are:

(1) understanding organic chemistry in space, and (2) how it evolves during the process of formation of Solar-like planetary systems. This is obtained by systematically study a set of crucial interstellar Complex Organic Molecules (iCOMs) in a sample of sources representative the first phases of Solar-type star formation.

(2) The immediate goal is to pin down where iCOMs are located, their abundance, and how they are influenced by evolutional and environmental factors.

SOLIS is part of an on-going large-scale effort to fully understand the iCOMs formation and destruction routes and the formation of a Solar-like planetary systems. This effort involves astrophysical observations, modeling, laboratory experiments and theoretical chemistry calculations. SOLIS builds on previous large observational programs, notably CHESS and ASAI, and involves an interdisciplinary team, in order to fully exploit the huge amount of information that SOLIS provides us with.



Left panel: Formamide (NH_2CHO) imaged towards the protostellar shock L1157-B1 (from Codella et al. 2017), **Right panel:** Continuum, HC_3N, and HC_5N emission towards the OMC-2 protocluster (from Fontani et al. 2017).

A special case:

Protostellar shocks as factories of interstellar complex organic molecules: the ASAI & SOLIS synergy

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The role of the pre-solar chemistry in the chemical composition of the Solar System bodies is far to be understood. The molecular complexity builds up at each step of the process leading to star formation, starting from simple molecules and ending up in interstellar Complex Organic Molecules (iCOMs). How these molecules are formed in the harsh conditions of the interstellar medium is still a puzzle. The two current theories predict formation by reactions in the gas phase or on the interstellar dust grains, the latter through surface reactions or induced by energetic processing. It is of paramount importance to combine high-sensitivity unbiased spectral survey to collect large numbers of lines for each iCOM (for reliable identifications and to analyse excitation conditions) as well as to image their spatial distribution to investigate their association with different ingredients of the Sun-like star formation recipe (e.g. warm envelopes and cavities opened from hot jets, accretion disks).

In this context, high-velocity shocks caused by protostellar jets, such as that driven by the L1157-mm Class 0 object, can be considered perfect astrochemical laboratories due to sputtering and shuttering leading to the erosion of the grain cores and ices, and consequently to the chemical enrichment of the gas phase. We present here the recent results on the bright shock L1157-B1 obtained thanks to the unprecedented combination of (i) the high-sensitivities of the IRAM 30-m ASAI unbiased (full coverage of the 1, 2, and 3mm bands, http://www.oan.es/asai) spectral survey with (ii) the high-angular resolutions images provided by the NOEMA SOLIS large program (https://solis.osug.fr) A large number of iCOMs have been unambiguously detected by ASAI using numerous (up to 125) lines. Some iCOMs have been detected for the first time in shocks, such as ketene (H_2CCO), dimethyl ether (CH_3OCH_3), formamide (NH_2CHO) and glycolaldehyde ($HCOCH_2OH$). The SOLIS images show for the first time a differentation between COMs spatial distributions, associated with different physical conditions. Reliable estimates of the COMs abundances towards L1157-B1 have then been derived. Coupling these observations with comprehensive astrochemical models has shed light on the formation routes of ethanol (C_2H_5OH), formamide (NH_2CHO), and glycolaldehyde ($HCOCH_2OH$).