ASAI IRAM-30m Large Program
(Astrochemical Surveys At IRAM)

http://www.oan.es/asai

Goal
(see Lefloch et al. 2018, MNRAS 477, 4792 for an overview)

With the advent of the new generation of high-sensitivity, broad-band receivers at the IRAM 30m, we are now in position to address the question of our "chemical origins", namely to understand the chemical evolution of the matter during the long process that brought it from prestellar cores (PSCs) and protostars to protoplanetary disks, and ultimately to the bodies of the Solar System. We propose to carry out an unbiased spectral exploration of a carefully selected sample of template sources, which cover the full format ion process of solar-type stars. This will provide a full census of the chemical species present in the gas neutrals (including complex organic species), anions, and cations, down to abundances as low as $\sim 10^{-12}$ with respect to H_2. A complete modeling will allow to determine the physical and dynamical conditions of the targets. The resulting data set will remain as a reference database for astrochemists (astronomers, chemists, and theoreticians).

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. 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 ($HCOCH_2OH$).