

## Broad band rotational spectroscopy and plasma characterization

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In this work we present an experimental setup in which millimetric-wave astronomical receivers and spectrometers are coupled to a reaction chamber to study the spectroscopy and chemical evolution of carbon containing molecular species of astrophysical interest, via their rotational emission lines.

In a first proof of concept, a small prototype reactor (50 cm length, 25 cm diameter) was placed in the beam path of the Aries 40 m radio telescope (Yebes Observatory, Guadalajara, Spain) facing the Q-band receiver operating in the 41-49 GHz frequency range, providing 2 GHz bandwidth and 38 kHz resolution. The radiation signal received by the antenna, or that emitted by a liquid N<sub>2</sub> trap, were used as cold background. Experiments with samples exposed to cold plasma generated by an inductively coupled RF (13.56 MHz) glow discharge, or UV irradiation, were performed; and the feasibility of the experiment was demonstrated [1].

In a second phase, new receivers have been designed and built, and are now coupled to a new larger reaction chamber (1 m length, 50 cm diameter), which provides longer optical paths and allows to operate at lower plasma pressures ( $\sim 0.1$  Pa), in a dedicated laboratory. The new receivers cover the Q (31.5-50GHz) and W (72-116GHz) bands with 38 kHz resolution. A cryogenic cold load operates as background reference at 17 K. Plasmas produced in gas mixtures containing light hydrocarbons or other carbon bearing species and other gases are mainly employed for the spectroscopic study of the precursors, which dissociate in the plasma by electron impact, and the products, generated in gas phase or by heterogeneous reactions with the reactor surfaces [2]. In most cases, deposits produced by these plasmas on different sample substrates have been characterized ex-situ by different methods.

The mm-wave emission technique provides large sensitivity, instantaneous bandwidth and spectral purity, so that it is perfectly suited for high resolution spectroscopy of molecular species of astrophysical importance. High accuracy measurements of the frequencies and intensities can be determined.

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### References

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