USING RADIOASTRONOMY TECHNIQUES AND COLD PLASMAS TO STUDY TRANSIENT AND STABLE MOLECULAR SPECIES OF ASTROPHYSICAL INTEREST: A PROOF OF CONCEPT

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The development of new powerful radiotelescopes is enhancing tremendously the detection of stable and transient species in the interstellar space at mm and sub-mm wave wavelengths, and is improving the understanding of the kinetic processes involved. Evaluation of these data can take great advantage of the information obtained in laboratory cold plasmas.

In this work we describe the proof of concept of the joint use of standard radio astronomical receivers and low pressure cold plasmas for emission spectroscopic studies of different precursors and products. The goal is to obtain in the laboratory valuable information on rotational emissions of molecular species of astrophysical interest at high spectral resolution. An inductively coupled RF discharge has been used to generate the plasma. Gas pressures 10-30 Pa allow stable plasma operation and produce column densities similar to those of interstellar clouds. The experiment is performed in the 40 m radio-telescope of the Observatory of Yebes (Spain), using its 41-49 GHz band receiver. The beam of the antenna pointing towards the zenith is used as cold emission background. The RF discharge doesn't induce any electromagnetic spurious signals in the receiver, and astronomical detection of a SiO maser in the AGB star TX Cam is unaffected by the presence of the plasma. OCS is selected for preliminary gas detection in this emission band. OCS and CS_2 are chosen as plasma precursors of the CS radical, which emits also in this region. O_2 discharges applied after sulphur deposition on the reactor walls by the previous OCS and CS_2 plasmas lead to the detection of SO_2 produced by surface reactions.

In conclusion, these experiments confirm the viability of using standard radioastronomy receivers to detect molecular and short lived species in gas simulation chambers based on plasma reactors.