SUBMILLIMETER AND MID/FAR-INFRARED SPECTROSCOPY IN INTERSTELLAR AND CIRCUMSTELLAR CLOUDS

JOSE CERNICHARO, *CSIC. IEM. Dpt. Molecular Physics. C/Serrano 121. 28006 Madrid. Spain. e-mail:cerni@astro.iem.csic.es*.

The observation of the rotational emission of molecules in the space can be used to determine the physical and chemical conditions of the emitting gas. The low–J pure rotational transitions of species like CO, HCN, CN, HCO^+, . . ., have been observed during the last thirty years using ground-based radio telescopes operating at millimeter and submillimeter wavelengths. Many molecules have been discovered in this way in the space, even prior to its detection in the terrestrial laboratories. The gas that can be investigated through these molecular transitions is cold and of moderate volume density. Although many important studies have been carried out on galactic and extragalactic molecular clouds, these observations can not give an accurate view of the warm and dense regions where star are formed and of the hot gas surrounding stars in the last stages of their evolution.

The ISO satellite has offered us the opportunity to study the mid and far-infrared spectrum of molecular clouds and evolved stars. In this lecture I will review the main results obtained in the field of molecular astrophysics with ISO. The physical processes related to star formation can be, for the first time, analyzed in great detail through the observation of high excitation lines of water vapor and other molecular species. Although most of the observed molecules, H_2O, CH^+, high–J rotational lines of CO and HCN, have well known rotational constants, the analysis of the observed emission has shown the lack of some important molecular properties that have to be obtained from laboratory experiments or from ab initio quantum chemistry calculations.

In this lecture I will review the type of molecules that can be observed in the space in the far– and mid–infrared and the physical processes related to the pumping of the ro-vibrational levels of the most abundant species (C_2H_2 and HCN in C-rich objects, H_2O in O-rich objects).

The future space platform “Far Infrared Space Telescope” (FIRST) will be equipped with high resolution heterodyne receivers that will allow to study the chemical complexity of the universe. In order to prepare the scientific program of this mission, a close collaboration between astronomers and molecular spectroscopists is needed. The spectroscopic information that we need to get the maximum scientific output from FIRST will be reviewed.