THE CHEMICAL STRUCTURE OF PRE–STELLAR MOLECULAR CLOUD CORES

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Stars like our Sun form in molecular cloud condensations with typical sizes of 15,000 AU (about 2×10^{17} cm), kinetic temperatures of about 10 K and central densities of a few $\times$ 10^5 H_2 molecules per cc, called starless cores. In recent years, with the improvements in the sensitivity and resolution of millimeter–wavelength telescopes and spectrometers, it has been possible to investigate in detail the internal structure of these objects with the aim of finding the initial conditions of the star formation process and to follow the chemical evolution of molecular material just prior the formation of a protoplanetary system. These observational studies have shown that starless cores present strong abundance variations. In particular, there are evidences that common species such as CO and CS disappear from the gas phase within about 7,000 AU, whereas Nitrogen–bearing species do not present significant abundance variations. All this has been interpreted as evidence of differential molecular freeze–out onto dust grains. Particularly interesting objects are the so–called pre–stellar cores, i.e. centrally concentrated starless cores with central densities of $\simeq 10^6$ cm^{-3}, thought to be on the verge of star formation. These cores are characterized by large abundances of deuterated species, correlated with the amount of CO freeze–out, and there are indications that the central $\sim$ 2,500 AU are totally deprived of species heavier than He, suggesting that just before entering the future star–disk system, dust grains are completely covered by thick icy mantles. Which molecular lines can thus be used to trace the central zones of pre–stellar cores, the future stellar cradle? One possibility is the light molecular ion H_2D^+, recently detected, in its ortho form, in a statistically significant sample of pre–stellar cores.
In this talk I'll review the above observational evidences, pointing out the fundamental role of chemistry and molecular spectroscopy in studying the physical and chemical properties of pre–stellar cores.