Rotational Spectroscopy of astrophysical molecules

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The identification of new molecules in the interstellar medium (ISM) is often intrinsically linked to their prior study in the laboratory, especially at centimeter to submillimeter wavelengths where the recorded spectra act as identity cards. Yet, current astronomical surveys, using instruments as ALMA or the GBT, display a wealth of transitions that cannot be assigned to any known molecule. Further laboratory data, in particular rest frequencies in the range where these instruments operate, is thus more than ever needed.

From an Earth-experimentalist point of view, the candidates for interstellar detection can be sorted into two groups: stable and reactive species. In the first group, the recent interstellar detection of the first PAHs-type molecules (e.g., benzonitrile, cyanonaphthalenes, and indene), after decades of unsuccessful searches, has brought this family of molecules back into light and stresses the need for new laboratory data on related relatively large compounds. As for the second group, although reactive species represent a significant amount of the known interstellar species (more than 50%), the astronomical detection of relatively large ones remains hindered by the lack of available laboratory data. Even for already known reactive species, such laboratory data are often limited to the centimeter and millimeter-wave region (f < 300-400 GHz), while observatories such as ALMA can operate up to about 1 THz. Reactive species are indeed often challenging to produce and characterize in the laboratory compared to their stable, often commercially available, counterparts. New laboratory data on a wide range of both stable and reactive species are thus more than ever needed.

In our group, we are exploiting chirped-pulse millimeter-wave and frequency-multiplication-based (sub)millimeter spectroscopy to record the rotational spectrum of known or postulated astronomical species and provide accurate rest frequencies for astronomical searches up to the terahertz domain. In this talk, I will present an overview of our experimental capabilities illustrated by results on several stable and reactive species of astrophysical importance.