Why the Submillimeter? Why Has It Taken So Long?

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***Abstract* – The cause and effect relations between the physics of the submillimeter spectral region and the past, present, and future scientific and technological applications of this region will be discussed.**

This talk will focus on the physical foundations of gas phase spectroscopy. Chief among these are the strong peak in the interaction strength of the rotational degree of freedom with radiation in the submillimeter, the thermal population of many rotational states and their rich spectral fingerprint, the small Doppler widths that allow the resultant spectra to be resolved, the extraordinary spectral brightness of coherent sources (1 mW in 1 MHz corresponds to 10^{14} K), and the extreme quiet of the background.

A theme will be that this physics has led us to the current set of technical and scientific applications and that it can continue to lead us in fruitful directions. An additional theme is that there is a strong relation between the spectroscopic needs of a particular application and the appropriateness of the many available technologies. In other words there is a natural selection process among proposed submillimeter technologies that is driven by the needs of the applications.

The environment of the spectroscopically active molecule also contributes to the richness of spectroscopy in the submillimeter and impacts scientific and technical directions. Pressures vary from the near vacuum of the interstellar medium, to the ~10^{-5} atmospheres of Doppler limited laboratory spectroscopy, to spectroscopy in the atmosphere itself. Temperatures range from below that of the cold interstellar medium to temperatures that approach those of stars, and extend into non-equilibria environments such as plasmas.

Applications from physical chemistry, remote and point sensing, molecular astrophysics, and atmospheric science will be used to provide quantitative illustrations of these general principles.

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