Millimeter-wave Rotational Spectroscopy of Polar Aromatic Compounds: Phenyl Radical (C_6H_5), *ortho*-Benzyne (*o*-C_6H_4), Protonated Benzene ($C_6H_7^+$)

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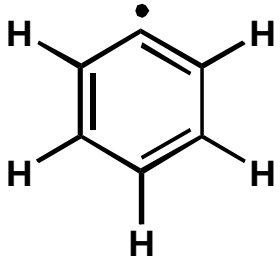
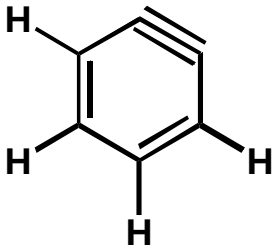
Benzene has been detected in proto-planetary nebula CRL 618 via infrared spectroscopy by the Infrared Space Observatory. Due to its symmetry and resulting lack of a dipole moment, however, benzene does not exhibit rotational transitions that allow detection by radioastronomy. Fortunately several reactive aromatic species, such as phenyl radical (C_6H_5), *ortho*-benzyne (*o*-C_6H_4), and protonated benzene ($C_6H_7^+$) have dipole moments and should be detectable in the interstellar medium via their rotational spectra. At this point, the rotational spectrum of phenyl radical and *ortho*-benzyne have been observed and published in the microwave region of the spectrum but are not available in the millimeter region. We are attempting to generate all three of these molecules in a gas discharge tube and measure their absorptions over a region of 80 to 300 GHz. From the measured signals, we will determine the rotational constants for each of the molecules. The measured laboratory frequencies will provide the basis for radioastronomical searches for these molecules.

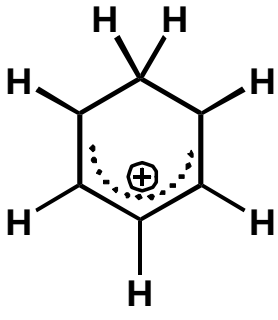
A millimeter-wave absorption spectrometer being used in this research project has been used previously for the investigation of numerous small inorganic molecules. The apparatus consists of a three-meter Pyrex discharge chamber containing two cylindrical electrodes. The discharge tube operates at low pressure and a range of temperatures reasonably approximating conditions in the interstellar medium. The microwave signal is generated by a Gunn-diode microwave source, which is then further amplified and multiplied to reach the desired frequencies. The signal is focused onto a liquid-helium-cooled indium antimonide detector. The spectral data are gathered and processed on a VAX-VMS computer system running Fortran-based programs.



phenyl radical



***ortho*-benzyne**



protonated benzene