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High Resolution Spectroscopy of Laboratory-Produced Interstellar Molecule having Response to Visible Light

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Diffuse interstellar bands (DIBs) still remain the longest standing unsolved problem in spectroscopy and astrochemistry, although several hundreds of DIBs have been already detected. It is expected that identifications of DIBs can give us crucial information for extraterrestrial organic molecule. One of the best approaches to identify carrier molecules of DIBs is a measurement of DIB candidate molecule produced in the laboratory to compare their absorption spectra with astronomically observed DIB spectra.

Radical in a gas phase is a potential DIB candidate molecule. The electronic transitions of polyaromatic hydrocarbon radicals result in optical absorption. However, because radicals are unstable, their electronic transitions are difficult to observe using a laboratory spectrometer system. To solve this difficulty, we have developed a glow-discharge cell using a hollow cathode in which radicals can be effectively produced as a high-density plasma. The radicals produced were measured by using the cavity ringdown (CRD) spectrometer and the discharge emission spectrometer.

The CRD spectrometer, which consists of a tunable pulse laser system, an optical cavity and a discharge device, is an apparatus to observe an high-resolution optical absorption spectrum. The electronic transition of thiophenoxy radical C_6H_5S was observed in the discharge emission of thiophenol C_6H_5SH. The frequency of the electronic transition of thiophenoxy radical was measured.

A optical discharge emission was examined by a HORIBA Jobin Yvon iHR320 monochromator. We detected the phenoxy radical C_6H_5O in the discharge of phenol C_6H_5OH. The band observed at 6107 A in the discharge was assigned to the electronic transition of phenoxy radical on the basis of the sample gas dependences and the reported low resolution spectra. The frequency of the electronic transition of phenoxy radical was measured.

Comparison studies of thiophenoxy and phenoxy radicals were made with known DIB spectra.

Keywords: Diffuse Interstellar Band, interstellar molecule, spectroscopy, cavity ringdown, molecular cloud, discharge