High resolution infrared spectra of protonated benzene isolated in solid parahydrogen

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Identification of infrared (IR) spectra of protonated polyaromatic hydrocarbons (PAH) is important in understanding the unidentified IR bands of interstellar media. We demonstrate a new method that is superior to the Ar-tagging IR photodissociation or the IR-multiphoton-dissociation (IRMPD) methods currently used. The protonated benzene (C$_6$H$_7^+$) was produced on electron bombardment of a mixture of benzene (C$_6$H$_6$) and para-hydrogen (p-H$_2$) during deposition. IR features of C$_6$H$_7^+$ and C$_6$H$_7$ were identified by observing the change in intensity upon photolysis and comparison with theoretical calculations. Lines of C$_6$H$_7^+$ decreased in intensity when the matrix was irradiated with light at 365 nm, those of C$_6$H$_7$ increased in intensity. Similar experiments were performed for a sample of C$_6$D$_6$/p-H$_2$ and the production of C$_6$D$_6$H$_2^+$ was confirmed. Observed wavenumbers, relative IR intensities and deuterium isotopic shifts agree with those predicted for C$_6$H$_7^+$ and C$_6$H$_7$. Compared with previous methods, this method provides a wider spectral coverage with much narrower lines and more accurate relative IR intensities, and may be readily applied to larger protonated and neutral PAH.

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Date submitted: 08 Nov 2011