

Unidentified Molecular Bands In The Plasma Tail Of Comet Hyakutake (C/1996 B2)

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Unidentified molecular emission bands first observed in optical spectra of the plasma tail of Comet Halley (1P/1982 U1) have been discovered in pure ion tail spectra of comet Hyakutake (C/1996 B2) and three other recent comets (Nakamura-Nishimura-Macholz P/1994 N1, Austin C/1989 X1, and Brorsen-Metcalf 32P/1989 N1), but not in comet Hale-Bopp (C/1995 O1). The strengths of the bands near 4940Å, 5310Å, and 6000Å are correlated among the comets observed, indicative that the unidentified bands arise from a single molecular species. The bands have an asymmetric spatial distribution that extends in the antisolar direction, resembling molecular ions observed in comet plasma tails. Thus, the source of the unidentified bands is probably a single species of molecular ions. Of known laboratory molecular ion spectra, none can be attributed to the unidentified cometary emission bands. The absence of the unidentified ions in the tail of Hale-Bopp may be explained by a parent species of the unidentified ions that mimics the coma dynamics and photochemistry of H₂ more closely than CO. This is inferred from the large tail CO⁺/H₂⁺ ratio observed in Hale-Bopp, which arises from the comet's large production rate that extends the ionopause and coma collision zone. Our observations provide evidence that the source region for the ions in plasma tails of comets lies external to the magnetic field-free ionopause. CO⁺ in the plasma tail will also be discussed.