Chapter 6

Observation of hydrocarbons in the infrared wavelength range

Hydrocarbons can only be detected in the IR. They can not be detected at radio wavelengths, because the molecules are homopolar and have no allowed rotational transitions. They are also not detectable in the ultraviolet wavelength range, because the higher electronic states are predissociated (see Herzberg [1966]). Ethane has strong vibrational transitions in the IR:

Vibrational level	wavelength [μm]
v_7	3.35
v_5	3.43
v_8	6.79
v_6	7.25
v_9	12.2

Table 6.1: Emission lines of ethane in the infrared wavelength range (Herzberg [1945] and Lii and Allinger [1992])

The only detectable emission band of acetylene in comets is the v_3 vibrational band at 3.03 μm in the IR wavelength range.
The comets C/1996 B2 (Hyakutake) and C/1995 O2 (Hale-Bopp) arrived just in time to utilize the high spectral resolution and sensitivity of infrared échelle spectrographs newly installed on some of the large telescopes.
The hydrocarbons ethane C_2H_6 and methane CH_4 have been detected in comet Hyakutake using the NASA infrared telescope facility on Mauna Kea, Hawaii [Mumma *et al.*, 1996]. Emission lines of two branches of the v_7 band have been detected on March 25, 1996. The emission lines have been observed up to a nucleocentric distance of about 1000 km. The emission was strongly peaked at the position of the nucleus, as expected for a nucleus source. On April 2 two more branches of the same emission band have been detected, confirming the identification of ethane.

In comet Hale-Bopp multiple branches of the v_7 band of ethane were detected between September 20, 1996 and September 26, 1997 [Dello Russo *et al.*, 2001]. Again there was no indication for a distributed source of ethane. The emission peaked at the position of the nucleus and no correlation with the dust profiles was found.
The v_3 band of acetylene (C_2H_2) was detected in comet Hyakutake on April 8, 1996 by Tokunaga *et al.* [1996] and Brooke *et al.* [1996] using the NASA infrared telescope facility on Mauna Kea, Hawaii. In comet Hale-Bopp the same band was detected on February 24, 1997 by Lis *et al.* [1997] using the same instrument and on March 3, 1997 by Weaver *et al.* [1997] using the United Kingdom Infrared Telescope (UKIRT) on Mauna Kea, Hawaii.