RADIO-FREQUENCY OBSERVATIONS OF INTERSTELLAR CH_4 AND HC_5N

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ABSTRACT. We detected new $^{12}CH_4$ transitions at 21,303 and 94,089 MHz in emission from Orion A, and observed temporal variations of intensity among several velocity components at 76,700 MHz. We also detected an HC_5N transition at 21,301 MHz in emission from IRC+10216.

We reported the first detection of interstellar methane (Fox and Jennings 1978) after observing six radio emission lines from Orion A. Subsequently, infrared absorption by CH_4 was detected in IRC+10216 (Hall and Ridgway 1978), and infrared features in NGC 7027 and other galactic sources were associated with CH_4 fluorescence in interstellar grain mantles (Allamandola and Norman 1978). Methane, a nonpolar molecule by symmetry, may nevertheless have pure rotational vibronic ground-state transitions resulting from vibration-rotation interactions (Fox 1971). Several of these weak lines (Fox 1972) were measured in the laboratory by various techniques (Holt et al. 1975), and molecular parameters were inferred from which accurate transition frequencies have been calculated.

The new J = 19 F2(5)-F(1) CH_4 transition at 94,088.51 MHz was observed in Orion A (α_{1950}=05^{h}32^{m}47^s.0, δ_{1950}=-05°24'21") during 1979 March 4-5; a previously detected transition at 76,700.02 MHz was observed several times between 1977 November 20 and 1979 March 4; in both cases the NRAO* 11-m telescope at Kitt Peak was used. In the latest observations the 80-120 GHz receiver was equipped with exceptionally low-noise mixer diodes (Linke et al. 1978). The new J=15 A1(1)-A2(1) transition at 21,303.45 MHz was detected on 1979 February 10 and 11 by the NRAO 43-m telescope at Greenbank equipped with a 18-26 GHz maser receiver. Details are given in Jennings and Fox (1979). At 76,700 MHz, we observed rapid (∿ hours) and slow (∿ months) variability of intensity among several velocity components in Orion A. Figure 1 shows our spectra of these temporal variations in the source.

We also observed the J=8-7 transition of HC_5N at 21,301.247 MHz in IRC+10216 (α_{1950}=9^{h}45^{m}14^s.8, δ_{1950}=13°30'40") on 1979 February 14. The detection of HC_5N in this source was reported by Winnewisser and Walmsley

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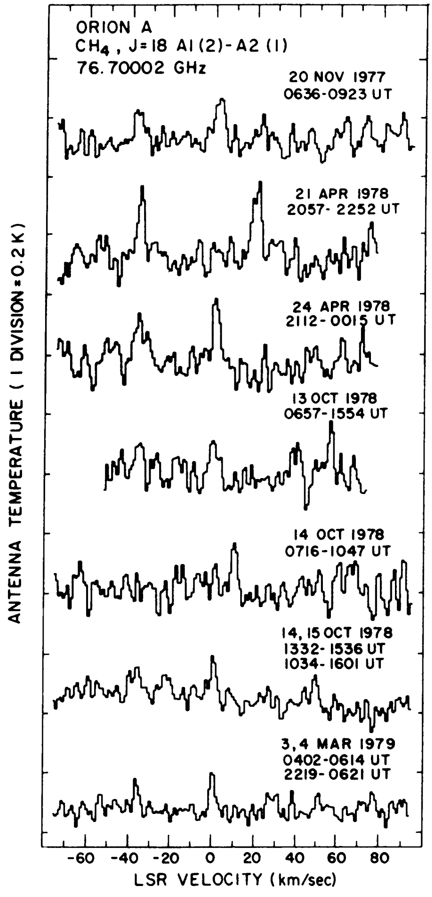

Figure 1. Temporal variations in CH_4 emission from Orion A. The resolution is 1 km s^{-1}; a two-point smoothing has been applied to all data. The spectra show emission components (never all present simultaneously) at -36, 0, +10, +19, +49 and possibly +29 km s^{-1}; the two most persistent are at -36 and 0. On 1978 April 21, the 0 component was not visible; it was replaced by a strong line at +19. Only 3 days later, the emission structure returned to the original configuration, with the 0 component strongly present and the +19 absent. On October 13, the emission was in the most common configuration of components at -36 and 0. During the first 210 min of the session on October 14, however, both seemed absent, being replaced by emission at +10. During the final 2 hours of that session, and on the following day, the -36 and 0 features returned, accompanied by one at +49. On 1979 March 3 and 4, the -36 and 0 components recurred. Our data also suggest a long-term variation. The spectra seem consistent with a compact, multi-component source, having shell-like structure centered at ∿8.5 km s^{-1}.

(1978) who observed the J=9-8 transition. Our J=8-7 emission appears as a single line, ∿7 km s^{-1} wide, and centered near -28 km s^{-1}. This structure is distinctly different from that of the J=9-8 feature which is ∿28 km s^{-1} wide and flat-topped (characteristic of optically thin emission). The reason for this structural difference is not yet clear.

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