GAS PRODUCTION RATES IN COMETS

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ABSTRACT. Emission fluxes of CN, C_2 and C_3 carbon- bearing molecular species observed in the coma of comets Bennett (1969i ≡ 1970II), West (1975n ≡ 1976VI), P/Halley (1982i), Hartley-Good (1985ℓ) and Bradfield (1987s) are analysed in the framework of Haser model. CN, C_2 and C_3 production rates are determined using recently derived fluorescence efficiencies. The dependence of CN, C_2 and C_3 production rates on the heliocentric distance and the possible correlations among these radicals is studied and briefly discussed.

INTRODUCTION

As a part of the systematic programme - Determination of Gas and Dust Production Rates in Comets (GDPC) - going on in this laboratory (Almeida et al., 1989; Almeida, 1991), the emission band fluxes of cometary CN, C_2 and C_3 carbon bearing molecular species observed in the coma of comets Bennett (1969i ≡ 1970II) (Babu and Saxena, 1972) West (1975n ≡ 1976 VI) (Sivaraman et al., 1979), P/Halley (1982i) (Goraya et al., 1989a; 1989b), Hartley-Good (1985ℓ) (Rautela et al., 1989) and Bradfield (1987s) (Rautela and Sanwal, 1988; Ojha and Joshi, 1989) are analysed. These comets are studied in the framework of the Haser model (1957) by using recently derived fluorescence efficiencies (g-factors) at $r_h = 1$ AU (Almeida et al., 1989) and appropriate numerical parameters which are known for the more prominent species CN, C_2 and C_3 (Cochran, 1985). Haser model analysis of CN, C_2 and C_3 production rates are developed for these comets and the possible logarithimic correlations among these molecular species and comets graphically analysed.

DISCUSSION

The derived CN, C_2 and C_3 production rates using recently derived fluorescence efficiencies (Almeida et al., 1989) may have a systematic error amounting to about ± 20 percent and where possible these results were compared with the ones found in the literature. Equations 1 of Almeida et al. (1989) and Konno and Wyckoff (1989), derived independently, are equivalent within this uncertainty.

In the particular case of West (1975n ≡ 1976VI) since the comet broke up in four different parts (A ⟶ D: 1976 Feb. 19.1 ± 0.2; A ⟶ B: 1976 Feb. 27.7 ± 0.2;

P. D. Singh (ed.), Astrochemistry of Cosmic Phenomena, 443–445.

A $\longrightarrow$ C: 1976 Mar. 6.5 $\pm$ 0.3 (where A is the principal fragment and B, C, D are secondary fragments (Sekanina, 1982)), the expected errors should be at least twice as much since the data used (Sivaraman et al., 1979) corresponds to observations performed after the primary nucleus (A) of the comet had splited in these four fragments close to perihelion passage (February 25.22, 1976 (UT)). Surprisingly the results for comet West (1975n $\equiv$ 1976VI) correlates very well with the ones obtained for the other four comets (see for instance Figure 2), and particularly with comet P/Halley (1982i) for CN and C_2. This might suggest that Sivaraman et al. (1979) tracked mainly the principal fragment (A) of the nucleus during their observations.

From Figures 1 to 4 one can easily conclude that as far as the global production rates are concerned it decreases for CN and C_2 and increases for C_3 with the heliocentric distance. Hartley-Good (1985 ℓ) is the comet that shows the least C_3 production rate, compared to CN and C_2 among the five comets considered in this study.

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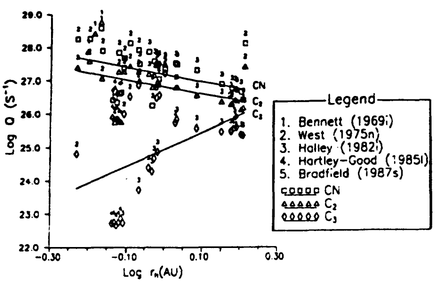

Figure 1

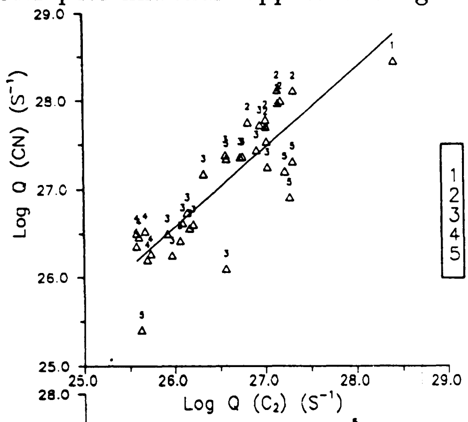

Figure 2

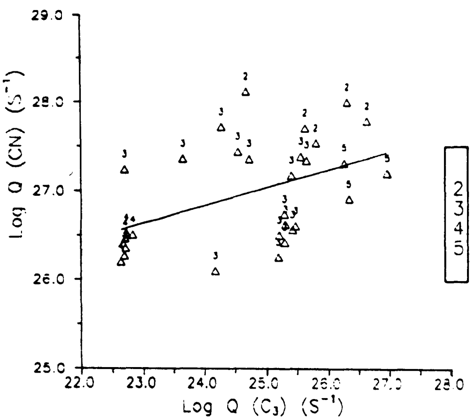

Figure 3

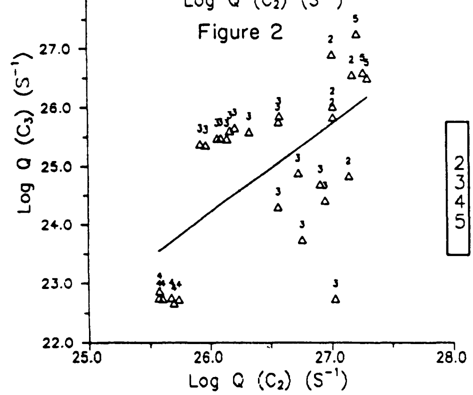

Figure 4

Figure 1 - Global production rates of CN, C_2 and C_3 molecules as a function of heliocentric distance for comets, Bennett (1969i ≡ 1970II), West (1975n ≡ 1976VI), P/Halley (1982i), Hartley-Good (1985ℓ) and Bradfield (1987s). The straight lines represent the logarithimic correlations.
Figure 2 - Logarithimic correlation between production rates of CN and C_2 molecules for comets Bennett (1969i ≡ 1970II), West (1975n ≡ 1976VI), P/Halley (1982i), Hartley-Good (1985ℓ) and Bradfield (1987s).
Figure 3 - Logarithimic correlation between production rates of CN and C_3 molecules for comets Bennett (1969i ≡ 1970II), West (1975n ≡ 1976VI), P/Halley (1982i), Hartley-Good (1958ℓ) and Bradfield (1987s).
Figure 4 - Logarithimic correlation between production rates of C_2 and C_3 molecules for comets Bennett (1969i ≡ 1970II), West (1975n ≡ 1976VI), P/Halley (1982i), Hartley-Good (1985ℓ) and Bradfield (1987s).

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