SCANNER OBSERVATIONS OF COMET BRADFIELD (1987 s)

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Abstract. Spectrophotometric observations of the head of comet Bradfield (1987 s) during three nights in 1987 are presented. An estimate of the CN, C_2 and C_3 column densities and production rates have been made.

1. Introduction

Comet Bradfield was discovered by William A. Bradfield when its magnitude was around 10. We observed the comet spectrophotometrically on six nights in 1987. The analysis for three nights have been reported earlier by Rautela and Sanwal (1988). We identified emission features due to CN, C_2, and C_3 molecules. Basic data of the comet for three nights of observations are given in Table I.

2. Observations

The comet was observed with spectrum scanner, mounted at the cassegrain focus ($f/13$) of the 104-cm telescope. A circular diaphragm of 3 mm which corresponds to 45 arc sec as projected on the sky to allow whole light from the head of the comet was used. An exit slit of 0.7 mm allowing 50 A of the spectrum to fall on the photomultiplier was used. The observing techniques and the method of reduction were the same as given by Rautela and Sanwal (1988). ξ^2 Cet was observed as the standard star. The absolute flux distribution for three nights is shown in Figure 1. The prominent emission features are due to CN ($\Delta V = 0$), C_2 ($\Delta V = +1, 0, -1$) and C_3 ($\Delta V = 0$).

After locating the continuum on the scans by selecting wavelength regions free of emission bands, we estimated the total emission band flux of the emission bands. Emission band flux relative to C_2 ($\Delta V = 0$) are listed in Table II.

TABLE I

Basic data of Comet Bradfield (1987 s)

Date 1987 U.T.	Geocentric distance Δ(AU)	Heliocentric distance r(AU)	Radius of the circular region in sky at distance 10^4 (km)
Nov. 29.559	0.876	0.960	1.43
Dec. 03.567	0.855	0.992	1.40
Dec. 05.550	0.844	1.010	1.38

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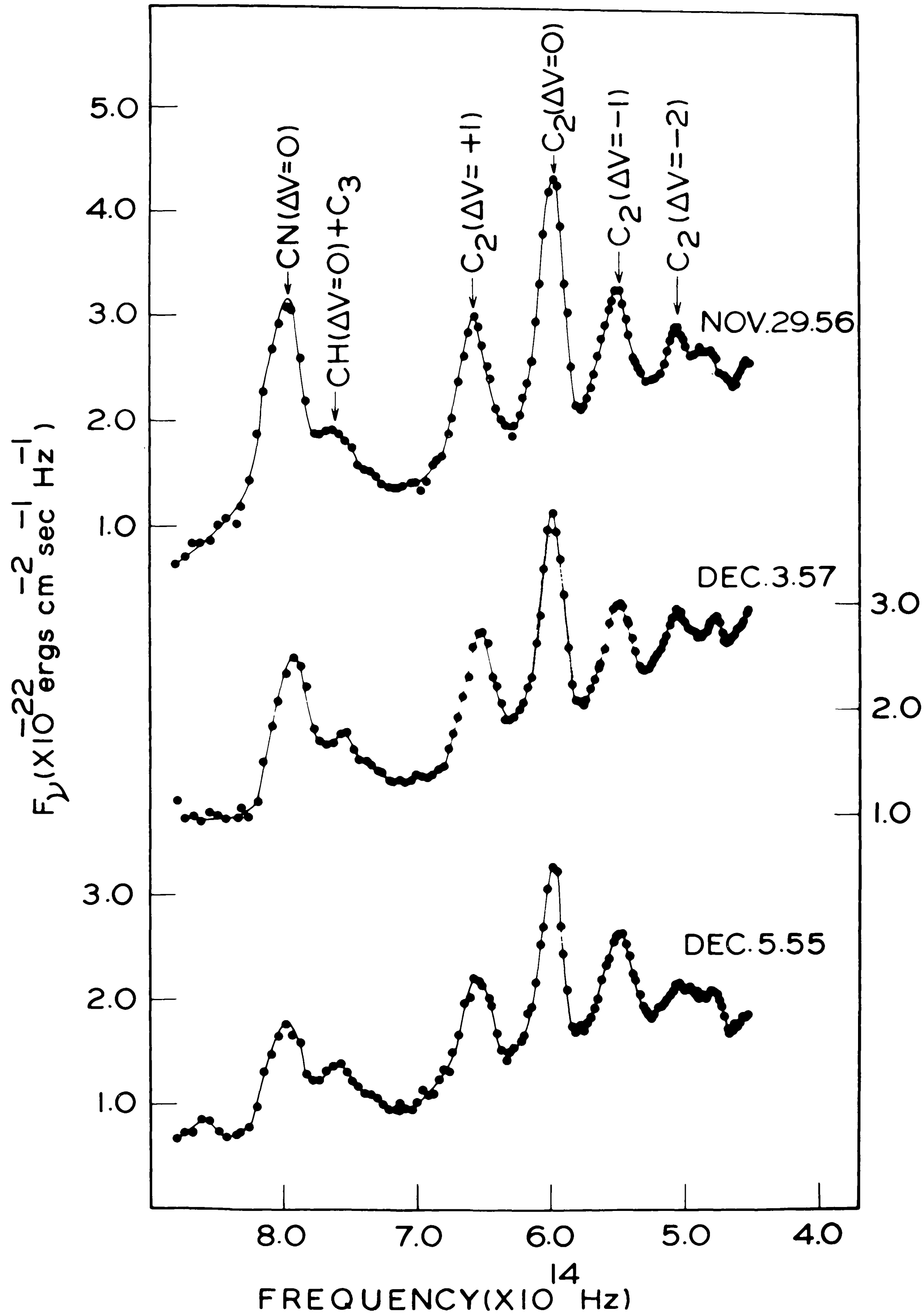

Fig. 1. Absolute flux distribution of the head of Comet Bradfield (1987 s).

TABLE II

Emission band fluxes relative to C_2 ($\Delta V = 0$)

Date 1987 (U.T.)	Apparant F ($C_2, \Delta V = 0$) ergs cm^{-2} sec$^{-1} \times 10^{-9}$	F/F ($C_2, \Delta V = 0$)			
		CN($\Delta V = 0$)	C_3($\Delta V = 0$)	C_2($\Delta V = 1$)	C_2($\Delta V = -1$)
Nov. 29.559	4.99	1.693	0.583	0.691	0.443
Dec. 03.567	4.22	1.074	0.491	0.561	0.345
Dec. 05.550	3.70	0.832	0.427	0.591	0.431

3. Column Densities and Production Rates

The number of molecules of each observed species, contained in a cylinder of radius defined by the diaphragm used and extending entirely through the coma was evaluated using the standard formula by Millis *et al.* (1982).

$$\log M(\rho) = \log F(\rho) + 27.449 + 2\log(\Delta r) - \log g\,,$$

where F is the observed flux in cgs units, r and Δ are the heliocentric and geocentric distances of the comet respectively in AU, and g the fluorescence efficiency (in cgs units) per molecule at 1 AU. We used the values of fluorescence efficiency for C_2 and C_3 from Srivaraman *et al.* (1987). Because of the Swings effect g (CN) varies significantly with the comets heliocentric radial velocity. To calculate radial velocity the orbital elements for the comet were taken from *IAU Circ.* No. 4483 and value of g was obtained from the figure of Tatum and Gillespie (1977). The column densities were then converted into production rate (Q) through the relation given by A'Hearn and Cowan (1975) as

$$M(\rho) = QV^{-1}\rho\left[\int_{x}^{\mu x} K_0 Y\,\mathrm{d}y + (1/x)(1 - 1/\mu) + K_1(\mu x) - K_1(x)\right],$$

where v = velocity of released species, μ = ratio between daughter and parent molecules scale-lengths, x = ratio between ρ and daughter molecule scale-lengths. K_0 and K_1 are modified Bessel functions of the second kind of order 0 and 1. Following Delsemme (1982) we assumed that $v = 0.58/\sqrt{r}$. The parent and daughter molecule scale-lengths were taken from Cochran (1985). Bessel functions were calculated using the tables of Abramowitz and Stegun (1964).

An arbitrary measure of the solid particle production rate was also calculated following the equations given by A'Hearn *et al.* (1979) from the equation

$$\log(Q)(\text{Solids}) = \log L(5240) + 2\log r - \log\rho\,,$$

where L is luminosity at wavelength 5240 A. The production rates and column densities thus calculated are listed in Table III.

TABLE III

Column densities (log *M*) and production rates (log *Q*)

Date 1987 UT	log (*M*)					log (*Q*)			
	$CN(\Delta V = 0)$	$C_3(\Delta V = 0)$	$C_2(\Delta V = 1)$	$C_2(\Delta V = 0)$	$C_2(\Delta V = -1)$	CN	C_2	C_3	Dust
Nov. 29.559	31.54	30.59	31.46	31.35	31.33	27.33	27.39	26.14	12.44
Dec. 03.567	31.55	30.52	31.37	31.29	31.22	27.15	27.31	26.06	12.45
Dec. 05.550	31.24	30.46	31.40	31.23	31.23	27.04	27.34	26.02	12.37

4. Conclusion

The production rates of the various observed species and dust are plotted in Figure 2 against heliocentric distance for all the six nights of observations. The straight lines have been fitted by free hand. The production rates of molecular species C_2, C_3, and CN show a systematic variation with heliocentric distance. The ratio of CN and C production rate indicates that CN is over abundant in this comet as compared to other comets. The dust production rate is almost constant at different heliocentric distances.

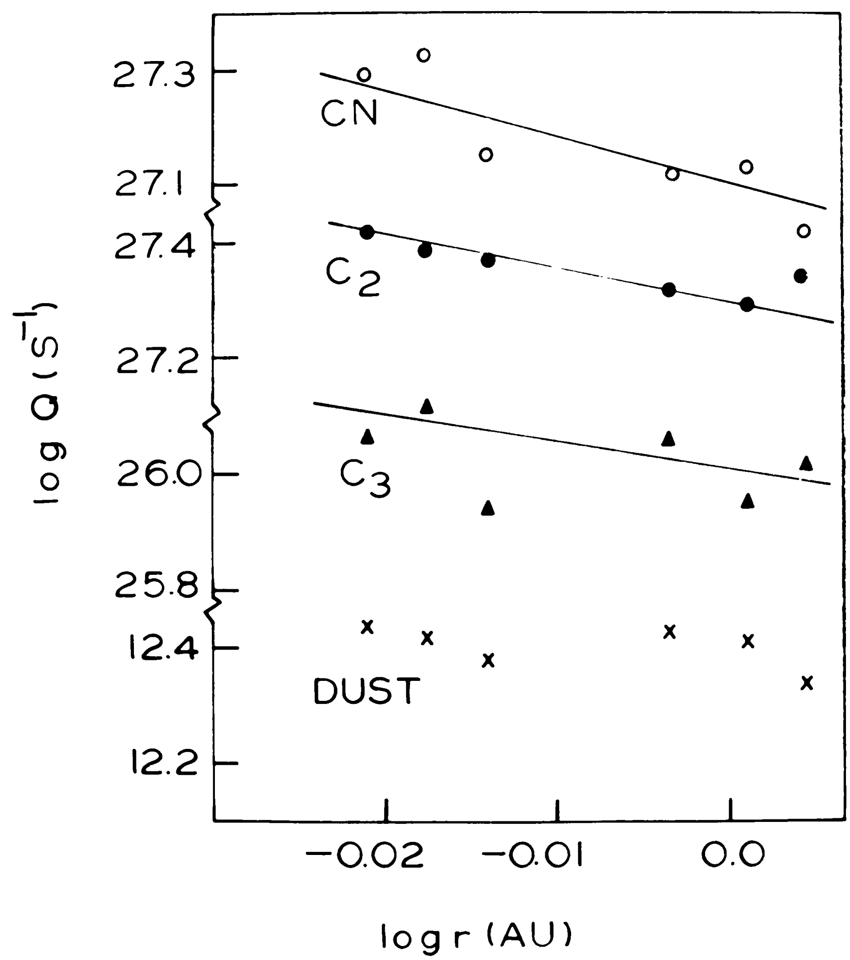

Fig. 2. The production rates of CN, C_2, C_3 molecules and dust as a function of heliocentric distance.

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