EMISSIONS FROM THE HEAD OF COMET BRADFIELD (1978c)

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Abstract. The flux distribution in the head of Comet Bradfield (1978c) during the pre-perihelion period has been obtained in the wavelength range 400–640 nm. The emission fluxes at 474 nm, 516 nm, 564 nm and 589 nm are reported. By use of the observed monochromatic brightness of the Swan band sequences, the number of C_2 molecules in the head of the comet are estimated.

1. Observations and Reduction

Spectrophotometric scans of the head of Comet Bradfield (1978c) during its pre-perihelion phase were obtained on the 52 cm, f/13 reflector of the Uttar Pradesh State Observatory on 5 and 6 March, 1978. The scanner used for this purpose consists of a monochromator with an entrance diaphragm covering 93 arc-seconds of sky in diameter and giving a dispersion of 7 nm mm^{-1} at the exit slit. The comet, as apparently seen, nearly filled the entrance diaphragm. The width of the exit slit was adjusted so as to admit 5 nm of the spectrum. A thermoelectrically cooled EMI 9658 B photomultiplier and standard d.c. recording techniques were employed.

The atmospheric conditions were good. However the comet was within 30 degrees of the sun during the observation period, resulting in large extinction and in twilight conditions. Besides affecting the accuracy of our results, this also limited the range of our spectral scans to the interval 400–640 nm.

The stars β Aql and α Lyr were observed on each night to serve, respectively, as the comparison and the standard star. After correcting for extinction by the graphical method, the observations of the comet and of α Lyr (at intervals of 2.5 nm) were normalized at 479 nm so that $m_\lambda(479) = 0^m.00$. In order to get the normalized fluxes of the comet relative to α Lyr, the differential magnitudes (comet $-$ α Lyr)$_\lambda$ were converted into intensity ratios for the wavelengths of interest. Figure 1 shows the normalized fluxes of the comet on both the dates, based on the absolute fluxes of α Lyr given by Hayes and Latham (1975). Comparison of our observations of α Lyr with the latter were also used to determine the instrumental constants.

2. Fluxes and Luminosities of Emission Features

In Figure 1, the emission features of the (1–0), (0–0) and (0–1) Swan band sequences of C_2 and that of Na have been identified. After locating the continuum on the spectrum scans (following Swings and Haser, 1956) the areas of the emission band profiles

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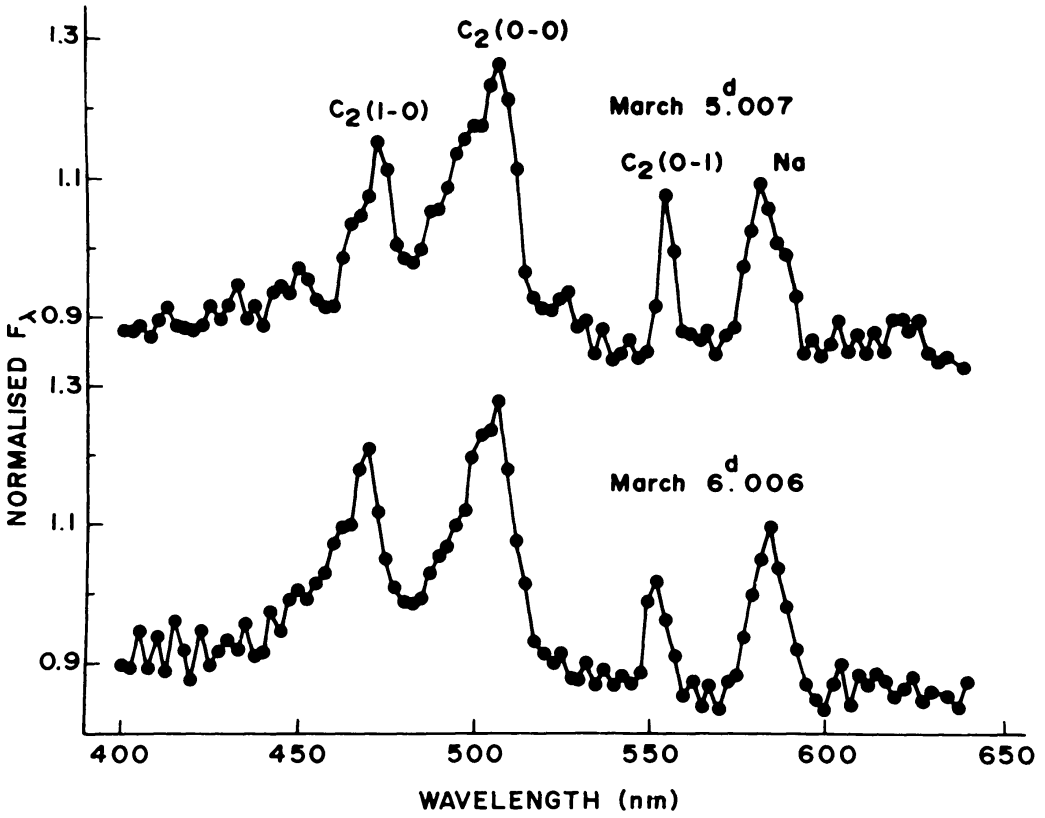

Fig. 1. Flux distributions in the head of Comet Bradfield (1978c) normalized to 479 nm.

were planimetered. These areas, which are identified with the total band intensity of the related band are given in Table I relative to that of the C_2 band at 516 nm, along with some other relevant data. The total energies, L, in the C_2 band at 516 nm streaming out of the head of the comet along with the observed fluxes are also given in the table.

An inspection of Figure 1 reveals that the fluxes of Swan band emissions are nearly the same on both dates while the flux of Na emission increased by some 15% within a day, with decreasing heliocentric distance. This behaviour of Na emission in this

TABLE I

Relative fluxes of emission features in the head of Comet Bradfield (1978c)

Date March 1978 (U.T.)	Δ in AU	r in AU	$F(C_2, \Delta V = 0)$ at 516 nm (ergs cm^{-2} s^{-1}) in units of 10^{-9}	$F/F(C_2, \Delta V = 0)$			$L(C_2, \Delta V = 0)$ (ergs s^{-1}) in units of 10^{19}
				C_2 (1–0) 474 nm	C_2 (0–1) 564 nm	Na 589 nm	
5.01	1.167	0.549	10.465	0.302	0.167	0.480	4.031
6.01	1.170	0.539	10.466	0.305	0.170	0.553	4.047

comet is similar to that of Comet Kohoutek (1973f) (Babu, 1974), Comet West (1975n) (Chaubey, 1978) but is different from the behaviour of Comet Bennett (1969i) (Babu and Saxena, 1972).

3. Number of C_2 Molecules

In order to calculate the number of molecules in the head of Comet Bradfield (1978c), we used the formulation (Wurm, 1943)

$$N = \frac{Lm_e}{\pi e^2 f p \varrho(\nu, r)},$$

where

L = the luminosity of respective band;
m_e = the mass of an electron;
p = the vibrational transition probability;
f = the oscillator strength; and
$\varrho(\nu, r)$ = the solar radiation density at frequency ν, at a heliocentric distance r.

The number of C_2 molecules in a linear diameter of 3.94×10^4 km across the comet head estimated by us at the mean $r = 0.543$ AU are listed in Table II along with the molecular constants.

In Table II, the f values have been calculated using the recent values of electronic transition moments of the C_2 Swan bands given by Cooper and Nicholls (1975). The p values are taken from Spindler (1965) and $\varrho(\nu, r)$ is estimated from the solar flux data listed by Vernazza *et al.* (1976).

The apparent agreement between the values of $N(C_2)$ as derived from the Swan band sequences is better than is to be expected in the light of uncertainties in the molecular constants and in the method of analysis used. The number of C_2 molecules in this comet is comparable to that estimated by Arpigny (1965) for Comet Mrkos (1957d) and Comet Cunningham (1940c).

TABLE II

Number of C_2 molecules

Band	f	p	$\varrho(\nu, r)$ (W cm^{-2} μm^{-1})	log N
C_2 (1–0) 474 nm	0.0089	0.2409	0.1936	32.542
C_2 (0–0) 516 nm	0.0243	0.7335	0.1881	32.601
C_2 (0–1) 516 nm	0.0071	0.2142	0.1852	32.563

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