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Spectrophotometric study of comet C/1996 B2 Hyakutake

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Abstract. The spectrophotometric observations of Comet C/1996 B2 Hyakutake were taken on six nights at its closest approach (March 23-April 09, 1996), with 104 cm telescope of the NainiTal Observatory, using EG & G Spectrograph coupled with Optical Multi Channel Analyser and Reticon Array Detector. The molecular emission bands of CN at 3888 Å, and C2 (Δv= +1, 0, -1) at 4690 Å, 5160 Å, and 5530 Å respectively, were detected. Column densities and production rates at different heliocentric and geocentric distances were also determined.

1. Introduction

Comet C/1996 B2 Hyakutake was discovered by the Japanese amateur Yuji Hyakutake on Jan. 30, 1996 (James, 1996).

This comet came within 0.11 A.U. (15 million km) of the earth on 24th March 1996 and closest to the Sun on May 2, 1996 (0.231 A.U.) This was the closest approach by any comet since 1983.

Keeping in view the scientific importance of observing the comets as rare events we took spectrophotometric observations on six nights of March and April, 1996 at low dispersion, and production rates for CN and C_2 molecules were determined.

2. Observations and reduction

Comet C/1996 B2 Hyakutake was observed on six nights of March and April, 1996 (March 23, 24, 30, 31 and April 8 and 9) using EG & G Spectrograph with an optical multi channel analyser (OMA) mounted at the Cassegrain focus of the 104-cm telescope of U.P. State Observatory, NainiTal. This spectrograph gives a dispersion of 2.5 Å/pixel. The complete instrumental details are given in our earlier paper (Sanwal et al. 1994).

Many spectral scans (at least 3) of the comet were taken on each observing night. Along with the comet, standard star α Leo was also observed for determining the nightly extinction coefficients and to find out absolute flux of the comet. A plot of absolute flux against wavelength is shown in Fig. 1. The geocentric distance (Δ) and the heliocentric distance (r) of the comet on different observing nights are given in Table 1.

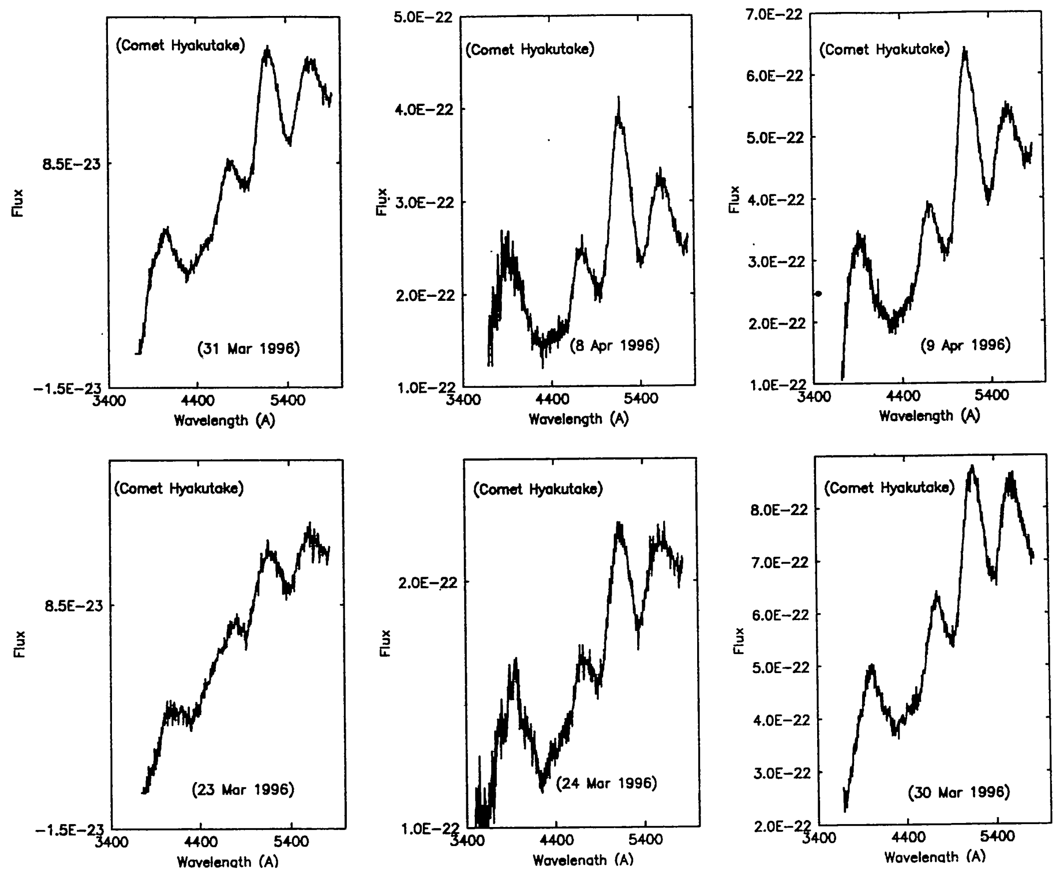

Table 1. Emission bands column densities and production rates for molecules and solid particles.

Date	Δ(AU)	r(AU)	species	log(M)	log(Q)	logQ(solid)
Mar 23, 96	0.127	1.090	CN	29.035	24.575	10.08
			C_2	29.161	25.252	10.08
Mar 24, 96	0.111	1.069	CN	29.355	24.981	10.422
			C_2	29.225	25.063	10.422
Mar 30, 96	0.185	0.942	CN	30.247	25.604	11.02
			C_2	30.216	25.812	11.02
Mar 31, 96	0.214	0.920	CN	29.614	24.850	9.961
			C_2	29.570	25.008	9.961
Apr 8, 96	0.462	0.738	CN	30.515	25.480	10.805
			C_2	30.500	25.696	10.805
Apr 9, 96	0.494	0.715	CN	30.671	25.612	10.888
			C_2	30.720	25.888	10.888

3. Molecular emission bands

The prominent emission bands of CN at 3888 Å, and C2 (Δv= +1, 0, -1) at 4690 Å, 5160 Å, and 5530 Å, are shown in Fig. 1. For determining the column densities and production rates, area under the emission bands were measured.

4. Column densities and production rates

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

$$log\ M(\rho) = log\ F\ (\rho) + 27.479 + 2log\ (\Delta r) - log$$

where F is the observed flux in cgs units, r and (Δ) are the heliocentric and geocentric distances of the comet in astronomical units and g the fluorescence efficiency (in cgs units) per molecule at 1 A.U.

The column densities determined using the above formula (Millis et al. 1982) were then applied in the formula given below (A'Hearn and Cowan, 1975) to determine the production rates for CN and C_2.

$$\mathrm{M}\ (\rho) = QV^{-1}\left[\int_x^{\mu x} K_0\ (y)dy + (\frac{1}{x})(1 - \frac{1}{\mu}) + K_1\ (\mu x) - K_1\ (x)\ \right],$$

where v= velocity of released species, μ= ratio between daughter and parent molecule scale length, 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 v = 0.58/ $\sqrt{r}$. The parent and daughter molecule scale length were taken from Cochran (1985). Bessels functions were determined using the table of Abramowicz and Stegun (1964). The estimated column densities and production rates for CN and C_2 (average of C_2, Δv= +1, 0, -1 bands) molecules at different heliocentric and geocentric distances are given in Table 1.

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

$$log(Q)\ (solids) = log(L)\ \lambda + 2logr - log\ \rho$$

where L is the luminosity at wavelength λ. The production rates determined for solid particles are also given in Table 1. The column densities and production rates are generally increasing with decreasing the heliocentric distance.

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