MOLECULAR EMISSION FROM THE HEAD OF COMET OKAZAKI–LEVY–RUDENKO (1989*r*)

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Abstract. Spectrophotometric scans of the head of Comet Okazaki–Levy–Rudenko during three nights in October 1989 are presented. An estimate of the CN and C_2 production rates and column densities have been made.

1. Introduction

Kiyomi Okazaki discovered this comet photographically using a 0.25 m Schmidt camera, when its magnitude was 13, on August 24.50243 UT. This comet was also discovered independently by David Levy and Michael Rudenko on August 25.21 UT when the magnitude was 10.6. At the time of discovery by Okazaki the comet was as a diffuse object with central condensation and no tail. Lynch and Russell (1989) obtained infrared circular-variable-filter wheel spectroscopy and filter photometry of the comet during November 5–8, 1989, using NASA Infrared Telescope Facility with 9.5″ aperture. The comet showed a strong structureless 10 μm silicate emission feature extending about 20 per cent above continuum. A colour temperature was about 10 per cent above the equilibrium temperature of 345 K. Between Nov. 5 and 8, the 10 μm brightness increased by roughly a factor of 2. Total visual magnitude estimates were made by many people on various dates. Luu and Jewitt (1989) reported the submillimeter continuum detection of the comet during Nov. 18–24. This is believed to be first dynamically new comet to be detected in the submillimeter range. The detected flux densities varied with time. The flux densities imply a mass of the order 10^8 kg contributed by millimeter sized and larger particles.

We observed the comet on Oct. 16, 17 and 20, 1989, spectrophotometrically to detect the emission features due to various molecules and to make an estimate of the abundance and production rates of the observed species.

2. Observations

The comet was observed with a spectrum scanner, mounted at the Cassegrain focus (f/13) of the 104-cm reflector. A circular diaphragm corresponding to 45 arc sec centered on the nucleus of the comet was used. The scanner consists of a Hilger and Watts monochromator giving a dispersion of 70 A/mm in first order. The exit slit width 0.7 mm, allowing 50 A of the spectrum to fall on the detector,

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TABLE I

Basic data of comet Okazaki–Levy–Rudenko (1989*r*)

Data 1989 UT	Geocentric distance Δ (AU)	Heliocentric distance r (AU)	Radius of the circular region in sky 10^4 (km)
Oct. 16.551	1.295	0.846	2.11
Oct. 17.517	1.281	0.834	2.09
Oct. 20.545	1.238	0.795	2.02

was used. The detector was a cooled (−20 °C) EMI 9658B photomultiplier. Standard d.c. techniques were used for recording. Scans of sky taken before and after each scan of comet were used to eliminate the contribution by the sky background.

The standard star α Lyr was observed on each night to check the wavelength calibration of the scanner and to standardize the observations of the comet. The observations were also corrected for atmospheric extinction and were reduced to absolute values. The absolute values of the fluxes thus obtained correspond to Taylor's (1984) calibration of α Lyr. The absolute flux distribution of the comet for three nights is shown in Figure 1. The emission features due to CN at 388.3 nm, C_2 ($\Delta V = 0, 1, -1$) at 469.5, 516.5 and 553.8 nm respectively are prominent. The heliocentric distance of the comet during our observations were more than 0.795 AU and sodium emission was not detected at this distance.

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

3. Column Densities and Production Rates

In our earlier paper (Rautela and Sanwal, 1988) we have given the detailed procedure for the calculations of column densities and production rates of various species. We adopted the formula by Millis *et al.* (1982) to estimate 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. The column densities thus estimated were converted into production rates through the relation given by A'Hearn and Cowen (1975). The column densities and production rates estimated for the comet Okazaki–Levy–Rudenko are listed in Table III for the days of our observations. We used the values of fluorescence efficiency for C_2 from Sivaraman *et al.* (1987). Fluorescence efficiency of CN varies significantly with the comets heliocentric radial velocity. To calculate radial velocity at different heliocentric distances, the orbital elements for the comet were taken from IAU Cir. No. 4918. Values of fluorescence efficiency for CN were then obtained from the figure of Tatum and Gillespie (1977). Though the comet was observed for a small range of heliocentric distance still it shows that the production rates of the molecular species increase as the comet approaches the Sun.

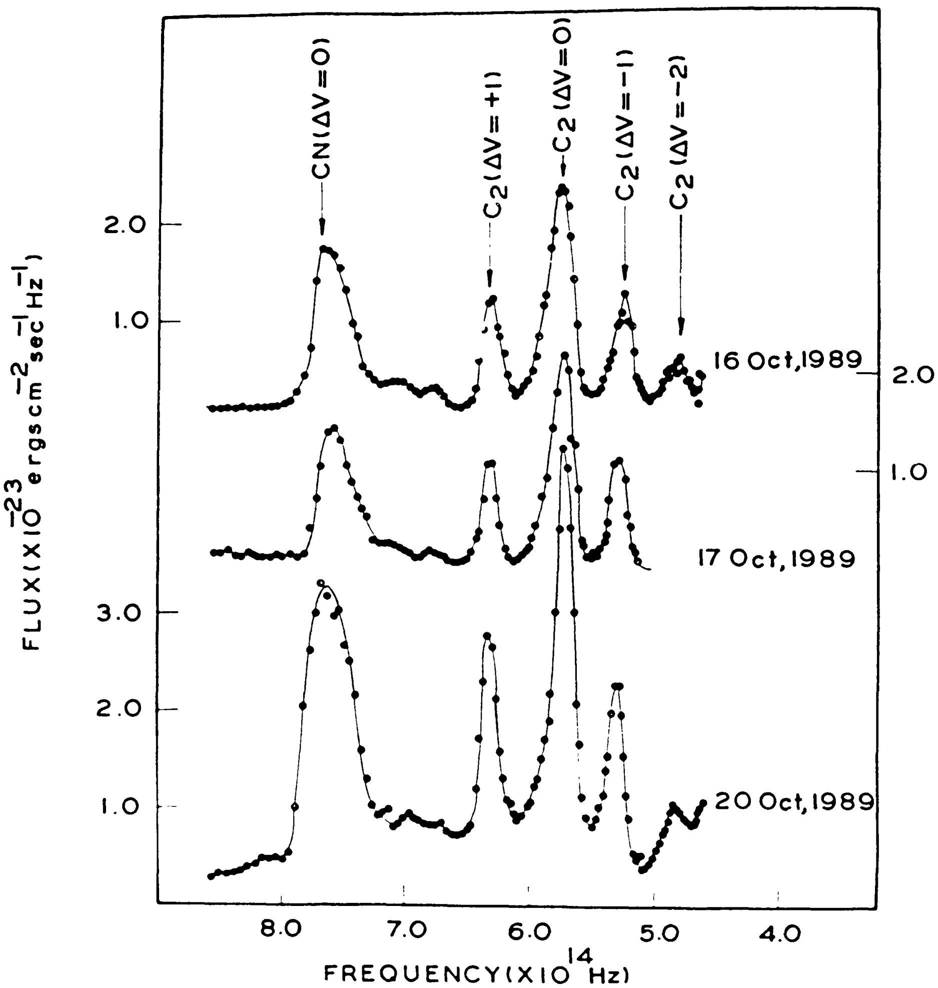

Fig. 1. Absolute flux distribution of the head of comet Okazaki–Levy–Rudenko (1989*r*).

TABLE II

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

Date 1989 UT	Apparent f (C_2, $\Delta V = 0$) ergs cm^{-2} sec^{-1} $\times 10^{-10}$	F/F CN ($\Delta V = 0$)	(C_2, $\Delta V = 0$) C_2 ($\Delta V = 0$)	C_2 ($\Delta V = -1$)
Oct. 16.551	5.125	1.192	0.371	0.354
Oct. 17.517	4.990	1.015	0.365	0.360
Oct. 20.545	7.105	1.710	0.449	0.325

TABLE III

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

Date 1989 UT	log M CN ($\Delta V = 0$)	C_2 ($\Delta V = 1$)	C_2 ($\Delta V = 0$)	C_2 ($\Delta V = -1$)	log Q CN	C_2
Oct. 16.551	30.61	30.43	30.59	30.47	26.19	26.29
Oct. 17.517	30.51	30.38	30.56	30.44	26.10	26.27
Oct. 20.545	30.81	30.56	30.64	30.40	26.43	26.40

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