Spectroscopic Studies of a few Molecular Bands in Comets

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Abstract Spectroscopic studies of comets were started at ARIES way back (some 35 years ago) and in this programme spectrophotometric observations of several comets were taken. The prominent emission features of CN ($\Delta v = 0$) at 3883Å, C_2 ($\Delta v = +1, 0, -1$) at 4695, 5165 and 5538Å were detected. Weak emission features due to CH + C_3 at 4050 Å and C_2 ($\Delta v = -2$) at 6190 A were also detected. Emission feature of NaD at 5890 Å were also occasionally observed. In this paper dust and gas production rates for the emission features of CN ($\Delta v = 0$) at 3883 Å, C_2 ($\Delta v = +1, 0, -1$) at 4695, 5165 and 5538 Å at different heliocentric and geocentric distances are presented.

Keywords: Comet, spectrophotometry, column densities and production rates
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INTRODUCTION

Comets are one of the most fascinating and exciting objects as they are unpredictable. They can suddenly brighten or fade, can lose their tails or develop multiple tails. Some of the comets can even fragment into several pieces under the influence of tidal forces of our solar system. A group of astronomers believe that early collisions between the earth and the comets brought vast amount of water that has made the oceans. The oceans enabled life on the earth. Mass extinction of different life-forms may have also been caused by a comet and earth collision. Comet nuclei are the frozen reservoirs of dust and ice from early solar nebula. A reasonable working model for the nucleus which is an icy-conglomerate model was first proposed by Whipple in the 1950's. In this model the nucleus was believed to be a discrete rotating body consisting of frozen water, complex molecules formed out of abundant elements H, C, N, O and dust. After the spacecraft Giotto [1] photographed the nucleus of Halley's Comet in 1986, it is now known that a comet nucleus has a surface that is best described as a black crust. This black crust helps the comet in absorbing heat, which in turn causes some of the ice under the crust to turn to gas, building pressure beneath the crust. When the comet is far off from the Sun, the continuum spectrum seen is simply that of reflected sunlight. When it approaches the Sun, the gas, mostly made of complex molecules and dust are released from the nucleus due to solar heating which later on makes coma and tails (dust and gas plasma) which extends to several million kms. Of all solar system bodies, comets suffered the least post-formation alteration in

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their composition. So they are the best objects to study; the primitive matter involved in the origin of the solar system, material that has been stored in deep freeze for around 4.5 billion years.

The LINEAR (Lincon Near Earth Asteroid Research) and the NEAT (Near Earth Asteroid Tracking) programme discover a large number of comets every year. Some of them become observable from the ground based telescopes. There are several space mission programmes for making comets observations. Every comet is unique and travels through unique path in the solar system. Therefore, extensive observations of every comet in all possible modes of observations in whole electromagnetic wave range are significant.

OBSERVATIONS AND DATA ANALYSIS

The spectrophotometric observations in the wavelength region 3500-6500 Å for the comets Bennett (1972), West (1975n), Bradfield (1978c), Bradfield (1979I), Bradfield (1980t), Austin (1982g), Encke (1984), Kohoutek (1973f), P/Crommelin (1818I) Wilson (1986I), Bradfield (1987s), P/Halley (1986), Okzaki-Levy-Rudenko (1989r), Austin (1989C1), Levy (1990c), Swift-Tuttle (1992t), Hyakutake (C/1996B2), Hale-Bopp (C/1995 O1), LINEAR (C/2000 WM1), Ikeya- Zhang (C/2002 C1) and NEAT (C/2001 Q4) over time from 1972-2004 were acquired with different instrumental setups like monochromator, OMA (Optical Multi-channel Analyzer) with Reticon Array as detector and HR 320 spectrograph with CCD camera as detector. The prominent emission bands mostly detected was of CN ($\Delta v = 0$) at 3883 Å, C_2 ($\Delta v = +1, 0, -1$) at 4695, 5165 and 5538Å. Generally C_3+CH (4050 Å) bands are blended with CN 3883 Å due to poor resolution of observations. The dispersion of spectra was 50-100 Å/mm. Each comet was observed for 4-5 nights on average at the perihelion distance. Most of the observations were made with the 104 cm reflecting telescope of the ARIES, Nainital at its Cassegrain focus (focal ratio: f/13). The observational procedure and to measure fluxes in these emission bands and to calculate the column densities and production rates for dust and gases are given in our recent paper Singh et. al. [2] and references therein. Figure 1 shows a plot between geocentric distance (distance of comets from the earth) and heliocentric distance (distance of comets from the Sun) against the production rates. The upper panel represents dust and the lower panel represents gases. Different symbols represent different molecular species. Most of the observations have been taken at the perihelion distance of around 0.4-1.4 AU heliocentric distance when the molecular bands due to CN and C_2 (Swan) are very strong. An enhancement of about one order in the production rate is noticed at around 0.9 to 1.1 AU heliocentric distance. The gas and dust production rates depend on the intrinsic constitution of individual comets and its heliocentric distance.

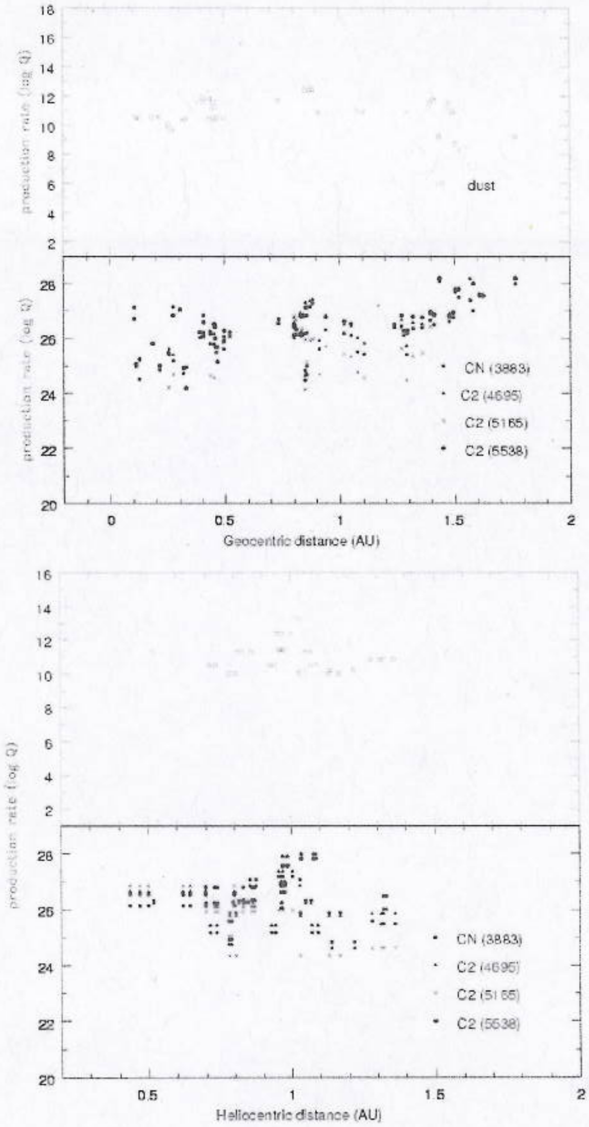

FIGURE 1: Variation of production rates for gas and dust against geocentric distances (top) and heliocentric distances (bottom).

REFERENCES

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