SPATIAL DISTRIBUTION OF MOLECULES AND DUST WITHIN THE COMA OF COMET HALLEY

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ABSTRACT

We have made spectral scans of Comet Halley at high spatial resolution using the scanner at the Cassegrain focus (f/13) of the 102 cm reflector at Kavalur. The scans cover generally the wavelength region from 3900 to 6200A and are at 40A resolution and on a few occasions in the blue region at 20A resolution. The f/13 beam provided an image of the coma with a scale of 15.5 arc sec mm^{-1}. We have obtained scans on several consecutive nights in March 1986 with a 25.9 arc sec entrance aperture of the scanner at discrete and systematically displaced locations within the coma both in the direction of the tail as well as normal to it about the position of the nucleus. The spatial gradients of the distribution of the different molecular species and dust have been derived from the brightness profiles.

Keywords: Spectrophotometry of Comet Halley, Spatial Distribution of Gas and Dust.

1. INTRODUCTION

The inner structure of the coma in terms of the neutral molecules and the dust can be derived from the emission profiles obtained at high spatial resolution. One of the earlier attempts in this direction was on Comet West (Bappu et al. 1980) when high spatial resolution profiles were obtained, that brought out many interesting features about the band emission as well as the continuum. Here, we report the emission profiles in the emission bands of C_3, $C_2(1,0)$, $C_2(0,0)$, $C_2(0,1)$ and the continuum at 4860A derived from the spectrophotometric observations which formed a part of an intensive programme of observations carried out on Comet Halley using the telescopes at the Vainu Bappu Observatory, Kavalur, of the Indian Institute of Astrophysics.

2. OBSERVATIONS

We describe here only a part of our spectrophotometric observations on Comet Halley and the results derived from them. These observations obtained on the nights of March 21, 23, 28, 29, 30, 31 and April 12 of 1986, consist of spectral scans with an automated spectrum scanner at the f/13 Cassegrain focus of the 102 cm reflector. The scanner used a thermoelectrically water cooled RCA C31034 tube in the pulse counting mode. The entrance aperture of the scanner was a circular diaphragm 25.9 arc sec diameter that isolated different parts of the coma of the comet. The exit slot of the scanner had a band pass of 40A in the first order, and with this, scans were obtained on the comet from 3900 to 6200A. The telescope has an image scale of 15.5 arc sec mm^{-1} at the Cassegrain focus. This large scale enabled us to sample different regions within the coma on these nights using the 25.9 arc sec diaphragm. On 5 nights we systematically displaced the diaphragm to locations along the tail direction and on the remaining 2 nights the displacements were to locations approximately normal to the radius vector in addition to one position along the direction of the tail and another towards the sun. One of the positions every night was centred around the nucleus, so that all measurements of each night could be referred to this position. These positions are schematically represented in Fig.1. We have been able to go out in the direction of the tail as much as 2 arc min from the nucleus. For each of the locations of the diaphragm, we made the spectral scans. Scans of the neighbouring sky taken before or after each scan on the comet or standard star enabled elimination of the contribution of the background sky. The extinction coefficients and the system calibration were computed from observations made every night of the standard star 109 virginis. The scans were then converted into absolute flux (F_λ). The plot of F_λ vs wavelength for each location of the diaphragm within the coma show the emission bands of $C_3(4050)$, CH + CN(0,1), $C_2(1,0)$, $C_2(0,0)$, $C_2(0,1)$ and $C_2(2,4)$ very well. We have evaluated from these spectral energy curves the flux in the emission bands of C_3, $C_2(1,0)$, $C_2(0,0)$ and $C_2(0,1)$ above the continuum for each of these scans and also the continuum flux at 4860A.

3. EMISSION PROFILES AND GRADIENTS

For every night, for each of these emissions we have plotted the emission flux versus ρ, where ρ is the distance in arc sec of the centre of the diaphragm corresponding to the different locations within the coma with nucleus as the reference. These plots give the emission profiles and we have derived the emission gradients from them assuming

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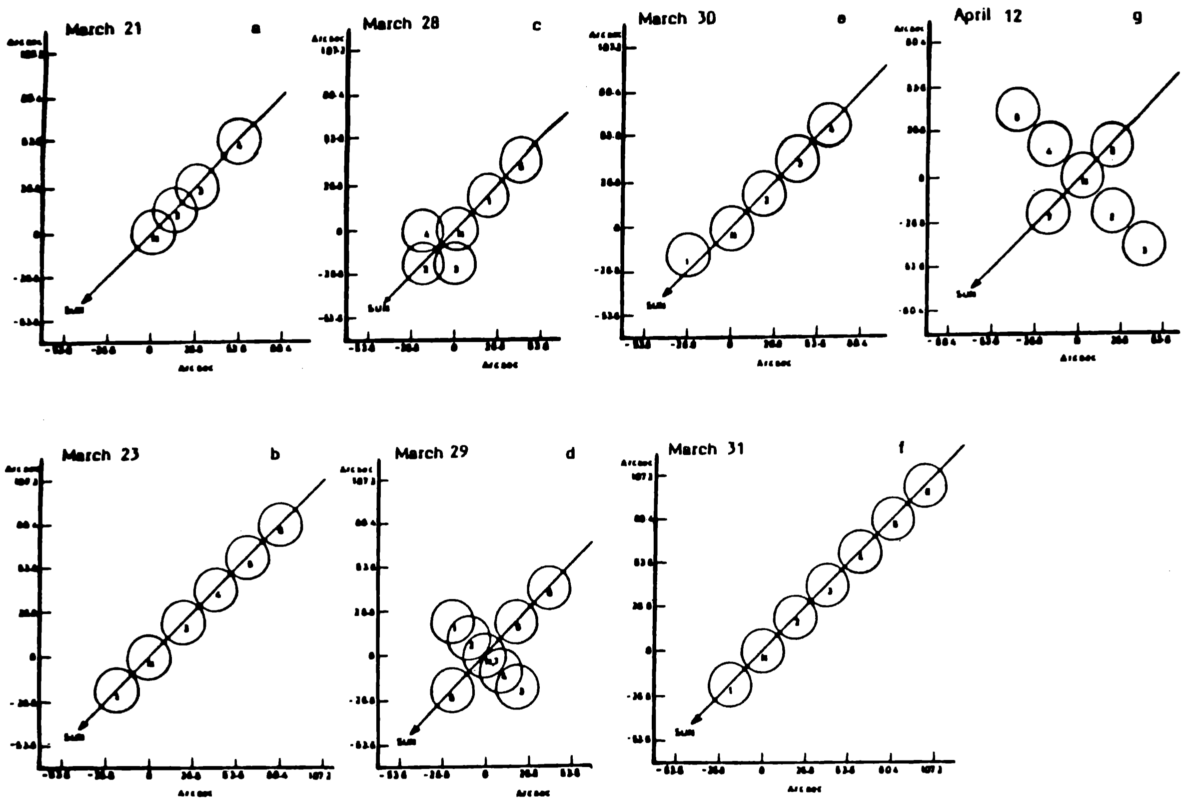

Fig. 1(a-g): The circles represent the locations of the 26 arc circular entrance diaphragm within the coma of Comet. N represents the nucleus and the 1, 2, 3, ... are the different locations of the diaphragm. The X and Y axis are marked in seconds of arc with the nucleus as the origin.

that the profiles can be represented in the form $F_\lambda = F_o \rho^{-n}$. The values of the index 'n' for the emissions and the continuum along the radius vector and normal to it show differences. The gradients are generally very steep for the C_3(4050A) emission with a mean value of n = -0.6 in the direction of the tail as well as normal to it, showing that the coma is rather symmetrical. The gradients for the C_2(1,0), C_2(0,0) and C_2(0,1) along the radius vector are much less steep with a value n = -0.3 along the radius vector. This low value of n shows the large extension of the coma at these wavelengths. In the normal direction, on April 12 the value of n is less by almost 50% of that in the direction of the radius vector showing the asymmetry in the shape of the coma. The continuum shows a mean value of n = -0.4 along the radius vector and n = -0.7 normal to it, most probably caused by the presence of dust jets in the anti sunward direction. The cometary images obtained by us with the Schmidt telescope at Kavalur which cover these periods very well, show that the dust output has been changing fast. The different values of 'n' for the continuum profiles most probably reflect these changes. The work relating the continuum gradients with these images quantitatively is in progress and will be reported in a subsequent paper.

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REFERENCE

Bappu, M.K.V; Parthasarathy, M; Sivaraman, K.R. and Babu, G.S.D.: 1980, Monthly Notices Roy. Astron. Soc. **192**, 641.