A HIGH-VELOCITY COMPONENT OF ATOMIC HYDROGEN IN COMET BENNETT (1970 II)

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The Lyman alpha emission from Comet Bennett (1970II) was measured near perihelion (March 1970) by the University of Colorado ultraviolet photometer experiment on OGO-5. The spectrometer field of view of about 3° crossed the cometary hydrogen coma four times. The hydrogen coma was observed to extend more than 30 x 10^6 km in the antisolar direction.

A model for the hydrogen density was developed which took the actual cometary motion and the gradients of the forces of gravitation and radiation pressure into account. Exact trajectories of atoms in the orbital plane representing the column densities perpendicular to the plane were calculated. The variation of the hydrogen lifetime along the trajectory as well as the solar Lα profile were considered. The strong curvature of the hydrogen cloud in the orbital plane of the comet was used to determine the solar Lα flux independent of instrumental calibration. Figure 1 illustrates the observational geometry and the calculated Lα isophotes. In general, the values for the cometary hydrogen parameters: production rate, outflow velocity and lifetime, determined from different satellite observations (Keller, 1973a,b; Bertaux _et al_., 1973) based on Haser's (1966)

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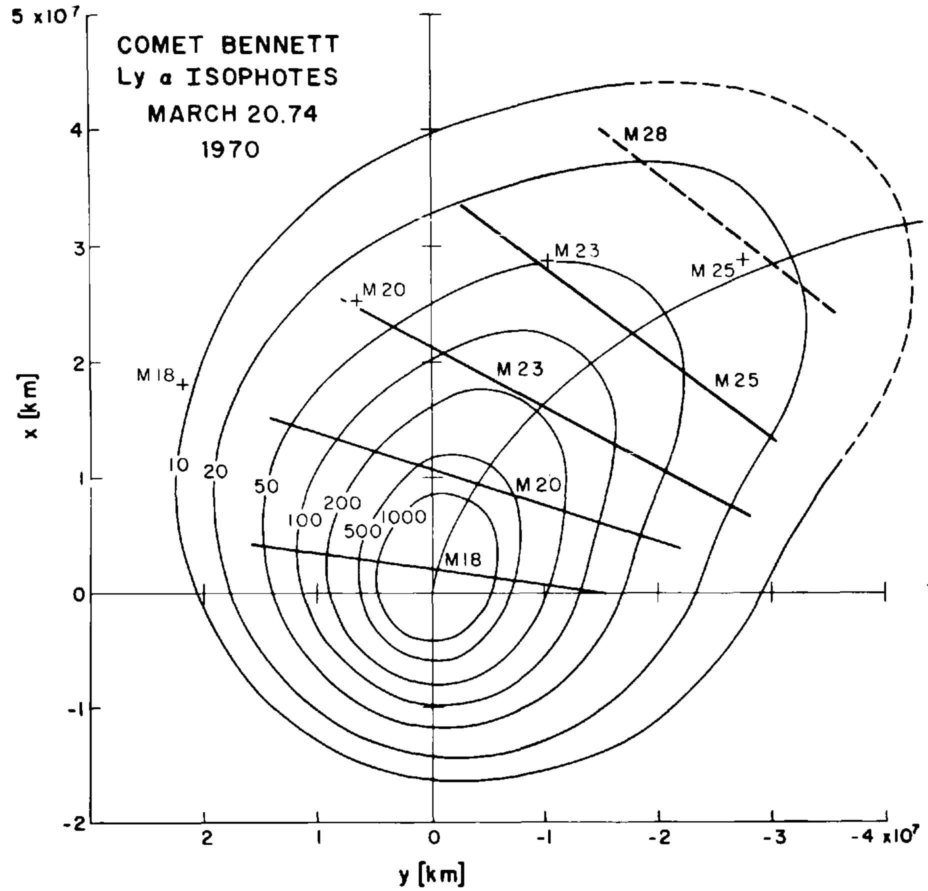

Figure 1. Lα isophote map of a model calculation for 20.74 March. The x coordinate points in antisolar and the y coordinate in the direction of the cometary motion. x and y lie in the orbital plane of the comet. The cometary nucleus is located at the origin. Two velocity components, $v_H = 7$ and 21 km s^{-1}, $F_o = 5 \times 10^{11}$ ph s^{-1} cm^{-2} A^{-1} and $t_H = 1.3 \times 10^6$ s are used. The isophotes are labeled with relative apparent emission rates. 10 corresponds to 8.86 R for $Q = 5.9 \times 10^{29}$ H atom s^{-1} at 1 a.u. ($n = 2$). Heavy lines are scans of the OGO-5 University of Colorado photometer at their particular geometrical position depending on the observational date (M28 dashed). The crosses (+) are defined by the x and y coordinates of the earth at the times when the maximum intensities were observed. The curved line is the syndyname.

fountain model were confirmed by this investigation A significant discrepancy of the model calculations using the established outflow velocity of about 8 km s^{-1} with the observations was detectable at the wings of the field of view tracks, i.e., on the outermost parts of the hydrogen coma; especially on the leading edge (Fig 2) An additional high velocity component of about 20 km s^{-1} was necessary to fit the data Under the assumption of a radial maxwellian velocity distribution a best fit was found using a 50:50 mixture of hydrogen atoms with mean outflow velocities of 7 and 21 km s^{-1}. Figure 2 illustrates very well how difficult the detection of this high velocity component is. Both of the computed profiles agree closely in the inner part of the hydrogen coma. The low velocity component masks the high velocity portion. The subsolar parts of the coma would be much more sensitive to the value of the outflow velocity.

The hydrogen atoms are created with non-thermal velocities stemming from the excess energies of the dissociation processes. The region where collisions are important around the nucleus is smaller than the hydrogen source region (Keller, 1973b). Hence, we cannot expect the hydrogen atoms to be thermalized. The high velocity component of about 20 km s^{-1} might well be directly connected with such a dissociation process. The first dissociation of H_2O, for

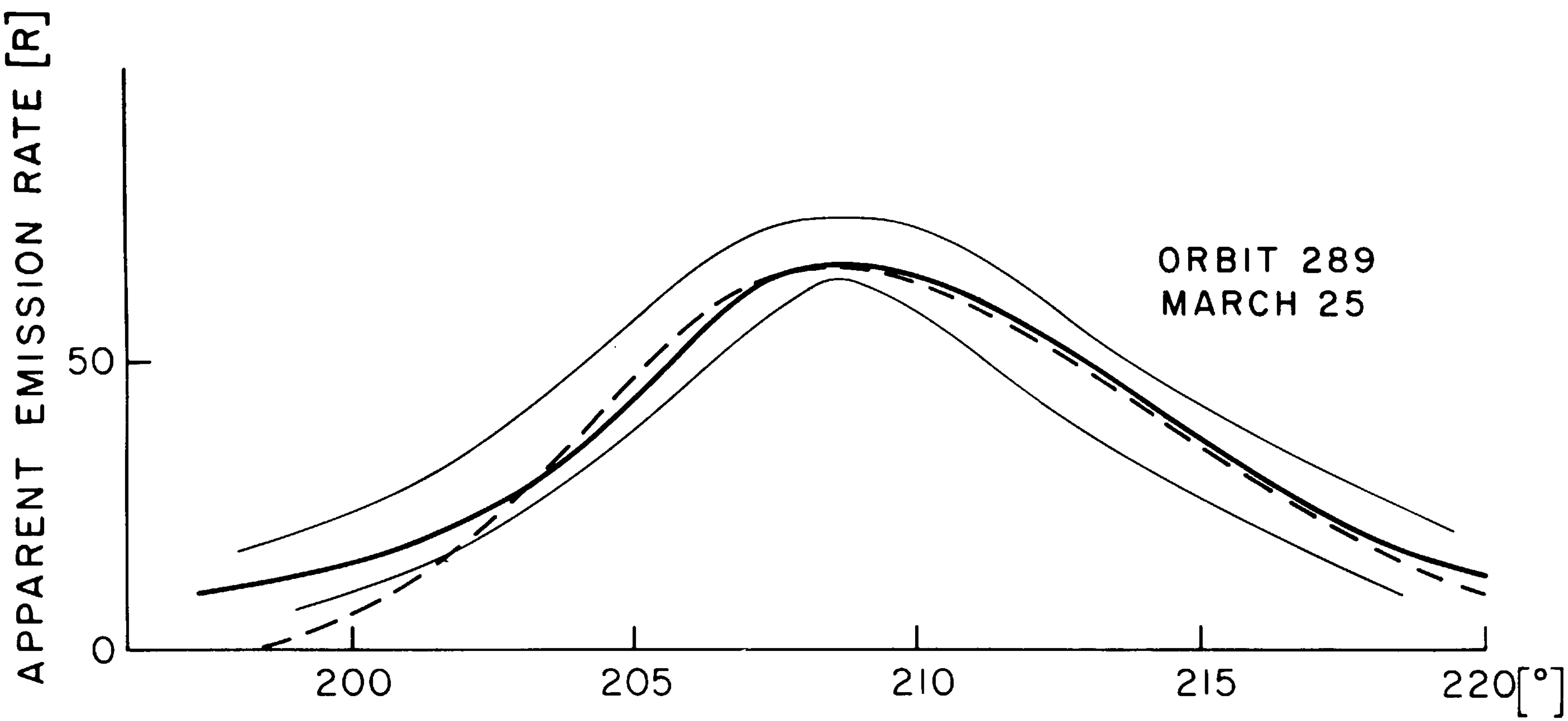

Figure 2. The abscissa is the true anomaly of the satellite orbit in degrees. The ordinate is the Lα emission rate. The light curves represent the probable error boundaries of the observational data of the scan on March 25, 1970; heavy line — the "best fit" calculated model using two maxwellian velocity distributions with mean velocities of $v_H = 7$ and 21 km s^{-1}. Dashed line (--) a single velocity model with $v_H = 9$ km s^{-1}. The remaining model parameters are: solar Lα flux, 5×10^{11} ph s^{-1} cm^{-2} A^{-1}; lifetime, 1.3×10^{6} s; and hydrogen production rate, 5.9×10^{29} atom s^{-1} (all at 1 a.u.)

example, yields hydrogen atoms with a velocity of at least 16 km s^{-1} (Keller, 1971)

The comparison of the model calculation with the observed data further yielded the following values for the hydrogen quantities: production rate, 5 9 ($\pm$2) x 10^{29} H atom s^{-1}; lifetime, 1 3 (-0.3 + 0.7) x 10^{6} s (both at 1 a u.) The solar Lα flux in line center was determined to be 5.0 ($\pm$1 0) x 10^{11} photon s^{-1} cm^{-2} A^{-1} independent of any instrumental calibration. For more details of the model calculations and results, see Keller and Thomas (1975)

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