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Variation of Radiation in Comet Hale–Bopp

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In this communication, the short-term and long-term variations in the total visual radiation from the coma of comet Hale–Bopp is reported. The overall emission of radiation from the comet is discussed. The raw data on total magnitudes were gathered from the International Astronomical Union Circulars. These data were converted to heliocentric magnitude (H) to remove the effect of the magnitude variations due to varying geocentric distance. We have compared the observed light curve with the predicted one.

Key Words: Comet Hale-Bopp, Variability, Light curve.

INTRODUCTION

Comet Hale–Bopp was an interesting object deserving much detailed studies. It was remarkable in brightness at a distance of over 7 AU at the time of its discovery in late July, 1995. In March–April, 1997 it was an impressive object in the northern hemisphere. Hale–Bopp was the brightest comet in atleast two decades. Fortunately, it was spotted more than 1.6 yr before perihelion, while still at 7.2 AU from the sun; giving observers plenty of time for preparations. This has provided an unprecedented opportunity to follow the evolution of a large and active comet beyond Jupiter to perihelion and back. This comet has been observed extensively by amateurs and professional astronomers the world over.

Comet Hale–Bopp was quite suitable for the study of visual behaviour of radiation. The radiation measurements provide a database for studying the factors, which affect the distribution of visually estimated total magnitudes of the comets in general. Such observations are very useful to construct a synthetic light curve for future comets.

OBSERVATIONAL DATA

We have gathered all the raw data on total visual radiation in terms of magnitudes reported primarily in the International Astronomical Union Circulars (IAU circulars) as well as from other published sources. The visual magnitude estimates reported include a wide range of telescope aperture with various techniques used by different observers. This will definitely increase the scatter in the plotted data. Still, the observed data

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give us many useful informations about the variation of radiation in comets.

RESULTS AND DISCUSSIONS

The most continuous set of physical data available for the study of cometary activity is the visual photometric base describing the total radiation in terms of magnitude (m_1) of the coma. The visual radiation/ magnitude data describe primarily the cometary activity associated with the resonance-fluorescence of diatomic carbon (C_2) and with the release of the dust from the nucleus. The way in which cometary luminosity varies with comet-sun distance provides a major clue to how the gas and dust emissions from the active areas on the cometary nucleus vary as a function of the temperature of the nucleus and its spin axis orientation. This change in luminosity also depends on the decay processes that affect the gas molecules and dust particles as they move through the coma. Unfortunately, the measurements of this luminosity is complicated by the fact that observations are taken from earth, which is a moving platform. Earth-based observations yield the comet's total apparent magnitudes, m_1.

In this paper we discuss the variation of radiation brightness of comet Hale–Bopp as a function of varying earth-sun distance. In Fig. 1, we have displayed the raw data of total visual magnitudes converted to heliocentric magnitudes (H). The conversion of total visual magnitude to heliocentric magnitude (H) removes the effect of magnitude variation due to a varying geocentric distance[1]. This conversion is most important if one wants to study the nature of the variations of brightness of the comet as a function of heliocentric distance. In Fig. 1, the predicted total brightness of the comet has also been displayed. The predicted data were adopted from the computed values[2]. The observed light curve (dots) of Hale–Bopp shows very interesting behaviour. The scatter in the observed data points reflect uncertainties in the magnitude determination due to wide range of telescope apertures and binoculars used by different observers and real short-term variations of brightness due to some real activities in the comet.

Fig. 1 shows that the comet Hale–Bopp was very irregular in emission of radiation. The short–term variations in the radiation are obvious from the observed light curve (dots) of the comet. Another interesting feature reflected from the observed light curve is that the comet emitted more radiation than predicted during pre-perihelion as well as post-perihelion periods. The comet exhibited more fluctuations in emitted radiation at around 2-5.5 AU from the Sun. Also, Fig. 1clearly shows that the comet Hale–Bopp was emitting much more radiation during the post-perihelion period, as compared to pre-perihelion period.

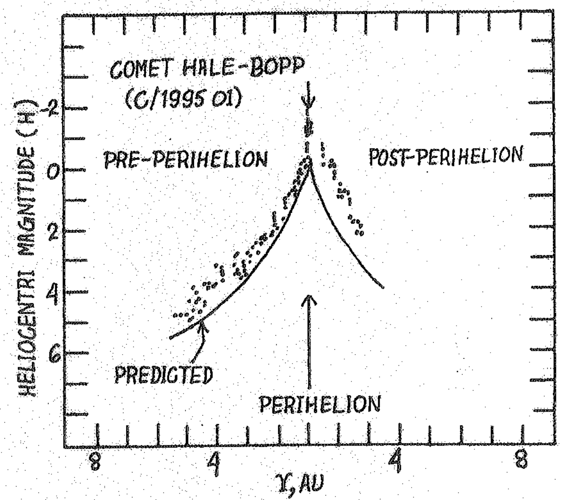

Fig. 1. Variation of radiation of Comet Hale–Bopp during pre- and post-perihelion periods

The jetting activity has already been reported[3] since May, 1996 to September, 1996 including the appearance of a bright fan and numerous linear spikes extending from the nucleus. These activities may be the major source of large fluctuations in the emitted radiation as seen in the observed light curve, during the period when the comet was at 3-4.5 AU from the Sun.

Bright jet and arcs were observed[4] during early March, 1997. Spiral bright jet around March 1, 1997 was also reported[5]. Most interesting, the change in the direction of the rotation axis of the comet during late February and early March, 1997 show that during this period the comet was very active[5]. These activities are also reflected from the much increased fluctuations in the emitted radiation of the light curve (Fig.1) near perihelion. Spiral jet arc structures and a bright shell was also observed[6] on March 6, 1997.

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