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On the magnitude variations of comet Swift-Tuttle (1992t)

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Abstract. The standard UBV magnitudes of the head of comet Swift-Tuttle (1992t) during four nights in December 1992, are estimated using our photoelectric observations. The overall brightness variations in the comet are discussed.

Key words : comet—UBV photometry

1. Introduction

Preliminary observations of the periodic comet Swift-Tuttle were reported by us in an earlier note (Padalia et al. 1993). As they indicated sharp magnitude variations on several nights, we have made a detailed study of these variations on four nights when the atmospheric conditions were good for photometric observations and the comet was available in the sky for about one hour.

2. Observations

The comet was observed by us on four nights i.e., 9,10,15 and 17 December 1992. The 105 arcsec diaphragm was used for the photometry of the cometary head. For the geocentric distance of the comet (Δ = 1 AU), this diaphragm would correspond to a circular area of 7.61 x 10^4 km in diameter. The telescope used was 38-cm reflector using a cooled (–20°C) 1P21 photomultiplier tube and *UBV* filters of Johnson and Morgan system, and a d.c. amplifier. The filter characteristics of the *UBV* filters are as follows:

U filter - Peak 3650 Å, FWHM 600 Å
B filter - Peak 4400 Å, FWHM 833 Å
V filter - Peak 5500 Å, FWHM 1400 Å

Two comparison stars β Aql and δ Aql and five other standard stars were observed to find the daily magnitude variations of the comet. Finally the comparison star β Aql was found to be more stable than the other stars, with the standard deviations of ± $0.^m015$, ±$0.^m025$ and ±$0.^m015$ in *U,B* and *V* filters respectively. Hence, the final reductions were done using the star β Aql only. The individual observations of the comet for all the four nights were corrected for extinction effects using nightly extinction coefficients (obtained from observations of β Aql) and the instrumental magnitudes were transformed to standard *U,B,V* system, following the standard technique *vide* Gupta (1979), are tabulated in table 1.

3. Discussion of the light curves and conclusions

The individual standard magnitudes in *UBV* filters of the comet, on four nights, are reported in table 1, and these magnitudes are plotted against *UT* for each night in Fig.1. And inspection of the light curves on December 9, indicates a gradual decrease in magnitude (or increase in brightness) of the comet with a sudden peak appearing around $13.^{h}6$(UT), giving a total change in magnitude of $0.^{m}93$, $0.^{m}36$ and $0.^{m}47$ (difference between maximum and minimum magnitude points) in *U*, *B*, and *V* filters respectively. On the night of December 10, no sudden increase or decrease in magnitude has been noticed. However, around $13.^{h}4$(*UT*), the magnitude of the comet began to increase after a gradual decrease, and this variation is prominent in *U* filter. The observations secured on December 15 are scanty to make any conclusion, however, it is clear that the magnitudes are sharply increasing in all the three filters. In addition to this, overall brightness of the comet on December 15 has increased compared to other nights. The light curves on December 17, show a continuous increase in the magnitude in all the three filters. A total change of $0.^{m}63$, $0.^{m}37$ and $0.^{m}40$ have been noticed in *U, B* and *V* filters respectively.

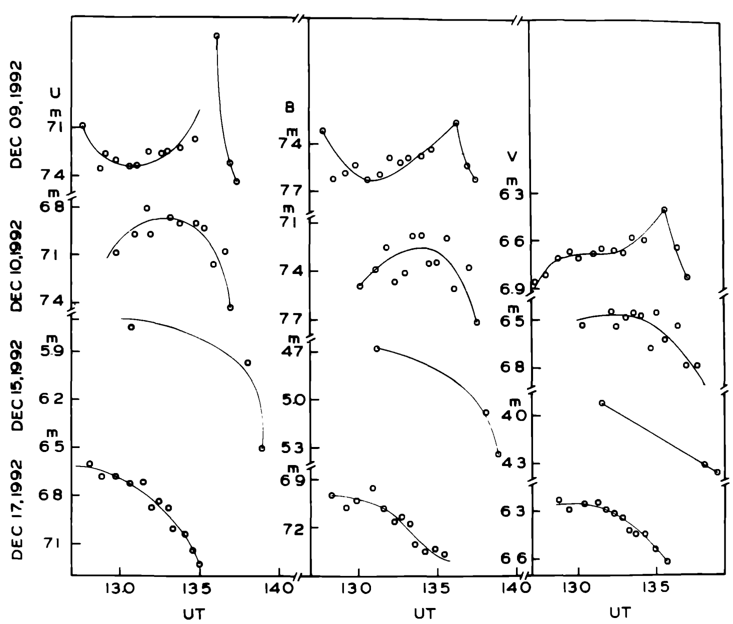

Figure 1. Light curves of the comet Swift-Tuttle (1992 t) in *U, B, V* filters. The ordinates represent standard magnitudes of the comet in each filter and abscissae denote the time in *UT*. The solid line indicates free-hand curve drawn through individual points.

These four sets of light curves indicate that on each night, the magnitude of the comet has not been stable and has varied typically. It is relevant to mention here that sudden brightness variations or periodic variations (of few hours) in brightness have been noticed in other comets also. The former has been found by Grudzińska (1980) in comet Schwassman - Wachmann (1925 II), and has been attributed either to the solar activity or more plausible cause has been given to the influence of meteor streams coming in the way of comet. The latter has been pointed out in case of comet d'Arrest, and a periodicity of 5.17 hours has been found by Fay & Wisniiéwski (1978) by analysing their photoelectric light curves; the amplitude variation was about $0.^m15$ in visual. A simple explanation for this variation has been given as the rotation of the pear shaped nucleus, whose projected brightness is variable with viewing angle. Thus, photoelectric photometry has been of vital importance in determining the periodic brightness variation, rotation and shape of the nucleus of the comet. The variations in brightness may also be due to background stars entering into the diaphragm.

We carefully checked the comet's path during our observations and ascertained that there were no stars to contaminate our observations. In comets, the following causes are cited in the literature which are responsible for the brightness variations:

(a) solar activity (b) rotation or spin of non-spherical shaped nucleus (masked by coma) (c) dissipation of jets

However, due to lack of sufficient observational time, we are unable to say which of the reasons is responsible for the brightness variations in comet Swift - Tuttle reported by us here. Increase in overall brightness, and dissipation of fan-shaped jets have been suggested in comet Swift - Tuttle by J.V. Scotti (IAU Cir. No. 5643, Oct. 22, 1992). Sharp increase in IR brightness of the comet over 24 hours has been obtained by G.P. Tozzi & G. Calamai (IAU Cir. No. 5650, Nov. 10, 1992).

Therefore, short duration brightness variations appear to be a normal feature of this comet.

Table 1. Standard *UBV* observations of comet Swift-Tuttle (1992 t) December 9, 1992

UT h m	*U* m	*UT* h m	*B* m	*UT* h m	*V* m
12 43.7	7.066	12 45.5	7.307	12 46.3	6.067
12 47.6	7.339	12 49.1	7.600	12 51.2	6.619
12 52.5	7.255	12 53.9	7.588	12 55.1	6.704
12 56.4	7.296	12 57.6	7.524	12 58.8	6.663
13 00.0	7.338	13 01.9	7.609	13 03.8	6.704
13 05.7	7.332	13 07.3	7.585	13 07.9	6.685
12 09.3	7.243	13 10.6	7.486	13 11.7	6.651
13 13.0	7.254	13 14.5	7.519	13 15.9	6.672
13 17.1	7.240	13 17.8	7.481	13 18.6	6.682

Table 1. *Continued.*

UT h m	*U* m	*UT* h m	*B* m	*UT* h m	*V* m
13 20.3	7.233	13 22.6	7.481	13 23.6	6.593
13 25.7	7.157	13 27.2	7.418	13 28.2	6.607
13 32.7	6.524	13 33.6	6.254	13 37.1	6.405
13 38.0	7.319	13 39.7	7.543	13 40.5	6.644
13 41.7	7.425	13 42.9	7.634	13 43.8	6.707
		December 10, 1992			
12 59.2	7.070	13 00.6	7.490	13 01.9	6.531
13 05.2	6.964	13 06.6	7.275	13 10.9	6.443
13 10.0	6.804	13 10.2	7.133	13 14.2	6.537
13 12.2	6.962	13 13.2	7.350	13 17.7	6.473
13 18.8	6.851	13 16.4	7.397	13 21.1	6.444
13 22.2	6.879	13 20.2	7.163	13 23.8	6.456
13 28.6	6.896	13 23.1	7.157	13 27.3	6.676
13 31.7	6.921	13 26.2	7.237	13 30.7	6.449
13 34.9	7.152	13 29.7	7.232	13 33.7	6.614
13 39.5	6.964	13 32.9	7.180	13 38.4	6.523
13 42.5	7.418	13 36.1	7.495	13 41.4	6.786
–	–	13 40.5	7.265	13 45.9	6.789
–	–	13 43.7	7.700	–	–
		December 15, 1992			
13 04.4	5.746	13 07.0	4.676	13 08.8	3.911
13 48.2	5.958	13 47.1	5.080	13 50.2	4.205
13 50.6	6.510	13 51.8	5.340	13 53.2	4.359
		December 17, 1992			
12 48.6	6.600	12 50.3	6.993	12 52.0	6.219
12 53.7	6.668	12 54.9	7.056	12 56.2	6.281
12 58.6	6.673	12 59.9	7.016	13 01.9	6.249
13 03.6	6.709	13 04.9	6.946	13 07.0	6.242
13 08.6	6.709	13 09.6	7.069	13 10.3	6.283
13 11.7	6.872	13 12.9	7.140	13 13.6	6.309
13 14.6	6.820	13 15.5	7.117	13 16.2	6.340
13 17.2	6.867	13 18.6	7.167	13 18.8	6.426
13 19.8	6.996	13 20.9	7.295	13 21.7	6.450
13 23.9	7.017	13 24.8	7.346	13 25.8	6.452
13 27.0	7.140	13 28.2	7.321	13 29.8	6.527
13 30.9	7.223	13 32.4	7.356	13 33.3	6.617

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