Bull. Astr. Soc.India (1997) **25,** 103-116

Variability of eta Hydrae

B. K. Saxena

M.P. Council of Science and Technology, Bhopal, India

R. K. Srivastava

Uttar Pradesh State Observatory, Manora Peak, Nainital, India

Received 14 November 1995; accepted 9 February 1996

Abstract. The first observations of η Hya, taken at Pachmarhi, are presented. Night to night light variability on η Hya has been discussed. Maximum amplitude of light variation is found to be 0^m 096. Preliminary results show that semi-regular variations with period aroound $0^d.1$ are present. The colour of η Hya has also been estimated.

Key words: photoelectric – photometery – variable star

1. Introduction

The star η Hya (= BD+3° 2039= HD 74280 = HR 3454) has been shown to be a variable (cf. Hoffleit and Jaschek, 1982), with a light variation of $0^m.015$. Hirshfeld and Sinnott (1982) determined its magnitude as 4.3 and spectral type, B3V. Hirshfeld and Sinnott (1985) found the period of variability as $0^d.16$. Not enough is known about this star, and further details will be taken-up in the next analysis after obtaining some more observations. The present observations, taken at Pachmarhi, by the author, are preliminary in nature.

2. Observations

The photoelectric observatons of η Hya were carried out at Pachmarhi with an 8-inch reflector, using SSP 3 photometer and, B and V filters. A comparison star, β Cnc has been used to apply the extinction corrections.

In all, five nights of observations (February 3,4,5,7, and 8) were obtained in 1992. The data could not be reduced to the standard system as sufficient observations of standard stars are not available with us. However, it is expected that the standardization may not change the results to a noticeable extent, as it will shift the level of observations by a certain amount of light. The differential magnitudes, Δb & Δv, are the differences between the magnitudes of the variable star and the comparison star. Non-standard values of b & v and observations and colours (b-v) are listed in Table 1. Non-standard observatins of B & V filters are shown in Fig 1, along with the mean instrumental magnitudes of the comparison star, as Imb and Imv and B & V filters respectively.

3. Colours

The average colour of the comparison star has been derived, which stands at b-v = $+1^m.637$. The differential colours of the variable η Hya have also been derived (listed in Table 1). The average differential colour of the variable comes out to be Δ(b-v) = -1.674. Since differential magnitudes have been calculated in the sense 'variable *minus* comparison', the differential colour of the comparison star is added to the colour of η Hya, which places the colour of the variable, η Hya, at b - v = $10^m.037 (\simeq -0^m.04)$. This is the approximate (non standard) colour, just for a rough assessment of the spectral type of the star.

Assuming the luminosity class of the variable as V, this b-v value shows that the spectral type of the variable may be around B9, (vide Apr, 1958), as against B3V given in the catalogue (Hoffleit and Jaschek, 1982). This difference in the spectral type may be due to non-standardization of our present data. This data will be standardised by observing sufficient number of standard stars in the coming observing season.

4. Results

The results of η Hya derived on the basis of these (non-standard) observations are listed in Table 2. These results suggest that, on different nights, the amplitude (Maximum *minus* Minimum) of light varies from $0^m.006$ to $0^m.096$ approximately with graphical error-ranging from $0^m.004$ to $0^m.028$. However, the average error of b & v observations does not exceed $0^m.019$. In this light, except at a few places in the ligth curves (Fig. 1), the variation of light is more than 3σ level, particularly in b, and thus, the variablity of η Hya seems quite established. This is, further, evidenced by the variation in the differential colours, b-v, (Fig. 1). The shape of variability changes from night-to-night as seen in the light curves. At places, it shows the shape of a minimum, while at other places, where the amplitude variation is less, it shows irregular type of variation. The period (Max.to Max. or Min. to Min.) is also varying.

Table 1. Observations and colours of η Hya.

	UT	h	UT	v	UT	(b-v)
Feb.3, 1992	$14^h00^m.0$	$-0^m.826$	$14^h03^m.0$	$0^m.788$	$14^h01^m.5$	$-1^m.614$
	14 01.0	-0.849	14 03.1	0.785	14 02.1	-1.634
	14 02.0	-0.846	14 03.6	0.791	14 02.8	-1.637
			14 04.0	0.785	14 04.5	-1.596
			14 05.0	0.796		
	15 01.0	-0.918	15 03.1	0.777	15 02.1	-1.695
	15 02.0	-0.913	15 03.3	0.774	15 02.6	-1.687
	15 02.3	-0.949	15 04.0	0.769	15 03.1	-1.718
	15 02.6	-0.938	15 05.0	0.767	15 03.8	-1.705
			15 05.6	0.783		
	16 18.0	-0.947	16 19.0	0.765	16 18.5	-1.712
	16 18.3	-0.968	16 20.0	0.760	16 19.2	-1.728
	16 18.6	-0.957	16 20.6	0.747	16 19.6	-1.704
	16 18.8	-0.942	16 20.6	0.746	16 19.7	-1.688
	16 19.0	-0.931	16 20.8	0.757	16 19.9	-1.688
	17 12.0	-0.891	17 14.0	0.755	17 13.0	-1.646
	17 13.0	-0.881	17 14.1	0.743	17 13.6	-1.624
	17 13.1	-0.880	17 15.3	0.737	17 14.2	-1.617
	17 13.3	-0.895	17 15.6	0.737	17 14.5	-1.632
	17 13.8	-0.893	17 15.8	0.756	17 14.8	-1.649
	18.05.0	-0.878	18 07.0	0.784	18 06.0	-1.662
	18 05.3	-0.891	18 07.3	0.772	18 06.3	-1.663
	18 06.0	-0.883	18 08.0	0.770	18 07.0	-1.653
	18 06.8	-0.891	18 08.6	0.787	18 07.7	-1.678
	18 06.9	-0.891	18 08.8	0.755	18 07.9	-1.646
	19 24.0	-0.908	19 26.3	0.763	19 25.2	-1.671
	19 24.3	-0.895	19 26.6	0.742	19 25.5	-1.637
	19 25.0	-0.927	19 27.0	0.761	19 26.0	-1.688
	19 25.6	-0.907	19 27.3	0.780	19 26.5	-1.687
	19 26.0	-0.893	19 27.8	0.774	19 26.9	-1.667
	20 17.0	-0.878	20 19.0	0.757	20 18.0	-1.635
	20 17.3	-0.878	20 19.3	0.756	20 18.3	-1.634
	20 18.0	-0.875	20 19.6	0.755	20 18.8	-1.630
	20 18.6	-0.890	20 19.8	0.743	20 19.2	-1.633
	21 29.0	-0.947	21 30.0	0.837		
	21 29.6	-0.945	21 31.0	0.823		
			21 32.0	0.789		

Table 1. Continued.

	UT	h	UT	v	UT	(b-v)
Feb.3, 1992	22 34.0	-0.926	22 35.0	0.745	22 34.5	-1.671
	22 34.2	-0.890	22 36.0	0.730	22 35.1	-1.620
	22 34.8	-0.908	22 36.6	0.752	22 35.7	-1.660
	22 35.0	-0.946	22 36.8	0.755	22 35.9	-1.701
Feb.4, 1992	16 16.0	-0.875	16 18.0	0.783	16 17.0	-1.658
	16 16.3	-0.853	16 18.3	0.783	16 17.3	-1.636
	16 16.9	-0.843	16 19.0	0.782	16 17.9	-1.625
	16 17.0	-0.846	16 20.0	0.780	16 18.5	-1.626
	16 17.6	-0.859	16 20.6	0.781	16 19.1	-1.640
	17 00.0	-0.869	17 03.0	0.767	17 01.5	-1.636
	17 01.0	-0.863	17 03.9	0.769	17 02.5	-1.632
	17 01.3	-0.867	17 04.0	0.768	17 02.7	-1.635
	17 02.0	-0.864	17 04.6	0.766	17 03.3	-1.630
	17 02.6	-0.865	17 04.8	0.765	17 03.7	-1.630
	18 25.0	-0.900	18 27.0	0.762	18 26.0	-1.662
	18 25.3	-0.904	18 27.4	0.765	18 26.4	-1.669
	18 26.0	-0.887	18 28.0	0.764	18 27.0	-1.651
	18 26.4	-0.887	18 29.0	0.765	18 27.7	-1.652
	18 26.9	-0.887	18 29.8	0.772	18 28.4	-1.659
	19 48.0	-0.873	19 49.8	0.746	19 48.9	-1.619
	19 48.3	-0.873	19 50.0	0.746	19 49.2	-1.619
	19 49.0	-0.872	19 50.3	0.744	19 49.7	-1.616
	19 49.6	-0.874	19 50.6	0.745	19 50.1	-1.619
	20 46.0	-0.851	20 48.0	0.739	20 47.0	-1.590
	20 46.5	-0.846	20 48.8	0.742	20 47.7	-1.588
	20 47.0	-0.874	20 49.0	0.742	20 48.0	-1.616
	20 47.6	-0.871	20 49.6	0.739	20 48.6	-1.610
	20 47.8	-0.883	20 49.8	0.742	20 48.8	-1.625
	21 46.0	-0.879				-1.625
	21 47.0	-0.852				-1.607
	21 48.0	-0.876				-1.631
	21 49.0	-0.892				-1.646
	21 50.0	-0.907				-1.655
Feb.5, 1992	15 32.0	-0.866	15 34.4	0.776	15 33.2	-1.642
	15 32.6	-0.874	15 35.0	0.767	15 33.8	-1.641
	15 33.0	-0.869	15 35.6	0.767	15 34.3	-1.636
	15 33.8	-0.856	15 36.0	0.768	15 34.9	-1.624
	15 34.0	-0.849	15 36.8	0.767	15 35.4	-1.616

Table 1. Continued.

	UT	h	UT	v	UT	(b-v)
Feb. 5, 1992	16 32.0	-0.844	16 34.5	0.754	16 33.0	-1.598
	16 32.6	-0.831	16 34.8	0.759	16 33.7	-1.590
	16 32.6	-0.847	16 35.0	0.757	16 33.8	-1.604
	16 33.0	-0.846	16 35.6	0.755	16 34.3	-1.601
	16 33.6	-0.846	16 36.0	0.762	16 34.8	-1.608
	17 34.0	-0.871	17 36.2	0.757	17 35.1	-1.628
	17 34.2	-0.880	17 36.8	0.758	17 35.5	-1.638
	17 34.6	-0.882	17 37.0	0.761	17 35.8	-1.643
	17 35.0	-0.879	17 37.6	0.758	17 36.3	-1.637
	17 35.6	-0.869	17 37.9	0.753	17 36.8	-1.622
	19 46.0	-0.862	19 48.1	0.757	19 47.1	-1.619
	19 46.4	-0.866	19 48.4	0.760	19 47.4	-1.626
	19 46.8	-0.859	19 49.2	0.759	19 48.0	-1.618
	19 47.0	-0.885	19 49.6	0.759	19 48.3	-1.644
	19 47.4	-0.891	19 49.8	0.755	19 48.6	-1.646
	21 13.0	-0.912	21 14.6	0.749	21 13.8	-1.661
	21 13.4	-0.915	21 15.0	0.747	21 14.2	-1.662
	21 14.0	-0.915	21 16.0	0.746	21 15.0	-1.661
	21 14.3	-0.918	21 17.1	0.745	21 15.7	-1.663
			21 17.4	0.745		
	21 54.0	-0.877	21 56.0	0.740	21 55.0	-1.617
	21 54.4	-0.879	21 56.3	0.739	21 55.4	-1.618
	21 55.0	-0.879	21 56.6	0.735	21 56.8	-1.614
	21 55.4	-0.885	21 57.0	0.740	21 56.2	-1.625
	21 55.8	-0.866	21 57.8	0.736	21 56.9	-1.602
Feb.7, 1992	16 30.0	-0.889	16 32.0	0.747	16 31.0	-1.636
	16 30.3	-0.891	16 32.5	0.743	16 31.4	-1.634
	16 31.0	-0.893	16 32.8	0.743	16 31.9	-1.636
	16 31.3	-0.895	16 33.0	0.744	16 32.1	-1.639
	16 31.6	-0.878	16 34.0	0.742	16 32.8	-1.620
	17 39.0	-0.896	17 41.4	0.776	17 40.2	-1.672
	17 39.4	-0.895	17 42.0	0.775	17 40.7	-1.670
	17 39.8	-0.899	17 42.6	0.775	17 41.2	-1.674
	17 40.0	-0.903	17 43.0	0.775	17 41.5	-1.678
	17 41.0	-0.883	17 43.6	0.772	17 42.3	-1.655
	19 00.0	-0.923	19 02.4	0.738	19 01.2	-1.661
	19 00.6	-0.916	19 03.0	0.736	19 01.8	-1.652
	19 01.0	-0.920	19 03.6	0.738	19 02.3	-1.658
	19 01.6	-0.912	19 04.0	0.737	19 02.8	-1.649
	19 02.0	-0.916	19 04.8	0.735	19 03.4	-1.651

Table 1. Continued.

Feb. 7, 1992	UT	h	UT	v	UT	(b-v)
	20 14.0	-0.889	20 16.8	0.747	20 15.4	-1.636
	20 14.4	-0.881	20 17.0	0.748	20 15.7	-1.629
	20 15.0	-0.888	20 17.4	0.742	20 16.2	-1.630
	20 16.0	-0.897	20 18.0	0.740	20 17.0	-1.637
	20 16.4	-0.899	20 18.6	0.739	20 17.5	-1.638
	21 13.0	-0.939	21 15.0	0.726	21 14.0	-1.665
	21 13.6	-0.917	21 15.2	0.729	21 14.4	-1.646
	21 14.0	-0.918	21 15.4	0.728	21 14.7	-1.646
	21 14.3	-0.927	21 15.6	0.731	21 15.0	-1.658
	21 14.6	-0.917	21 15.8	0.724	21 15.2	-1.641
	22 00.0	-0.929	22 02.2	0.719	22 01.1	-1.648
	22 00.2	-0.906	22 02.8	0.721	22 01.5	-1.627
	22 01.0	-0.904	22 03.0	0.715	22 02.0	-1.619
	22 01.6	-0.944	22 03.4	0.714	22 02.5	-1.658
	22 02.0	-0.937	22 04.0	0.728	22 03.0	-1.665
Feb. 8, 1992	15 08.0	-0.878	15 10.6	0.767	15 09.3	-1.645
	15 08.3	-0.878	15 11.3	0.769	15 09.8	-1.647
	15 09.0	-0.885	15 11.6	0.771	15 10.2	-1.656
	15 09.4	-0.872	15 12.2	0.767	15 10.8	-1.639
	15 10.0	-0.874	15 12.6	0.768	15 11.3	-1.642
	16 20.0	-0.918	16 23.0	0.743	16 21.5	-1.661
	16 20.6	-0.911	16 24.0	0.741	16 22.0	-1.652
	16 21.0	-0.915	16 24.0	0.740	16 22.8	-1.655
	16 21.6	-0.907	16 25.0	0.739	16 23.8	-1.641
	16 22.0	-0.903	16 25.8	0.738	16 23.9	-1.641
	17 20.0	-0.894	17 22.0	0.745	17 21.0	-1.639
	17 20.6	-0.884	17 23.0	0.749	17 21.8	-1.633
	17 20.8	-0.898	17 24.0	0.746	17 22.4	-1.644
	17 21.0	-0.885	17 25.0	0.749	17 23.0	-1.634
	17 21.6	-0.884	17 25.6	0.747	17.23.6	-1.631
	19 15.0	-0.916	19 18.0	0.746	19 16.5	-1.662
	19 15.6	-0.926	19 18.6	0.745	19 17.1	-1.671
	19 16.0	-0.917	19 19.0	0.749	19 17.5	-1.666
	19 16.6	-0.911	19 20.0	0.746	19 18.0	-1.657
	19 17.0	-0.908	19 20.6	0.744	19 18.8	-1.652
	20 19.0	-0.879	20 21.0	0.752	20 20.0	-1.631
	20 19.6	-0.880	20 22.0	0.745	20 20.8	-1.625
	20 20.0	-0.874	20 23.0	0.743	20 21.5	-1.617
	20 20.6	-0.874	20 23.6	0.745	20 22.1	-1.619
	20 20.8	-0.866	20 24.0	0.751	20 22.4	-1.617

Table 1. Continued.

Feb. 8, 1992	UT	h	UT	v	UT	(b-v)
	21 13.0	-0.911	21 15.6	0.722	21 14.3	-1.633
	21 13.6	-0.910	21 16.0	0.727	21 14.8	-1.637
	21 14.0	-0.889	21 16.6	0.726	21 15.3	-1.615
	21 14.6	-0.889	21 17.0	0.728	21 15.8	-1.617
	21 15.0	-0.914	21 17.6	0.731	21 16.3	-1.645
	22 04.0	-0.878				-1.602
	22 05.0	-0.879				-1.609
	22 05.8	-0.879				-1.611
	22 06.0	-0.886				-1.618
	22 06.6	-0.875				-1.611

5. Discussion

Various star catalogues do point out the variable nature of η Hya, however, none presents the actual work done on this star along with references. Thus, our discussion is based only on a few available references. A search for more details of this star is in progress.

The amplitude is found to be approximately $0^m.006$ to $0^m.096$ as against $0^m.015$ suggested by Hoffleit and Jaschek (1982), and the period varies from $1^h.6$ to $4^h.3$ as against $3^h.84$ suggested by Hirshfeld and Sinnott (1985). The shapes of light curves are varying, which is an indication of the intrinsic light variability. Since the maxima are seen, more observations are needed to confirm these results. The errors of observations are reasonable and are near to photoelectric errors, except at a few places.

The derived average non-standard b - v colour of the variable suggests that its approximate spectral-luminosity class may be B9V as against B3V given by Hoffleit and Jaschek (1982), Hirshfeld and Sinnott (1982) and, this difference may be due to non-standardization of the present observations and the effect of colour excess. The variability is more pronounced in B filter than in V.

6. Summary

The present observations of the star η Hya, show noticeable light variability. The type of variability cannot be ascertained with the present observations, however, semi-regular nature of variations are apparent in the light curves of η Hya. The presence of intrinsic light variability cannot be denied.

Since the present observations are the first obsevations, non-standard type, and, thus, preliminary in nature, consequently, features of light variability cannot be discussed in detail.

Table 2. Preliminary results of η HYA.

Date of observation	Max(UT) v	Max(UT) b	Min(UT) v	Min(UT) b	Amplitude range v	Av	Obe err	Amplitude range b	Av	Obs. err	Av err of b & V obs	Remarks
Feb 3. 1992	16^h56^m 18 56 21 26	15^h52^m 19 14 21 40	18^h12^m 19 46	17^h40^m 20 18	0^m,008 to 0^m.040	0^m.024	±0^m.020	0^m.071 to 0^m.096	0^m.084	± 0^m.018	±0^m.019	Variability well evidenced in b observations
Feb 4, 1992	18 40	18 24	16 30 20 22	16 26 20 42	0.006 to 0.038	0.022	± 0.010	0.021 to 0.038	0.032	± 0.028	± 0.019	Slow variability in b & v observations
Feb 5, 1992	17 40 21 42	18 26 21 12	15 50 20 16	16 36 19 54	0.008 to 0.022	0.015	±0.010	0.018 to 0.046	0.032	± 0.014	± 0.012	Slow variability in b & v observation comp. more pronounced
Feb 7, 1992	19 24	21 50	17 44	20 34	0.024 to 0.044	0.034	± 0.004	0.020 to 0.038	0.033	± 0.004	± 0.004	Sufficient variability in b & v observations
Feb 8, 1992	16 26 19 46 21 20	16 18 19 16 21 10	18 36 20 26	17 50 20 26	0.006 to 0.016	0.011	± 0.010	0.030 to 0.042	0.036	± 0.020	± 0.015	Variability more pronounced in b observations

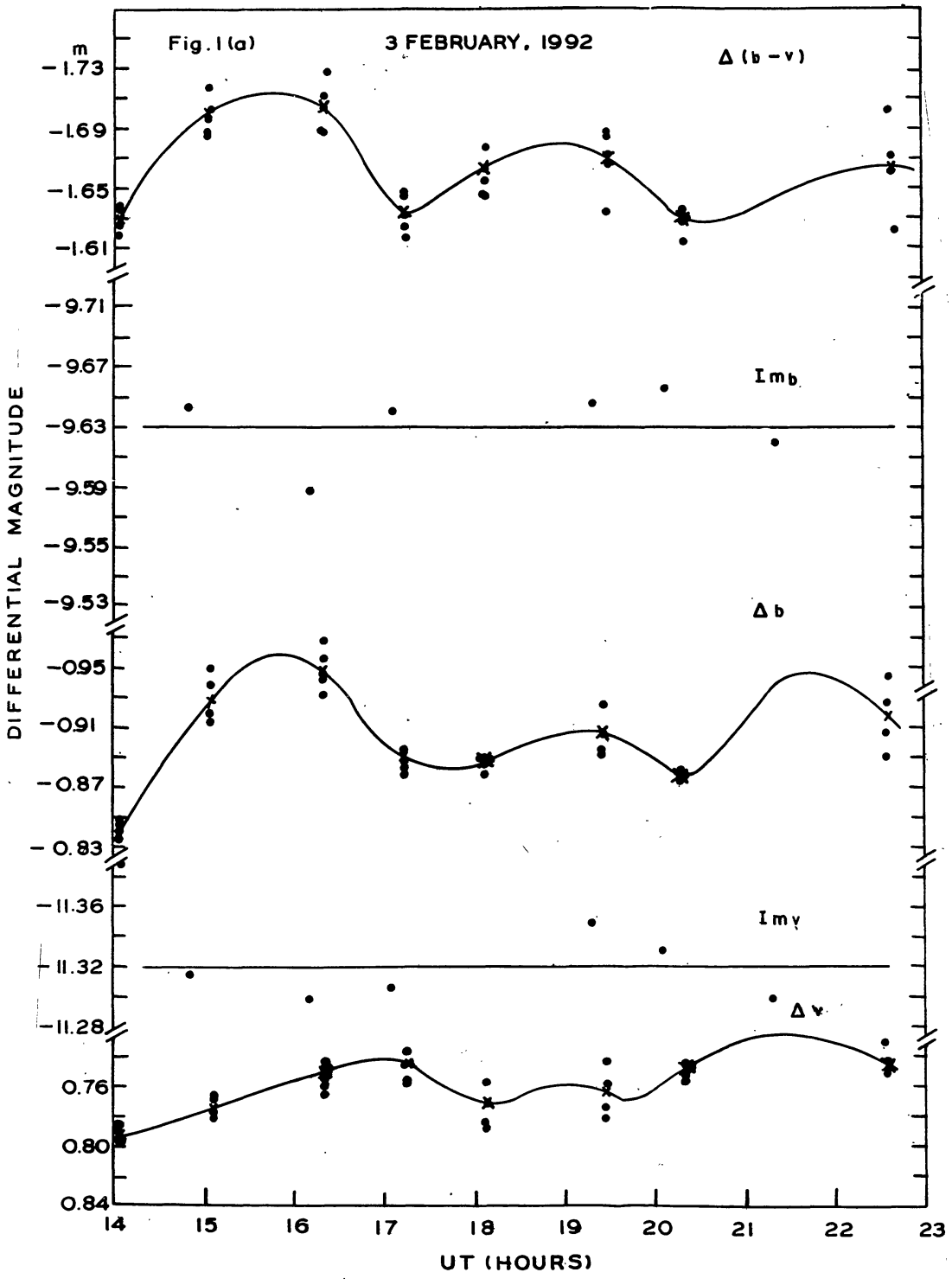
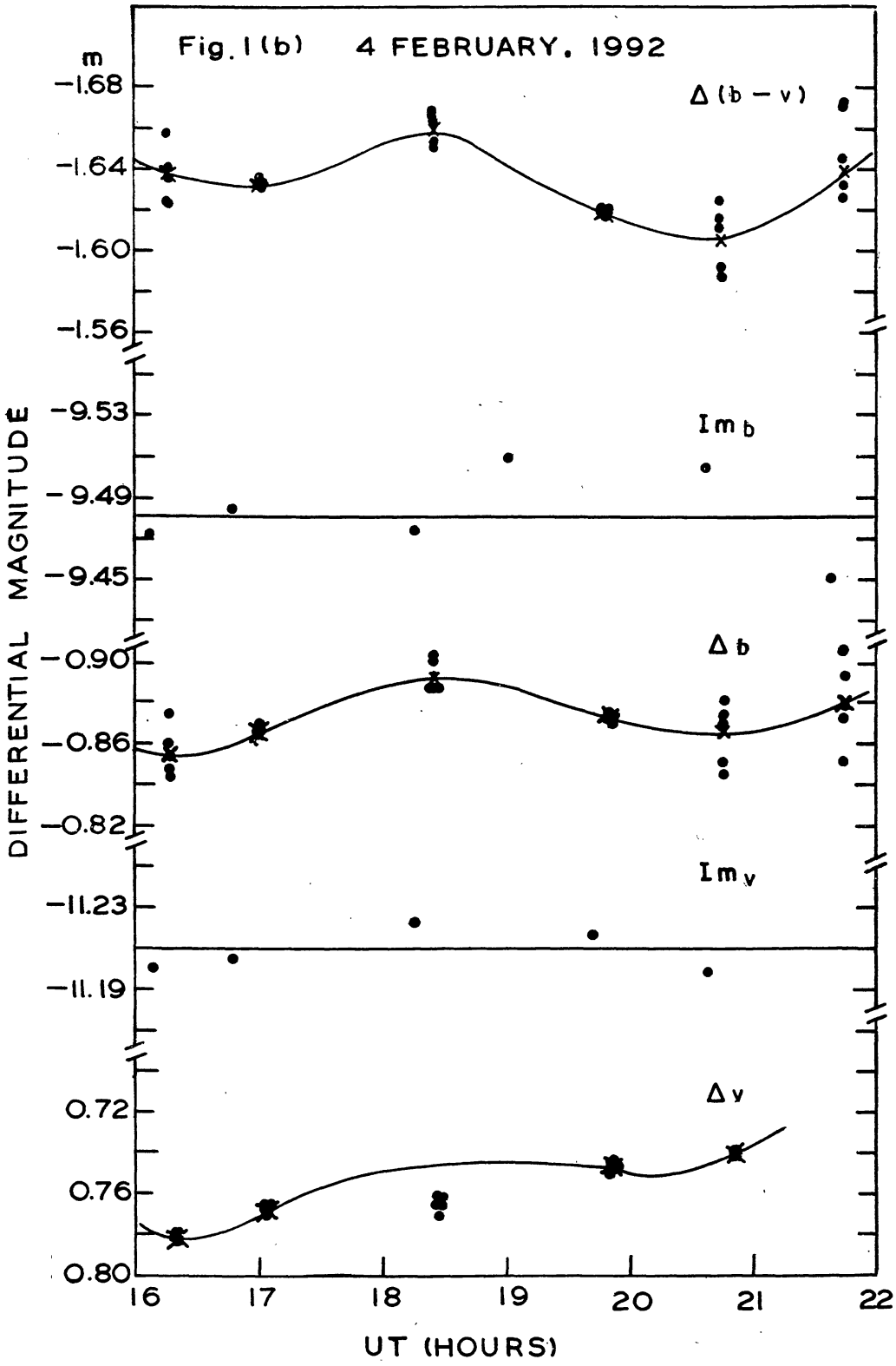
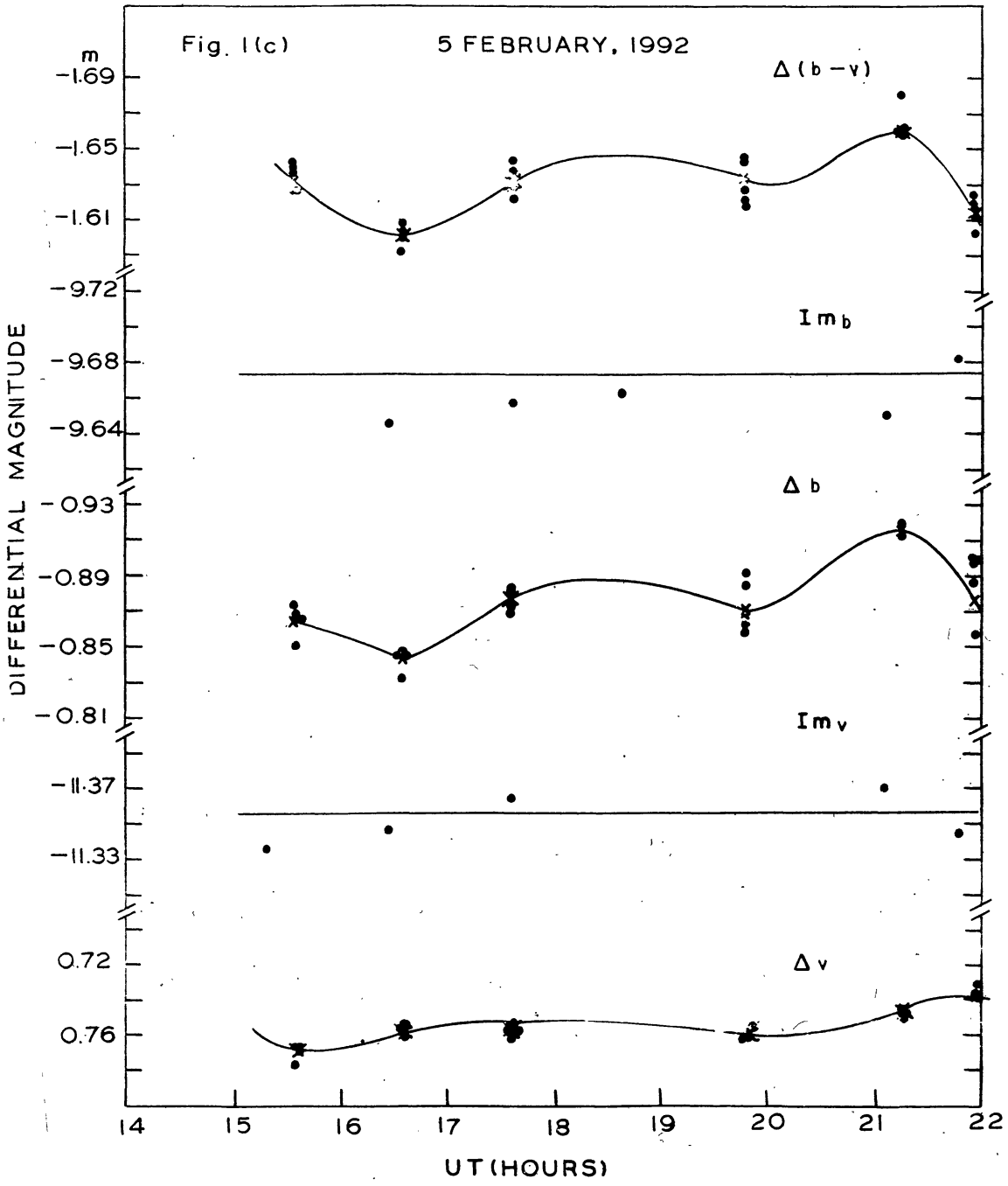
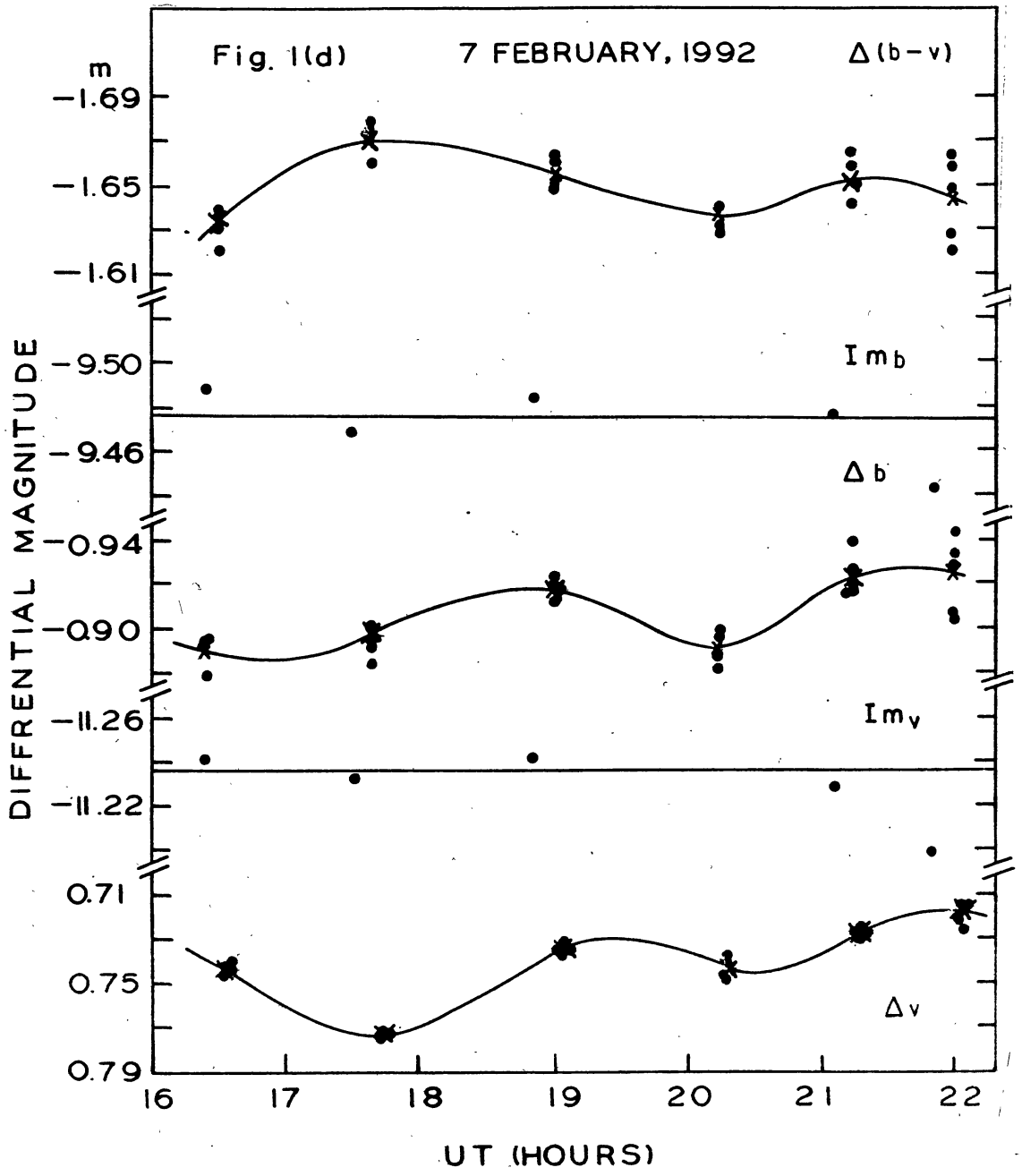
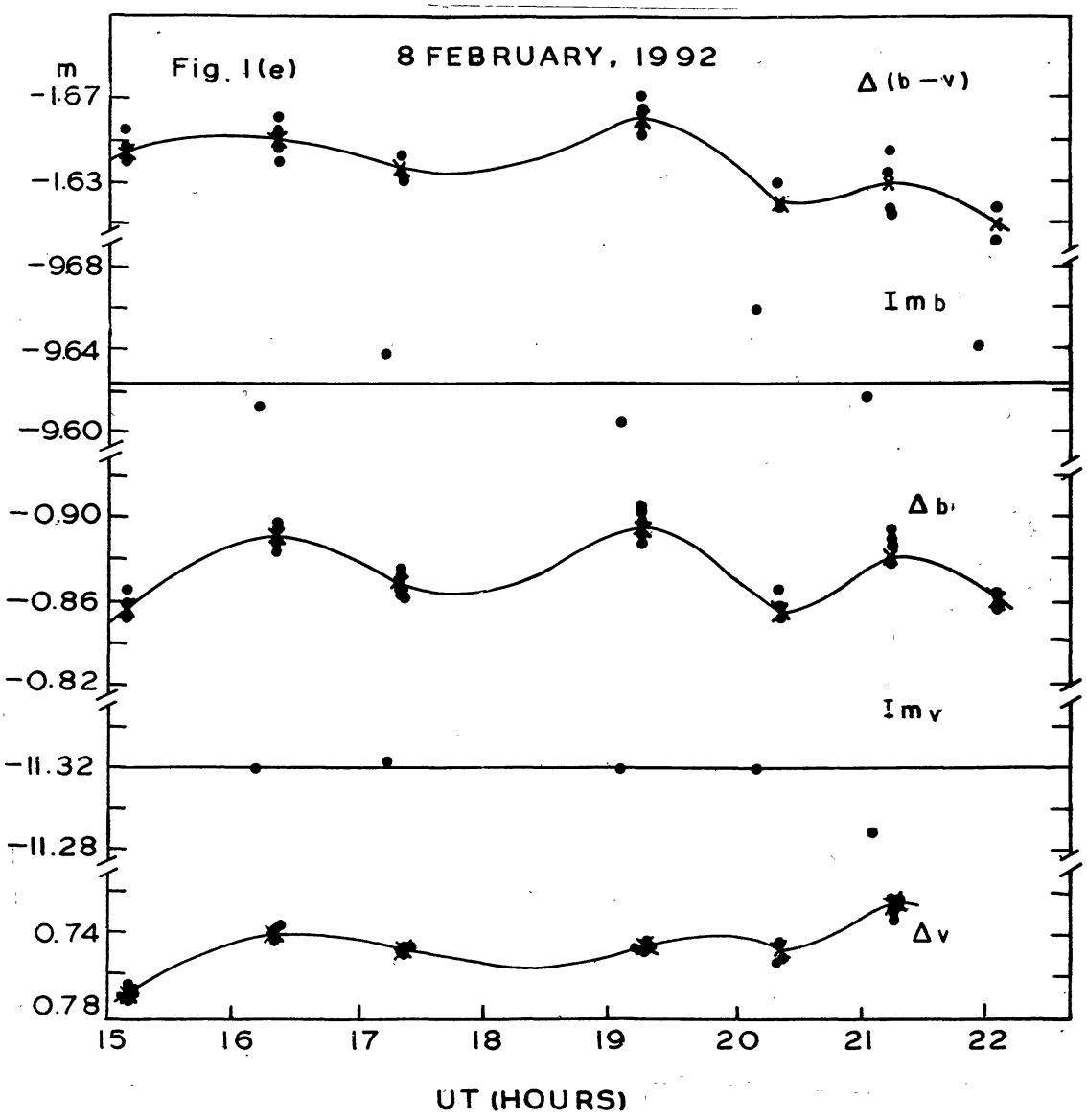


Fig. 1. (a-e) Non-standard light and colour curves of η Hydrae.









7. Acknowledgements

B. K. Saxena is highly obliged to the Director General, MP Council of Science & Technology, Bhopal for constant encouragement and invaluable help of every aspect in promoting this research work. He is highly indebted to Dr A.K. Gwal for his help in preparing this manuscript and is also highly grateful to Dr R.K Srivastava for guidance and supervision and valuable help in bringing out this manuscript.

The authors are highly thankful to the Director of UP State Observatory, Nainital for providing necessary help in preparing this communication. The authors are also thankful to Mrs Sadhna Saxena, Mrs Reena Verma, Mr H.S. Brisht, Mr R.K. Singh and Mr B. S. Siyunary for their help in computing and tracing work of this paper.

8. References

Arp H.C. 1958, Handbook Phys. 51, 83.
Hirshfeld A., Sinnott R.W., 1982, Sky Catalogue 2000.0, Vol. I p. 224.
Hirshfeld A., Sinnott R.W., 1982, Sky Catalogue 2000.0, Vol. II p. 234.
Hirshfeld D., Jaschek C., 1982, Yale University Catalogue, p. 132.