A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 60

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PHOTOELECTRIC OBSERVATIONS OF NOVA HER 1963

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by

I. ALMÁR and E. ILLÉS—ALMÁR

Nova Herculis 1963, discovered on Febr. 6 1963 by E. Dahlgren, was observed photoelectrically in three colours from Febr. 9 1963 to Oct. 2 1964 at the Konkoly Observatory. Magnitudes, reduced to a single comparison star and one photometric system, were compared with other photoelectric observations taken from the literature. The plotting of a composite light curve proved to be possible, at least in the first three months. Rapid fluctuations in brightness and colour have been suspected already in 1964 and confirmed later by photoelectric observations at the Asiago Observatory. Breaks discovered on the colour-index and on the logarithmic light curves were confronted with spectroscopic results.

OBSERVATIONS

The observations were made using the 24″ Newtonian reflector, equipped with a photoelectric photometer, containing an EMI photomultiplier and UG1, BG12 + GG13 and GG11 filters in ultraviolet, blue and yellow light respectively. In the second half of April 1963 the original silver coating of the mirror was replaced by an aluminium one. This was the only considerable change in the equipment used during the 43 nights when altogether 297 v, 293 b−v and 262 u—b measurements of the nova have been obtained.

In the first 11 nights only BD + 42°3035 = HD167965 = HR6845 was observed as a comparison star. Later we decided to use pairs of near-by stars with different colour-indices for making easier the determination of the extinction coefficients. Table I gives the magnitudes and colours of the comparison stars in the UBV system. Fig. 1 is an identification chart.

Table I

BD		V	B—V	U—B
+42° 3035	A	+5.55	−0.13	−0.49
+41° 3010	B	+8.47	+0.37	+0.02
+42° 3024	C	+8.77	+0.88	+0.64
	D	+10.51	+0.99	+0.74
	F	+10.93	+0.36	+0.11

The components of the double star BD + 41°3010 = ADS11174 could be seen separated in the guiding telescope on very clear nights but the diaphragm

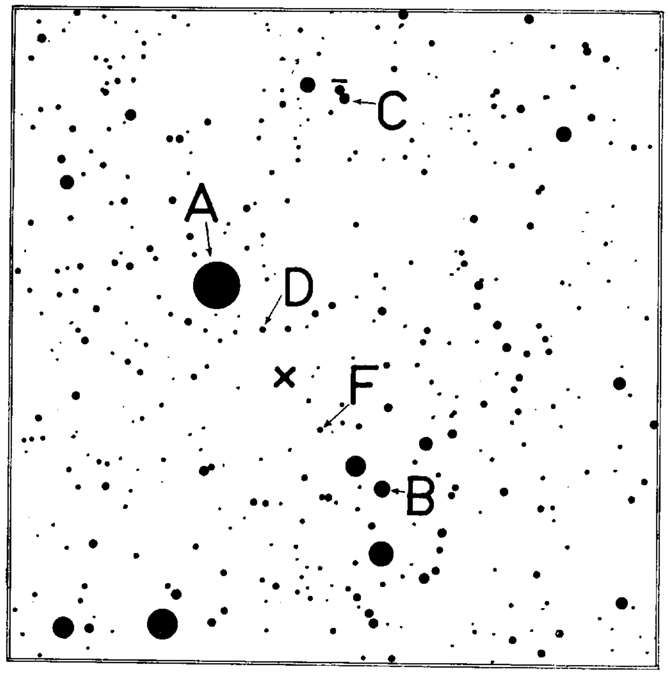

Fig. 1. The identification chart of Nova Her 1963 (cross) with the comparison stars.

used for the photoelectric measures greatly exceeded their separation. All magnitudes and colours of Nova Her 1963 relative to BD + 42°3035 are listed in Table II in our "1963 IX—XII" photometric system (see later).

Table II

J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$	J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
069.615	—1.386	+0.066	—	078.607	—0.813:	+0.085:	—0.313:
.617	—1.453	+0.136	—0.324	.611	—0.841:	+0.126:	—0.329:
.623	—1.444	+0.114	—0.328	.617	—0.750:	+0.081:	—0.336:
.637	—1.403	+0.101	—0.326	.620	—0.814:	+0.092:	—0.318:
.642	—1.422	+0.116	—0.330				
.657	—1.402	+0.082	—0.301	082.601	—0.389	+0.085	—0.329
.662	—1.423	+0.105	—0.298	.605	—0.398	+0.111	—0.337
.665	—1.367	+0.052	—0.299	.609	—0.374	+0.110	—0.375
.668	—1.422	+0.109	—0.301	.610	—0.352	+0.077	—0.361
.675	—1.409	+0.091	—0.295	.612	—0.346	+0.066	—0.343
.677	—1.412	+0.100	—0.301				
.681	—1.419	+0.098	—0.303	090.570	—0.477	+0.061	—0.271
.687	—1.417	+0.103	—0.308	.571	—0.474	+0.051	—0.268
.689	—1.337	+0.022	—0.299	.576	—0.465	+0.046	—0.282
.692	—1.415	+0.109	—0.311	.577	—0.471	+0.042	—0.269
.698	—1.395	+0.079	—0.314	.579	—0.474	+0.053	—0.296
.701	—1.417	+0.099	—0.313				
.703	—1.411	+0.089	—0.307	104.579	+0.442:	—0.038:	—0.275:

J. D. 2438 . . .	Δy	$\Delta(b-y)$	$\Delta(u-b)$
104.584	+0.450	−0.066	−0.299
.586	+0.426	−0.045	−0.261
.591	+0.364	−0.031	−0.254
.592	+0.424	−0.089	−0.310
113.563	+0.610:	−0.098:	−0.247
.568	+0.638	−0.109	−0.244
.569	—	—	−0.246
.573	+0.609	−0.074	−0.245
.575	+0.645	−0.103	−0.258
.578	+0.618	−0.078	−0.257
.580	+0.627	−0.081	−0.266
114.564	+0.870	−0.134:	−0.246:
.569	+0.825	−0.099	−0.253
.570	+0.829	−0.110	−0.253
.572	+0.828	−0.114	−0.245
.576	+0.838	−0.119	−0.255
.578	+0.834	−0.111	−0.255
.581	+0.832	−0.099	−0.256
.583	+0.838	−0.105	−0.258
118.549	+0.528	−0.082	−0.233
.551	+0.540	−0.077	−0.249
.568	+0.527	−0.062	−0.271
.569	+0.534	−0.082	−0.235
.573	+0.533	−0.072	−0.242
126.539	+1.144	−0.175	−0.223
.541	+1.146	−0.170	−0.233
.545	+1.147	−0.167	−0.234
.547	+1.160	−0.173	−0.242
.551	+1.176	−0.197	−0.238
.553	+1.176	−0.143	−0.217
.555	+1.178	−0.187	−0.235
159.515	+1.775	+0.110	−0.038
.516	+1.781	—	—
.522	+1.738	+0.125	−0.076
.524	+1.759	+0.136	−0.073
.527	+1.783	+0.129	−0.038
.534	+1.758	+0.109	−0.077
.536	—	—	−0.070
.544	+1.775	—	—
.549	+1.793	+0.062	−0.092
.553	+1.779	+0.063	−0.059
.555	+1.756	+0.059	−0.072
.562	+1.773	+0.213	−0.186
.565	+1.772	+0.084	−0.066
.567	+1.770	+0.079	−0.060
160.444	+1.849	+0.088	−0.078
.446	+1.841	+0.074	−0.046
.452	+1.832	+0.081	−0.026
.454	+1.847	+0.074	−0.049
180.404	+2.358	+0.268	—

J. D. 2438 . . .	Δy	$\Delta(b-y)$	$\Delta(u-b)$
180.405	+2.274	+0.364	—
.410	+2.265	+0.311	—
.417	—	—	−0.004
.417	—	—	+0.005
.421	—	—	+0.006
.422	—	—	+0.017
.427	+2.291	+0.273	+0.032
.428	+2.319	+0.247	+0.028
.430	+2.317	+0.263	+0.016
.431	+2.353	+0.234	+0.003
197.486	+2.459	+0.339	+0.094
.493	+2.421	+0.396	—
.495	+2.407	+0.372	+0.082
.509	+2.477	+0.354	+0.062
.511	+2.463	+0.335	+0.097
.519	+2.457	+0.380	+0.104
.521	+2.505	+0.356	+0.145
.523	+2.478	+0.362	+0.088
220.375	+2.698	+0.514	+0.252
.377	+2.691	+0.511	+0.276
223.353	+2.778:	+0.519:	+0.272
.356	+2.746:	+0.554:	+0.229
.362	+2.762	+0.526	+0.291
.364	+2.732	+0.551	+0.287
.369	+2.751	+0.565	+0.275
.371	+2.828:	+0.462:	+0.278
.373	+2.728	+0.541	+0.297
.379	+2.740	+0.556	+0.293
.381	+2.752	+0.521	+0.278
224.504	+2.710	+0.599	+0.279
.507	+2.716	+0.576	+0.307
.512	+2.697	+0.606	+0.280
.515	+2.709	+0.577	+0.277
.539	+2.760	+0.576	+0.194
.547	+2.721	+0.548	+0.348
.549	+2.740	+0.633	+0.258
236.506	+2.872	+0.701	—
.514	+2.871	+0.694	+0.323
.519	+2.857	+0.683	+0.274
.521	+2.860	+0.697	+0.380
.526	+2.855	+0.709	—
.528	—	—	+0.226
.530	+2.870	+0.673	—
.531	—	—	+0.301
241.519	+2.925	+0.673	+0.391:
.521	+2.953	+0,607	+0.437:
.547	+2.904	+0.664	+0.446:
.549	+2.946	+0.654	+0.542:
253.477	+3.022	+0.727	+0.490
.481	+3.004	+0.841	+0.385

J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
253.508	+3.044:	+0.591:	+0.339:
.511	+3.020:	+0.641:	+0.292:
.519	+3.016	+0.612	+0.344
.526	+3.045:	+0.608:	+0.285:
261.508	+3.107	+0.898:	+0.358:
.515	+3.064	+0.930	+0.374
.520	+3.102:	+0.919:	+0.379
.525	+3.110	+0.915:	+0,403:
285.415	+3.369	+1.023:	+0.379:
.430	+3.388	+1.047:	+0.463:
292.413	+3.464:	+1.083:	+0.359:
.417	+3.416	+1.110	+0.416
422	+3.404	+1.116	+0.421
.427	+3.419	+1.097:	+0.388:
305.398	+3.478	+1.107	+0.457
.403	+3.568	—	—
.409	—	—	+0.613:
.416	+3.481	+1.139	+0.419
322.343	+3.710	+1.226	+0.436
.348	+3.725	+1.214	+0.453
.354	+3.708	+1.231	+0.548
.359	+3.701	+1,180	+0.473
338.297	+3.810	+1.350	+0.409
.302	+3.802	+1.372	+0.353
.306	+3.860	+1.325	+0.329
.312	+3.847	+1.326	+0.398
.317	+3.868	+1.204	+0.452
345.278	+3.862	+1.383	+0.394
.285	+3.901	+1.387	+0.242
.291	—	—	+0.485
.297	+3.891	+1.319	+0.467
302	+3.876	+1.276	+0.571
352.290	+3.965	+1.365	+0.388:
.297	+3.950	+1.338	+0.438
.303	+3.993	+1.359	+0.404
.311	+3.946	+1.396	+0.339
371.199	+4.114	+1.432:	+0.303:
.205	+4.121	+1.385	+0.356
208	+4.104	+1.425	+0.384
.213	+4.117	+1.412	+0.356
.217	+4.049:	+1.502:	+0.380
.222	+4.170:	+1.372:	+0.320:
387.185	+4.223	+1.476:	+0.407:
.192	+4.219	+1.441	+0.262
.197	+4.223	+1.397	+0.406
.204	+4.201	+1.502	+0.380
.209	+4.249	+1.409	+0.351
.214	+4.250	+1.433:	+0.358:

J. D. 2438 ...	Δy	$\Delta(b-y)$	$\Delta(u-b)$
439.639	+4.656	+1.512:	+0.442:
.662	+4.639	+1.467:	+0.368:
.670	+4.604	+1.492	+0.387
.675	+4.629	+1.529	+0.318
.681	+4.668	+1.458:	+0.275:
473.599	+4.970	+1.566	+0.130
.604	+4.961	+1.587	+0.261
.609	+4.959	+1.553	+0.173
492.542	+5.047	+1.480:	+0.270:
.549	+5.199	+1.485	+0.178
.555	+5.031	+1.257	+0.352
.561	+5.137	+1.508	+0.293
.565	+5.073	+1.482	+0.221
.571	+5.094	+1.382	+0.351
497.503	+5.200	+1.317	—
.506	+5.081	+1.411	—
.509	+5.063	+1.414	—
.512	+5.156	+1.346	—
.524	+5.166	+1.347	—
.527	+5.153	+1.468	—
.528	+5.168	+1.336	—
.535	+5.149	+1.473	—
.538	+5.201	+1.333	—
.541	+5.187	+1.288	—
.547	+5.088	+1.417	—
.550	+5.152	+1.352	—
.553	+5.138	+1.446	—
.562	+5.177	+1.451	—
.564	+5.116	+1.424	—
.568	+5.206	+1.397	—
.578	+5.222	+1.380	—
.580	+5.239	+1.332	—
.588	—	—	+0.271
.589	+5.142	+1.322	—
.593	+5.162	+1.381	—
.595	+5.172	+1.288	—
.604	+5.154	+1.377	—
.607	+5.135	+1.417	—
.610	+5.194	+1.450	—
522.429	—	—	+0.064
.432	+5.311	+1.441	—
.436	+5.321	+1.419	+0.068
.438	+5.292	+1.463	+0.223
.443	+5.305	+1.394	+0.263
.535	+5.286	+1.468	+0.193
.539	+5.347	+1.384	—
.540	+5.384	+1.374	—
.545	—	—	+0.135
.550	+5.391	+1.400	—
.551	+5.362	+1.323	—
.565	+5.335	+1.468	—
.566	+5.371	—	—

J. D. 2438...	Δy	Δ(b−y)	Δ(u−b)
524.495	+5.349	+1.328	+0.294
.498	+5.353	+1.371	+0.196
.555	+5.365	+1.269	+0.432
.560	+5.477	+1.219	+0.336
.563	+5.429	+1.345	+0.269
528.473	+5.398	+1.253	+0.225
.480	+5.451	+1.400:	−0.109:
.492	+5.359	+1.356	+0.136
.502	+5.354	+1.370	+0.155
.511	+5.393	+1.411	+0.040:
.514	+5.398	+1.348	+0.179
.520	+5.412	+1.343	+0.168
.526	+5.368	+1.366	+0.198
.530	+5.401	+1.420	+0.054
.538	+5.381	+1.412	+0.113
.545	+5.388	+1.396	+0.168
529.477	+5.418	+1.350	+0.422
.484	+5.415	+1.381	+0.160
.490	+5.403	+1.330	+0.152
.497	+5.425	+1.318	+0.176
.500	+5.432	+1.360	+0.141
549.436	+5.613:	+1.251:	+0.131:
583.378	+5.947:	+1.209:	+0.003
.385	+5.790	+1.459	+0.302
.391	+5.892	+1.477	−0.029
.399	+5.852	+1.394	0.000
.407	+5.866	+1.261	+0.212
.416	+5.903:	+1.233:	+0.120:
586.365	—	—	+0.038
.372	+5.772	+1.246	+0.066
.375	+5.769	+1.155	+0.157
.378	+5.795	+1.147	—
.382	+5.728	+1.181	+0.130
.384	+5.727	+1.284	+0.177
.389	+5.792	+1.253	+0.192
.391	+5.805	+1.183	—
.393	—	—	+0.208
.395	+5.780	+1.271	+0.162
.399	+5.784	+1.228	+0.148
586.403	+5.790	+1.235	+0.085
.407	+5.786	+1.189	+0.058
.409	+5.769	+1.270	+0.068
.411	+5.782	+1.289	—
.415	+5.837	+1.248	+0.007
.420	+5.795	+1.260	+0.137
.422	—	—	+0.222
.424	+5.808	+1.194	+0.076
.427	+5.804	+1.178	+0.131:
.430	+5.817	+1.144	+0.044:
.433	+5.803	+1.249:	+0.062
607.379	+5.835	+1.162	+0.042
.388	+5.855	+1.137	−0.018:
.393	+5.917	+1.172	+0.254
.396	+5.916	+1.348	−0.040
.404	+5.924	+1.130	+0.078
.407	+5.867	+1.185	+0.046
.415	+5.821	+1.169	+0.240
.419	+5.843	+1.228	+0.047
.427	+5.942	+1.147:	+0.105:
615.334	+6.048	+1.185	+0.143
.339	+6.040	+1.231	−0.004
.347	+5.971	+1.351	−0.031
.352	+6.056	+1.224	+0.098
.396	+5.976	+1.296	+0.114
.401	+6.070	+1.260	+0.059
.407	+6.018	+1.322	+0.042
.412	+5.986	+1.352	+0.241
.443	+6.103	+1.318	+0.114
.449	+6.104	+1.182	—
.453	+5.998	+1.303	—
.483	+5.993	+1.084	—
.488	+5.949	+1.277	—
.505	+5.993	+1.055	—
.510	+6.063	+1.030:	—
671.298	+6.276	+1.937:	+0.195:
.306	+6.210	+1.098	+0.037
.313	+6.269	+1.088	−0.012
.323	+6.174	+1.078	+0.075
.332	+6.286	+1.150	−0.076
.341	+6.260	+1.076	−0.053

REDUCTION

The reduction of a long series of medium-band width photoelectric observations of a nova to a homogeneous photometric system is hampered by the fact, that the necessary changes over to fainter and fainter comparison stars may be accompanied by gradual changes in the photometric system. Nevertheless it is unadvisable to rely on a single comparison star for a large interval of magnitudes because this would reduce the accuracy of the measurements.

Average values of the principial coefficients (k′ and k'_c) and second-order coefficients (k''_c) of the atmospheric extinction were determined separately for each observing season using all material available at the observatory. Observed magnitudes and colour-indices were corrected for atmospheric extinction (differential extinction included) according to the relations [1]:

$$\Delta y_0 = \Delta y - k_y \Delta X$$
$$\Delta(b-y)_0 = \Delta(b-y)J_x - k'_{by}\Delta X$$
$$\Delta(u-b)_0 = \Delta(u-b)G_x - k'_{ub}\Delta X$$

The resulting extra-atmospheric quantities are not directly comparable because of the lack in uniformity of the whole photometric system. As a constant reference source of light was not available, the transformation coefficients ε, μ, ψ had to be derived by means of several Johnson standard stars. Colours and/or magnitudes of 2–6 suitably chosen standard stars were measured on 9 nights, together with the determination of UBV magnitudes of the comparison stars (see Table I). Average transformation coefficients are given in Table III as a function of time.

Table III

	1963			1964	
	II–IV	V–VIII	IX–XII	I–VI	VII–XII
ε	−0.15	−0.15	−0.15	−0.15	−0.15
μ	0.86	1.02	1.02	1.00	1.00
ψ	0.84	1.08	1.00	0.95	0.91

We decided to reduce all observations to the photometric system of our telescope from Sept. to Dec. 1963 as standard. Data reduced to this photometric system are marked with u, b, y. The transformation to the UBV system which involves a considerable shift in the effective wave-length, is inadmissible in peculiar stars like novae, where spectral deviations from blackbody characteristics are so pronounced. We hoped that a natural system of our own would be more realistic in this particular case. Magnitudes and colours transformed to the "1963 IX–XII" system are given by

$$\Delta y = \Delta y_0$$
$$\Delta(b-y) = \frac{\mu}{1.02}\Delta(b-y)_0$$
$$\Delta(u-b) = \psi\Delta(u-b)_0$$

where the coefficients come from Table III.

Finally however a unified magnitude and colour sequence of the 5 comparison stars in the new photometric system was needed. It was obtained by making two kinds of observations: 1. special connections to Johnson standard stars on 8 nights as mentioned above, 2. simultaneous observations of comparison stars (sometimes alternately with the nova itself) on 30 nights. Both kinds of results were reduced to the "1963 IX—XII" system using the known ε, μ, ψ values. Suitable sequences of magnitudes and colours of the 5 comparison stars were established by trial and error. Table IV gives the result in respect to BD + 42°3035 which was the comparison star used almost exclusively by all observers of Nova Her 1963.

Table IV

	y	$b-y$	$u-b$
B—A	+2.989	+0.494	+0.508
C—A	+3.369	+0.987	+1.125
D—A	+5.119	+1.095	+1.225
F—A	+5.452	+0.480	+0.604

Table II contains heliocentric Julian Dates of the observations and all y, $b-y$ and $u-b$ values relative to BD + 42°3035. Observations in respect to other comparison stars were transformed according to Table IV; double (simultaneous) measurements, after being reduced to BD + 42°3035, are simply averaged. Uncertain values are denoted by a colon. Table V contains for every separate night, mean values of Δy, $\Delta(b-y)$ and $\Delta(u-b)$; they are plotted in figures 2 and 3.

Standard deviations on a night of moderate quality in 1963 are $0^{m}_{.}025$ in yellow, $0^{m}_{.}006$ in blue, $0^{m}_{.}018$ in ultraviolet and in 1964 $0^{m}_{.}026$ in yellow, $0^{m}_{.}048$ in blue and $0^{m}_{.}068$ in ultraviolet. The lack of observations in April 1963 is due to the lengthy delay of the new coating of the mirror.

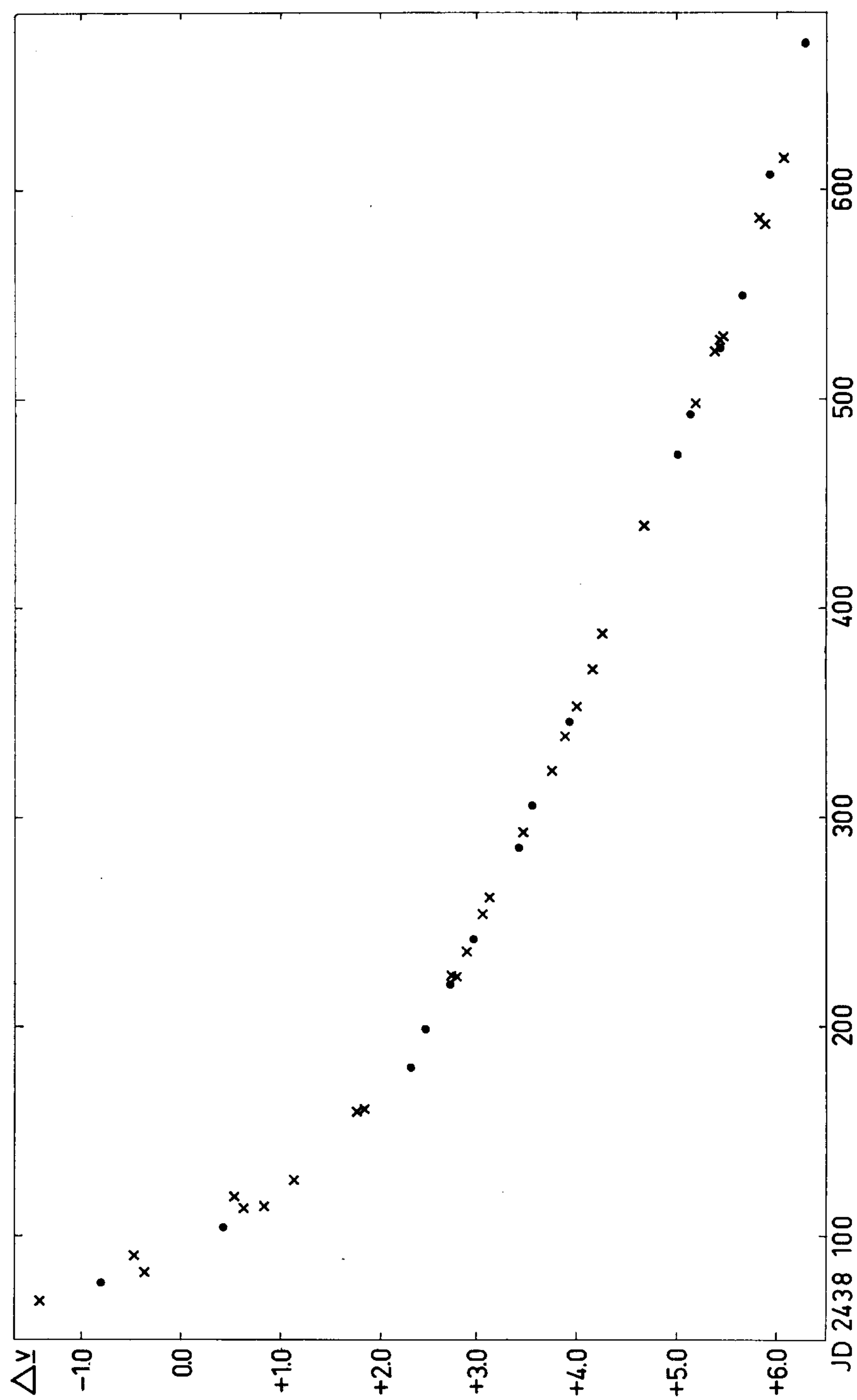

Fig. 2. Magnitude differences between Nova Her 1963 and BD + 42°3035 in yellow according to Table V, obtained at the Konkoly Observatory. Uncertain observations are denoted by points.

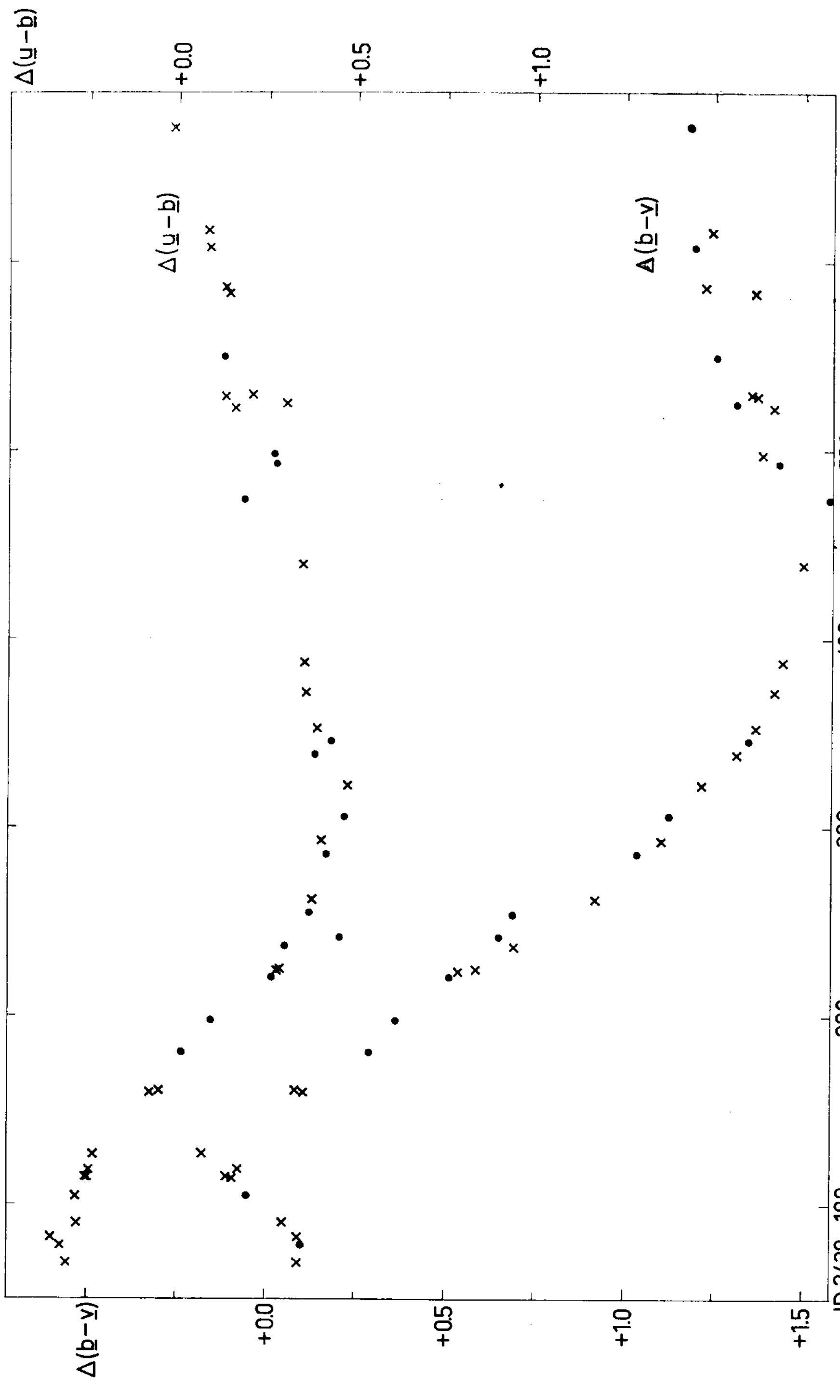

Fig. 3. Colour-index curves according to Table V, obtained at the Konkoly Observatory. Uncertain observations are denoted by points.

Table V.

J. D. 2438...	Δy	$\Delta(b-y)$	$\Delta(a-b)$
069.667	−1.409	+0.093	−0.309
078.614	−0.804:	+0.096:	−0.324
082.607	−0.372	+0.090	−0.349
090.575	−0.472	+0.051	−0.277
104.586	+0.419:	−0.055:	−0.280
113.573	+0.625	−0.090	−0.252
114.574	+0.837	−0.110	−0.253
118.562	+0.532	−0.075	−0.246
126.546	+1.161	−0.173	−0.232
159.543	+1.770	+0.106	−0.076
160.449	+1.842	+0.079	−0.050
180.421	+2.311:	+0.280:	+0.013:
197.508	+2.458:	+0.362:	+0.097:
220.376	+2.695:	+0.512:	+0.264:
223.368	+2.753	+0.537	+0.278
224.525	+2.722	+0.588	+0.281
236.521	+2.864	+0.693	+0.301:
241.534	+2.932:	+0.649:	+0.454:
253.504	+3.021	+0.689:	+0.373:
261.517	+3.096	+0.918	+0.378
285.423	+3.379:	+1.035:	+0.421: .
292.420	+3.425	+1.105	+0.404
305.407	+3.509:	+1.123:	+0.473:
322.351	+3.711	+1.213	+0.478
338.307	+3.837	+1.315	+0.388:
345.291	+3.882:	+1.345:	+0.432:
352.300	+3.963	+1.365	+0.393
371.211	+4.113	+1.417	+0.358
387.200	+4.228	+1.441	+0.356
439.665	+4.639	+1.497	+0.356
473.604	+4.963:	+1.569:	+0.188:
492.557	+5.097:	+1.428:	+0.278:
497.556	+5.159	+1.382	+0.271:
522.475	—	—	+0.158
.506	+5.337	+1.413	—
524.534	+5.395:	+1.306:	+0.305
528.512	+5.391	+1.369	+0.132
529.490	+5.419	+1.348	+0.210
549.436	+5.613:	+1.251:	+0.131:
583.396	+5.865	+1.362	+0.141
586.402	+5.786	+1.220	+0.134
607.403	+5.880:	+1.189:	+0.089
615.380	—	—	+0.086
.421	+6.025	+1.238	—
671.319	+6.246:	+1.174:	−0.012

DISCUSSION

a) Beside the numerous visual and photographic observations [2, 3, 4, 5, 6, 7, 8, 9] a lot of excellent photoelectric measurements of Nova Her 1963 has been published by several observers up to the present time [10, 11, 12, 13, 14, 15]. Though their photometric system may be entirely different, it is tempting to try a comparison of the light curves obtained. The greatest number of observations of the nova was accomplished in the first 3 months after its maximum:

Peking [14]	1963 Febr. 17 — Nov. 19
Tokyo [13]	1963 Febr. 9 — Apr. 21
Leiden [12]	1963 Febr. 22 — Oct. 18
Asiago [10]	1963 Febr. 10 — May 25
Vilnius [11]	1963 Febr. 12 — March 22
(Budapest	1963 Febr. 9 — 1964 Oct. 2)

In the first two cases measurements are directly expressed relative to BD $+ 42°3035$. Nevertheless UBV magnitudes and colours of this near-by star are given by all the observers:

	V	B−V	U−B
Peking	5.57	−0.15	−0.42
Tokyo	5.54	−0.12	−0.53
Leiden	5.602	−0.065	−0.447
Asiago	5.60	−0.19	−0.39
Vilnius	5.62	−0.14	−0.39
(Budapest	5.55	−0.13	−0.49)

In the other three cases it was easy to reduce UBV values of the nova to u, b, y varying the magnitudes of BD $+ 42°3035$ and a reasonable coincidence could be obtained. Figure 4 gives the composite light curves compiled from measurements made in different photometric systems in the first 66 days after the nova's maximum. The complicated and irregular light variation of the nova (frequently averaged out in visual or photographic light curves) can be traced from the very beginning. The remarkable coincidence of the observations seems to be the consequence of the relatively flat intensity distribution in the spectrum of the nova on these days, whereby the intensity measurements are insensitive to changes in the effective wave length.

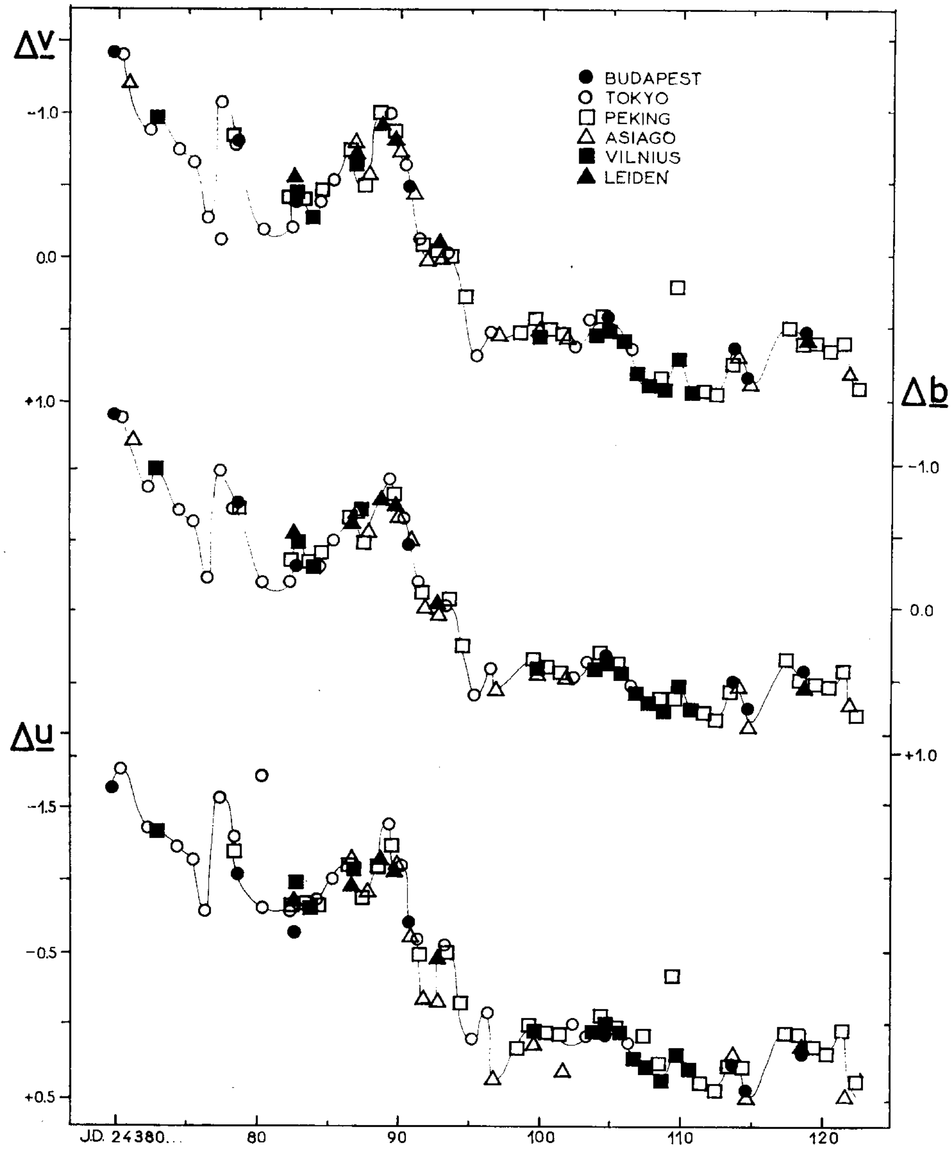

Fig. 4. All magnitude differences between Nova Her 1963 and BD + 42°3035 in ultraviolet, blue and yellow, obtained at different observatories before Apr. 4 1963.

It is worth while noting that these very pronounced light fluctuations, with a pseudo-period of from 1.5 to 3 days, apparently did not have an effect on the colour-indices (see Fig. 3). At the beginning of April there was a break on the $b-y$ colour curve and about May 10 the character of the light curves in all the three colours changed, i.e. light fluctuations came to a sudden end.

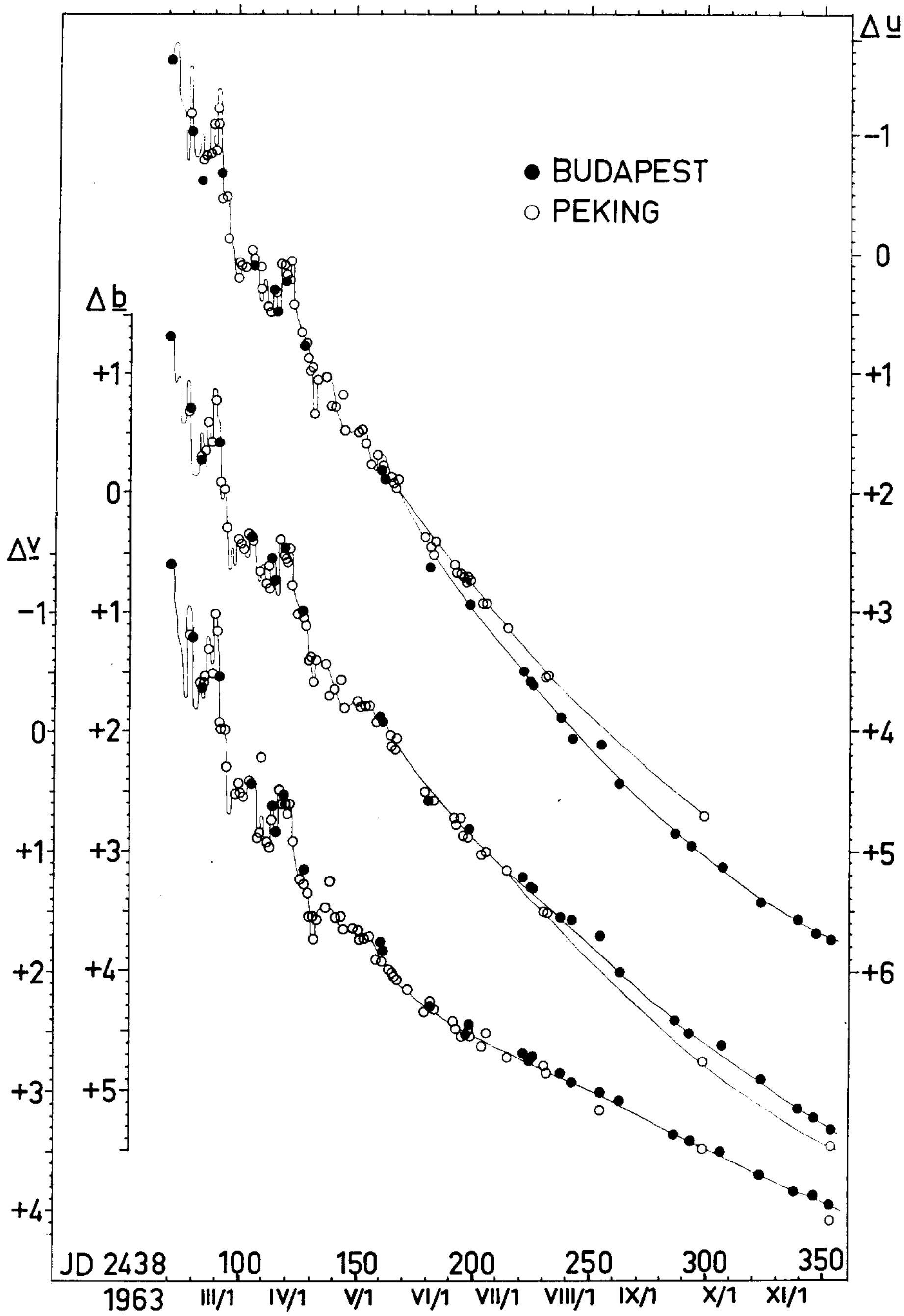

Fig. 5. Magnitude differences between Nova Her 1963 and BD + 42°3035 obtained at the Budapest and Peking observatories. The solid lines were plotted following Fig. 4.

From that point on there is no coincidence between our light curves and those published in the literature; the role of the effective wave length in the photometry of the nova became decisive. One exception is to be emphasized. The filters used at the Peking Astronomical Observatory being identical with ours, our findings also agree in the later part of the corresponding light curves (Fig. 5). This experience shows that medium-band width photoelectric observations of even such peculiar stars as novae are comparable in certain cases. The absence of fluctuations on this second part of the light curves has been stated also by *Breckinridge* [15].

In the third part of the light curves other photoelectric observations are missing for comparison. In order to study possible fluctuations longer series of observations were carried out in 1964. During several nights quick, irregular variations were found. The curves reproduced in Fig. 6 are typical examples. In the diagrams magnitudes and colours in respect to both comparison stars are plotted separately, showing the variation in the mutual relative y, $b-y$, $u-b$ values of the comparison stars too. The existence of quick brightness and colour fluctuations seems to be established. More confidence was given to the reality of this phenomenon from the fact that one year later rapid changes in different colours were observed also at the Lick Observatory from where we have received the following private communication from Dr. G. Chincarini: "During the night June 29/30 1965 the nova was observed with the 24" reflector of the Lick Observatory in order to get measurements in the u, b, v colours. On this night the integrator with 10 sec integration time was used. Since the signal was not as constant as for normal stars the nova was kept on the diaphragm for about 1^h. Changes in u and b magnitudes were observed. Because of the good quality of the sky and the constancy of the equipment (checked as usual with a radium source) we accepted it as a fact. The next night, I had the telescope, was on July 7/8 1965. The star was then observed for 90 min. almost only in the u colour and the telescope was checked by the radium source every 8 min. A direct current amplifier was used. The night was photoelectrically good and the sky was measured every 15 min. The brightness of the sky was however very low. In figure 7 the u and b magnitudes are given in an arbitrary scale. The nova seems to show rapid casual fluctuations. However the observations are not enough to see if any periodicity is present."

One of us had the opportunity to continue the photoelectric observations of Nova Her 1963 with a photometer attached to the 122 cm reflector of the Asiago Astrophysical Observatory (Italy). The light curves (without a filter) on 16 and 28 March 1966 indicate in addition to short-period fluctuations the presence of a minimum of approximately 40 min. duration and 0.1 mag. depth, similar to partial eclipses of Algol type binaries. (Observations: Table VI, composite light curve: Fig. 8.) The periodicity of the phenomenon has not been ascertained [31].

Dr. G. Chincarini and S. Howard announce [32], however, that according to new observations carried out at Lick Observatory on the nights April 20, 21, 22 and 27 1966 the light curve of the nova is characterized by *a)* fluctuations of amplitude between 0.2 and 0.1 magnitudes and lasting from 5 to 50 minutes, *b)* overimposed a few minima with amplitude of 0.1 — 0.2 magnitudes and lasting only 15 minutes.

More observations are urgently needed in order to understand the nature of the fluctuations.

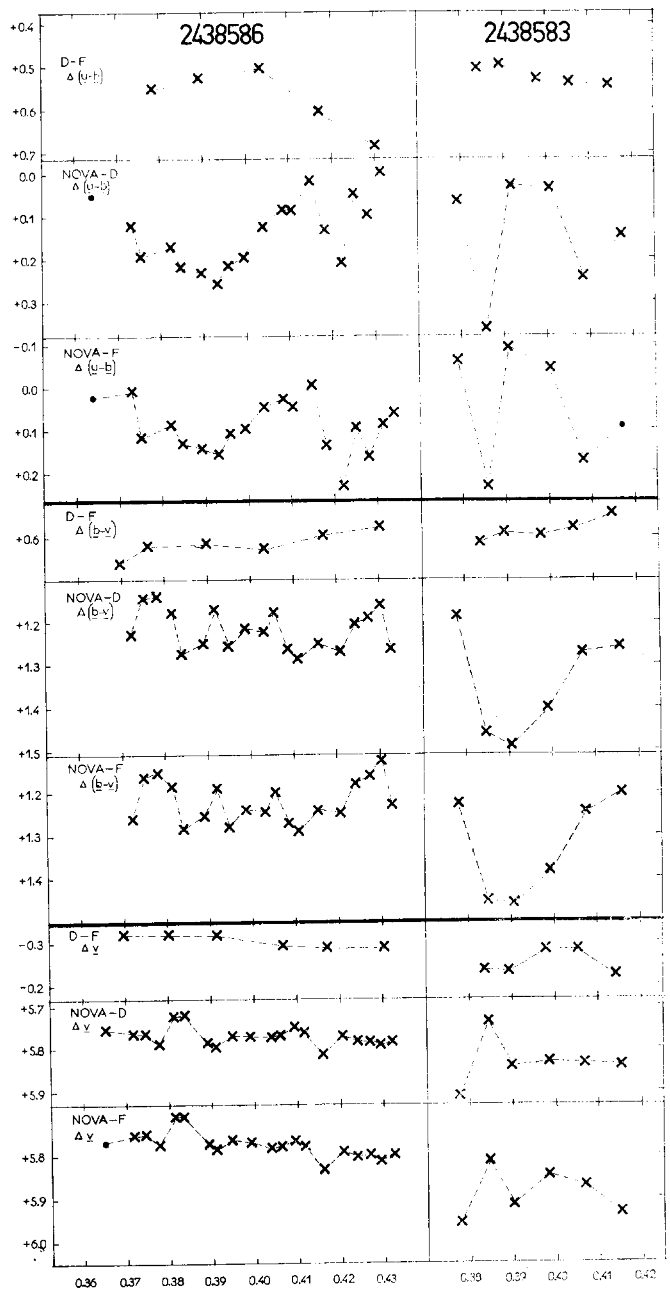

Fig. 6. Examples of rapid fluctuations in brightness and colour of the nova in 1964. Relative light and colour curves of the near-by comparison stars are published as control observations.

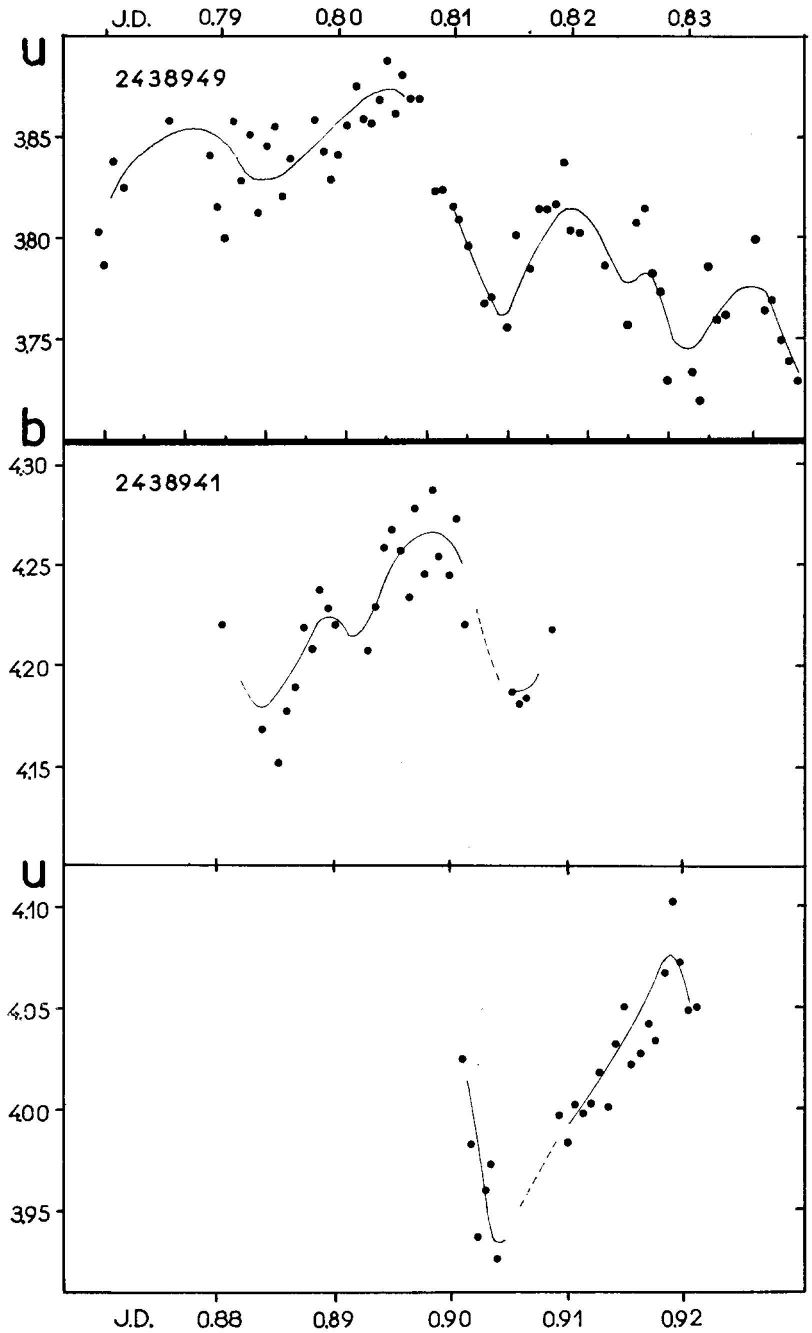

Fig. 7. Dr. Chincarini's observations at the Lick Observatory in blue and ultraviolet, in 1965.

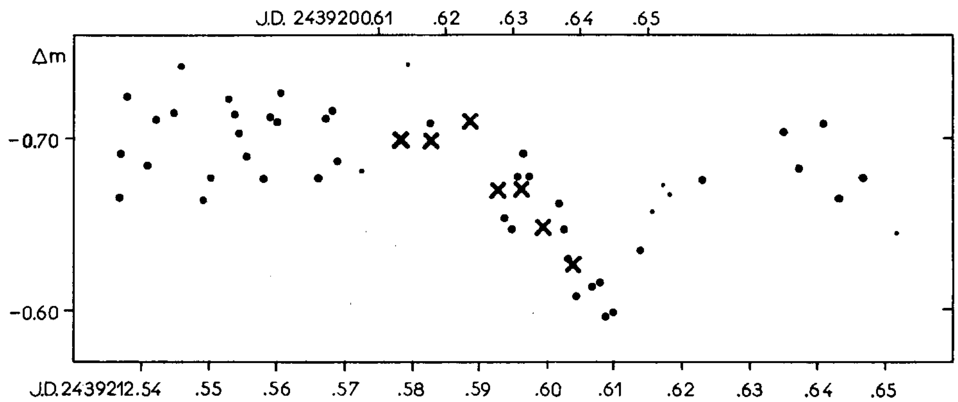

Fig. 8. The light curve of Nova Her 1963 composed from observations on 16 and 28 March 1966 carried out at the Asiago observatory. (16 March: crosses, 28 March: points)

Table VI

J. D. 2439 . . .	Δm	J. D. 2439 . . .	Δm
200.6134	—0.699	.5723	—0.680:
.6176	—0.698	.5793	—0.742:
.6235	—0.709	.5827	—0.708
.6276	—0.669	.5938	—0.653
.6311	—0.670	.5949	—0.648
.6346	—0.648	.5956	—0.678
.6389	—0.627:	.5966	—0.691
212.5365	—0.665	.5973	—0.677
.5369	—0.690	.6018	—0.662
.5376	—0.724	.6025	—0.647
.5407	—0.684	.6032	—0.630
.5420	—0.710	.6043	—0.608
.5448	—0.714	.6070	—0.615
.5458	—0.741	.6078	—0.616
.5490	—0.663	.6088	—0.597
.5501	—0.676	.6098	—0.599
.5529	—0.722	.6140	—0.634
.5539	—0.713	.6157	—0.657:
.5545	—0.702	.6171	—0.672:
.5556	—0.689	.6182	—0.667:
.5580	—0.676	.6230	—0.676
.5591	—0.711	.6348	—0.704
.5598	—0.709	.6373	—0.683
.5605	—0.726	.6407	—0.709
.5661	—0.675	.6432	—0.666
.5671	—0.711	.6466	—0.678
.5678	—0.715	.6515	—0.645:
.5688	—0.686		

b) There is a wellknown method of *Vorontsov-Velyaminov* [16] to distinguish between different parts of the light curve of a nova, plotting magnitudes against log $(t-t_0)$. He stated that the light curve of all but very slow novae can be transformed into straight lines using the logarithm of the number of days which have elapsed since maximum $(t-t_0)$ on the axis of abscissas. It means that light curves of novae are composed from sections, all satisfying the same exponential equation.

$$t = t_0 + 10^{\frac{m-m_i}{b_i}} \qquad i = 1,\ 2,\ 3, \ldots$$

with different m_i and b_i values. Though the maximum of Nova Her 1963 was not observed, several authors agree in its datum as January 27, 1963. Transforming the light curves by *Vorontsov-Velyaminov*'s method we obtained points on a curved, instead of a straight line for the first part of each of the light curves. In order to express the equation of each part of the light curves in the form given above, we tried to determine an optimum set of parameters (t_0, b, m_0) from three points selected arbitrarily on the first part of each of the light curves $\left(m_1, t_1;\ m_2, t_2;\ m_3 = \frac{1}{2}\ (m_1 + m_2),\ t_3\right)$:

$$t_0 = \frac{t_1 t_2 - t_3^2}{t_1 + t_2 - 2t_3}$$

From that point on, where the observed curve bent from the calculated one, we repeated the procedure and similarly deduced a new set of parameters. Resulting t_0 values are somewhat surprising:

t_0 (J.D.24380 . . .)

	part 1	part 2	part 3
y	36	01	95
b	26	26	26
u	26	26	26

After we have found that $t_0 = 2438026$ gave an entirely satisfactory solution in all three colours, we used it as a common zero point, in spite of the fact, that it was definitely earlier than any possible moment for the maximum. It is essential only that its use permits us to transform the light curves into a series of straight lines, not only in the case of the Budapest observations, but for all other photoelectric material. As has been stated already, light curves of different authors coincide in the first part, and that of Hungarian and Chinese observations in the second part of all light curves. This suggestion manifests itself clearly in Fig. 9 where observed Δu, Δb, Δy values are plotted against log $(t-2438026)$. In the second part of the diagram, after the first break, there is a definite divergency between the corresponding sections of the logarithmic light curves of different authors, at least, in one colour. For the sake

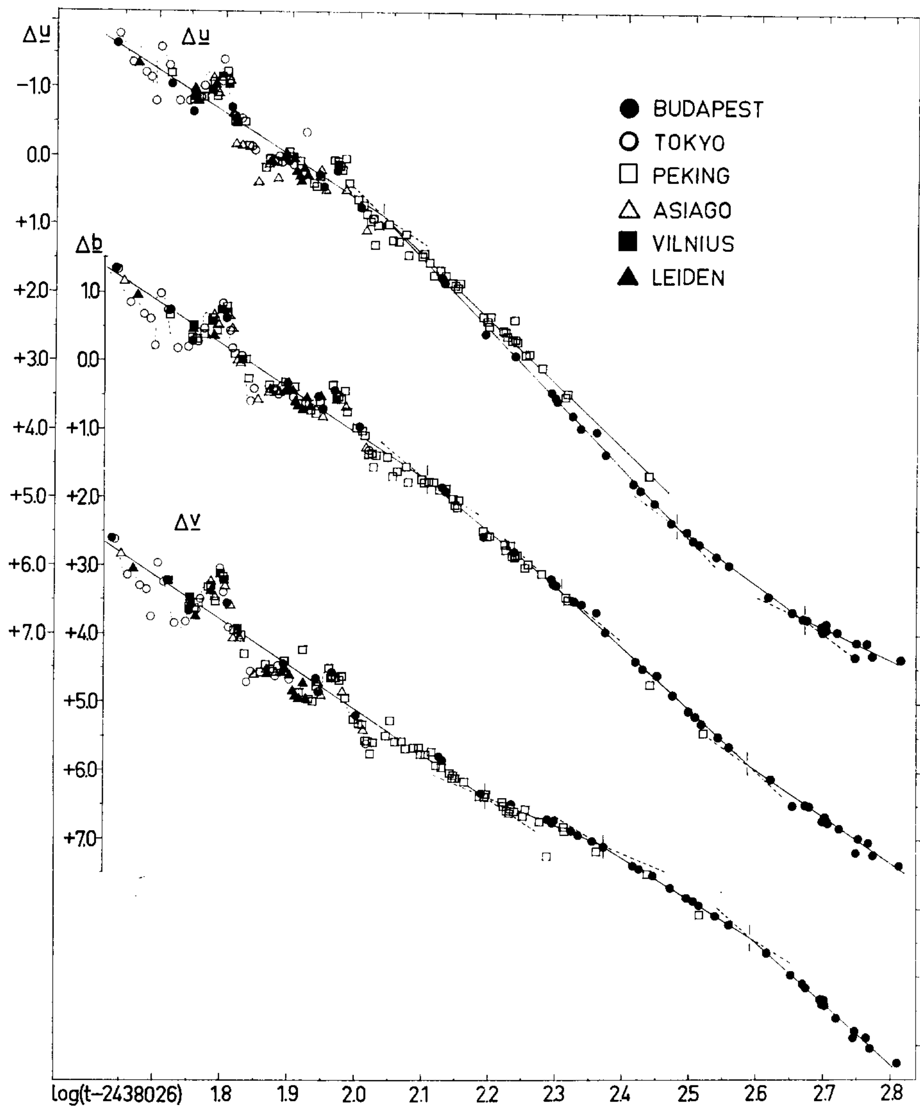

Fig. 9. Magnitude differences between Nova Her 1963 and BD + 42°3035 versus logarithm of time interval $t-t_0$, where $t_0=2438026$.

of clarity after 20 Apr. 1963 all observations of Vilnius, Tokyo, Leiden and Asiago were omitted. The slope of all straight lines (b_1, b_2, . . .), however, are given in Table VII.

Dates of changes in the slope of the broken lines in Fig. 9 are listed in Table VIII.

Table VII

	y				b				u			
	h_1	h_2	h_3	h_4	h_1	h_2	h_3	h_4	h_1	h_2	h_3	h_4
Budapest	6.64	4.11	6.06	8.86	6.56	8.14	9.06	6.76	6.41	10.24	6.75	4.52
Peking				—			—	—		9.43	—	—
Tokyo		—	—	—		—	—	—		—	—	—
Asiago		9.57	—	—		—	—	—		10.44	—	—
Leiden	—	6.76	—	—	7.10	8.70	—	—	—	9.36	—	—

Table VIII

	$\log (t-t_0)$	t
u	2.037	2438135
	2.475	325
	2.660	483
b	2.105	2438153
	2.305	228
	2.580	406
y	2.193	2438182
	2.371	261
	2.587	413

It is worth while noting that three observational materials (Budapest, Leiden, Peking) afford the opportunity of determining independently the time of the first break (t_c) and the subsequent changes in the rate of decline. The same method applied to photographic observations by *Busch* [5] and *Hang-Heng-rong* etc. [9] yielded somewhat different results.

The "combined logarithmic light curves" also give proof of the statement in [14] that t_c values increase with effective wave length. Later there is no such simple relation.

From logarithmic light curves it is easy to deduce the brightness and colour of the nova at its maximum by simple extrapolation. Supposing that the maximum occured on January 27 and using our UBV $= u\,b\,y$ values for BD $+ 42°3035$ we obtain

$$y_{\max} = +3.18$$

$$(b-y)_{\max} = -0.04$$

$$(u-b)_{\max} = -0.79$$

or from the colour curves on Fig. 4

$$(b-y)_{\max} = -0.07$$

$$(u-b)_{\max} = -0.82$$

that is to say in the three colours respectively

$$y_{\max} = 3.18$$
$$b_{\max} = 3.11$$
$$u_{\max} = 2.29$$

According to *Schmidt* [17] the distance and the absolute magnitude of novae can be derived by means of the time needed for the first drop of 3 magnitudes in visual brightness (t_{3y}). Thus

$$M_{pg} = -11.5 + 2.5 \log t_{3y} = -7.13$$

yielding 1100 pc as a distance of Nova Her 1963. It is in the order of magnitude given by *Genderen* [12] and *Chincarini* [10].

There are, however, several thorough spectroscopic observations and investigations on Nova Her 1963 [18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29]. If we compare the evolution of the spectrum with that of the brightness in different colours the coincidence around April — May 1963 is apparent. The end of the "early decline" period at about 1 April, marked by the disappearance of absorption lines, by changes in the continuum and by sudden variation in the radial velocity derived from Orion type lines [18] is accompanied by the largest sudden decrease in brightness and by the prominent break in the $b-y$ curve. During the short transition stage the rate of decline changes in all colours, one after the other. The beginning of the nebular stage (about May 1), transforming the appearance of the whole spectrum, is marked on the light curves by the vanishing of fluctuations. The continuous evolution of the spectrum in the nebular stage is parallelled by the relative stability of the form of the light and colour-index curves. It would be undoubtedly interesting to compare in details spectral and photometric variations of novae during later stages of their evolution.

We should like to express our indebtedness to Prof. L. Rosino, Director of the Asiago Astrophysical Observatory, for having allowed us to use their photoelectric equipment; it is a pleasure to thank Dr. G. Chincarini for unpublished data and helping in the observations at Asiago; finally the help of Mr's L. Fodor, K. Gefferth, A. Gesztesi and K. Thaly in the observations and the reduction are gratefully acknowledged.

Budapest, July 1966

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ERRATA

In Mitteilungen der Sternwarte der Ungarischen Akademie der Wissenschaften Nr. **59** p. 9 last two equations read

$$(\mu_n - \mu_0)' = \frac{k\,\varkappa^2}{\bar{R}_n^2}(\mu_n - \mu_0)$$

$$\sin i' = \frac{\sqrt{\sin^2\varphi_0 - 2\sin\varphi_0\sin\varphi_n\cos(\mu_n - \mu_0)' + \sin^2\varphi_n}}{\sin(\mu_n - \mu_0)'}$$

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