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Photoelectric light curve of YY Eridani

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Abstract

Photoelectric light curves in B and V of the W Ursa Majoris star YY Eridani have been determined. Gradual lengthening of the period has been observed.

The light curve of the star YY Eridani, HD 26609, an eclipsing binary was obtained by a photoelectric photometer employing an RCA 1P21 photomultiplier tube, on twelve nights during December 1965—March, 1966 at Kodaikanal. The telescope used was a 20cm refractor. The signal from the photomultiplier was amplified by a linear D.C. amplifier and recorded on a potentiometric type stripchart recorder. The observations were taken in two colours, blue and yellow using standard glass filters of the UBV system with pass bands centred around 4500A and 5500A. For comparison, two other nearby stars were observed. The details of the three stars are given below:

Star	HD No.	(1950)	(1950)	Spectral type
YY Eridani . . .	26609	4h 9m 10s.125	- 10° 35′ 19″.58	G5, G5
Comparison . .	26650	4h 10m 9s.980	- 10 41′ 35″ .20	A5
Check . . .	26902	4h 12m 25s.410	- 10° 11′ 36′ .56	K0

Altogether 468 comparisons in blue and 422 in yellow light were obtained during this period. Six primary and three secondary minima were observed. It is found that to fit our observation with earlier ones by Cillie (1951) Haruhuta (1953), Kwee (1958) and Purgathofer (1961), a further change in the period must be assumed.

The new period is found to be near the value obtained by Purgathofer. The elements are well represented by the equation

$$\text{Min.} = \text{JD } 2433617^{d}.5197 + 0^{d}.32149630E$$

the epoch being counted from Cillie's well determined minima of JD 2433617.5197. The observed minima timings were found to be in excellent agreement to those calculated by the above equation.

The table below gives the residuals (O-C) for the six primary minima recorded.

TABLE I

Primary Minima of YY Eridani

Heliocentric J.D	Computed Times	Residual (O-C)
2439120.2503	2439120.2501	.0001
124.1085	124.1083	+ .0002
165.2596	165.2599	- .0003
166.2211	166.2213	--.0002
167.1886	167.1888	-.0002
187.1216	187.1216	+ .0000

The times of the three secondary minima were also determined and are tabulated in Table II. It is seen that the mean time interval between the secondary minima and the preceding primary minima is $0^{d}.1611$ which is $0^{d}.0003$ later than the midpoint of the cycle. This value is within the limits of error of the measurement and hence the secondary minima may be considered equidistant from the two nearby primary minima.

TABLE II

Secondary Minima of YY Eridani

Heliocentric J.D.	Computed time of previous primary min.	Residual (O-C)
2439162.2058	2439162.0449	.1609
165.0999	164.9901	.1615
181.1742	181.0132	.1610

The previous observers have noted a gradual lengthening of the period of this particular system. Our results also corroborate their findings. The results of the period change are represented in Fig. 1 where periods determined by several authors over the 33 year interval are plotted against the measured epochs. All the photoelectric observations can be fitted by a smooth curve. Considering the uncertainty in determining the actual times of minima by the photographic technique, the earlier photographic observations by Bodokia (1938) and Jensch (1934) can also be considered to be contained in the extended curve.

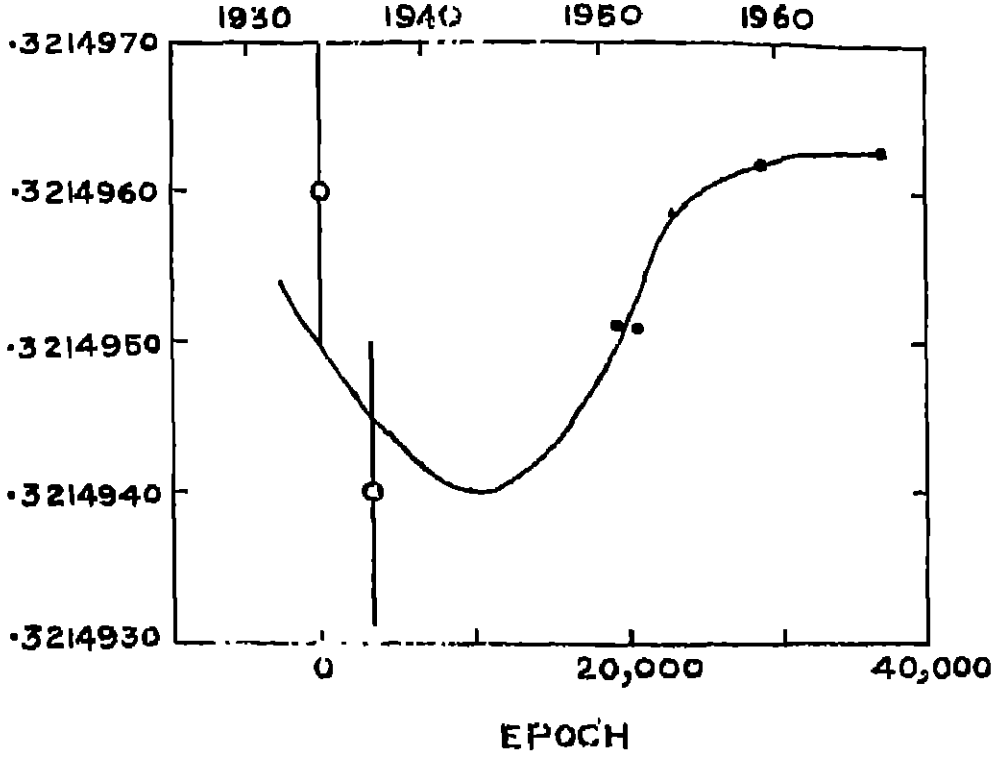

Fig. 1 Period Variation of YY Eridani

TABLE III

J.D.	Δm	J.D.	Δm
	Blue		
2439120.1642	— 017*	2439120.3253	—.189
.1696	.125	.3260	.215
.1677	125	.3309	.116
.1712	087	.3323	.169
.1788	109	.3337	.121
.1808	.185	.3350	.161
.1933	126	3378	.183
.1955	.093	.3387	.168
.2024	+ 007	.8431	.196
.2051	.015	.3161	.129
.2128	.125	.3189	.175
2156	031	9515	.062
.2219	091	.3566	.097
.2226	.058	.8586	.082
.2246	.081	.3308	.012
.2260	.195	.3649	.032
.2337	347	.3670	.045
.2357	.558	.3697	.099
.2371	408	.3701	.032
.2134	.117	.3716	.025
.2162	621	.3758	.080
.2182	600	.3771	.111
.2515	.477	.3705	—.008
.2572	509	2439162.0925	+ .324
2579	.151	.0939	.140
.2607	.590	.0991	.097
.2611	.517	.1008	.107
.2635	.570	.1022	.101
.2705	386	.1092	.068
.2725	.379	.1112	.035
.2733	.309	.1126	.116
.2707	191	.1168	.068
.2902	157	.1182	.078
.2929	.229	.1196	.053
.2930	.169	.1230	.106
.2892	.068	.1251	.080
.2027	.093	.1265	.079
.2911	.019	.1811	.222
.2976	— 032	.1320	.270
.2900	+ .026	.1125	.120
.3010	— 007	.1152	.077
.3052	026	.1166	.089
.3080	.097	.1180	.126
.3128	010	.1598	.201
.3140	.021	.1612	.267
.3169	.061	.1702	.193
.3205	.105	.1730	.230
.3226	.190	.1751	.273
.3292	.211		

*Observations on JD 2439120 were through a narrow band interference filter (±1%) centred round 4200Å.

TABLE III (*Contd.*)

J.D.	Δm.
2439162.1827	.311
.1831	.968
.1897	.193
1910	.333
.1921	.539
.1991	.712
.2001	.700
.2015	.669
.2022	.616
.2028	.677
.2095	656
.2042	.655
.2056	.626
.2077	.692
.2084	.611
.2160	.729
.2167	.561
.2174	461
.2230	.459
.2257	531
.2270	.501
.2382	.281
.2389	.330
.2480	.007
.2507	.278
.2521	.152
.2618	.007
.2072	.050
.2709	.025
2439165.0784	.480
.0798	.475
.0912	.598
.0819	.591
.0840	.561
.0853	.502
.0867	571
.0881	.637
.0902	.680
.0916	.619
.0944	.711
.0951	.753
.0958	.739
.0971	.795
.0985	.811
.1006	.745
.1020	.712
.1041	.690
.1055	.797
.1069	.652
.1082	.656
.1096	.622
.1159	.315
.1179	.169

J.D.	Δm.
2439165.1187	.106
.1193	427
.1200	381
.1263	295
.1284	.280
.1298	249
.1367	180
.1381	170
.1395	.118
.1485	.138
.1499	.120
.1517	.080
.1561	085
.1603	.022
.1652	.050
.1707	.193
.1728	.122
.1712	.095
.1811	099
.1832	.038
.1867	.019
.1891	.019
.1920	.026
.1961	.023
.1999	.074
.2020	101
.2017	.112
.2105	.141
.2130	198
.2392	.403
.2939	.360
.2101	.173
.2115	.191
.2436	.487
.2450	551
.2470	605
.2481	.647
.2503	.656
.2519	.707
.2533	.735
.2554	.720
.2575	706
.2595	647
.2609	.676
.2637	691
.2651	.629
.2665	.610
.2706	.346
.2734	.302
.2753	.323
2439166.1996	351
.1964	.295
.1998	.423

TABLE III (*Contd.*)

J.D	Δm
2439166.2039	.479
.2040	.472
2069	.506
.2110	.545
.2130	.610
.2151	.612
.2165	.690
2172	.748
2193	.812
.2207	.859
.2248	.783
.2262	.822
.2276	.788
.2290	.781
.2316	.732
.2332	.795
.2378	.619
2439167.1511	.174
1518	.240
.1553	.242
.1567	.272
.1587	.274
.1608	.300
.1657	.458
.1664	.494
.1685	.525
1698	.549
1719	.602
.1747	.661
.1761	.709
.1775	.759
.1789	.785
.1802	.782
.1816	.800
.1837	.799
.1851	.859
.1865	.806
.1893	.843
.1920	.788
.1927	.816
.1941	.769
.1955	.762
.1976	.738
.2018	.642
.2032	.586
.2053	.597
.2073	.505
.2108	.409
.2122	.357
.2156	.339
.2198	.278
.2267	.149
.2281	.135
.2323	.088

J.D	Δm
2439171.1013	.767
.1055	.679
.1381	.162
.1430	.144
.1457	+.122
.1561	−.003
.1575	+.110
.1589	.105
.1645	.029
.1698	.024
.1700	.057
.1714	.050
.1756	.053
.1769	.062
.1889	.091
.1901	.126
.1929	.056
.1961	.078
.2033	.085
.2051	.080
.2123	.096
.2141	.110
.2165	.141
.2227	.107
.2248	.162
.2304	.176
.2325	.191
.2345	.246
.2359	.252
.2380	.350
.2401	.415
.2443	.414
2439175.0059	.416
.0894	.850
.0977	.169
.0998	.209
.1026	+.196
.1421	−.008
.1435	.002
.1491	+.078
.1539	.050
.1615	.096
.1629	.093
.1718	−.147
.1740	.104
.1851	.080
.1872	+.018
.1900	.027
.1921	.099
.1942	.211
.1962	.204
.1983	.206
.2004	.375
.2032	.439

TABLE III (*Contd.*)

J.D	△m
2439175.2013	.471
.2112	.625
.2148	.716
2439176.0775	.228
.0837	.083
.0951	.061
.0879	.059
.0900	091
.0962	.098
.1011	.092
.1039	.069
.1122	.149
.1150	.098
.1220	117
1269	.068
.1337	.000
2439180.1007	.121
.1012	.133
.1076	.105
.1101	.118
.1201	.079
.1215	+ .068
.1295	− 012
.1305	+ .118
.1393	.016
.1391	.000
.1960	.007
1103	.041
.1116	.084
.1165	.013
.1186	.001
.1900	.041
.1514	.031
.1581	.079
.1562	.125
.1601	.206
.1618	.193
.1623	.159
.1615	.110
.1670	.100
.1688	.190
.1701	.182
.1757	.151
.1777	.191
.1826	.242
.1880	.339
.1916	.466
.1986	.589
.1999	575
.2062	.689
2439181.0770	.081
.0892	.011

J.D	△m
2439181.0816	.023
.0909	.023
.0930	027
·0999	·015
·1019	·070
·1075	·056
1103	017
·1131	·093
·1145	·079
·1159	·058
·1173	·085
·1199	·050
·1207	052
·1235	·075
·1256	·070
·1277	·084
·1291	·098
·1304	·102
·1318	·118
·1339	·139
·1353	·152
·1367	·157
·1402	·202
·1415	·213
·1429	·252
·1450	·264
·1461	·285
·1478	286
·1489	347
·1515	·353
·1526	378
·1575	415
·1589	·517
·1603	·508
·1624	·561
·1638	·564
·1651	·577
·1665	·599
·1686	·625
·1749	·676
·1760	·616
·1789	·611
·1818	·611
·1892	·584
·1880	·164
·1901	·455
·1922	·104
·1936	·379
·1985	·327
·2003	·202
·2047	·257
·2061	·189
·2082	·174
·2197	·134

TABLE III (*Contd.*)

J.D.	Δ^m	J.D.	Δ^m
2139187·0811	·227	2139187·1968	·577
·0889	·240	·1982	·570
·0917	·284	·1132	·456
·0952	·113	·1519	319
·0991	·500	·1556	·318
·1008	526	·1618	·223
·1077	·629	·1632	·210
·1105	·670	·1695	·150
·1119	·691	·1709	·111
·1153	·759	·1778	·125
·1160	·738	1792	·090
·1174	·762	·1868	·034
·1188	·790	·1882	+·010
·1202	·740	·1938	—·010
·1223	·773	·1951	+·011
·1237	·751	·1986	·033
·1250	·769	·2000	·026
·1271	·748	·2014	·037
1290	·727		

Yellow

2439124·1001	·380	2139124·2382	·101
·1022	·100	·2405	·096
·1050	·130	·2424	·089
·1126	·425	2439162·0919	—·141
·1151	·402	·0933	·073
·1181	·354	·0981	·126
·1258	·234	·1002	·132
·1292	·157	·1009	·171
·1320	·117	·1099	·182
·1389	+·011	·1120	·186
·1410	—·026	·1181	·177
·1439	·042	·1176	·264
·1605	·195	·1190	·268
·1626	·208	·1201	·203
·1646	·225	·1238	·226
·1711	·108	·1259	·227
·1764	·118	·1266	·271
·1869	·250	·1315	·211
·1903	·247	·1312	·191
·1931	·235	·1410	·265
·1945	·253	·1446	·266
·2021	·210	·1458	·202
·2042	·240	·1474	·141
·2091	·252	·1600	·068
·2111	·234	·1627	·131
·2160	·212	·1710	·073
·2202	·202	·1791	·043

TABLE III (*Contd.*)

J.D	Δm
2439162·1759	−·019
·1821	+·021
·1828	·036
·1842	·071
·1904	·182
·1918	·197
·1932	·191
·1988	·253
·1995	·259
·2002	·270
·2009	·263
·2022	·268
·2029	·272
·2036	·278
·2050	·310
·2057	·332
·2070	·305
·2085	·316
·2175	·116
·2182	·157
·2221	+·059
·2245	·019
·2270	+·036
·2376	−·141
·2389	·110
·2487	·220
·2501	·237
·2508	·226
·2615	·300
·2612	·351
·2626	·301
·2703	·120
2439165·0777	+·019
·0791	·117
·0805	·148
·0819	154
·0826	·171
·0840	·191
·0860	·223
·0871	·232
·0895	·206
·0909	·305
·0923	·315
·0944	·376
·0964	·368
·0978	·390
·0985	·389
·1013	·370
·1027	·370
·1048	·339
·1062	·372
·1075	·300
·1090	·286

J.D	Δm
2439165·1096	+·272
·1152	159
·1180	131
·1186	089
·1207	069
·1256	−·002
·1277	+·034
·1291	·062
·1960	·131
·1971	117
·1988	107
·1471	212
·1485	189
·1540	229
·1554	·241
·1658	·304
·1693	·300
·1714	·276
·1728	·242
·1804	·270
·1818	·272
·1874	·262
·1894	·296
·1936	241
·1971	·231
·2005	·213
·2040	·200
·2109	·161
·2197	·155
·2325	·019
·2352	·056
·2394	·109
·2400	·177
·2422	·183
·2448	·279
·2463	·279
·2477	·328
·2491	·351
·2512	·391
·2526	116
·2540	·122
·2561	·110
·2580	·116
·2602	·103
·2616	·390
·2614	·401
·2658	·319
·2679	·338
·2715	·318
·2734	·214
·2762	172
2439166·1929	−·053
·1957	·032

TABLE III (*Contd.*)

J.D.	Δ^m
2439166·1090	+·017
·2026	·119
·2038	·123
·2075	·121
·2096	·185
·2116	·197
·2130	·269
·2151	·330
2163	·345
2179	·462
·2193	489
·2207	·502
·2255	·438
·2269	·472
·2289	·303
·2297	·378
·2325	·386
·2330	·365
·2380	·259
·2408	·266
2439167·1510	—·001
·1523	·062
·1560	·032
·1573	+·008
·1591	·039
·1608	·083
·1650	·191
·1637	·143
·1671	·156
·1691	·207
·1703	·241
·1712	·268
·1726	·275
·1754	·319
·1768	·371
·1702	·303
·1706	·426
·1809	·406
·1830	·417
·1844	·412
·1838	·433
·1900	·142
·1920	·407
·1931	·381
·1948	·397
·1962	·317
·1976	·311
·2025	·222
·2038	·186
·2045	·147
·2059	·139
·2079	·120
·2108	·026

J.D.	Δ^m
2439167·2129	—·006
·2156	·041
·2212	·119
·2226	·175
·2271	·171
·2288	·198
2439171·1013	+·250
·1018	·214
·1981	·119
·1413	—·116
·1161	·141
1568	·319
1582	·270
·1596	·228
·1651	·205
·1650	·288
1707	273
·1721	·203
·1763	·211
·1789	·220
·1892	·242
·1859	·246
·1908	·236
·1930	·241
·1971	·248
·2026	·237
·2031	·216
·2068	·226
·2130	·210
·2159	·197
·2172	·191
·2231	·166
2235	·114
·2311	·054
·2332	—·039
·2352	+·022
·2373	·036
·2387	097
·2408	·141
·2450	·190
2439175·0852	·153
·0887	·096
·0981	—·116
·1019	·142
·1414	·307
·1135	·290
·1484	·192
·1532	·217
·1615	·248
·1629	·221
·1727	·228
·1747	·168
·1865	·117

TABLE III (*Contd.*)

J.D.	Δm
2439175·1886	−·097
·1907	·093
·1928	·098
·1949	·111
·1969	−·084
·1997	+·010
·2018	·018
·2046	·100
·2115	·242
·2136	·321
2439176·0791	−·203
·0792	·198
·0844	·248
·0858	·231
·0886	·218
·0907	·214
·0955	·272
·0969	·281
·1018	·347
·1015	·387
·1129	·195
·1157	·226
·1210	·197
·1275	·291
·1311	·279
2439180·1014	·176
·1010	·174
·1089	·134
·1111	·215
·1187	·218
·1208	·237
·1222	·211
·1292	·334
·1312	·307
·1340	·311
·1361	·309
·1375	·314
·1410	·273
·1429	·240
·1472	·282
·1486	·252
·1507	·290
·1521	·271
·1541	·270
·1569	·203
·1611	·092
·1625	·150
·1639	·207
·1652	·220
·1679	·190
·1687	·194
·1708	·174
·1769	·158

J.D.	Δm
2439180·1781	— 112
·1893	— 079
·1995	+ 013
·1923	077
·1992	·211
·2013	262
·2069	319
2439181·0742	— 176
·0763	·191
·0784	·209
·0846	·258
·0860	·214
·0923	291
·0944	·291
·1013	·220
·1027	·246
·1096	·239
·1124	·229
·1138	·220
·1159	·211
·1186	·215
·1200	207
·1221	·208
·1248	·202
·1270	185
·1291	·177
·1304	·170
·1318	·168
·1332	·168
·1353	·140
·1367	·141
·1381	·116
·1415	077
·1429	·064
·1443	036
·1464	·032
·1478	·028
·1492	—·007
·1513	+·007
·1527	·035
·1540	·091
·1589	·173
·1603	·181
·1617	·227
·1638	·230
·1651	·269
·1665	270
·1679	·288
·1706	·330
·1769	·366
·1789	·340
·1797	·332
·1832	·303

TABLE III (*Contd.*)

J. D.	Δm
2199181·1846	·261
·1901	·120
·1936	·096
·1998	—·016
·2019	·043
·2061	·069
·2075	·091
·2096	·106
·2131	·157
2199187·0018	·131
·0890	·105
·0924	—·007
·0959	+·075
·1001	·153
·1018	·172
·1084	·324
·1112	·365
·1126	·376
·1153	·419
·1167	·433
·1181	·457
·1195	·426
·1209	·457

J. D.	Δm
2·199107 1290	··439
·1214	·412
·1250	·442
·1278	·441
·1299	·389
·1375	·290
·1389	·222
·1459	+·102
·1536	—·025
1569	·026
·1625	·072
·1639	·093
·1702	·122
·1715	·138
·1787	·173
·1799	·202
·1875	·260
·1889	·266
·1911	·301
·1951	·278
·1993	·259
·2007	·213
·2021	·257

TABLE V

Phase	mb	n	Phase	mv	n
.019	.776	10	.013	+.426	7
.089	.700	6	.026	+.371	7
.055	.510	6	017	+.251	6
.115	.283	1	066	+.112	3
.175	.106	11	.118	-.052	5
.203	.027	10	.175	—.182	11
.305	.016	15	.234	-.266	18
.360	.110	11	.306	-.291	21
.103	.211	9	.370	-.161	12
.127	.358	5	.408	-.012	9
.415	.157	1	.110	+.101	12
.160	.558	11	.167	+.231	10
.103	.628	8	.482	+.317	1
.500	.662	3	.503	+.371	7
.516	.625	5	.512	+.327	1
550	.116	4	510	+.221	3
.580	.285	3	.563	+.011	5
.611	.149	5	.591	-.011	7
.703	.025	6	.617	146	8
.777	.038	8	.605	-.230	17
.011	.007	7	.770	-.219	16
.900	.250	7	.837	-.207	13
.925	.133	1	.899	-.079	9
.093	.320	3	.992	+.162	12
.962	.651	5	.979	+.389	14
.985	.766	8	.997	+.461	6

TABLE IV

Phase	mb	mv	mb − mv
.000 m_1	+0m.790	+0m.465	+0.325
250	+0.005	−0.270	+0.275
500 m_2	+0.662	+0.975	+0.287
.750	+0.005	−0.262	+0.267

To get an idea of the magnitude of uncertainty in the determination of our period we may note that the periods have been calculated over 20,000 cycles. An error of one minute in the minima determination which is expected in a photoelectric method will give an uncertainty of $\pm 0^d.00000008$. The earlier photoelectric observers also have indicated comparable figures. The photographic observations by Jensch and Bodokia were somewhat handicapped by lack of well determined minima timings over a long interval and the uncertainties may be estimated to about $\pm 0^d.0000012$ on similar basis.

In Table III, the observed differences in magnitudes in two colours between the variable and the comparison stars have been tabulated against the heliocentric Julian moments.

Normal points of the light curve were calculated from 173 comparisons in blue light and 253 comparisons in yellow light from data recorded in Table IV. Figure 2 shows the normal light curve in blue and yellow light respectively.

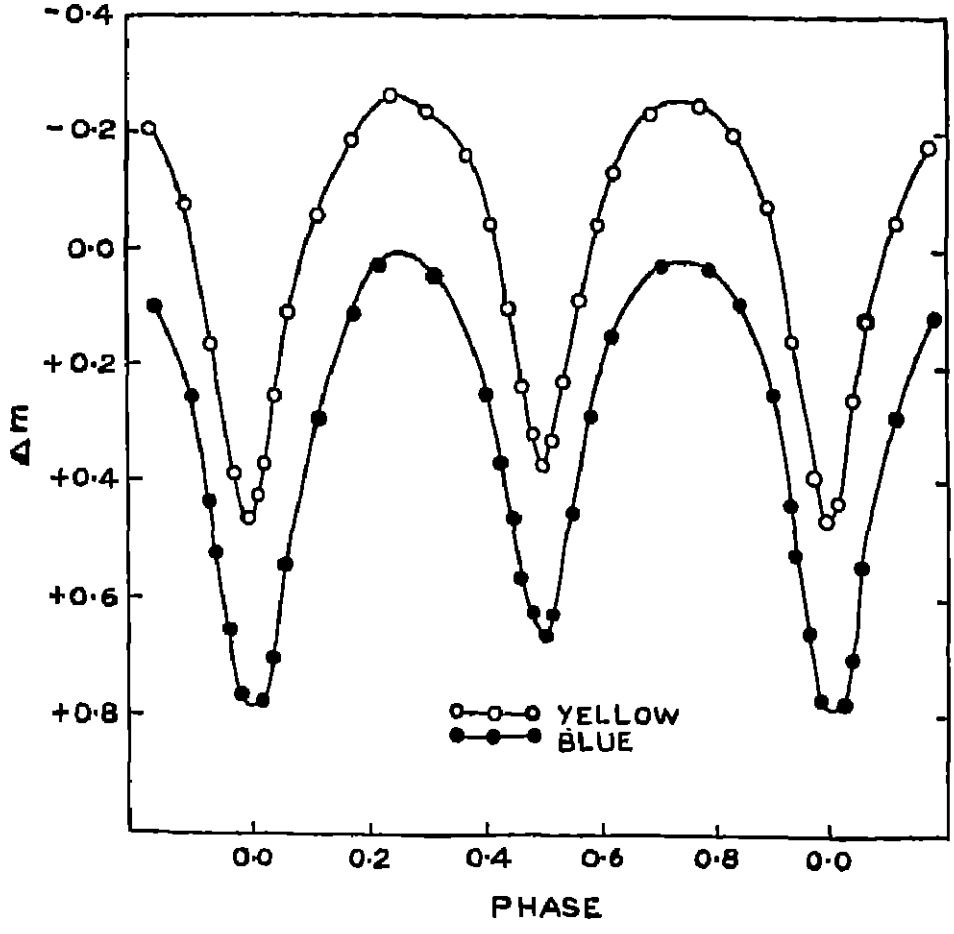

Fig. 2—Light Curve of YY Eridani

From the normal curve the maxima and minima values have been determined and tabulated in Table V. It is seen that the amplitude of the primary minimum exceeds that of the secondary minimum by $+0^{m}.13$ in blue and $+0.20$ in yellow while the brightness of the system is the same outside eclipses at either elongation.

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KODAIKANAL OBSERVATORY,
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