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New UBV Photometry of IU Aurigae

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The paper presents 356 UBV photoelectric measurements of the early-type eclipsing variable star IU Aurigae. The measurements were made in the years 1982—1985. The effect of the dynamical term on times of minima in a three-body system is discussed.

Jsou předložena nová fotoelektrická měření zákrytové proměnné raného typu IU Aurigae. 356 měření v systému UBV bylo získáno v letech 1982 až 1985. Je diskutován vliv dynamického členu na okamžiky minim v systému tří těles.

1. Introduction

Up to now, IU Aur (HD 35652; spectral type BO : p, magnitude in maximum $V = 8{\cdot}2$, period $1{\cdot}8115^{d}$) is the only eclipsing variable the minima depths of which secularly change. Since the discovery of its variability (Mayer, 1964), the primary minimum depth in V colour has increased from $0{\cdot}43^{m}$ to $0{\cdot}68^{m}$. Most probably, the reason of this change is the rotation of the nodal line caused by a third body. More data about this system can be found in recent papers where light curves of this star are solved (Leung and Li, 1986; Drechsel and Mayer, 1987; Mayer and Drechsel, 1987). It is important to monitor the light curve changes, since then the parameters of the system can be determined more accurately.

In several papers photometry of IU Aur in different epochs has been obtained; these data are summarized in Tab. 1. In all cases, the comparison star was HD 35619, also of early spectral type, nearly identical colours, convenient brightness and only $3{\cdot}7'$ distant (Table 2). Its UBV values by Landolt and Blondeau (1972) are based on 130 measurements from 6 nights, therefore they will be used throughput.

2. Measurements

In this paper, measurements obtained with the 65 cm telescope of the Charles University located in Ondřejov are presented. The measurements, numbering 356,

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were made in 10 nights in the years 1982–85; they are given in Table 3 and plotted in Fig. 1.

In the years 1982 and 1983, the transformation equations to the standard UBV system were

$$\Delta V = \Delta v - 0{\cdot}126\Delta(B - V),$$
$$\Delta(B - V) = 1{\cdot}190\Delta(b - v),$$
$$\Delta(U - B) = 1{\cdot}045\Delta(u - b);$$

and in the years 1984 and 1985, they were

$$\Delta V = \Delta v - 0{\cdot}078\Delta(B - V),$$
$$\Delta(B - V) = 1{\cdot}119\Delta(b - v),$$
$$\Delta(U - B) = 1{\cdot}020\Delta(u - b).$$

Considering the colour differences following from data in Tab. 2 we see, that no transformation was necessary except in the deepest part of the primary minimum, where corrections not larger than $0{\cdot}002^m$ were to apply.

The measurements were made mostly in order to precise the period of the variable, so the minima are covered well, but other parts of the light curve not. It appears that in maximum (however note that only the phase around 0·25 is covered) the variable is about $0{\cdot}005^m$ brighter than in the year 1964. The change of brightness in minima is illustrated in Fig. 1.

The times of minima from the presented data were already calculated and have been published (Mayer, 1987). Normal points were also formed from the data and used for solving the light curve by the Wilson-Devinney code (Drechsel and Mayer, 1987; Mayer and Drechsel, 1987). The phases given in Tab. 3 have been calculated as already described in the latter paper: due to the light-time-effect amplitude being larger than $0{\cdot}005^d$, the phases, when closer than 0·1 (phase) to a minimum, were calculated using the measured minimum time, and for other measurements, the ephemeris

Pri.Min. = J.D.hel. $2438448{\cdot}4068 + 1{\cdot}811474^d\,E$ was used.

3. The dynamical term

The system of IU Aur consists of the eclipsing pair and a third body. The third body manifests by periodic behaviour of times of minima, known as the light time effect (LTE; see e.g. Irwin, 1959), and also by change of the orbital longitude of the close pair components. The largest amplitude of these changes has the term analogical to the annual equation in the motion of the Moon, with the period which equals to the orbital period of the third body. Exact formulae for the third body effects have been given by Söderhjelm (1982). The eclipsing pairs in IU Aur and similar systems

are close binaries with circular orbits. Therefore, we are interested in formulae for $e_1 = 0$; and, for simplicity, we will also consider $\gamma = 0$ and $C/G_2 = 1$ (in Söderhjelm's notation). Then, using Söderhjelm's formulae 5, 6 and 7, the formula for $\delta\lambda_1$ ($\lambda_1 = g_1 + h_1 + l_1$) can be written as

$$\delta\lambda_1 = 2k_1[(\tfrac{2}{3} - Z)(v_2 - l_2 + e_2 \sin v_2) + (Z - 2)S], \tag{1}$$

where

$$k_1 = \frac{3}{8}\frac{m_3}{M}(1 - e_2^2)^{-3/2}\frac{P_1}{P_2},$$

$$Z = \cos j + \cos^2 j,$$

$$S = \sin 2(v_2 + \omega_2) + e_2 \sin(v_2 + 2\omega_2) + \tfrac{1}{3}\sin(3v_2 + 2\omega_2).$$

Here j is the inclination between both orbits, P_1 the priod of the eclipsing pair, and the values with index 2 are the usual parameters of the third-body orbit. Approximately can be written $v_2 - l_2 + e_2 \sin v_2 = 3e_2 \sin v_2$. The effect on observed minima due to this dynamical term is

$$(O - C)_{\mathrm{DYN}} = P_1 \,.\, \delta\lambda_1/2\pi\,. \tag{2}$$

In case of coplanar orbits $\cos j = 1$, $Z = 2$ and the square parenthesis term equals $-4e_2 \sin v_2$. Note that when $e_2 = 0$ the dynamical term is zero only in the coplanar case; if $j \neq 0$, the amplitude can be even larger than if $j = 0$, since then the square parenthesis term equals $(Z - 2)\sin 2(v_2 + \omega_2)$.

The dynamical effect depends on P_1^2/P_2, therefore is neglectably small for longer third-body periods. IU Aur presents a case where this effect can play a role.

The total effect on times of minima is

$$O - C = (O - C)_{\mathrm{LTE}} + (O - C)_{\mathrm{DYN}}, \tag{3}$$

where

$$(O - C)_{\mathrm{LTE}} = \frac{m_3}{M^{2/3}}\frac{P_2^{2/3}\sin i_2^0}{173(1 - e_2^2\cos^2\omega_2)^{1/2}}\left[\frac{\sin v_2}{1 + e_2\cos(v_2 + \omega_2)} + e_2\cos\omega_2\right]. \tag{4}$$

Periods are given in days; $M = m_1 + m_2 + m_3$.

There are 9 parameters in the formula (3): $m_3, M, P_1, P_2, j, i_2^0, e_2, \omega_2$ and T (implicitly in v_2). The periods and the total mass can be considered as known (or estimated); j and i_2^0 are joined by an equation with another angle (observable). From the shape of the $O - C$ curve then remains to calculate 5 unknowns. This can be done e.g. by harmonic analysis or perhaps better by numerical optimalisation.

Another case where the dynamical term can play a role is FZ CMa (Moffat et al., 1983). The amplitude of the term can reach about $0{\cdot}0005^{\mathrm{d}}$, and the mass function

can be only 70 to 80 % of its original value. Then the problem with too large mass of the third body, discussed by Moffat et al., is removed.

Given the present accuracy of the $O - C$ curves in both cases (for IU Aur see Mayer, 1987, Fig. 2) it seems to have better to wait for some more minima times until the elaborated solution is attempted.

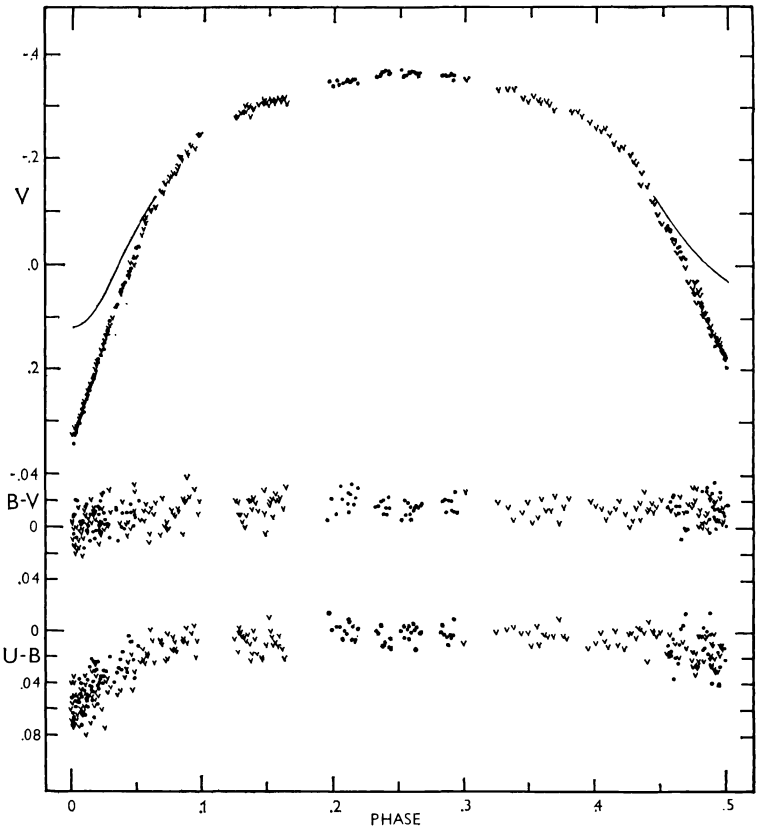

Fig. 1. V, $B - V$ and $U - B$ curves of IU Aur for the mean epoch 1984.4. To illustrate the change of minima depths, the V measurements from JD 2438667 (primary minimum) and JD 2439424 (secondary minimum) are schematically plotted.

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Table 1. Published photoelectric measurements of IU Aur

Source	Mean epoch	Photometric system and number of measurements
Mayer (1971)	1964.5	U: 276; B: 250; V: 552
Rossati (1967)	1967.0	λ 515 nm: 592
Mayer (1971)	1968.7	U: 389; B: 424; V: 494
Mayer (1976)	1973.1	UBV: 420
Eaton (1977)	1974.9	λ 340 nm: 526; BV: 573
Papoušek and Vetešník (1982)	1976.6	U: 548; B: 756; V: 833
Mayer (1983)	1978.8	UBV: 112
This paper	1984.4	UBV: 356

Table 2. Data on the variable and comparison stars

Star	Catalog No.	Right ascension 1950	Declination 1950	V	$B-V$	$U-B$	Source/Phase
Comp.	HD 35619	$5^h24^m17^s$	$+34°42.9'$	8.55	+0.24	−0.71	Johnson (1955)
	BD+34°1046			8.60	+0.23	−0.69	Hiltner (1956)
				8.572	+0.241	−0.701	Landolt and Blondeau (1972)
IU Aur	HD 35652	$5^h24^m33^s$	$+34°44.5'$	8.210	+0.229	−0.699	maximum
	BD+34°1051′			8.740	+0.230	−0.683	secondary minimum
				8.890	+0.241	−0.644	primary minimum

Note: IU Aur UBV data are given for the epoch 1984.4, relatively to the HD 35619 values by Landolt and Blondeau (1972).

Table 3. Measurements of IU Aur (differences Var minus HD 35619)

J.D.hel.	ΔV	ΔB	ΔU	Phase
2445240				
.5097	.152	.118	.155	.4904
.5180	.160	.151	.177	.4950
.5262	.196	.179	.200	.4995
.5336	.178	.163	.178	.5036
.5401	.150	.142	.142	.5072
.5481	.125	.114	.131	.5116
.5539	.103	.098	.101	.5148
.5200	.070	.055	.078	.5200
.5727	.040	.021	.040	.5252
.5789	.030	.012	.022	.5286
.5851	−.002	−.014	−.009	.5320
.5905	−.014	−.038	−.020	.5350
.5959	−.028	−.039	−.031	.5380
.6025	−.049	−.063	−.062	.5416
.6090	−.069	−.085	−.070	.5452
.6153	−.084	−.105	−.105	.5487
.6220	−.100	−.117	−.115	.5524
.6278	−.124	−.137	−.138	.5556
.6354	−.152	−.165	−.145	.5598
.6459	−.156	−.175	−.180	.5656
2445271				
.4283	−.119	−.138	−.141	.5562
.4334	−.146	−.160	−.170	.5590
.4389	−.157	−.186	−.187	.5620
.4437	−.176	−.182	−.185	.5646
.4495	−.190	−.206	−.202	.5679
.4543	−.200	−.206	−.207	.5704
.4597	−.209	−.208	−.208	.5734
.4661	−.220	−.231	−.220	.5770
.4730	−.220	−.241	−.232	.5808
.4794	−.234	−.250	−.252	.5844
.4867	−.248	−.260	−.250	.5884
.4928	−.259	−.266	−.260	.5918
.4990	−.257	−.272	−.273	.5951
.5061	−.261	−.278	−.271	.5991
.5152	−.274	−.295	−.283	.6041
.5432	−.286	−.309	−.305	.6196
.5503	−.295	−.312	−.310	.6234
.5558	−.293	−.298	−.309	.6264
.5633	−.297	−.322	−.320	.6306
.5707	−.307	−.321	−.318	.6347
.5764	−.310	−.324	−.323	.6378

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.5813	−.310	−.332	−.323	.6406
.5862	−.316	−.325	−.330	.6433
.5919	−.320	−.325	−.315	.6470
.5999	−.309	−.328	−.328	.6508
.6085	−.318	−.330	−.329	.6556
.6196	−.336	−.340	−.344	.6618
.6276	−.336	−.351	−.354	.6662
.6417	−.336	−.356	−.357	.6740
.6859	−.350	−.376	−.368	.6983
2445337				
.4016	.158	.170	.218	.9776
.4066	.182	.190	.222	.9804
.4093	.199	.183	.218	.9821
.4129	.213	.221	.250	.9841
.4155	.232	.225	.279	.9853
.4186	.229	.229	.282	.9870
.4210	.250	.245	.278	.9886
.4242	.250	.271	.317	.9903
.4270	.280	.279	.335	.9919
.4296	.282	.297	.335	.9932
.4322	.312	.296	.345	.9947
.4349	.301	.321	.353	.9962
.4376	.314	.326	.378	.9977
.4409	.310	.304	.369	.9995
.4439	.316	.308	.369	.0012
.4462	.320	.300	.367	.0025
.4487	.319	.301	.371	.0038
.4512	.299	.303	.339	.0052
.4550	.273	.273	.312	.0073
.4576	.264	.262	.307	.0088
.4600	.281	.266	.311	.0101
.4683	.223	.217	.261	.0147
.4708	.208	.213	.235	.0160
.4737	.213	.222	.246	.0176
.4794	.178	.157	.200	.0208
.4823	.150	.151	.188	.0224
2445605				
.5033	.183	.184	.227	.9818
.5070	.212	.201	.248	.9838
.5114	.226	.228	.279	.9861
.5146	.243	.244	.291	.9880
.5192	.258	.266	.306	.9905

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.5224	.271	.275	.321	.9923
.5270	.297	.301	.348	.9948
.5303	.317	.318	.367	.9967
.5352	.325	.333	.370	.9994
.5389	.321	.327	.373	.0014
.5435	.302	.311	.359	.0039
.5465	.296	.294	.346	.0056
.5513	.267	.265	.308	.0082
.5548	.243	.260	.300	.0100
.5589	.238	.242	.279	.0124
.5619	.226	.217	.257	.0141
.5667	.208	.200	.254	.0167
.5699	.190	.190	.222	.0185
.5753	.170	.154	.199	.0215
.5804	.145	.135	.175	.0243
.5855	.119	.118	.150	.0271
.5897	.103	.112	.133	.0294
2446004				
.4235	−.352	−.358	−.372	.1972
.4275	−.343	−.365	−.365	.1994
.4351	−.351	−.362	−.365	.2036
.4372	−.343	−.371	−.374	.2048
.4421	−.347	−.368	−.362	.2075
.4448	−.351	−.375	−.375	.2090
.4475	−.354	−.371	−.369	.2104
.4498	−.352	−.363	−.372	.2117
.4519	−.348	−.371	−.378	.2129
.4542	−.349	−.378	−.371	.2141
.4564	−.355	−.372	−.375	.2154
.4587	−.356	−.376	−.369	.2166
.4611	−.347	−.374	−.376	.2180
.4882	−.359	−.374	−.374	.2329
.4918	−.363	−.378	−.376	.2349
.4938	−.362	−.380	−.384	.2360
.4957	−.365	−.384	−.372	.2371
.4988	−.373	−.382	−.371	.2388
.5007	−.369	−.383	−.374	.2398
.5028	−.370	−.379	−.367	.2410
.5047	−.362	−.383	−.370	.2420
.5069	−.369	−.383	−.377	.2432
.5240	−.372	−.377	−.377	.2527
.5260	−.358	−.377	−.372	.2538
.5280	−.363	−.371	−.374	.2549

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.5307	−.361	−.379	−.380	.2564
.5327	−.370	−.384	−.377	.2575
.5348	−.367	−.376	−.379	.2586
.5368	−.370	−.375	−.373	.2597
.5387	−.370	−.381	−.386	.2608
.5408	−.370	−.384	−.384	.2619
.5428	−.366	−.381	−.367	.2631
.5450	−.364	−.377	−.380	.2643
.5475	−.360	−.374	−.373	.2656
.5498	−.367	−.383	−.382	.2669
.5793	−.365	−.383	−.382	.2832
.5813	−.363	−.383	−.387	.2843
.5834	−.361	−.372	−.369	.2855
.5863	−.357	−.376	−.371	.2870
.5882	−.361	−.379	−.368	.2881
.5904	−.365	−.377	−.373	.2893
.5962	−.363	−.374	−.369	.2905
.5947	−.353	−.376	−.372	.2917
.5969	−.362	−.372	−.380	.2929
2446005				
.5799	−.312	−.341	−.320	.8356
.5819	−.322	−.335	−.323	.8367
.5870	−.315	−.337	−.335	.8395
.5888	−.321	−.339	−.329	.8405
.5913	−.316	−.335	−.328	.8419
.5933	−.315	−.339	−.331	.8430
.5963	−.313	−.332	−.322	.8446
.5983	−.317	−.325	−.322	.8457
.6005	−.313	−.333	−.335	.8469
.6027	−.307	−.324	−.337	.8482
.6082	−.309	−.305	−.297	.8512
.6104	−.316	−.326	−.306	.8524
.6126	−.310	−.337	−.318	.8536
.6183	−.308	−.321	−.305	.8568
.6210	−.298	−.316	−.311	.8583
.6231	−.301	−.320	−.322	.8594
.6251	−.295	−.314	−.298	.8605
.6273	−.302	−.316	−.295	.8617
.6293	−.284	−.302	−.294	.8628
.6313	−.302	−.321	−.320	.8639
.6335	−.293	−.301	−.295	.8652
.6363	−.302	−.303	−.300	.8667
.6384	−.291	−.296	−.293	.8679

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.6408	−.292	−.296	−.297	.8692
.6429	−.290	−.299	−.304	.8703
.6454	−.280	−.297	−.297	.8717
.6473	−.285	−.294	−.280	.8728
.6493	−.283	−.302	−.298	.8739
.				
2446018				
.3836	−.244	−.263	−.255	.9018
.3869	−.242	−.251	−.231	.9037
.3905	−.221	−.248	−.253	.9057
.3956	−.228	−.250	−.249	.9085
.3985	−.209	−.244	−.235	.9101
.4006	−.212	−.230	−.232	.9112
.4036	−.214	−.231	−.225	.9129
.4058	−.203	−.199	−.191	.9141
.4103	−.203	−.214	−.198	.9166
.4123	−.188	−.202	−.188	.9177
.4150	−.183	−.194	−.185	.9192
.4171	−.180	−.188	−.174	.9203
.4194	−.175	−.185	−.181	.9216
.4216	−.165	−.178	−.164	.9228
.4257	−.165	−.164	−.162	.9251
.4278	−.167	−.172	−.152	.9262
.4297	−.161	−.161	−.138	.9273
.4319	−.156	−.158	−.148	.9285
.4338	−.138	−.160	−.152	.9296
.4362	−.141	−.136	−.130	.9309
.4448	−.113	−.131	−.107	.9356
.4467	−.111	−.121	−.114	.9367
.4491	−.099	−.113	−.107	.9380
.4515	−.106	−.097	−.098	.9393
.4535	−.102	−.099	−.079	.9404
.4555	−.090	−.101	−.084	.9415
.4575	−.078	−.095	−.070	.9426
.4596	−.083	−.089	−.067	.9438
.4615	−.069	−.082	−.069	.9449
.4641	−.057	−.064	−.040	.9463
.4707	−.034	−.059	−.028	.9499
.4727	−.015	−.044	−.001	.9510
.4746	−.016	−.027	−.012	.9521
.4772	−.011	−.022	−.006	.9535
.4791	−.013	−.012	−.008	.9546
.4812	−.005	−.009	.014	.9557
.4832	−.009	−.002	.027	.9568

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.4850	.009	.006	.039	.9578
.4869	.014	.014	.046	.9589
.4899	.035	.017	.061	.9605
.4920	.039	.036	.066	.9617
.4940	.047	.044	.088	.9628
.4960	.052	.040	.087	.9639
.5061	.097	.086	.127	.9695
.5080	.116	.090	.135	.9705
.5101	.114	.112	.147	.9717
.5126	.125	.123	.160	.9731
.5147	.122	.111	.183	.9742
.5168	.141	.118	.117	.9754
.5259	.182	.171	.217	.9804
.5283	.192	.185	.229	.9817
.5308	.200	.191	.243	.9831
.5336	.224	.204	.272	.9847
.5369	.229	.225	.303	.9859
.5505	.280	.277	.348	.9940
.5528	.302	.318	.366	.9953
.5559	.313	.327	.366	.9970
.5583	.320	.316	.375	.9983
.5607	.318	.314	.381	.9996
.5634	.342	.334	.406	.0011
.5732	.296	.290	.333	.0065
.5765	.283	.271	.344	.0083
.5787	.263	.247	.297	.0096
.5812	.255	.246	.308	.0109
.5834	.239	.231	.291	.0121
.5859	.236	.247	.275	.0135
.5887	.216	.212	.250	.0151
.5928	.200	.191	.230	.0173
.5953	.189	.194	.225	.0187
.5975	.173	.173	.230	.0201
.6001	.165	.171	.208	.0214
.6026	.152	.149	.197	.0227
.6050	.149	.125	.165	.0241
.6225	.079	.066	.106	.0337
.6245	.071	.059	.092	.0348
.6271	.044	.054	.084	.0363
.6294	.047	.047	.070	.0375
.6315	.033	.024	.055	.0387
.6337	.032	.034	.051	.0399
.6359	.030	.011	.044	.0411
.6388	.019	.009	.042	.0427

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.6410	.012	.002	.007	.0439
.6430	.006	−.010	.000	.0450
.6452	−.017	−.017	−.007	.0463
.6473	−.018	−.026	−.002	.0474
.6493	−.034	−.041	−.005	.0485
.6548	−.037	−.054	−.041	.0516
2446335				
.5225	.135	.130	.171	.9747
.5259	.154	.155	.190	.9770
.5313	.180	.167	.218	.9797
.5350	.199	.193	.230	.9818
.5392	.216	.212	.256	.9840
.5435	.234	.233	.276	.9864
.5467	.245	.240	.298	.9882
.5509	.264	.260	.316	.9904
.5545	.276	.272	.330	.9926
.5582	.283	.289	.352	.9946
.5621	.304	.309	.370	.9967
.5654	.316	.320	.368	.9985
.5687	.316	.316	.368	.0004
.5722	.310	.316	.364	.0023
.5760	.290	.300	.358	.0044
.5815	.274	.281	.336	.0074
.5857	.271	.265	.318	.0098
.5894	.250	.235	.300	.0118
.5932	.230	.219	.272	.0138
.5974	.208	.206	.250	.0162
.6015	.203	.196	.242	.0184
.6059	.187	.170	.195	.0209
.6127	.145	.129	.160	.0248
2446363				
.5623	−.077	−.090	−.081	.4553
.5641	−.069	−.086	−.066	.4563
.5665	−.063	−.082	−.062	.4577
.5681	−.065	−.085	−.069	.4585
.5700	−.049	−.062	−.058	.4596
.5719	−.052	−.066	−.030	.4606
.5758	−.048	−.057	−.036	.4628
.5773	−.035	−.049	−.023	.4636
.5811	−.027	−.018	−.022	.4657
.5826	−.019	−.017	−.023	.4665
.5843	−.016	−.013	−.028	.4675

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.5860	.001	−.008	.001	.4684
.5879	−.013	−.011	.003	.4695
.6093	.080	.056	.068	.4813
.6107	.081	.068	.063	.4821
.6127	.085	.074	.085	.4832
.6143	.088	.064	.080	.4840
.6159	.099	.072	.070	.4849
.6176	.096	.085	.093	.4859
.6191	.099	.103	.087	.4867
.6206	.123	.118	.119	.4875
.6222	.120	.097	.105	.4884
.6236	.130	.116	.123	.4892
.6256	.124	.117	.135	.4903
.6272	.134	.135	.143	.4912
.6288	.133	.121	.142	.4921
.6303	.143	.130	.157	.4929
.6318	.149	.130	.160	.4937
.6334	.150	.139	.154	.4946
.6350	.161	.135	.174	.4955
.6382	.157	.148	.167	.4972
.6398	.163	.155	.167	.4981
.6417	.167	.166	.187	.4992
.6433	.169	.163	.171	.5001
.6450	.163	.160	.172	.5010
.6466	.167	.152	.169	.5019
.6484	.163	.148	.156	.5029
.6501	.167	.146	.173	.5038
.6518	.151	.146	.176	.5047
.6536	.139	.131	.150	.5057
.6552	.139	.133	.153	.5066
.6570	.136	.119	.147	.5076
.6584	.133	.115	.138	.5084
.6600	.127	.115	.131	.5093
.6620	.130	.112	.138	.5104
.6635	.130	.108	.129	.5112
.6650	.112	.099	.110	.5120
.6666	.105	.095	.096	.5129
.6682	.104	.105	.104	.5138
.6731	.080	.076	.096	.5165
.6748	.083	.082	.083	.5174
.6764	.075	.075	.076	.5183
.6780	.068	.042	.063	.5192
.6797	.053	.044	.070	.5201
.6816	.043	.041	.056	.5212

Table 3 continued

J.D.hel.	ΔV	ΔB	ΔU	Phase
.6832	.066	.037	.068	.5221
.6854	.048	.029	.049	.5233
.6870	.050	.022	.046	.5242
.6893	.025	.009	.023	.5254
2446364				
.5038	.130	.132	.169	.9744
.5077	.154	.156	.193	.9766
.5110	.170	.166	.204	.9785
.5144	.176	.170	.224	.9802
.5177	.182	.187	.232	.9821
.5211	.198	.200	.248	.9840
.5247	.220	.222	.267	.9860
.5282	.228	.232	.291	.9880
.5316	.248	.249	.304	.9898
.5350	.264	.251	.314	.9917
.5390	.284	.278	.328	.9937
.5450	.300	.305	.370	.9966
.5487	.308	.308	.366	.9993
.5536	.304	.302	.368	.0020
.5568	.298	.306	.360	.0037
.5609	.275	.279	.342	.0060
.5643	.267	.265	.308	.0082
.5676	.256	.258	.308	.0096
.5710	.241	.238	.294	.0116
.5746	.230	.234	.276	.0136
.5794	.202	.202	.249	.0161
.5841	.178	.166	.233	.0187
.5877	.164	.156	.210	.0208
.5911	.146	.151	.192	.0226
.5943	.128	.125	.162	.0244