A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

Nr. 73.

K. OLÁH

RED GIANT STARS OF M3

BUDAPEST, 1979

HU ISSN 0324-2234
Felelős kiadó: Szeidl Béla
7910540 MTA KESZ Sokszorosító
F.v.:dr. Héczey Lászlóné

RED GIANT STARS OF M3

ABSTRACT

Photographic observations of seven red giant stars of M3 ($CI \geq 1^{m}.3$) are presented. The star v.Z.1397 was found to be variable with the period of 31.395 or 215.8 days. Two other stars, v.Z.238 and 837 previously known as variables, show constant light within the observational error. It seems that only the two reddest stars in M3, i.e. v.Z.1397, $CI=1^{m}.58$ and v.Z.318 = V95, $CI=1^{m}.60$, are variable.

INTRODUCTION

The investigation of red giant variable stars in globular clusters is of great importance especially from the theoretical point of view. These stars lie at the tip of the red giant branch in the HRD and are at an interesting stage of their evolution. It can be supposed that from a given colour index all the redder giant stars show light variation (see e.g. *Osborn* and *Fuenmayor*, 1977). For this reason much work has been done on the red giants of various clusters.

In addition, a number of studies have already been published on some red giants of M3 (see for example *Walker*, 1955; *Russev*, 1971). Here we present a photographic study of red giant stars of M3 covering the time interval 1938-1962.

OBSERVATIONS

The red giant stars of M3 redder than $CI=1^{m}.3$ (see *Sandage*, 1953) were selected in order to investigate their possible light variations. Recent photoelectric B-V observations (*Cohen* et al., 1978) show no substantial difference from the values observed by *Sandage* for the three stars v.Z.238, 1392 and 1397, but for v.Z. 205 the B-V colour index measured by *Cohen* et al. is about $0^{m}.1$ redder than *Sandage*'s value (detailed remarks on this star are included).

From the selected ten stars the following six have been measured: v.Z.238, 297, 837, 1392, 1397 and I-I-109 (designation after *Sandage*, 1953) whereas v.Z.490, 612, 752 and 1053 proved to be unmeasurable in our photographic plates because of their position near the centre of the cluster. As comparisons, v.Z.216, 237, 334 740 and 1402 were used (selected from *Sandage*'s paper).

The detailed description of the observational material can be found in *Szeidl*'s paper (*Szeidl*, 1965).

The measurements were carried out with both the Becker and the Cuffey iris photometer of the Konkoly Observatory. Every plate was measured twice using the two photometers. No difference were found between the observational errors of the two sets of measurements. The mean values of the two measured magnitudes are given in Table 2.

The mean error of one single measurement is $\pm 0\overset{m}{.}061$, nevertheless, the standard deviations of the measurements of different stars vary depending on their positions. In Table 1 the mean of all magnitudes, the standard deviations and the numbers of observations are given for each measured star.

Table 1

star	$\overline{m}_{pg}$	standard deviation	number of observations
v.Z. 205	14.094	0.059	200
238	14.235	0.061	205
297	14.287	0.058	204
837	14.171	0.071	201
1392	14.373	0.053	189
1397	14.295	0.094	195
I-I-109	14.029	0.104	165

REMARKS ON INDIVIDUAL STARS

v.Z.205 = I-III-28

This star was originally chosen as a comparison, but has never fitted the calibration curve. Therefore, the star was added to the other variable candidates.

The mean of the observed magnitudes ($14\overset{m}{.}09$) was found to be $0\overset{m}{.}1$ fainter than *Sandage*'s result ($13\overset{m}{.}99$). According to *Cohen* et al.'s observations the star seems to be about $0\overset{m}{.}1$ redder than previously thought.

As 68% of the measured values are within a $\pm 0\overset{m}{.}06$ interval around the mean, we can say that the star does not vary at least with an amplitude larger than $0\overset{m}{.}12$ (Figure 1).

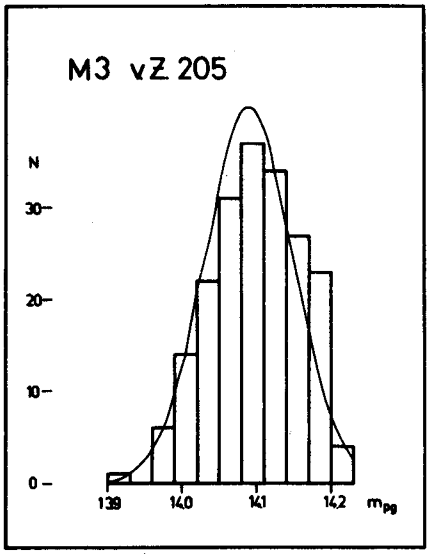

Figure 1: Histogram of the measured magnitudes of v.Z.205 with $0^m.03$ wide intervals. The normal distribution curve was calculated with the estimated mean: 14.094 and standard deviation: 0.059

v.Z.238 = AA

v.Z.238 was supposed by *Russev* (*Russev*, 1971) to be variable with $80^d.98$ period and $0^m.24$ amplitude. The mean brightness of the star given by him differs from our result by only $0^m.02$ ($14^m.26$ and $14^m.24$ respectively) but the scatter of *Russev*'s values is much wider than ours.

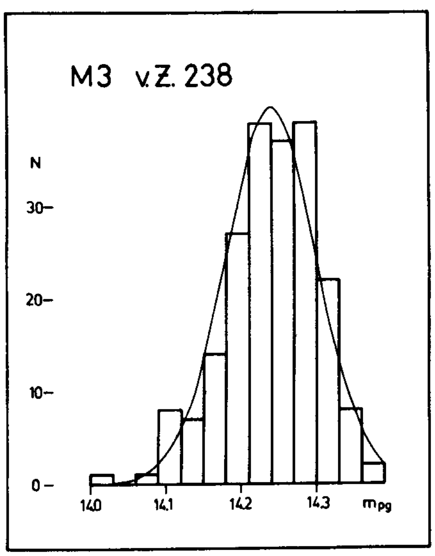

Figure 2: Histogram of the measured magnitudes of v.Z.238 with $0^m.03$ wide intervals. The normal distribution curve was calculated with the estimated mean: 14.235 and standard deviation : 0.061

Concerning our observations, no light variation was found for this star, 73% of the measured magnitudes are within a range of $\pm 0^{m}.06$ around the mean (Figure 2).

v.Z.297

According to our measurements, this star does not show any light variation. 76% of the obtained magnitudes lie in the region $14^{m}.29 \pm 0^{m}.06$ (Figure 3).

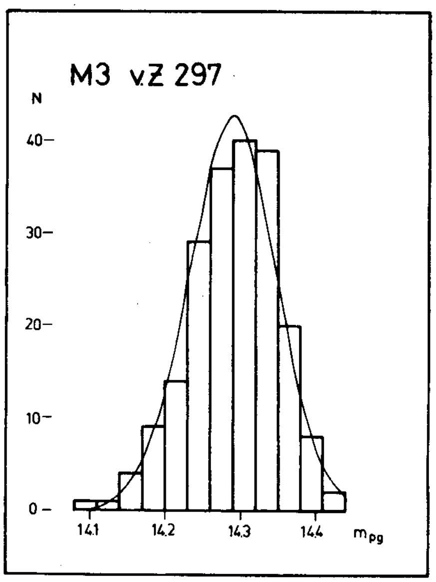

Figure 3: Histogram of the measured magnitudes of v.Z.297 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.287 and standard deviation: 0.058.

v.Z.837 = I-II-46

For this star, *Russev* found light variation with a period of $89^{d}.59$ and an amplitude of $0^{m}.33$. There is no great difference between the mean brightness given by him ($14^{m}.11$) and our result ($14^{m}.17$) but as with v.Z.238, the scatter of his magnitudes is considerably wider.

The distribution of the measured values is close to the normal one (Figure 4) and from all the data 74% take place within $\pm 0^{m}.07$ around the mean. Therefore we can claim that this star also does not vary with an amplitude greater than $0^{m}.14$.

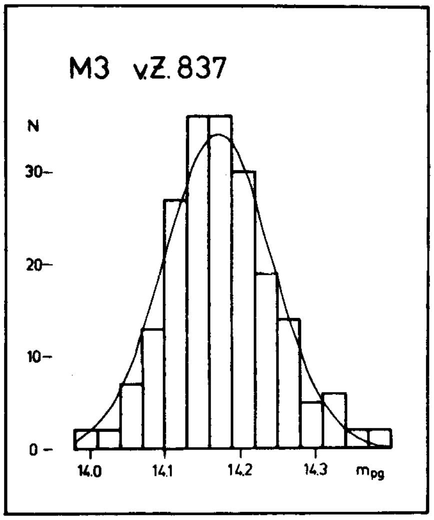

Figure 4: Histogram of the measured magnitudes of v.Z.837 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.171 and standard deviation: 0.071

<u>v.Z.1392 = I-I-21</u>

This star does not show light variation; 78% of the measured values fall within the range of $0\overset{m}{.}06$ around the mean (Figure 5).

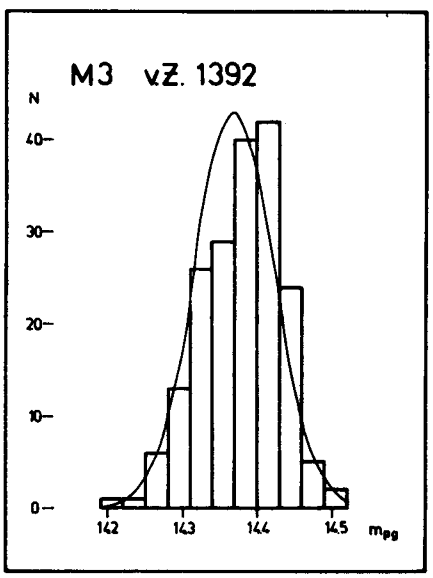

Figure 5: Histogram of the measured magnitudes of v.Z.1392 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.373 and standard deviation: 0.053

v.Z.1397

The distribution of the measured magnitudes of this star does not follow a normal distribution (Figure 6). Two peaks are visible in the histogram which is characteristic of the histograms of variable stars. The standard deviation of the values obtained is definitely larger ($\pm 0^m.094$) than the average standard deviation of the other non-variable stars. As well as the others, this star lies in a very good measurable place far from the centre.

A modified *Lafler-Kinman* method was used to search for period with trial periods from 30 to 350 days. As a result, two almost equally well acceptable periods were received: $31^d.395$ (Figure 7) and $215^d.8$ (Figure 8).

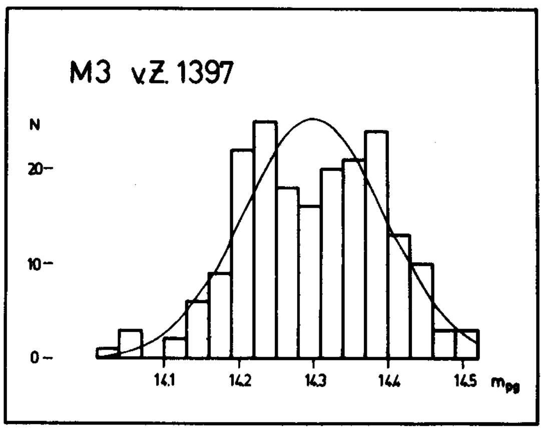

Figure 6: Histogram of the measured magnitudes of v.Z.1397 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.295 and standard deviation: 0.094

I-I-109

The scatter of the measurements of this star is relatively wide, because of its close companion and dense surroundings. The histogram of the measured values does not follow a normal distribution but the shape of it is not similar to a variable star's histogram (Figure 9).

In this case the search for period was unsuccessful, no suitable period has been found. The wide scatter is very probably due to the above mentioned effects.

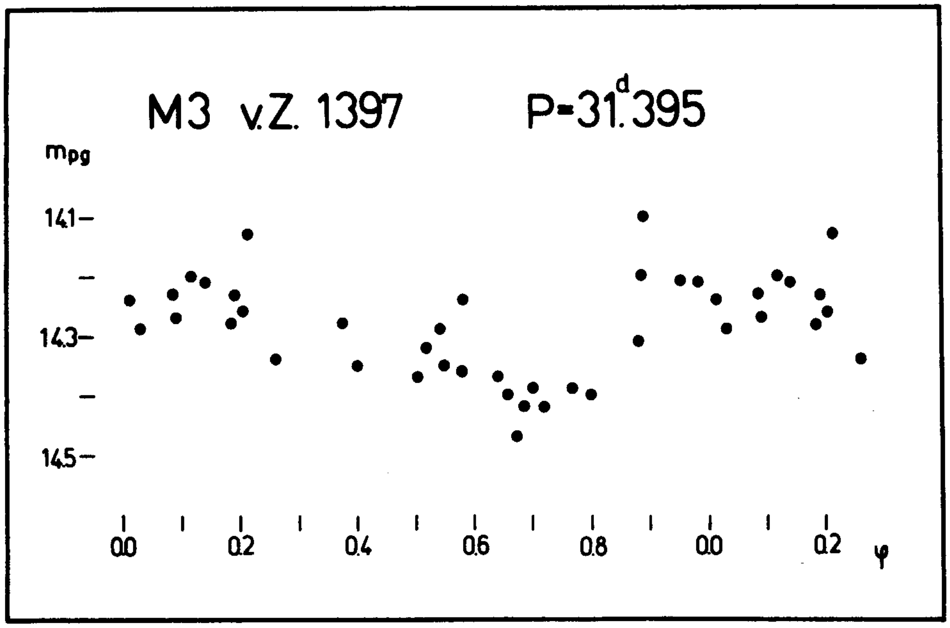

Figure 7: Light curve of v.Z.1397 with the period of 31.395 days

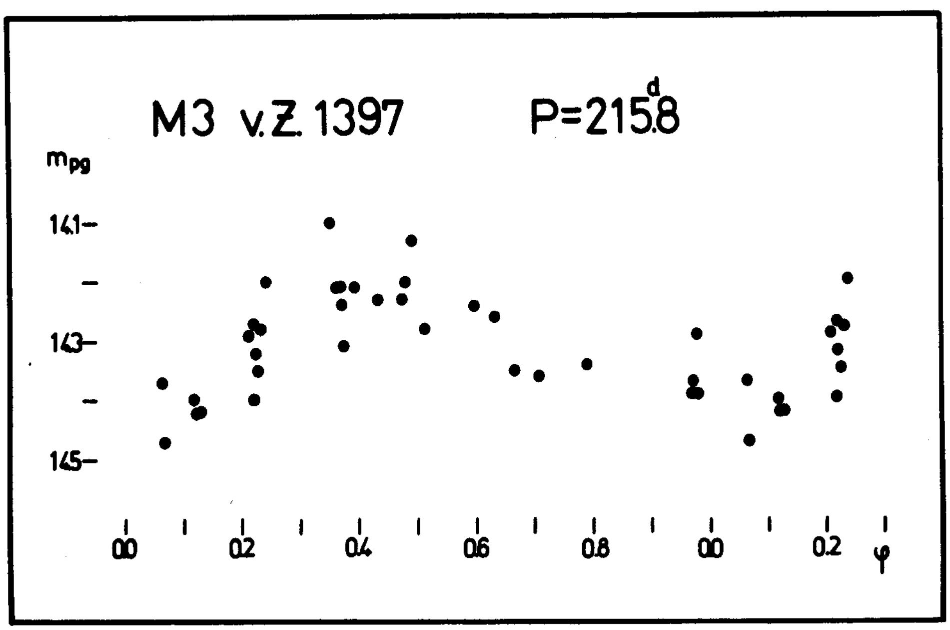

Figure 8: Light curve of v.Z.1397 with the period of 215.8 days

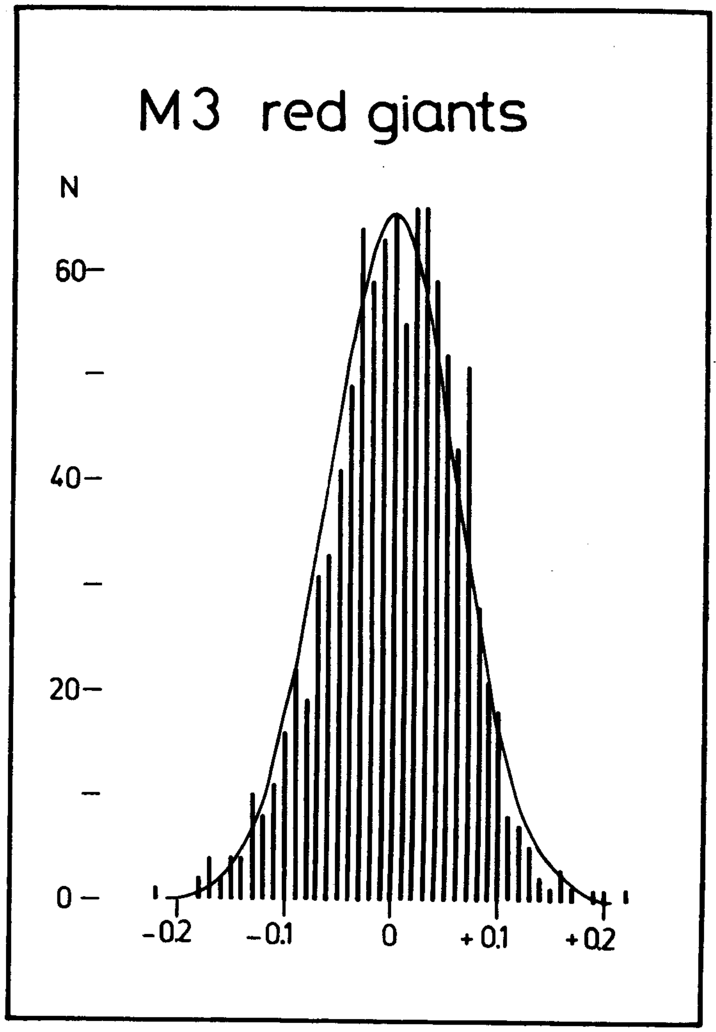

Figure 10: Composite distribution of all measured magnitudes of v.Z.205, 238, 297, 837 and 1392. The means were placed at the 0 point. The estimated standard deviation of the normal distribution curve is 0.061.

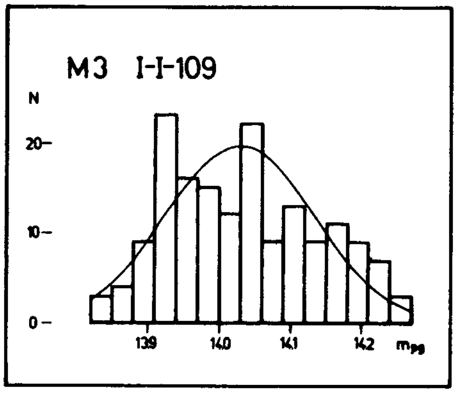

Figure 9: Histogram of the measured magnitudes of I-I-109 with 0.03 wide intervals. The normal distribution curve was calculated with the estimated mean: 14.029 and standard deviation: 0.104

CONCLUSION

The results of the present investigation seem to confirm the idea that from a given colour index all redder giant stars are variable in globular clusters.

v.Z.1397 is the reddest star (CI=$1^m.58$) in our sample and shows small amplitude light variation. There exists one redder giant star in M3, namely v.Z.318 = V95 (CI=$1^m.60$), the only known red variable of the cluster with large amplitude.

Our photographic observations do not preclude the possibility of the very small amplitude (less than $0^m.15$) light variations among the red giant stars measured. Precise photoelectric observations are necessary for making the final decision on the variability of these stars.

I gratefully acknowledge the many helpful discussions with Dr. B. Szeidl and thank him for his continuous encouragement. Mr. B. Kálmán Jr. is thanked for his valuable assistance with the instruments.

REFERENCES

Cohen, J.G., Frogel, J.A. and Persson, S.E., 1978, Astroph. J. 222.165
Osborn, W. and Fuenmayor, F., 1977, Astron. Journal 82.395
Russev, R.M., 1971, Per. Zvezdy 18.171
Sandage, A., 1953, Astron. Journal 58.61
Szeidl, B., 1965, Budapest Mitt. Nr. 58
1973, Budapest Mitt. Nr. 63
Walker, M.F., 1955, Astron. Journal 60.197
von Zeipel, M.H., 1908, Ann. obs. Paris 25.F

Table 2

Photographic observations

(m-10)

J.D.	205	238	297	837	1392	1397	I-I-109
2428963.487	4.17	4.21	4.27	4.28	4.25	-	3.98
28991.403	4.20	4.28	4.32	4.33	4.36	4.24	4.06
.416	4.12	4.20	-	4.23	4.33	4.23	4.01
.430	4.13	4.21	4.19	4.37	4.35	4.20	4.03
.522	4.12	4.28	4.35	4.32	4.31	4.29	4.04
.542	4.18	4.27	4.34	4.29	4.31	4.22	4.02
29346.376	4.09	4.24	4.14	4.26	4.30	4.18	4.03
.392	4.10	4.21	4.12	4.18	4.23	4.22	3.94
29719.549	4.20	4.32	4.25	4.09	4.44	4.36	4.02
.560	4.12	4.28	4.29	4.19	4.36	4.42	3.93
29720.546	-	4.28	4.32	4.33	-	-	3.95
.558	-	4.31	4.34	4.30	-	-	4.01
29774.405	4.08	4.21	4.25	-	-	4.27	3.97
.417	4.16	-	4.27	4.25	-	4.37	3.92
29775.403	4.10	4.27	4.35	4.16	4.41	4.37	4.05
.415	4.18	4.31	4.27	4.11	4.40	4.30	3.94
.426	4.19	4.23	4.29	4.20	-	4.35	3.97
.437	4.21	4.27	4.30	4.21	-	4.37	4.04
.447	-	4.34	4.28	4.24	-	4.36	4.09
30052.462	4.02	4.31	4.34	4.10	4.30	4.28	3.92
.474	3.99	4.36	4.28	-	4.26	4.19	3.94
.489	4.09	-	4.30	4.24	4.47	4.31	-
.501	3.96	4.24	4.30	4.05	4.34	4.32	3.96
30078.418	3.98	4.17	4.34	4.12	4.37	4.33	3.92
.434	3.99	4.25	4.42	4.13	4.28	4.21	-
.470	3.92	4.26	4.30	4.04	4.30	4.35	-
.483	4.02	4.24	4.28	4.20	4.39	4.20	3.85
.498	4.08	4.30	4.41	4.12	4.33	4.29	3.95
.509	4.02	4.19	4.38	4.16	4.29	4.20	3.82
.521	4.06	4.30	4.33	4.16	4.33	4.24	3.93
.536	4.03	4.24	4.32	4.14	4.33	4.23	3.84
.548	4.07	4.16	4.39	4.07	4.37	4.29	3.91
33390.497	4.11	4.26	4.28	4.24	4.31	4.43	4.24
.534	4.15	4.24	4.28	4.27	4.44	4.43	-
.545	4.14	4.21	4.29	4.18	-	4.37	4.19
.558	4.13	4.23	4.33	4.25	4.44	4.42	4.17
.570	4.15	4.20	4.30	4.20	4.38	4.34	4.21
.586	4.08	4.21	4.25	4.26	4.32	4.36	4.18
33420.424	4.10	4.20	4.18	4.16	4.44	4.38	4.15
.438	4.06	4.15	4.15	4.17	4.41	4.45	4.10
.450	4.13	4.18	4.25	4.12	4.41	4.38	4.13
.476	4.10	4.27	4.24	4.16	4.43	4.40	4.13
.487	4.08	4.22	4.14	4.16	4.35	4.40	4.07
.498	4.12	4.23	4.26	4.12	4.47	4.40	4.14
.510	4.14	4.27	4.23	4.14	4.44	4.43	4.08
.523	4.11	4.29	4.20	4.12	4.30	4.33	4.09
33421.385	4.18	4.34	4.33	4.13	4.44	4.49	4.07
.442	4.10	4.20	4.26	4.08	4.35	4.37	4.05
.454	4.11	4.26	4.27	4.04	4.37	4.42	4.04
.465	4.08	4.24	4.28	4.08	4.37	4.39	3.97
.475	4.10	4.27	4.33	4.06	4.38	4.45	4.05

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2433421.486	4.08	4.19	4.25	4.01	4.35	4.38	3.98
.497	4.13	4.27	4.39	-	4.32	4.46	4.00
.535	4.17	4.24	4.30	4.07	4.38	4.40	4.05
.548	4.12	4.24	4.26	4.00	4.30	4.41	4.03
33422.398	4.18	4.28	4.21	4.21	4.44	4.40	4.18
.431	4.11	4.19	4.17	4.20	4.50	4.51	4.14
.442	4.04	4.24	-	4.14	4.41	4.38	4.16
.452	4.10	4.23	4.17	4.20	4.48	-	-
.472	4.17	4.23	4.24	4.14	4.34	4.38	4.11
.483	4.15	4.29	4.27	4.24	-	4.46	4.16
.493	4.14	4.29	4.21	4.16	4.44	4.42	4.06
.508	4.08	-	4.19	-	4.40	4.36	4.04
.520	4.06	4.20	4.22	4.15	4.41	4.43	4.14
33763.406	4.12	4.25	4.32	4.12	4.37	4.39	4.12
.420	4.06	4.24	4.25	4.08	4.33	4.34	4.12
.442	4.18	4.31	4.33	4.20	4.38	4.38	4.18
.455	4.12	4.21	4.31	4.13	4.44	4.37	-
.464	4.08	4.24	4.26	4.10	4.40	4.34	4.20
.483	4.16	4.29	4.22	4.18	4.43	4.43	4.20
.494	4.18	4.31	4.24	4.17	4.40	4.36	4.15
.504	4.07	4.30	4.30	4.18	4.42	4.34	4.16
.514	4.09	4.21	4.29	4.12	4.39	4.33	4.16
.525	4.06	4.20	4.30	4.08	-	4.31	4.14
34118.355	-	4.28	4.35	-	-	-	-
.372	-	4.21	4.36	4.19	4.36	4.12	4.09
.428	-	4.10	4.34	4.02	-	-	3.84
.443	4.02	4.02	4.21	3.99	4.25	4.05	3.92
.470	-	4.21	4.33	4.24	-	4.17	-
.485	4.03	4.11	4.38	4.05	-	4.04	3.95
.499	4.13	4.22	4.30	4.14	4.35	4.12	3.98
.513	4.08	4.07	4.29	4.04	-	4.02	3.96
.540	4.05	4.15	4.37	-	4.20	4.15	-
34120.471	4.07	4.11	4.29	4.15	4.38	4.19	3.92
.484	4.10	4.11	4.30	4.21	4.38	4.21	3.92
.497	4.07	4.17	4.36	4.17	4.42	4.19	3.94
.510	4.09	4.21	4.26	4.19	4.41	4.24	3.93
.523	4.12	4.13	4.25	4.13	4.33	4.16	3.93
.536	4.17	4.20	4.34	4.11	4.40	4.18	3.89
.551	4.11	4.21	4.30	4.10	4.34	-	3.92
.564	4.21	4.20	4.31	4.24	4.36	4.29	4.03
.579	4.19	4.22	4.31	4.24	4.35	4.20	3.87
34121.401	4.06	4.14	4.27	4.12	4.36	4.17	4.04
.412	4.16	4.19	4.33	4.17	4.35	4.25	4.05
.422	4.13	4.23	4.28	4.21	4.40	4.22	4.05
.431	4.17	4.23	4.35	4.16	4.36	4.22	3.99
.441	4.13	4.13	4.28	4.14	4.32	-	3.91
.484	4.17	4.17	4.29	4.20	4.40	4.23	4.01
.495	4.10	4.14	4.26	4.17	4.37	4.18	3.99
.505	4.15	4.15	4.36	4.23	4.49	-	4.02
.517	4.07	4.14	4.26	4.13	4.36	4.14	-
.528	4.04	4.09	4.37	4.15	4.39	4.27	3.89
.539	4.04	4.09	4.29	4.17	4.40	4.15	4.02
.552	4.18	4.11	4.35	4.23	4.41	4.22	4.05

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2434121.562	4.15	4.16	4.31	4.15	4.42	4.23	4.05
.594	-	4.20	4.34	4.25	-	4.28	3.94
.605	4.16	4.20	4.28	4.21	-	4.21	-
34122.404	4.02	4.21	4.32	4.13	4.39	4.23	3.97
.416	4.07	4.17	4.36	4.18	4.35	4.29	3.93
.431	4.10	4.09	4.32	4.16	4.43	4.19	-
34126.433	4.07	4.19	4.33	4.13	4.27	4.21	4.07
34131.415	4.14	4.26	4.24	4.20	4.39	-	4.13
34487.347	4.06	4.23	4.28	4.25	4.35	-	-
.367	4.11	4.26	4.36	4.39	-	4.45	4.21
.385	4.12	4.28	4.27	4.36	4.40	4.36	-
.397	4.10	4.26	4.34	4.33	4.41	4.37	4.23
.410	4.14	4.20	4.31	4.32	4.40	4.31	4.21
.428	4.14	4.28	4.37	4.31	4.39	4.40	-
.438	4.13	4.22	4.27	4.30	4.42	4.38	4.24
.449	4.16	4.18	4.27	4.34	4.33	4.34	4.18
.460	4.13	4.30	4.32	4.27	4.43	4.46	4.24
.474	4.12	4.25	4.30	4.25	4.30	4.37	-
.483	-	4.22	4.33	4.26	4.33	4.33	4.23
.494	4.14	4.23	4.24	4.28	4.41	4.36	4.22
.508	4.08	4.29	4.31	4.26	4.38	4.37	4.16
.518	4.07	4.20	4.29	4.26	4.38	4.33	4.22
34488.530	4.09	4.26	4.25	4.24	4.42	4.45	4.19
.540	4.04	4.21	4.38	4.15	4.36	4.49	4.15
34567.388	4.02	4.29	4.25	4.11	4.39	4.23	4.09
35223.415	3.97	4.21	4.31	4.21	4.43	4.26	3.92
.428	4.07	4.28	4.27	4.14	4.42	4.26	3.86
.441	4.06	4.30	4.25	4.10	4.40	4.27	3.90
.467	4.11	4.31	4.26	4.14	4.39	4.26	3.94
.490	4.07	4.24	4.34	4.12	4.41	4.21	3.90
.503	4.05	4.27	4.33	4.15	4.40	4.21	3.95
.517	4.05	4.24	4.27	4.17	4.35	4.14	3.95
.530	3.97	4.25	4.32	4.15	4.29	4.24	3.97
.546	4.01	4.29	4.24	4.22	4.45	4.24	3.98
.573	4.05	4.27	4.21	4.15	4.37	4.22	3.94
35224.454	3.98	4.29	4.25	4.11	4.34	4.19	3.90
.472	4.07	4.28	4.25	4.18	4.42	4.24	3.91
.485	4.00	4.27	4.27	4.11	4.31	4.19	3.91
.499	4.07	4.32	4.31	4.17	4.32	4.26	3.99
.512	4.00	4.30	4.23	4.15	4.34	4.22	3.93
.524	4.07	4.34	4.32	4.19	4.37	4.19	4.01
.542	4.04	4.29	4.25	4.09	4.40	4.20	4.01
.556	3.99	4.28	4.37	4.11	4.41	4.18	3.98
.569	4.08	4.27	4.30	4.11	4.39	4.20	3.93
.583	4.01	-	-	4.07	4.28	4.14	3.93
35227.534	3.99	4.24	-	4.17	4.44	4.06	4.01
.547	4.11	4.23	4.17	4.18	4.37	4.16	4.08
.560	4.04	4.19	4.10	4.21	4.33	-	4.08
.573	4.13	4.30	4.19	4.17	4.31	4.13	4.10
.586	4.00	4.26	4.22	4.19	4.31	4.16	3.93
35598.507	4.03	4.23	4.23	4.19	4.31	4.30	4.10
.524	4.01	4.30	4.15	4.17	4.41	4.28	4.09
.537	4.14	4.34	4.25	4.20	4.39	4.28	4.19

Table 2 (continued)

J.D.	205	238	297	837	1392	1397	I-I-109
2435600.363	4.10	4.24	4.31	4.12	4.32	4.26	4.06
.378	4.10	4.33	4.20	4.23	4.39	4.27	4.11
.391	4.10	4.28	4.24	4.17	4.27	4.28	4.15
.405	4.04	4.31	4.32	4.19	4.47	4.36	4.05
.421	4.16	4.34	4.23	4.15	4.36	4.39	4.15
.434	4.15	4.32	4.22	-	4.44	4.23	4.11
.446	4.03	4.20	4.22	4.19	4.41	4.21	4.05
.501	4.10	4.22	4.18	4.17	4.25	4.24	4.07
.525	4.16	4.25	4.20	4.16	4.38	4.23	4.07
35603.369	4.13	4.31	4.35	4.22	4.38	4.27	4.03
.381	4.04	4.24	4.25	-	-	4.24	3.90
.397	4.07	4.31	4.40	4.23	4.40	4.32	3.92
.408	4.11	4.27	4.23	4.16	4.38	4.29	-
.419	4.03	4.18	4.31	4.15	4.39	4.33	3.97
.431	4.17	4.26	4.29	4.25	4.39	4.30	4.01
.446	4.06	4.18	4.31	4.25	4.30	4.26	-
.457	4.02	4.21	4.24	4.15	-	4.26	3.94
.468	4.13	4.29	4.33	4.22	4.45	4.29	4.05
.491	4.01	4.26	4.19	4.14	4.29	4.24	3.98
.507	4.11	4.31	4.26	4.20	4.35	4.33	3.92
36991.457	4.17	4.27	4.26	4.13	4.42	4.37	4.05
.470	4.16	4.26	-	4.09	4.40	4.36	-
.485	4.18	4.28	4.36	4.08	4.43	4.33	3.94
37018.470	4.18	4.37	4.34	4.22	4.43	4.25	-
.483	4.16	4.34	-	4.18	4.40	-	-
.496	4.14	4.33	4.32	4.10	-	-	-
.510	4.00	4.24	4.27	4.16	4.36	4.32	-
.523	4.04	4.22	4.28	4.10	4.44	4.43	-
.537	4.00	4.22	4.33	4.13	4.40	-	-
.550	4.14	4.29	4.35	4.19	4.32	4.33	-
.577	4.08	4.23	4.30	4.14	4.40	4.34	-
.609	4.06	4.31	4.28	4.10	4.31	4.27	-
.623	4.09	4.29	4.35	4.22	4.38	4.40	-
.637	4.01	4.26	4.27	4.15	4.32	4.35	-
37057.539	4.09	4.21	4.34	4.12	4.37	4.39	-
.552	3.97	4.16	4.33	4.08	4.37	4.38	-
.578	4.06	4.20	4.22	4.06	4.31	4.34	-
37058.529	-	4.14	4.21	4.07	4.43	4.32	-
.580	4.10	4.19	4.29	4.19	4.29	4.26	-
37757.598	4.19	4.27	4.40	4.13	4.47	4.40	-
37791.365	4.07	4.15	4.30	-	4.33	4.35	-
.380	4.13	4.17	4.33	4.18	4.35	4.37	-
.394	4.17	4.24	4.34	4.20	4.43	4.33	-
.424	4.18	4.24	4.27	4.22	4.41	4.21	-
.439	4.11	4.16	4.34	4.17	4.39	4.29	-
.454	4.04	4.13	4.29	4.14	4.39	4.27	-
.469	4.08	4.20	4.33	4.13	4.34	4.33	-
.483	4.07	4.15	4.35	4.11	4.41	4.24	3.88
.497	4.15	4.23	4.39	4.18	4.42	4.31	-
.519	4.17	4.26	4.31	4.14	4.43	4.34	3.90
.533	4.16	4.21	4.35	4.20	4.37	4.37	-
.549	4.05	4.19	4.30	4.11	4.37	4.32	3.86
.563	4.09	-	4.25	4.19	4.34	4.25	3.88