LIGHTCURVE ANALYSIS OF (5892) 1981 YS_1 REVISITED

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In previous issues of the *Minor Planet Bulletin*, the authors reported independent findings for the period of asteroid (5892) 1981 YS_1. The analysis of the curves was re-examined and the parameters previously reported by Warner were found to be the more likely solution. The process brought to light some of the pitfalls of data analysis, especially regarding aliases. The combined data led to a slightly changed synodic period, 10.59±0.02h with an amplitude of 0.27±0.03mag.

Initial Findings and Re-examination

Asteroid (5892) 1981 YS_1 was discovered from Purple Mountain Observatory on 1981 Dec. 23. The approximate diameter (Harris 2003) is 6km. Warner (2003) previously reported a synodic period of 10.60±0.02h and amplitude of 0.26±0.03 mag. In a subsequent issue of the *Minor Planet Bulletin* (Ditteon 2003), a period of 11.905±0.005h and amplitude of 0.33 mag. were reported. See those previous articles for the lightcurve plots. The second article prompted Warner to contact Ditteon to arrange for an exchange of data to see if combining the two sets could resolve the discrepancy. This was made easier by the fact both authors were using the same MPO Canopus data analysis program, which allows importing data from other observers into the common data files used for period analysis.

While this was happening, an email was sent to Dr. Alan Harris of Space Science Institute for his analysis. His reply, without having the data in hand and based only on reviewing the published lightcurves, eventually proved to be correct (Harris 2003a):

> "I immediately noticed that all [Ditteon sessions] except for the very last day of observation (January 11) are separated by multiples of 2 days, or 48 hours. So the period assumes 4 cycles in close to 48 hours, specifically 47.62 hours. Because the curve is so symmetrical, we could think of 8 half-cycles in 47.62 hours in looking for aliases. If I take [the Warner] period of 10.59 hours and divide that into 47.62 hours, I get 4.4967 cycles! It appears to me that [Ditteon] picked up the alias of 4.0 cycles in 47.62 hours instead of the correct 4.5 cycles per 47.62 hours, which would yield a period of 10.58 hours. If this hypothesis is correct, I'll bet the last day (January 11) has so few data points that it was unable to reveal the half-cycle ambiguity error. If [there had been] enough data on the odd days, I'm sure that the alias solution would go away."
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> "This is an excellent example of why you should plot each day with different symbols, so the composite can be "unscrewed". In addition to being unable to judge the quality of a composite, if the composite turns out to be a wrong period, the value of the underlying data is preserved if one can "unscrew" it and put it back together with the right period."

Once the combined data was available, Warner tried searches around both periods and others – to be certain a third solution did not present itself. The result was a slight revision of the solution, i.e., 10.59±0.02h instead of 10.60±0.02h. The amplitude is 0.27±0.03 mag. The revised lightcurve is shown in Fig. 1.

Nothing critical should be taken from this episode. Instead, it shows the better aspects of lightcurve work: collaboration among observers, the willingness to re-examine results in light of new data, and learning yet another lesson about the pitfalls that lie in waiting for the unsuspecting researcher.

This also brings up the question of whether or not an asteroid with a published period should be worked by a later observer, if the goal is simply period determination and not for other reasons such as shape modeling or H-G determinations. In this case, both papers were in process and so neither knew about the other's work. Also in this case, it proved beneficial that there were two independent findings as it led to establishing an even firmer solution. If an asteroid has a rating of '2', it would be a good idea to try to find the original paper and see if the asteroid deserves additional work. A rating of '1' definitely merits additional observations. A rating of '3' can probably be passed over in lieu of more deserving targets. A '4' rating is ambiguous. While it does indicate a pole solution has been reported, the period may still be in error. Again, this is where examination of the literature can help make or break the case for additional work. Even when the period is well known, one can check if there is a pole solution wanting only a few more observations. In short, truly needless duplication of effort is relatively rare and, as been shown above, duplicate work can lead to improved and more certain results.

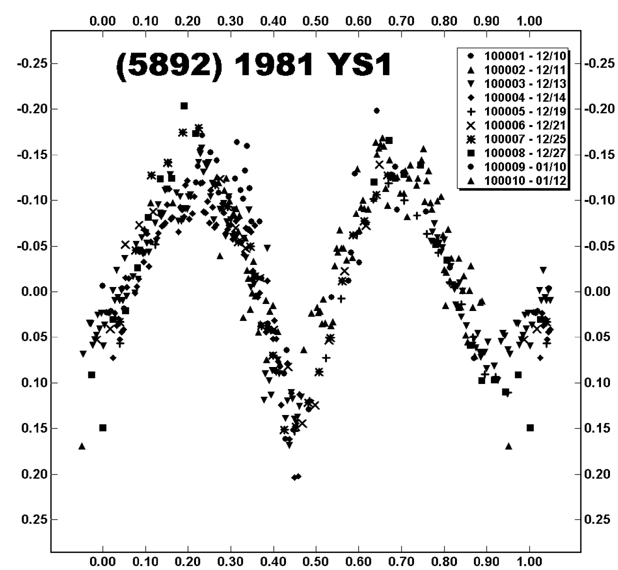

Figure 1. The combined data lightcurve for (5892) 1981 YS1. The synodic period is 10.59±0.02h and amplitude is 0.27±0.03m.

The authors want to thank Dr. Harris for his continuing and invaluable support and insights.

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PERIOD DETERMINATIONS FOR 265 ANNA AND 1584 FUJI

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Minor planets 265 Anna and 1584 Fuji were observed from two sites widely separated in longitude. The former was observed over 12 nights (22 rotations) and the latter over 15 nights (23 rotations). Unfiltered CCD photometry yielded a synodic rotation period of 11.681 ± 0.006 hours for Anna and a period of 14.880 ± 0.013 hours for Fuji. The amplitudes are 0.48 and 0.17, respectively.

Introduction

Minor planet 265 Anna was discovered in 1887 by J. Palisa at Vienna Observatory. No previously published lightcurves have been found for this main-belt asteroid and no data are listed in the tabulations of Harris and Warner (2003). Its diameter is quoted as 30 km and the albedo as 0.054. Minor planet 1584 Fuji was discovered in 1927 by O. Oikama at Tokyo and named after the highest mountain in Japan. This main-belt, S-type asteroid is one of the Phocaea group with an albedo of 0.13 and a B-V of 0.89. There are no previously published lightcurves, but the asteroid is listed in the tabulations of Harris and Warner (2003), where its period is noted as possibly 10 hours with an amplitude of 0.3 magnitudes. The diameter is quoted as 25 km. Both of these asteroids were chosen from the lists published in the *Minor Planet Bulletin* (e.g. Warner, et al., 2004).

Observations and Results

In early 2004 both these minor planets were favorably placed for southern observers. Unfiltered CCD photometry was employed and no light-time corrections have been applied. Data were plotted as instrumental differential magnitude vs JD and initial graphical analysis was carried out.

For 265 Anna, some 14 extrema observed during March 2004 yielded an initial period of 11.700 hours. Analysis was then performed using the AVE software (Barbera, 2004) and the Phase Dispersion Minimisation (PDM) technique. Periods between 0.35 and 1.2 days were searched and a distinct minimum on the periodogram occurred at 0.486 days. This was then refined further by trial phase stacks – finally yielding a period of 0.487 days or 11.681 ± 0.006 hours. Using this period and a zero phase epoch of JD 2453083.96 the data were phase stacked as shown in Figure 1. An additive constant was applied to match the magnitudes on different nights. The lightcurve variation is 0.48 magnitudes. Using a tri-axial ellipsoid model, this implies an axial ratio a/b of 1.55 – a significantly non-spherical shape – possibly a good candidate for shape modelling. The high value of the variation suggests that this asteroid was at near-equatorial aspect at this opposition. As all phases of the rotation were observed with a good density of points, we believe this is a secure result.

For 1584 Fuji, some 11 extrema observed in February 2004 were used in the initial graphical analysis, yielding a period of 14.89 hours. The AVE software and the PDM method were then employed to search periods between 0.3 and 0.85 days. The periodogram showed a large distinct minimum at 0.620 days (14.880 ± 0.013 hours) and a secondary minimum at 0.310 days. The latter was judged to be an alias as the phase stack produced a single maximum and minimum. The data were phase stacked using the above period and a zero phase epoch of JD 2453047.049 (Figure 2). For the final lightcurve the individual night lightcurves were adjusted by an additive constant. The lightcurve amplitude is 0.17 magnitudes. This variation implies an axial ratio a/b of 1.17, however, the previously reported variation of 0.3 magnitudes suggests a higher ratio at more equatorial aspects. Almost all phases of the rotation were observed with a high density of points yielding a secure result.

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