THE ELUSIVE PERIOD OF THE HILDA 1269 ROLLANDIA

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I present high quality lightcurve data on the large Hilda 1269 Rollandia. The data were obtained using a 0.9m telescope at Cerro Tololo Interamerican Observatory in Chile in May 2013 and cover over 17 hours split over two consecutive nights. This data is not sufficient to find a reliable rotation period for Rollandia. However, the data it is sufficient to rule out most of the published periods for this object.

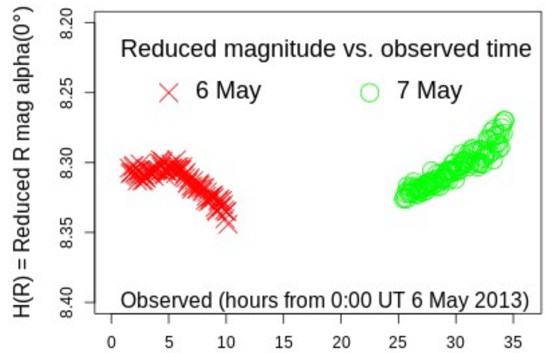
1269 Rollandia is a member of the Hilda group discovered in 1930 by G. Neujmin at Simeiz, in the Crimean Peninsula. Rollandia is the fifth largest Hilda, with a diameter of about 105 km (Mainzer et al., 2019).

I observed Rollandia using the 0.9-m SMARTS telescope at Cerro Tololo Observatory in Chile on two night in May of 2013, using 100 s long exposures. I obtained interleaved V and R sequences of images to search for any color variation with phase. When planning the run, I thought the period for Rollandia was ~15.3 h. This period would have allowed a complete lightcurve to be obtained using long sequences (>8 hours) on two consecutive nights. The object was ideally placed and was in a dark sky and at airmass less than 2 for almost 9 hours each night. On 2013 May 6, I obtained 108 R and 107 V exposures spanning 8.6 h, and on 2013 May 7, 114 R and 113 V exposures spanning 8.8 h. The observing conditions were superb.

All CCD images were reduced and measured using custom scripts using the IRAF software package. Reduction steps included subtraction of background images to reduce the effects of contaminating stars and galaxies, and pairwise comparison of seeing and transparency monitoring stars to look for stellar variations during the night.

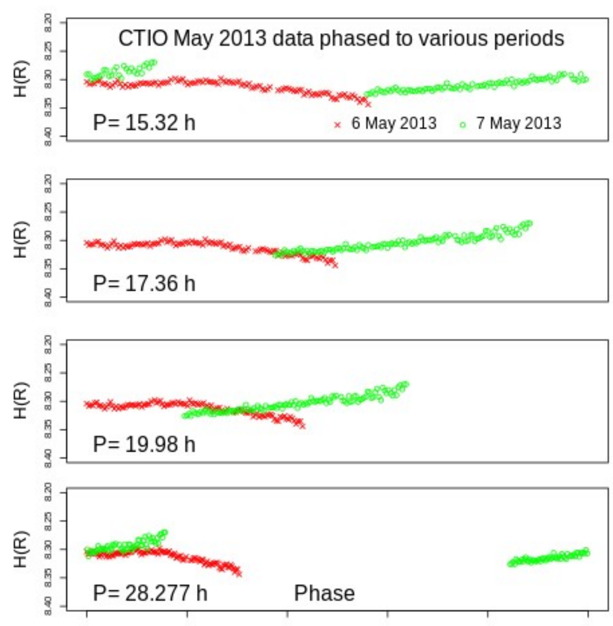
Photometric calibration in the Landolt VR magnitude system was made using observations of several Landolt standard fields each night (Clem and Landolt, 2013). On both nights the V and R lightcurves of Rollandia were visually indistinguishable in shape. The color computed from adjacent V and R images showed no noticeable change with time over the course of either night. The average color was V-R = 0.486 on 6 May and 0.477 on 7 May. The color calibrations were independently derived each night and have estimated uncertainties of about 0.01 mag. Thus, the two color determinations agree well, given the calibration uncertainty, and the overall average V-R color of Rollandia is 0.482.

Magnitudes were reduced to absolute (r = 1 au, Δ = 1 au, phase = 0°) R band magnitudes (H(R)) using the Bowell et al. (1989) H, G formalism with $G = 0.15$. The H(R) magnitudes are plotted as a function of the observation midpoint time, with the x-axis starting at 0:00 UT on 6 May 2013. The random photometric error bars are about 0.007 mag and are not shown on the plot as they are only a little larger than the symbol size.



There have been a number of periods published for Rollandia. Fauvaud and Fauvaud (2013) quote a period of 15.32 h. Warner et al. (2017) quote 19.98 h. Warner and Stephens (2019) discuss several possible periods and adopt 17.36 h, while Polakis (2019) gives a period of 28.277 h. Slyusarev et al. (2013) give a lower limit to the period of 36 h. (This value replaces the preliminary period of 30.98 h in Slyusarev et al. (2012) (personal communication, Slyusarev). Behrend (2019web) gives a period estimate of 72 h, but this is based only on a small fragment of a period, about 6 hours of data. Colazo et al. (2021) present a period of 39.81 h.

To check the consistency of these periods with my data, I phased the CTIO data to the various periods, as shown in the figures below. My data covers a time span of about 32.7 h from the first observation on 6 May to the last on 7 May. Thus, if the correct period is less than 32.7 hours, the data should repeat itself for a portion of the lightcurve. In my opinion, none of the four phased plots produce an acceptable repeating lightcurve. Thus, these four periods are inconsistent with the CTIO data.

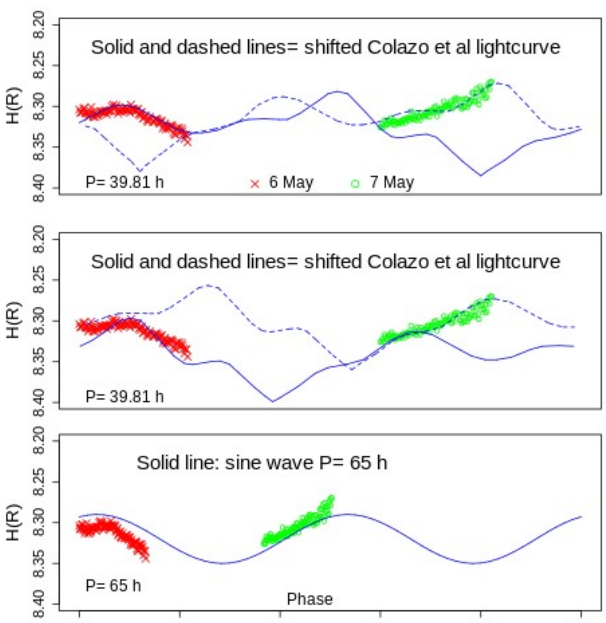


Number	Name	yyyy mm/dd	Phase	L_{PAB}	B_{PAB}	Period(h)	P.E.	Amp	A.E.
1269	Rollandia	2013 05/06-05/07	5.1,4.	24	3	unknown	unknown	0.07	0.01

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema during the period. L_{PAB} and B_{PAB} are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984).

For the Colazo et al. (2021) period, 39.81 h, the CTIO data would not span a full period. The Colazo et al. (2021) lightcurve shows a two peaked curve, with the two maxima separated by 0.44 or 0.56 of a period, corresponding to 17.5 or 22.3 h. The CTIO data might show a broad maximum at about 4 h UT on 6 May and another maximum at or somewhat past 35 h after 0:00 UT on 6 May. I tried to fit the CTIO data to the Colazo two peaked 39.81 h period lightcurve by shifting the phase and magnitude of the Colazo et al. lightcurve. Of course, the two lightcurves would not be expected to match in detail as the observing geometries were different. However, if the correct period is 39.81 h, the time difference between lightcurve peaks in the CTIO data should line up pretty well with those in the Colazo data. The top two panels of the last figure show four (of many) attempts to align the peak times. Clearly, the CTIO data is inconsistent with any such match, indicating that the rotational period of Rollandia is not 39.81 h.

In the bottom panel of the figure, I show the CTIO data phased to a period of 65 h, and a simple sinewave lightcurve of 65 h rotational period. This is obviously not meant to be a proper fit to the period, but does suggest that much longer periods than those published so far should be considered, as suggested by Behrend (2019web).



In summary, I believe the rotational period of Rollandia must be considered unknown at present. As a period of several days is quite possible, finding the correct period might well require a lot of time coverage from a number of telescopes at different longitudes. At the next few oppositions of Rollandia (June 2021 and July 2022), the object will be at a declination near -20°, so will be extremely difficult for northern hemisphere observers, but will be ideally places for long sequences from southern hemisphere observatories.

One possible explanation for the disparate published periods is that Rollandia is a tumbling object. If it is, it would be the largest known tumbling minor planet. Plots were produced with the freely available R software package (R Core Team 2020).

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