PRELIMINARY SPIN-SHAPE MODEL FOR 755 QUINTILLA

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We present a preliminary shape and spin axis model for main-belt asteroid 755 Quintilla. The model was achieved with the lightcurve inversion process, using combined dense photometric data acquired from three apparitions, between 2004 to 2020 and sparse data from USNO Flagstaff. Analysis of the resulting data found a sidereal period P = 4.55204 ± 0.00001 hours and two mirrored pole solutions at (λ = 109°, β = -12°) and (λ = 288°, β = -3°) with an uncertainty of ± 20 degrees.

The Minor planet 755 Quintilla has been observed by the authors for three oppositions from 2004 to 2020. Moreover, in order to cover several apparition geometries, we used sparse data from the USNO Flagstaff Station (MPC Code 689), downloaded from the Asteroids Dynamic Site (AstDyS-2, 2020).

The observational details of the dense data used are reported in Table I with the mid date, number of the lightcurves used for the inversion process, longitude and latitude of phase angle bisector (LPAB, BPAB).

Reference	Mid date	# LC	LPAB°	BPAB°
Buchheim, Pray (2005)	2004-04-16	3	207	2
Fauerbach (2019)	2018-11-02	2	54	-3
Franco et al.(2020)	2020-01-28	6	116	-3

Table I. Observational details for the data used in the lightcurve inversion process for 755 Quintilla

Lightcurve inversion was performed using MPO LCInvert v.11.8.2.0 (BDW Publishing, 2016). For a description of the modeling process see LCInvert Operating Instructions Manual, Durech et al. (2010); and references therein.

Figure 1 shows the PAB longitude/latitude distribution for dense/sparse data used in the lightcurve inversion process. Figure 2 (top panel) shows the sparse photometric data distribution (intensities vs JD) and (bottom panel) the corresponding phase curve (reduced magnitudes vs phase angle).

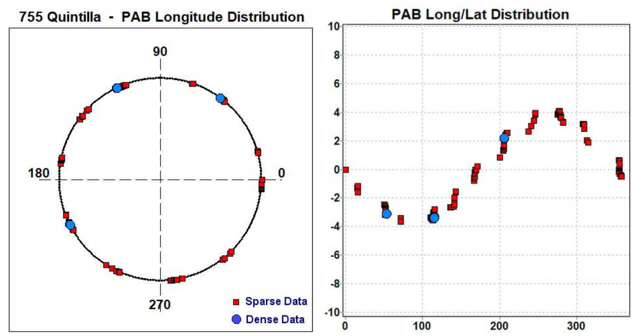

Figure 1: PAB longitude and latitude distribution of the data used for the lightcurve inversion model.

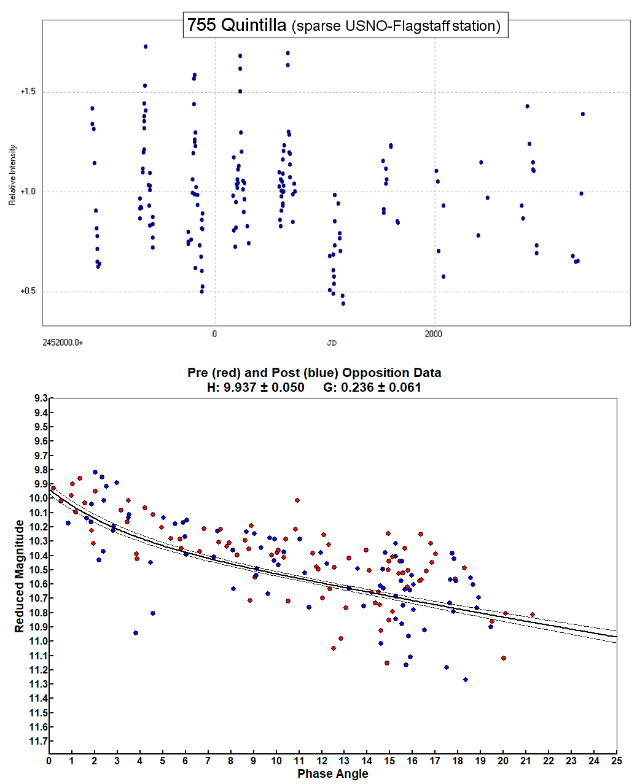

Figure. 2: Top: sparse photometric data point distribution from (689) USNO Flagstaff station (relative intensity of the asteroid's brightness vs Julian Day). Bottom: phase curve obtained from sparse data (reduced magnitude vs phase angle).

In the analysis the processing weighting factor was set to 1.0 for dense and 0.3 for sparse data. The "dark facet" weighting factor was set to 0.5 to keep the dark facet area below 1% of total area and the number of iterations was set to 50.

The sidereal period search was started around the average of the synodic periods found in the asteroid lightcurve database (LCDB; Warner et al., 2009). We found a group of five sidereal period with Chi-Sq values within 10% of the lowest value, one of them more isolated and with a lower Chi-Sq (Figure 3).

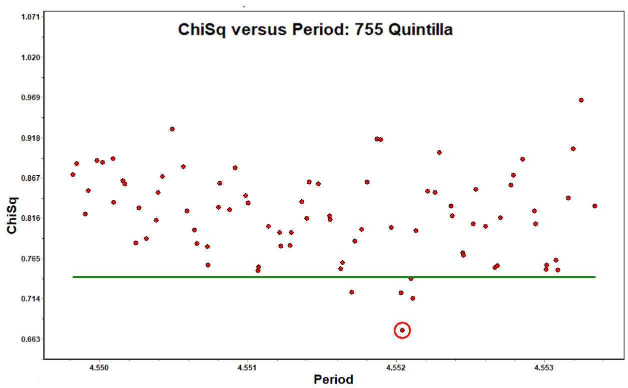

Figure 3: The period search for 755 Quintilla shows five sidereal period with Chi-Sq values within 10% of the lowest value, one of them more isolated and used for the inversion process.

The pole search was started using the "medium" search option (312 fixed pole position with 15° longitude-latitude steps) and the sidereal period with the lowest Chi-Sq set to "float". From this step we found two roughly mirrored lower Chi-Sq solutions (Figure 4) separated by about 180° in longitude at ecliptic longitude-latitude pairs (105°, -15°) and (285°, 0°).

The two best solutions (lower Chi-Sq) are reported in Table II. The sidereal period was obtained by averaging the two solutions found in the pole search process. Typical errors in the pole solution are ± 20° and the uncertainty in sidereal period has been evaluated as a rotational error of 40° over the total time span of the data set. Figure 5 shows the shape model (first solution with a lower Chi-Sq) while Figure 6 shows the fit between the model (black line) and some observed lightcurves (red points).

λ °	β °	Sidereal Period (hours)	Chi-Sq	RMS
109	-12	4.55204 ± 0.00001	0.67488	0.0274
288	-3		0.67616	0.0274

Table II. The two spin axis solutions for 755 Quintilla (ecliptic coordinates) with an uncertainty of ± 20 degrees. The sidereal period was the average of the two solutions found in the pole search process.

The analysis did not identify a *unique solution* (Durech et al., 2009) so we consider this model as a preliminary solution. Indeed, the pole search distribution is poorly constrained, specially along the ecliptic latitude. However, a check for the other four sidereal periods found produce similar solutions with higher Chi-Sq and RMS values. We invite to observe this asteroid in the next oppositions, in order to find a more robust solution.

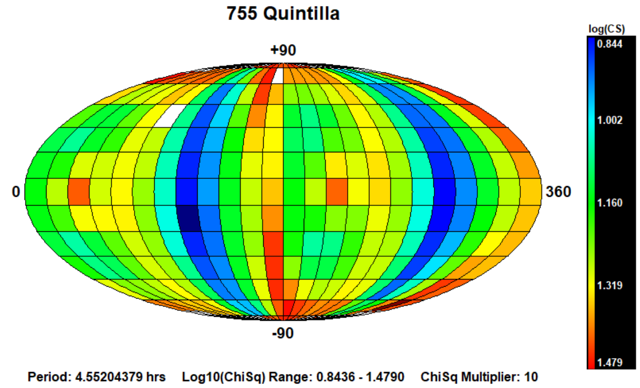

Figure 4: Pole search distribution. The dark blue region indicates the smallest Chi-Sq value while the dark red region indicates the largest.

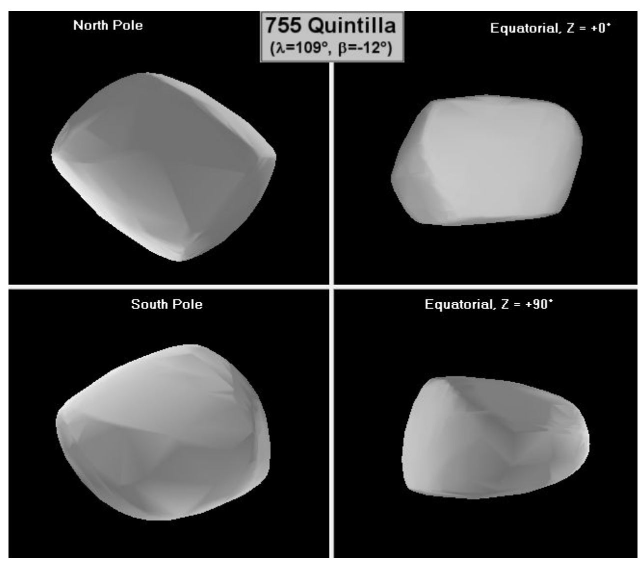

Figure 5: The shape model for 755 Quintilla (λ = 109°, β = -12°).

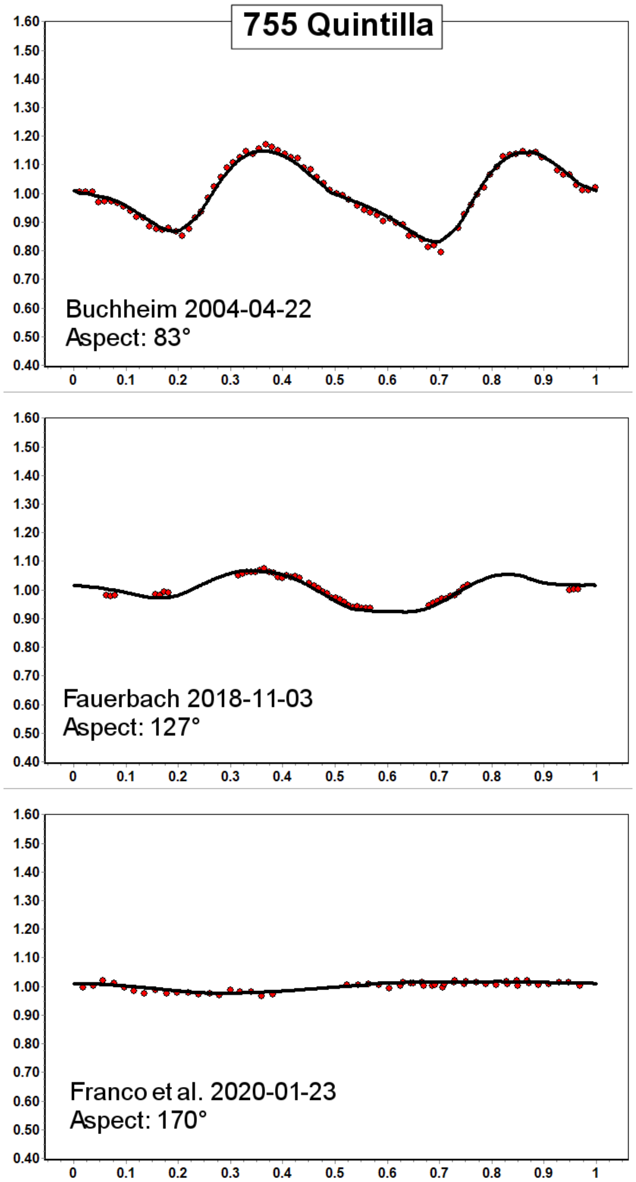

Figure 6: Model fit (black line) versus observed lightcurves (red points) for (λ = 109°, β = -12°) solution.

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