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The Non-Principal Axis rotation of (5247) Krylov

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Abstract

The observations of the Non-Principal Axis (NPA) rotator (5247) Krylov were made during three apparition, 2006, 2016 and 2017. We reconstructed its spin state and shape model and found that this asteroid exhibited Short Axis Mode (SAM) and it is relatively close to the Principal Axis (PA) rotation state.

1. Introduction

The NPA rotators offer an important evidence to the evolutionary processes of these bodies because their excited spin states are thought to be caused either by internal- and/or external- forces. The spin state of NPA rotators can be reconstructed using time-series radar observation or disk-integrated observation. However, the radar observations can be restrictively conducted only on a close approaching asteroids or a few large asteroids. Therefore, the ground-based photometric observations are requested for analysis of the spin properties of various NPA rotators.

The (5247) Krylov (hereafter Krylov) is a NPA rotator in the inner main belt [1]. It is classified as a S-type asteroid [1] and belongs to the Phocaea asteroid family [2]. In addition, the diameter of Krylov has a difference between the AKARI (10.44 km) [3] and NEOWISE (7.716 or 8.665 km) [4]. Such a difference in diameter estimates could be caused partly by assuming that this asteroid has a PA rotation. Hence, in order to analysis the physical properties of Krylov, an understanding of its spin state is requested.

2. Observations

The photometric observations of Krylov were conducted during three apparition, 2006, 2016 and 2017 using a 0.35-2.1 m telescopes. The observation details are shown in Table 1.

Table 1: Observation details

Observatory*	Telescope aperture	Duration	Filter
Modra	0.6-m	2006. June – July (21 nights)	Clear
SMO	0.35-m	2006. May – June (12 nights)	Clear
KMTNet (CTIO, SAAO & SSO)	1.6-m	2016. Jan. – April (51 nights)	R
TUG	1.0-m	2017. July – Aug. (4 nights)	R
LOAO	1.0-m	2017. June – Sep. (4 nights)	R
BOAO	1.8-m	2017. June – Sep. (6 nights)	R
OAdM	0.8-m	2017. June – Aug. (7 nights)	R
La Sagra	0.45-m	2017. June (3 nights)	R
Mcdonald	2.1-m	2017. July (6 nights)	r
BlueEye 600	0.6-m	2017. July (2 nights)	R

*SMO = Sugarloaf Mountain Observatory, KMTNet = Korea Microlensing Telescope Network, CTIO = Cerro Tololo Inter-American Observatory, SAAO = South African Astronomical Observatory, SSO = Siding Spring Observatory, TUG = TÜBİTAK National Observatory, LOAO = Lemmonsan Optical Astronomy Observatory, BOAO = Bohyunsan Optical Astronomy Observatory, OAdM = Montsec Astronomical Observatory.

3. Physical model

The physical model of Krylov was reconstructed employing lightcurve inversion technique [5,6,7]. Our solution and convex shape of Krylov is shown in Table 2 and Figure 1.

Table 2: The physical model of Krylov

Physical parameter*	Value**
λ_L [deg.]	292^{+2}_{-5}
β_L [deg.]	-59^{+3}_{-2}
P_ϕ [hr]	$67.2802^{+0.0003}_{-0.0006}$
P_ψ [hr]	$368.804^{+0.010}_{-0.009}$
ϕ_0 [deg.]	120^{+7}_{-1}
ψ_0 [deg.]	1^{+1}_{-1}
I_a	$0.40^{+0.05}_{-0.09}$
I_b	$0.950^{+0.017}_{-0.008}$

* λ_L, β_L are the ecliptic coordinates of the angular momentum vector $\vec{L}$; P_ψ, P_ϕ are the periods of rotation and precession; ϕ_0, ψ_0 are the standard Euler angles at t_0; I_a, I_b are the principal moments of inertia. They are normalized by I_c [5,8]. **The uncertainties of parameters were estimated within 1σ confidence level [9].

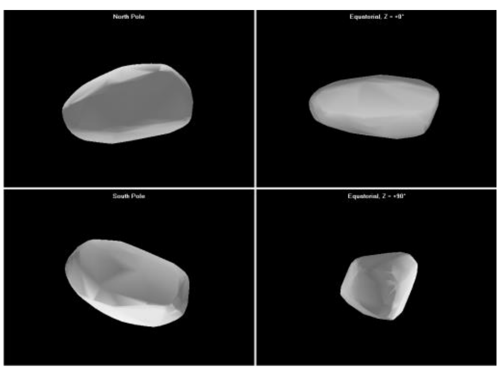

Figure 1: The shape model of Krylov

4. Summary and Discussion

We found the spin state and shape model of Krylov by inversion of lightcurves from three apparitions. As a result this asteroid rotates in SAM with the rotation and precession periods of $P_\phi = 67.2802$ hr and $P_\psi = 368.804$ hr, respectively. Its ratio of the rotational kinetic energy to the lowest energy for given angular momentum is $E/E_0 \cong 1.02$. Hence, Krylov is relatively close to the Principal Axis (PA) rotation state. We discussed the cause of this spin state as two cases. The first possibility is that this asteroid was excited by a low external energy. The other possibility is that its NPA spin state was substantially damped from a higher excited rotation state.

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