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Photometric Observations of Comet-Asteroid Transition Object 107P/Wilson-Harrington

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A development in recent theoretical studies for the Solar System formation is the suggestion of the Nice model [1]. The Nice model proposes the migration of giant-planets from an initial compact configuration into their present positions. The dynamical evolution of the giant-planets by the Nice model leads to the insertion of primitive trans-Neptunian objects into the outer main belt asteroid (MBA) region [2]. On the other hand, a development in recent observational studies is the discovery of main-belt comets (MBCs) [3]. MBCs are objects that display cometary activities in the MBA region. Six of seven known MBAs inhabit in the outer-MBA region. The mechanism of the cometary activity is controversial: i.e. impact collisions or ice sublimations. A possible activation mechanism for MBCs might be impacts with small (e.g., meter-sized) objects because the long distant from the sun makes ice sublimations difficult to happen. The discovery of MBCs indicates that objects in the outer-MBA region have enough volatile materials, as suggested by the Nice model. Furthermore, some outer-MBAs would migrate to the orbit of near-earth objects (NEOs). A part of such volatile rich objects would impact with the Earth in the earliest stage of the Solar System. The study of objects in which cometary activity is shown provides keys to the origin of Earth's water and life. 107P/Wilson-Harrington (also know as 4015 Wilson-Harrington, hereafter, 107P) was discovered accompanied by a faint cometary tail in 1949. Despite a devoted search, no cometary activity has been detected since the initial observation [4]. Therefore, 107P is a so-called comet-asteroid transition objects. 107P is also categorized near-earth objects (NEOs). A numerical simulation mentions that there is a 65% chance that 107P has an origin in the outer-MBAs region [5]. Thus, 107P might include much volatile material like MBCs. Moreover, if the cometary activity of 107P is driven by impact collisions, the collision would affect the rotation of 107P. In that case, the lightcurve of 107P shows the multi-periodicity. Besides, 107P is a promising target by an advanced asteroid probe. Clarification of the rotational states of 107P is important to design the future sample return mission.

We had conducted the photometric observations of 107P using five small- and medium sized telescopes in 2009-2010 apparition. The lightcurve had showed a periodicity of 0.2979 day (7.15 h) and 0.0993 day (2.38 h), which has a commensurability of 3:1 [6]. We suggest the following four possibilities for the interpretation. 1) 107P is a tumbling object with a sidereal rotation period of 0.2979 day and a precession period of 0.0993 day. 2) 107P is not a tumbler. The sidereal rotation period is 0.2979 day. The period of 0.0993 day represents the roughly symmetrical hexagonal shape. 3) 107P is not a tumbler. The sidereal rotation period is 0.2979 day. The period of 0.0993 day comes from the binary eclipse. 4) The observations were conducted at the phase angle of around 50 degree. Therefore, the shade by topography would provide the period of 0.0993 day. In that case, 107P is not a tumbler. The sidereal rotation period is 0.1490 day (a half period of 0.2970 day). Here, tumbling, binary asteroid, and the topographical effect imply that the cometary activity of 107P results from the impact collisions. The lightcurve that is made at the low phase angle permits us to determine whether the topographical effect is present. We have a plan of next observation campaign of 107P at low phase angle in 2013.

References

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