===== ASROC 2025 abstract =====

Title: *An Investigation in the orbital evolution of the Near-Earth Asteroid Eros*

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Abstract

- Context

Orbits of near-Earth asteroids (NEAs) are usually unstable, that is to say, the elements will be changed during the evolution. Sometimes, the results through our simulations present crossing the Earth's orbit, which means it will collide the Earth if the both meets together according to the results. Focusing on the larger near-Earth objects (NEOs), on top 10+ in size companion, it will occur the serious crisis to the Earth. Hence, we need to obtain precisely initial elements of orbits, for instance, 433 Eros in this work, as soon as possible to find out the true evolution. 433 Eros, the simulated object for this work, is the second-largest near-Earth object with its recent diameter of ~16.84 km and perihelion of ~1.133 AU (astronomical unit) from Small Body Data Base (SBDB), JPL in NASA. In the past research [1] mentioned that there would probably become the Earth-crossing asteroid within many numerical simulation tests.

- Aim

In this research, we investigated the orbital evolution of 433 Eros. In addition to simulate 433 Eros' orbital evolution, we check when Eros encounters the Earth, and even hits the Earth. Then, since with long-time simulations the large different results are occurred by the small differences of initial conditions and sets, so we use cloning particles, whose orbital elements with covariance matrix, and observe these evolution. Finally, we need to make a conclusion, determining the most possible results among them, inferring the reasonable process of the evolution.

- Method

To simulate 433 Eros' orbital evolution, we used two packages, REBOUND and MERCURY. We used MERCURIUS integrator in REBOUND, and the similar method with MERCURY, using Hybrid symplectic integrator for planetary dynamics [2]. We used data in JPL Horizons systems, including the covariance matrix for generating the clones, and set up 100 clones the time step with 2 percents of Eros' orbital period (~12.863 days). We recorded a data count when the simulation reached 4000 time steps, that is, 80 periods of Eros' orbit (~140.87 years). Also, we set up 10000 counts to simulate ~1.4 Myrs to observe the results referring to P. Michel+, 1996 [1]. Finally, we had to print the distance from Eros to the Earth to check the number when Eros encountered and hit the Earth, thinking the most probable reason eventually.

- Expectation

We expected that the result is longer than P. Michel+, 1996 [1]. We probably select the most similar one of the past in our results. So far, we hoped the reasonable reason come out, more discussions in Eros' orbital evolution. Last but not least, we even hoped that we could find out the accurate change in every Eros' orbital elements.

- Conclusion

Therefore, after simulating Eros' orbital evolution, we believed there would become vary results in the future. In short, we should always keep concentrating on these initial conditions, hoping the slower time to hit the Earth.

Reference

[1] P. Michel+; Nature; 380, 25; 1996

[2] Hanno Rein+; MNRAS; 465, 5490-5497; 2019