SEMINAR

專題演講

國立中央大學 太空科學與工程學系

Department of Space Science and Engineering, National Central University

Time

Wednesday,
December 17, 2025
15:00 – 16:00

Place

健雄館(科四館)

S4-917 教室
Room S4-917,
Chien-Shiung Building

Time-symmetry, solar system chaos, and Earth's climate history

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To first approximation, the structure of large scale astronomical systems is governed by gravity, which is described by time-reversible ordinary differential equations. I present novel time-symmetric numerical methods for simulations of structure formation which respect this time-symmetry and show they can be significantly more accurate than non-reversible numerical methods in studying gravitational dynamics. One of these methods is being implemented as TRACE in the REBOUND software package, and we find for interesting planetary dynamics problems it offers a speed advantage of an order magnitude or more compared to other codes.

Next, I focus on the effects of stellar flybys on Earth's climate history. Stellar flybys can have notable effects on the solar system's long-term dynamical evolution, injection of Oort cloud comets into the solar system, properties of trans-Neptunian objects, and more. Using a state-of-the-art solar system model, including a lunar contribution and the J2 solar quadrupole, and random stellar parameters, we find no influence of passing stars on paleoclimate reconstructions over the past 56 Myr, in contrast to recent results from other authors who did not include some of these physical effects.

Finally, I tackle the problem of the stability of the Solar System. Although great progress has been made in the last decades towards an understanding of chaos and stability of the Solar System, I show that some studies are affected by numerical artifacts, which causes artificial Solar System chaos and instability. The physical mechanism behind Mercury's orbital instability has been traditionally described by a diffusive process in a secular frequency, but our current work shows a sub-diffusive process fits simulated data better. An explanation for this sub-diffusion remains elusive.