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Orbital Evolution of S Stars Due to Resonant Relaxation

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Recently the precession rate of S2 around the SMBH at the Galactic Center is reported (Abuter et al., 2020). At the same time, other astronomical and physical values, such as orbital elements of S2, mass of the central SMBH, the distance to it, parameters for GR effect and so on, are estimated.

From a theoretical point of view, Rauch & Tremaine (1996) predicted the precession of stars around an SMBH due to resonant relaxation (RR) which is a relaxation in the angular momentum space. Though RR may take place around the SMBH at the GC, the estimation in above report did not include this effect.

We performed a series of N-body simulations (w/wo General Relativistic effect) of a star cluster model of the GC.

We found that:

(1) RR takes place in the GC.

(2) S2's periapsis can move up to 10^{-4} rad. per period.

(3) The largeness of the movement of periapsis is not negligible compared to that due to GR effect.

Thus the effect of RR may affect the values estimated in Abuter et al., 2020.

We also found that the largeness of movement of periapsis of S2 depends on the mass M and the number of stellar/compact objects N of the star cluster as $\sim MN^{-1/2}$.

How large the periapsis moves due to RR is determined probabilistically for the statistical nature of RR. It is, therefore, difficult to say something about the mass and composition of the GC cluster from only the observation of S2. However, if future observations provide us not only precession data of S2 but also those of other S stars, it will be a clue to make clear the mass and components of the central region of the Galaxy.

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