General Relativity and Quantum Cosmology

Perturbed stellar motions around the rotating black hole in Sgr A* for a generic orientation of its spin axis

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Empirically determining the averaged variations of the orbital parameters of the stars orbiting the Supermassive Black Hole (SBH) hosted by the Galactic Centre (GC) in Sgr A* is, in principle, a valuable tool to put on the test the General Theory of Relativity (GTR), in regimes far stronger than those tested so far, and certain key predictions of it like the no-hair theorems. We analytically work out the long-term variations of all the six osculating Keplerian orbital elements of a test particle orbiting a non-spherical, rotating body with quadrupole moment Q_2 and angular momentum S for a generic spatial orientation of its spin axis k. This choice is motivated by the fact that, basically, we do not know the position in the sky of the spin axis of the SBH in Sgr A* with sufficient accuracy. We apply our results to S2, which is the closest star discovered so far having an orbital period P_b = 15.98 yr, and to a hypothetical closer star X with P_b = 0.5 yr. Our calculations are quite general, not being related to any specific parameterization of k, and can be applied also to astrophysical binary systems, stellar planetary systems, and planetary satellite geodesy in which different reference frames, generally not aligned with the primary's rotational axis, are routinely used.

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