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Effect of tidal field on the gyroscopic precession around compact astrophysical objects

A spinning gyro orbiting around a massive compact astrophysical body can capture the general relativistic effects around the central object. If the gyro rotates at some fixed orbit around the star, then the qualitative and quantitative nature of the overall gyro precession frequency can reveal various properties of the central object. If the central object has a companion, then the precession frequency of the gyro will get affected. This work discusses how the tidal field due to a companion object affects the spin precession frequency and orbital angular velocity of a spinning gyro orbiting around a compact astrophysical object. The central object is either a neutron star or a white dwarf. The test gyro is any planetary or asteroid-like object orbiting a neutron star or a white dwarf.
Moreover, the companion object that causes the tidal field can be a neutron star, white dwarf or a stellar black hole.

It is seen that the tidal effect significantly affects the spacetime around the central object, which affects the gyro precession frequency and the orbital angular velocity. Slow rotation approximation has been considered for the central object, which creates negligible deformation. The change in the gyro's precession frequency and the orbital angular velocity due to the tidal field increases with an increase in the companion object's mass and decreases as the separation between the central star and the companion star increases. The tidal effect also varies with the stiffness of the equation of state of matter describing the host star. The lower the compactness of the host star, the greater the tidal response; thus, the greater the change in the gyro's precession and angular velocity of the geodesic.

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