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Lense-Thirring precession in strong gravitational fields

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The exact Lense-Thirring precession frequencies for Kerr, Kerr–Taub–NUT,Taub–NUT, Plebanski-Demianski spacetimes are explicitly derived. Remarkably, in the case of the zero angular momentum Taub–NUT spacetime, the frame-dragging effect is shown not to vanish, when considered for spinning test gyroscopes. In the case of the interior of the rotating neutron stars, the exact frame-dragging rate monotonically decreases from the center to the surface along the pole and along the equatorial distance, it decreases initially away from the center, becomes negligibly small well before the surface of the neutron star, rises again, and finally approaches to a small value at the surface. The appearance of a local maximum and minimum in this case is the result of the dependence of frame-dragging frequency on the distance and angle. Moving from the equator to the pole, it is observed that this local maximum and minimum in the frame-dragging rate along the equator disappear after crossing a critical angle. It is also noted that the positions of the local maximum and minimum of the frame-dragging rate along the equator depend on the rotation frequency and central energy density of a particular pulsar. The same anomaly can also be found in the case of Kerr–Taub–NUT spacetime but it is along the pole. Presently, direct observation of the Lense-Thirring precession of a classical or quantum spin vector relative to local inertial frames dragged along a timelike curve in any stationary spacetime is impossible in the presence of strong gravitational fields. Analogue models of black holes offer an alternative option of its indirect measurement in a comparatively accessible laboratory setup. We deduce precise estimate of the angular velocity of precession of a test spin outside the ergoregion of a fluid mechanical rotating "dumb hole" in acoustic spacetimes. It is our hope that with present technological expertise in manipulating analogue black holes, experimentalists will be able to successfully verify our estimate and hence, more importantly, the predicted strong gravity Lense-
Thirring effect.

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