Contribution ID: **50** Type: **not specified**

Stationary equilibrium torus supported by Weyssenhoff ideal spin fluid around Kerr Black holes

Friday 20 December 2024 15:00 (15 minutes)

We present non-self-gravitating, geometrically thick torus solutions described by a Weyssenhoff ideal spin fluid in a rotating black hole spacetime. The Weyssenhoff spin fluid shares the same symmetries of the background geometry, i.e., stationarity and axisymmetry. We further assume that the alignment of the spin is perpendicular to the equatorial plane. Under this setup, we determine the integrability conditions of the general relativistic momentum conservation equation of Weyssenhoff ideal spin fluid using the Frenkel spin supplementary condition. We then present equilibrium solutions of the spin fluid torus with constant specific angular momentum distributions around Kerr black holes by numerically solving the general relativistic momentum conservation equation. Our study reveals that the isobaric surfaces of the tori get significantly modified in comparison to an ideal fluid torus, due to the presence of the spin tensor and its coupling to the Riemann curvature tensor. We also put some constraints on the model and on the values of the s_0 parameter that controls the magnitude of the spin angular momentum of the fluid.

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