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Accretion flows around spinning compact objects in the post-Newtonian regime

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We present the structure of a low angular momentum accretion flows around rotating compact objects incorporating relativistic corrections up to the leading post-Newtonian order. To begin with, we formulate the governing post-Newtonian hydrodynamic equations for the mass and energy-momentum flux without imposing any symmetries. However, for the sake of simplicity, we consider the flow to be stationary, axisymmetric, and inviscid. Toward this, we adapt the polytropic equation of state (EoS) and analyze the geometrically thin accretion flow confined to the equatorial plane. The spin-orbit effects manifest themselves in the disk structure. This is a relativistic interaction between the body's spin and the motion of fluid elements inside the gravitational potential of the body. In the present analysis, we focus on global transonic accretion solutions, where a subsonic flow enters far away from the compact object and gradually gains radial velocity as it moves inwards. Thus, the flow becomes supersonic after reaching a certain radius, known as the critical point. For a better understanding of the transonic solutions, we classify the post-Newtonian equations into semi-relativistic (SR), semi-Newtonian (SN), and non-relativistic (NR) limits and compare the accretion solutions and their corresponding flow variables. With these, we find that SR and SN flow are in good agreement all throughout, although they deviate largely from the NR ones. Interestingly, the density profile seems to follow the profile $\rho \propto r^{-3/2}$ in the post-Newtonian regime. The present study has the potential to connect Newtonian and GR descriptions of accretion disks.

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