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Emission of Gravitational Waves by Precession of Slim Accretion Disks Dynamically Driven by the Bardeen-Petterson Effect

The electromagnetic radiation emitted from some astrophysical objects such as active galactic nuclei (AGNs), micro-quasars (M-QSRs), and central engines of gamma-ray burst (GRBs), seems to have a similar physical origin: a powerful jet of plasma ejected from a localized system, presumably composed of an accretion disk encircling a compact object. This radiation is generally beamed in the polar directions and in some cases, it appears to have a spiral-like structure that could be explained if the central system itself precesses.
In this work, we use the slim disk accretion model, presented by Popham et. al. (1999), to study the gravitational waves (GWs) emitted by the precession of the accretion disk around a solar-mass Kerr black hole (KBH). For practical purposes, this model describes the central engine of a class of GRBs when: a transient stationary state is reached, the accretion rates are in the range (0.1 - 10) $M_{\odot}$ s^{-1} (also called hyperaccretion), the energy of the disk is efficiently radiated by neutrino emission, and its radial extent is less than $R \sim 10^8$ cm.
Based on current information on the parameters of these systems, we present a model for computing the induced precession by the combination of viscous effects in such disks and the relativistic frame-dragging effect (or Lense-Thirring effect). The astrophysics of such combination is collectively known as the Bardeen-Petterson (BP) effect, and it has been useful to describe both AGNs and M-QSRs.
The chosen slim disk model is found to be consistent with the hydrodynamic simulations of the BP effect, obtained by Nelson & Papaloizou (1999). In addition, we compute the precession periods on these disks, related with the BP effect, and we found that they are also in agreement with the available data for GRBs.
In light of these results, the model that we propose for computing the GWs emitted by the central engines of such class of GRBs, is based on an accretion disk, reaching a stationary slim disk structure, and with quasi-rigid precession determined by the Bardeen-Petterson effect.
We evaluate the feasibility of direct detection of the GWs computed for such a model and for the quoted range of accretion rates, and we compare our results with two recent papers that are based on more complex disk models. We find that the precession of hyperaccretion slim disks could be detected by gravitational wave observatories like advanced-LIGO, ET, BBO, DECIGO, and ultimate-DECIGO. The outcome agrees with the results obtained by the quoted papers, and are more likely to be detected if such a class of sources are placed at distances less than 1˜Mpc, corresponding to the Local Group. We conclude that being our results quite close to those having been reported for more complex disk models, it allows us to characterize similar sources in a simpler way.

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