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Numerical GRMHD Simulations of Self-Gravitating Collapsing Stars

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Gamma-ray bursts are one of the most energetic phenomena in the Universe. The collapsar model is the most widely accepted model for explaining long gamma-ray bursts. This model proposes that cores of massive stars with sufficient angular momentum collapse to black holes, while the stellar envelope starts to fall onto the newly born object. We performed three-dimensional GRMHD simulations of this phenomenon with various initial conditions, including the physical fact that the gravitational field comes not only from the central black hole, but also from the stellar envelope. We compared models with and without self-gravity to investigate the exact effects of self-gravity in these models. We discuss black hole mass, spin, and accretion rate evolution in time, as well as conditions necessary for jet emission and, as a result, an observable electromagnetic transient. At the end, we discuss the effect of self-gravity on the disc fragmentations, which, under specific conditions, can be a source of gravitational waves.

Primary author: PŁONKA, Piotr (University of Warsaw)

Co-author: Prof. JANIUK, Agnieszka (Center for Theoretical Physics, PAS)

Presenter: PŁONKA, Piotr (University of Warsaw)

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