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GRMHD Simulations of Accretion Disk Winds: Implications for Kilonova Emission and r-Process Element Formation

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Neutron star mergers, known to be the progenitors of short gamma-ray bursts, may also produce luminous transients called kilonova. These transients are powered by the radioactive decay of heavy elements synthesised in neutron-rich ejecta. Kilonova emission arises from two major sources: the dynamical ejecta expelled during the merger and the winds from the accretion disk. The accretion onto the rotating black hole is a source of power for the GRB jets, while the disk winds may act as collimation mechanism.

We model the kilonova process in the accretion disk winds using general relativistic magnetohydrodynamic (GRMHD) simulations. Our tool is the HARM-EOS code, developed recently by the CTP PAS astrophysics group. The code incorporates a tabulated, composition-dependent, 3-parameter equation of state. By varying the black hole, disk and wind properties in the initial configuration, we explore how they affect the dynamics of the ejecta. We probe their composition and quantify the relative abundances of heavy and light elements produced via rapid neutron capture (r-process). We run a nuclear reaction network, and using these results, we discuss the properties of the resulting kilonova emission, providing insight into its observational signatures.

Primary author: SAJI, JOSEPH (Center for Theoretical Physics, PAN)

Presenter: SAJI, JOSEPH (Center for Theoretical Physics, PAN)

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