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The Collimation of Relativistic Jets in Post-Neutron Star Binary Merger Simulations

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The gravitational waves from the binary neutron star merger GW170817 were accompanied by a multi-wavelength electromagnetic counterpart, which confirms the association of the merger with a short gamma-ray burst (sGRB). The afterglow observations implied that the event was accompanied by a narrow, ˜5°, and powerful, ˜1050 erg, jet. We study the propagation of a Poynting flux-dominated jet within the merger ejecta (kinematic, neutrino-driven, and magneto-rotational instability turbulence-driven) of a neutrino-radiation-GRMHD simulation of two coalescing neutron stars. We find that the presence of a post-merger low-density/low-pressure polar cavity, which arose due to angular momentum conservation, is crucial to let the jet break out. At the same time the ejecta collimates the jet to a narrow opening angle. The collimated jet has a narrow opening angle of ˜4°-7° and an energy of 1049-1050 erg, in line with the observations of GW170817 and other sGRBs.

Primary author: PAIS, Matteo (Hebrew University of Jerusalem)

Co-authors: PIRAN, Tsvi (The Hebrew University of Jerusalem); Prof. LYUBARSKY, Yuri (Ben Gurion University); Dr KIUCHI, Kenta (Einstein Institute for Gravitational Physics (Max Planck)); Prof. SHIBATA, Masaru (Einstein Institute for Gravitational Physics (Max Planck))

Presenter: PAIS, Matteo (Hebrew University of Jerusalem)

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