COMPREHENSIVE NUCLEOSYNTHESIS ANALYSIS FOR EJECTA OF COMPACT BINARY MERGERS

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We present the first comprehensive study of r-process element nucleosynthesis in the ejecta of compact binary mergers (CBMs) and their relic black-hole (BH)-torus systems. The evolution of the BH-accretion tori is simulated for seconds with a Newtonian hydrodynamics code including viscosity, pseudo-Newtonian gravity for rotating BHs, and an energy-dependent two-moment closure neutrino transport scheme. The investigated cases are guided by relativistic double neutron star (NS-NS) and NS-BH merger models. Our nucleosynthesis analysis includes the dynamical ejecta expelled during the CBM phase and the neutrino and viscously driven outflows of the relic BH-torus systems. While typically ~20-25% of the initial torus mass are lost by viscously driven outflows, neutrino-powered winds contribute at most another ~1%. Since BH-torus ejecta possess a wide distribution of electron fractions and entropies, they produce heavy elements from A~80 up to the actinides, with relative contributions of A>130 nuclei being subdominant. The combined ejecta of CBM and BH-torus phases can reproduce the solar abundances amazingly well for A>90. Varying contributions of the torus ejecta might account for observed variations of lighter elements with 40<Z<56 relative to heavier ones, and a considerable reduction of the prompt ejecta compared to the torus ejecta, e.g. in highly asymmetric NS-BH mergers, might explain the composition of heavy-element deficient stars.