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Atomic inputs and opacity numerical estimation concerning early-stage kilonova ejecta

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In the Universe, the nucleosynthesis beyond iron group elements occurs thanks to neutron capture processes. In the context of the multi-messenger astronomy, the observation of the electromagnetic (EM) counterpart of the GW170817 event, known as kilonova (KN), provided evidence that the coalescence of binary neutron stars systems is a favourable stellar site hosting the rapid neutron capture process (r-process). The luminosity of a KN, a quasi-thermal EM transient powered by the radioactive decay of unstable heavy neutron rich isotopes, mainly depends on the thermal energy produced during the element nucleosynthesis and on the plasma ejecta opacity. However, to better understand KN spectra, a detailed knowledge of atomic inputs is required. Modelling the ejecta opacity points to the necessity of overcoming uncertainties in opacity calculations arising from often oversimplified atomic structure models. In this framework, by means of the relativistic atomic code package grasp2018, we present numerical results of selected light r-process nuclei at different ionisation states of interest for the early-stage KN ejecta, which have been performed to estimate plasma opacity values. Finally, we highlight the importance of having more and accurate atomic inputs to better address the opacity estimation.

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