Sensitivity of Kilonova Light Curves to Fission Barrier Heights and Fission Channels

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Abstract

Fission heating is one of the key nuclear-physics ingredients controlling the late-time electromagnetic emission of neutron-star merger ejecta. In particular, the production of very neutron-rich translead and superheavy nuclei during the r-process can lead to spontaneous, beta-delayed, and neutron-induced fission, modifying both the radioactive heating rate and the resulting kilonova light curve. In this work, we study the sensitivity of kilonova observables to nuclear inputs related to fission, with special emphasis on fission barrier heights and the corresponding fission lifetimes.

We compare different prescriptions for fission barrier heights and propagate their impact into calculated fission, decay rates, and radioactive heating rates. The objective is to determine how variations in the barrier model affect the amount of energy released by fission, the epochs at which this contribution becomes relevant, and its relative importance with respect to other radioactive decay channels. We further separate the contributions from different fission mechanisms in order to quantify their individual role in shaping the bolometric kilonova light curve.

The results provide a systematic assessment of how uncertainties in fission barrier heights, lifetimes, and fission channels translate into uncertainties in kilonova heating and luminosity. This analysis helps identify the nuclear-physics inputs that most strongly affect late-time kilonova emission and therefore constrains which fission properties require improved theoretical modeling or experimental information for more reliable interpretation of post neutron-star merger observations.

Topic: Nuclear Astrophysics.