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Lanthanide and actinide opacity computations for kilonova modeling

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Gravitational waves from the neutron star merger GW170817 were detected for the first time in August 2017 [1]. Such an astrophysical event also provokes the ejection of hot and radioactive matter which powers an electromagnetic signal known as kilonova. This first observation also provided evidences that rapid neutron-capture process (or r-process) of nucleosynthesis responsible for heavy element production takes place during these events. The luminosity and spectra of such radiative emission depend significantly on the ejecta opacity, which is dominated by millions of lines from f-shell elements newly created by r-process, i.e. lanthanides and actinides [2]. Atomic data and opacities for these elements are thus sorely needed to model and interpret kilonova light curves and spectra.

In this context, the present work focusses on atomic data and opacity computations for lanthanides and actinides. More specifically, since the observations of the kilonova AT2017gf0 (the GW170817 electromagnetic counterpart) have been recorded about one day after the neutron star merger happened, the kilonova temperature and density are such that only the first ionization stages of the ejected elements (from the neutral to three-time ionized species) are expected to be present in the ejecta [3].

In this contribution, we plan to discuss our new computations of atomic data and expansion opacities for all the weakly-ionized lanthanides and actinides and compare them with previously reported studies (e.g., [3-6]). In order to do so, we use the pseudo-relativistic Hartree-Fock (HFR) method as implemented in Cowan's code [7], in which the choice of the interaction configuration model is of crucial importance.

References

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