Opacities for Neutron Star Mergers

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Ongoing efforts to improve and expand the relativistic capabilities in the Los Alamos suite of atomic physics codes have produced a more robust approach that can accommodate larger fine-structure models with configuration interaction. The use of this capability to generate opacities that are relevant for astrophysical modeling is reported here. The calculation and application of cold lanthanide opacities to the study of light curves produced in neutron star mergers (NSMs) is specifically discussed. The astrophysical site of the nucleosynthesis r-process (rapid neutron capture) remains unknown. While the r-process is widely accepted to occur in core-collapse supernovae, it can not account for the relative abundances of all of the heavy elements in the universe. Therefore, it is of interest to study compact objects with large concentrations of neutrons, such as NSMs, which may provide alternative sites for r-process production. In order to know if/how it is possible to distinguish NSMs from other events, one needs to simulate the light generated by them, which requires the use of heavy-element opacities calculated at cold, low-density conditions. Thus, opacities are presented for lanthanide elements in fine-structure detail and the consequences of these data for the possible detection of NSMs are discussed.

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