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Atomic processes in the wake of neutron-star mergers: Electron-ion recombination of low-charged heavy ions

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In 2017, the LIGO/Virgo collaboration detected the first gravitational-wave signal from the merger of a neutron-star binary. Less than two seconds later, a network of telescopes detected a short gamma-ray burst, followed by a longer optical "afterglow" powered by the radioactive decay of the neutron-rich material ejected in the merger, i.e., a kilonova. The kilonova light-curves potentially reveal the abundances of the heavy chemical elements that are produced in the preceding violent neutron-star merger events. In order to be able to reliably infer elemental abundances from the astronomical observations, absolute cross sections are required for the basic atomic processes that occur in the afterglow. So far, local thermodynamic equilibrium (LTE) conditions have been assumed in the astrophysical modeling of kilonovae, which certainly is an oversimplification given the highly dynamic and transient nature of the phenomenon. Any future more accurate non-equilibrium modeling will have to rely on accurate atomic cross sections, which generally cannot be easily calculated (if at all) to a sufficient precision for the heavy many-electron ions of interest. In order to satisfy these data needs we will measure absolute rate coefficients for the electron-ion recombination of low-charged heavy ions as part of the scientific program of the Hessian cluster project ELEMENTS. In a first attempt, we will use moderately charged xenon ions from the CRYRING local injector, which can be rather easily produced with the existing ECR ion source.

Primary author: SCHIPPERS, Stefan (JLU Giessen)

Presenter: SCHIPPERS, Stefan (JLU Giessen)

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