Dancing with the Stars: Laboratory Astrophysics with Highly Charged Ions

Joan Marler
Clemson University, Department of Physics and Astronomy, Clemson, SC, USA
jmarler@clemson.edu

The abrupt end of the dance of two neutron stars was recorded as the first detection of a gravitational wave and heralded in the new era of multi-messenger astronomy. The subsequent measurements across the electromagnetic spectrum holds great promise for a deeper understanding of the physics in these extreme environments. Of particular interest is a deeper understanding of the heavy-element nucleosynthesis expected to occur in the ejecta from this neutron-rich environment, the so-called r-process. The laboratory spectroscopic data on the vast range of heavy elements (Rb-U), including the lanthanides and actinides, are so severely limited at present that emission models are only in qualitative agreement with the observed spectra.

To partially alleviate this situation, a computational/experimental laboratory astrophysics collaboration between Auburn University, Clemson University, the University of Georgia, and Queen's University Belfast has been formed to generate reliable line lists for a range of r-process elements from neutral to triply charged. I will mainly discuss the experimental effort which will be undertaken at the Clemson University EBIT (CUEBIT). The CUEBIT has recently gone on-line and is now producing up to fully stripped ions from low to medium Z targets. The trap is connected to a beam line which was designed to extract and focus decelerated (down to 100's q eV) beams of single charge state ions and deliver them to modular back-end apparatus.

Time permitting, I will discuss additional experimental progress in measuring charge exchange-induced X-ray and extreme ultraviolet emission from systems relevant to both solar and extrasolar sources. Extensive observations are expected from near-term x-ray telescopes missions (e.g. XRISM) and complementary laboratory investigations of these processes aid in the understanding of observed astrophysical spectra and are extremely useful to help scientists make judicious choices of spectral ranges for future observations.

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