Contribution ID: **36** Type: **flash talk**

Exploring the Formation of Heavy Elements in Kilonovea via Rapid Neutron Capture Process

Thursday 10 October 2024 18:05 (5 minutes)

The formation of heavy elements beyond iron in the universe has long been a subject of astrophysical inquiry, with the rapid neutron capture process (r-process) playing a critical role. Kilonovae, explosive events resulting from the merger of neutron stars, have emerged as key sites for r-process nucleosynthesis. This study explores the formation of heavy elements in kilonovae through detailed modeling of their light curves, focusing on the blue and red kilonova components. The blue kilonova, typically associated with less neutron-rich ejecta, is powered by the radioactive decay of lighter r-process elements, while the red kilonova arises from the more neutron-rich ejecta producing heavier elements.
To understand the complex interplay between these components, we model the kilonova light curve of AT2017gfo, the first observed kilonova associated with the gravitational wave event GW170817. By adjusting key model parameters such as ejecta mass, velocity, and opacity, we explore how different physical conditions affect the observed light curve. Our results demonstrate that a combination of blue and red kilonova models is essential to replicate the multi-band observations of AT2017gfo. This work not only provides insights into the r-process element synthesis but also sheds light on the diverse outcomes of neutron star mergers, contributing to our understanding of the origins of the universe's heavy elements.

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Session Classification: Flash talks