The prolific dusty laboratories of stellar mergers revealed by JWST

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Luminous Red Novae (LRNe) are a class of extragalactic transient eruptions originating from massive stellar mergers. These eruptions exhibit peak luminosities between those of classical novae and supernovae, low expansion velocities, and a rapid transition to red colors driven by dust formation in their ejecta. LRNe are relatively common, with a volumetric rate ∼70% that of the local core-collapse supernovae (CCSNe) rate. Their high occurrence rate and efficient dust production suggest that these stellar mergers could be significant contributors to the cosmic dust budget, potentially helping to explain the unusually dusty galaxies in the early universe.

In this talk, I will present the first mid-infrared observations of extragalactic LRNe obtained with the *James Webb Space Telescope (JWST)* to investigate their dust content. Our sample includes ten LRNe spanning a broad range of progenitor primary masses (∼3–20 $M_\odot$) and observed at post-merger phases between ∼3–10 years. Using radiative transfer modeling of their infrared spectral energy distributions, we derive dust masses for each source and estimate that the cumulative dust contribution from LRNe is approximately 25% that of CCSNe. Given the significantly lower ejecta velocities of LRNe (∼100 $\mathrm{km\,s^{-1}}$ versus ∼1000 $\mathrm{km\,s^{-1}}$ for CCSNe), their dust is less likely to be destroyed by reverse shocks, potentially making their effective dust yield comparable to or greater than that of CCSNe.

Our observations also show that, at earlier epochs, the mid-IR spectra of mergers are dominated by features from oxygen-rich molecules such as water vapor, CO, and SiO, that transition to strong features of silicate and alumina dust at later epochs. I will describe results from an ongoing *JWST* campaign that aims to trace the molecular-to-dust condensation sequence in real time around a nearby stellar merger. These results demonstrate the importance of stellar mergers as valuable laboratories for studying both the cosmic dust budget and the dust-formation sequence in oxygen-rich environments.