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Lighting the Beacons of the Early Universe: JWST Insights into Supernova Dust Evolution

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Supernovae are the ultimate beacons of the time domain universe, signaling the cataclysmic end of massive stars and acting as the cosmic alchemists that forge the building blocks of galaxies. As the world of astronomy changes through the arrival of large survey datasets and advanced space based observatories, we are finally able to resolve long standing questions regarding the origin and evolution of cosmic dust. Core collapse supernovae are pivotal to this story, serving as the primary architects of the chemical enrichment seen in both the local and distant universe. Leveraging the unparalleled infrared capabilities of the James Webb Space Telescope, our research provides a transformative view of the lifecycle of these explosive transients. This presentation explores the longitudinal evolution of supernova ejecta, tracing the journey from the first emergence of molecular precursors to the formation of massive dust reservoirs decades after the initial explosion. By analyzing high resolution data from the Near Infrared Spectrograph and the Mid Infrared Instrument, we have identified the signatures of carbon monoxide and silicon monoxide during the infancy of dust condensation. These space based observations allow us to penetrate obscured regions and measure substantial dust masses that rival historical benchmarks. By providing critical constraints on progenitor mass loss and ejecta physics, this work contributes to the global effort to understand the variable phenomena that shape our evolving cosmos.

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