N32a Discovering Supernovae at Epoch of Reionization with Nancy Grace Roman Space Telescope

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Some massive stars explode as superluminous supernovae (SLSNe) or pair-instability supernovae (PISNe) that are luminous enough to observe even at $z > 6$ and allow for the direct characterization of massive star properties at the reionization epoch. In addition, theorized long-sought-after PISNe are expected to be present preferentially at high redshifts, and their discovery will have a tremendous impact on our understanding of massive star evolution and the formation of stellar mass black holes. The near-infrared Wide Field Instrument on Nancy Grace Roman Space Telescope will excel at discovering such rare high-redshift supernovae. In this work, we investigate the best survey strategy to discover and identify SLSNe and PISNe at $z > 6$ with Roman. We show that the combination of the F158 and F213 filters can clearly separate both SLSNe and PISNe at $z > 6$ from nearby supernovae through their colors and magnitudes. The limiting magnitudes are required to be at least 27.0 mag and 26.5 mag in the F158 and F213 filters, respectively, to identify supernovae at $z > 6$. If we conduct a 10 deg^2 transient survey with these limiting magnitudes for 5 years with a cadence of one year, we expect to discover around 20 PISNe and around 3 SLSNe at $z > 6$, depending on the cosmic star-formation history. Such a supernova survey requires the total observational time of approximately 525 hours in 5 years.