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Radio Supernovae in the Great Survey Era

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Radio properties of supernova outbursts remain poorly understood despite longstanding campaigns following events discovered at other wavelengths. After ~ 30 years of observations, only ~ 50 supernovae have been detected at radio wavelengths, none of which are Type Ia. Even the most radio-loud events are ~ 10^4 fainter in the radio than in the optical; to date, such intrinsically dim objects have only been visible in the very local universe. The detection and study of radio supernovae (RSNe) will be fundamentally altered and dramatically improved as the next generation of radio telescopes comes online, including EVLA, ASKAP, and MeerKAT, and culminating in the Square Kilometer Array (SKA); the latter should be > 50 times more sensitive than present facilities. SKA can repeatedly scan large (> 1 deg^2) areas of the sky, and thus will discover RSNe and other transient sources in a new, automatic, untargeted, and unbiased way. We estimate SKA will be able to detect core-collapse RSNe out to redshift z ~ 5, with an all-redshift rate ~ 620 events yr^-1 deg^-2, assuming a survey sensitivity of 50 nJy and radio lightcurves like those of SN 1993J. Hence SKA should provide a complete core-collapse RSN sample that is sufficient for statistical studies of radio properties of core-collapse supernovae. EVLA should find ~ 160 events yr^-1 deg^-2 out to redshift z ~ 3, and other SKA precursors should have similar detection rates. We also provided recommendations of the survey strategy to maximize the RSN detections of SKA. This new radio core-collapse supernovae sample will complement the detections from the optical searches, such as the LSST, and together provide crucial information on massive star evolution, supernova physics, and the circumstellar medium, out to high redshift. Additionally, SKA may yield the first radio Type Ia detection via follow-up of nearby events discovered at other wavelengths.

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