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Connecting Superluminous Supernovae, Gamma-ray Bursts, and Fast Radio Bursts to the Birth of Millisecond Magnetars

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The repeating fast radio burst (FRB) 121102 was recently localized to a star-forming region in a dwarf host galaxy remarkably similar to those of superluminous supernovae (SLSNe) and long gamma-ray bursts (GRB), both of which were previously proposed to be powered by the birth of a millisecond magnetar. We demonstrate how a single magnetar engine can power both a SLSN and GRB, depending on the engine lifetime and the misalignment angle between the magnetar's rotation and magnetic axes. We also show that the production of a successful relativistic jet may be ubiquitous in engine-powered SLSNe, and describe several observational tests of this connection, including orphan radio afterglows and early optical signatures in the SLSN light curve. Finally, we describe recent results on the time-dependent ionization structure of the expanding supernova ejecta on timescales of decades following the explosion, due to photo-ionization by the nascent 'magnetar wind nebula'. We precisely quantify when a fast radio burst can escape through the ejecta; create probability distributions of the local dispersion measure; and make predictions for the synchrotron radio emission from the magnetar wind nebula (analogous to the quiescent radio counterpart to FRB 121102).

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