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Islands of explosions in a sea of implosions

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The wealth of observational data on supernova light curves, compact object masses, and chemical abundances holds critical clues on how massive stars live and die. However, the utility of these observables were severely hampered due to our limited understanding of the late stages of evolution in massive stars and their explosion mechanism. We address this problem by combining novel insights into their final phases of evolution with the development of a new and efficient method for simulating supernovae through calibrated neutrino-driven explosions. In this talk, I will review some of the most exciting results we have found from the application of this approach to various populations of massive stars, which has profound implications for their final fates, and to the properties of neutron stars and black holes, supernova light curves, and nucleosynthesis produced through their demise. The results provide a natural solution to some of the long standing open problems in astromony and also challenge some of the conventional views that were held for many decades. I will end the talk by discussing ideas and prospects on using the existing and future gravitational wave measurements to constrain the physics of stellar evolution and supernova explosions.