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Unveiling the Progenitors of Short-duration Gamma-ray Bursts

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Gamma-ray bursts (GRBs) are relativistic explosions which originate at cosmological distances, and are among the most luminous transients in the universe. Following the prompt gamma-ray emission, a fading synchrotron "afterglow" is detectable at lower energies. While long-duration GRBs (duration>2 sec) are linked to the deaths of massive stars, the progenitors of short-duration GRBs (duration<2 sec) have remained elusive. Predictions formulated over the past two decades have suggested that they are the mergers of two compact objects, involving either two neutron stars or a neutron star and a black hole. Such merging systems are also important to understand because they are premier candidates for gravitational wave detections with current facilities and are likely sites of heavy element nucleosynthesis. The launch of NASA's Swift satellite in 2004, with its rapid multi-wavelength monitoring and localization capabilities, led to the first discoveries of short GRB afterglows and therefore robust associations to host galaxies. At a detection rate of roughly 10 events per year, the growing number of well-localized short GRBs has enabled comprehensive population studies of their afterglows and environments for the first time. In this talk, I describe my multi-wavelength observational campaign to address testable predictions for the progenitors of short GRBs. My work comprises several lines of independent evidence to demonstrate that short GRBs originate from the mergers of two compact objects, and also provides the first constraints on the explosion properties for a large sample of events. With the direct detection of gravitational waves from compact object mergers on the horizon, these studies provide necessary inputs to inform the next decade of joint electromagnetic-gravitational wave search strategies.