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Short Gamma-Ray Burst Models and Simulations¹

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While the sources of long-duration gamma-ray bursts (GRBs), at least in a number of cases, have been unambiguously identified as exploding massive stars, the origin of short GRBs is still much less certain, although a connection to compact object mergers, in particular neutron star and neutron star black hole binaries, seems very likely. What is the difference between short and long bursts? What are the possibilities to pin down the astrophysical objects that produce the short bursts? What is the status of numerical simulations, what can they tell us, and what are their limitations? The talk will address these and other questions and will show where contributions from other fields are needed for making progress. Hydrodynamic simulations of the final plunge that terminates the orbital evolution of compact binaries have made significant progress and now have begun to take into account general relativity, magnetic fields, and microphysical descriptions of dense neutron star matter. In particular the gravitational wave signal emitted from this phase and the subsequent ringdown contains very valuable information. In contrast, the following evolution of the merger remnant still poses major challenges for the modeling because of the long secular timescales, the potential relevance of different kinds of instabilities, the complexities of the neutrino transport, and the simultaneous presence and interaction of accretion and outflows on vastly varying scales. Modeling efforts were able to bring insight into selected aspects, but a consistent picture of the source that produces the ultrarelativistic GRB outflow has not been developed yet.

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