SpECTRE: towards high-order hydrodynamics and exascale numerical relativity

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Gravitational waves are now regularly being detected using the LIGO and Virgo experiments. However, determining the sources of the measured gravitational waves requires theoretical models. The most accurate (and expensive) of these are given by numerical relativity simulations of binary black hole and neutron star mergers. Among the biggest challenges in numerical relativity are generating high-accuracy binary black hole waveforms for future detectors, and efficiently resolving complex magnetohydrodynamical phenomena that occur during the merger of two neutron stars. The code SpECTRE (github.com/sxs-collaboration/spectre) is designed to overcome both of the challenges. I will present new finite-difference and finite-difference-discontinuous Galerkin methods that we believe are the most promising candidates for efficient, robust, and accurate high-order hydrodynamics simulations. I will also show the first early-inspiral simulation of binary black holes using SpECTRE, including preliminary work using load-balancing. I will conclude with a roadmap for both hydrodynamics and binary black hole simulations.