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Perspectives on relativistic astrophysics in the century's first decade[1]

JOHN FRIEDMAN, University of Wisconsin-Milwaukee

Among the fundamental questions in astrophysics facing us at the start of the 21st century are the nature of matter above nuclear density and the a detailed understanding of the universe's most energetic events. This talk will briefly review some of major advances associated with these problems and some of the key problems that remain. Breakthroughs in numerically solving the Einstein-Euler equations and the anticipated dawn of gravitational wave astronomy led to striking advances in simulating the inspiral and merger of double neutron star systems and – following the binary black-hole triumph – of neutron star - black hole systems. Advances in understanding the linear and nonlinear modes of rotating neutron stars emerged from these codes and from the development of second-order perturbation theory. The extreme-mass-ratio-inspiral of black holes and neutron stars to galactic black holes was understood to first-order in the mass ratio, but second-order accuracy, self-force, and resonant behavior will all be needed in the next decade. Converging efforts in numerical relativity and data analysis has provided initial estimates of the accuracy with which one can extract from gravitational waveforms the physical characteristics of their sources.

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