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Advances and challenges in solving the two-body problem in General Relativity

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Since the discovery of the first binary black-hole merger in 2015, analytical and numerical solutions to the relativistic two-body problem have been essential for the detection and interpretation of nearly 100 gravitational waves from compact-object binaries. Future experiments will detect black holes at cosmic dawn, probe the nature of gravity, and reveal the composition of neutron stars with exquisite precision.Theoretical advances (of up to two orders of magnitude in the precision with which we can predict the relativistic dynamics) are needed to turn gravitational waves into precision laboratories of astrophysics, cosmology and gravity.

In this talk I will discuss recent advances in modeling the two-body dynamics and gravitational radiation, review the science that accurate waveform models have enabled with gravitational-wave observations, and highlight the theoretical challenges that lie ahead to fully exploit the discovery potential of increasingly sensitive detectors on the ground, such as Cosmic Explorer and Einstein Telescope and in space, such as LISA and TianQin.

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