Title : High accuracy waveform models for high precision gravitational wave astronomy

Abstract :
Gravitational wave (GW) signals sourced from the merger of binary black holes (BBHs) offer a new window to study black holes and their host environments (such as galaxies or globular clusters) as well as cosmological parameters such as the Hubble constants. Characterization of GW signals however heavily rely on accurate gravitational waveform models. The most accurate way to compute waveforms is by solving the Einstein equation directly. This can only be done numerically (e.g. numerical relativity) — which is computationally expensive, taking weeks to months for a single simulation. Such a huge computational cost has paved the way for the development of approximate models that are now widely used in data analysis studies. However, these models can compromise accuracy in favor of speed. Recently, data-driven surrogate models have been shown to be capable of generating waveforms that are almost indistinguishable from NR in a fraction of a second. In this talk, I will summarize state-of-the-art NR surrogate models and discuss the application of these models to high-accuracy inference. We find that for many GW events, NR surrogates provide both more accurate and better-constrained parameter estimates in many of the key parameters including sky localization, mass ratio, and spin quantities. Furthermore, using numerical relativity surrogate models, we are able to constrain the properties of the remnant black hole and kick velocity. This information will help understand the environment and evolutionary pathways of black holes.