Dissertations

Searches For Gravitational Waves From Binary Black Hole Coalescences With Ground-based Laser Interferometers Across a Wide Parameter Space

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Abstract
This is an exciting time for Gravitational Wave (GW) theory and observations. From a theoretical standpoint, the grand-challenge problem of the full evolution of a Binary Black Hole (BBH) system has been solved numerically, and a variety of source simulations are made available steadfastly. On the observational side, the first generation of state-of-the-art GW detectors, LIGO and Virgo, have achieved their design goal, collected data and provided astrophysically meaningful limits. The second generation of detectors are expected to start running by 2015. Inspired by this zeitgeist, this thesis focuses on the detection of potential GW signatures from the coalescence of BBH in ground-based laser interferometers. The LIGO Scientific Collaboration has implemented different algorithms to search for transient GW signatures, targeting different portions of the BBH coalescence waveform. This thesis has used

the existing algorithms to study the detection potential of GW from colliding BBH in LIGO in a wide range of source parameters, such as mass and spin of the black holes, using a sample of data from the last two months of the S5 LIGO science run (14 Aug 2007 to 30 Sept 2007). This thesis also uses numerical relativity waveforms made available via the Numerical INJection Analysis project (NINJA). Methods such as the Chirplet based analysis and the use of multivariate classifiers to optimize burst search algorithms have been introduced in this thesis. These performance studies over a wide parameter space were designed to optimize the discovery potential of ground-based GW detectors and defining strategies for the search of BBH signatures in advanced LIGO data, as a step towards the realization of GW astronomy