Title: Applications of Maximum Entropy in Gravitational Wave Astronomy

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Abstract:
Large gravitational wave detectors in the United States (LIGO) and Europe (GEO and Virgo) have just now reached a sensitivity that makes them sensitive to gravitational wave emission from astronomical phenomena. In the next decade, ESA and NASA plan to place an even more sensitive detector (LISA) into space. Sources that these detectors have the capability of observing include the formation of the black holes that are thought to power gamma-ray bursts, the stellar core collapses that power type II supernovae, the coalescence of supermassive black holes that follows the collision of their host galaxies, and the myriad of compact binary white dwarf binary systems that populate our galaxy. The first detection of gravitational waves by these detectors will usher in the era of gravitational wave astronomy: the use of gravitational waves as a tool of astronomical discovery.

Gravitational wave detectors are not imaging instruments and individual gravitational wave detectors lack the ability to localize a source on the sky. From a network of detectors we can synthesize a beam and thus determine the position of a source and the radiation amplitude and phase in each gravitational wave polarization. Alternatively, the signal acquired from a detector that is moving with respect to a source will be phase and amplitude modulated in a manner that depends on the source's sky location, the signal in each polarization, and the detector's changing position and orientation with respect to the source. From this information and models of the radiation expected from different sources we can test general relativity and learn about the sources we are observing. Here we describe the development and use of maximum entropy based tools to recover the gravitational wave signal amplitude and phase in each polarization, and the sky location of one or more sources whose radiation is incident on an array of detectors or a moving detector. These tools are being used now for the analysis of data from the United States LIGO detector and will likely play an important role in the analysis of data from the LISA detector.