Contribution ID: **183** Type: **Talk in a parallel session**

Hierarchical inference of cosmological and astrophysical population properties from gravitational wave observations and galaxy catalogs

Thursday, 11 July 2024 17:00 (20 minutes)

Gravitational waves (GWs) from compact binary coalescences are standard sirens that can probe the cosmic expansion history of the late-time Universe once the binary chirp mass-redshift degeneracy is broken. Methods for injecting redshift information into the inference process range from the direct detection of electromagnetic counterparts ("bright sirens") to the use of statistical properties inferred either from a catalog of possible hosts or from spectral features in the source-frame mass distribution ("dark sirens").
In this talk, I will present CHIMERA, a code that combines these methods within a hierarchical Bayesian framework to constrain cosmological and GW population parameters simultaneously. I will discuss the constraints obtained with this code on a set of simulated O4 and O5 GW events and a complete galaxy catalog, showing that a percentage-level measurement of H0 can be obtained with $\mathcal{O}(100)$ well-localized GW events and a spectroscopic galaxy catalog, while correctly marginalizing the population assumptions. I will then describe the technical improvements we are developing to address the computational limits of the code and to accommodate the large amount of GW data coming from 3G detectors, such as the Einstein Telescope and LISA. Finally, I will briefly present the blinded mock data challenge we are conducting between CHIMERA and similar codes for hierarchical Bayesian inference using GW data and galaxy catalogs to assess possible computational limitations or systematic effects.

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Session Classification: Multi-messenger astronomy with gravitational waves

Track Classification: Gravitational Waves (GW): Gravitational wave cosmology