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From Astrophysics to Cosmology: forecasting Einstein Telescope's potential with improved merger rate models for spectral siren methods

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The persistence of the Hubble tension requires new validation methods. While gravitational waves provide a promising solution, the rarity of standard sirens has forced to rely on *dark sirens* and as such, a wealth of dark sirens methods have been developed.

In this talk we will explore our new state-of-the-art models for binary black hole (BBH) merger rates and their applications to spectral siren methods for the Einstein Telescope (ET) era.

First, we will begin with a detailed look at the astrophysical modeling and its key aspects for the evolution of the merger rate: the role of star formation history and the results from population synthesis simulations. Building on this, we will then present projected number counts and conduct a comparative analysis for different proposed design configurations for the ET.

Finally, we will showcase forecast results demonstrating the cosmological and astrophysical constraints achievable through BBH number counts alone; and then we will outline a tentative approach for a complete spectral siren method, by constructing semi-parametric mass models with redshift evolution coming naturally from our merger rate formalism.

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