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Binary black hole mergers from Population III stars

Thursday, 26 October 2023 17:00 (2 hours)

In this presentation, I will provide a comprehensive analysis of the uncertainty regarding the merger rate density and mass spectrum of binary black holes (BBHs) originating from Population III (Pop. III) stars. I will explore four distinct formation histories of Pop. III stars and investigate 11 models concerning the initial orbital properties of their binary systems.

The results I have obtained demonstrate a significant impact of uncertainties of the orbital properties on the BBH merger rate density, potentially varying up to two orders of magnitude. Specifically, models with shorter initial orbital periods tend to lead to higher merger rates. Additionally, the uncertainty in the star formation history significantly influences both the shape and normalisation of the BBH merger rate density. Depending on the assumed star formation rate, the peak of the merger rate density can shift from $z \sim 8$ to $z \sim 16$. Moreover, the maximum BBH merger rate density for our fiducial model ranges from ~ 2 to ~ 30 Gpc^{-3} yr^{-1}.

I find that the typical BBH masses are not affected by the star formation rate model and only mildly influenced by the binary population parameters. Pop. III primary black holes are generally more massive, ranging from 30 to 40 $M_\odot$, compared to those formed from metal-rich stars (8 - 10 $M_\odot$).

Finally, I estimate that the Einstein Telescope will detect $10 - 10^4$ Pop. III BBH mergers per year, depending on the star formation history and binary star properties.

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