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The cosmological significance of the Taiji-TianQin-LISA network

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Gravitational waves (GWs) can provide important new probes for exploring the evolution of the universe. One significant advantage of GWs is their ability to measure absolute distances on cosmological scales, rather than relative distances, which is crucial for cosmological research, especially in determining the Hubble constant. Analogous to the "standard candles" and "standard ruler" in cosmology, distance measurements based on GWs are referred to as "standard sirens".

In the past decade, there has been a serious problem in measuring the Hubble constant, with results from early and late universe measurements showing about a 10% discrepancy, reaching a statistical significance of 5σ [1]. Standard sirens are considered to play a crucial role in resolving the Hubble crisis.

To constrain cosmological parameters using standard sirens, it is also necessary to know the redshift information of the GW sources. If a GW event has an electromagnetic counterpart, and the redshift of the source can be determined through observations of electromagnetic waves, then such a standard siren is called a "bright siren". For GWs without electromagnetic counterparts, galaxy catalogs can be used, and statistical methods can be applied to determine the redshifts; such standard sirens are called "dark sirens".

GWs in the millihertz frequency range can be detected using space-based detectors. Currently, there are two proposed detection projects domestically, "Taiji Project" and "TianQin Project", while internationally, there is the LISA project. Similar to ground-based GW detectors, if space-based detectors form a network, it can significantly improve the localization accuracy of GW sources. The prospects of the Taiji-LISA network have been carefully studied [2, 3]. Recently, Jin et al. [4] have explored the potential value of the Taiji-TianQin-LISA network in cosmological research. The authors found that (1) using bright sirens to measure the Hubble constant can achieve an accuracy of 0.9%, but it is challenging to provide tight constraints on the dark-energy equation of state. (2) Bright sirens can effectively break the degeneracy of cosmological parameters generated by the cosmic microwave background. (3) Dark sirens can also provide a very accurate measurement of the Hubble constant, with an accuracy of up to 1.2%. Therefore, we look forward to the millihertz GWs detected by the Taiji-TianQin-LISA network playing a crucial role in solving important cosmological problems.

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