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Probing multiverse using gravitational wave observations

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From the theory of the multiverse cosmology, it is possible that our universe collides with other universes locally in its history, which may result in local changes of the curvature of the spacetime. In this paper, we propose a method to probe the multiverse using gravitational wave observations for the first time. Our method firstly makes triangles using two detected gravitational wave sources and the Sun, and then measures the curvature of the triangles. We use 11 gravitational wave sources detected by LIGO and Virgo during O1 and O2, and make 55 triangles by combining them to measure their curvature. The curvature is measured by comparing the distance between two gravitational wave sources estimated by the gravitational wave observations with the one obtained with assumption of a simple model of the cosmological evolution.
As a result, we found that, for 43 of 55 triangles, the distances estimated by the model are greater than the ones obtained by the gravitational wave observations. This indicates a negative curvature, which may be due to the simplification of the cosmological evolution. For the rest 12, the distances are not determined because of uncertainty of the parameters of the gravitational wave observations. Further gravitational wave observations and more sophisticated model of the cosmological evolution is essential to test the multiverse cosmology observationally.

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