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Recent topics on cosmology with primordial black holes and their implications for particle physics

The 2017 Nobel Prize in Physics was awarded to three members of the American LIGO (LIGO) team for the world's first detection of gravitational waves. The gravitational waves were created by the collision of binary black holes, each weighing about 30 times more than the sun, about 1.3 billion light years away. At the same time, this was the first observation to detect the existence of a black hole without using electromagnetic waves. However, the origin of such heavy black holes is still largely unknown. Theoretically, density fluctuations (or curvature perturbation) are predicted to have been created by inflation in the early Universe. The theoretical model is that quantum fluctuations in the inflaton field become density fluctuations. On large scales, galaxies and galaxy clusters were formed by the collapse of dark matter and matter seeded by those density fluctuations.

On the other hand, theory predicts that primordial black holes (PBHs) and secondary gravitational waves were created from large density fluctuations on untested small scales. The masses of PBHs vary, with the lighter ones emitting Hawking radiation and evaporating away, while the heavier ones remain to the present day and are candidates for dark matter. Some of them may also form the black hole binary stars mentioned above. For these reasons, the study of the formation of PBHs and gravitational waves on small scales has been pointed out as a possible key to solving the mystery of the birth of the Universe.

In my talk, the theoretical models will be explained from the standpoints of both particle theory and cosmology. Finally, I discuss how future observations will distinguish primordial black holes from astrophysical black holes.

Secondary category for the parallel session (optional)

Cosmology

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