Contribution ID: **6** Type: **Contributed Talk**

Hunting Primordial Black Hole Dark Matter in Lyman-alpha forest

Tuesday 10 December 2024 15:10 (20 minutes)

The question that what constitutes Dark Matter (DM) is one of the most pressing ones in contemporary physics, and one that has not been answered to any degree so far. Primordial Black Holes (PBHs) are one of the most well-motivated dark matter candidates. PBHs which are light enough that the Hawking radiation is substantial have been constrained by either the non-detection of the radiation itself, or by the non-observation of any measurable effects of the radiation on astrophysical and cosmological observables. In this work, we constrain the existence of such PBHs by the effect their Hawking radiation would have had on the temperature of the intergalactic medium (IGM). We use the latest deductions of IGM's temperature from the Lyman-alpha forest observations. We put constraints on the fraction of dark matter that PBHs can constitute with masses in the range 5 x 10ˆ15 g –10ˆ17 g, separately for spinning and non-spinning black holes. We derive the constraints by dealing with the heating effects of the astrophysical reionization of the IGM in two ways. In one way, we completely neglect this heating due to astrophysical sources, thus giving us relatively weak constraints, but which are completely robust to the reionization history of the universe. In the second way, we use some modelling of the ionization and temperature history and use them to derive more stringent constraints. We find that for PBHs of mass 10ˆ16 g, the current measurements can constrain the PBH-density to be less than 0.1% of the total dark matter density, both for spinning and non-spinning black holes. Thus, we find that these constraints from the Lyman-alpha measurements are competitive, and hence provide a new observable to probe the nature of dark matter.

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Session Classification: Cosmology