Contribution ID: **66** Type: **Talk**

Cosmological Magnetic Fields from Primordial Kerr-Newman Black Holes

Wednesday, 21 June 2023 17:20 (20 minutes)

The origin of our universe's cosmological magnetic fields remains a mystery. In this study, we consider whether these magnetic fields could have been generated in the early universe by a population of charged, spinning primordial black holes. To this end, we calculate the strength and correlation length of the magnetic fields generated by this population, and describe their evolution up to the current epoch. We find that near-extremal black holes in the mass range M~10^28–10^36 g could potentially generate magnetic fields with present day values as large as B~10^{−20}–10^{−15} G; those with M⪆10^38 g could have produced even larger fields B⪆10^{−14} G. To motivate this scenario, we briefly discuss how new physics may have induced a chemical potential which could have briefly maintained the black holes in an electrically charged state in the early universe. Finally, we comment on a correlation between the parameters of the cosmological magnetic field and the stochastic gravitational wave background coming from the merger of primordial black hole binaries as the primary observable signature of this scenario.

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Session Classification: Session 12