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Primordial black holes: Linking Microphysics and Macrophysics

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Black holes could span 60 decades of mass - from the Planck scale (10-5g) to the cosmological scale (1022Mo) - and therefore provide an important link between microphysics and macrophysics. In the macroscopic domain, attention has recently turned to the possibility that primordial black holes (i.e. those formed in the early universe) could provide the dark matter or the black-hole mergers detected by LIGO or even some features of cosmic structure. In the microscopic domain, primordial black holes lighter than the Earth would have a Hawking temperature exceeding that of the cosmic microwave background, so that quantum effects are important. Such quantum black holes span the lower 30 decades of mass and provide a unique probe of the early universe and high energy physics. The micro-macro link is most striking at the Planck scale, with Planckian black holes likely to play a key role in quantum gravity. This raises the question of what happens to relativity theory as one approaches the Planck scale from above (eg. the Schwarzschild radius) and to quantum theory as one approaches it from below (eg. the Compton radius). It is argued that there should be a smooth transition between these two scales, corresponding to a unified Compton-Schwarzschild expression. In this case, there may also be a link between elementary particles and sub-Planckian black holes. It is also argued that the duality between the Compton and Schwarzschild scales should be maintained if the number of spatial dimensions increases, which has important implications for the observability of black holes in accelerators.

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