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Ultrarelativistic black hole formation WILLIAM EAST, FRANS PRETORIUS, Princeton University — A topic in general relativity that remains poorly understood is the formation of black holes in ultrarelativistic collisions. Besides being an interesting theoretical question, it has been suggested that this may occur in the collision of cosmic rays with the Earth's atmosphere and in proton collisions at the LHC, in scenarios where large extra dimensions set the true Planck scale at around a TeV. We present results from numerical simulations of the head-on collision of equal mass particles, modeled as self-gravitating fluid spheres, obtained by solving the Einstein equations coupled to hydrodynamics. We focus on cases well within the kinetic energy dominated regime ($\gamma = 8$ to 12) and find that black hole formation does occur for sufficiently large boosts. Moreover, near yet above the threshold of black hole formation, the collision initially leads to the formation of two distinct apparent horizons that subsequently merge. We argue that this can be understood in terms of a focusing effect, where one boosted particle acts as a gravitational lens on the other and vice versa, and that this is further responsible for the threshold being lower (by a factor of a few) compared to simple hoop conjecture estimate.

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