RADIATED ENERGY IN THE COLLISION OF TWO PARTICLES AT THE VELOCITY OF LIGHT

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The Nobel laureate Gerard t'Hooft argued in the 1980s that if two particles are collided with velocities extraordinarily close to the speed of light, a black hole should form and part of the energy, E, should be emitted into gravitational radiation. Moreover, the process should be describable by classical (i.e. non quantum) relativistic gravity.

About a decade ago, it was further suggested that if there are D space-time dimensions (with D>4), the necessary velocity for these events could be attained at the Large Hadron Collider, at the European Centre for Nuclear Research (CERN), or in other realistic man-made particle accelerators. It then became a central problem to calculate the total energy emitted into gravitational radiation. Knowing this quantity reveals the size of the black hole formed, since the remaining energy (not radiated) is captured therein. Such microscopic black holes would then decay via Hawking radiation. This decay leaves identifiable signatures in particle physics data, such as a high multiplicity of jets and a large transverse momentum.

The detection of such microscopic black holes would be an astonishing discovery, since it would provide strong evidence towards the existence of extra-dimensions besides the usual three spatial and one temporal. The absence of such detection, on the other hand, provides constraints on the existence and size of such dimensions. Thus, the best possible phenomenology must be performed to either identify detection or set bounds on models.

In a paper published in Physical Review Letters (PRL 108(2012)181102), a team from the University of Aveiro has shown that the energy E follows a remarkably simple pattern with the space-time dimension D. This result provides the best phenomenological value to implement in Monte Carlo event generators being used at the LHC experiments ATLAS and CMS, but raises also a theoretical mystery to explain the simplicity of the obtained pattern.

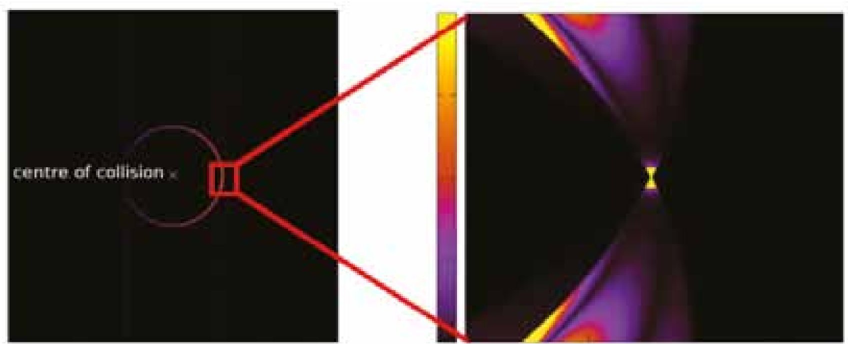

FIGURE 1
Projected representation of the radiation wave front emitted after a collision in D=5 (left panel), and a zoom of the wave amplitude profile seen by an observer near the collision axis (right panel).