Detecting Black Holes with ATLAS

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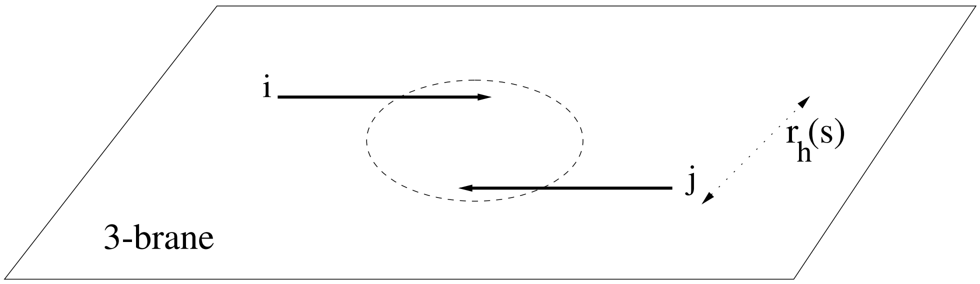
Outline

- Black Holes in Models with Extra Dimensions
- Black Hole Production Cross Section
- Simulation of Black Hole Decays

Models with Extra Dimensions

- In theories with extra dimensions it is possible for the fundamental Planck scale to be as low as $\sim$ TeV

- This means it is possible that tiny black holes could be produced at the LHC when partons pass within the horizon radius



- Horizon radius $r_h = \left[\frac{4(2\pi)^{D-4}M}{(D-2)\Omega_{D-2}M_p^{D-2}}\right]^{\frac{1}{D-3}}$

Cross section for Black Hole Production

- There has been much discussion in the literature about what the cross section for black hole production is

- The consensus opinion seems to be that the classical $\sigma = \pi r_h^2$ is valid for black hole masses well above the Planck scale

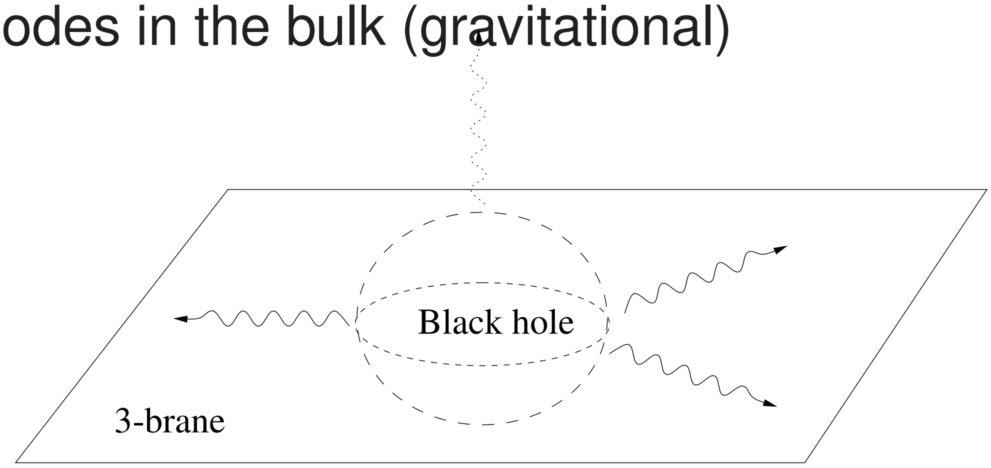
- For masses close to the fundamental Planck scale a theory of quantum gravity would be required to calculate the cross section

- Although the parton level cross section grows with black hole mass, the parton distribution functions fall rapidly at these high energies

Decays

- The decay of these tiny black holes is instantaneous on LHC detector time scales and is made up of three major phases
  - Balding phase
  - Hawking evaporation phase (a brief spin-down phase, then a longer Schwarzschild phase)
  - Planck phase

- Hawking radiation is emitted predominantly into modes on the brane (SM particles) but also into modes in the bulk (gravitational)



Simulation and Signatures

- Work in progress simulates the Schwarzschild phase of the decay using HERWIG 6.3

- Particle ratios are predicted based on 4-D Hawking radiation (hadronic activity is about five times the leptonic activity)

- We aim to fully take into account the increase of the Hawking temperature as the mass decreases, and any effects from the recoil of the black hole

- Experimental signatures include the multiplicity and ratios of different particles, energy spectra of primary final state partons, sphericity of events etc.