Research Highlight: Mathematics of Black Holes and Heavy Ion Collisions
Work of Professor Brett MCINNES

In experiments at the Relativistic Heavy Ion Collider or RHIC and at the Large Hadron Collider or LHC, nuclei of heavy atoms are collided at extremely high energies (even higher at the LHC than at the RHIC), resulting the formation of a form of matter never previously seen: the Quark-Gluon Plasma or QGP. The properties of this plasma are in principle fully derivable from known physics, but in practice the known mathematical techniques for doing so are inadequate to the task. A new method drawn from string theory, the AdS/CFT correspondence offers hope of throwing some light on this situation. This correspondence reduces extremely complex systems such as the QGP to much simpler (but still somewhat difficult) systems involving black hole theory in a certain fictitious spacetime. This idea has scored some notable success in describing the plasmas produced at the RHIC, but it appears to be less successful in describing the LHC plasmas.

Prof McInnes showed that the requirement of the internal mathematical consistency of the AdS/CFT correspondence imposes conditions which are certainly satisfied by the RHIC plasmas but which may not be satisfied by the LHC plasmas, thereby explaining the puzzling apparent failure of the method to extend to the higher-energy case.

Reference: B.McInnes, “Field theories without a holographic dual”. Nuclear Physics B, 913 (2016): 852-876.