Project proposal for Summer Vacation Project Programme with USTC

Beyond the Standard Model of Particle Physics with Highly Energetic Jets

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The Standard Model of particle physics may be one of the most successful physical theories of all time, but it is also startlingly incomplete: even the recently discovered boson at 125 GeV, most likely the long-awaited Higgs boson, raises many profound questions about the nature of electroweak symmetry breaking, the hierarchy of fundamental forces, and the origin and survival of the universe. There are strong grounds for expecting to observe new, exotic ("Beyond the Standard Model") physics phenomena at the TeV scale, and yet, after several years of successful data-taking at the record-breaking high energies of the LHC, this new physics remains as elusive as ever. The Oxford ATLAS group pushes the frontier of new physics searches at the mass/energy frontier, especially using novel techniques to reconstruct and characterize **highly energetic heavy-quark (*t* and *b*) jets and boosted gauge bosons** in order to look for **heavy resonances, vector-like quarks, and miniature and Planckian black holes**.

The proposed project is a part of this search for new physics. A current priority is to improve our understanding of the internal structure of highly energetic jets, in order to move beyond the standard jet reconstruction and tagging techniques which have been employed at lower energies. New techniques will be created, tested, and compared with standard techniques. Recent outcomes, including work from the 2013 USTC Summer Vacation Project Programme, have been documented in *Phys. Rev.* **D88** (2013) 014044 and at the 5th International Workshop on Boosted Object Phenomenology, Reconstruction and Searches (BOOST 2013). The proposed project will take this and related work further. These studies will primarily be based on simulations of high-energy collisions, but may incorporate data from the ATLAS detector.

The project student should have at least an understanding of special relativity and quantum mechanics. Prior understanding of particle physics is helpful, but is not required; the student will be expected to learn relevant material during the project.

In addition, the project student should be fluent with scientific computing, as much of the work will be done on the computer, in particular C++ on Linux, using the ROOT analysis software package (http://root.cern.ch).