TIFR Centre for Interdisciplinary Sciences
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Colloquium

Simulating the proton

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Almost all the known mass of the universe can be attributed to nuclei, i.e. bound states of protons and neutrons. These nucleons are made up of quarks and gluons, that strongly interact according to the laws of quantum chromodynamics (QCD). QCD constitutes the theoretically cleanest and most solid component of the present standard model of elementary particles and their (strong and electroweak) interactions. This "model" leaves many questions unanswered. However, discovering physics "beyond the standard model" does not only require new experiments but also theoretical predictions of QCD corrections to non-QCD processes.

In spite of QCD being well established since over four decades as the fundamental theory of the strong interactions, relatively little is known even about the inner structure of the proton: what is its size? Why is it so heavy? How are its mass, momentum and spin distributed among its constituents, the quarks and gluons? Answering these questions requires solving strongly coupled, non-linear multi-body bound state problems. This does not only pose exciting calculational challenges but nucleons are the fundamental probes for new physics both in collider experiments and in dark matter detectors.

After some motivation and introduction I will report on recent supercomputer simulations of QCD, discretized on a four-dimensional space-time grid (Lattice QCD). Tremendous progress has been achieved recently in the field, due to novel techniques and algorithms, in combination with an ever-increasing compute power, which will also be commented on.

Wednesday, Feb 25th 2015

4:00 PM (Tea/Coffee at 3:30 PM)

Seminar Hall, TCIS