APR12-2012-000321
Abstract for an Invited Paper
for the APR12 Meeting of
the American Physical Society

The Hottest, and Most Liquid, Liquid in the Universe

KRISHNA RAJAGOPAL, Massachusetts Institute of Technology

What was the universe like microseconds after the big bang? At very high temperatures, protons and neutrons fall apart — the quarks that are ordinarily confined within them are freed. Before experiments at the Relativistic Heavy Ion Collider started recreating little droplets of big bang matter, it was thought to be a tenuous gas-like plasma. Now we know from experiments at RHIC and at the Large Hadron Collider that at these extreme temperatures nature serves up hot quark soup — the hottest liquid in the universe and the liquid that flows with the least dissipation. The only other comparably liquid liquid is the coldest liquid in the universe, namely the fluid made of trapped fermionic atoms at microKelvin rather than TeraKelvin temperatures. These are two examples of strongly coupled fluids without any apparent quasiparticle description, a feature that they share with other phases of matter like the strange metal phase of the cuprate superconductors that aren't conventionally thought of as liquids but that are equally challenging to understand. I will describe how physicists are using RHIC and LHC experiments — as well as calculations done using dualities between liquids and black holes discovered in string theory — to discern the properties of hot quark soup. In this domain, string theory is answering questions posed by laboratory experiments. I will describe the opportunities and challenges for coming experiments at RHIC and the LHC, chief among them being understanding how a liquid with no apparent particulate description emerges from quarks and gluons.