Relativistic Heavy Ion Collider

At the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, physicists from around the world are exploring the earliest moments of the universe, the most fundamental particles of matter, and the forces through which they interact.

Scientific Accomplishments

Quark-Gluon Plasma
Instead of producing an anticipated gas of free quarks and gluons, heavy ion collisions at RHIC have produced a liquid of strongly interacting quarks and gluons. With a temperature 250,000 times hotter than the center of the Sun, this quark-gluon plasma has given scientists a surprising idea of what the universe was like just after the Big Bang some 14 billion years ago—a nearly perfect liquid with practically no viscosity, or resistance to flow.

Exotic Findings
RHIC’s collisions have also produced tiny “bubbles” that may internally disobey fundamental symmetries of quark-gluon interactions, as well as the heaviest antimatter nucleus yet discovered. These exotic findings may have implications for understanding and exploring fundamental symmetries in the early universe, and offer insight into models of neutron stars.

Proton Spin Mystery
RHIC’s polarized proton collisions are providing the first information on how gluons contribute to the overall spin of a proton, which cannot be accounted for by the spin of its quarks alone. Early evidence suggests that gluons don’t contribute enough to solve the mystery of the “missing” spin, opening new explorations into how quarks and gluons interact and move inside protons and other particles.

Looking Ahead
RHIC findings have raised compelling questions about the theory that explains the interactions of the most fundamental particles of matter—the quarks and gluons that comprise individual protons and neutrons within atomic nuclei. An ongoing upgrade of RHIC will allow scientists to address these questions with technologies enabling higher collision rates (RHIC II).

Benefits Beyond Physics
Research at RHIC has triggered innovations in accelerator technology that could greatly improve worldwide access to particle-beam delivery systems used to treat cancer. Likewise, advances in data distribution and analysis systems developed for RHIC will benefit society at large. Furthermore, many scientists and engineers trained at RHIC go on to work in fields as diverse as national security, medicine, energy generation, space exploration, and more.

Societal Impact