The Relativistic Heavy Ion Collider (RHIC)

The Relativistic Heavy Ion Collider (RHIC) is designed to study matter as it existed fractions of a second after the birth of the universe—as a plasma of quarks and gluons, the fundamental components of matter.

At RHIC, physicists accelerate and collide heavy ions (atoms of heavy elements stripped of their electrons) at high energies to mimic the hot, dense conditions of the early universe (250,000 times hotter than the center of the sun). Surprisingly, the data have revealed quark-gluon matter that behaves as a nearly-perfect liquid, rather than the predicted gas. RHIC physicists also accelerate and collide polarized protons to explore the mysterious internal spin structure of the proton.

The Machine

RHIC is really two accelerators in one—made up of crisscrossing rings of superconducting magnets, enclosed in a tunnel 2.4 miles in circumference. In the two rings, beams of heavy ions or protons are accelerated to nearly the speed of light in opposite directions, held in their orbits by powerful magnetic fields. The particles can collide at six points around the circles where RHIC’s two rings intersect. Thousands of collisions take place every second, each producing a spray of thousands of subatomic particles.

Two large, complementary detectors, PHENIX and STAR, collect the collision products, providing physicists worldwide with data to help them investigate the inner workings of matter and the birth of the universe. PHENIX detects collision products that can reveal information about the initial collision temperature, as well as the time evolution during its later stages.

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The Future

RHIC’s findings have enriched our understanding of matter and raised compelling new questions. To address these and help reveal detailed characteristics of RHIC’s quark-gluon plasma, key improvements are planned to increase collision rates and improve the detectors. In the longer-term, the addition of a high-energy electron beam would allow physicists to probe another new form of matter locked deep inside ordinary nuclei. These capabilities would further expand our ability to explore the newest and most intriguing questions about the substructure of the world around us.