Brookhaven National Laboratory
Colloquium on RHIC Results
June 18, 2003
Remarks

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Executive Office of the President

Thank you Director Chaudhari, for inviting me to this event. All of us who have come into contact with RHIC and its detectors and the team of extraordinary people who make it all work share a deep sense of pride. My own pride has less to do with the minor role I played in RHIC's success, and more with the privilege of being part of a community capable of producing it.

I want to take just a few minutes to express my sense of where these experiments fit in a very grand conception of nature that is unfolding during our generation. A series of remarkable discoveries in recent decades is once again altering our view of humankind's place in nature's scheme. This realignment is comparable in significance to the Copernican revolution at the dawn of modern science, in which our species began to be displaced from the center of the universe. It appears that we humans, and every aspect of our physical world immediately apparent to us, are merely residual phenomena living in the fine-structure of the ground state of a stupendous system of condensed matter whose main components remain completely hidden from us.

We know from a series of physical and astronomical observations that ordinary matter comprises about 5% of the total substance of the universe. The remainder is dominated by something we call *Dark Matter* (30%) and *Dark Energy* (65%) for want of better names. We cannot see these, and have no idea what they are, but we need them to explain the behavior of the tiny remainder that we can see.

Our own small share of matter is no more than the ashes of a great conflagration in which equal amounts of matter and anti-matter almost burned themselves up. We do not understand why enough remained to allow for our creation, but here we are, grown up from pieces of what we call the *Standard Model*, and trying to puzzle out all the rest – the other 95% – from their behavior.

That behavior is inexplicable unless we assume that what we call empty space is actually filled with matter that cooled and condensed after the seething chaos of the Big Bang. This so called *vacuum condensate* is not simple, and it almost certainly includes stuff that is not part of the Standard Model. It is the need for our particles to push their way through this condensate that gives them the property we call mass. Some of the mass comes from the *Higgs Mechanism*, a crude device invented to make the math of the Standard Model consistent. But most of the mass comes from pieces that we ought to be able to understand. It comes from the pieces that interact strongly to comprise the nuclei of atoms, where more than 99.9% of mass resides. These pieces are *quarks* and *gluons*.

Others here have contributed to a detailed picture of the quark sector of the Standard Model called *Quantum Chromodynamics* (QCD). My own picture is somewhat out of date, and does not capture the full story of how things work. But roughly speaking, the gluons, being massless, can be produced with negligible energy, and being themselves subject to the strong force they can attract each other and clump. That means two gluons can have lower energy than none, so gluons pop spontaneously into existence everywhere, dragging some quark stuff with them because quarks and gluons are so strongly linked. The result is a vast roiling ocean, filling the entire universe, called the QCD vacuum state in which we are all swimming in this frozen era of cosmic history. For quarks and gluons, "cold" means something less than a trillion degrees.

The ubiquitous QCD condensate is not simple. It has structure in both space and time. And its effects on the interactions of particles that take place within it are not simple. It was precisely to probe these effects that RHIC and its detectors were constructed. The energy carried into a collision region by speeding gold nuclei heats up the condensate, which alters the environment in which the nuclear constituents interact. The spectrum of stuff emerging from such a heated region will look different from the spectrum emerging from collisions where the condensate is relatively undisturbed. That such differences have been clearly observed is highly significant, and gives credence to the emerging world view.

The RHIC experiments differ conceptually from other accelerator experiments because they acknowledge that the fundamental constituents of nature are masked by the frozen wasteland of the vacuum condensates. The goal of RHIC is not isolated discovery, but exploration of the complex and ubiquitous environment in which we isolated creatures live out our brief existence.

I offer my congratulations to the experimental teams, the staff of the RHIC/AGS complex, and the visionary leaders and builders who decades ago started the wheels turning that brought us to today's event.

Latest RHIC Results to be Presented at Brookhaven

EVENT: Scientists conducting research at the Relativistic Heavy Ion Collider (RHIC), the world's largest facility for research in nuclear physics, will present results from their latest experiments at a special scientific colloquium. The scientists will be available to meet with reporters after the talks. Research at RHIC offers insight into the basic structure of matter.

WHEN: Wednesday, June 18, 2003, 11 a.m.

WHERE: The U.S. Department of Energy's Brookhaven National Laboratory, Large Seminar Room in Building 510, Physics. Brookhaven Lab is located on William Floyd Parkway (County Road 46), one and a half miles north of Exit 68 of the Long Island Expressway.

DETAILS: The Relativistic Heavy Ion Collider is designed to produce a very hot and dense microcosm of matter - known as quark-gluon plasma - that is believed to have existed in the first microseconds after the birth of the universe. The latest experiments - conducted from January through March 2003 - collided heavy gold nuclei head-on with deuterons (nuclei consisting of one proton and one neutron). These collisions, along with collisions between two beams of protons, serve as a basis for comparison with RHIC's collisions of two gold beams.

In comparing these very different types of collisions, scientists have seen distinctions that clearly show that head-on gold-gold collisions are producing a nuclear environment quite different from that of deuteron-gold collisions. Although RHIC scientists are not ready to claim success, they are confident that RHIC collisions of gold ions have created unusual conditions and that they are on the right path to the discovery of quark-gluon plasma (see news release posted at www.bnl.gov).

Researchers will present detailed results, and both experimentalists and theorists will be available for media interviews to put the experimental findings into the context of the search for quark-gluon plasma. Also expected to attend the colloquium are: John Marburger, Science Adviser to the President; James Decker, Principal Deputy Director, DOE Office of Science; Peter Rosen, Associate Director for High Energy and Nuclear Physics within the Office of Science; and Dennis Kovar, Director of the Division of Nuclear Physics within the Office of Science.

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