

April 15, 2008

Letter of Intent

**“CATHIE”
(Center of Analysis and Theory
for Heavy Ion Experiments)**

PREAMBLE

We propose to form a new center at BNL to address specifically the following issues: 1) realistic three-dimensional numerical hydro-dynamical simulations of heavy ion collisions; 2) realistic calculations of jet production and energy losses in a high-density medium; and 3) realistic calculation of charm production, including J/ψ . Interrelation between those three can include, for example, hydro-dynamical study of waves induced by quenched jets or flow of charm. These topics constitute the performance milestones for Nuclear Theory, and are aligned with the Office of Nuclear Physics long-term performance measures and with the strategic plan of the Office of Science.

The large-scale experimental efforts in high-energy nuclear physics – the construction and commissioning of RHIC and five very successful runs – have provided spectacular discoveries and a lot of new puzzles. There is no doubt we are dealing with a new form of matter, which has many unexpected properties. Instead, the matter observed at RHIC is strongly coupled and is different from the weakly coupled quark-gluon plasma; this leads to small viscosity (short mean free path), small charm diffusion coefficient, and very large jet energy losses. The initial partonic wave functions of the colliding nuclei at high energies appear highly coherent, and can be described as a condensate of gluons (“color glass condensate”).

Now, when the shift of the paradigm had occurred, it became clear how much all of us still had to learn. In fact, strongly coupled systems are at the forefront of research in many other fields of physics, from ultra-cold atomic gases to plasma physics and even string theory.

Executive summary:

1. We propose to form an Advisory Board representing all major theory groups involved in RHIC and LHC physics and the RHIC and LHC experiments to oversee the activities of the new Center, such as the development of a quantitative approach to theoretical description of heavy ion collisions, and related workshops and programs.
2. We propose to conduct an open search and to hire a scientist (either a theorist or an experimentalist) to coordinate the work on the quantitative modeling and simulations of heavy ion collisions. The job responsibilities would include maintaining a depository of simulation codes, running tests, and performing quantitative analyses of the data. This person would be responsible for day-to-day coordination of the activities of the groups working on the development of models of various stages of heavy ion collisions.

The Advisory Board will provide advice during the search process.