

Proposal for Summer 2008 Workshop at the Aspen Center for Physics

on

QCD Matter at RHIC and LHC

We propose to organize a summer workshop entitled “QCD Matter at RHIC and LHC” at the Aspen Center for Physics. Our goal is to initiate cross-disciplinary interactions between the leading experts in particle and nuclear physics, plasma physics, cosmology, and condensed matter physics. We plan to critically review the findings and unsolved questions from the first six years of the operation of Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory, to identify the critical theoretical issues that need addressing, to formulate new research directions, and to make the predictions for the future program of RHIC as well as for the heavy ion program at the LHC before it begins.

Specific topics to be discussed at the Workshop include:

- the current experimental findings at RHIC;
- quantitative characterization of QCD matter and of its transport properties: the dynamics of the phase transition, the approach to equilibrium, entropy, shear and bulk viscosities, diffusion constants, etc;
- hard probes of QCD matter and its bulk properties;
- the use of condensed matter physics methods in the study of strongly correlated quark-gluon plasma;
- novel insights offered by the holographic AdS/CFT correspondence and the use of string theory techniques in QCD;
- cross-disciplinary connections and implications of RHIC results for cosmology.

We feel that this workshop is timely in view of the upcoming new stage of the experimental program at RHIC (implementation of detector upgrades and the planned increase of luminosity) and the start of the LHC heavy ion experiments. From the overwhelming response to our initial inquiry, we are convinced that there is strong enthusiasm in the community to work on these problems, and a strong desire to discuss the open issues in the friendly and relaxed atmosphere of the Aspen Center.

We would like to propose that the workshop take place for 4-5 weeks, preferably in the second half of July and beginning of August. We hope that you share our excitement for this new and this rapidly developing field of physics.

Best regards,

The organizers

Organizers

John Harris

Department of Physics
Yale University
217 Prospect Street
New Haven, CT 06511-8499, U.S.A.

Phone: (203) 432-6106
Fax: (203) 432-6175
Email: john.harris@yale.edu

Founding spokesperson of STAR Collaboration at RHIC, The US coordinator of the ALICE experiment at LHC; Relativistic heavy ion physics, ...

Barbara V. Jacak

Department of Physics and Astronomy
Stony Brook University
Stony Brook, NY 11794-3800, U.S.A.

Phone: (631) 632-6041
Fax: (631) 632-8176
Email: barbara.jacak@stonybrook.edu

Spokesperson of PHENIX Collaboration; Relativistic heavy ion physics, ...

Dmitri Kharzeev

Head, Nuclear Theory Group
Physics Department
Brookhaven National Laboratory
Upton, NY 11973-5000, U.S.A.

Phone: (631) 344-7231
Fax: (631) 344-7561
Email: kharzeev@bnl.gov

QCD, relativistic heavy ion physics, condensed matter physics,

Jian-Wei Qiu

Department of Physics and Astronomy
Iowa State University
Ames, IA 50011-3160, U.S.A.

Phone: (515) 294-7377
Fax: (515) 294-6027
Email: jwq@iastate.edu

Perturbative QCD, relativistic heavy ion physics, QCD effective theory, phases of QCD,

Urs Achim Wiedemann

Theory Division, CERN
PH-TH, Case C01600
CERN, CH-1211
Geneva 23, Switzerland

Phone: (41) 22 76 72753
Fax: (41) 22 76 73850
Email: Urs.Wiedemann@cern.ch

QCD, relativistic heavy ion physics, string theory,...

A designated contact person:

Jian-Wei Qiu

A designated person responsible for working to ensure diversity:

Barbara V. Jacak

Description and justification for the workshop

RHIC results strongly indicate the creation of dense and hot QCD matter with very interesting properties. Indeed, one of the most striking results that has come from the RHIC heavy ion program is the observation that hot QCD matter created in $Au - Au$ collisions behaves like an almost ideal liquid with low shear viscosity rather than a gas of quarks and gluons. This observation does not yet have any satisfactory theoretical explanation due to the enormous complexity of QCD in the regime of strong coupling, even though a few promising approaches have started to emerge. Novel ideas are needed in order to build a theory of strongly correlated quark-gluon matter in the vicinity of the critical temperature.

This is why it is timely to initiate a cross-disciplinary discussion involving in particular the experts from condensed matter physics and string theory. The connection to condensed matter physics, with its extensive experience in dealing with strongly correlated systems, is clear. As for string theory, recently it has become a powerful tool in the studies of conformal gauge theories that are connected through the holographic AdS/CFT correspondence to gravity in five-dimensional Anti-de Sitter space. For example, a study of shear viscosity in $N = 4$ SUSY Yang-Mills theory has indicated that the shear viscosity η at strong coupling is small, with the viscosity-to-entropy ratio not far from the conjectured bound of $\eta/s = 1/4\pi$. While $N = 4$ SUSY Yang-Mills theory is quite different from QCD and does not possess the salient features of the hadronic world including the asymptotic freedom and confinement, these results may still provide hints towards the study of QCD matter. Until now, the significance of the latest RHIC results for the cosmology of the Early Universe has not been clarified; this will be one of important discussion topics for our Workshop.

A quantitative theoretical description of RHIC results has become an urgent task, since it is needed to fully understand the significance of experimental findings, to formulate the directions for future research at RHIC and at the LHC, and to realize fully the potential of these machines.

RHIC experiments now undergo extensive upgrades and are getting ready for a new generation of measurements at a higher luminosity; the LHC heavy ion program is about to start in late 2008 or in 2009. Therefore the summer of 2008 would be a particularly convenient time for the Workshop which we propose. In fact we have received a very enthusiastic response both from the community involved at present in RHIC and LHC research, and from the experts in string theory, condensed matter physics, and cosmology. The Aspen Center with its stimulating and informal atmosphere would be an ideal location for the Workshop.

Preferred, acceptable, and impossible weeks

The availability of the principle organizers:

| | |
|-------------------------|-----------|
| John Harris: | 2-3 weeks |
| Barbara Jacak: | 2 weeks |
| Dmitri Kharzeev: | 4 weeks |
| Jian-Wei Qiu: | 4 weeks |
| Urs Wiedemann: | 2-3 weeks |

Potential timing conflicts with national and international meetings or other workshops:

Summer program at the Institute of Nuclear Theory (INT):

The QCD Critical Point (INT-08-2b), July 28 - August 22, 2008

A preference for a time adjacent to another meeting to increase international participation:

Right before or slightly overlap with the beginning of the INT program could enhance the international participation

The proposed length (in weeks) of the workshop:

4-5

Other serious constraints:

None. This seems to be an ideal summer for hosting such a meeting without a conflict with the major international meeting in the field, e.g. the "Quark Matter" Conference.

List of individuals who have committed to participate the workshop if it is approved

| | |
|-----------------------|--|
| Francois Arleo | CERN, Switzerland |
| Steffen A. Bass | Duke University |
| Gordon Baym | University of Illinois at Urbana-Champaign |
| Rene Bellwied | Wayne State University |
| Dietrich Bodeker | Universitaet Bielefeld, Germany |
| Peter Braun-Munzinger | GSI, Germany |
| Stanley J. Brodsky | Stanford University |
| Wit Busza | Massachusetts Institute of Technology |
| Helen Caines | Yale University |
| Brian Cole | Columbia University |
| Kari J. Eskola | Jyvaskyla University, Finland |
| Philippe de Forcrand | Eidgenossische Tech. Hochschule (ETH), Switzerland |
| Francois Gelis | CEA-Saclay, France |
| Steven S. Gubser | Princeton University |
| Miklos Gyulassy | Columbia University |
| John Harris | Yale University |
| Tetsuo Hatsuda | University of Tokyo, Japan |
| Ulrich Heinz | The Ohio State University |
| Barbara Jacak | Stony Brook University |
| Peter Jacobs | Lawrence Berkeley National Laboratory |
| Xiangdong Ji | University of Maryland |
| Joseph Kapusta | University of Minnesota |
| Dmitri Kharzeev | Brookhaven National Laboratory |
| Igor R Klebanov | Princeton University |
| Volker Koch | Lawrence Berkeley National Laboratory |
| Yuri Kovchegov | The Ohio State University |
| Alex Kovner | University of Connecticut |
| Mikko Laine | Universitaet Bielefeld, Germany |
| John Lajoie | Iowa State University |
| Mike Leitch | Los Alamos National Laboratory |
| Eugene Levin | Tel Aviv University, Israel |
| Steve Libby | Lawrence Livermore National Laboratory |
| Abhijit Majumder | Duke University |
| Jamie Nagle | University of Colorado |
| Borghini Nicolas | Universitaet Bielefeld, Germany |
| Nestor Armesto Perez | Universidade de Santiago de Compostela, Spain |
| Owe Philipsen | Westfalische Wilhems Universitat Muenster, Germany |
| Jian-Wei Qiu | Iowa State University |
| Krishna Rajagopal | Massachusetts Institute of Technology |
| Ralf Friedrich Rapp | Texas A&M University |
| Dirk Rischke | Universitaet Frankfurt, Germany |
| Helmut Satz | Universitaet Bielefeld, Germany |

| | |
|--------------------|---------------------------------------|
| Jurgen Schukraft | CERN, Switzerland |
| Arif Shoshi | Universitaet Bielefeld, Germany |
| Dam Thanh Son | University of Washington |
| Johanna Stachel | Universitaet Heidelberg, Germany |
| Peter Steinberg | Brookhaven National Laboratory |
| Misha Stephanov | University of Illinois at Chicago |
| George Sterman | Stony Brook University |
| Michael Strickland | Universitaet Frankfurt, Germany |
| Leonard Susskind | Stanford University |
| Chung-I Tan | Brown University |
| Derek Teaney | Arkansas State University |
| Kirill Tuchin | Iowa State University |
| Flemming Videbaek | Brookhaven National Laboratory |
| Raju Venugopalan | Brookhaven National Laboratory |
| Werner Vogelsang | Brookhaven National Laboratory |
| Ramona Vogt | Lawrence Berkeley National Laboratory |
| Xin-Nian Wang | Lawrence Berkeley National Laboratory |
| Urs Wiedemann | CERN, Switzerland |
| Bolek Wyslouch | Massachusetts Institute of Technology |
| Laurence Yaffe | University of Washington |
| W.A. Zajc | Columbia University |