Title
HEAVY ION PHYSICS - INTRODUCTION TO THE HEAVY ION PARALLEL SESSIONS AT CIPANP

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HEAVY ION PHYSICS - INTRODUCTION TO THE HEAVY ION PARALLEL SESSIONS AT CIPANP*

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ABSTRACT

A brief introduction into some of the physics probed by heavy ion projectiles at low, intermediate and high energies is given. Emphasis is placed on nuclear matter under extreme conditions in this discussion, which should provide a common area of interest to both particle and nuclear physics.

INTRODUCTION

In putting together the six parallel sessions on heavy ion physics we have emphasized the area of "extreme conditions" in nuclear matter rather than the more conventional aspects such as nuclear structure. This area of heavy ion studies is getting more attention these days, particularly with the push to higher energies and therefore provides a relatively natural bridge to couple interests in both particle and nuclear physics.

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PHYSICS WITH HEAVY IONS

As a starting point it is convenient to discuss what happens in heavy ion collisions as a function of bombarding energy. This is done below by dividing the energy scale into: low, intermediate and high energies. The rough energy ranges listed are for fixed target experiments.

1) Low Energy: This covers the range of bombarding energies below ~30-50 MeV/nucleon. At the lower end of this scale, the nucleus is often thought of as a classical liquid; but with increasing energy the nucleonic composition starts to manifest itself and we enter a region where the nucleus can be roughly treated as a gas. The large numbers of nucleons present in these collisions allow extremme conditions in nuclei to be studied, including:
   - superheavy element production/searches
   - introduction of large angular momenta into the nuclear system (study of angular momentum limits reached, relaxation of system, . . .)
   - local deposition of energy (hot spot formation and propagation)
   - ability to study collective aspects of nuclei by using pion production near the absolute kinematic limits as a probe.

2) Intermediate Energy: This corresponds roughly to the interval from 50 to 1000 MeV/nucleon and spans the range from a simple "pure" nucleon gas treatment to the on-set of the hadron gas regime (i.e., excitation of the nucleonic degrees of freedom yielding nuclear matter with N^*, Δ, π, η, ρ, ω, . . . content). In this range the incident nuclear projectiles have the ability of delivering a large amount of energy over a large volume, allowing experiments to:
   - probe extreme conditions of temperature (T) and baryon density (ρ) in nuclear matter with the goal of obtaining information on the equation of state $W(\rho, T)$
   - search for unusual or exotic nuclear states or phenomena such as abnormal nuclei (Lee-Wick), pion condensation, Δ-matter, anomalons, . . .
   - use the property of kinematic focussing (in peripheral colllisions) at higher energies as a powerful tool for studying production of nuclei far from stability and in producing beams of secondary neutron-rich nuclei for conventional nuclear physics studies.

3) High Energy: Covering the region from a few GeV/nucleon to the highest energies available in the cosmic radiation. At these higher energies one expects to move from the arena of confined hadronic matter to one of deconfined quark matter (quark-gluon plasma). Heavy nuclei at high energy provide us with the opportunity of creating both high energy and baryon density in central nucleus-nucleus collisions with the potential of:

- o creating the quark-gluon plasma in both a baryon-rich (large ρ) and baryon-free (high T) region
- o forming in a controlled environment a new state of matter which is coupled to conditions in the early universe
- o probe the long-range aspects of QCD, and
- o extend our present studies of hot, dense hadronic matter to higher T, ρ.

Figure 1 shows the phase diagram of hadronic matter in the temperature-relative baryon density plane. It is only within the last decade that we have started to probe nuclei beyond the region of $T \approx 0$, $\rho/\rho_o = 1$. Nucleus-nucleus collisions offer us a unique opportunity of probing a much larger region of this diagram, including the region of deconfined quark matter--the quark-gluon plasma.

PHASE DIAGRAM OF
HADRONIC MATTER

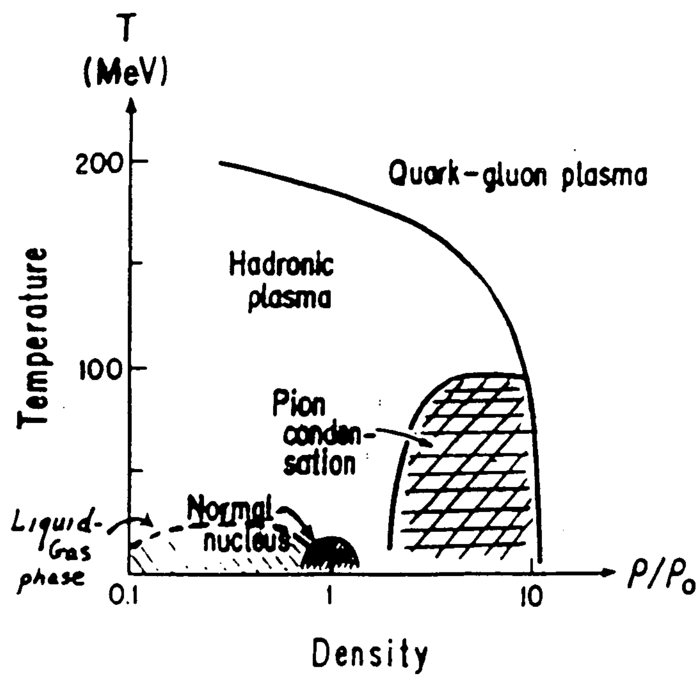

Figure 1: Phase diagram for hadronic matter.

PROGRAM FOR HEAVY ION SESSIONS

Listed below is the program for the six parallel heavy ion sessions.

Session A - (May 23)
- J. Kogut (Univ. of Ill.): "Recent Results from Lattice Gauge Calculations"
- P. Carruthers (LANL): "Hydrodynamic Flow Structures in Quantum Field Theory"
- A. Goldhaber (Stony Brook): "Nuclear Stopping Power"

Session B - (May 24)
- G. Yodh (Univ. of Maryland): "High Energy Nucleus-Nucleus Collisions: A Summary of Cosmic Ray Data"
- Y. Takahashi (Marshall Space Flight) : "Recent Results from the JACEE Experiment"
- G. Young (ORNL): "Subthreshold Production of Pions"

Session C - (May 28)
- D. Boal (Simon Fraser/MSU): "Low Energy Phase Transitions in Nuclear Matter"
- A. Hirsch (Purdue): "Fragment Production and the Liquid-Gas Phase Transition"
- S. Fung (UC Riverside): "Source Size Measurements (HBT) in High Energy Nucleus-Nucleus Collisions and First Results on Uranium in Streamer Chamber at the Bevalac"
- K. Crowe (UC Berkeley): "$\pi\pi$ Correlation Measurements in Fe + Fe Collisions"

Session D - (May 28)
- H.-G. Ritter (GSI/LBL): "Collective Flow and High Density Nuclear Matter"
- A. Sandoval (GSI/LBL): "Nuclear Matter Equation of State"
- K. Nakai (Univ. Tokyo/KEK): "Pions, Protons and Excited Nucleons from Hadron-Nucleus Reactions at Several GeV"

Session E - (May 29)
- M. Tanaka (BNL): "Study of the Neutral Energy Spectrum in the Central Region of $\alpha\alpha$ Interactions at $\sqrt{s}$ = 124 GeV at the CERN ISR"
- W. Zajc (Univ. of Penn.): "Particle Production in $\alpha\alpha$ Collisions at the CERN-ISR"

Session F - (May 29)
- C. M. Ko (Texas A&M): "Strange Particle Production in Relativistic Nuclear Collisions"
- D. Sivers (ANL): "Classical Chromodynamics and Extended Nuclear Matter"
- P. J. S. Watson (Carleton Univ.): "Hadrons in Nuclear Matter"

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