EuroConference on Quark matter

Precisely one decade ago the GSI/LBL Collaboration at the Bevalac reported distinct evidence of collective side-wards flow in high energy heavy ion collisions. This ground breaking key-observation impressively demonstrated the compression and heating up of nuclear matter and provided the most sensitive tool to study the nuclear matter equation of state (EOS). This year now, evidence for azimuthally asymmetric transverse flow at 10 times higher projectile energy (11 AGeV Au+Au) was presented by Johanna Stachel for the BNL E814/E877 collaboration at the EuroConference on "Physics of High Energy Heavy Ion Collisions" in Helsinki, Finland between June 17-22, 1994. The same topic was discussed also in talks by Bravina, Csernai, Ol- litraut, Stöcker, Gutbrod and others. Flow is predicted to show up also in experiments at the CERN SPS when Pb-beams will become available by the end of this year. Strong changes in the EOS due to the phase transition threshold are expected to show up strongly in this measurable if the phase transition to Quark-gluon Plasma (QGP) is of strong first order.

As Ingvar Otterlund pointed out in his opening address, the EuroConference was in a particularly fortunate situation to demonstrate the healthy age distribution in the field. Among the 120 participants, almost half of the researchers were still at an age below 35 years. Actually, the conference was preceded by a two week long NordPlus School on the same subject in Jyväskylä, where 30 students were prepared in an intensive course, so that they could gain a maximum profit out of the conference also.

Not only the existence of a phase transition to a QGP, but also the order of the transition itself is a crucial issue in this field. Consequently, this subject was addressed in several talks and many lively discussions. Lattice calculations, reviewed by Hildegard Meyer-Ortmans and Helmut Satz, are presently limited to small volumes, where naively no phase transition can exist and can be detected. However, scaling studies of the probability distribution of the energy density may reveal the expected infinite volume behavior even in finite volume calculations. In experiments, of course, such scaling studies would be complicated, thus large colliding systems, i.e., heavy beams and large energy provide the most favorable conditions. Furthermore, the QGP would be formed in a very dynamical system, where phase transition dynamics is also a key issue. As Keijo Kajantie pointed out, neither finite volumes, nor short time scales are hindering us to apply the theory to the early Universe.

Miklos Gyulassy discussed fluctuations which arise in a phase transition in a small system, where the initial parton and particularly gluon distributions may fluctuate strongly. This may also lead to observable signatures, e.g. via fluctuations in the neutral/charged pion ratios or via pion interferometry. H. Satz advocated the frequently discussed $J/\psi$ to probe the confinement/deconfinement. Since deconfined gluons are at given temperature five times harder than those in a confined stage they would cause the $J/\psi$ to break up for temperatures larger than 200 MeV.

Until it is convincingly proven experimentally the debates on the existence of the phase transition will of course persist. There is a school of theorists who attempt to describe all observed phenomena in terms of hadronic degrees of freedom. The decrease of effective hadronic masses in dense matter is a central assumption in this approach. Robert Pisarski pointed out that the expectations on decreasing effective masses may be false, and he presented an example where
the $\rho$-mass increases with increasing density and temperature. Such kind of in-medium changes of the $\rho$-mass and -width can uniquely be studied by lepton-pair experiments. Roberto Salmeron critically summarized the experimental data on vector meson production. After normalization to charged particles, present data suggest the observed $\phi/(\rho + \omega)$ enhancement with increasing centrality being caused mainly by a decrease of the denominator rather than by an increase of the nominator.

The old strangeness signal is well and alive, particularly what the enhancement of strange antibaryons are concerned. Several groups measured strangeness enhancement or performed strangelet searches with results reported by E. Andersen, Safarik, Stock, Pretzl, and others. The excess over pp-data is obvious and rather consistent between different experiments, and it turned out in the discussion that even the most sophisticated microscopic string models cannot reproduce the strange antibaryon production unless string fusion, string clusters, or other exotic objects are incorporated in these models. Although QGP scenarios are supported by the data as pointed out by Rafelski, a detailed dynamical model, with the proper treatment of the phase transition dynamics and rehadronization is still to be worked out.

With the advent of second generation experiments on both sides of the atlantic, two particle correlation studies now focus on high statistics as well as on clean particle identification enabling detailed comparisons of $\pi\pi$- and $K\bar{K}$-correlations. A proper interpretation of the large body of experimental data, which were presented by Bøggild, needs to fold out various dynamical processes and contributions from resonance decays, both of which are best studied by detailed comparisons with model calculations. New attempts in this direction, discussed by Heinz, Razumov, and others, may help to unravel the information obtained from many different correlation observables.

Electromagnetic probes measured as real and virtual photons are the only signal of the QGP that reaches the detectors directly, but their cross sections are very low, as pointed out by Vesa Ruuskanen. Four experiments at CERN aim to look for this signal and their results were reviewed by Karl-Heinz Kampert. Preliminary data of each of these experiments indicate an excess over the known hadronic sources in central nuclear collisions, and are compatible with background in peripheral ones as well as in proton-nucleus collisions. The dominant contribution of these photons is believed to originate from the hadronic phase with some additional contribution of lepton pairs being possible due to enhanced charm production. To account for the photon yields within present models, the system is required to rest for a significant time at a temperature close to the critical one, a picture which is in fact supported by the observed slope of the prompt photon $p_T$ spectrum. If the signal persists final analysis, it could be an indication for hadronic matter at the boiling point.

Commonly, it is believed that the existence and particularly the experimental verification of a phase transition should be more favorable in larger nuclear systems and/or higher bombarding energies. The community is thus preparing for the Pb-beam experiments at the SPS to start this fall and on a long term also for experiments at RHIC in Brookhaven and LHC at CERN. Status reports on the collider experiments were given by Tom Ludlam and Jürgen Schukraft.

Altogether, the organizers have chosen well balanced and complete share between a conference and school programme with sufficient time for intensive and fruitful discussions. Com-
plemented by the peaceful surroundings and the location, it provided the basis of an illuminative and successful conference.