Is Strangeness still interesting at RHIC ?

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Abstract

With the advent of the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory (BNL), Heavy Ion Physics will enter a new energy regime. The question is whether the signatures proposed for the discovery of a phase transition from hadronic matter to a Quark Gluon Plasma (QGP), that were established on the basis of collisions at the BEVALAC, the AGS, and the SPS, respectively, are still useful and detectable at these high incident energies. In the past two decades, measurements related to strangeness formation in the collision were advocated as potential signatures and were tested in numerous fixed target experiments at the AGS and the SPS. In this article I will review the capabilities of the RHIC detectors to measure various aspects of strangeness, and I will try to answer the question whether the information content of those measurements is comparable to the one at lower energies.

1 Introduction

Since the beginning of Relativistic Heavy Ion Collisions at the BEVALAC, the quest for evidence of a phase transition between hadronic matter and a chirally symmetric and deconfined phase, called the Quark Gluon Plasma, has led to numerous proposed hadronic and leptonic signatures. Early theoretical suggestions of hadronic signatures had to be revised after it was shown that final state interactions affect the initial formation observables of hadrons. One potential signal that is still being considered is strangeness formation. Measurements relating to strangeness production in a deconfined phase are numerous and span from simple strangeness yields (as evidence for strangeness enhancement), over strangeness ratios (as evidence for strangeness equilibration) all the way to strangeness distillation (as evidence for chiral symmetry restoration or strange quark matter formation). In the following sections, I will show that the RHIC detectors are well equipped to repeat and extend the strangeness measurements performed at the AGS and SPS, and I will give you a personal view on the significance of those measurements at RHIC based on some recent theoretical work.

I will start by briefly describing the accelerator and the various RHIC experiments. I will then focus on the STAR detector, which addresses most strangeness measurements at RHIC. After a short description of the relevant detector components, I will present detector performance simulations relevant for strangeness measurements. All simulations shown were provided by the various RHIC detector groups and should be considered preliminary.

In the Discussion and Conclusions chapter I will relate those measurements to some recent theoretical work and then draw my conclusion on whether strangeness is still interesting at RHIC. The reader should complement this article with many of the articles in these proceedings, which essentially show that the measurement of strangeness ratios at the AGS and SPS might have led to a deep understanding of the collision dynamics and possible evidence for transition like behavior at the SPS.

We do not know what nature has in mind for us at RHIC, and therefore any model description has to be incomplete. Still, even on the basis of the most basic models, we can establish a significant change in the collision environment from SPS to RHIC. This change is documented in the above table which shows a comparison between SPS and RHIC parameters, as presented by Dumitru and Rischke [1], under certain model assumption, namely a parton cascade with a hydrodynamical 'afterburner' to describe the hadronization phase. In this case the system follows a cylindrically symmetric, longitudinally

Parameter	**RHIC**	**SPS**
Energy density ϵ_i	17 GeV/fm^3	5.3 GeV/fm^3
Baryon Density ρ_B	2.3 ρ_0	4.5 ρ_0
dN$_B$/dy	25	80
Initial Temperature T$_i$	300 MeV	216 MeV
Chemical Potential μ_q	47 MeV	167 MeV
Strange chem. potential μ_s	0 MeV	0 MeV
Entropy per baryon S/ρ_B	200	40
Freeze-out Temperature	160 MeV	130 MeV
Hadronization Time	16 fm	10 fm

boost invariant expansion. Clearly, the enhancements in the entropy per baryon and the energy density are large, whereas the baryon density shows the expected decrease. Because the plasma in the central region, if formed, will most likely be baryon-poor at these energies, certain strangeness physics observables which rely on high baryon density, like strange quark matter formation [2] or medium modifications [3], [4], might be less likely to occur at mid-rapidity, where most detectors have their best coverage. Still, measurements in the forward regions might yield access to a more baryon rich plasma.

2 RHIC and its detectors

The Relativistic Heavy Ion Collider (RHIC) at BNL will enable us for the first time to accelerate heavy ions in collider mode. Therefore, it will greatly enhance the energy available in each collision compared to previous fixed target experiments. The accelerator is scheduled to commence data runs by November 1999, in about one year from now. The maximum available beam energy for Gold Ions will be 100 + 100 A GeV. The minimum available energy in collider mode will be 30 + 30 A GeV ($\sqrt{s}$ = 60 GeV) due to certain injection constraints. This minimum energy might become important if we try to connect the RHIC measurements to the highest energy fixed target measurements (the SPS E$_{lab}$ = 160 A GeV corresponds to a $\sqrt{s}$ = 17 GeV) for the purpose of a signal excitation function. RHIC is also capable of colliding pp-, pA- and many other AA-systems. pp-running is scheduled to commence in Year-2 and it will be complemented by an elaborate Spin Program, based on the acceleration of polarized protons.

Presently, four detectors are being built for RHIC: two large detectors, PHENIX [5] and STAR [6], and two smaller devices, PHOBOS [7] and BRAHMS [8]. The smaller detectors are specialized setups with a dedicated program, whereas the large detectors attempt to measure as many observables in a single collision as possible. PHENIX has a focus on leptonic signals, with some significant capabilities in hadron measurements; STAR is dedicated to hadronic measurements with some limited lepton measurement capabilities. In the following I will provide a brief overview of each detector and its respective strangeness capabilities.

PHOBOS is a table-top two arm spectrometer consisting of various types of high resolution Silicon detectors. Its main physics goal is to study inclusive hadron production down to very low transverse momentum. Its strangeness capabilities include the very precise measurement of neutral and charged kaon spectra and their respective particle correlations, plus the ϕ-meson decay into the kaon channel.

BRAHMS is a small acceptance spectrometer with variable angle setting, which is build on the same principle as the successful series of AGS experiments E802, E859, E866, E902. This detector will yield inclusive measurements of hadronic particle production over the full rapidity range. Its main strangeness capabilities include the measurement of charged kaon spectra, K$^+$K$^-$-interferometry, plus the ϕ-meson decay into the kaon channel.

PHENIX is a large detector consisting of an axial field magnet with a two-arm central detector plus muon detection systems attached in each forward direction. The detector is dedicated to leptonic probes, but it has very good hadronic detection capabilities in the central arms. This allows PHENIX not only to measure the kaon spectra very precisely and to very high transverse momentum, but also the simultaneous measurement of both ϕ-meson decay channels, the di-lepton channel and the K^+K^- channel.

STAR is a close to 4π coverage detector consisting of a central solenoidal axially symmetric magnet which hosts the central Time Projection Chamber (TPC), a Silicon Vertex Tracker (SVT) plus an Electro-Magnetic Calorimeter (EMC). In the forward directions the coverage is extended by two Forward Time Projection Chambers (FTPC), one on each side. This complete coverage allows event-by-event analysis of hadronic signals and jets. STAR is the dedicated hadron detector at RHIC. The crucial detector component for its strangeness measurements is the Silicon Vertex Tracker, a three barrel vertexing and tracking device, which enables the reliable reconstruction of secondary and tertiary vertices for the fast decaying strange mesons and baryons. The SVT is based on a new Silicon detector technology, called Silicon Drift Detectors [9], [10], which was recently successfully implemented in a 15 plane tracking device in the fixed target heavy ion experiment E896 at the AGS. This STAR test detector will yield strange and multi-strange baryon measurements in the Au+Au system at 11.6 A GeV at the AGS within the next year.

The STAR measurement capabilities include all major strangeness signals, in particular the measurements of spectra, ratios and cross sections for K^+, K^-, K^0_s, Λ, $\overline{\Lambda}$, Ξ^-, $\overline{\Xi^-}$, Ω^-, and $\overline{\Omega^-}$, in conjunction with π,p,d etc. Based on the multiplicities and the detector coverage, only the charged kaon spectra and the $K^\pm/\pi^\pm$ ratio can be studied event-by-event. STAR also measures particle correlations for charged and neutral kaons, and possibly $\Lambda\Lambda$-Interferometry. In addition, it complements the ϕ-meson studies by the other three RHIC detectors. Finally it enables the search for strange quark matter in form of the H-Dibaryon or higher mass strangelets.

Based on the comparison of all the capabilities listed above, I conclude that there is some limited overlap between detectors, in particular in the measurements of the kaon spectrum and the ϕ-meson decay. The phase space coverage and the resolutions are quite different, though, therefore at RHIC, in contrast to the AGS and SPS experiments, we do not expect many different measurements of the same observable. The premier strangeness detector will be STAR, although PHENIX has an advantage in the basic meson spectra due to very good particle identification extending to rather large momenta. STAR has a focus on good rapidity coverage and presently relies, for the particle identification, on de/dx measurements in the tracking detectors. For the future, STAR is considering a particle identification upgrade either via a RICH detector or a Time of Flight wall, both of which might be available at RHIC start-up time.

In the following section I will focus on simulations by my own collaboration, STAR, and a few simulations graciously provided by PHENIX.

3 RHIC strangeness simulations

3.1 Coverage, Acceptances, and Efficiencies

Each RHIC detector has different phase-space coverage. Most of the strangeness measurements will be performed at mid-rapidity in a pseudo-rapidity window of $\eta = \pm 1.5$. As a typical example, Fig.1a shows the geometrical acceptance for K^0_s and Λ particles in the central STAR tracking system. Certain measurements with the BRAHMS detector and the FTPC in STAR will extend this coverage to forward rapidities.

The transverse momentum coverage is determined by the method applied to particle identification. In the baseline STAR detector (SVT+TPC) the particles are identified via energy loss in the various layers of the tracking detectors. This method allows kaon over pion separation from the lowest momenta (around 70 MeV/c) to around 700 MeV/c. With the peak of the kaon spectrum close to 500 MeV/c, particle identification via de/dx is limited. Higher momentum separation requires more sophisticated detectors, like a time of flight system (TOF), a ring imaging Cherenkov counter (RICH) or a transition radiation detector (TRD). PHENIX, BRAHMS, and PHOBOS employ several of those techniques, thus extending the kaon over pion separation limit to around 1.5 GeV/c.

Reconstruction efficiencies are crucial for the detection of decaying strange mesons and baryons. The efficiency might depend on the number of initial hadrons. Parton Cascades with realistic hadronization scenarios (e.g. VNI, HIJING-B) presently yield a significantly higher particle multiplicity than standard string fragmentation models (e.g. FRITIOF, VENUS 4.12). Performance simulations of the STAR tracking system, though, show no degradation in reconstruction efficiencies up to initial particle multiplicities of four times the yield of a string fragmentation model. The standard numbers for particle occupancies presently being used are 1000 charged pions, 150 charged kaons, and around 150 baryons per unit rapidity. Within the coverage of the central detector of STAR we thus expect a total of about 2000 charged particles per event.

Fig.1b shows tracking efficiencies for secondary particles (decay products) in STAR as a function of the transverse momentum of the particle.

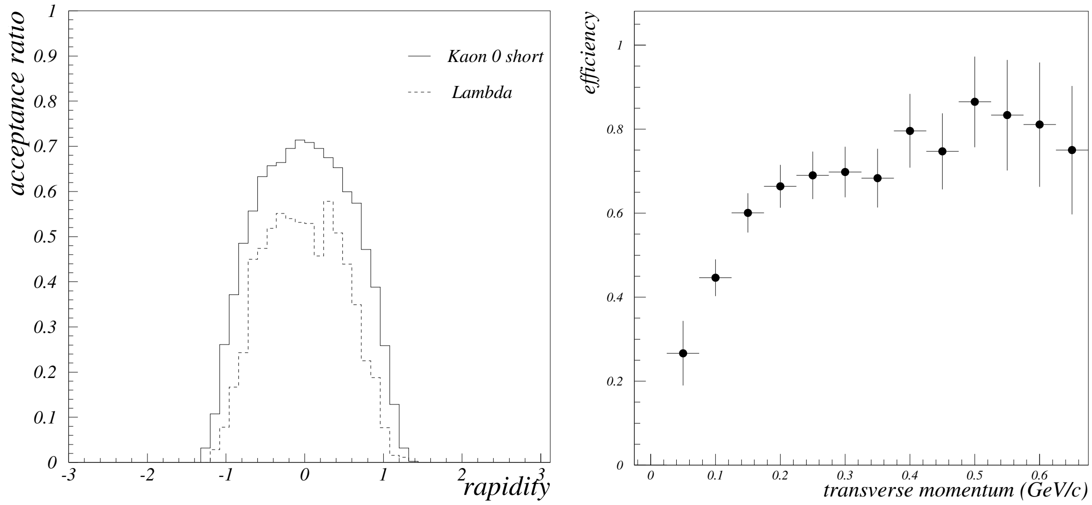

Figure 1: a.) Geometrical acceptance of K_s^0 and Λ in the integrated STAR tracking system b.) Secondary track reconstruction efficiency for SVT alone as a function of momentum.

3.2 Kaon capabilities

At RHIC, kaons will still account for close to 90% of the strangeness yield, based on standard string fragmentation models. Strange baryons, though very interesting as rare probes of strangeness equilibration and in-medium behavior, will contribute only moderately to the strangeness yield.

The most basic strangeness quantity, the charged kaon spectrum, will be measured by all four detectors. PHENIX has very precise particle identification over a large momentum range and will therefore yield a reliable inclusive measurement of the transverse momentum spectrum. The other three experiments will be able to contribute to the charged kaon spectrum at different levels. PHOBOS will reduce the transverse momentum lower limit from the PHENIX cut-off at 400 MeV/c down to below 100 MeV/c. BRAHMS will measure the kaon spectrum at various rapidity settings away from the central coverage of PHENIX and PHOBOS. And STAR will measure the kaon spectrum in a limited momentum range, but its 2π coverage allows it to measure the kaon yield in this momentum range on an event-by-event basis. Fig.2 compares different detection methods and their respective momentum range for protons, pions, and kaons in STAR. The STAR-SVT/TPC de/dx measurement covers the kaon spectrum from around 70 MeV/c to around 600 MeV/c. The proposed RICH upgrade will identify kaons for around 1.2 GeV/c to 3 GeV/c. The PHENIX TOF wall will cover the kaon spectrum from 400 MeV/c to about 1.5 GeV/c.

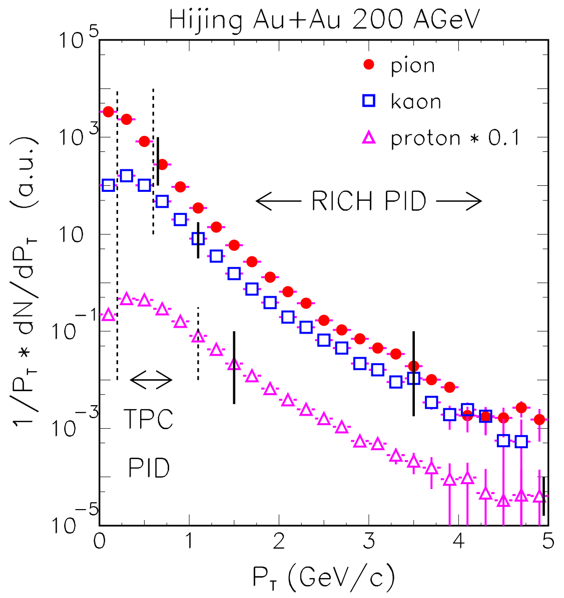

Figure 2: Transverse momentum spectrum of charged protons, pions, and kaons, and the ranges of several particle identification devices

Based on the kaon yield per event, recent STAR simulations showed that the K/π ratio can be determined event by event for a certain momentum range (p_T= 200 - 600 MeV/c), in which the particle identification via de/dx yields reliable results. The error on those measurements is on the order of 10%. Fluctuations in the event-by-event K/π ratio might help in selecting a set of events that show an unusually high level of strangeness enhancement.

The large number of kaons also allows very precise charged kaon-interferometry measurements in all four experiments. As in previous fixed target experiments at the AGS and SPS, two particle interferometry will be used to extract the source size of the system at freeze-out. In addition, PHOBOS and STAR have good coverage for measuring the K_s^0 yield and spectrum, and STAR is unique in measuring K_s^0-K_s^0 correlations . Neutral particle interferometry measurements add several advantages to the HBT analysis [11]. Furthermore, it was suggested by Greiner and Mueller , that both K_s^0 and Λ interferometry could provide potential QGP formation signatures [12].

3.3 Strange and Multi-Strange Baryons

The detection of Λ, Ξ, and Ω particles is a unique feature of STAR. Fig.3a shows an Armenteros plot demonstrating K_s^0 and Λ separation based on the combined tracking system information. Figs.3b show the present status of invariant mass reconstruction efforts for K_s^0, Λ and Ξ^-. A good mass resolution and a good signal to noise ratio for all strange particles is obtained. The efficiency for the Ω^- reconstruction, which is not shown here, is expected to be comparable to that of the Ξ^- reconstruction, see Table 2.

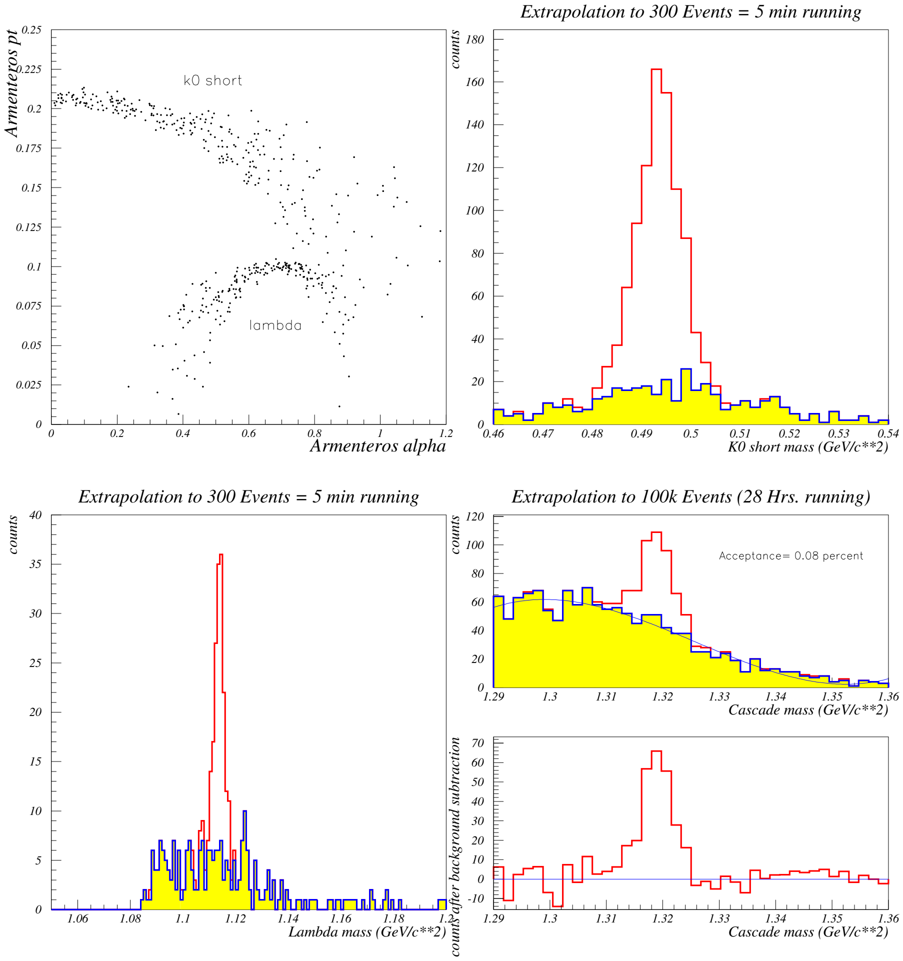

Figure 3: a.) Armenteros plot showing K_s^0 and Λ separation based on SVT information b.) Invariant mass spectra of reconstructed K_s^0,Λ, and Ξ^- particles based on SVT and TPC tracking information.

Particle	Efficiency incl. acceptance and reconstruction efficiency	particles/event	run time to obtain 1000 particles
K^o	3.7%	2.5	7 min.
Λ	8%	0.5	35 min.
Ξ^-	0.08%	0.003	4.1 days
Ω^-	0.07%	0.00005	several months

Table 2 shows the yield per event and the estimated run time to obtain a significant sample of strange particles in STAR.

From this table we conclude that a.) no strangeness signal besides the charged kaon spectrum can be measured event-by-event, and b.) it will take around six months to collect the required statistics for a good multistrange baryon measurement. It is interesting to point out that ALICE at the LHC will be able to measure at least the K^0_s event by event [13]. Based on current event generator predictions one expects that, even at LHC energies, all the higher strangeness particles will be out of reach for an event-by-event study.

The inclusion of a fourth SVT layer based on Silicon Strip Detectors, as was suggested by the French STAR collaborators, has been accepted by the collaboration as an official detector upgrade. It is estimated to improve the Λ reconstruction efficiency by a factor three, and to raise the Ξ and Ω efficiencies by about an order of magnitude. Although this will not lead to further event-by-event capabilities for strange baryons, it might be the necessary requirement towards successful $\Lambda\Lambda$ interferometry measurements due to the large increase of events in which at least a pair of Λ's is reconstructed.

Because of the construction schedule of the SVT, the TPC will run without the SVT in RHIC year-1. In rapidity, the TPC extends slightly beyond the SVT whereas the inclusion of the SVT will improve the coverage at low transverse momenta. Preliminary simulations show that with the TPC alone a neutral kaon measurement and a limited Λ study are within reach in the first year of RHIC. The multi-strange baryon spectra and ratios will be measured in the second year of RHIC, starting in the Fall of 2000. At this time, the complete STAR strangeness program will be comparable to the SPS measurements of WA97 and NA49 combined.

3.4 ϕ-Meson reconstruction

It was suggested by several authors [14],[15] that the decay of the ϕ-meson in a baryon dense medium, could lead to a signal for medium modifications in hadronic matter. Because of its short life-time the ϕ might decay when off mass shell, and therefore the ϕ mass peak as reconstructed from the decay products would be shifted. The ϕ decays into two main charged channels, namely the K^+K^- channel and the e^+e^- channel. Although the branching ratios of the two channels are very different (49.1% for the kaon channel, 3×10^{-4} for the lepton channel) a high precision measurement of the ϕ mass peak, requiring a resolution better than the natural width of the ϕ (= 4.4 MeV), is possible in both channels. The kinematic limit in the K^+K^--channel is just 32.6 MeV below the ϕ-mass and based on the lifetime of the ϕ only a fraction of the produced ϕ's will decay in medium. Thus, in this decay branch, the effect will most likely only cause a widening of the mass peak. A more reliable measurement therefore is the determination of a relative change in the branching ratios by simultaneously measuring both charged decay channels. PHENIX and STAR have good capabilities for measuring the ϕ decay branching ratios. Fig.4 shows simulations of the PHENIX ϕ mass peak in both channels. These studies were done for early stages in the PHENIX data taking. The ϕ to K^+K^- studies were done for 3 million central events (the estimated data volume that will be collected during the first few weeks of data taking at reduced luminosity) assuming only 1/2 of one PHENIX detector arm is instrumented. The e^+e^- studies assume the first full year of running at reduced luminosity with both arms fully instrumented.

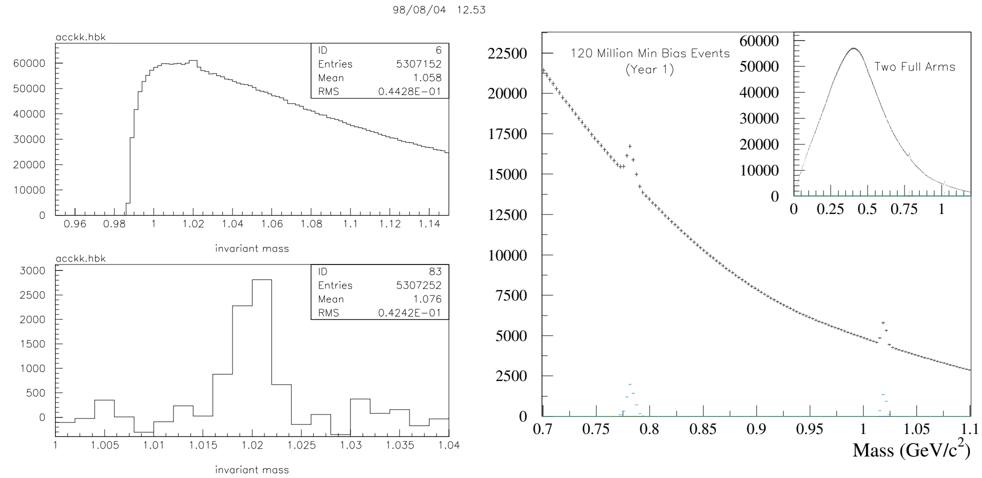

Figure 4: PHENIX reconstructed Invariant Mass spectrum a.) in the K^+K^--channel and b.) in the e^+e^--channel

3.5 Strange Quark Matter

In most of the theoretical predictions for strange quark matter formation in relativistic heavy ion collisions [16], the main requirements are large baryon densities and a relatively small bag pressure and energy density. Therefore most of the past experiments were performed at AGS energies. Jack Sandweiss gave a nice summary of the experimental status at this conference [17]. Based on these arguments, the probability of forming a strangelet in the central rapidity region at RHIC seems low, but the fact that the forward rapidity regions at RHIC are expected to have high net baryon densities, might lead to an interesting phenomenon, namely the possible formation of two separate phases of QGP in rapidity, distinguishable by their respective baryonic content. In this scenario the probability of forming strange quark matter is enhanced at forward rapidities. The suggested detection methods are similar to the ones presently employed by E864 (AGS) and NA52 (SPS) for long-lived strangelets and by E896 (AGS) for short-lived strangelets. The STAR Silicon Detector Prototypes were used in E896 to detect short lived H-Dibaryons via the Σ^-p-channel. The analysis of those measurements is still ongoing. The detection of the long-lived strangelets in the STAR tracking system would be based on the characteristic energy loss behavior of particles with an unusual Z/A-ratio. A detailed study of these effects can be found in [18].

4 Discussion and Conclusions

By studying the list of simulations shown in the previous section it becomes obvious that the Strangeness Physics program proposed at RHIC is very similar to the one at the AGS and SPS. Thus, the question remains, whether the measurement of strangeness observables at RHIC will lead to any new physics, or whether the conclusions deduced from strangeness measurements at AGS and SPS are still applicable at the higher energies. In other words, is strangeness still interesting at RHIC ? Based on my interpretation of the latest model calculations for the RHIC energy regime my answer would be an unequivocal 'Yes', but my arguments might be different than expected.

During this conference most AGS and SPS measurements were described with models assuming full thermal and chemical equilibration [19], [20]. Both theory talks from Heinz [21] and Becattini [22] documented evidence for thermal and chemical equilibration, and in particular Heinz pointed out the quantitative difference between chemical equilibration and freeze-out as measured by particle ratios, and thermal equilibration and freeze-out as measured by particle distributions. Also, the effect of collective expansion is by now well parameterized and understood. Rafelski [23] showed again that certain particle ratios, in particular those including strange anti-baryons [24] and multi strange baryons [25] can not be easily explained with hadronic thermalization or even with string fragmentation, leading to the conclusion that we are observing an onset of a new phenomenon at AGS and SPS energies [26], [27]. This point is obviously much debated and some thermal models [28] as well as interacting string fragmentation models [29],[30] have claimed that many of the higher particle ratios and distributions can be described with the simple assumption of an interacting dense hadron gas.

For RHIC energies the situation is less uncertain because the expected energy density simply requires a description based on perturbative QCD, at least for the very early part of the interaction. Even more, most high energy models agree that the heavy ion collision at RHIC will undergo three distinct phases, namely the initial hard parton-parton scattering, then a pre-equilibrium phase, and finally the hadronic equilibration that seems to be well understood at lower energies. The first stage is well described by perturbative QCD, the second stage is addressed by parton cascade models [31],[32], and the third stage which includes the hadronization and subsequent final state interactions has recently been modeled by combining an initial parton cascade with either hydrodynamical or string fragmentation-like transport codes. This merging of the three phases of the interaction into one continuous code seems the most complete way of describing the RHIC interaction, and in the following I would like to focus on two recent publications, namely the parton cascade-hydro model by Dumitru and Rischke [1], and the combined VNI-parton cascade/HIJET-hadron code by Geiger and Longacre [33]. Although neither model should be taken too literally at this point, the interpretation of some of the results allows us to shed some light on what to expect at RHIC, especially for the production of strange baryons and mesons.

Fig.5 shows the relative contributions of each of the three stages to the final hadron distribution in a particular model [33].

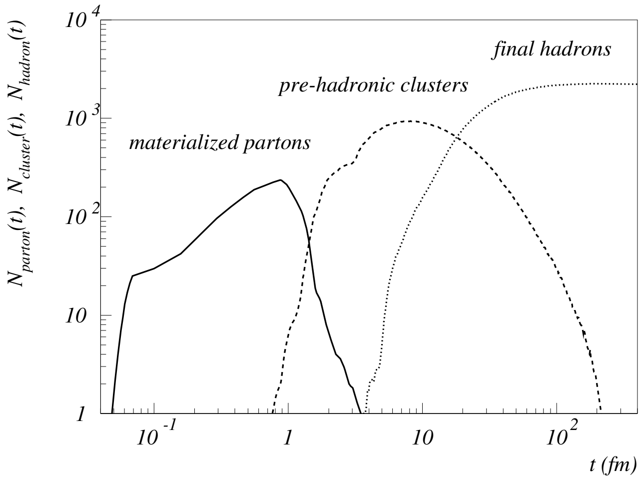

Figure 5: Relative contributions from the various reaction stages to the final hadron distribution (from [33]).

We assume, based on our present knowledge of the anticipated RHIC energy density and the shape of the quark and gluon structure functions, that the initial hard scattering phase is gluon dominated. Therefore the main contribution to strangeness formation in the early part of the collision is due to gluon fusion, gluon decay and gluon scattering. Early work by Geiger [34] predicted a very large strangeness enhancement based on a phase transition. Generally, models that include a parton cascade greatly enhance the multiplicity of produced particles, in particular by increasing the number of produced pions.

The strange quarks will most likely not chemically equilibrate [35] but the parton cascade might lead to fast local thermal equilibration. The significant strangeness formation in the parton cascade, mostly due to re-interaction of soft gluons has to be taken into account when defining the initial condition for a subsequent hadronic transport code. Fig.6 shows a simulation by Dumitru and Rischke [1] which documents the transverse momentum spectra for direct thermal hadrons at RHIC assuming a parton cascade followed by a hydrodynamical transport. Obviously the shape of the spectra can be analyzed to determine collective dynamics at RHIC. m_T-scaling is only valid in a small transverse momentum range from 1.5-2.5 GeV/c, whereas the low p_T and the high p_T part of the spectrum show significant deviation from the scaling, and thus provide important collective information.

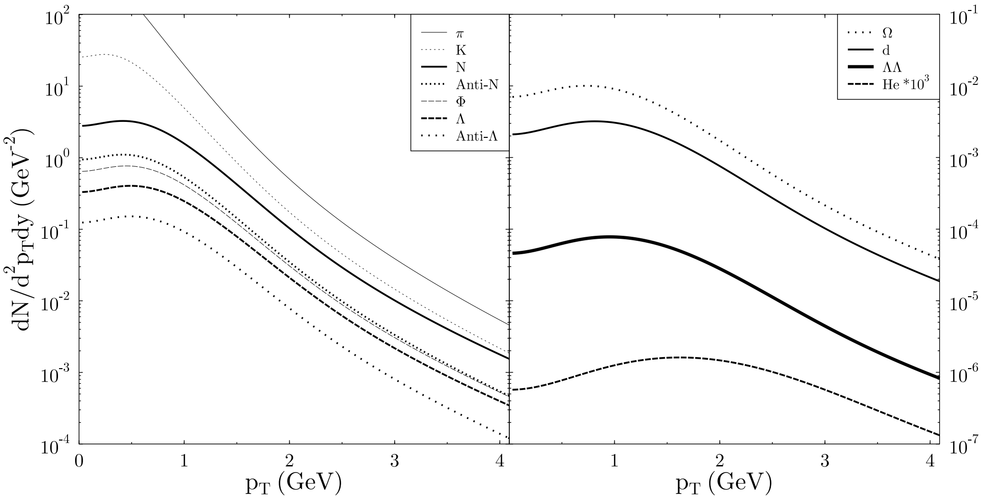

Figure 6: Transverse momentum spectra for direct thermal hadrons at RHIC energies from a hydrodynamical simulation assuming freeze-out at T = 130 MeV (from [1]).

Another interesting feature of the hadronic transport after a parton cascade is shown in Fig.7. Here we compare the rapidity distributions for non-strange baryons and anti-baryons with and without a hadronic 'afterburner' following particle generation via parton cascade [33]. The net baryon density close to mid-rapidity is not zero, but it is small. However, there is significant baryon density in forward direction. The hadron cascade requires non-strange quarks for its Λ formation, whereas the $\overline{\Lambda}$ formation requires non-strange anti-quarks. Thus, the strange baryon and anti-baryon distributions follow the distributions of the protons and anti-protons. This leads to distinctly different rapidity distributions for the Λ and the $\overline{\Lambda}$. The Λ, in this model, is peaked at more forward rapidities and shows a distinct 'dip' at mid-rapidity, whereas the $\overline{\Lambda}$ is peaked at mid-rapidity as expected.

These simulations are very model-dependent and should be taken with a grain of salt, but they might point us at the measurements we have to analyze to shed some light on the strangeness production mechanisms in RHIC collisions.

In summary, I would reiterate on my conclusion that strangeness is still interesting at RHIC. Because of the nature of the interactions at RHIC, the emphasis of strangeness measurements might shift away from the question of phase transition detection through chemically enhanced and equilibrated signals to the question of whether the different interaction phases in a collision at RHIC energies leave remnants in the final measurement. As an example, we know that any parton cascade model requires a transition, the question is whether this transition can be measured in quantities like the strangeness yield which seems to combine several production mechanisms in a single observable. As I tried to show in the few theoretical predictions, basic strangeness measurements, like yield, ratios, rapidity and transverse momentum distribution are an important piece in the big puzzle of plasma formation. They will be

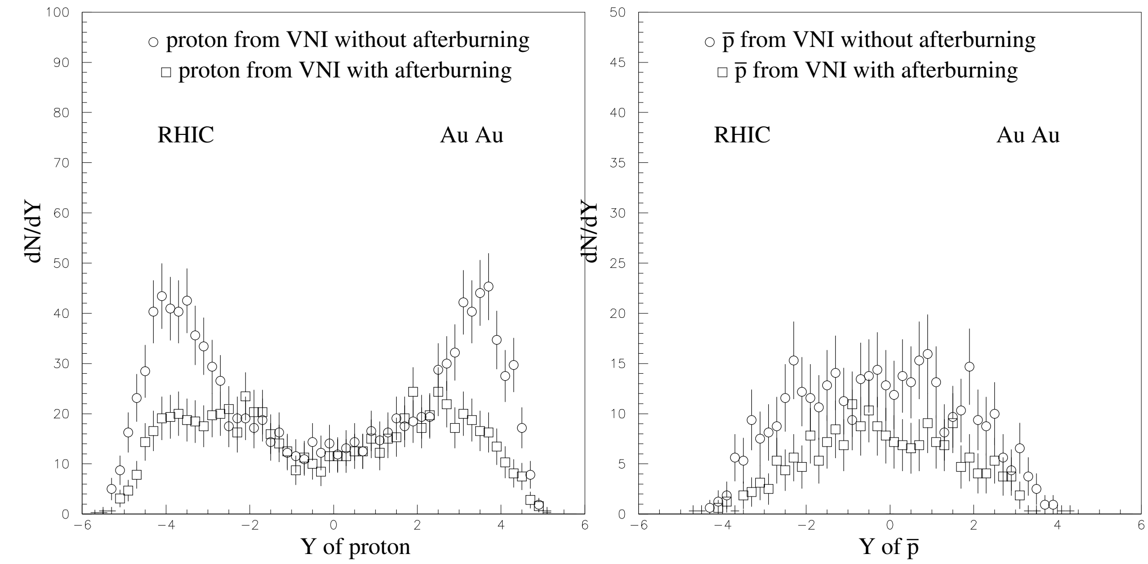

Figure 7: Rapidity distributions of p, $\overline{p}$ based on the VNI parton cascade with and without hadronic 'afterburner' in Au+Au collisions at RHIC energies (from [33]).

most useful in correlation with many other hadronic and leptonic measurements at RHIC. Most likely, no single measurement will be sufficient to define the phase transition. In this sense one should view strange baryons as a.) rare signals, b.) heavy baryons, and c.) produced particles. In these categories, strangeness will make its contribution, together with many other observables, towards detecting the QGP.

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