phase transition in local equilibrium, proceeding through the formation of a mixed phase. Smaller radii and emission times may result for a crossover or for a rapid out-of-equilibrium phase transition similar to spinodal decomposition. Cylindrically symmetric transverse expansion and longitudinally boost-invariant scaling flow are assumed. This approximation should be reasonable for central collisions at high energy, and around midrapidity. The model reproduces the measured $p_T$-spectra and rapidity densities of a variety of hadrons at $\sqrt{s} = 17.4$ GeV (CERN-SPS energy), when assuming the standard thermalization (proper) time $\tau_t = 1$ fm/$c$, and an entropy per net baryon ratio of $s/\rho_B = 45$. Due to the higher density at midrapidity, thermalization may be faster at BNL-RHIC energies - here we assume $\tau_t = 0.6$ fm/$c$ and $s/\rho_B = 200$. With these initial conditions preliminary results on the multiplicity, the transverse energy, the $p_T$-distribution of charged hadrons, and the $T_B$ ratio at $\sqrt{s} = 130$ GeV are described quite well. HBT correlations of pions at small relative momenta do not depend sensitively on these initial conditions. The later hadronic phase is modeled via a microscopic transport model that allows us to calculate the so-called freeze-out, i.e., the time and coordinate space points of the last strong interactions of an individual particle species, rather than applying a freeze-out prescription as necessary in the pure hydrodynamic approach. Here, we employ a semi-classical transport model that treats each particular hadronic reaction channel (formation and decay of hadronic resonance states and $2 \to n$ scattering) explicitly. The transition at hadronization is performed by matching the energy-momentum tensors and conserved currents of the hydrodynamic solution and of the microscopic transport model, respectively (for details, see [17]). The microscopic model propagates each individual hadron along a classical trajectory, and performs $2 \to n$ and $1 \to m$ processes stochastically. Meson-meson and meson-baryon cross sections are modeled via resonance excitation and also contain an elastic contribution. All resonance properties are taken from [14]. The $\pi K$ cross section for example is either elastic or is dominated by the $K^*(892)$, with additional contributions from higher energy states. In this way, a good description of elastic and total kaon cross sections in vacuum is obtained [18]. Medium effects on the hadron properties, as for example recently studied by hydrodynamical calculations employing a chiral equation of state [14], are presently neglected. For further details of this dynamical two-phase transport model, we refer to refs. [13,14,17].

For the following correlation analysis, a coordinate system is used in which the long axis ($z$) is chosen parallel to the beam axis, where the out direction is defined to be parallel to the transverse momentum vector $K_T = (p_T + p_T^2)/2$ of the pair, and the side direction is perpendicular to both. Due to the definition of the out and side direction, $R_{out}$ probes the spatial and temporal extension of the source while $R_{side}$ only probes the spatial extension. Thus the ratio $R_{out}/R_{side}$ gives a measure of the emission duration (see also eqs.(1)-(3) and discussion below). It has been suggested that the ratio $R_{out}/R_{side}$ should increase strongly once the initial entropy density $s_i$ becomes substantially larger than that of the hadronic gas at $T_c$ [8]. The Gaussian HBT radius parameters are obtained from a saddle-point integration over the classical phase space distribution of the hadrons at freeze-out (points of their last (strong) interaction) that is identified with the Wigner density of the source, $S(x, K)$ [8].

$$R_{out}^2(K_T) = \langle \vec{y}^2 \rangle(K_T) ,$$
$$R_{out}^2(K_T) = \langle (\vec{x} - \vec{y})^2 \rangle(K_T) = \langle \vec{x}^2 + \vec{y}^2 - 2\vec{x} \cdot \vec{y} \rangle ,$$
$$R_{long}^2(K_T) = \langle (\vec{z} - \vec{y})^2 \rangle(K_T) ,$$

with $\vec{x}$ the $K_T$ being the space-time coordinates relative to the momentum dependent effective source centers. The average in (1)-(3) is taken over the emission function, i.e., $\langle f(K) \rangle = \int f(x)S(x, K)dx$. In the obs system $\beta = (\beta_\perp, 0, \beta_\parallel)$, where $\beta = K/E_K$ and $E_K = \sqrt{m^2 + K^2}$. Below, we cut on midrapidity kaons ($|\beta_\parallel| < 0.1$), thus the radii are obtained in the longitudinally comoving frame. In the absence of $\vec{x}$-$\vec{y}$ correlations, i.e. in particular at small $K_T$, a large duration of emission $\Delta \tau = \sqrt{\langle \vec{t}^2 \rangle}$ increases $R_{out}$ relative to $R_{side}$.

The absolute values of the kaon radii determined by the above expressions (1)-(3) are considerably smaller than the pion radii, especially at low $K_T$. The pion radii are larger than a factor of two at low $K_T$ ($< 400$ MeV) while at higher $K_T$ the values become similar. This is due to the resonance source character of mesons.

Microscopic transport calculations show that at SPS energies ($\sqrt{s} = 17.4$ GeV) about 80% of the pions are emitted from various resonances [21]. This leads to a strong substructure of the freeze-out distributions [21], e.g. strongly non-Gaussian tails. The ratio $R_{out}/R_{side}$ for kaons is shown in Fig. 1. The bag parameter $B$ is varied from 380 MeV/fm$^3$ to 720 MeV/fm$^3$, i.e., the latent heat changes by $\sim 4B$, corresponding to critical temperatures of $T_c \approx 160$ MeV and $T_c \approx 200$ MeV, respectively. A change of $T_c$ implies a variation of the longitudinal and transverse flow profiles on the hadronization hypersurface (which is the initial condition for the subsequent hadronic rescattering stage). We find $R_{out}/R_{side}$ to be smaller at the same (small) transverse momentum $K_T$ than the same ratio for pions because of the larger mass of the kaons. At the same low $K_T$, the velocities of kaons are considerably smaller than those of the pions. Accordingly, the temporal contribution to $R_{out}$ in equation (2) ($\langle \beta_\parallel^2 \vec{P}^2 \rangle$) is smaller which eventually leads to a smaller ratio $R_{out}/R_{side}$ for kaons at the same low $K_T$ [24]. Thus, for kaons, the ratio increases gradually compared to the rather rapid increase for the pions.
The correlation functions are calculated from the phase space distributions of kaons at freeze-out using the correlation after burner by Pratt [20]. It is assumed that the particles are emitted from the large system independently, which allows to factorize the $N$-boson production amplitude into $N$ one-boson amplitudes $A(x)$. Then, the emission function is computed as the Wigner transform $S(x, K) = \int d^4 y \ e^{i K \cdot (x + y)} A(x-y/2)$. The two-boson correlation function is given by

$$C_2(p, q) - 1 = \frac{\int d^4 x S(x, K) \int d^4 y S(y, K) \exp(2i K \cdot (x - y))}{\int d^4 x S(x, K)^2},$$

where $2K = p + q$, $2k = p - q$, and $2k^2 = E_p - E_q$. The second line in (5) holds in the limit where the width of the correlation function is small such that $p \sim q \sim K$.

Given a model for a chaotic source described by $S(x, K)$, such as the transport model described above, eq. (4) can be employed to compute the correlation function. While the expressions (4) based on a Gaussian ansatz yield larger values for the pion radii than performing a fit to the correlation functions, for the kaon transverse radii, similar results are obtained with both methods. Only $R_{\text{long}}$ is expected to be larger if determined by (4) similar as for the pions because here the non-Gaussian contribution is mainly driven by the longitudinal expansion.
sion dynamics that is similar for pions and kaons [23]. Kaons are better candidates for the Gaussian expressions because not only fewer resonance decays are expected to be important for the freeze-out but, moreover, because long-living resonance decays do not play a role as in the pion case. For $T_c \approx 200$ MeV, $R_{\text{out}}$ is only approximately 1 fm larger than in the $T_c \approx 160$ MeV case. This reflects a fact already known from the pions. Higher $T_c$ leads to an earlier hadronization, thus causing a prolonged hadronic phase. When taking finite momentum resolution ($f.m.r.$) into account, the true particle momentum $p$ obtains an additional random component. This random component is assumed to be Gaussian with a width $\delta p$. The relative momenta of pairs are then calculated from these modified momenta. However, the correlator is calculated with the true relative momentum. While $R_{\text{out}}$ remains constant or even slightly increases with $K_T$ when calculated without f.m.r., it drops if a f.m.r. of $\approx 2\%$ of the center of each $K_T$ bin is considered, a value assumed for the STAR detector [23]. Accordingly, the discrepancies w/o f.m.r. increase with $K_T$. The f.m.r. leads to smaller radii. $R_{\text{out}}$ is strongly reduced while $R_{\text{side}}$ shows a moderate reduction. Thus, the $R_{\text{out}}/R_{\text{side}}$ ratio is considerably reduced through the f.m.r. For example, in the $T_c \approx 200$ MeV case, it is reduced from 1.8 to 1.3. However, it is always larger than one. The $\lambda$ parameter is roughly constant as function of $K_T$ for $\delta p/p = 0$ but decreases rapidly with a f.m.r.. This decrease is also seen in recent experimental data at the SPS for Pb+Pb collisions at $\sqrt{s} = 17.4$ GeV [24]. The correlation strength is transported to larger $q$ values by the f.m.r. effects.

We have calculated kaon HBT parameters for Au+Au collisions at RHIC energies, assuming a first-order phase transition from a thermalized QGP to a gas of hadrons. No unusually large radii are seen ($R_i \leq 10$ fm). A strong direct emission component from the phase boundary is found at high transverse momenta ($K_T \sim 1$ GeV/c) where also the sensitivity to the critical temperature, the latent heat and specific entropy of the QGP is enlarged. Finite momentum resolution effects reduce the true HBT parameters and the ratio $R_{\text{out}}/R_{\text{side}}$ substantially. Kaon results from RHIC at high $K_T$ will provide an excellent probe of the space-time dynamics close to the phase-boundary and to the properties of this prehadronic state, possibly an equilibrated Quark-Gluon-Plasma.

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