Dilepton production in heavy-ion collisions within the parton hadron string dynamics (PHSD) transport approach.

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PHSD

To address the dilepton production in a hot and dense medium – as created in heavy-ion collisions – we employ an up-to-date relativistic transport model, the Parton Hadron String Dynamics (PHSD) [1], that incorporates the explicit partonic phase in the early reaction region. The approach consistently describes the full evolution of a relativistic heavy-ion collision from the initial hard scatterings and string formation through the dynamical deconfinement phase transition to the quark-gluon plasma (QGP) as well as hadronization and to the subsequent interactions in the hadronic phase.

Dileptons from sQGP

The partonic phase description is based on the dynamical quasiparticle model (DQPM) matched to reproduce lattice QCD results in thermodynamic equilibrium [2]. Dilepton radiation by the dynamical quasiparticles proceeds via the following elementary processes:

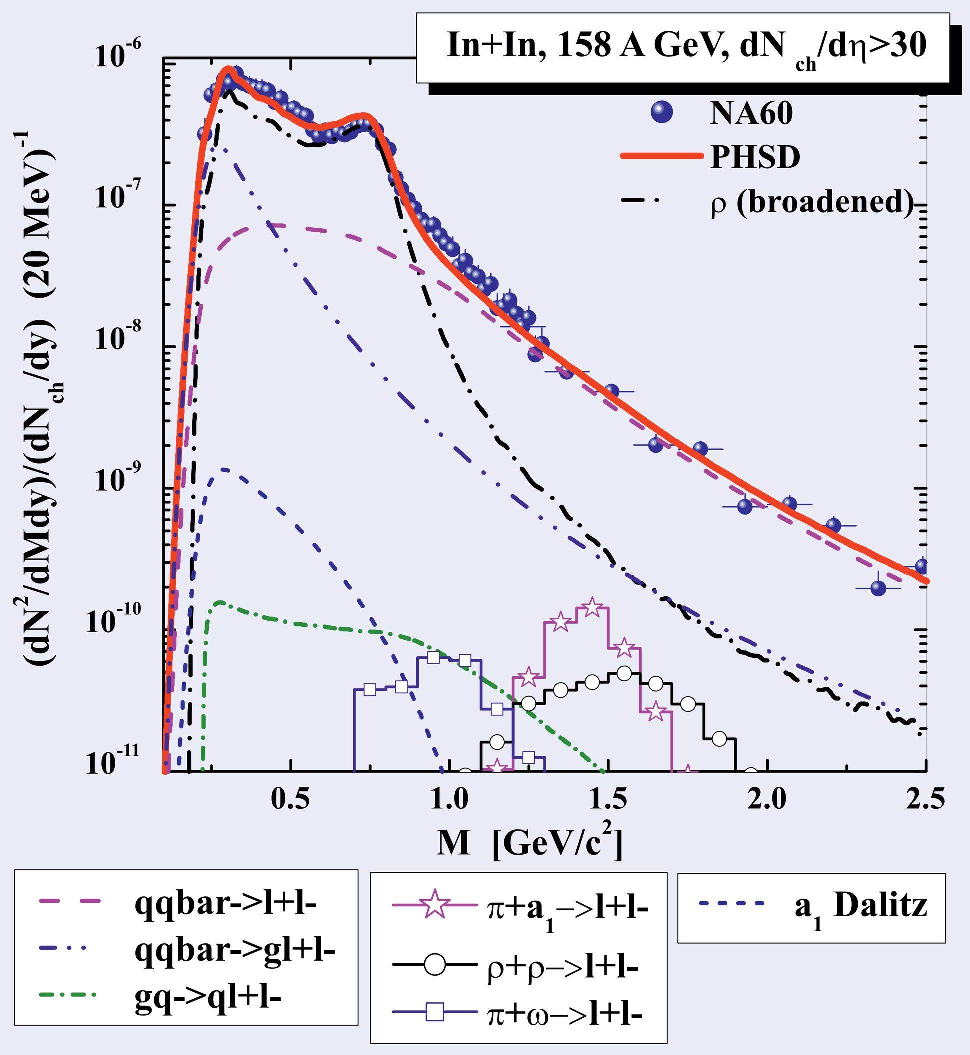
$q+\bar{q}\to\gamma^*$, $q(\bar{q})+g\to\gamma^*+q(\bar{q})$, and $q+\bar{q}\to g+\gamma^*$

Note that the running coupling α_S depends on the local energy density and reaches order 1. Thus the contribution of the higher order diagrams is considerable. Also, we take into account the non-perturbative spectral functions and self-energies of quarks and gluons thus going beyond the leading twist [3].

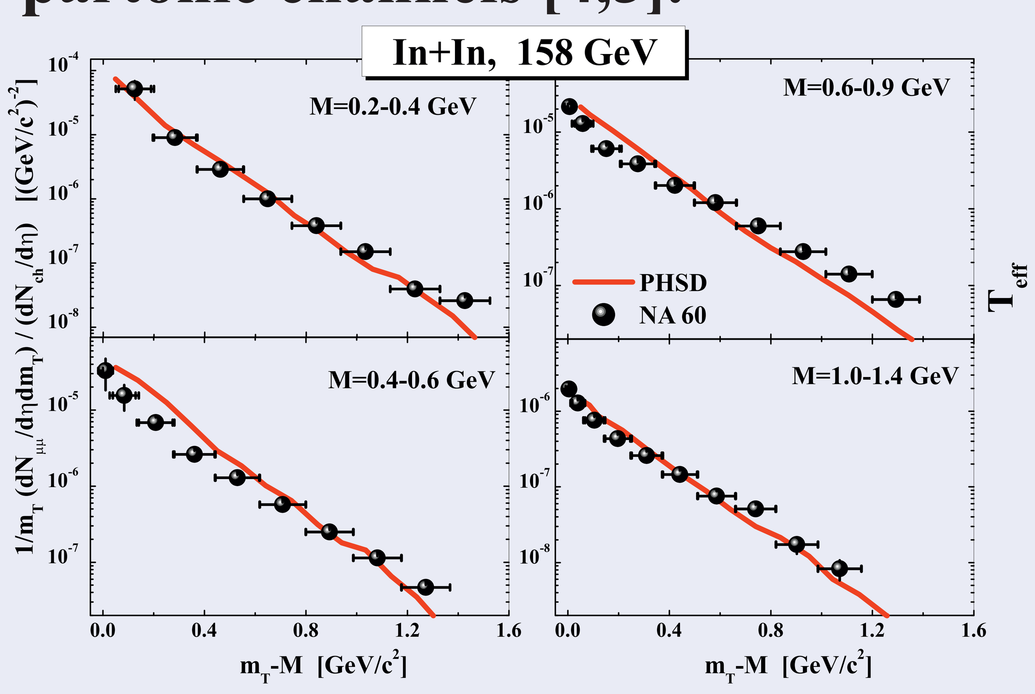
Results

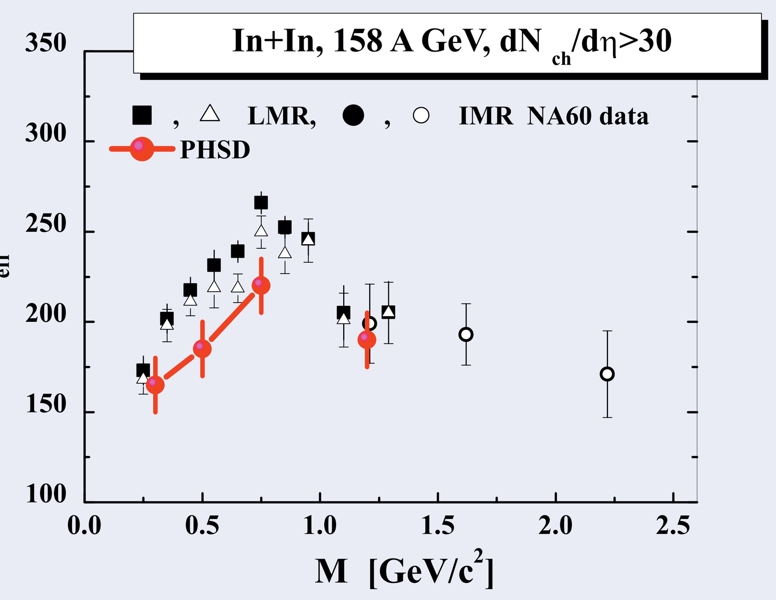
Within the PHSD transport approach, we calculate the dilepton spectra in In+In collisions at 158 AGeV and in Au+Au at $s^{1/2}$=200 GeV. A comparison to the data of the NA60 and PHENIX Collaborations shows that the spectra for masses above 1 GeV are dominated by the radiation from the QGP and the charm meson decays. There is a discrepancy between the PHSD calculations and the PHENIX data for masses from 0.2 to 0.6 GeV, which is not amended by accounting for the radiation from the QGP, since the latter is small relative to the radiation from hadrons in this mass range.

SPS energies



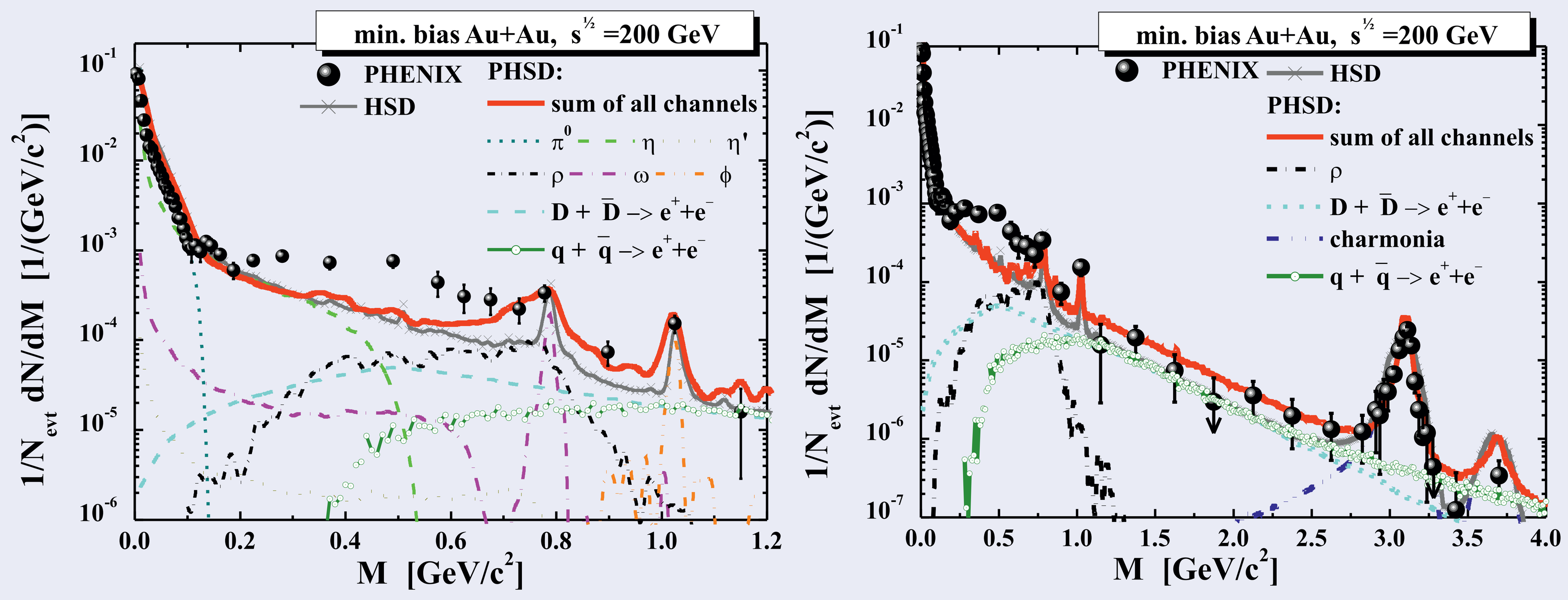
In Fig. 1 we present PHSD results for the dilepton spectrum excess over the known hadronic sources as produced in In+In reactions at 158 AGeV compared to the acceptance corrected data of the Na60 Collaboration. The calculation confirms the earlier finding in the HSD hadronic model that the NA60 data favor the scenario of a broadening of the ρ meson spectral function in the medium. On the other hand, the yield at masses above 1 GeV is dominated by the dilepton production from partonic channels [4,5].



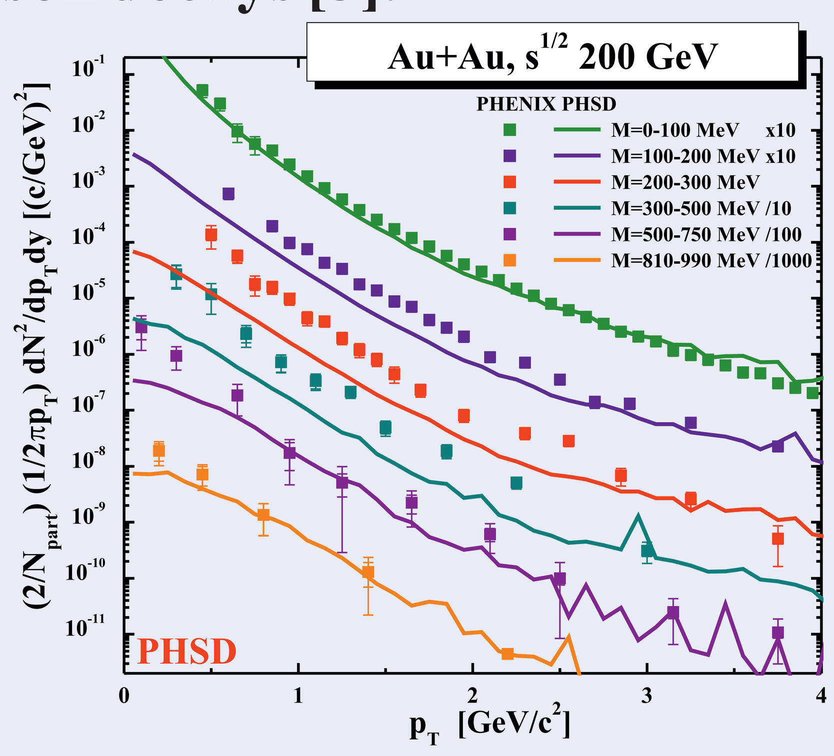


Accounting for partonic dilepton sources allows to reproduce in PHSD the transverse mass spectra and the effective temperature (slope parameters) of the dileptons in the intermediate mass range [4,5].

RHIC energies



We calculate the dilepton spectra in Au + Au at $s^{1/2}$=200 GeV and compare to the PHENIX data. Left, we present the results for low masses (M = 0 –1.2 GeV), where the yield in PHSD is dominated by hadronic sources. There is a discrepancy between the PHSD calculations and the data in the region of masses from 0.2 to 0.6 GeV, which is not amended by accounting for the radiation from the QGP, since the latter is small relative to the radiation from hadrons integrated over the evolution of the collision. On the other hand, the partonic radiation is visible in the mass region M=1–4 GeV (see r.h.s plot). The observed yield in the mass range between the ϕ and J/Ψ peaks is the sum of the contributions from the sQGP and the charmed meson decays [5].



Finally, the p_T spectrum of the dileptons produced in Au+Au collisions at $s^{1/2}$=200 GeV in PHSD is compared to the PHENIX data. The underestimation of the yield for M from 0.2 to 0.6 GeV is consistent with the analysis of the M-spectrum (above) and is concentrated at low p_T.

[1] W.Cassing, E.L.Bratkovskaya, NPA 831 (2009) 215; [2] E.L.Bratkovskaya, W.Cassing, V.P.Konchakovski, O.Linnyk, NPA 856 (2011) 162; [3] O.Linnyk, J.Phys.G 38 (2011) 025105; [4] O.Linnyk, E.L.Bratkovskaya, W.Cassing, NPA 830 (2009) 491C; [5] O.Linnyk, W.Cassing, E.L.Bratkovskaya, J.Manninen, NPA 855 (2011) 273, and references therein.