e^+e^- production in pp, pd and pA reactions at SIS energies

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The modification of hadron properties in the nuclear matter is of fundamental interest. The dilepton data from heavy-ion experiments at SPS energies have provided first experimental evidence for a change of the vector meson properties, however, the heavy-ion data can be interpreted within different scenarios of in-medium modifications, i.e. by the dropping mass scenario or the collisional broadening approach. Since in heavy-ion experiments the nuclear matter is probed at different densities and temperatures within the complex dynamical evolution, it will be very useful to have independent experimental information from photon-nucleus, pion-nucleus or proton-nucleus reactions, where the properties of vector mesons are probed at normal nuclear density or below. This question becomes very actual with respect to the HADES experiments coming up at GSI soon [1].

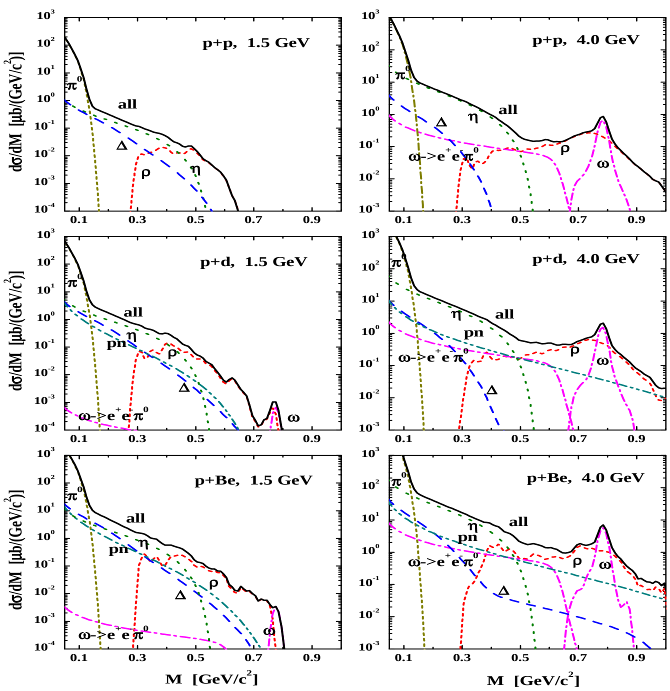

Figure 1: The dilepton invariant mass spectra $d\sigma/dM$ for pp (upper part), pd (middle part) and pBe collisions (lower part) at 1.5 GeV (left panel) and 4.0 GeV (right panel) including a 10 MeV mass resolution [2].

Dilepton production in from pp, pd and pBe collisions from 1 – 5 GeV has been studied in Ref. [2] within the framework of the combined resonance-string approach [3]. here, it has been found that the DLS data for pp and pd collisions can be reasonably well described whereas for pBe systems (especially at 4.9 GeV) our calculations give slightly higher dilepton yield. We have demonstrated, futhermore, the importance to measure dileptons from pp and pd (or even pBe) collisions simultaneously since such data provide constraints on the isospin dependence of pp and pn interactions, which is important for an understanding of heavy-ion data.

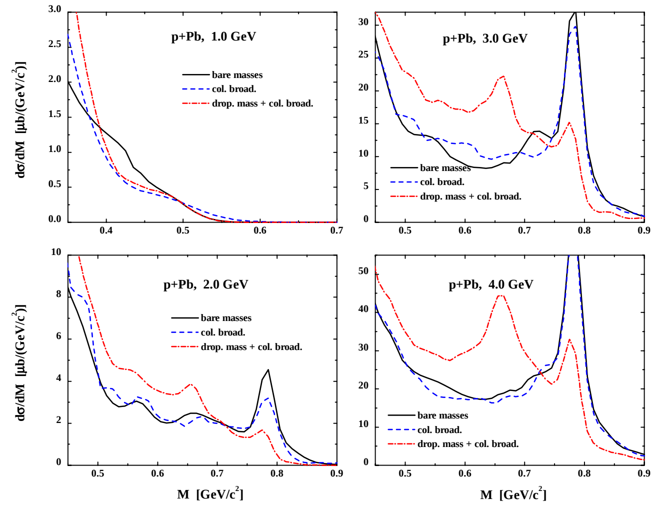

Figure 2: The comparison of different in-medium modification scenarios, i.e. collisional broadening (dashed lines) and collisional broadening + dropping vector meson masses (dash-dotted lines), with respect to the bare mass case (solid lines) for $p+Pb$ from 1–4 GeV [4].

In Fig. 1 we show our detailed predictions for the differential dilepton spectra from pp, pd and pBe collisions at 1.5 and 4.0 GeV energy with a 10 MeV mass resolution that can be controlled experimentally by the HADES Collaboration in near future.

A comparison of the different in-medium modification scenarios is shown in Fig. 2, i.e. collisional broadening (dashed lines) and collisional broadening + dropping vector meson masses (dash-dotted lines), with respect to the bare mass case (solid lines) on a linear scale for $p+Pb$ collisions from 1–4 GeV. The collisional broadening + 'dropping mass' scenario leads to an enhancement of the dilepton yield in the range $0.5 \leq M \leq 0.75$ GeV and to a reduction of the ω-peak, which is more pronounced for heavy systems (up to a factor 2 for $p+Pb$ at 3–4 GeV), since most of the ρ's and ω's now decay in the medium approximately at density ρ_0. This leads to a pronounced peak around $M \approx 0.65$ GeV, which can be attributed to the in-medium ω decay since the ρ spectral strength is distributed over a wide low mass regime. Especially when comparing dilepton spectra from C and Pb targets, it should be experimentally possible to distinguish an in-medium mass shift of the ω meson by taking the ratio of both spectra.

References

[1] The HADES Collaboration, Proposal, GSI 1994.

[2] E.L. Bratkovskaya et al., Nucl. Phys. A 686 (2001) 476.

[3] M. Effenberger et al., Phys. Rev. C 60 (1999) 044614.

[4] E.L. Bratkovskaya, nucl-th/0101067.