Dilepton production in nucleon-nucleon collisions around 1 GeV/nucleon: a theoretical prospective

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Dileptons observed in the nucleus-nucleus collisions travel unscathed from the production point to the detector. Therefore, they provide clear information about the early dense and hot stage of heavy ion collisions. This is in contrast to the hadronic probes which often suffer from strong final state interactions. The quantum chromodynamics (QCD) predicted restoration of chiral symmetry at higher nuclear densities is manifested in the modification of masses of the vector mesons as a function of the nuclear matter density. Enhancements observed in the measured dilepton production cross sections in heavy ion collisions at the SPS energies, have been attributed to in-medium modifications of the vector meson masses.

However, the large yields observed in the invariant mass distributions of dileptons measured at Berkeley (at 1-2 GeV/nucleon beam energies) by the DLS group [1], are yet to be explained satisfactorily. Independent transport model calculations have been unable to describe these data fully. In order to resolve the "DLS-puzzle" the high-acceptance dielectron spectrometer (HADES) has been built [2] at GSI, Darmstadt which allows to study the dilepton production in elementary as well as nucleus-nucleus collisions with much wider acceptance. The remarkable fact is that the HADES data agree well with those of the DLS collaboration. Therefore, there is no longer any question against the validity of the DLS data and the previous failures to explain them by various transport models have to do with problems in the theoretical calculations which persists even now.

In a recent HSD transport model calculation [3] it is shown that if one uses larger cross sections for elementary *pp* and *pn* bremsstrahlung processes, the enhancement seen in the dilepton yields of the DLS and HADES data on ^{12}C + ^{12}C collisions can be reproduced. Thus the resolution of the DLS puzzle has come down to proper understanding of the dilepton production in elementary nucleon-nucleon (NN) collisions.

In this talk, a fully relativistic and gauge invariant framework [4] for calculating the cross sections of dilepton production in NN collisions will be discussed. This is based on the meson-exchange approximation for the NN scattering amplitudes. Predictions of this model will be compared with those of the other covariant models that have been used earlier to describe this reaction. It will be argued that there is no compelling reason to believe that dilepton yields in the elementary NN collisions are as large as those used in the transport model calculations of Ref. [3].

References

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