Charmonium Dissociation Cross Sections and J/? Suppression

T. Barnes (ORNL & UT), Cheuk-Yin Wong (ORNL), E. S. Swanson (U. Pitt. & JLAB), S. Sorensen (UT), and B. H. Sa (CIAE)

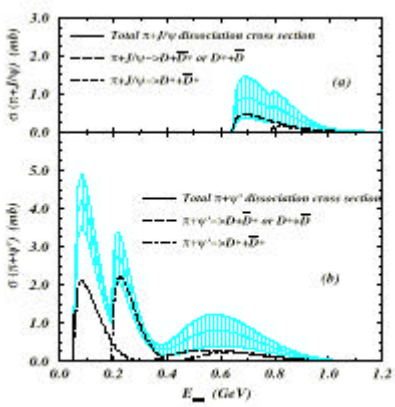
- J/? production is strongly suppressed in quark-gluon plasma and can be used as a signature for QGP.
- However, J/? (or its precursor) is absorbed by collision with nucleons, ????? , and other particles.
- It is important to know the J/? dissociation cross section in collisions with ?, ?, ? , N,... in order to find out the suppression of J/? by the QGP.

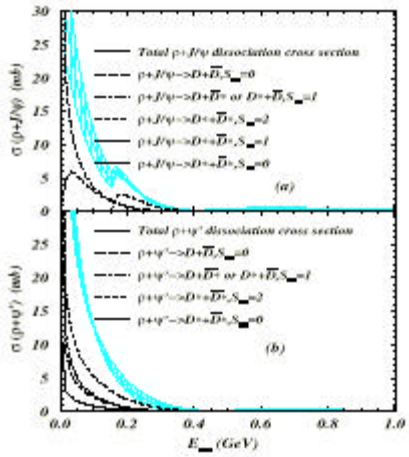
Our Phenomenological Approach

- Use the known hadron masses and phase shifts to determine quark-gluon forces and bound-state wave functions which are then used to calculate the dissociation cross section, using the Quark Interchange Model of Barnes and Swanson [Phys. Rev. D46, 131 (1992)].

Results in Progress and Future Directions

- ?-and ?-induced Dissociation Cross Sections





- Use the cross sections in Monte Carlo programs
- Calculate the dissociation cross section of ? J

T. Barnes, E. S. Swanson, and C. Y. Wong, Phys. Rev. C62, 045201 (2000).
T. Barnes, E. S. Swanson, and C. Y. Wong, Procs., Hirschegg mtg., nucl-th/0002034.
T. Barnes, E. S. Swanson, and C. Y. Wong, Procs. Dubna mtg., nucl-th/0006012.

Relativistic Generalization of the Barnes–Swanson Model

T. Barnes (ORNL & UT), Cheuk-Yin Wong (ORNL,
E. S. Swanson (U. Pitt. & Jlab), and H. Crater (UT)

•J/? dissociation cross sections in collisions with ?, ?, ?, N are needed to understand J/? suppression.

•It is important to generalize the Barnes–Swanson Model for relativistic reaction of hadrons with J/?.

Relativistic Bound States and Scattering

•We use Dirac's constraint dynamics to obtain a Hamiltonian formulation of the relativistic N-body problem in which the particles interact pair-wise through scalar and vector interactions.

•The resultant N-body Hamiltonian is relativistically covariant. It can be easily separated in terms of the center-of-mass and the relative motion of any two-body subsystem. It can also be separated into an unperturbed Hamiltonian with residual interactions.

•Solutions of the unperturbed Hamiltonian can be obtained by solving Schrödinger-like equations.

•The resultant two-body wave functions can be used as basis states to evaluate reaction matrix elements in the general N-body problem.

•We prove a relativistic version of the post-prior equivalence which guarantees a unique evaluation of the reaction matrix elements. We show explicitly how such matrix elements can be evaluated in terms of the wave functions of the composite particles and the relevant Lorentz transformations.

•We shall use this relativistic formulation to examine the ?-J/? and ?-? reactions.

C. Y. Wong and H. Crater, Phys. Rev. C (in press).

Direct Photon Production in High-Energy Heavy-Ion Collisions

Cheuk-Yin Wong (ORNL) and Hui Wang (ORNL & CIAE)

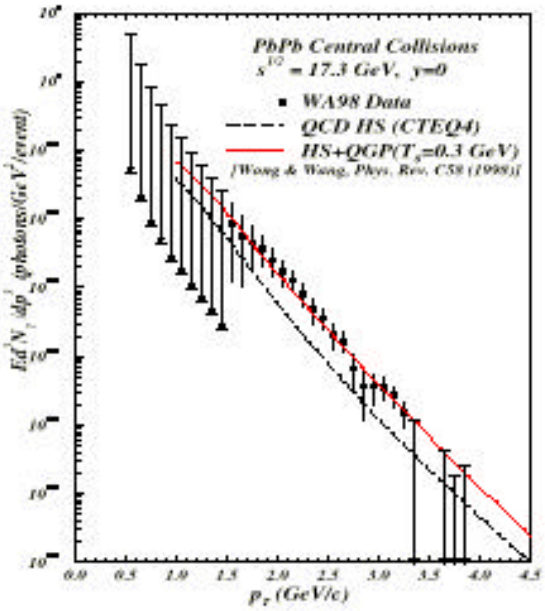
•ORNL experimentalists and their collaborators in the WA98 Collaboration reported recent new results on photon production in Pb-Pb collisions at 158 ? AGeV [1].
•Photon production in the quark-gluon plasma provides an indication for the formation of the QGP. But photons are also produced by parton hard scattering.
•We need to know the cross section of direct photon production from hard scatterings and the QGP in order to find out whether photons are emitted by the QGP.

Our Phenomenological Approach

•We study photon production from the hard scattering of partons by including intrinsic parton transverse momentum and next-to-leading-order contributions.
•The parton intrinsic transverse momentum leads to an enhancement of photon production cross section.
•The WA98 data can be explained as due to photon emission by a QGP with a temperature of 300 MeV cooling to 200 MeV. A quark-gluon plasma may have been produced in high-energy central Pb+Pb collisions.

Future Directions

•We shall study the energy loss and
•the multiple collision of partons to see what effect they have on the photon distribution.



[1] WA98 Collaboration, M. M. Aggarwal et al, Phys. Rev. Lett. **85**, 3595 (2000).
[2] C. Y. Wong and H. Wang, Phys. Rev. C **58**, 376 (1998).