Two-Photon Interactions from Heavy Ions Accompanied by Nuclear Breakup

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The high photon flux from relativistic heavy ions leads to high cross sections for two-photon interactions at heavy ion colliders. These interactions occur at impact parameters b where no hadronic interactions are possible[1].

The high photon flux leads to a significant probability for the two-photon interaction to be accompanied by additional electromagnetic interactions. Here, we consider two-photon reactions accompanied by mutual Coulomb excitation of the interacting nuclei[2]. The excitation is largely, but not completely to a Giant Dipole Resonance (GDR). These combined interactions are of interest for several reasons. The nuclear breakup produces neutrons which may be detected in zero degree calorimeters, providing an effective trigger [3].

The presence of the additional interactions preferentially selects two-photon interactions at smaller impact parameters; as b decreases, the maximum photon energy rises and the photon spectrum gets harder. This affects the rapidity distribution of the two-photon pairs. Figure 1 compares the rapidity distribution of exclusive $f_2(1270)$ production with the $f_2(1270)$ accompanied by mutual Coulomb excitation. With excitation, the $f_2(1270)$ are produced slightly more centrally.

The harder photon spectrum also affects the invariant mass distribution of lepton pairs. Figure 2 compares the mass spectrum of $\mu^+\mu^-$ with and without accompanying mutual Coulomb excitation. The spectrum with excitation is significantly harder than that without.

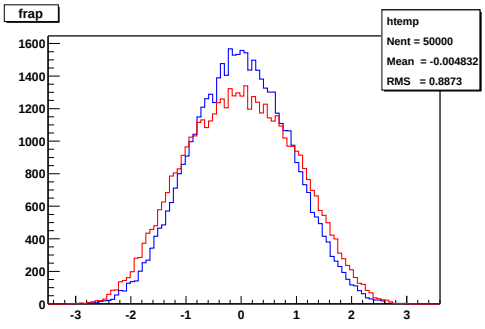

FIG. 1: $d\sigma/dy$ for exclusive $f_2(1270)$ production in 100 GeV per nucleon gold on gold collisions (red) and accompanied by mutual Coulomb excitation (blue). The curves are normalized to have an equal number of events.

Of course, the cross section for two-photon interactions with nuclear breakup is smaller than the exclusive cross section. For $f_2(1270)$ production wioth 100 GeV/nucleon gold beams at RHIC, the overall cross section is about 1.1 mb, compared to 59 μb for the $f_2(1270)$ with nuclear Coulomb breakup, and 11 μb for the $f_2(1270)$ with mutual GDR breakup (1 neutron in each direction).

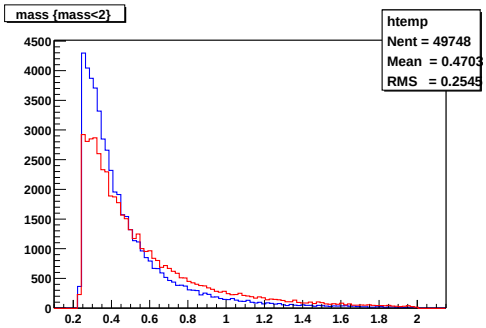

FIG. 2: The $\mu^+\mu^-$ mass spectrum for two-photon production in 100 GeV per nucleon gold on gold collisions (blue) and accompanied by mutual Coulomb excitation (red). The curves are normalized to the same number of events.

The spectral changes, though distinct, are smaller than are observed for photoproduction of ρ^0 mesons[4].

REFERENCES

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[1] G. Baur *et al.*, Phys. Rep. **364**, 359 (2002).
[2] Presented by S. Klein at the 2nd Workshop on Ultra-Peripheral Heavy Ion Collisions, CERN, Oct. 11-12, 2002.
[3] V. B. Morozov, PhD Dissertation, UC Berkeley, 2003.
[4] A. J. Baltz, S. R. Klein and J. Nystrand, Phys. Rev. Lett. **89**, 012301 (2002).