J/ψ AND ψ' SUPPRESSION IN NUCLEUS–NUCLEUS INTERACTIONS

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We report on the production of high mass muon pairs in p–A, S–U and Pb-Pb collisions, as measured by the NA38 and NA50 experiments at the CERN SPS. The ratio between ψ' and J/ψ cross-sections is found to be constant in p–A interactions but decreases from p–A to S–U and as the released transverse energy, E_T, increases. The first preliminary results on Pb-Pb collisions, obtained by the NA50 experiment (the successor of NA38), indicate that the J/ψ production is suppressed relative to the Drell–Yan continuum, from peripheral to central collisions, as previously observed in O-U and S-U interactions.

The dimuon mass distributions produced in p-A collisions at 200 and 450 GeV, in S-U collisions at 200 GeV and in Pb-Pb collisions at 158 GeV, have been measured by the NA38 and NA50 experiments, at CERN.

From the analysis of the p-A and S–U data, the NA38 experiment has been able to compare the production yields of the J/ψ and ψ' resonances, among each other and relative to the underlying Drell–Yan continuum [1]. As an example, the dimuon mass distribution measured in a sub-sample of the collected p-U data, is presented in Figure 1, where the superimposed lines correspond to the J/ψ and ψ' resonances, to the Drell–Yan

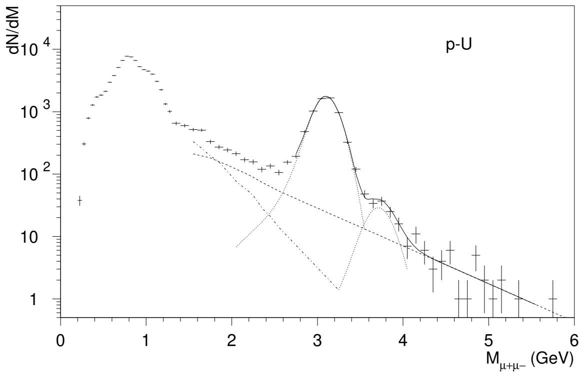

Figure 1: Dimuon mass distribution measured in p-U collisions.

mechanism and to the contribution from semi-leptonic decays of D$\bar{\text{D}}$ pairs. The combinatorial background contribution, due to uncorrelated pion and kaon decays, was estimated from the 'like-sign' events and subtracted away to get the 'signal' distribution shown here.

The ratio ψ'/ψ, ratio of production cross-sections times branching ratios into muon pairs, has been obtained by fitting the mass spectra available for each of the p-A data sets. The results, including the values obtained for the p–H_2 and p–D_2 data collected within the framework of the NA51 experiment, are shown in table 1. To get the ratio between *direct* production cross sections, we must correct these values for the branching ratios [2] and for the fraction of J/ψ mesons resulting from the decay of heavier resonances [3]. The resulting values are shown in figure 2, together with points from other experiments, either using protons [4] or other beam particles [5] (π^+, π^-, $\bar{p}$, γ). All values seem compatible with $\sigma(\psi')/\sigma_{dir}(J/\psi) = (\Gamma_{\psi'}/\Gamma_{J/\psi})(M_{J/\psi}/M_{\psi'})^3 \simeq 0.24$, as expected in the colour evaporation model [6]. The observation that the ψ' over J/ψ ratio, in hadro or photoproduc-

Table 1: Values of the ψ'/ψ ratio obtained in p-A collisions. Only statistical errors are quoted.

	p_{lab} (GeV)	$B\sigma^{\psi'}$ / $B\sigma^{\psi}$ (%)	Exp.t
p–W	200	1.80 ± 0.17	NA38
p–U	200	1.77 ± 0.22	NA38
p–C	450	1.90 ± 0.13	NA38
p–Al	450	1.36 ± 0.35	NA38
p–Cu	450	1.68 ± 0.11	NA38
p–W	450	1.59 ± 0.13	NA38
p–H_2	450	1.69 ± 0.03	NA51
p–D_2	450	1.80 ± 0.03	NA51

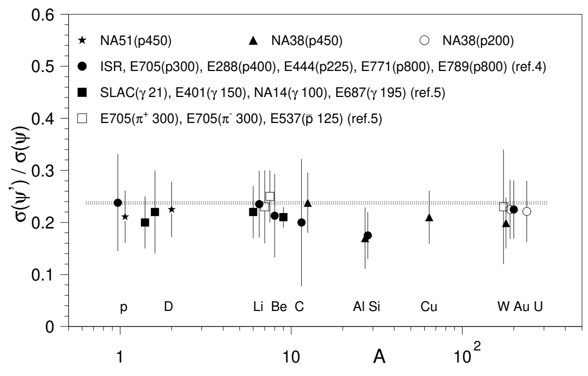

Figure 2: Ratio between ψ' and J/ψ production cross sections, as a function of A, for several energies and projectiles (p, $\bar{p}$, $\pi^{\pm}$, γ).

tion, does not depend on A or (at high energies) on $\sqrt{s}$, indicates that these charmonia bound states are formed outside the target nucleus, at least [7] when produced with positive x_F.

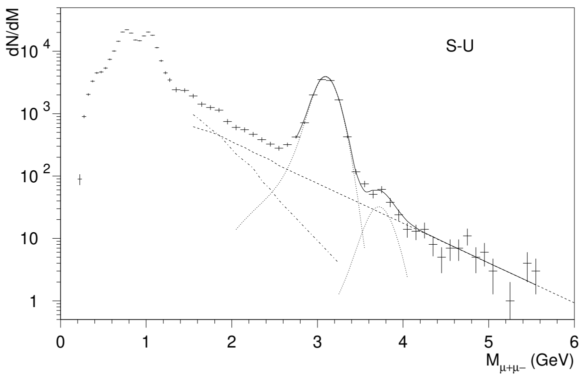

Figure 3: Dimuon mass distribution measured in S-U collisions.

In S–U collisions (see figure 3 for a sub-sample of the collected data), the ψ'/ψ and ψ/DY particle ratios were obtained in 4 ΔE_{T} bins. The 'charmonia suppression' can be appreciated in figure 4, where the dotted lines indicate the p–A values, corrected for isospin in the case of ψ/DY. DY means the Drell–Yan cross section for $1.5 < m_{\mu\mu} < 5.5$ GeV. In S-U interactions the ψ' yield is clearly seen to be suppressed relative to the J/ψ yield, the importance of this effect increasing as the collisions get more central. This provides a clear indication for the production of dense (hadronic or partonic) matter, which 'dissolves' the large ψ' but not the (direct) J/ψ.

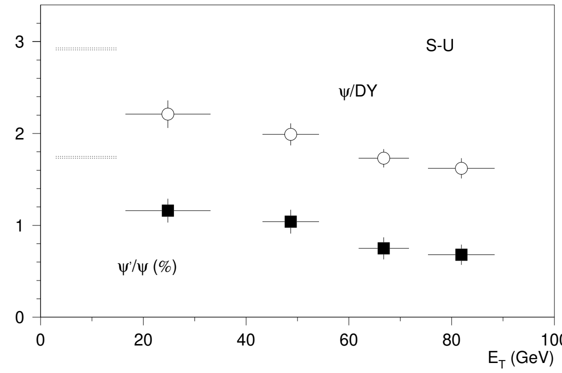

Figure 4: Ratios ψ'/ψ and ψ/DY in the 4 ΔE_{T} bins of S–U.

The first (preliminary) results on dimuon production in Pb-Pb collisions at 158 GeV per nucleon, obtained by the NA50 experiment, are now available (see figure 5). We should keep in mind that the number of J/ψ events in the final analysis Pb-Pb data sample, from the 1994 period, is about 200 times smaller than the S-U statistics. Nevertheless, figure 6 clearly shows that the production of J/ψ mesons is suppressed relative to the production of dimuons in the mass continuum between 2.2 and 2.8 GeV, from peripheral to central Pb-Pb collisions. A quantitative comparison between the J/ψ suppression observed

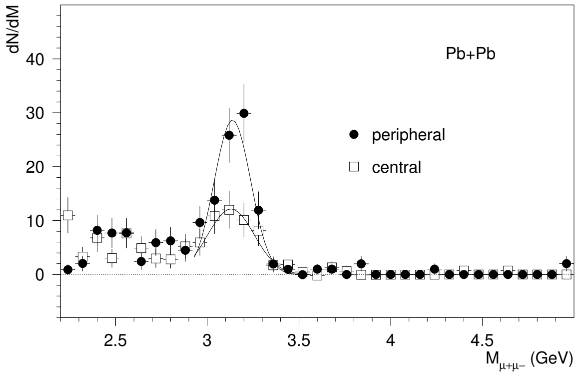

Figure 5: Dimuon mass distribution measured in Pb-Pb collisions.

in Pb-Pb and in S-U interactions requires a better understanding of systematics, the correction of acceptances and efficiencies, etc. While 1994 was, for NA50, essentially a technical run, the data taking period of November and December of 1995 will be entirely devoted to the collection of a high statistics event sample, that will surely allow a much more refined analysis.

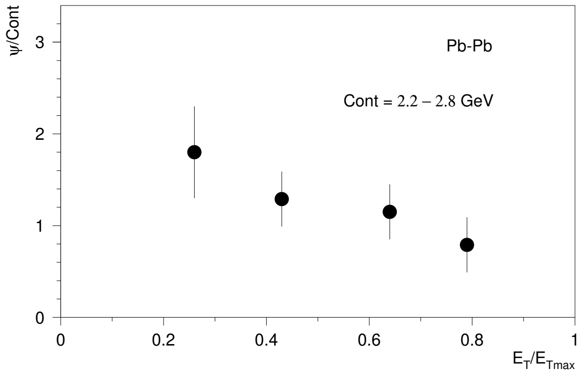

Figure 6: Ratio "J/ψ over Continuum" versus centrality.

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