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ETA PRODUCTION IN HEAVY-ION COLLISIONS AND THE DLS DI-ELECTRON ENHANCEMENT*

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The Dalitz-decay contribution of neutral mesons to the di-electron invariant-mass spectrum at 1 AGeV is deduced from a systematics of meson production cross sections measured with the photon spectrometer TAPS. A comparison with recently published di-electron mass spectra of the DLS collaboration shows that η Dalitz decay does not exhaust the e^+e^- yield in the mass range of 0.2–0.5 GeV/c^2.

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Dileptons are considered to be among the most direct probes of the hot and dense phase of heavy-ion reactions, as well as of the in-medium properties of hadrons produced in such collisions. In the few-GeV regime pioneering work has been done by the Dilepton Spectrometer (DLS) collaboration who has investigated di-electron emission in a series of experiments at the BEVALAC, both in p–p, p–d and heavy-ion collisions [1, 2]. At GSI this line of work will be taken up soon with a much superior device, namely the High-Acceptance Di-Electron Spectrometer HADES [3].

Here we report on a determination of the Dalitz-decay contribution of neutral meson (π^0 and η) to the di-electron invariant-mass spectrum. Calculated from the systematics of meson production cross sections measured with the photon spectrometer TAPS, these results are compared with recently published DLS data obtained at 1 AGeV [2].

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We have investigated π^0 and η production in various collision systems, in particular the C+C and Ar+Ca systems have been extensively studied [4,5]. Based on this, inclusive production cross sections can now be interpolated over 0.8–2.0 *A*GeV with errors $< 30\%$, including uncertainties due to imperfectly known angular distributions (see Ref. [6] for details). From these cross sections the π^0 and η Dalitz contributions have been obtained in a Monte Carlo calculation using:

(1) thermal meson sources at midrapidity with temperatures taken from fits to the measured transverse-mass distributions;

(2) Dalitz decay branching ratios of 1.198% for the π^0 and 0.49% for the η, respectively, and a phase-space population governed by VDM form factors; and finally

(3) a filter modeling the DLS detector acceptance.

Beyond the comparison with the Ca + Ca and C + C DLS data (upper part of Fig. 1) we have done the calculation also for light asymmetric

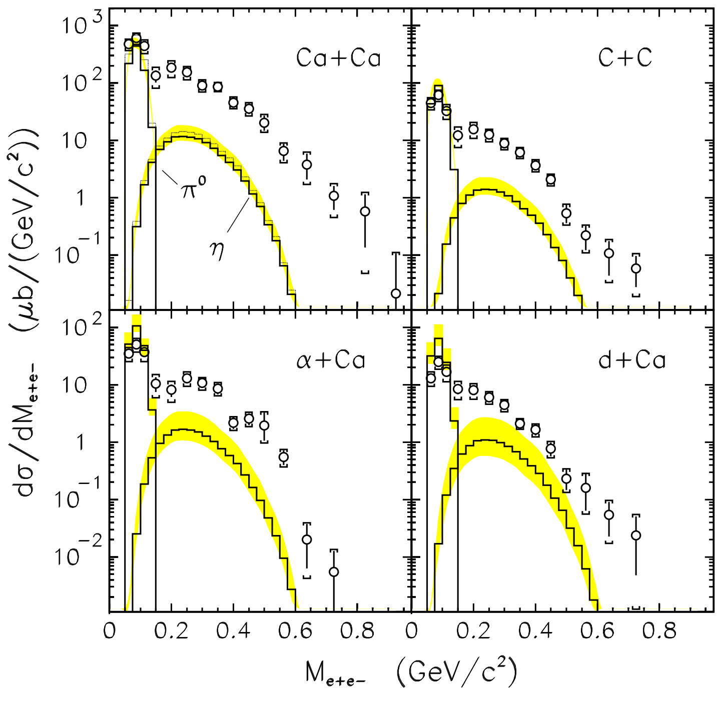

Fig. 1. Acceptance-filtered e^+e^- mass spectra at 1 *A*GeV. Data points are from DLS [2], histograms are our evaluated π^0 and η Dalitz contributions, with overall errors (statistical + systematic) shown as shaded bands.

systems, using scaled [6] meson production cross sections (lower part of Fig. 1). It is apparent that the experimental mass spectra are dominated for $M_{e^+e^-} \leq 0.15$ GeV$/c^2$ by the π^0 Dalitz decay. While we obtain good agreement with DLS in the Ca + Ca and C + C systems, our calculation overshoots somewhat in the two lighter systems, which could be impounded on the scaling procedure used. However, in the mass range spanned by the η Dalitz decay, *i.e.* $M_{e^+e^-} \simeq 0.15$–0.5 GeV$/c^2$, the DLS data exceed the deduced η component by large factors, ranging, *e.g.* at 0.25 GeV$/c^2$, from 10 in Ca + Ca and C + C, to 6 in α+Ca and still 4 in d+ Ca. Furthermore, a comparison of DLS e^+e^- data on $p + p$ reactions at 1–2 GeV [1] with the Dalitz contributions calculated in a similar manner from published $p + p$ π^0 [7] and η [8] production cross sections also reveals excess yield, albeit much less, as shown in Fig. 2 below.

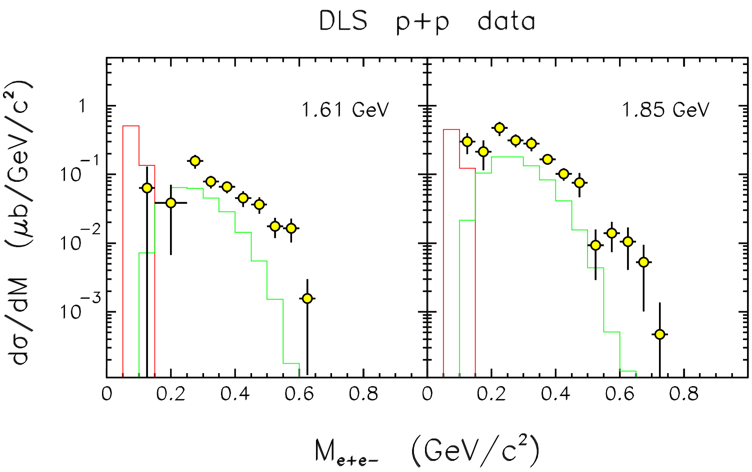

Fig. 2. Acceptance-filtered e^+e^- mass spectra for the p+p reaction. Data points are from DLS [1], histograms are the π^0 and η Dalitz contributions evaluated from published meson production cross sections [7, 8].

Consequently, in the mass range spanned by the η decay, additional physical processes, like pn bremsstrahlung, radiative Δ decays or yet other processes, are needed to account for the measured dilepton yields. This is also supported by transport models, *e.g.* HSM [9] and UrQMD [10] calculations. Finally, in the near future, data on ω production obtained by the TAPS collaboration [11] will put constraints too on the decay contributions of this heavy meson to the di-electron yields.

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