Observation of a Strong η-d Final State Interaction in the $pd \to pd\eta$ Reaction

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The PROMICE-WASA collaboration has measured differential cross sections for the $pd \to {}^3\mathrm{He}\,\eta$ reaction at four energies at the CELSIUS storage ring of The Svedberg Laboratory [1]. The average amplitude squared shows continuity with lower energy data and the angular distributions are all maximal for $\cos\theta_\eta \approx +0.5$. Preliminary data on the three-body final state in the $pd \to pd\,\eta$ reaction, obtained simultaneously in a kinematically complete experiment, show the η angular distributions to be much more isotropic. The pd invariant mass distribution is well described by phase space but the $\eta\,d$ invariant mass shows significant enhancement within the first few MeV above threshold. This behaviour is similar to that observed in the energy variation of the $pn \to d\,\eta$ total cross section [2] and is the signal of a strong η-deuteron final state interaction. As is seen in Fig. 1, the Q-dependence of the $\eta\,d$ excitation energy divided by phase space is consistent with that of $\sigma_T(pn \to d\,\eta)$ and can be described by a large η-d scattering length of $a = 1.64 + 2.99i$ [3].

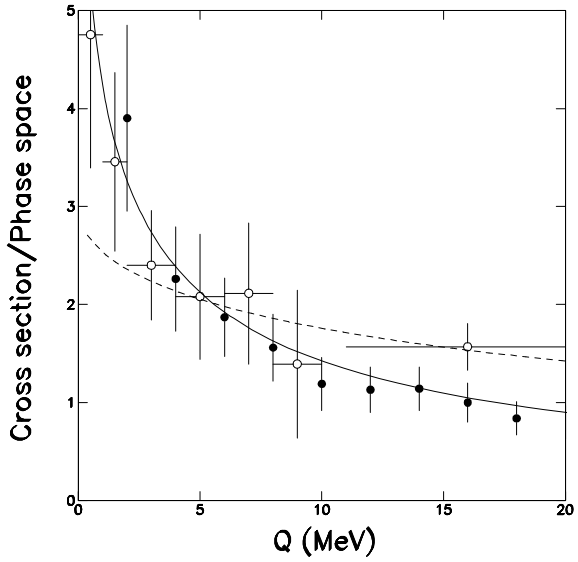

Figure 1: Ratio of experimental and phase-space Monte Carlo distributions in the ηd excitation energy Q for the $pd \to pd\,\eta$ reaction at 1032 MeV (closed circles), compared to shapes predicted by a scattering length formula with $a = 1.64 + 2.99i$ (solid curve) and $a = 0.73 + 0.56i$ [3] (broken curve). Open circles represent the shape of the total cross section for $pn \to d\eta$ divided by $\sqrt{Q}$ [2].

References

[1] R. Bilger *et al.*, Phys. Rev. C **65** (2002) 044608.
[2] H. Calén *et al.*, Phys. Rev. Lett. **80** (1998) 2069.
[3] N.V. Shevchenko *et al.*, Phys. Rev. C **58** (1998) R3055 .