Search for bound nuclear states of η and ω mesons with the (d,^{3}He) transfer reaction

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The origin of hadron masses is one of the fundamental questions of QCD, and the study of hadron mass shifts in hadronic matter is one of the presently most discussed questions in nuclear physics. While relativistic nucleus-nucleus collisions address possible hadron modifications during the transient stage of high baryon density or high temperature we want to discuss a complementary approach here.

We have proposed [1] to use the (d,^{3}He) transfer reaction near the recoil-free condition in order to study the η-nucleus and the ω-nucleus interaction and to search for bound nuclear η or ω states. Such states are as yet unobserved but the η- and ω-nucleus potential is predicted to be attractive enough to allow for the existence of bound states even in light nuclei. Light nuclei with only one or very few populated bound η/ω states form a particularly clean environment to relate experimentally determined binding energies of η or ω mesons to their effective in-medium masses at normal nuclear density in a model-independent way.

Excitation energy spectra for η and ω production in the (d,^{3}He) reaction on light nuclei with different potentials were calculated based on experimental $pd \to {}^3He\eta$ and $pd \to {}^3He\omega$ data and the nuclear response function using the Green function method. The predicted cross sections are of the order of 1 nb/sr/MeV.

We will demonstrate that the study of the (d,^{3}He) reaction at the GSI Fragment Separator (FRS) at $T_d =$ 3.5 GeV for η and at $T_d = 4$ GeV for ω allows to identify η/ω production on nuclear targets and, by the shape of the measured ^{3}He momentum spectrum, to distinguish between different predictions for the η/ω nuclear potential (Fig.1). The main prerequisites for the observation of η/ω bound states in the experiment is the operation at high luminosity, the use of an ion-optical mode of the FRS with maximum solid angle and momentum acceptance, and the suppression of an intense proton background due to d breakup in the target. A scheme fulfilling these requirements will be presented.

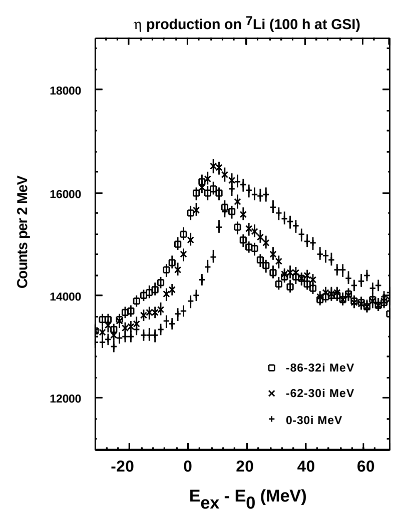

Fig.1 Expected excitation energy spectrum for the ^{7}Li(d,^{3}He) reaction near the η production threshold for 100 hours of running at GSI.

References

[1] R.S. Hayano, A. Gillitzer *et al.*, approved GSI proposal S214 (1997),
R.S. Hayano, S. Hirenzaki and A. Gillitzer, submitted to Eur. Phys. J. A