<u>Absorption of the ω and ϕ Mesons in Nuclei</u>

When a hadron is in a nuclear medium, such as being inside a nucleus and being surrounded by nucleons, the properties of the hadron are predicted to change. A change in a particle's intrinsic properties, like mass and natural width, may be attributed to a partial restoration of chiral symmetry. The spectrum of masses of the light hadrons is attributed to the breaking of this symmetry. Another type of medium modification is the change in a hadron's interaction with a bound nucleon. The hadron-nucleon cross section may change from its value when the nucleon is a free particle.

The photo-production the light vector mesons is an excellent experiment to study medium modifications. The ρ meson is short-lived, so it has a high probability of decaying inside nucleus with a modified mass and width. The ω and ϕ mesons have cτ greater than the radius of a large nucleus and will decay primarily outside the nucleus with their vacuum mass and width. While they are traveling through the nucleus, the latter mesons will interact with the bound nucleons. If their in-medium cross sections increase, the probability of being absorbed and not being detected will increase. The g7a experiment in Hall B at the Thomas Jefferson National Accelerator Facility (TJNAF) employed a photon beam, with a maximum energy of 4 GeV, to produce the three vector mesons in nuclei of ^{2}H, C, Fe, Ti, and Pb. The meson were reconstructed from their decay into e+e- pairs, which were detected by CLAS. The ρ meson results are published in two articles[1,2]. The results for the ω and ϕ mesons is the topic of a recent Physical Review Letter[3].

To access the in-medium ωN and ϕN cross sections, the ratios of the nuclear transparencies are determined. The nuclear transparency is $T_A=\sigma_A/A\sigma_N$, where σ_A is the nuclear cross section, σ_N is the nucleon cross section, and A is the nucleon number. The nucleon cross section is eliminated by calculating the ratio of transparency of a heavy nucleus to that of carbon, T_A/T_C. Figure 1 shows the ratio of transparencies versus A for both mesons. Compared with the data are Glauber calculations for various in-medium cross sections.

The data shows large absorptions for both mesons. The ϕN cross section is in the range of 15-70mb, which is comparable to the πN and ρN cross sections with a free nucleon. The ω meson is very large and cannot be reproduced by the simple Glauber calculation. One speculation is that, in addition to the enhanced cross section, there is a reduction in the detected meson yield due to ρ-ω mixing. An analysis of g12 data is underway to measure the ρ-ω interference in the e+e- channel. The g12 experiment had an intense, 6-GeV photon beam on a liquid hydrogen target. A future experiment with a 3-GeV photon beam on ^{2}H, C, Fe, Nb, and Sn targets will allow for an analysis of the momentum dependence of medium effects.

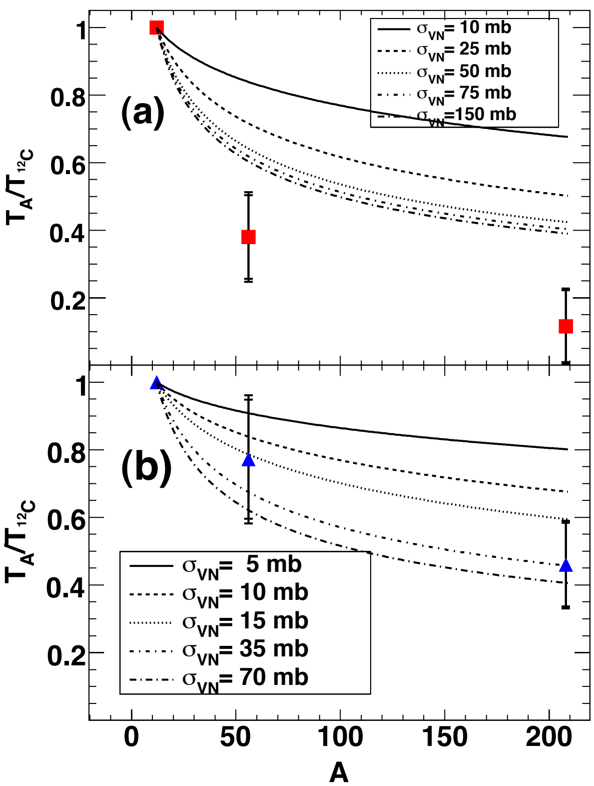

Figure 1: Ratio of transparencies for ω (a) and ϕ (b) mesons. The curves are Glauber calculations for various in-medium meson-nucleon cross sections.

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1 R. Nasseripour *et al.*, Phys. Rev. Lett.,**99**, 262302 (2007)

2 M. H. Wood *et al.*, Phys. Rev. C **78**, 015201 (2008).

3 M. H. Wood *et al.*, Phys. Rev. Lett. **105**, 112301 (2010)