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Search for Medium Modifications of the Light Vector Mesons at Jefferson Lab

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The E01-112 experiment at the Thomas Jefferson National Laboratory was an investigation of the properties of light vector mesons in dense nuclear matter, such as a shift in their masses and/or broadening of their widths. Theoretical calculations relate the modifications to partial restoration of chiral symmetry at high density or temperature. In the experiment, the ρ, ω, and ϕ mesons were photo-produced of off ^{2}H, C, Ti, Fe, and Pb targets and reconstructed with the CEBAF Large Acceptance Spectrometer (CLAS). The incident beam was tagged photons with energies up to 4 GeV. The mesons were detected via their rare leptonic decay to e^+e^-. This decay channel is preferred over hadronic modes in order to eliminate final state interactions in the nuclear matter. The ρ meson mass spectrum was extracted after the subtraction of a combinatorial background and after the removal of the ω and ϕ signals in a nearly model-independent way. The ρ mass spectra from the heavy targets (A $>$ 2) were compared with the mass spectrum extracted from the deuterium target. We obtain a mass-shift compatible with zero for the ρ meson. For the ρ-mesons widths, our result is consistent with standard nuclear many-body effects, i.e. collisional broadening and Fermi motion. Even though the ω and ϕ mesons have a high probability of decaying outside the nucleus in their vacuum state, their in-medium widths can be accessed through their absorption inside the nucleus. The signature of absorption is a decrease of the nuclear transparencies of these mesons as a function of the number of target nucleons. Preliminary results indicate a substantial widening of the ω and ϕ mesons in the medium.