Study of Chiral Property of Dense Nuclear Matter Through Measurements of Meson Mass Modification in Medium
KEK-PS E325

It is believed that the chiral symmetry, which is spontaneously broken in our world, should be restored in a system with a finite temperature and/or a finite density. Theoretically, it has been suggested that a signature of the chiral symmetry restoration could be seen as a possible mass shift of vector mesons in nuclear matter. The experiment E325 has been carried out at KEK-PS to investigate nuclear media effects on the invariant mass spectra of ρ, ω and ϕ mesons through their decays in the e^+e^- or K^+K^- channels. From the earlier data, the experiment has reported the signature of in-medium mass modification of ρ and/or ω mesons. This was the first observation in the leptonic in-medium decay of vector mesons at a normal nuclear matter density.

Our observation should be compared to the results from the CERES/NA45 experiment which reported the low-mass electron pairs enhancement in Pb-Au collisions at 158 A GeV[2], and from the TAGX experiment which reported the signature of ρ modification in photon induced interaction on a ^3He target[3]. Those observations including our results could be explained by a common physics behind, though the experimental verification is not sufficient yet.

The experiment E325 finished its data taking period of ~3200 hours in five years from 1998 to 2002. We have acquired almost 100 times larger statistics compared to the previous publication[1], with which we will be able to provide the dispersion relation of modified ρ/ω mesons and a spectral function of ϕ mesons.

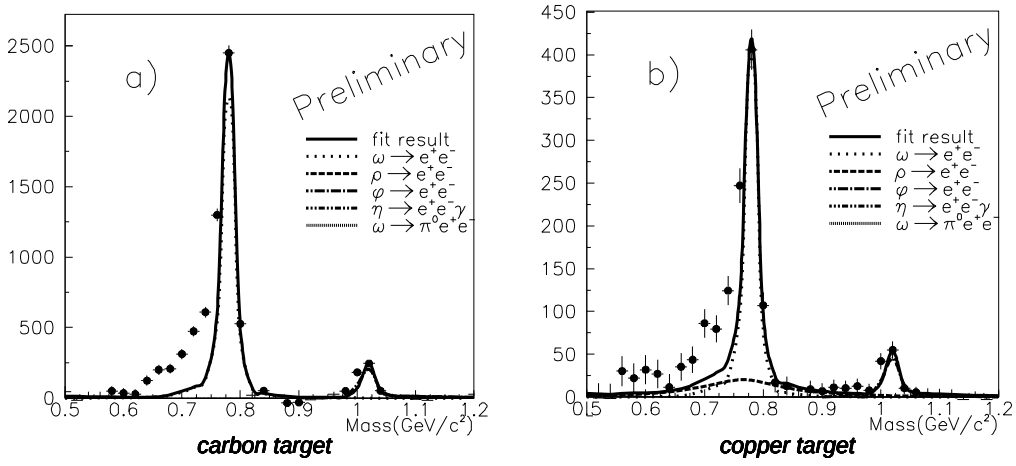

Figure 1: Invariant mass spectra of 2002 e^+e^- data, after the subtraction of the combinatorial background; a) is for the carbon target and b) is for the copper targets.

Figure 1 show the preliminary results for the data taken in 2002; a) is for the carbon target, and b) is for the copper targets. We have reproduced the mass shape with the combinatorial background and the known hadronic sources, $\rho \rightarrow e^+e^-$, $\omega \rightarrow e^+e^-$, $\phi \rightarrow e^+e^-$, $\eta \rightarrow e^+e^-\gamma$, and $\omega \rightarrow e^+e^-\pi^0$. The combinatorial background was evaluated by the event mixing method and subtracted in the figures.

The significant excess can be seen on the low-mass side of the ω, as consistent to the previous data, and some hint below ϕ. With these improved statistics, we are able to determine the free-decay ρ/ω ratio from the high mass tail of the spectrum. The obtained values are siginifficantly is smaller than the known ρ/ω ratio, unity, in pp interactions. Because most of ρ will be decaying inside a nucleus due to their short life time, it is natural to consider the excess is mainly dominated by the ρ meson modification.

The key measurements are momentum dependence of observed exess and the spectral-shape modification for ϕ mesons. Answers will be obtained when we finish the analysis of all the data we have.

References

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[2] G. Agakichiev *et al.* , Eur. Phys. J. **C4**(1998)231-247.

[3] G. J. Lolos *et al.* , Phys. Rev. Lett. **80** (1998) 241-244. Phys. Lett. **B528** (2002) 65-72.