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同位旋非对称核物质的△ 截面的研究

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近十年来，对于 FOPI 的发表的束流能量为 0.4-1.2 GeV 的 Au+Au 碰撞产生的 pion 产额以及π^-/π^+ 之比的实验数据的理论分析表明：目前利用π^-/π^+ 的数据结合输运模型比较给出的对称能约束存在很大的分歧和争议。这促使人们从实验和理论两个方面再次进行深入的研究和探索。理论方面，则需要进一步的理解同位旋相关的输运模型中π 产生的各个环节，如介质中Δ、π 的产生和传播等问题，以为将来可靠确定对称能奠定基础。在这项工作中，我们在单玻色子交换模型中引入了Δ 自由度，并且考虑了同位旋矢量介子，如ρ、δ 和π 的贡献，以其更合理的描写同位旋非对称核物质。基于此模型，我们研究了同位旋非对称核物质中Δ 产生截面，比如同位旋依赖的Δ 产生的能量阈值对于非对称核物质的介质中$NN \to N\Delta$ 的散射截面的影响。结果表明，截面介质修正因子$R = \sigma^*_{NN\to N\Delta}/\sigma^{\text{free}}_{NN\to N\Delta}$，在考虑了同位旋依赖的$\Delta$ 产生的能量阈值后，介质修正因子的同位旋效应变弱。但是，R 在阈值附近还可以观察到同位旋区分的效应。但是随着束流能量的增加，这种劈裂的幅度会变小。同时，我们分析了非对称核物质介质中$NN \to N\Delta$ 的散射截面和微分散射截面与状态方程软硬的关系。对于散射截面的介质修正因子 R 而言，我们的结果显示有效质量越大（对称能的斜率越大），介质的修正效应越小。

The symmetry energy at suprasaturation density is very important for understanding the nuclear astrophysics. In last couple decades, there are widely differences of the constraint of symmetry energy at suprasaturation density by comparing the π^-/π^+ ratio data from the FOPI Collaboration with calculations from transport models. It has stimulated both experimental and theoretical works to deeply understand the divergence. On the side of theory, one also need to deeply understand mechanism of the pion production and propagation, i.e., the in-medium Δ production, pion propagation, which are the key in transport models for describing the pion production in the simulation of heavy ion collisions. In this work, we study the Δ related inelastic scattering in isospin asymmetric nuclear matter in frame work of the one-boson exchange model. Δ and isovector mesons, i.e., ρ, δ and π, are included in order to reasonable describing the isospin asymmetric nuclear matter. Based on this model, we do the calculation of in-medium Δ production scattering in isospin asymmetric nuclear matter. Our results further confirm the dependence of medium correction factor, $R = \sigma^*_{NN\to N\Delta}/\sigma^{\text{free}}_{NN\to N\Delta}$, on the charge state of $NN \to N\Delta$ especially around the threshold energy, but the isospin splitting of medium correction factor R becomes weak at high beam energies. Secondly, we study the correlation between the in-medium $NN \to N\Delta$ cross section and the density dependence of the symmetry energy. By analyzing the selected effective Lagrangian parameters, our results show that the larger effective mass is, the weaker medium correction is. Thirdly, we analyze the dependence of M-matrix for $N\Delta \to NN$ on Δ mass, and give the precise calculation of $N\Delta \to NN$ cross section.

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