The $\eta \to 3\pi$ decay in nuclear medium as a possible probe for chiral restoration

Shuntaro Sakai[1], Teiji Kunihiro[1]

[1]Kyoto University

In this talk, we present the result of our recent analysis of the $\eta \to 3\pi$ decay width in the nuclear medium based on the linear sigma model with an emphasis on the possible relevance of the chiral restoration. There are two important ingredients for understanding the 3π decay of the η meson: (A) The η decay into 3π process stems from the QCD-originated isospin symmetry breaking, the mass difference of the u and d quarks, because the electromagnetic contribution vanishes at the leading order [1]. Furthermore, (B) it is pointed out that the final state interaction of pions in the flavor singlet scalar channel plays an essential role for the quantitative understanding of the decay width [2]. As for the point (A), we have recently found that the nuclear medium allowing isospin asymmetry $\delta\rho = \rho_n - \rho_p$ affects this decay rate significantly [3]: The decay width depends on not only the isospin asymmetry $\delta\rho$ but also the total baryon density $\rho = \rho_n + \rho_p$, and it turns out that the latter can have larger effect than the former due to the new vertex involving the nucleons and the η and 3 π's that can be only active in the nuclear medium. In this report, we extend the previous analysis so as to take into account the possible medium effect on (B), the final state interaction in the sigma meson channel, considering that the final state interaction would make the sigma meson pole known in the recent analysis of the π-π scattering. We employ the linear sigma model containing the sigma meson field explicitly. In this model, the sigma mass is directly associated with the chiral order parameter and may change in the nuclear medium. We shall show that the sigma meson pole indeed gives a large contribution to the decay width, which is further enhanced in the nuclear medium through the chiral restoration leading to a decrease of the sigma meson mass.

[1] D.G. Sutherland, Phys. Lett. **23**, 384 (1966).

[2] C. Roiesnel and T.N. Truong, Nucl. Phys. **B187**, 293 (1981).

[3] S. Sakai and T. Kunhiro, Prog. Theor. Exp. Phys. **2015**, 013D03.