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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	飯澤 優太朗	指導教員（主）： Academic Supervisor(main)	慈道 大介教授
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

In low-energy hadron physics, one can consider a global symmetry called isospin symmetry (SU(2) flavor symmetry) for the light quark sector, up and down quarks. We can also consider SU(3) flavor symmetry with the addition of further strange quarks for the light quark sector. SU(3) flavor symmetry as well as the symmetry breaking due to the difference among the quark masses are also important, and they appear in hadron phenomena. Among hadrons kaon is unique; it is a hadron that appears due to the dynamical breaking of chiral symmetry and reflects the large effect of explicit breaking of chiral symmetry due to the inclusion of the strange quark. In this dissertation, we study the flavor symmetry and its symmetry breaking phenomenologically via the hadron phenomena with strangeness induced by the kaon.

For the study of the isospin symmetry breaking, we propose to utilize the $K^-d \to \pi^-\Lambda p$ and $K^-d \to \pi^0\Lambda n$ reactions in order to investigate the difference between the low-energy Λp and Λn scatterings. In these reactions, the Λp and Λn scatterings appear as final state interactions. The large isospin breaking in the ΛN system is proposed by the experiments of the hypernuclei. The low-energy property of Λp was studied by the $pp \to K^+\Lambda p$ reaction, while that of the Λn has not yet been experimentally determined. We find that the ratio of the ΛN invariant mass spectra of the $K^-d \to \pi^-\Lambda p$ and $K^-d \to \pi^0\Lambda n$ reactions is useful for studying the qualitative properties of isospin symmetry breaking in the low-energy ΛN scattering.

For the SU(3) flavor symmetry breaking, we discuss the density dependence of the chiral condensate with the strange quarks in the nuclear matter. In order to confirm the dynamical breaking of chiral symmetry, the partial restoration of the chiral symmetry in nuclear matter is investigated. The magnitude of the chiral condensate $\langle \bar{u}u + \bar{d}d \rangle$ is expected to decrease as chiral symmetry is restored in the nuclear matter. The partial restoration of the chiral symmetry in nuclear matter is confirmed by the decrease in the chiral condensate obtained experimentally through the pion-nucleus interactions, the pionic atom and the pion-nucleus scattering. For the systematic study on the partial restoration of the chiral symmetry, we derive the in-medium chiral condensate with strange components and discuss the behavior of in-medium chiral condensate with the obtained KN scattering amplitude. We obtain the KN scattering amplitude using chiral perturbation theory and the experimental data of the K^+N elastic scatterings. We propose the low-energy experiments of KN scattering in order to obtain the KN scattering amplitude more precisely and discuss the chiral condensate.

As well as the pion-nucleus interaction from the pionic atoms, the K^--nucleus interaction from kaonic atoms may be a phenomenological tool to prove the partial restoration of the chiral symmetry. A pionic atom is well-understood by theoretical and experimental studies. The fundamental π^-- nucleon interaction is repulsive, and then the potential between π^- and a nucleus is also worked repulsively. Therefore the energy shift is seen repulsively in the pionic atoms. On the other hand, the K^- -nucleus interaction is not as precisely understood as the pion-nucleus interaction at present. The energy shift in the kaonic atom is repulsive as well as that in the pionic atom, while the interaction between K^- and a nucleon is attractive, and the K^--nucleus potential is also attractive. We study the global feature of the K^- -nucleus interaction in terms of the mechanism of the repulsive energy shifts by the strong interaction in kaonic atoms. Naively, the effect of the level repulsion to the kaonic atom by the kaonic nuclei coupled to the atomic state yields the repulsive energy shift, however, in our study we find that the level repulsion by the nuclear bound states is not responsible for the repulsive shift and reconfirm that the imaginary part of the optical potential plays a significant role for the repulsive shift in the kaonic atom.

Through these phenomenological studies with the kaon, we conclude that a phenomenological approach to flavor symmetry and its breaking is an effective way.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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