S-wave kaon-nucleon interactions and $¥Theta^+$ pentaquark from lattice QCD

Kotaro Murakami[1, 2]*, Sinya Aoki[3], Takumi Doi[2], Yan Lyu[2], and Wren Yamada[2]

[1]Institute of Science Tokyo, [2]RIKEN iTHEMS, [3]FQSP, RIKEN
on behalf of HAL QCD collaboration

Content

Interactions between a meson and a nucleon play an important role in various contexts such as the partial restoration of chiral symmetry [1] and the structure of exotic hadrons and nuclei [2]. Although kaon-nucleon scattering experiments have been conducted since the 1960s, our understanding of the interactions is still limited due to lack of experimental data at low momentum, which makes it difficult to elucidate such related phenomena accurately. On the other hand, recent developments in computational power and lattice QCD techniques have enabled precise calculation of hadron interactions from first principles. In this study, we investigate the S-wave kaon-nucleon interactions in lattice QCD using the time-dependent HAL QCD method [3,4]. The calculation is performed with $N_f=2+1$ quark flavors on the physical point, $m_{¥pi}¥approx 137$ MeV [5]. The result of the interaction potentials is purely repulsive for isospin $I=1$, while for $I=0$ it has a slight attractive pocket in addition to the repulsion. The obtained scattering observables are qualitatively consistent with the experimental results. Particularly, our results for $I=0$ suggests the P-wave dominance at low momentum [6]. Furthermore, our results indicate that there are no bound or resonant states corresponding to $¥Theta^{+}$ pentaquarks in this system.

Reference

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Field of Research: Interactions of mesons and baryons with strangeness
Experiment / Theory: Theory
Contribution Type: Contribution talk