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Nucleon-charmonium interactions from lattice QCD

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We present a realistic lattice QCD study on low-energy N-J/ψ and N-η_c interactions based on (2+1) flavor configurations with nearly physical pion mass $m_\pi = 146$ MeV.The interactions, extracted from the spacetime correlations of nucleon and charmonium system by using the HAL QCD method,are found to be attractive in all distances and possess a characteristic long-range tail consistent with the two-pion exchange potential. The resulting S-wave scattering lengths are $0.30(2)\left(^{+0}_{-2}\right)$ fm, $0.38(4)\left(^{+0}_{-3}\right)$ fm, and $0.21(2)\left(^{+0}_{-1}\right)$ fm for spin-$3/2$ N-J/ψ, spin-$1/2$ N-J/ψ, and spin-$1/2$ N-η_c, respectively. Our results are orders of magnitude larger than those from the photoproduction experiments assuming the vector meson dominance. Our findings may provide deeper understanding of the nonperturbative QCD phenomena ranging from the origin of nucleon mass to the in-medium J/ψ mass modification as well as the properties of hidden-charm pentaquark states.

Primary author: LYU, Yan (RIKEN)

Presenter: LYU, Yan (RIKEN)

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