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Emergence of the rho resonance from the HAL QCD potential

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In this talk, we report the rho resonance study using the HAL QCD method. We calculate the $I = 1 \pi\pi$ potential at $m_\pi \approx 410$ MeV by a combination of the one-end trick, sequential propagator and covariant approximation averaging (CAA). Thanks to those techniques, we determine the non-local $I = 1 \pi\pi$ potential at the next-to-next-to-leading order (N²LO) of the derivative expansion for the first time and obtain the pole of the S-matrix corresponding to the rho resonance.

We also discuss recent applications of the all-to-all techniques to other systems, such as the NN interaction and $I = 0 \pi\pi$ interaction.

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