K^--deuteron scattering length from a chiral unitary approach

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The scattering of low energy K^- off the deuteron has been intensively studied in the past and, although it is a process in which the impulse approximation has clearly been shown to be insufficient, it can still provide indirect information on the elementary K^-p and K^-n scattering lengths.
The treatment of K^--deuteron scattering requires more sophisticated approaches based on the solution of the Fadeev equations [1,2,3]. We recently evaluated the scattering length for K^--deuteron scattering [4] from a modern chiral perspective, using the $\bar{K}N$ amplitudes of a unitary coupled channel model which takes, as driving term, the meson-baryon chiral lagrangian at lowest order and which reproduces K^-p elastic and inelastic cross sections [5]. We solved the Fadeev equations within the integral form of the so-called fixed center approximation (FCA).
We find that the double scattering contribution is very large compared to the impulse approximation and that the charge-exchange contribution of this rescattering is as large as the sequential scattering of the K^- on the two nucleons. Higher-order rescattering corrections are evaluated using coupled channels, but including only the K^-pn and $\bar{K}^0nn$ ones, since those involving pions were found to give a small contribution. We also find that our result for the K^- deuteron scattering length obtained from scattering amplitudes that rely upon isospin symmetry, $A_{Kd} = -1.91 + i\,2.46$ fm, differs appreciably from that obtained within the physical basis, $A_{Kd} = -1.62 + i\,1.91$ fm. Our result differs from other multichannel Fadeev approaches, $A_{Kd} = -1.47 + i\,1.08$ fm [2] and $A_{Kd} = -1.34 + i\,1.04$ fm [3], especially for the imaginary part. This is mainly due to the different elementary amplitudes used in the different works. In fact, taking the elementary amplitudes given in [3] and using isospin symmetry, which leads to a particularly small imaginary part for the charge exchange $K^-p \to \bar{K}^0n$ amplitude, we obtain the FCA result $A_{Kd} = -1.54 + i\,1.29$ fm, very close indeed to the result quoted in [3]. The remaining difference is simply due to the FCA, which overestimates the full Fadeev calculation by about 15% [4,6].
Our findings show that isospin symmetry is not very accurate for energies close to threshold and one has to admit certain uncertainties when extracting the elementary amplitudes from the K^--deuteron data. Nevertheless, the deuteron results can still provide extra checks of accuracy for the modern chiral theories of the $\bar{K}N$ interaction.

References

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