Comments

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Comment on "Pion-decay widths of N and Δ baryons"

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The form of the simple pion-baryon interaction recently used by Preston and Dutta to calculate pion-decay widths is observed to incorrectly predict the relative phases of resonant quasi-two-body scattering amplitudes. We suggest an alternative interaction to allow further investigations of baryon-baryon one-pion-exchange potentials with a single coupling constant.

In a recent paper,[1] Preston and Dutta investigated decay rates by pion emission of several low-mass baryons. The aim of their study was to obtain guidance in describing baryon-baryon interactions by a one-pion-exchange (OPE) potential. They calculated partial widths from a nonrelativistic pion-baryon interaction which consisted of an $SU(6)_W$-invariant term containing a single coupling constant $f_{qq\pi}$. Their interaction lacked the $SU(6)_W$-breaking "recoil" term that was included in earlier, more extensive calculations by Koniuk and Isgur.[2] From their simpler interaction, Preston and Dutta derived a OPE potential between two nucleons that allowed $f_{qq\pi}$ to be related to the known coupling constant $f_{NN\pi}$ ($f_{NN\pi}^2/4\pi \simeq 0.08$). With $f_{qq\pi}$ so determined, they calculated pion-decay widths for several low-mass baryons and found that their predicted widths were much smaller than experimentally observed. They next treated $f_{qq\pi}$ as a free parameter which they determined by fitting experimental πN widths. The fitted coupling constant was then used to predict $\pi\Delta$, $\pi\Lambda$, and $\pi\Sigma$ decay widths. Preston and Dutta state that "the data does not distinguish (their) fit with only one coupling constant and the more sophisticated analysis of Koniuk and Isgur," which requires two coupling constants, g and h, to describe the same data. This statement is not strictly true if one includes experimental data for the relative phases of resonant quasi-two-body scattering amplitudes.

Experimental data clearly require the recoil term in the pion-baryon interaction which Koniuk and Isgur included and Preston and Dutta ignored. Although this fact is not evident from partial widths alone, it is clearly seen from the relative phases of such resonant amplitudes as $\pi N \rightarrow N^* \rightarrow \pi\Delta$, where the final hadrons have two allowed values of orbital angular momentum. Two alternatives exist for such amplitudes. The amplitudes can have either the same relative phase or opposite phases. These two alternatives are described by l-broken $SU(6)_W$.[3] The interaction used by Preston and Dutta gives rise to $SU(6)_W$-like phases [corresponding to unbroken $SU(6)_W$] whereas anti-$SU(6)_W$ phases are experimentally observed.[4]

The aim of Preston and Dutta to investigate baryon-baryon interaction potentials in terms of a single coupling constant may still be possible, however, since the fits of Koniuk and Isgur to the ground-state and negative-parity baryons are consistent with $g = -h$, as predicted by the naive quark-pair-creation model.[5]

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