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On the width of Δ in $N\Delta$ and $\Delta\Delta$ systems

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Collaboration

Abstract content

In two-nucleon reactions it is rather common usage to take into account the effect of the $\Delta(1232)$ excitation by simply including an additional channel with the $\Delta - N$ mass difference and free Δ width. In the momentum space propagator this leads to a factor $(E - \Delta M + i\Gamma/2)^{-1}$ and by its absolute square trivially to a resonant total cross section. In the coordinate representation $\Delta M - i\Gamma/2$ would be a repulsive and absorptive constant potential in the $N\Delta$ channel part of the Schrödinger equation. Also in this case the $N\Delta$ amplitude tends to maximize at the threshold energy.

This work studied in a simple phenomenological way the effect of the relative kinetic energy between the two intermediate baryons to see how or if it decreases the effective decay width of the $N\Delta$ and $\Delta\Delta$ two-baryon systems. Obviously this kinetic portion is not available for the (internal) pionic decay of the Δ's. Because, the wave function is necessarily also spatially constrained (must die asymptotically) the kinetic energy is not arbitrary, but its average is finite and, therefore, some suppression is expected and found.

Another aspect of kinetic energy, the effect of angular momentum barrier in the $N\Delta$ channel is also manifest in coordinate space calculations. Necessarily in higher angular momentum states the wave functions are strongly suppressed and this also can be seen in the widths. The dependence on $L_{N\Delta}$ is drastic {\it e.g.} in $pp \to d\pi^+$ amplitudes ${}^1D_2(NN) \to {}^5S_2(N\Delta)$, ${}^5D_2(N\Delta)$ and ${}^5G_2(N\Delta)$. In fact, due to the asymptotically bounded wave functions, the energy related to the angular momentum barrier is quantized and leads to rotational series in $L_{N\Delta}$, which closely describe the isovector dibaryons.

Similar suppression can be seen also in $\Delta\Delta$ states. This may have bearance in the context of the $d'(2380)$ resonance discovered at COSY.

Primary author(s) : NISKANEN, Jouni (Helsinki Institute of Physics, University of Helsinki)

Presenter(s) : NISKANEN, Jouni (Helsinki Institute of Physics, University of Helsinki)

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