Study of possible DND* states

V. Montesinos[1], J. Song[2], W. H. Liang[3], E. Oset[1], J. Nieves[1] and M. Albaladejo[1]

[1]Institut de Física Corpuscular (CSIC-UV, Spain); [2]School of Physics, Beihang University (Beijing, China);
[3]Department of Physics, Guangxi Normal University (Guilin, China)

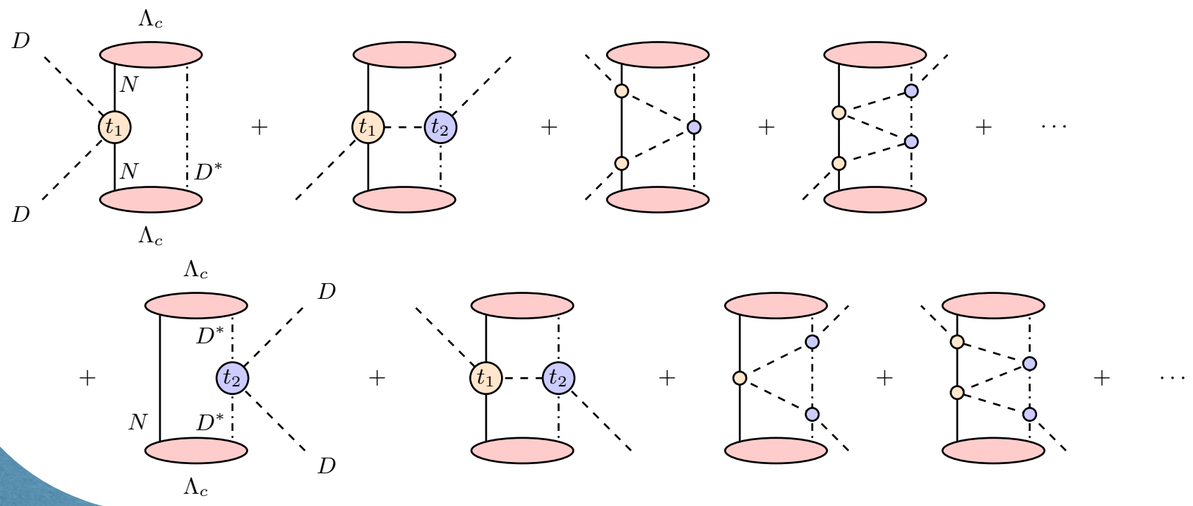
Introduction

Starting from a picture in which the $\Lambda_c(2940)$ and $\Lambda_c(2910)$ correspond mostly to ND^* bound states with $J^P = 1/2^-, 3/2^-$ we then add a D as a third particle and look for the possible binding of the DND^* three body system. We find two bound states with $J^P = 1/2^+, 3/2^+$; which experimental observation would help clarify the issue of the DN and D^*N interaction.

Methods

We use the Fixed Center Approximation to the Faddeev equations to obtain the three-body scattering amplitude. In this approximation there is a cluster of two bound particles and the third particle scatters with them. We assume that the D^*N pair is bound into the $\Lambda_c(2940)$ ($J^P = 1/2^-$) or the $\Lambda_c(2910)$ $(3/2^-)$, and take the D meson as the external particle (diagrammatically represented below).

For the DN and D^*N interactions we take them as pure isoscalar and approximate them as Breit-Wigners defined by the mass, width and couplings of the $T_{cc}(3875)$ (t_2 in diagrams below) and $\Lambda_c(2765)$ (t_1). The D propagator is weighted by the corresponding Λ_c form factor, which needs to be regularized. We use a momentum cutoff of 600 MeV.



Results

We find two states, one with total spin $1/2$ and another with $3/2$. With respect to the $\Lambda_c(2940)$ D and $\Lambda_c(2910)$ D thresholds these states are bound by approximately 70 and 50 MeV, respectively. Their widths correspond to the total three-body width and are of the order of 90 MeV. Additionally, we also consider the DN pair to be the bound cluster and the D^* as the external particle and find similar results shown in Fig. 2. The estimated masses and widths from the shown line shapes are shown in Table 1.

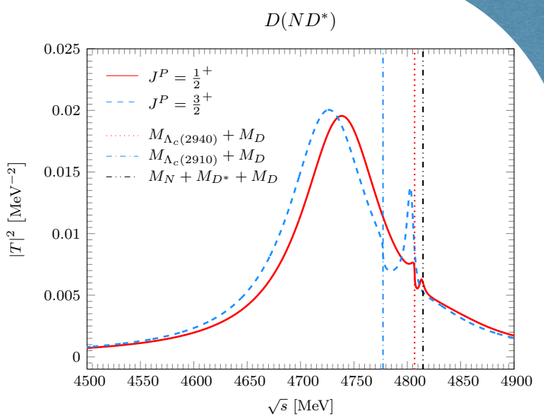


Fig 1. *Squared modulus of the spin $1/2$ (red solid line) and spin $3/2$ (blue dashed line) scattering amplitude as a function of the invariant mass of the three body system, assuming the ND^* pair to be clustered.*

Table 1. *Masses and widths for the found states in the ND^* and ND cluster pictures using a cutoff of 600 MeV.*

$D(ND^*)$			$D^*(ND)$		
J^P	Mass [MeV]	Width [MeV]	J^P	Mass [MeV]	Width[MeV]
$1/2^+$	4739	91	$1/2^+$	4761	24
$3/2^+$	4727	93	$3/2^+$	4707	98

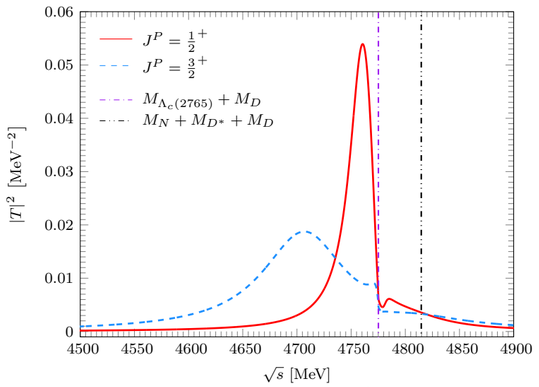


Fig 2. *Similar to Fig. 1, taking the ND^* cluster..*

Conclusions

From these results we conclude that these spin $1/2$ and spin $3/2$ should exist, and that their measurement would shed light into the assumptions made in the D^*N and DN bound states, helping clarify the issue of the DN and D^*N iteraction.

References

[1] V. Montesinos, J. Song, W. H. Liang et al., Phys. Rev. D 110, 054043 (2024)
[2] L. Roca and E. Oset, Phys. Rev. D 82, 054013 (2010).