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# A THREE-CHANNEL ( $pp$ , $N\Delta$ , $\pi d$ ) K-MATRIX ANALYSIS OF THE DIBARYON RESONANCES

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**Résumé** - Nous effectuons une recherche de pôle dibaryon pour les états  $J^P = 2^+$  et  $3^-$  par une simulation de matrice K pour les trois canaux ( $pp$ ,  $N\Delta$ ,  $\pi d$ ) pour l'analyse en déphasage des amplitudes  $pp$ - $pp$ ,  $pp$ - $\pi d$  et  $\pi d$ - $\pi d$ . Nous avons trouvé des pôles dans les régions de masse NN(2170) pour  $2^+$  et NN(2250) pour  $3^-$ . Il est remarquable d'obtenir de faibles élasticités  $pp$  ( $\leq 0,02$  pour  $2^+$  et  $\leq 0,04$  pour  $3^-$ ).

**Abstract** - A dibaryon-pole search in the complex energy plane has been performed for  $J^P = 2^+$  and  $3^-$  states in terms of the three channel( $pp$ ,  $N\Delta$ ,  $\pi d$ ) K-matrix simulation of the  $pp$ - $pp$ ,  $pp$ - $\pi d$  and  $\pi d$ - $\pi d$  amplitudes of the phase-shift analysis. We have found the resonance poles in the mass region of NN(2170) for  $2^+$  and of NN(2250) for  $3^-$ . One remarkable finding is small  $pp$  elasticities ( $\leq 0.02$  for  $2^+$  and  $\leq 0.04$  for  $3^-$ ).

One of interesting problems of the hadron physics is to establish the existence of dibaryons and clarify their dynamical origin. The final criterion of the existence of the dibaryons is the appearance of the pole in the scattering amplitude in the lower-half complex energy plane. Dibaryon-pole searches by the two-channel( $pp$ ,  $N\Delta$ ) K(M)-matrix method were performed by Edwards and Thomas /1/ and Bhandari et al. /2/. Among criticisms cast on these K(M)-matrix analyses, one important but not fully examined point is the validity of the two-channel approximation. In the absence of any reliable experimental  $N\Delta$  amplitude the obtained results heavily depend on the information of the  $pp$  channel to which the suggested resonances have relatively small coupling /3/.

We have made a three-channel( $pp$ ,  $N\Delta$ ,  $\pi d$ ) K-matrix analysis for  $J^P = 2^+$  and  $3^-$  states by taking the  $\pi d$  channel in addition to the  $pp$  and  $N\Delta$  channel. In order to discuss the existence of dibaryon in a model-independent way, we use the scattering amplitudes determined by the phase-shift analysis (PSA). The experimental data useful for our purpose are mainly restricted to the  $pp$ - $pp$ ,  $pp$ - $\pi d$  and  $\pi d$ - $\pi d$  processes.

First we have fitted the  $pp$ - $\pi d$  and  $\pi d$ - $\pi d$  amplitudes obtained by the PSA of our group as well as the  $pp$  elastic ones by Arndt group (preprint UPISA-2(1982)). As for the  $pp$ - $\pi d$  amplitudes we have used their moduli which seem to have been well fixed ( see Fig.2). The K-matrix elements are parameterized as  $K_{ij} = a_{ij} + b_{ij}s + c_{ij}s^2$  ( $i, j = 1, 2, 3$ ). Here  $s$  is square of the total energy. We have found ten good solutions for  $2^+$  and two ones for  $3^-$ . The three solutions of  $2^+$  show anti-clockwise rotating  $N\Delta$  amplitudes ( called as normal solution), while the rest does not (anomalous solution). The two solutions of  $3^-$  are normal. In Figs. 1 and 2 the best solutions are compared with the input PSA amplitudes. The  $pp$  elastic amplitudes of the solutions are in good agreement with the input amplitudes of Arndt group although

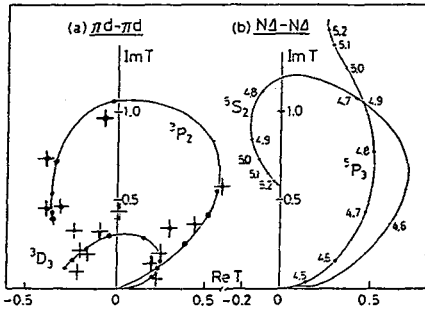


Fig.1 -(a) Argand diagram of the  $\pi d$ - $\pi d$  amplitudes. The PSA amplitudes are shown by cross. (b) Argand diagram of the  $N d$ - $N d$  amplitudes. The attached numbers to the curves are  $s$  in  $\text{GeV}^2$ .

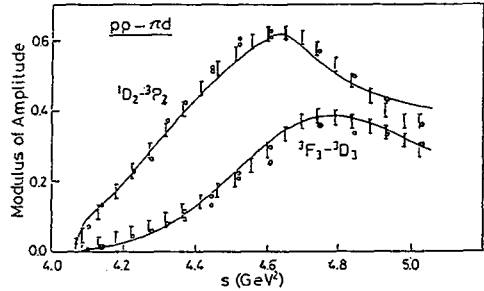


Fig.2 -Energy dependence of the moduli of the  $pp$ - $\pi d$  amplitudes. The input PSA amplitudes are shown by (I) and Bugg's solution is shown by open circles for comparison.

they are not shown.

By analytic continuation in the complex  $s$ -plane we have searched poles of the amplitudes in the region  $4.3 \leq \text{Re } s \leq 5.3$  and  $-0.5 \leq \text{Im } s \leq 0.5$  ( $\text{GeV}^2$ ). We have found one pole for all of the normal and anomalous solutions in the mass region of NN(2170) and NN(2250). Average values of the mass and width for the normal (anomalous) solutions are given in Table I.

Table I - Resonance parameters in MeV unit.		
	$J^P = 2^+$	$J^P = 3^-$
$M_R$	2162(2160)	2166
$\Gamma_T$	43(64)	133
$\Gamma_{pp}$	0.3( 1)	3
$\Gamma_{Nd}$	18(22)	67
$\Gamma_{\pi d}$	25(41)	63

A remarkable finding of the present solution is small  $pp$  and large  $\pi d$  elasticities. The obtained  $pp$  elasticities are less than 0.02 for  $2^+$  and 0.04 for  $3^-$ . If we really have small  $pp$  widths, this will be very informative on the origin of the dibaryon resonance. For more definite conclusion a good accumulation of  $pp$ - $\pi d$  and  $\pi d$ - $\pi d$  experiments, which allows reliable PSA, is crucial.

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