The reactions dd->dd $\pi\pi$ and pd>pd$\pi\pi$ and dibaryon resonances

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8th ICPPA, 27-30 October 2026, Moscow

CONTENT

- WASA@COSY dibaryon d*(2380) in the reactions pn-> d$\pi^0\pi^0$ and pn->pn. Experimental data and theoretical models.
- ANKE@COSY data on pd->pd$\pi\pi$ and t-channel excitation of d*(2380).
- Potential possibility to search for isoscalar dibaryons in **dd->dd $\pi\pi$** and **pd->pd$\pi\pi$** reactions in dd-collision at SPD NICA .
- Indication to others resonances in γ+d->d$\pi^0\pi^0$ (ELPH, BGOOD) and pp- data.
- About compositeness criterion
- Summary

F.J. Dyson, N.-H. Xuang, PRL 13, № 26 (1964) 815

(The idea of quarks : M. Gell-Mann, 1964)

SU(6)-symmetry

VOLUME 13, NUMBER 26 PHYSICAL REVIEW LETTERS 28 DECEMBER 1964

Table I. $Y = 2$ states with zero strangeness predicted by the 490 multiplet.

Particle	T	J	SU(3) multiplet	Comment	Predicted mass
D_{01}	0	1	10*	Deuteron	A
D_{10}	1	0	27	Deuteron singlet state	A
D_{12}	1	2	27	S-wave N-N^* resonance	$A+6B$
D_{21}	2	1	35	Charge-3 resonance	$A+6B$
D_{03}	0	3	10*	S-wave N^*-N^* resonance	$A+10B$
D_{30}	3	0	28	Charge-4 resonance	$A+10B$

D_{TJ}

6 non-strange dibaryons

M=A+B[T(T+1)+J(J+1)-2],

B=47 MeV with D_{12} from pp<-> pi^+ d (M.G. Mescheryakov et al., 1955)

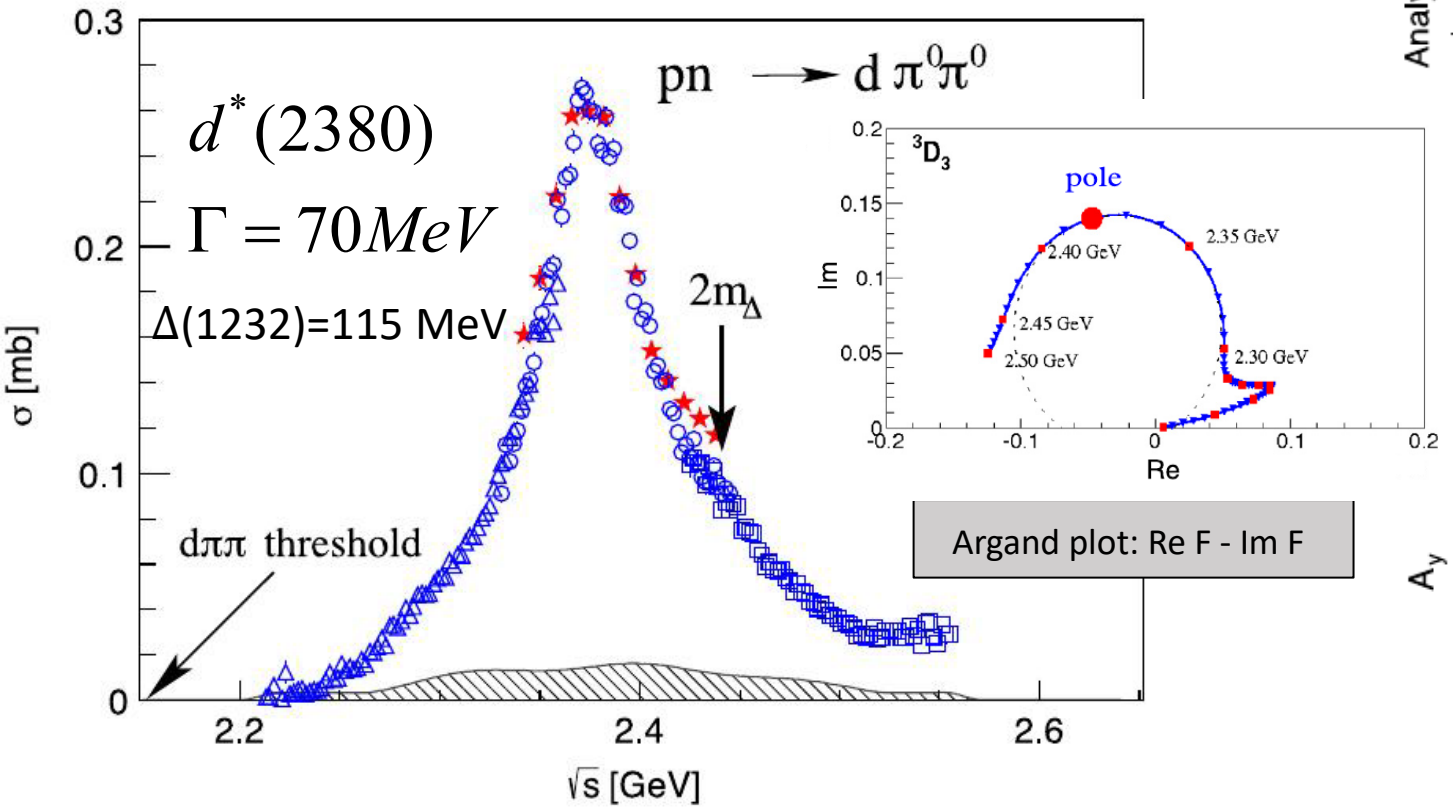
$M(D_{03})$=2350 MeV

H. Ikeda et al.,
PRL 42, №20 (1979) 1321; γd→np

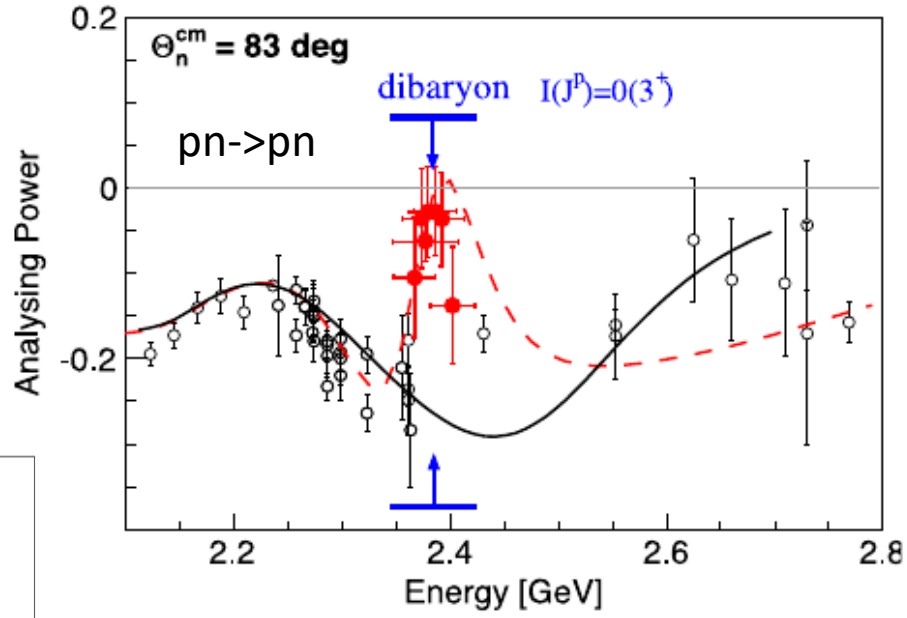
DIBARYON RESONANCE D_{03}

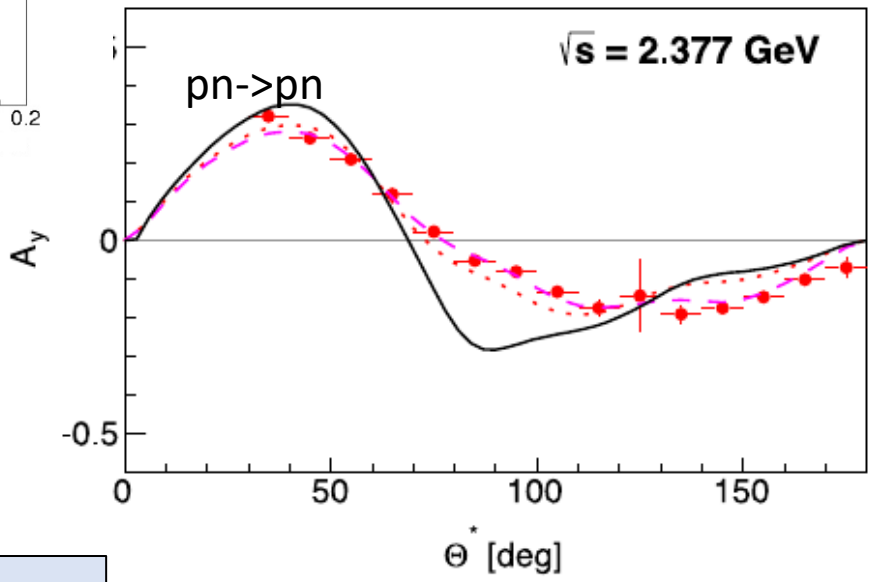
P. Adlarson et al. PRL 106(2011) 242302;
PRC 90 (2014) 035204

H. Clement / Progress in Particle and Nuclear Physics 93 (2017) 195–242



Argand plot: Re F - Im F





ABC – effect , A. Abashian, N. Booth, K. Crowe, PRL 5 (1960)

The first clear-cut experimental finding of a true dibaryon resonance

PHYSICAL REVIEW C **90**, 035204 (2014)

Neutron-proton scattering in the context of the $d^*(2380)$ resonance

ANKE finds $A_{xx} = -0.38(3)$ and $C_{x,x} = -0.39(5)$ at $T_d = 2.27$ GeV (Table I). Calculating these observables with the SP07 solution results in values of -0.30 and -0.48, respectively, which are significantly different. However, the new SAID solution gives $A_{xx} = -0.42$ and $C_{x,x} = -0.31$, which are closer to the ANKE experimental values.

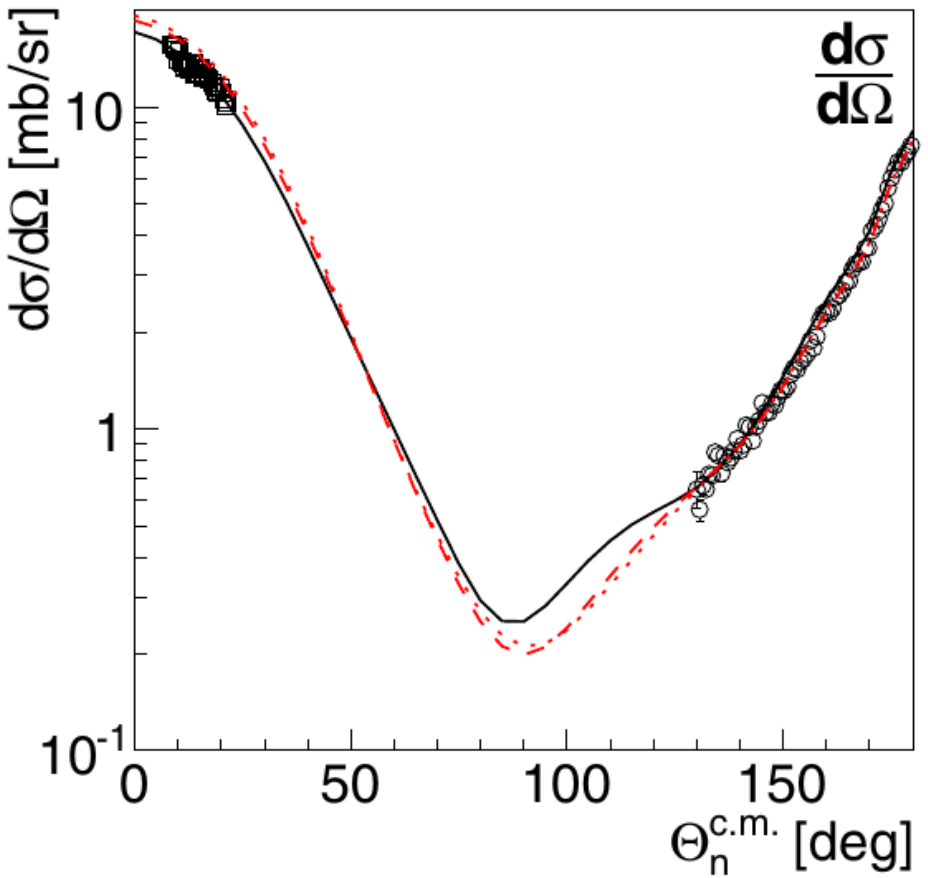


FIG. 11. (Color online) Angular distribution of the differential cross section $d\sigma/d\Omega$ at $T_n = 1.135$ GeV corresponding to the resonance energy $\sqrt{s} = 2.38$ GeV. For the meaning of the curves see the caption to Fig. 4. Plotted data are from Ref. [41] ($T_n = 1.135$ GeV) and Ref. [42] ($T_n = 1.118$ GeV).

What is the d*(2380) structure ?

I. Quasi-molecular state:

A.Gal, H. Garcilazo, Phys.Rev.Lett. 111 (2013) 172301; d (2380) is the $\pi\Delta N$*

II. Compact hexaquark system, hidden color component dominates:

Y. Dong et al. "d*(2380) in chiral constituent quark model"
Prog. Part. Nucl. Phys. 131 (2023) 104045:

$$|\Delta\Delta> + |CC>;$$
$$|\Delta N\pi>$$

Eur. Phys. J. C (2023) 83:645
https://doi.org/10.1140/epjc/s10052-023-11814-2

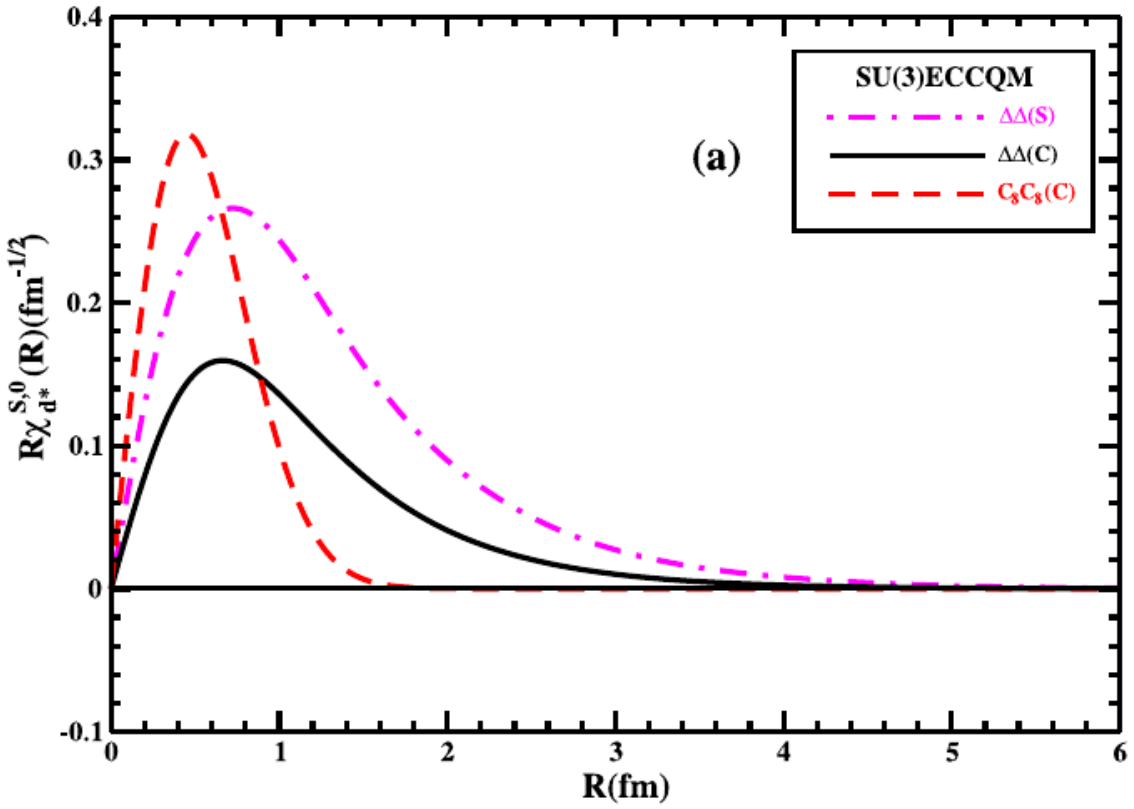
Regular Article - Theoretical Physics

Is $d^*(2380)$ a compact hexaquark state?

Manying Pan[1,a], Xinmei Zhu[2,b], Jialun Ping[1,c]

Reviews: H. Clement, Prog. Part. Nucl. Phys. 93 (2017) 195-242
H. Clement, T. Skorodko. Chin. Phys. C 45 , № 2 (2021) 022001

Y. Dong, P. Shen and Z. Zhang Prog. Part. Nucl. Phys. 131(2023) 104045



ΔΔ and HIDDEN COLOR COMPONENTS OF THE d*

Pure hexaquark state, $(0s)^6$:

$$|[6]_{\rm orb}[33]\rangle_{IS=03} = \sqrt{\frac{1}{5}}\,|\Delta\Delta\rangle_{IS=03} + \sqrt{\frac{4}{5}}\,|C_8C_8\rangle_{IS=03}$$

$\Delta\Delta + C_8C_8$:

$$\Psi_{d^*} = [\phi_\Delta(\vec{\xi}_1,\vec{\xi}_2)\phi_\Delta(\vec{\xi}_4,\vec{\xi}_5)\chi_{\Delta\Delta}(\vec{R})\zeta_{\Delta\Delta} + \phi_C(\vec{\xi}_1,\vec{\xi}_2)\phi_C(\vec{\xi}_4,\vec{\xi}_5)\chi_{CC}(\vec{R}))\zeta_{CC}]_{(SI)=(30)},$$

This means that a state represented by the symmetry bases of $[6]_{orb}$, namely a pure hexaquark state, has 80% $|C_8C_8\rangle_{IS=03}$ configuration. Clearly, the fraction of about $(66 \sim 68)\%$ for the $|C_8C_8\rangle_{IS=03}$ configuration of the obtained D_{03} state is very close to the fraction of 80% for a pure hexaquark state. Therefore, it is fair to say that the obtained D_{03} state (or $d^*(2380)$) is a compact exotic state in which a hexaquark configuration dominates.

PARTIAL DECAY WIDTHS OF d*.
Constituent chiral quark model by Y. Dong e. et al.

TABLE I. Calculated partial decay widths and corresponding branching ratios of d^* in the two-body, three-body, and four-body decay channels and the total width of d^*. Case I and Case II denote the single channel and coupled channel cases, respectively.

Wave function	This work			Ref. [20][a]		Expt. [2,4,29,30]	
M_{d^*}(MeV)	Case I $(100\%)\Delta\Delta$ 2374	Case II $(31.5\%)\Delta\Delta + (68.5\%)CC$ 2380		$(31.5\%)\Delta\Delta + (68.5\%)CC$ 2380		2375	
Decay channel	Γ(MeV)	Γ(MeV)	Br(%)	Γ(MeV)	Br(%)	Γ(MeV)	$Br(\%)$
$d^* \to d\pi^0\pi^0$	17.0	9.2	12.8	9.2	13.3	10.2	14(1)
$d^* \to d\pi^+\pi^-$	30.8	16.8	23.4	16.8	24.3	16.7	23(2)
$d^* \to pn\pi^0\pi^0$	19.8	9.6	13.3	7.8	11.3	8.7	12(2)
$d^* \to pn\pi^+\pi^-$	42.6	20.6	28.6	19.2	27.8	21.8	30(4)
$d^* \to pp\pi^0\pi^-$	7.2	3.5	4.9	3.9	5.65	4.4	6(1)
$d^* \to nn\pi^+\pi^0$	7.2	3.5	4.9	3.9	5.65	4.4	6(1)
$d^* \to pn$	8.2	8.7	12.1	8.3	12.0	8.7	12(3)
Total	132.8	71.9	100.0	69.1	100.0	74.9	103

[a]Four-body decay results in this column are obtained by using the ratios of cross section data between relevant decay channels.

Physics Letters B 801 (2020) 135146

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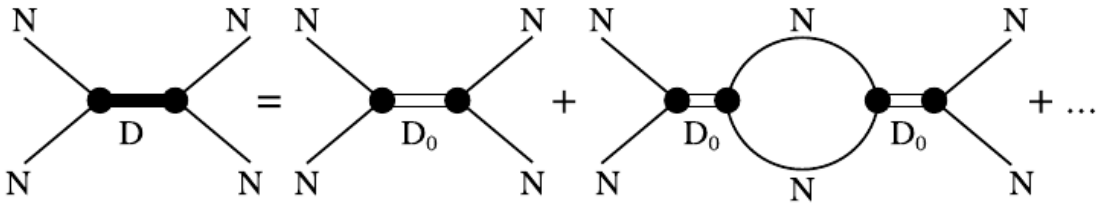
www.elsevier.com/locate/physletb

SHORT-RANGE NN INTERACTION and dibaryons

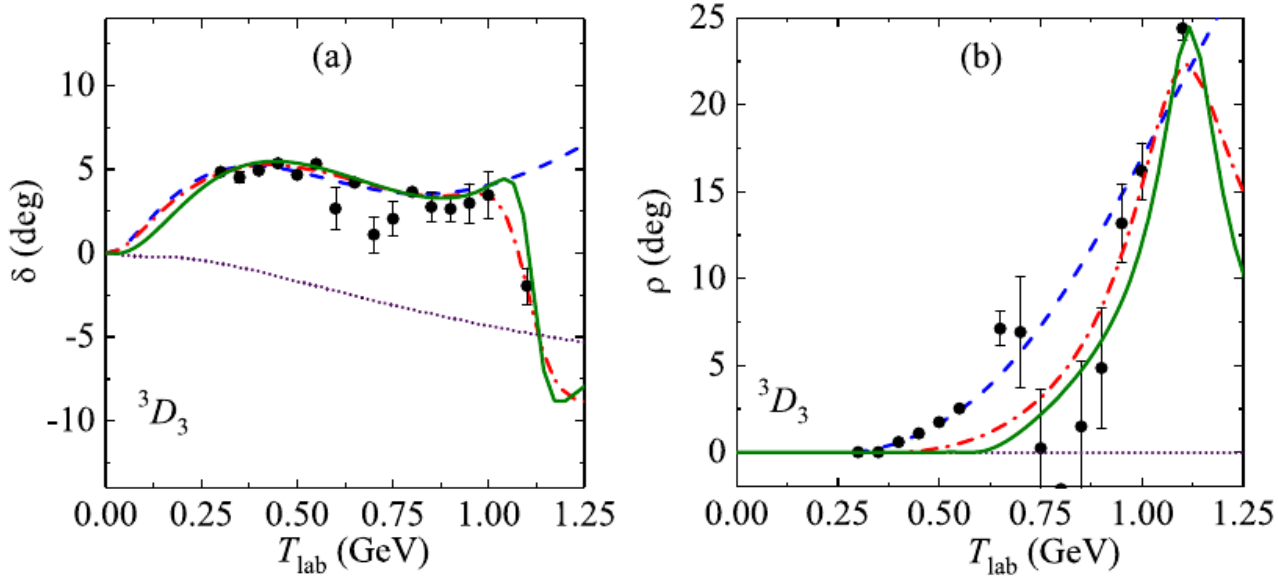
V.I. Kukulin et al., Chin.Phys. C 46 (2022) 0114106

Role of the $d^*(2380)$ dibaryon in NN interaction

V.I. Kukulin [a], O.A. Rubtsova [a], M.N. Platonova [a], V.N. Pomerantsev [a,*], H. Clement [b]



$^3D_3$- phase shift (up to 1 GeV) np->d*(2380)->np

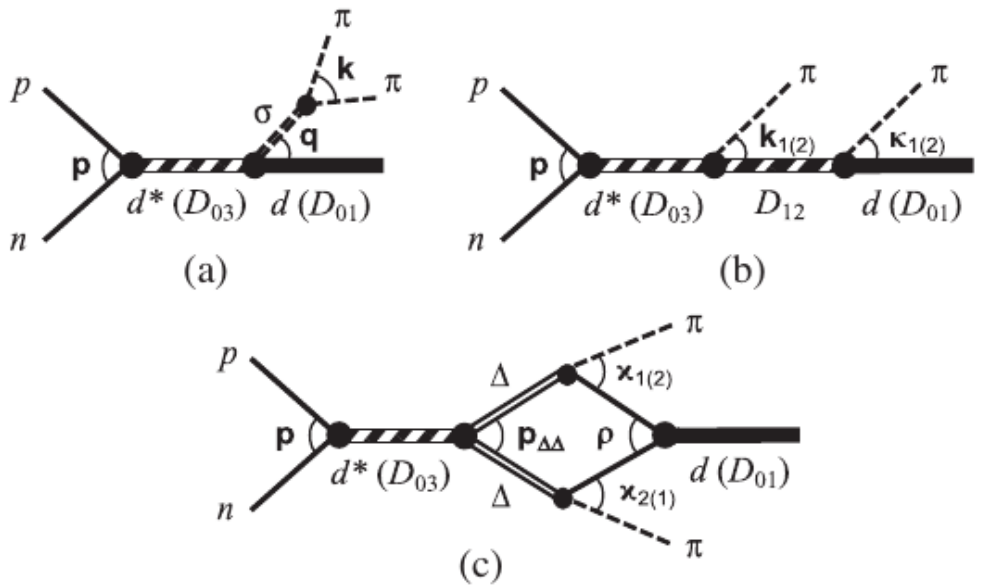


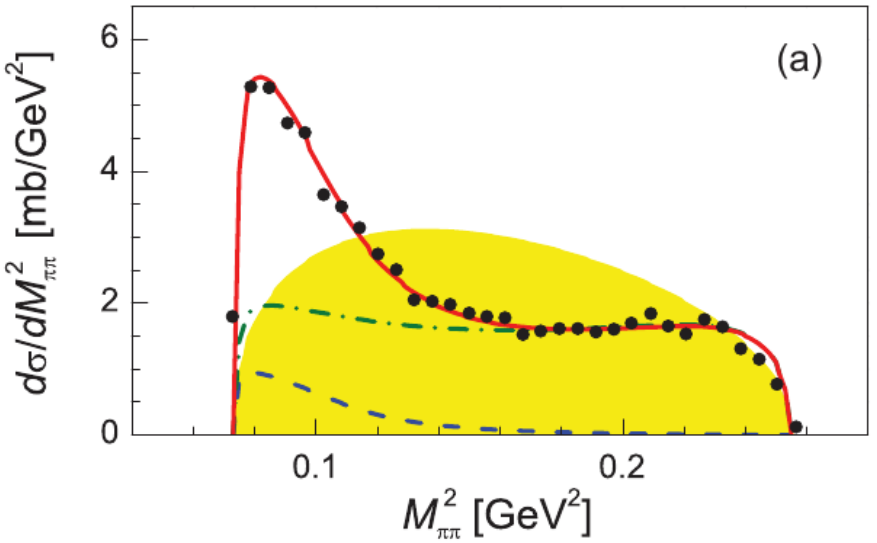
Platonova-Kukulin model for pn->d$\pi^0\pi^0$

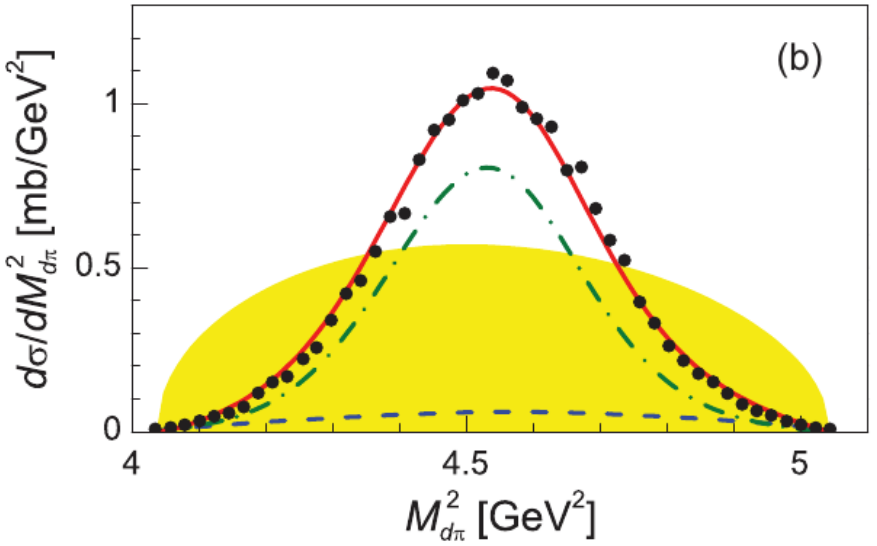
Isospin symmetry breaking in double-pion production in the region of $d^*(2380)$ and the scalar σ meson

M. N. Platonova† and V. I. Kukulin*
Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia

M.P. Platonova, V.I. Kukulin,
PRC 87 (2013) 2, 025202
[ABC-effect as a signal of chiral symmetry restoration in hadronic collisions]







t-channel excitation of d*(2380) in pd->pdππ at ANKE@COSY

V.I. Komarov et al., Eur. Phys. Jour. A 54 (2018) 206

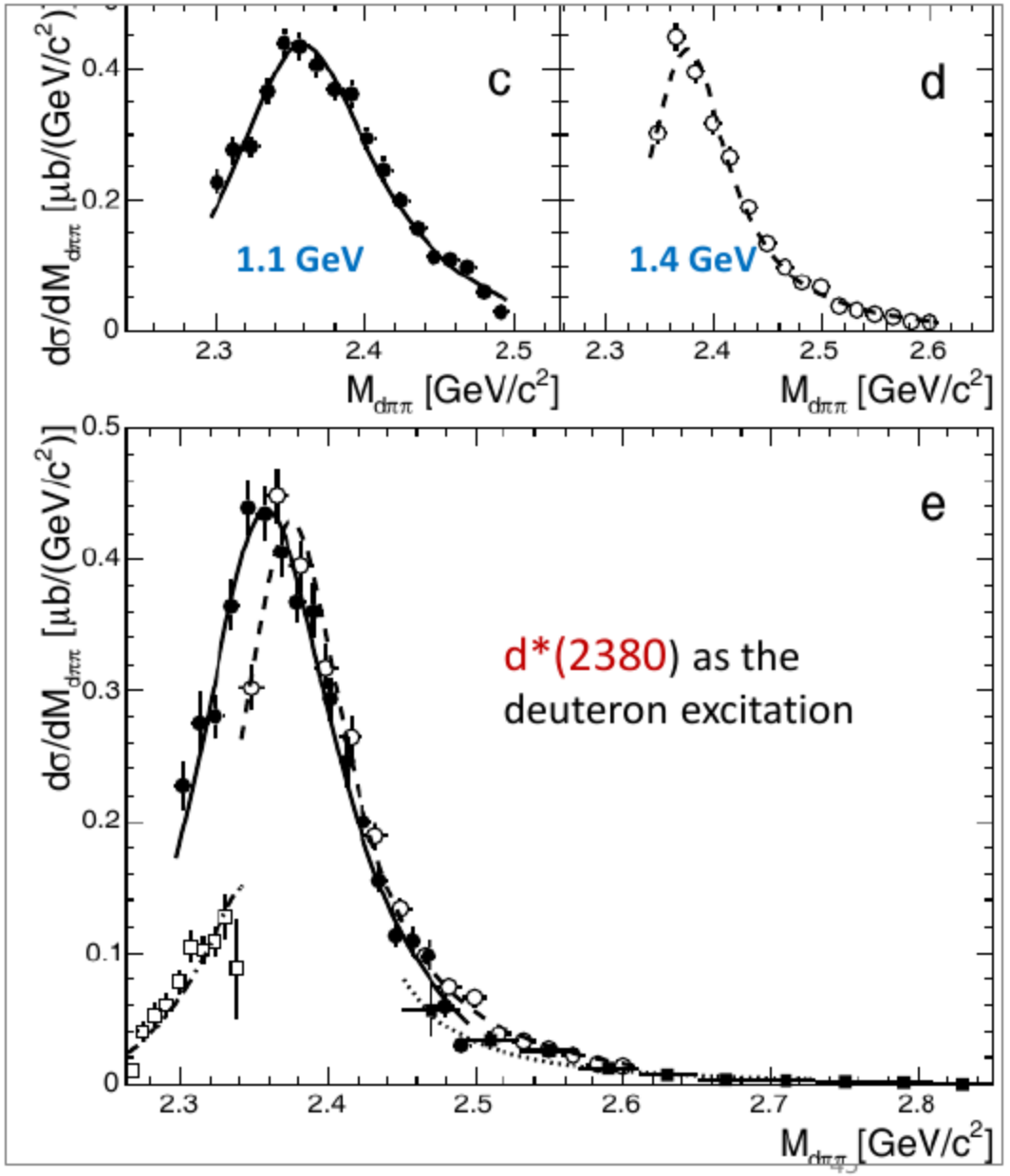
Eur. Phys. J. A (2018) 54: 206
DOI 10.1140/epja/i2018-12641-0

THE EUROPEAN PHYSICAL JOURNAL A

Regular Article – Experimental Physics

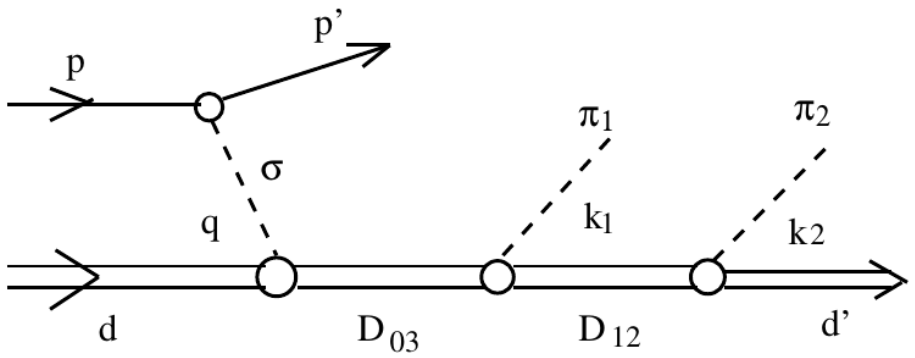
Resonance-like coherent production of a pion pair in the reaction pd → pdππ in the GeV region

V.I. Komarov[1], D. Tsirkov[1,a], T. Azaryan[1], Z. Bagdasarian[2,3], B. Baimurzinova[4,5], S. Barsov[6], S. Dymov[1,2], R. Gebel[2], M. Hartmann[2], A. Kacharava[2], A. Khoukaz[7], A. Kulikov[1], A. Kunsafina[1,4,5], V. Kurbatov[1], Zh. Kurmanaliyev[1,4,5], B. Lorentz[2], G. Macharashvili[3], D. Mchedlishvili[2,3], S. Merzliakov[2], S. Mikirtytchiants[2,6], M. Nioradze[3], H. Ohm[2], F. Rathmann[2], V. Serdyuk[2], V. Shmakova[1], H. Ströher[2], S. Trusov[2,8], Yu. Uzikov[1,9,10], Yu. Valdau[2,6], and C. Wilkin[11]



Admixture of isovector component was not excluded.
This channel is suitable for study at SPD NICA.

Our Model of the reaction pd->pd$\pi\pi$: PK + σ-exchange in t-channel



… + D_{03}->σd

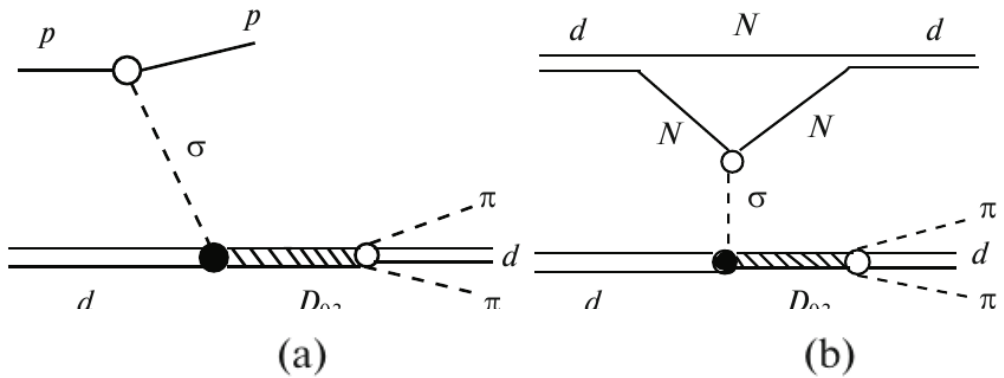
Excitation of dibaryons in the s-channel of NN in dd-> NN+d+$\pi\pi$ is not possible at SPD: sqrt{s_{NN}}=E^d_{cm}, where E^d_{min}=4 GeV > 2.38 – 2.63 GeV.

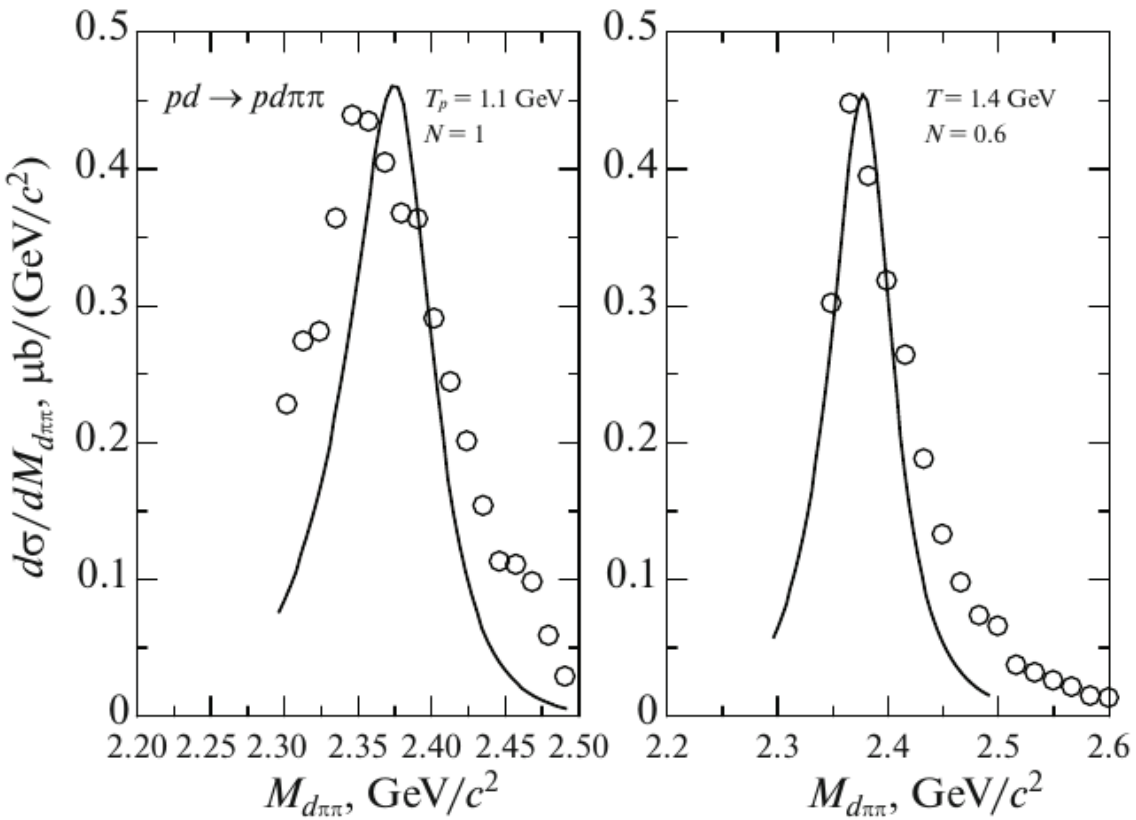
The t-channel excitation of dibaryons in pd- (or pd-) collisions is possible at SPD, like was at ANKE@COSY

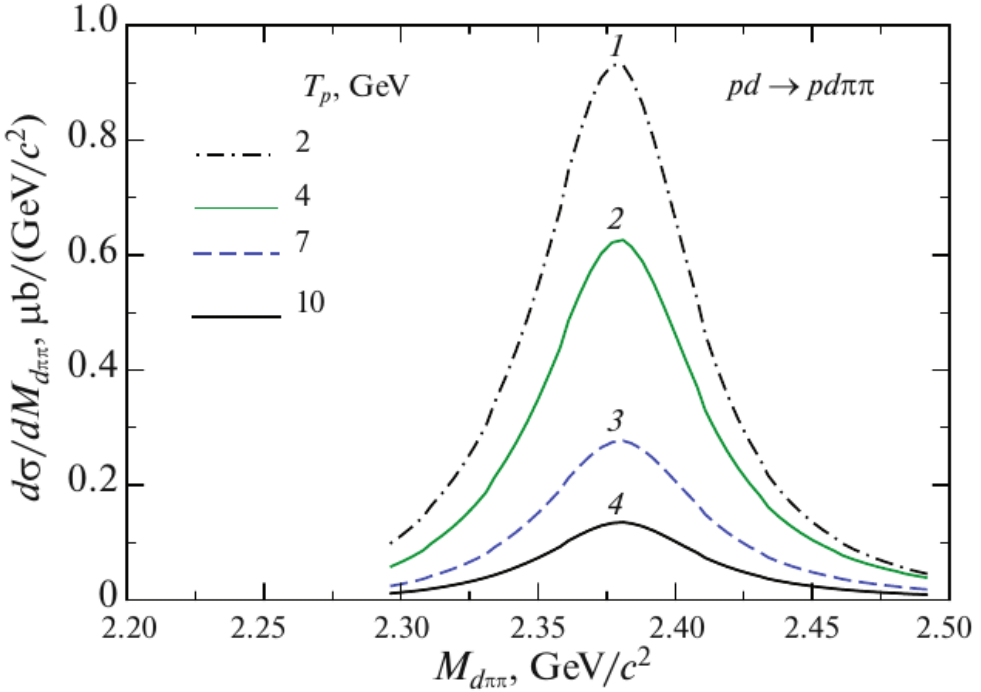
$$M^{\lambda'_p\lambda'_d}_{\lambda_p\lambda_d}(pd \to pd\pi\pi) = M^{\lambda'_p}_{\lambda_p}(p \to p'\sigma)\frac{1}{p_\sigma{}^2 - m_\sigma{}^2 + im_\sigma\Gamma_\sigma}M^{\lambda'_d}_{\lambda_d}(\sigma d \to d\pi\pi),$$

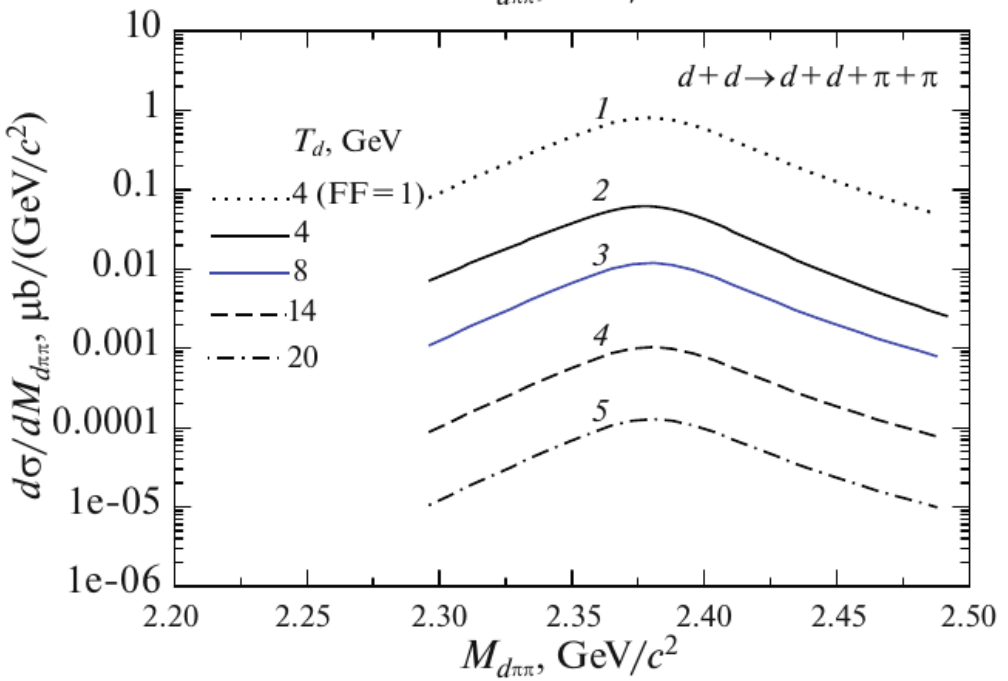
Yu. N. Uzikov, N. Tursunbayev, EPJ Web of Conf. **204** (2019) 08010 ;
Yu.N.Uzikov, A.A. Temerbayev, N.Tursunbayev , Phys. Part. Nucl. 57 № 5 (2026) 1026;

Yu.N. Uzikov, A.A. Temerbaeyv, N.T. Tursunbayev,
Phys.Part. Nucl. 57 №5 (2026) 1026; arXiv:2511.00587 [nucl-th]

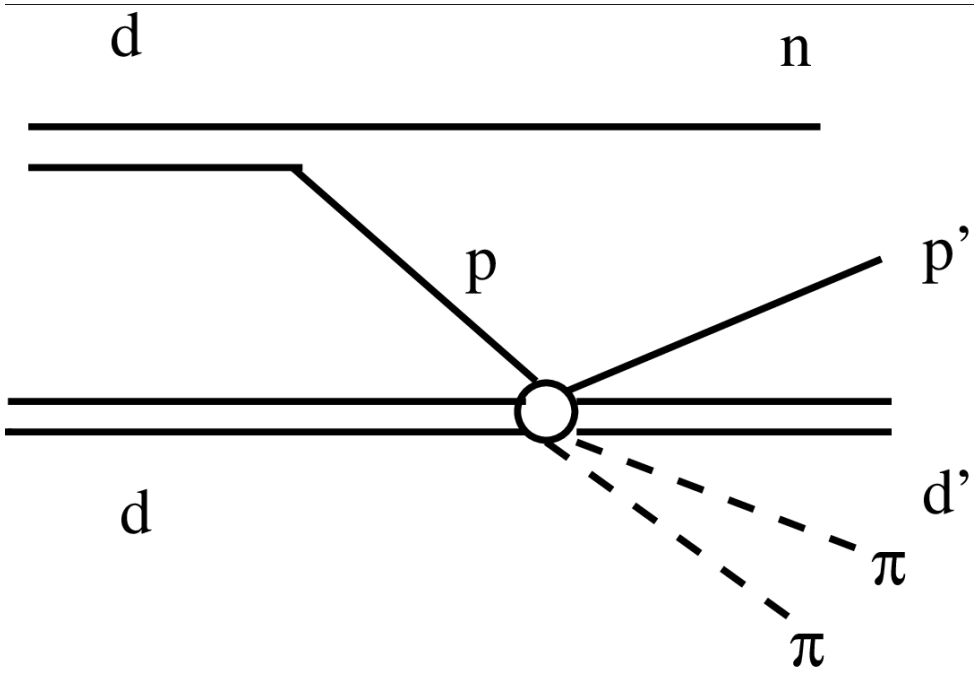








Another way: pd-> pd $\pi\pi$ subprocess in the dd-> npd $\pi\pi$ reaction



If all charged particles are detected in |f> and their 3-momenta are measured, then the missing invariant mass $M_x=m_n$ (neutron) will be reconstructed and its 3-momentum.

T.C. Jude, S. Alef, R. Beck et al.

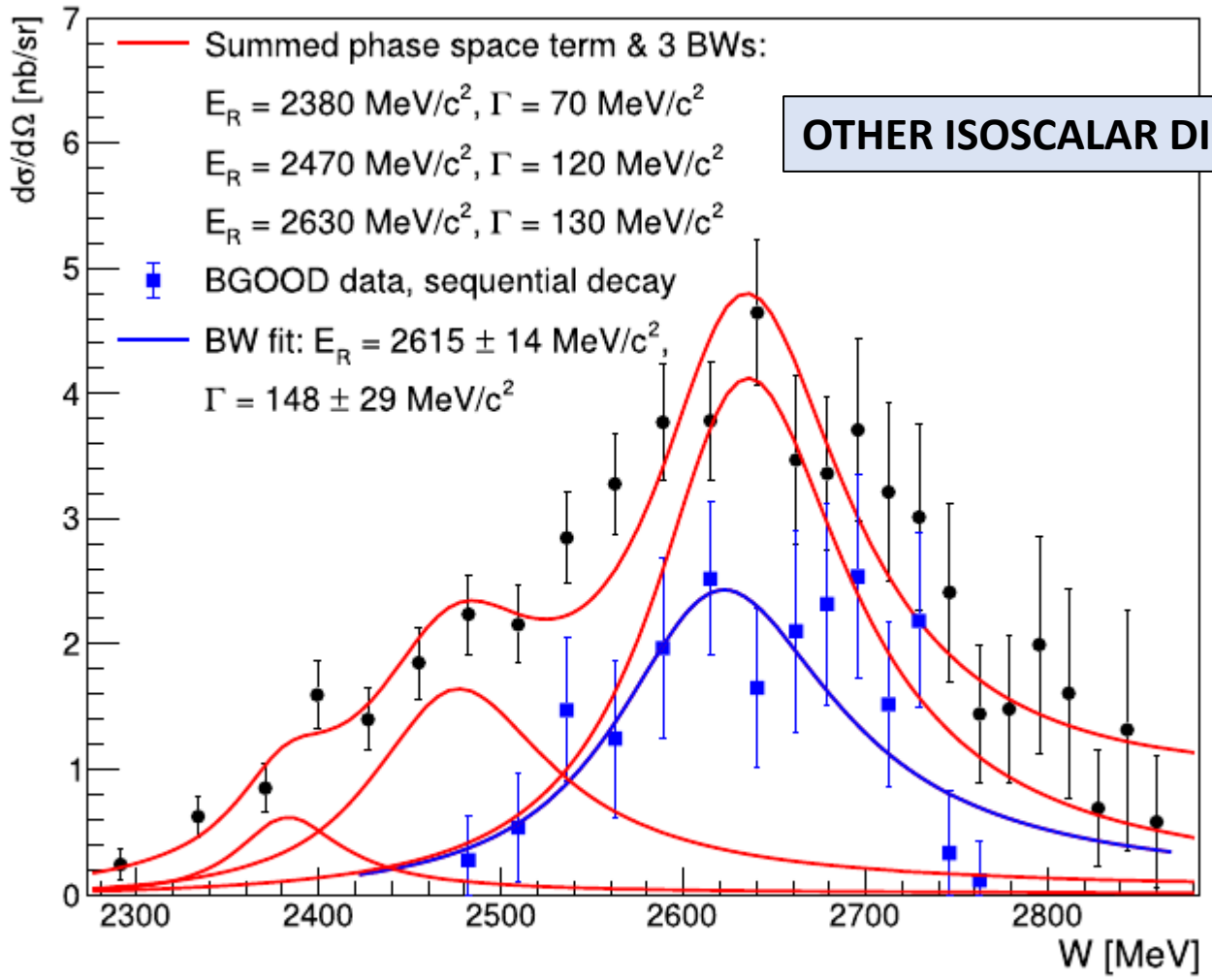


Fig. 7. $\gamma d \to \pi^0\pi^0 d$ differential cross section for $\cos\theta^d_{CM} > 0.8$ (the same as in Fig. 5). A fit including three Breit-Wigner functions (BW) are shown as the red lines, with the fixed masses and widths labelled inset. The additional small centre-

Germany: T.C. Jude, S. Alef, R. Beck et al.
(BGOOD at ELSA Coll.) PLB 8328 (2022) 137277

OTHER ISOSCALAR DIBARYONS

γ+d -> d$\pi^0\pi^0$

Japan: T. Ishikawa et al., (ELPH Coll) PLB 798 (2019) 413:
M_D= 2380, 2470, 2630 MeV

$\pi^0\pi^0$: I=0, 2

Isoscalar resonances: I=0

What is the origin of
the 2470 , 2630 MeV resonances?
Relation to the 2380 MeV?

Indications for isovector resonances
in γd->dπ

Is a possibility to search in dd- dd$\pi\pi$ and pd-pd$\pi\pi$ at SPD NICA?

ISOVECTOR TWO-BARYON RESONANCES

Resonant behavior of the $pp \to \{pp\}_s\pi^0$ reaction at the energy $\sqrt{s} = 2.65$ GeV

D. Tsirkov,[1] B. Baimurzinova,[1,2,3,*] V. Komarov,[1] A. Kulikov,[1] A. Kunsafina,[1,2,3] V. Kurbatov,[1] Zh. Kurmanalyiev,[1,2,3] and Yu. Uzikov[1,4,5]

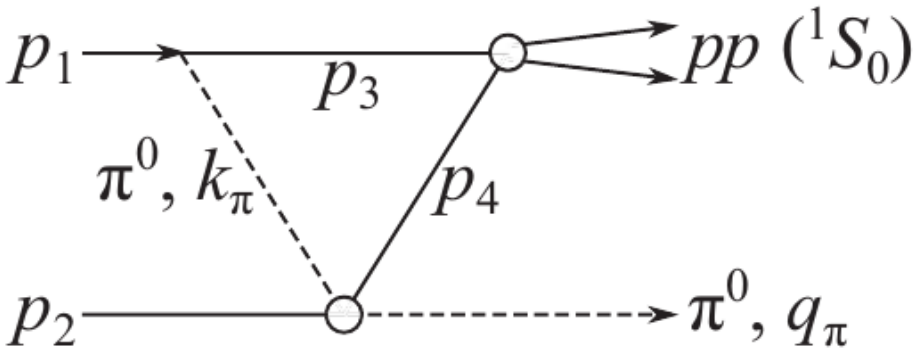
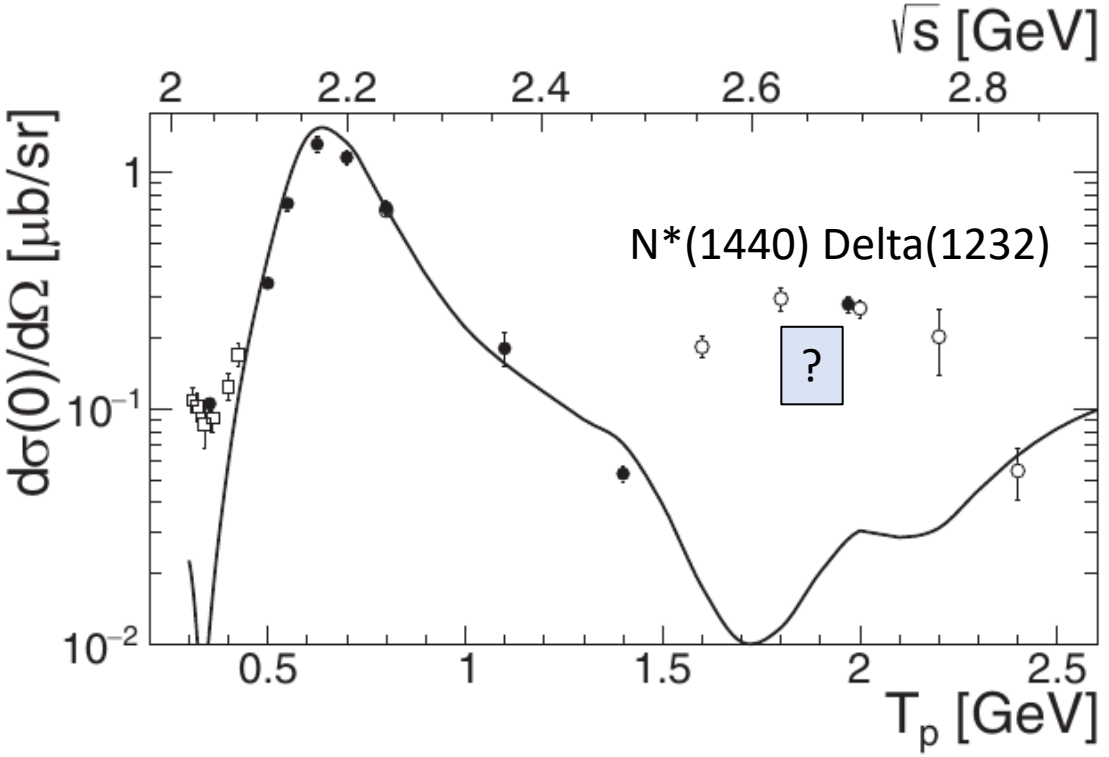


FIG. 6. The OPE mechanism of the reaction $pp \to \{pp\}_s\pi^0$.

shown. Note that the slope changes its sign in the region of the observed peak.



V. DISCUSSION

SUMMARY and OUTLOOK

- Properties of non-strange dibaryons are important for understanding short-range NN- dynamics $\Longrightarrow$SRC, infinite nuclear matter, neutron stars. Are they compact objects or quasi-molecules?

- Search for isoscalar dibaryons d* with M=2380 and 2470, 2630 MeV is desirable at the first phase of the SPD NICA in dd-collisions at sqrt{s_{dd}} =4-5 GeV.

- The cross sections of **dd->d*d->dd $\pi\pi$ and pd->pd $\pi\pi$** are estimated within the PK model. **The pd->pd$\pi\pi$ is more preferable, can be extracted from the dd->n+pd$\pi\pi$ in the region of dominance of the IA.**

- **Joint work using quark model of the Y. Dong theory group is planned.**

THANK YOU FOR ATTENTION!

Compositeness criterion

/for mesons X(3872), Y(4260)… /

Weinberg (1965), Morgan (1991), Tornquist (1995), **Baru, Haidenbauer, Hanhart,** ... (2003), . . .

- Wave fct. of a bound state with a compact & a two-hadron component in S-wave:

$$|\Psi\rangle = \begin{pmatrix} \sqrt{Z}|\psi_0\rangle \\ \chi(\vec{k})|h_1 h_2\rangle \end{pmatrix}$$

compact comp. w/ probability $\sqrt{Z}$

two-hadron comp. w/ relative w.f. $\chi(\vec{k})$

- consider the scattering amplitude and compare with the ERE:

$$a = -2\frac{1-Z}{2-Z}\left(\frac{1}{\gamma}\right) + \mathcal{O}\left(\frac{1}{\beta}\right) \;,\; r = -\frac{Z}{1-Z}\left(\frac{1}{\gamma}\right) + \mathcal{O}\left(\frac{1}{\beta}\right) \qquad \gamma = \sqrt{2\mu B}$$

a = scattering length, γ/B = binding momentum/energy (**shallow** b.s.)

μ = reduced mass of the two-particle system, $1/\beta$ = range of forces

$\Rightarrow$ pure molecule ($Z = 0$): maximal scattering length $a = -1/\gamma$
natural effective range $r = \mathcal{O}(1/\beta)$

$\Rightarrow$ compact state ($Z = 1$): the scattering length is $a = -\mathcal{O}(1/\beta)$
effective range diverges, $r \to -\infty$

The deuteron

Weinberg (1965)

- The deuteron: shallow neutron-proton bound state ($B_d \ll m_d$):

$$B_d = 2.225\,\text{MeV} \to \gamma = 45.7\,\text{MeV} \;= 0.23\,\text{fm}^{-1}$$

- range of forces set by the one-pion-exchange:

$$1/\beta \sim 1/M_\pi \simeq 1.4\,\text{fm}$$

- set $Z = 0$ in the Weinberg formula:

$$a_{\rm mol} = -(4.3 \pm 1.4)\,\text{fm}\,, \quad r_{\rm mol} = \mathcal{O}(1.4\,\text{fm})$$

- this is consistent with the data in the ${}^3S_1$ channel:

$$a = -5.419(7)\,\text{fm}\,, \;\; r = 1.764(8)\,\text{fm}$$

The deuteron is not a compact object, but is a molecula (Z=0)

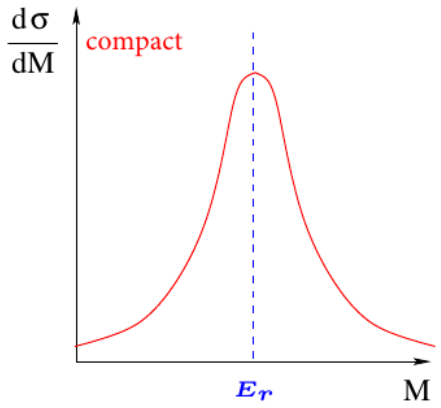
Details in: Guo, Hanhart, UGM, Wang, Zhao, Zou, Rev. Mod. Phys. **90** (2018) 015004

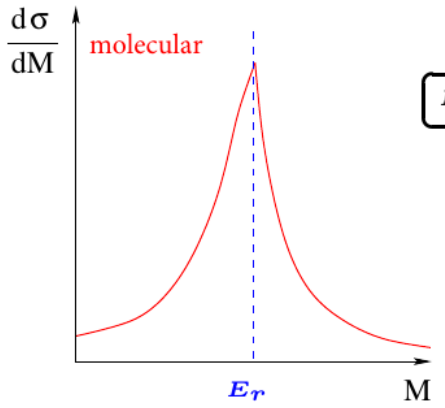
- Still assume closeness to a two-particle threshold:

$$T(E) = \frac{g^2/2}{E - E_r + (g^2/2)(ik + \gamma) + i\Gamma_0/2}$$

with $E = k^2/(2\mu)$, Γ_0 accounts for the inelasticities of other channels

- leads to very different **line shapes** for compact and molecular states:





$M = m_1 + m_2 + E$

k^2 term dominates → symmetric

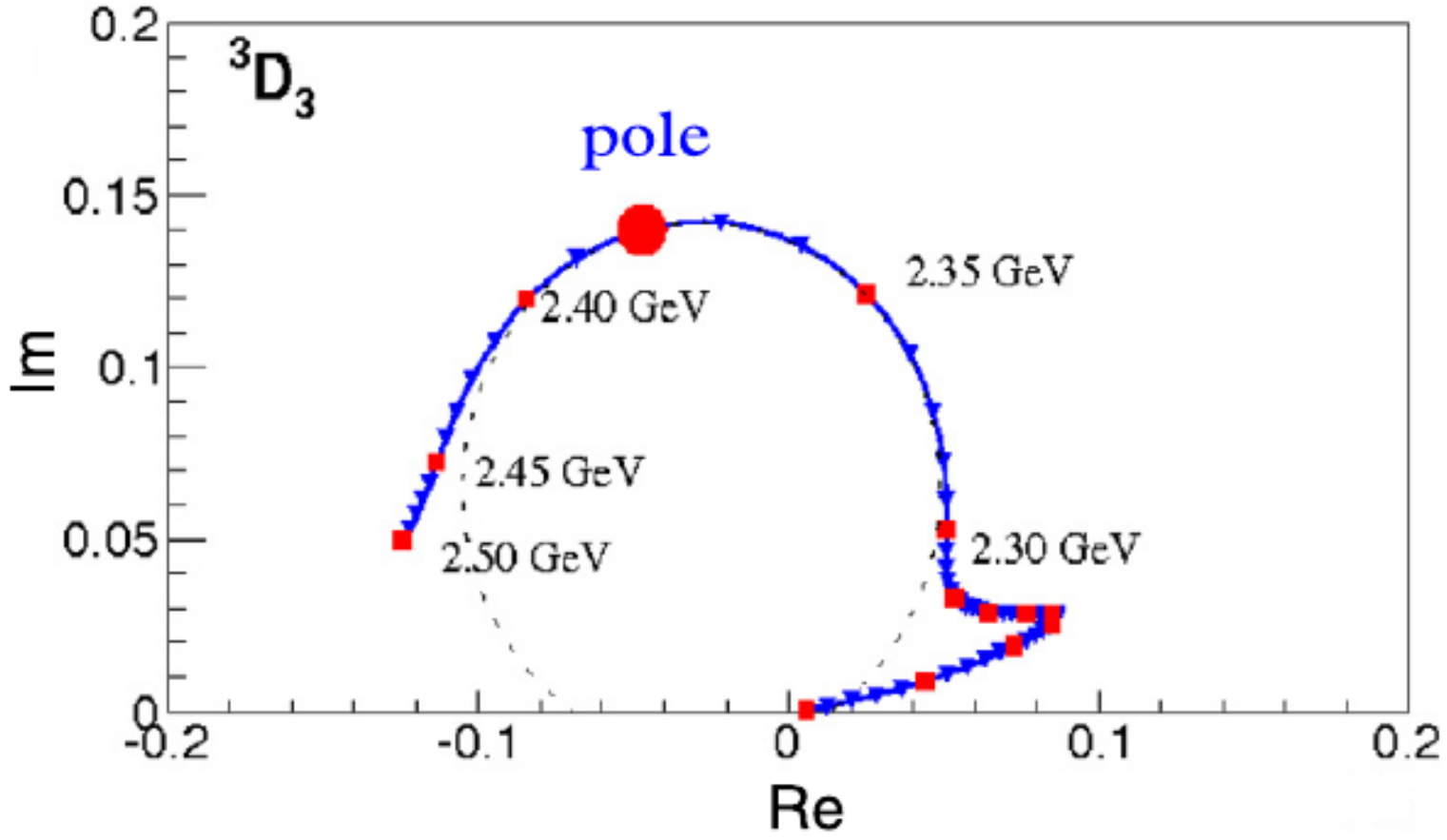
g^2 term dominates → asymmetric/cusp

- extension to instable particles/additional poles have also been worked out

pn->d*(2380)->np , dσ/dM measurement is required with high precision;
Coupled channels effect has to be t taken into account.
Apply this criterion to Y. Dong et al. results for pn->d*->pn

ARGAND PLOT FOR pn->pn; the pole is at invariant mass of the pn M=2380 MeV

P. Adlarson et al., PRC 90 (2014) 035204



History of the ABC effect

Low mass enhancement in $M_{\pi\pi}$

$$pn \to d\pi^0\pi^0 / d\pi^+\pi^-$$

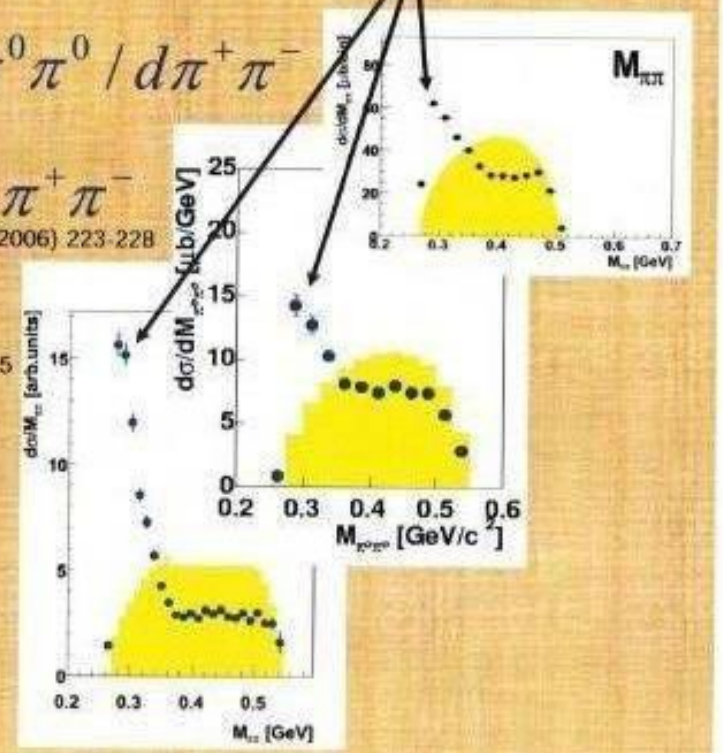
- $pd \to {}^3He\pi^0\pi^0 / \pi^+\pi^-$

M.Bashkanov *et.* al, Phys. Lett. **B637** (2006) 223-228

$$dd \to {}^4He\pi^0\pi^0 / \pi^+\pi^-$$

A. Pricking HK25

- Alexander **A**bashian,
  Norman E. **B**ooth
  Kenneth M. **C**rowe,
  Phys. Rev. Lett. **5**, 258 (1960)

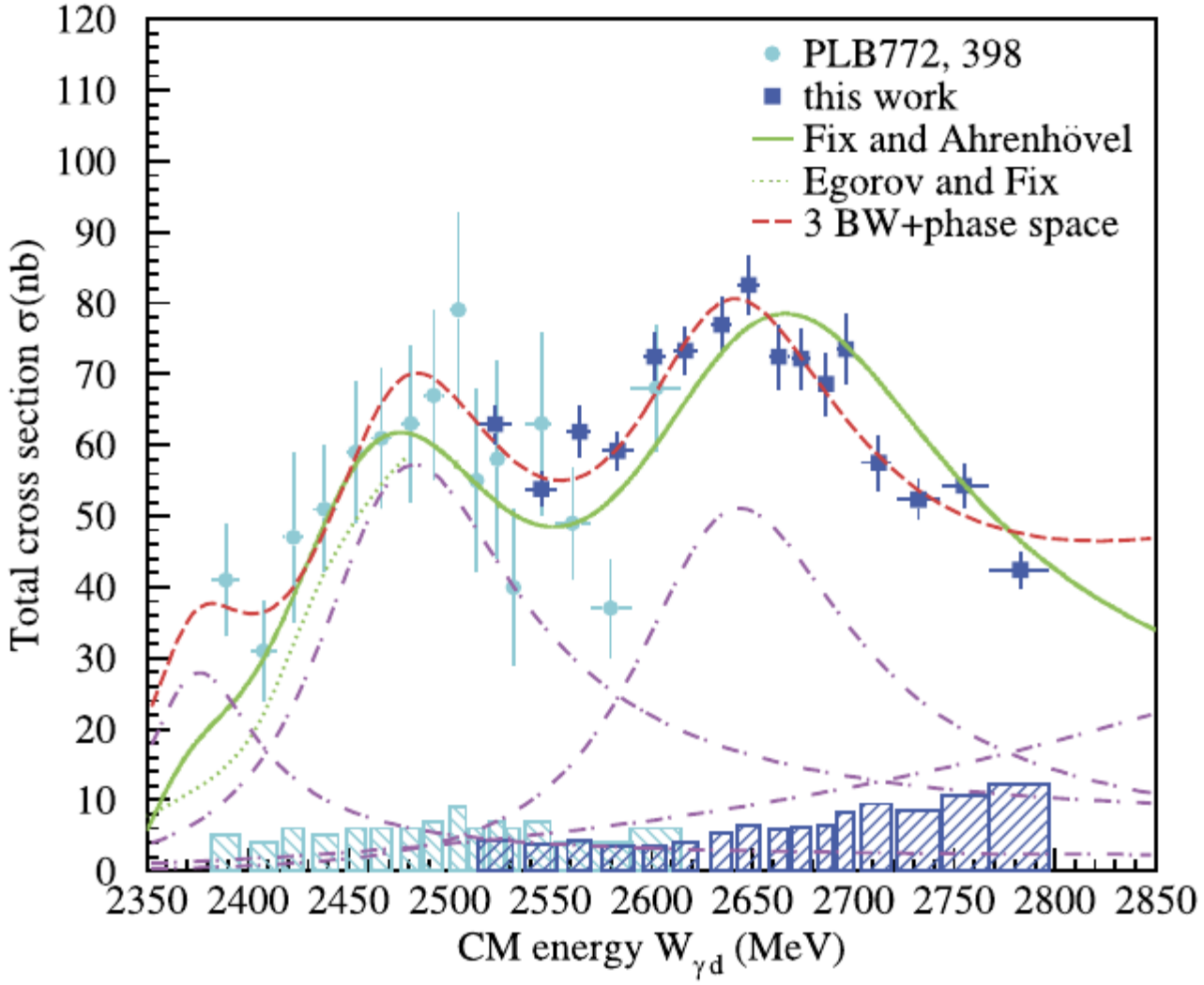


from talk by M. Bashkanov, DFG -meeting (Bonn,2010); $I_{\pi\pi} = 0 \implies$ ABC
http://wasasrv.ikp.kfa-juelich.de/WasaWiki/index.php/File:MB100716-ABC-meson10.pdf

Japan: T. Ishikawa et al., (ELPH Coll) PLB 798 (2019) 413:
M_D= 2380, 2470, 2630 MeV

OTHER ISOSCALAR DIBARYONS

$$\gamma + d \rightarrow d\pi^0\pi^0$$



1982 г. Февраль Том 136, вып. 2

УСПЕХИ ФИЗИЧЕСКИХ НАУК

ДИБАРИОННЫЕ РЕЗОНАНСЫ

М. М. Макаров

Reference to
H. Ikeda et al.,
PRL 42, №20 (1979) 1321;
γd→np

Assumption:
Dibaryon resonance = 6q

Angular Dependence of Proton Polarization in the Reaction $\gamma d \rightarrow pn$ and a Partial-Wave Analysis of Possible Dibaryon Resonances

H. Ikeda,[a] I. Arai, H. Fujii, T. Fujii, H. Iwasaki, N. Kajiura,[a] T. Kamae
K. Nakamura, T. Sumiyoshi, and H. Takeda[b]
Department of Physics, University of Tokyo, Tokyo 113, Japan

and

K. Ogawa
National Laboratory for High Energy Physics, Tsukuba, Ibaraki 300-32, Japan

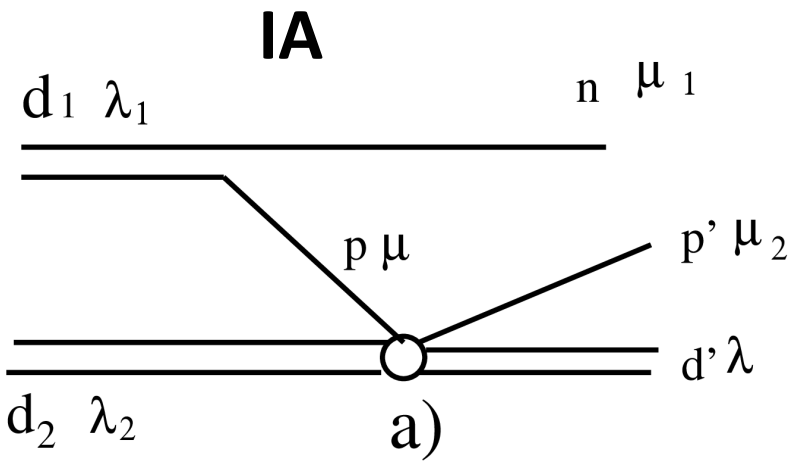
and

M. Kanazawa
Institute for Nuclear Study, University of Tokyo, Tokyo 188, Japan

(Received 22 March 1979)

The angular dependence of proton polarization in $\gamma d \rightarrow pn$ has been measured at photon energies between 400 and 650 MeV. The polarization and differential-cross-section data are consistently explained by introducing a dibaryon resonance $I(J^P) = 0(3^+)$ or $0(1^+)$ at ≈ 2360 MeV.

Relations between dd→ npd and pd→ pd in the IA



S-wave dominates at q<0.15 GeV/c and rescatterings are suppressed

Asymmetric pd-mode will be not available at NICA SPD, while symmetric dd mode will be established.

$$|M(dd \to npd)|^2 = K[u^2(q) + w^2(q)]\,|M(pd \to pd)|^2$$

$d_2^{\uparrow}$: Vector or tensor Polarized

$$A_Y^d(dd_2^{\uparrow} \to npd) = A_Y^d(pd^{\uparrow} \to pd),$$

$$A_{YY} = (dd_2^{\uparrow} \to npd) = A_{YY}(pd^{\uparrow} \to pd)$$

$d_1^{\uparrow}$: Vector Polarized

$$A_Y^d(d_1^{\uparrow}d \to npd) = \frac{2}{3}A_Y^p(p^{\uparrow}d \to pd)$$

Both d_1 and d_2 deuterons are vector or tensor polarized:

$$C_{Y,Y}(d^{\uparrow}d^{\uparrow} \to npd) = \frac{2}{3}C_{y,y}(p^{\uparrow}d^{\uparrow} \to pd)$$

$$C_{Y,YY}(d^{\uparrow}d^{\uparrow} \to npd) = \frac{1}{3}C_{y,yy}(p^{\uparrow}d^{\uparrow} \to pd)$$

Yu. N. Uzikov, e-Print: 2506.17799 [nucl-th] (PEPAN Lett. (2025))

dd-npd MC simulations: A. Datta, I.I. Denisenko ,Yu.N. U. (see talk by A. Datta)

$$M^{\lambda'_p\lambda'_d}_{\lambda_p\lambda_d}(pd \to pd\pi\pi) = M^{\lambda'_p}_{\lambda_p}(p \to p'\sigma)\frac{1}{{p_\sigma}^2 - {m_\sigma}^2 + im_\sigma\Gamma_\sigma}M^{\lambda'_d}_{\lambda_d}(\sigma d \to d\pi\pi),$$

$$M^{\lambda'_d}_{\lambda_d}(\sigma d \to d\pi\pi) = \sum_{\lambda_2,\lambda_3,\mu,m_1,m_2} \frac{F_{D_{03}\to d\sigma}F_{D_{03}\to D_{12}\pi_1}}{P^2_{D_{03}} - M^2_{D_{03}} + iM_{D_{03}}\Gamma_{D_{03}}} \frac{F_{D_{12}\to d\pi_2}}{P^2_{D_{12}} - M^2_{D_{12}} + iM_{D_{12}}\Gamma_{D_{12}}}$$
$$\times(1\lambda_d 2\mu|3\lambda_3)\mathcal{Y}_{2\mu}(\hat{\mathbf{q}})(2\lambda_2 1m_1|3\lambda_3)\mathcal{Y}_{1m_1}(\hat{\mathbf{k}}_1)(1\lambda'_d 1m_2|2\lambda_2)\mathcal{Y}_{1m_2}(\hat{\mathbf{k}}_2) + (\pi_1 \leftrightarrow \pi_2),$$

$$\frac{F_{D_{03}\to d\sigma}(q)}{M_{D_{03}}(q)} = \sqrt{\frac{8\pi\Gamma^{(l=2)}_{D_{03}\to d\sigma}(q)}{q^5}}, \quad \Gamma^{(l=2)}_{D_{03}\to d\sigma}(q) = \Gamma^{(l=2)}_{D_{03}\to d\sigma}\Big(\frac{q}{q_0}\Big)^5\Big(\frac{q_0^2+\lambda^2_{d\sigma}}{q^2+\lambda_{d\sigma}}\Big)^3,$$

$$\frac{F_{D_{03}\to D_{12}\pi_1}(k_1)}{M_{D_{12}\pi}(k_1)} = \sqrt{\frac{8\pi\Gamma^{(l=1)}_{D_{03}\to D_{12}\pi}(k_1)}{k_1^3}}, \quad \Gamma^{(l=1)}_{D_{03}\to D_{12}\pi}(k_1) = \Gamma^{(l=1)}_{D_{03}\to D_{12}\pi}\Big(\frac{k_1}{k_{10}}\Big)^3\Big(\frac{k_{10}^2+\lambda^2_{D_{12}\pi}}{k_1^2+\lambda_{D_{12}\pi}}\Big)^2$$

$$\frac{F_{D_{12}\to d\pi_2}(k_2)}{M_{d\pi_2}(k_2)} = \sqrt{\frac{8\pi\Gamma^{(l=1)}_{D_{12}\to d\pi}(k_2)}{k_2^3}}, \quad \Gamma^{(l=1)}_{D_{12}\to d\pi}(k_1) = \Gamma^{(l=1)}_{D_{12}\to d\pi}\Big(\frac{k_2}{k_{20}}\Big)^3\Big(\frac{k_{20}^2+\lambda^2_{d\pi}}{k_2^2+\lambda_{d\pi}}\Big)^2.$$

$$\Gamma(p) = \Gamma(p_0)\left(\frac{p}{p_0}\right)^{2l+1}\left(\frac{p_0^2+\Lambda^2}{p^2+\Lambda^2}\right)^{l+1}$$

The following numbers were used in our calculations for the D_{03} and D_{12} resonances and the vertices parameters: $M_{D_{03}} = 2.380$ GeV, $\Gamma_{D_{03}} = 70$ MeV, $M_{D_{12}} = 2.15$ GeV, $\Gamma_{D_{12}} = 0.11$ GeV, $m_\sigma = 0.5$ GeV, $\Gamma_\sigma = 0.55$ GeV, $q_0 = 0.362$ Gev/c, $k_{10} = 0.177$ GeV/c, $k_{20} = 0.224$ GeV/c, $\lambda_{\pi D_{12}} = 0.12$ GeV. The values $\Gamma^{(l=1)}_{D_{12}\to d\pi} = 10$ MeV, $\lambda_{d\sigma} = 0.18$ GeV and $\lambda_{d\pi} = 0.25$ GeV were