D-MESON PROPERTIES IN DENSE NUCLEAR MATTER

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Motivation

- Open-charm enhancement
- J/Ψ suppression
- D-mesic nuclei

m=495.67 MeV　　　　m=1866.9 MeV

$$\bar{K} = \begin{pmatrix} \bar{K}^0 \\ -K^- \end{pmatrix} \begin{matrix} \bar{d}\,s \\ \bar{u}\,s \end{matrix} \quad s=-1 \qquad D = \begin{pmatrix} D^+ \\ D^0 \end{pmatrix} \begin{matrix} \bar{d}\,c \\ \bar{u}\,c \end{matrix} \quad c=1$$

$I(J^P)=1/2\,(0^-)$　　　　$I(J^P)=1/2\,(0^-)$

Predictions for the D-meson potential

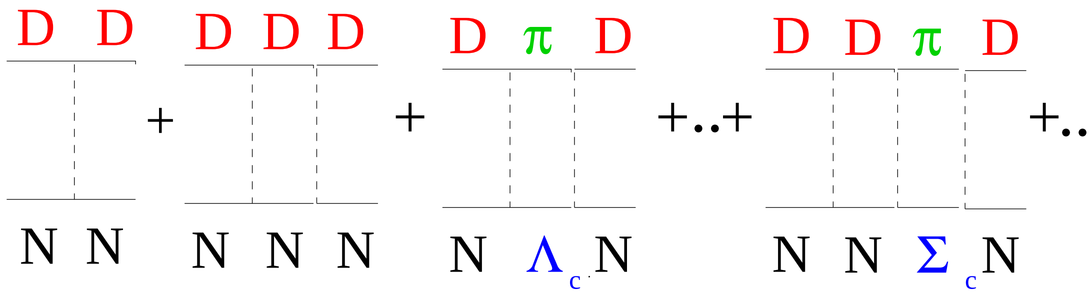
(QSR, QMC, chiral model): -50 $\sim$ -60 MeV at $\rho = \rho_0$

Coupled-channel approach: $\Lambda_c(2593)$ resonance

The s-wave DN amplitude obtained via *Lippman-Schwinger equation*

$$T_{if}(k_i,k_f;\sqrt{s}) = V_{if}(k_i,k_f) + \sum_l \int \frac{d^3k_l}{(2\pi)^3} \frac{V_{il}(k_i,k_l)\, T_{lf}(k_l,k_f;\sqrt{s})}{\sqrt{s} - E_l(k_l) - \omega_l(k_l) + i\epsilon}$$

in *coupled channels* ($\pi\Lambda_c$, $\pi\Sigma_c$, DN, $\eta\Lambda_c$ and $\eta\Sigma_c$)

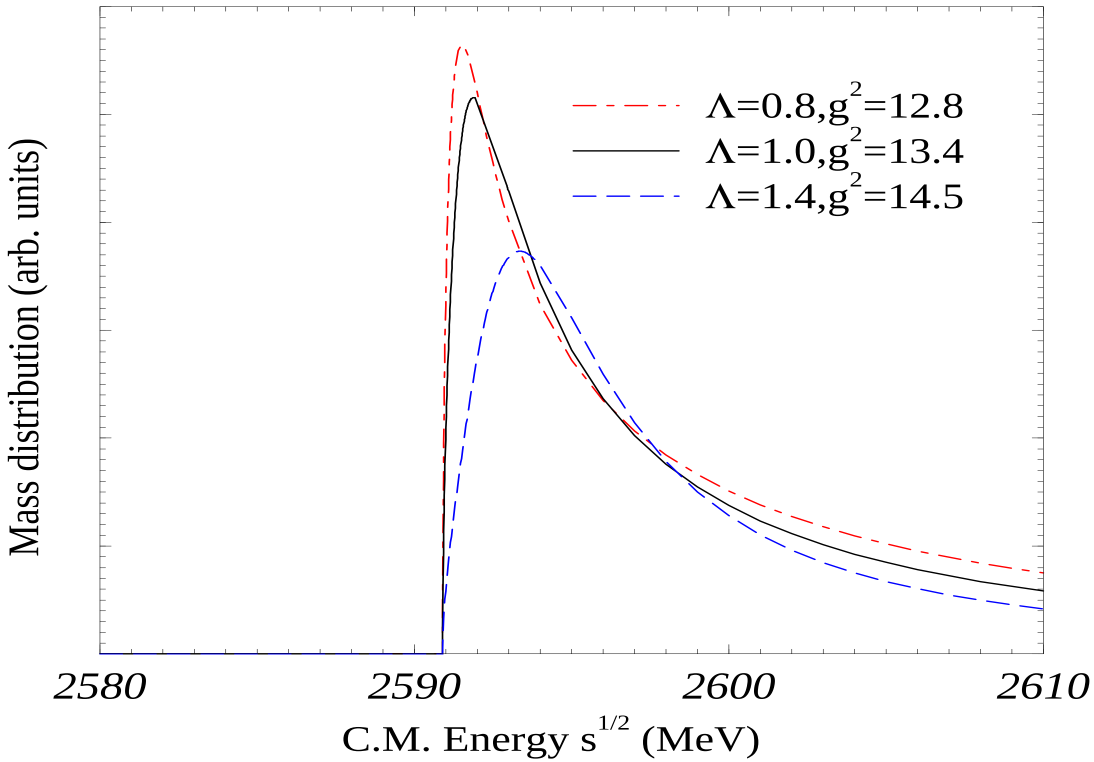


using a separable potential as bare interaction

$$V_{i,j}(k,k') = \frac{g^2}{\Lambda^2} C_{i,j} \Theta(\Lambda - k)\Theta(\Lambda - k')$$

g(coupling constant), Λ(cutoff), $C_{i,j}$(SU(3) matrix with u,d,c)

$\Lambda_c(2593)$ resonance



$I = 0,\ J^P = (1/2)^-$ with $\Gamma = 3.6^{+2.0}_{-1.3}$ MeV

$$\frac{d\sigma}{dm_{\pi\Sigma_c}} \propto \left|T^{I=0}_{\pi\Sigma_c\to\pi\Sigma_c}\right|^2 p_{cm}$$

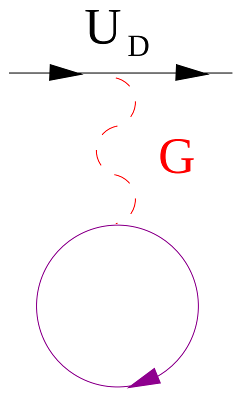
D-meson in nuclear matter

Brueckner-Hartree-Fock approach

for the in-medium DN interaction

$$G = V + V\frac{Q}{\omega - H}V + V\frac{Q}{\omega - H}V\frac{Q}{\omega - H}V + \ldots$$

$$G = V + V\frac{Q}{\omega - H}G$$



Bethe−Goldstone equation

Q Pauli blocking

H Particle dressing

$$U_D(k, E_D^{qp}) = \sum_{N \leq F} \langle DN \mid G_{DN \to DN}(\Omega = E_N^{qp} + E_D^{qp}) \mid DN \rangle$$

Self-consistently!!

After self-consistency for the on-shell $U_D(k, E_D^{qp})$,

the D-meson self-energy is

$$\Pi_D(k_D, \omega) = 2\sqrt{k_D^2 + m_D^2}\, U_D(k_D, \omega) \ ,$$

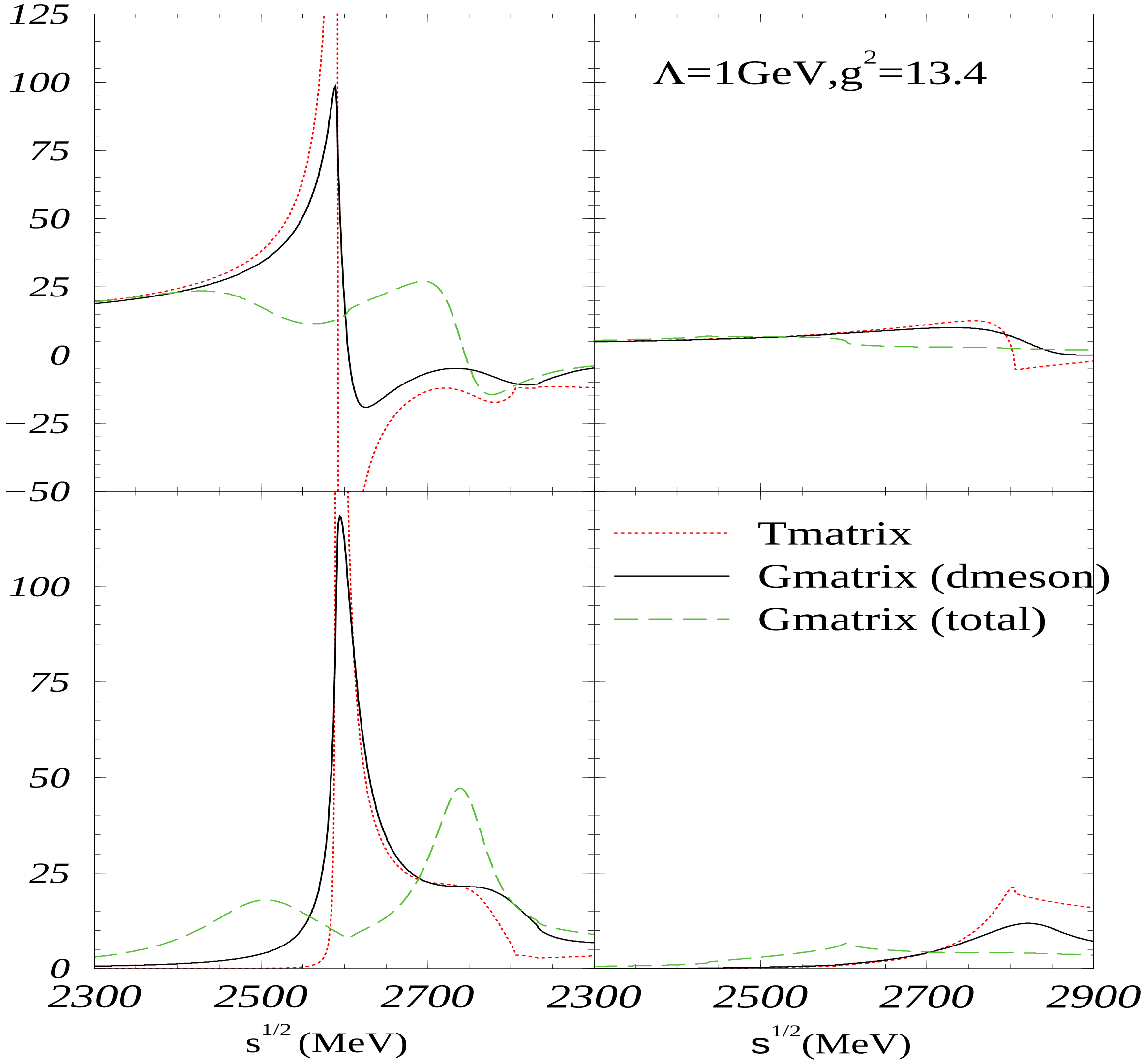
the D-meson single-particle propagator is

$$D_D(k_D, \omega) = \frac{1}{\omega^2 - k_D^2 - m_D^2 - \Pi_D(k_D, \omega)} \ ,$$

and the D-meson spectral density is

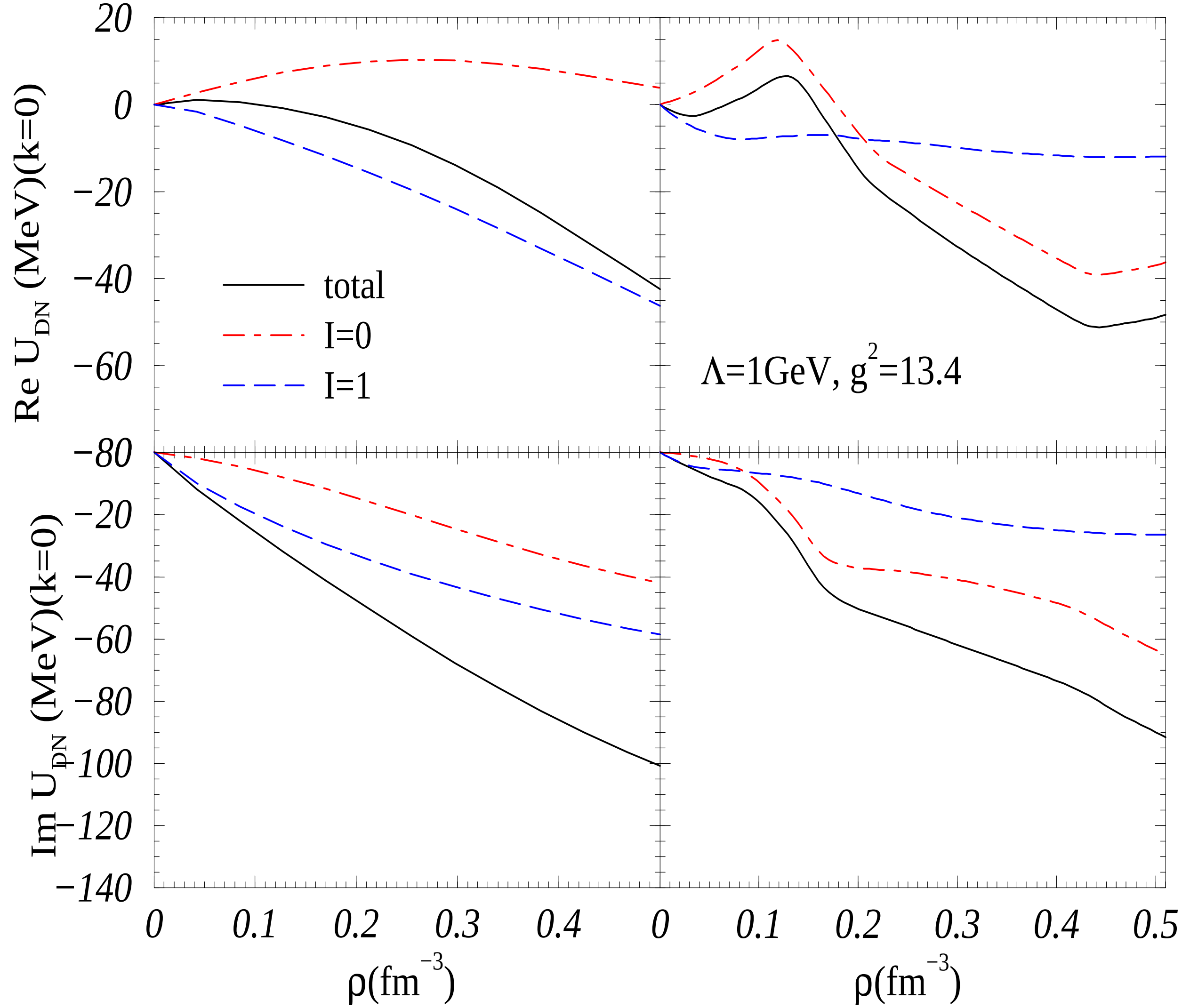
$$S_D(k_D, \omega) = -\frac{1}{\pi} \mathrm{Im}\, D_D(k_D, \omega) \ .$$

Results

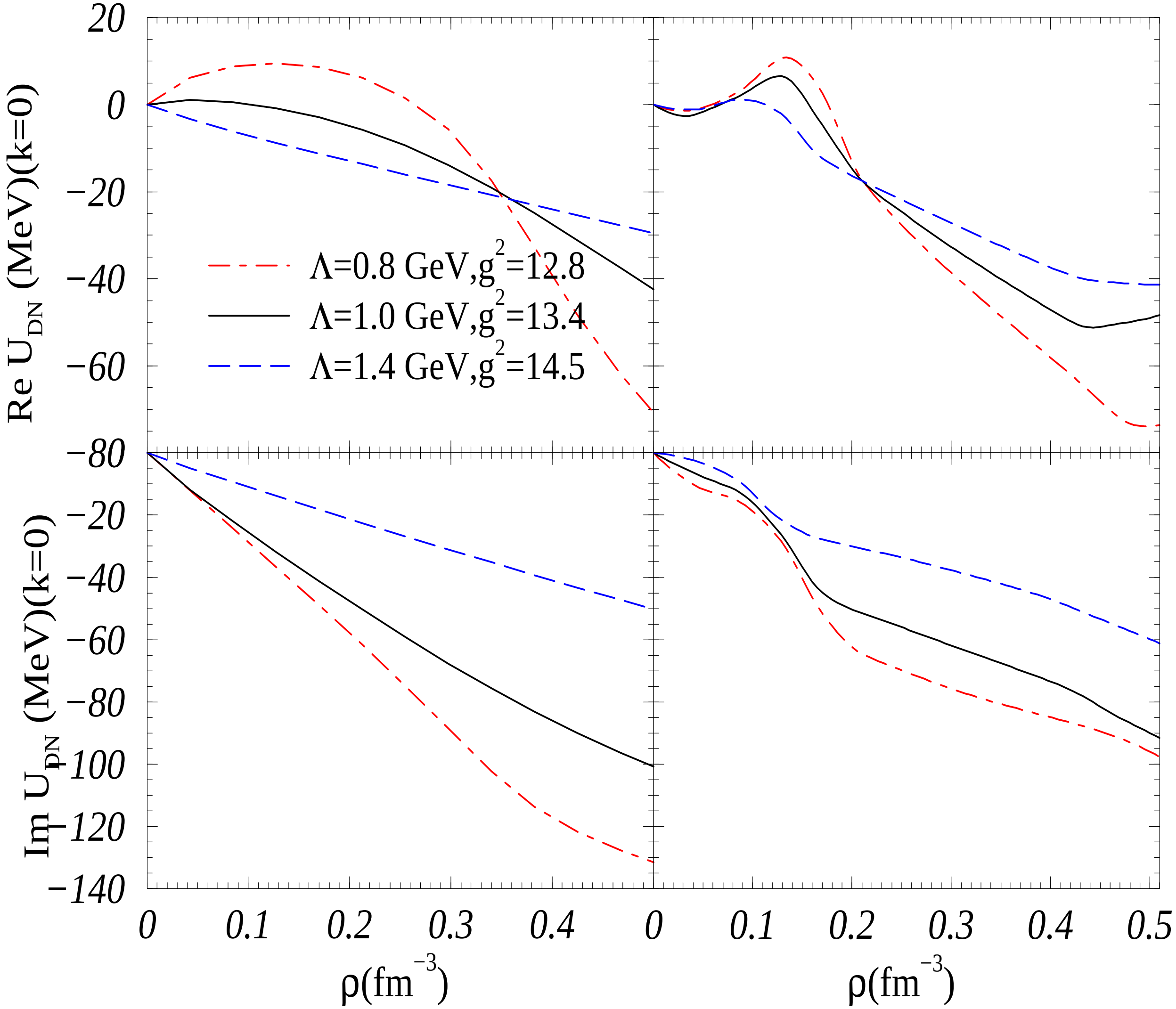


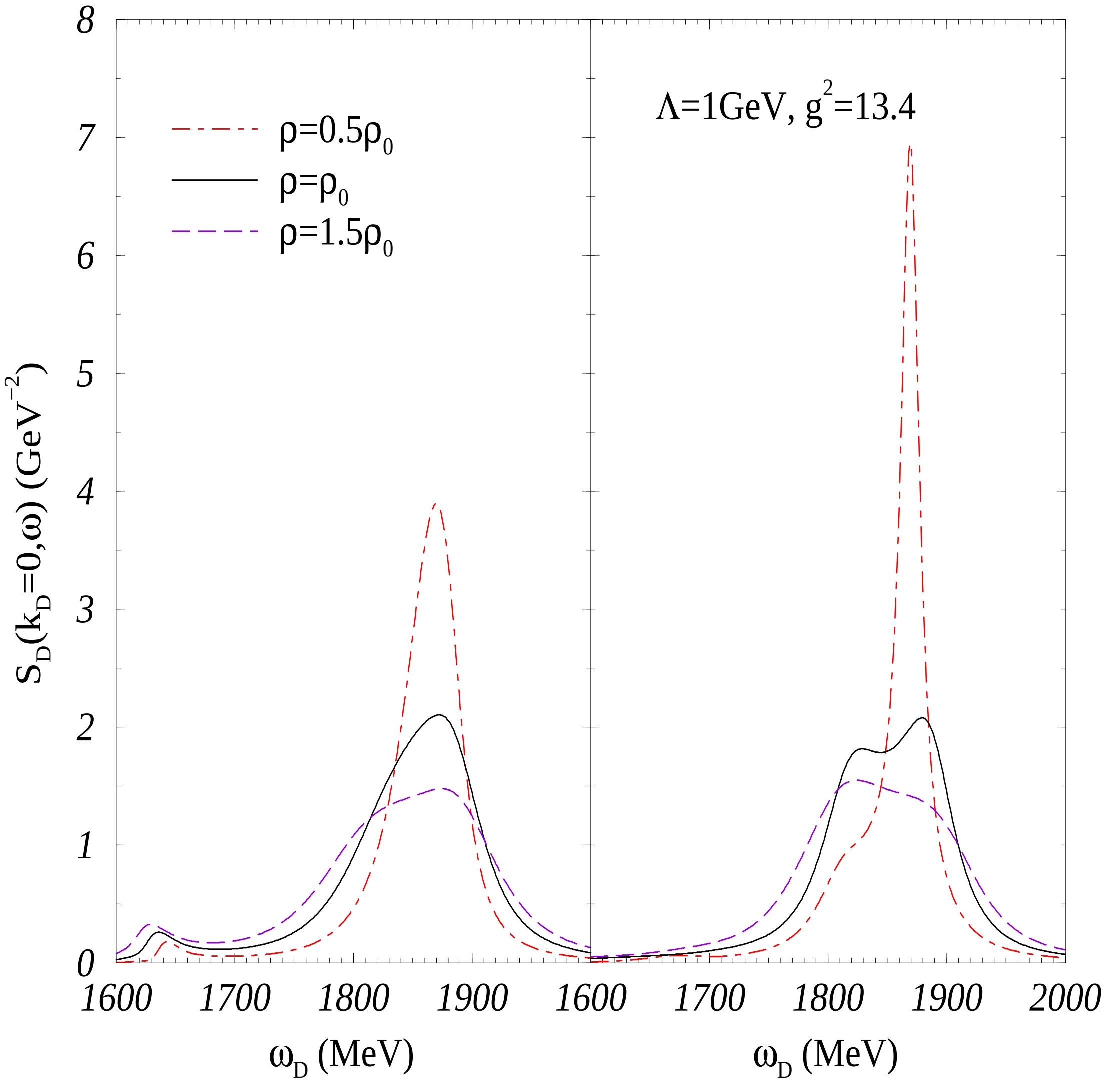
DN amplitude for I=0+ I=1

Isospin dependence & pion dressing



Dependence on g^2 and Λ





Spectral density without/with nucleon+pion dressing

Conclusions & Future

OBJECTIVE: D-meson properties in nuclear matter

METHOD: To solve the DN coupled-channel Bethe-Goldstone equation self-consistently taking as bare DN interaction a separable potential

- $\Lambda_c(2593)$ resonance generated dynamically for a given set of g^2 and Λ.
- D-meson potential obtained for two self-consistent approaches without/with dressing nucleons and pions
  - Self-consistent coupled-channel effects $\longrightarrow$ reduction of real part but important imaginary part.

Λ (GeV)	g^2	$U_D(MeV)(k=0,\rho_0)_{w/o}$	$U_D(MeV)(k=0,\rho_0)_w$
0.8	12.8	8.6-i 49.0	2.6-i 51.5
1.0	13.4	-2.9-i 41.2	-4.7-i 44.9
1.4	14.5	-11.2-i 18.2	-12.3-i 27.9

- Different isospin dominance.
- D-meson spectral density with different behaviour in the low energy region

FUTURE:

- Improve bare interaction
- PANDA experiment at GSI

More details: Phys. Rev. C 70 (2004) 025203