Hadron resonances in three-body systems made of Kaons

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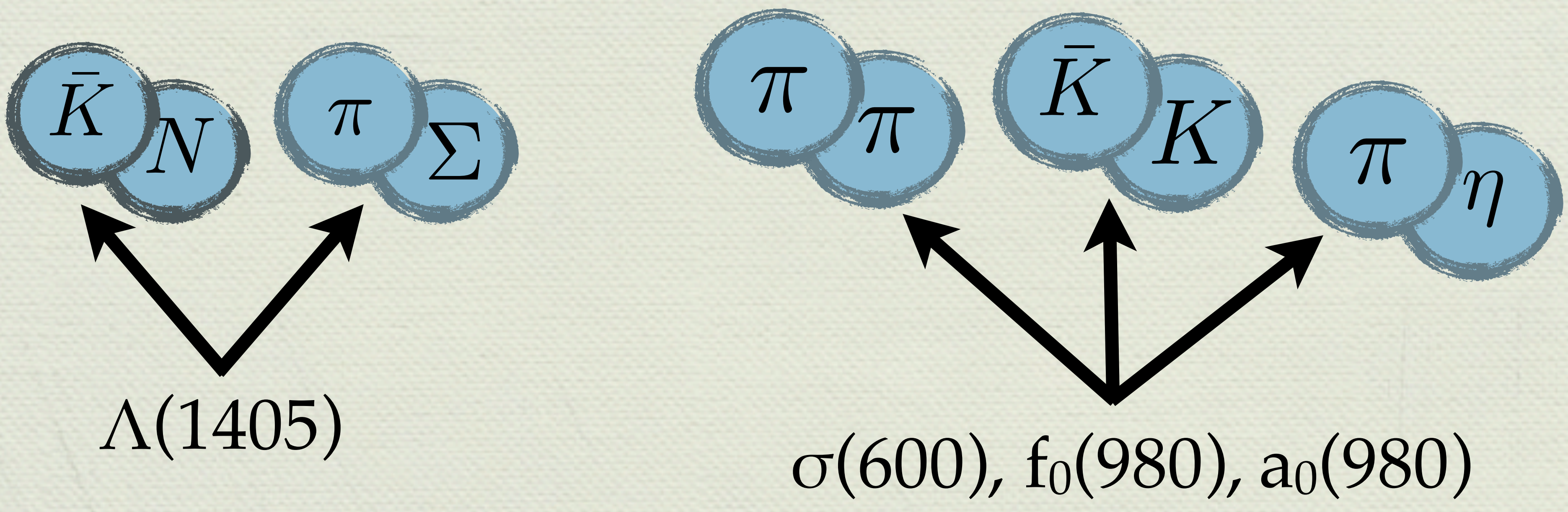
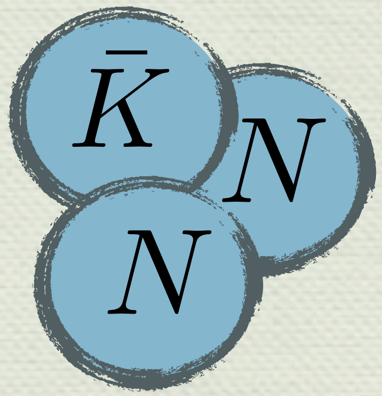
Introduction

- The study of systems made by mesons and baryons is one of the challenging issues in nuclear physics.
- The use of effective chiral Lagrangians has been very useful in understanding of the properties of several meson and baryon states.

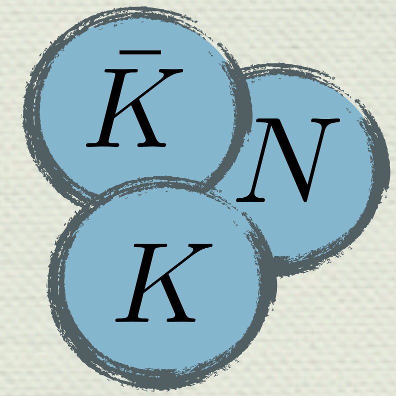


[1] J. A. Oller, Ulf-G. Meissner, Phys. Lett. B 500 (2001) 263-272; D. Jido, J. A. Oller, E. Oset, A. Ramos, U. G. Meissner, Nucl. Phys. A 725,181-200 (2003).
[2] J. A. Oller, E. Oset, Nucl. Phys. A 620 (1997) 438 ; J. A. Oller, E. Oset, J. R. Peláez, Phys. Rev. D 59 074001 (1999).
[3] J. Nieves, E. Ruiz Arriola, Phys.Rev. D64,116008 (2001); C. Garcia-Recio, J. Nieves, E. Ruiz Arriola, Phys.Rev.D67, 076009 (2003).

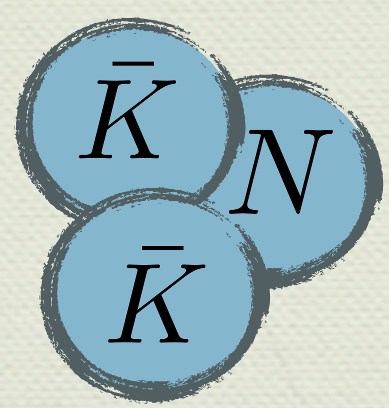
- Interest in few-body systems formed by one or more kaons



Quasibound state
(20-70 MeV) with
large width (70-100 MeV)



New N* 1/2+ around
1910 MeV



Very weakly bound state

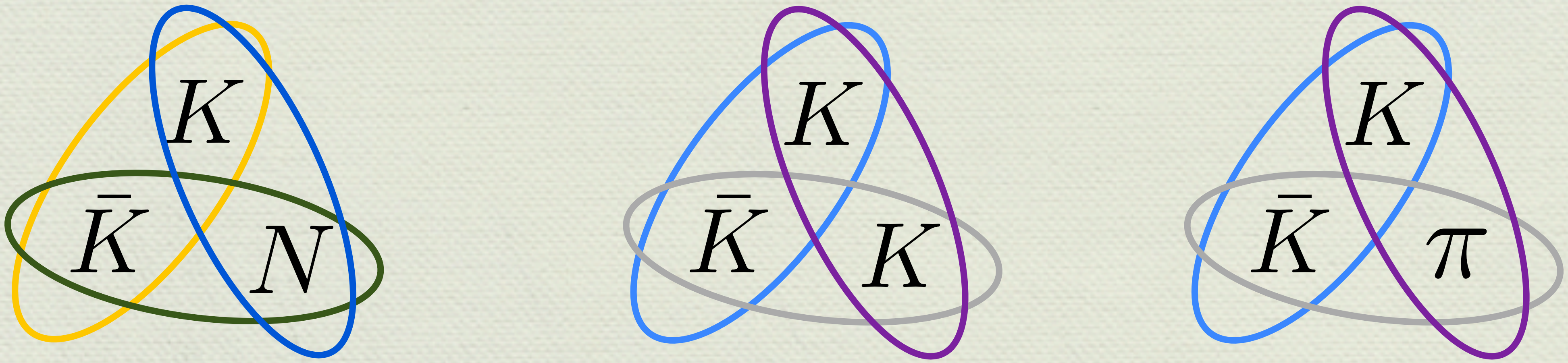
[4] Y. Ikeda and T. Sato, Phys. Rev. C 76, 035203 (2007); N.V. Shevchenko, A. Gal and J. Mares, Phys. Rev. Lett. 98, 082301 (2007); A. Dote, T. Hyodo and W. Weise, Nucl. Phys. A 804, 197 (2008); Y. Ikeda and T. Sato, Phys. Rev. C 79, 035201 (2009).
[5] D. Jido and Y. Kanada-En'yo, Phys. Rev. C **78**, 035203 (2008).[6] Y. Kanada-En'yo and D. Jido, Phys. Rev. C 78, 025212 (2008).

- Most peculiars:

$\Lambda(1405)$ → Double pole nature

$N^*(1910)$ → Simultaneous presence of the $\Lambda(1405)$ and $a_0(980)$

- We have studied the following systems



The Model

- We solve the Faddeev equations

$$T = T^1 + T^2 + T^3$$

$$T^i = t^i + t^i G[T^j + T^k]$$

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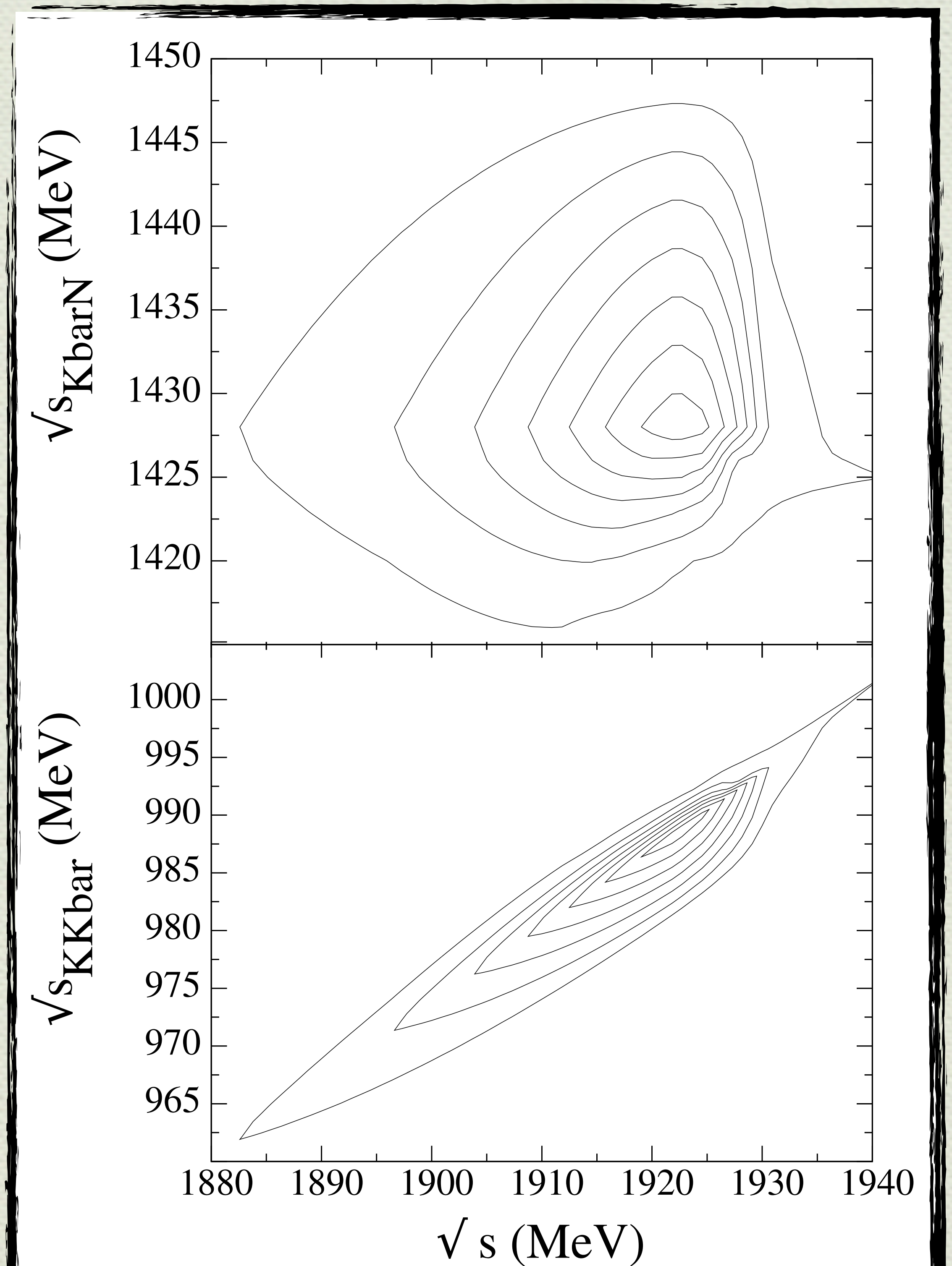
$$t = V + Vgt$$

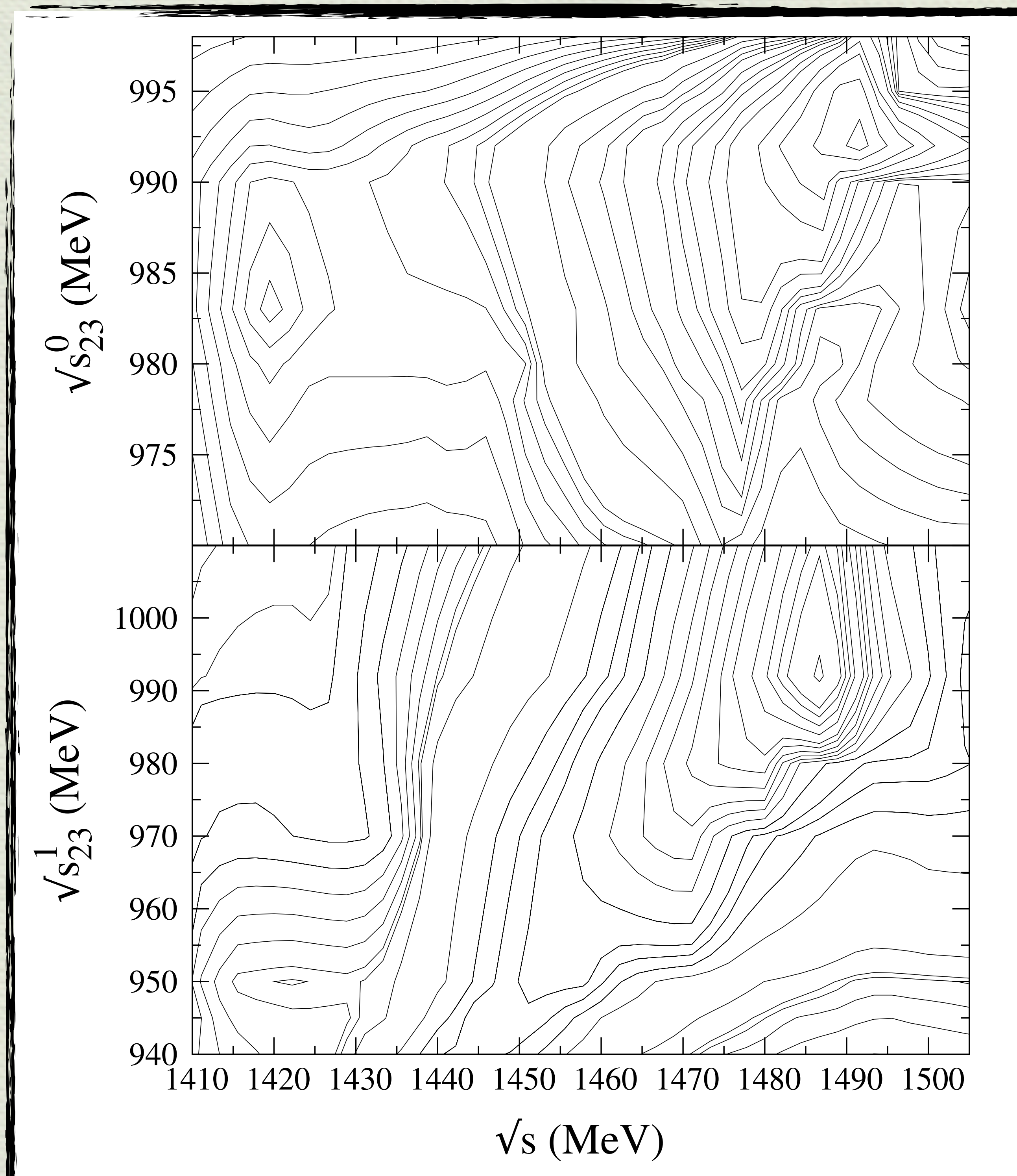
Results

- We consider as coupled channels:
  - $K\bar{K}N, K\pi\Sigma, K\pi\Lambda$
  - $KK\bar{K}, K\pi\pi, K\pi\eta$
  - $K\bar{K}\pi, \eta\pi\pi$
- All the interactions are in s-wave.

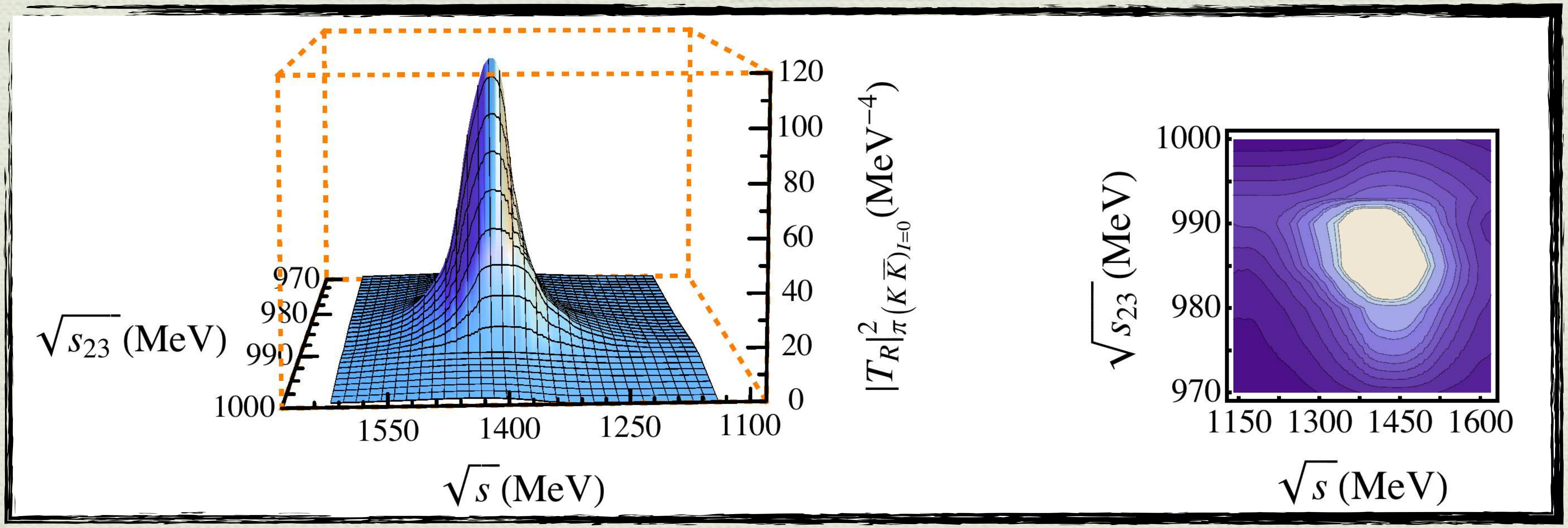
$K\bar{K}N$



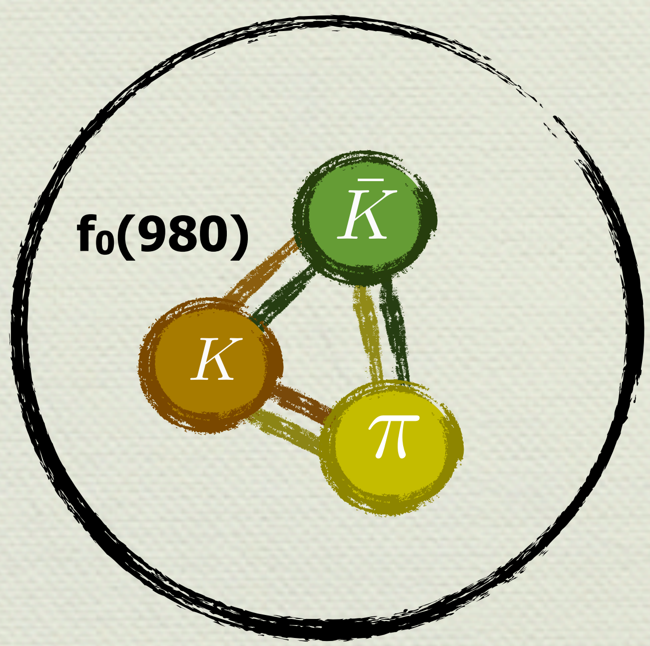
$K\bar{K}K$



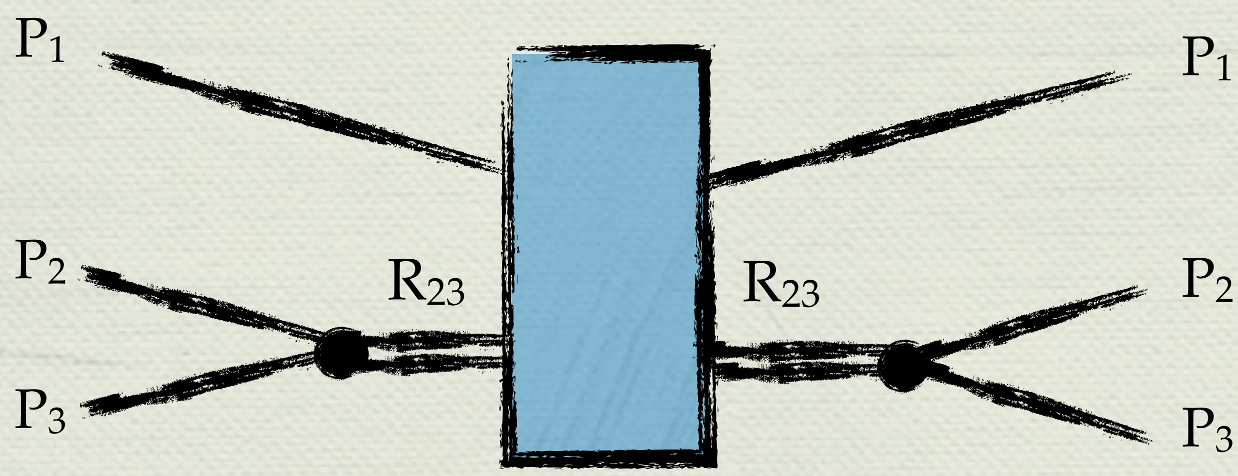
$\pi K \bar{K}$



□□$\pi(1300)$



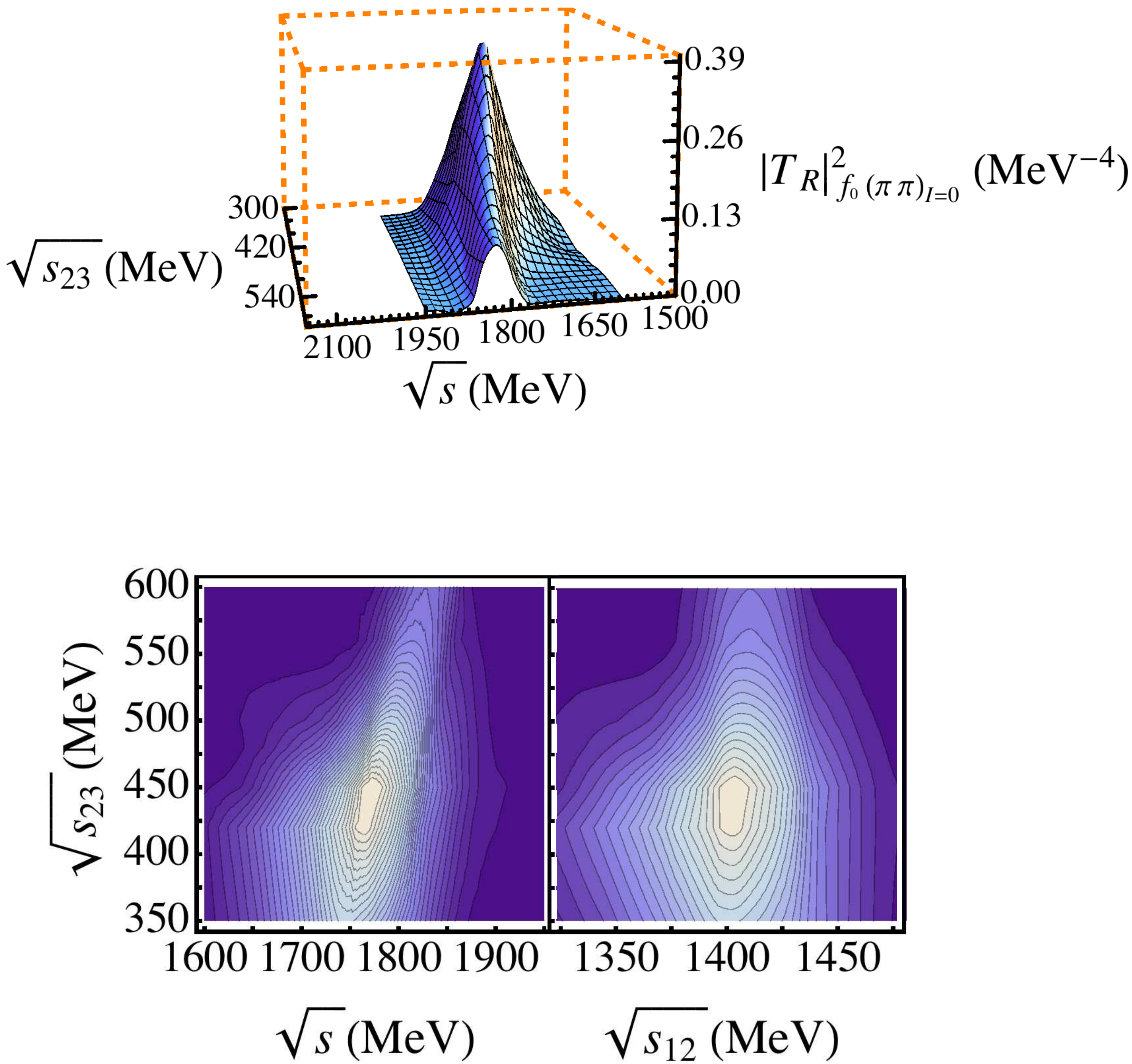
- We can use now these amplitudes to study systems like $f_0(980)\pi\pi,\, f_0(980)K\bar{K}$
- How to do this?



$$T_{P_1(P_2P_3)}(\sqrt{s},\sqrt{s_{23}}\simeq M_{R_{23}}) = g_{R_{23}\to(P_2P_3)}G_{R_{23}}\, t_{P_1R_{23}}(\sqrt{s})G_{R_{23}}\, g_{R_{23}\to(P_2P_3)}$$

$$t_{(P_2P_3)}(\sqrt{s_{23}}) = \frac{g^2_{R_{23}\to(P_2P_3)}}{s_{23}-M^2_{R_{23}}+iM_{R_{23}}\Gamma_{R_{23}}}$$

$$t_{P_1R_{23}}(\sqrt{s}) = \frac{iM_{R_{23}}\Gamma_{R_{23}}}{t_{(P_2P_3)}(\sqrt{s_{23}}=M_{R_{23}})}T_{P_1(P_2P_3)}(\sqrt{s},\sqrt{s_{23}}=M_{R_{23}})$$



0.39
0.26
0.13
0.00
$|T_R|^2_{f_0(\pi\pi)_{I=0}}$ (MeV^{-4})
300
420
540
$\sqrt{s_{23}}$ (MeV)
2100 1950 1800 1650 1500
$\sqrt{s}$ (MeV)
600
550
500
450
400
350
$\sqrt{s_{23}}$ (MeV)
1600 1700 1800 1900
1350 1400 1450
$\sqrt{s}$ (MeV)
$\sqrt{s_{12}}$ (MeV)

- Decay modes: $\pi\pi, \pi\pi\pi\pi, \pi\pi K\bar{K}$

- $f_0(1790)$ found by BES Collaboration.[6]

[6] M. Ablikim et al. [BES Collaboration], Phys. Lett. B607, 243-253 (2005). J. Z. Bai, et al. [BES Collaboration], Phys. Lett. B472, 207 (2000). A. V. Anisovich et al., Phys. Lett. B449 (1999) 154. D.V. Bugg, et al. , Phys. Lett. B353, 378 (1995).

Conclusions

- We have solved the Faddeev equations using unitary chiral dynamics to determine the input two-body t-matrices.
- We have studied several systems made of Kaons, like

$$K\bar{K}N, KK\bar{K}, \pi\pi\bar{K}, f_0(980)\pi\pi$$

- And we have found generation of several states

$$N^*(1910)(1/2^+), K(1460), \pi(1300), f_0(1790)$$