Examples of oscillation symmetry in hadronic and nuclear masses & widths and in astrophysics.

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Oscillation phenomena

- In classical physics : opposite interactions (potential and kinetic) generate oscillations (pendulum, spring, ...).
- In quantum physics : Schrodinger equations solved with potential and kinetic interactions

Eventual oscillations are studied on masses with

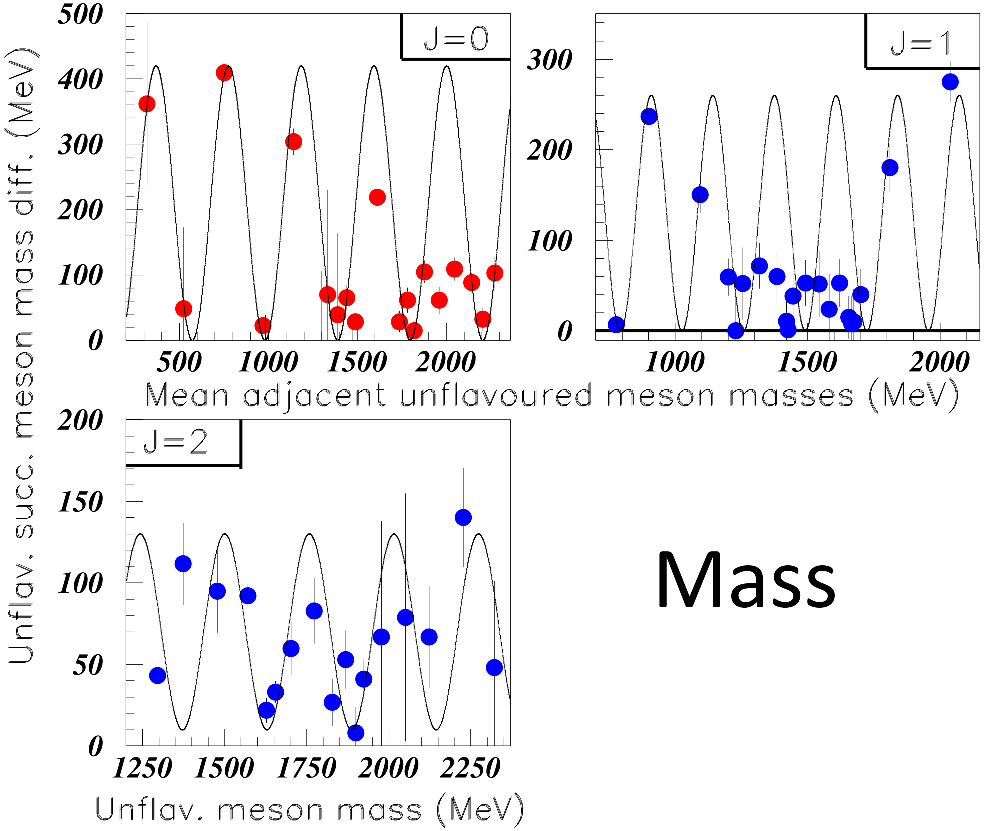
$$m_{n+1} - m_n = f[(m_{n+1} + m_n)/2]$$

$$\Gamma_T = f(m)$$

The data are fitted with cosine functions with defined periods

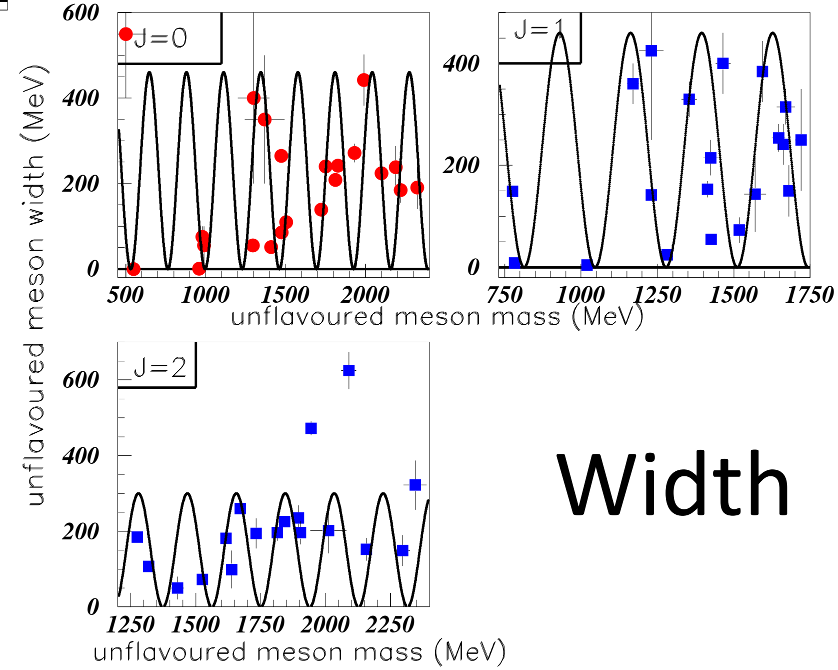
- In astrophysics: opposite interactions (gravitational and centrifugal related to the kinetic energy).

Unflavored mesons (I)



Successive mass difference versus mean (MeV)

Mass



Width

C. Patrignani *et al*. **(Particle Data Group)** Chin. Phys. **C40**,100001 (2017).

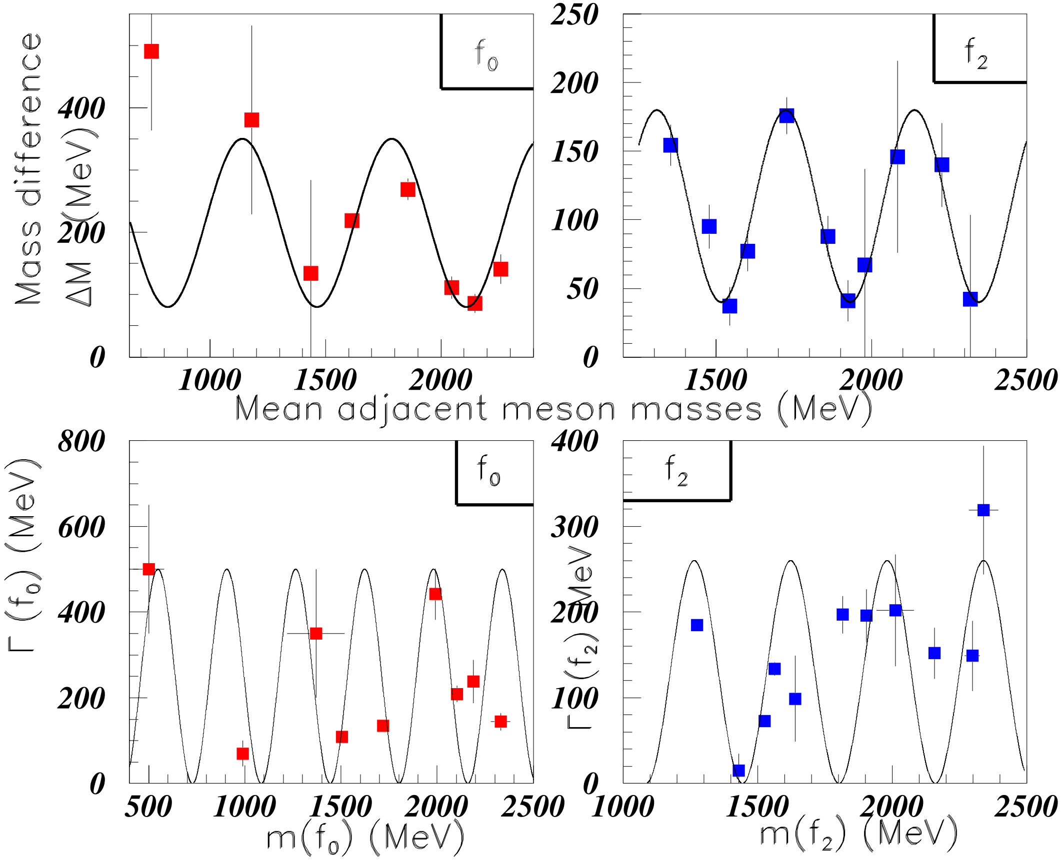
B. Tatischeff, *Systematics of oscillatory behavior in hadronic masses and widths*, arXiv: 1603.05505v2 [hep-ph] (2016).

B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins*, Journal of Particle Physics **1**, 13 (2017).

Unflavored mesons(II)

F_0 - meson

F_2 - meson



Successive mass difference versus mean adjacent masses (MeV)

Mass

Width versus mass

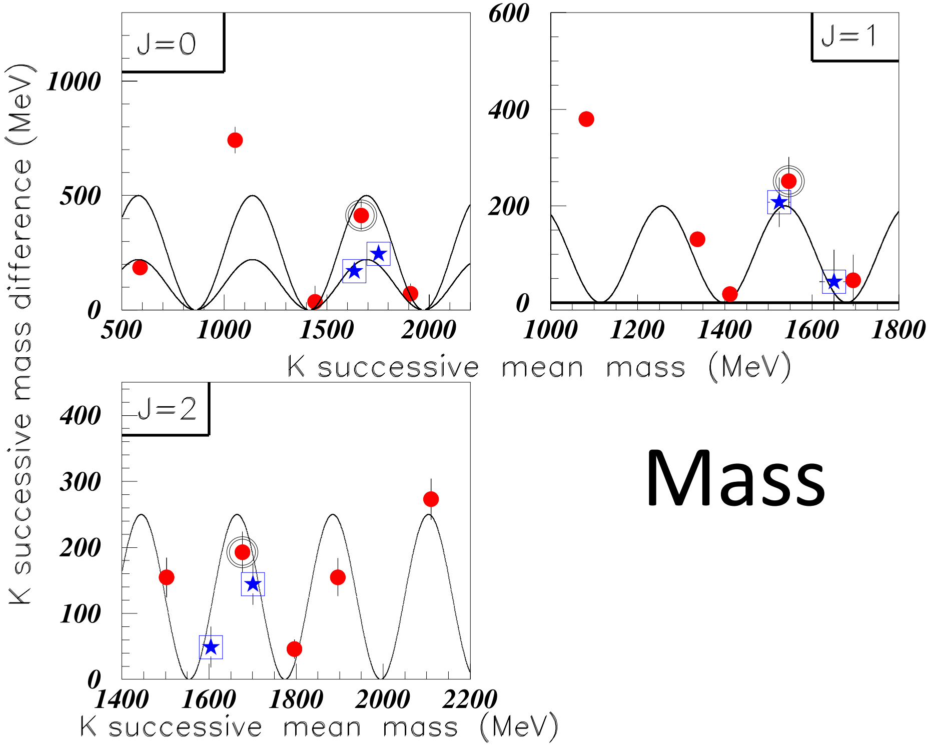
Width

C. Patrignani *et al.* **(Particle Data Group)** Chin. Phys. **C40**,100001 (2017).

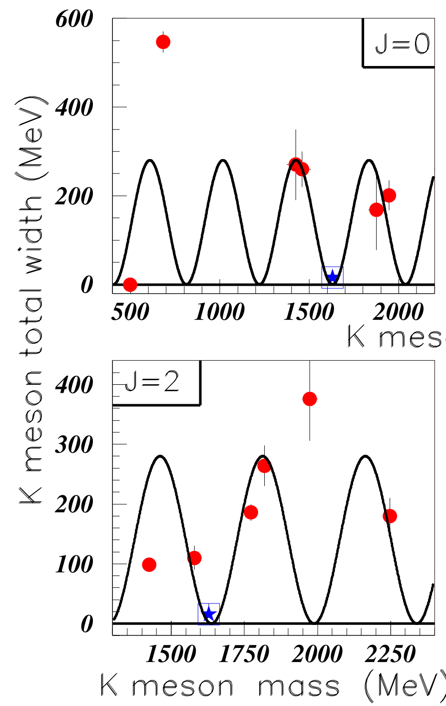
B. Tatischeff, *Systematics of oscillatory behavior in hadronic masses and widths,* arXiv: 1603.05505v2 [hep-ph] (2016).

B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

Strange mesons (K,K*)



Tentative prediction of the K(1630) spin:
J=0 excluded
J=1 or 2 favored



Mass

Width

Successive mass difference versus mean adjacent masses (MeV)

Width versus mass

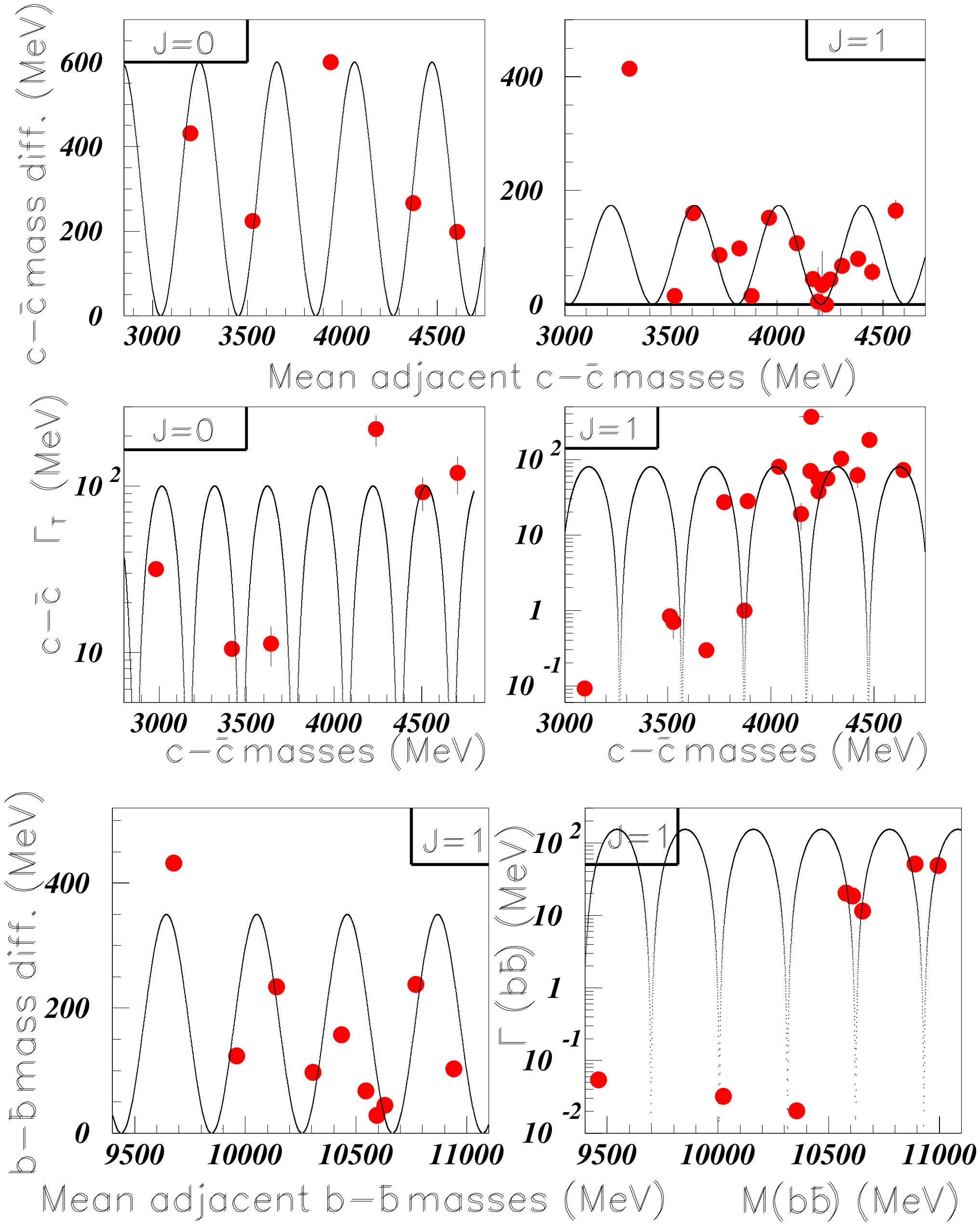
C. Patrignani *et al*. **(Particle Data Group)** Chin. Phys. **C40**, 100001 (2017).
B. Tatischeff, *Systematics of oscillatory behavior in hadronic masses and widths*, arXiv: 1603.05505v2 [hep-ph] (2016).
B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

Charmoniums, Bottomoniums

Mass & Width

Successive mass difference versus mean adjacent masses (MeV)

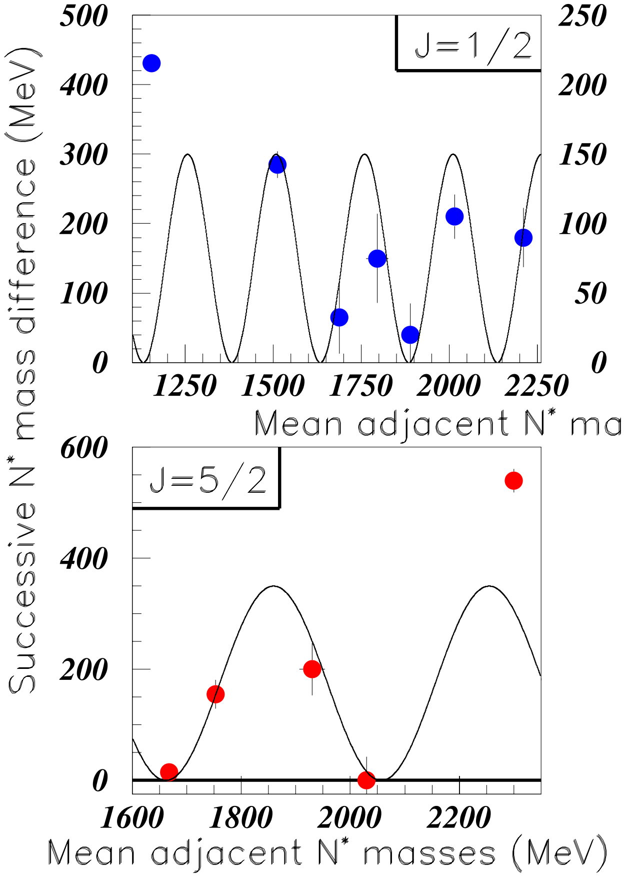
Width versus mass



$c\bar{c}$

$b\bar{b}$

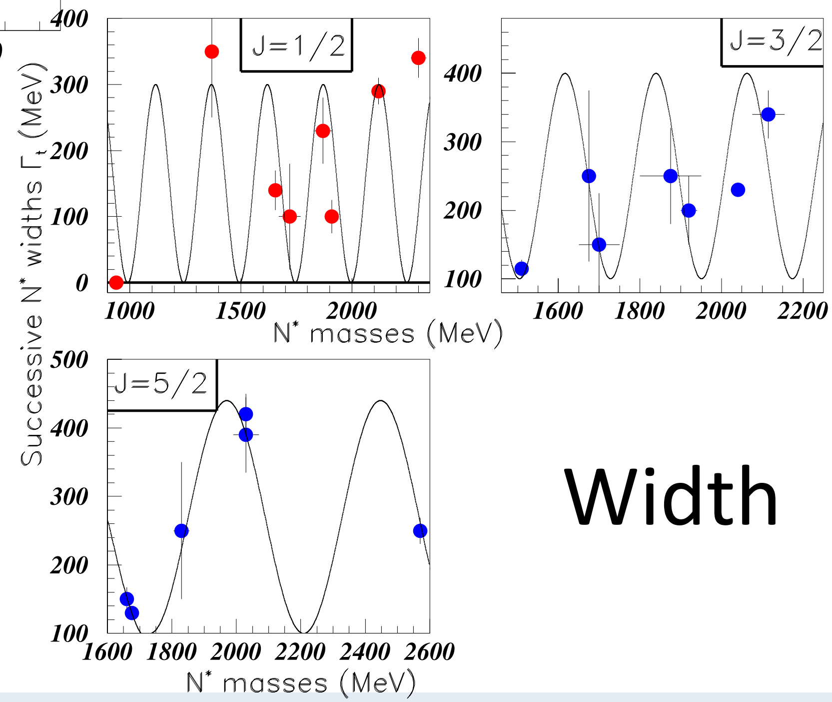
N* baryons



Mass

Successive mass difference
versus mean adjacent masses (MeV)

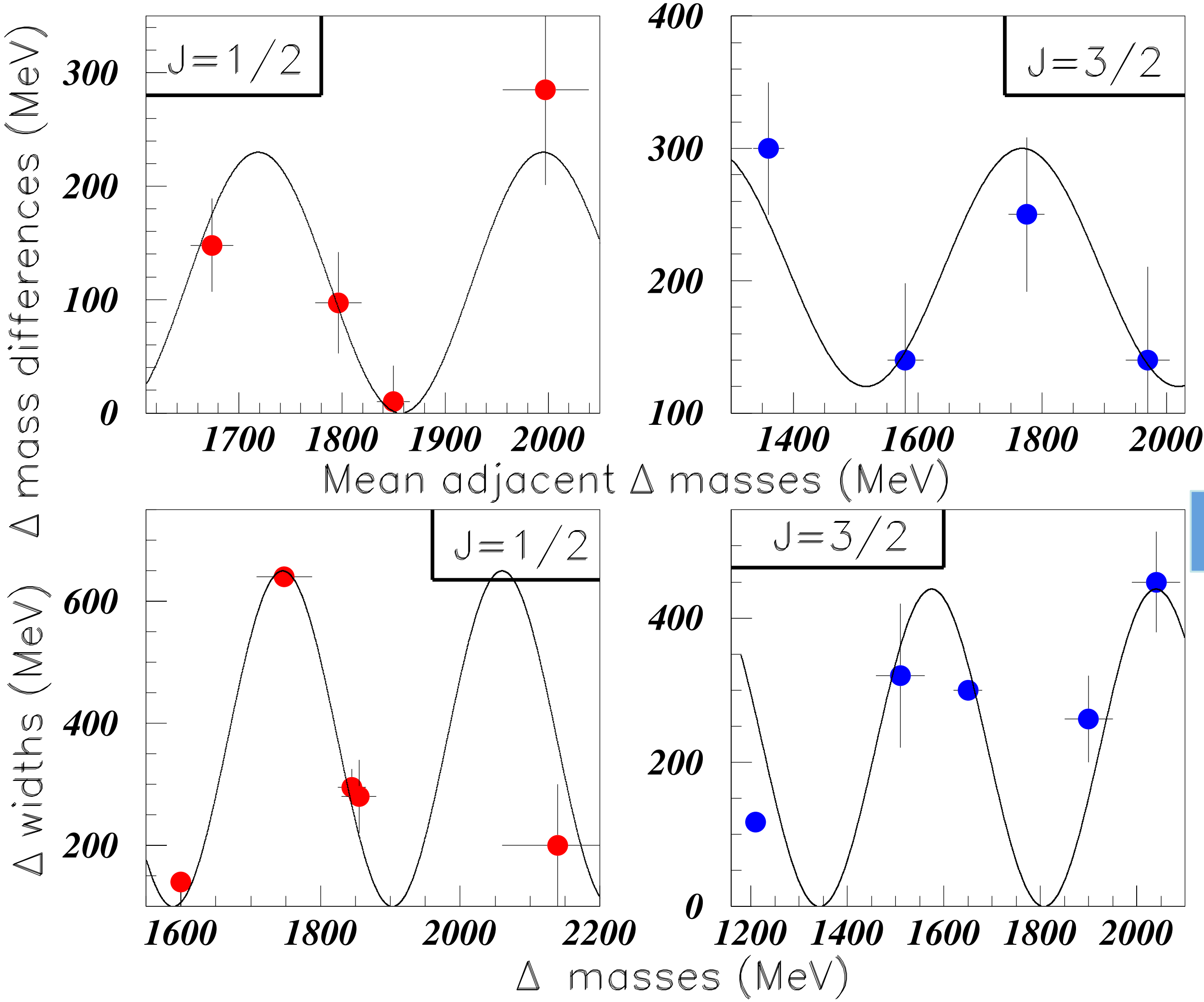
Width versus mass



Width

C. Patrignani *et al*. **(Particle Data Group)** Chin. Phys. **C40**,100001 (2017).
B. Tatischeff, *Systematics of oscillatory behavior in hadronic masses and widths*, arXiv: 1603.05505v2 [hep-ph] (2016).
B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

Δ* baryons



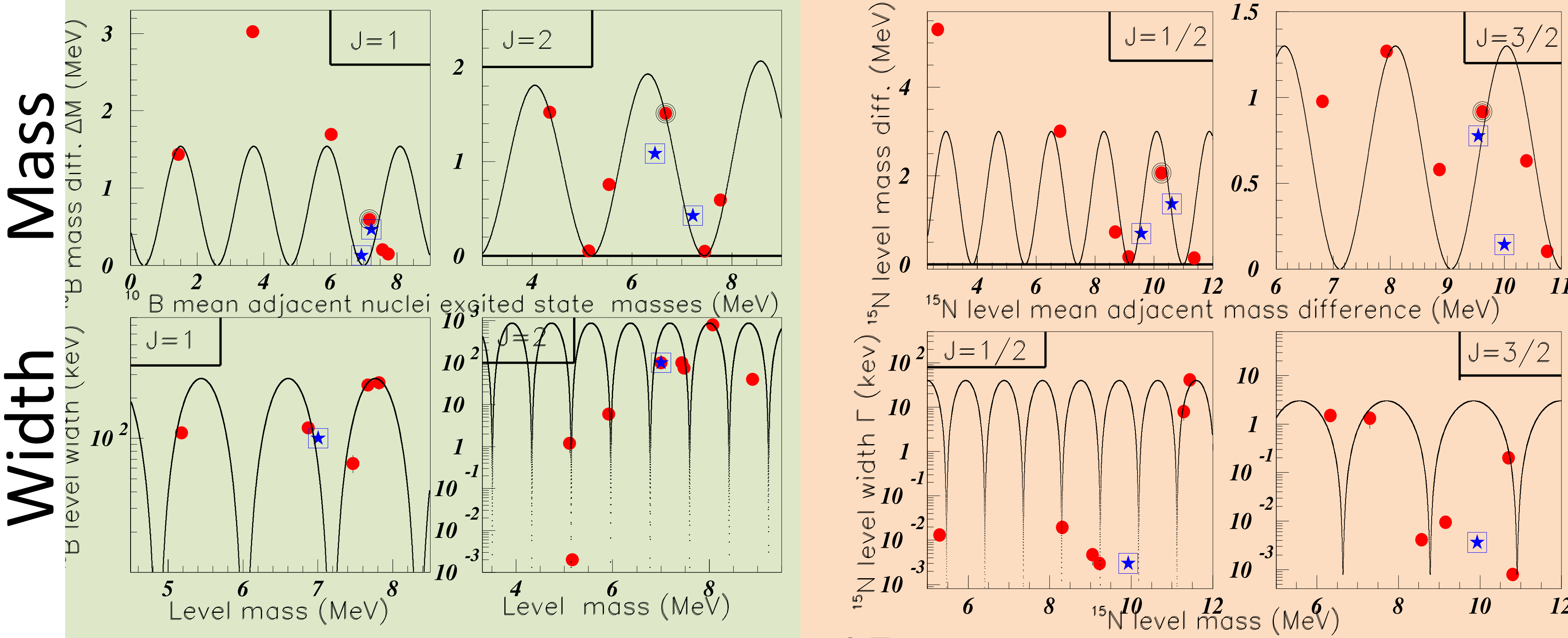
Successive mass difference
versus mean adjacent masses (MeV)

Width versus mass

J=1/2

J=3/2

^{10}B and ^{15}N nuclei



^{10}B J=1 J=2

M=7.002 MeV; J=1 preferred

^{15}N J=1/2 J=3/2

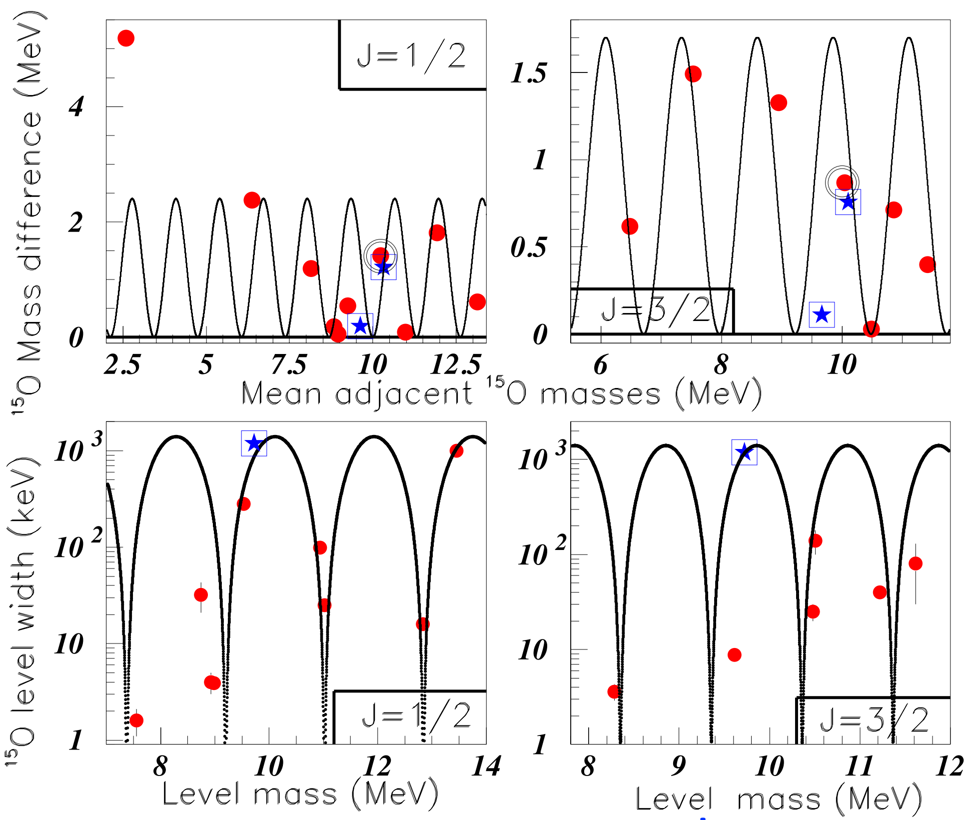
M=9.928 MeV; J=1/2 assigned

F. Ajzenberg-Selove, Energy Levels of Light Nuclei A=5-10, Nucl. Phys. **A320**, 153 (1979).

F. Ajzenberg-Selove, Energy Levels of Light Nuclei A=13-15, Nucl. Phys. **A268**, 150 (1976).

B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

^{15}O



Mass

Width

M=9.72 MeV (1/2, 3/2)$^{+}$ Γ=1185± 50 keV

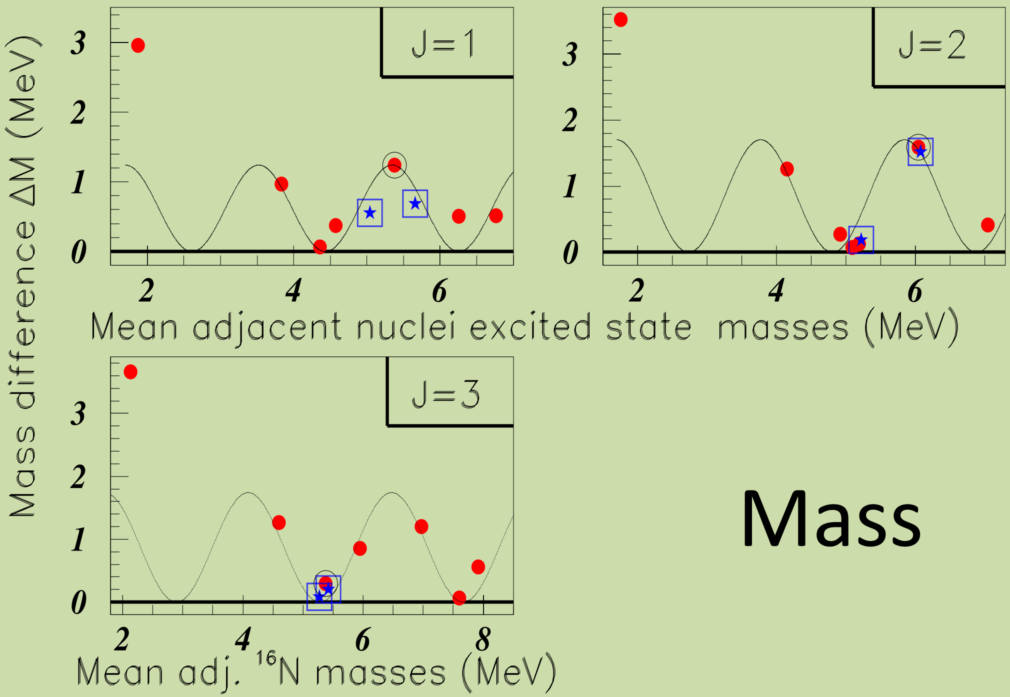
Preferred J=1/2

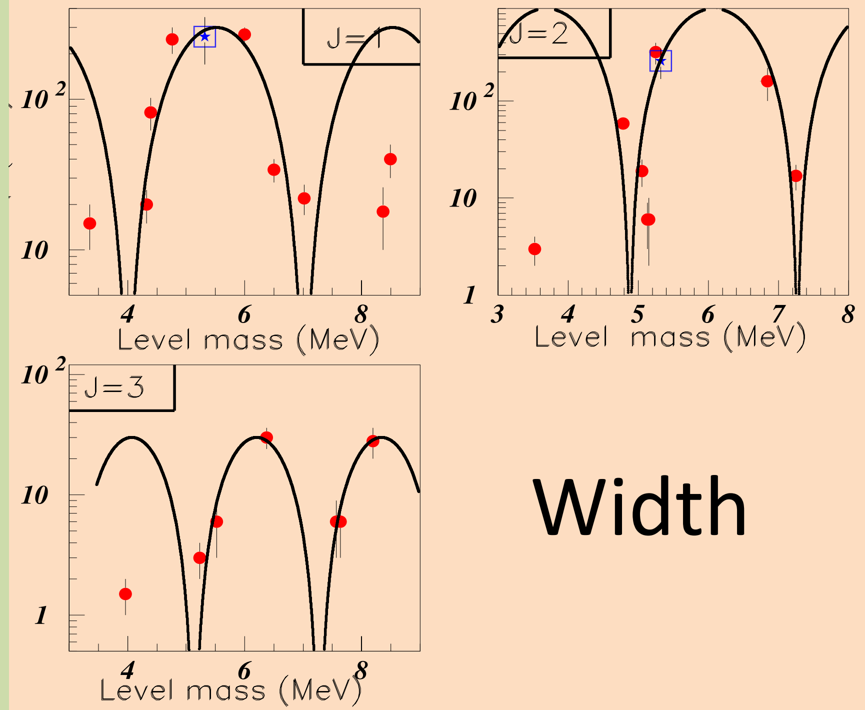
The state is included in the mass figure

F. Ajzenberg-Selove, Energy Levels of Light Nuclei A=13-15, Nucl. Phys. **A268**, 150 (1976).

B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

^{16}N





M=5.318±0.03 MeV, Γ=(260 keV) Spin (0^+, 1^+) ?

- only one J=0 state below M=5.318 MeV
- compatible with J=1

D.R. Tilley, H.R. Weller, and C.M. Cheves, *Energy Levels of Light Nuclei A=16,* Nucl. Phys. **A564,** 1 (1993).

B. Tatischeff, *Variation of Hadronic and Nuclei Mass Level Oscillation Periods for Different Spins,* Journal of Particle Physics **1**, 13 (2017).

Results for Hadrons and Nuclei

- Regular oscillations observed in particle and nuclei, masses and widths, provided they belong to *the same family and same spin*
- *Simple cosine functions describe the data.*
- *Only periods* are discussed, the oscillation amplitudes are not considered.
- Necessary *condition*: not too small number of data; several data in the same arch.

Generalisation

- Every time some object results from several smaller masses, these are submitted to opposite interactions otherwise the composite mass will disintegrate or mix into a totally new object with loss of individual components.

- Verified in quantum physics, like in classical physics, since both result from opposite interactions.

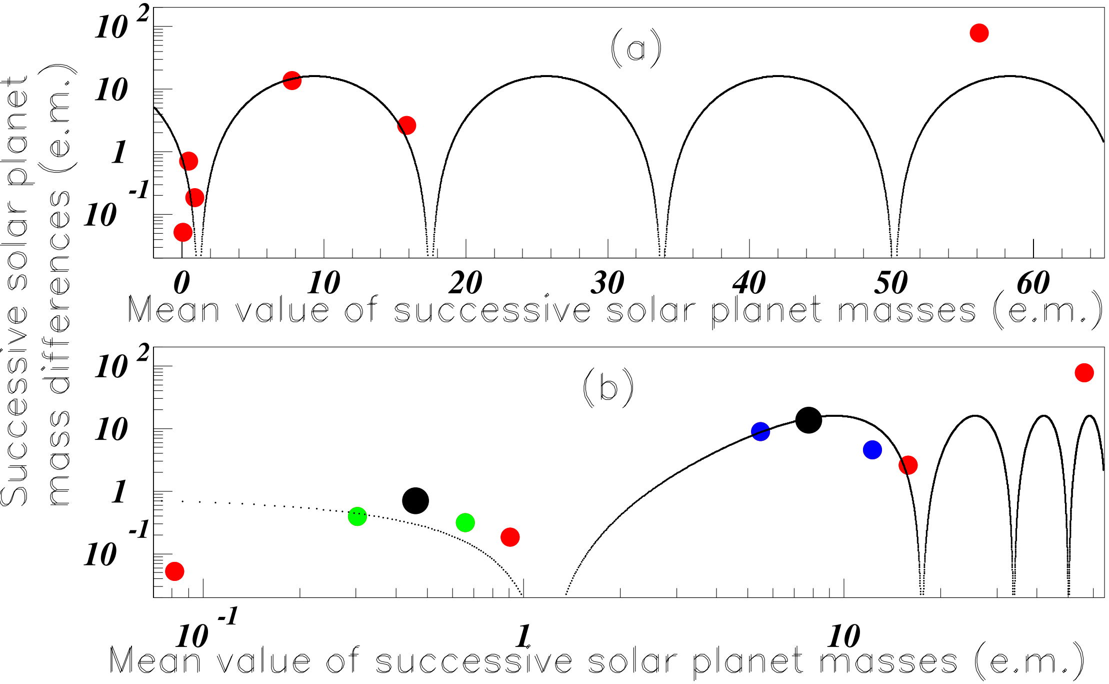
- Let us adress ourselves the question to look for the same observation in the astronomical world submitted to centrifugal forces related to kinetic and gravitational forces.

- Study possible oscillations in data belonging to different astronomical scales.

B.T. « May the oscillation symmetry be applied to TRAPPIST-1 terrestrial planets to predict the mass of the seventh planet ? »
Phys. and Astron. Int. J. 2018.2(3)-193-197- 29 Mai 2018

New solar planets ?

- Possible 9th giant planet :
  - to explain the strange behaviour of some bodies belonging to the Kuiper's belt;
  - Stabilize several orbits of transneptuniens bodies;
- Possible 10th planet allows to understand the abnormal behaviour of Kuiper's beltbodies and the Kuiper's cliff.



Prediction

New possible planets:

M (9th planet) ≈10 earth mass,

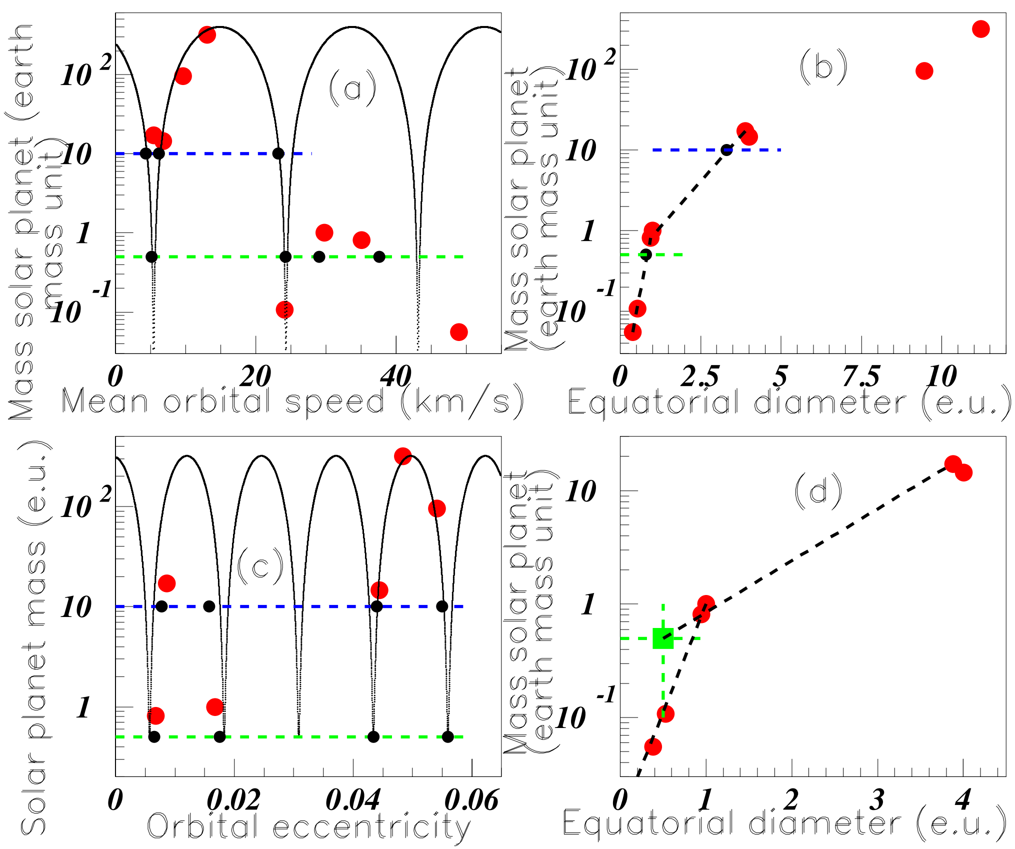
M(10th planet) ≈0.5 earth mass

Solar planets by increasing masses (in Earth mass (em)): Mercury, Mars, Venus, Earth, Uranus, Neptune, Saturn, and (Jupiter).

https://en.wikipedia.org/wiki/Planetary-mass
www.le-systeme-solaire.net
www.astronoo.com/fr/articles/caracteristiques-des -planetes.html
S. Rouat, Sciences et Avenir, N°850, 2017, p 42
www.astronomynotes.com/solarsys/plantbla.htm

Oscillation symmetry predictions on 9th and 10th planets properties

Planet	Mass (e.u.)	mean orb. speed	equat. diam.	orbital eccentricity
9 (blue)	10*	4.3 6.2 23.2	3.3	0.0077 0.0158 0.044 0.055
10 (green)	0.5*	5.15 24.2 29 37.6	0.8 (0.5*)	0.065 0.0175 0.0435 0.056



Indications of their Density, plan tilting, Rotation duration, revolution period

Study of solar moons, rings, Mass of the 7th planet around TRAPPIST-1 star ….

*S. Rouat, A la recherche des planètes neuf et dix Sciences et Avenir **850**, 42 (2017)*
P. Caughill, Futurism (2017), University of Arizona

Conclusions

- Regular oscillations observed in particle and nuclei, masses and widths, provided they belong to *the same family and same spin.*

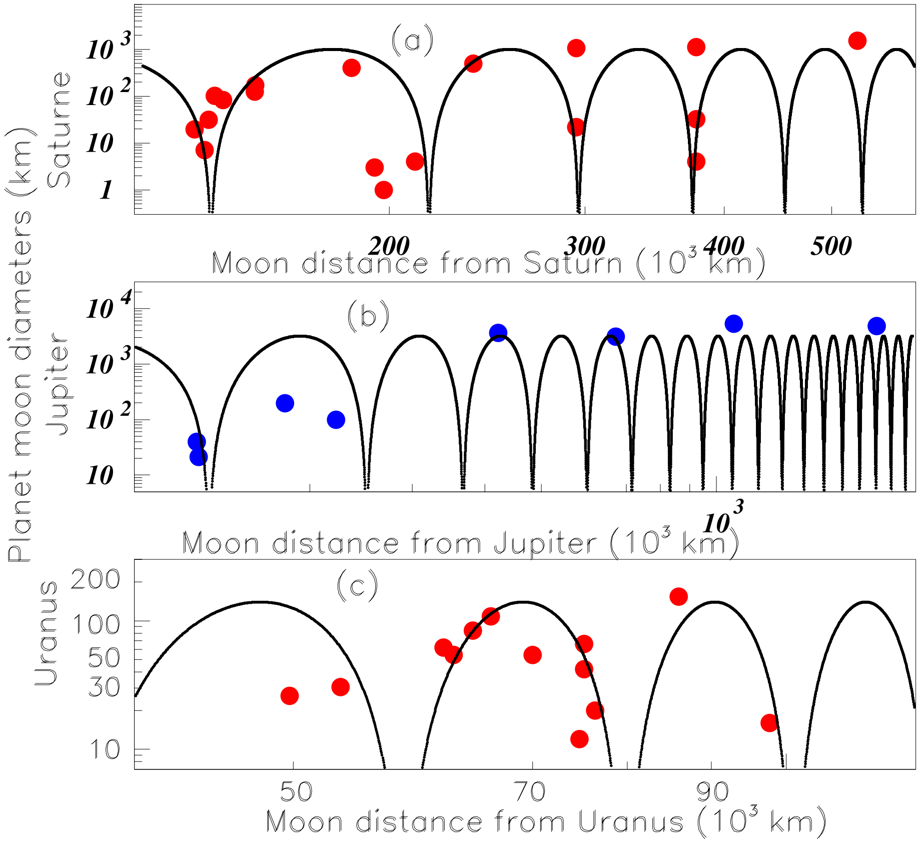
- Observed also in *astrophysical bodies.*

- One body property (pendulum ...) is extended to several bodies, as if they belong to one common entity.

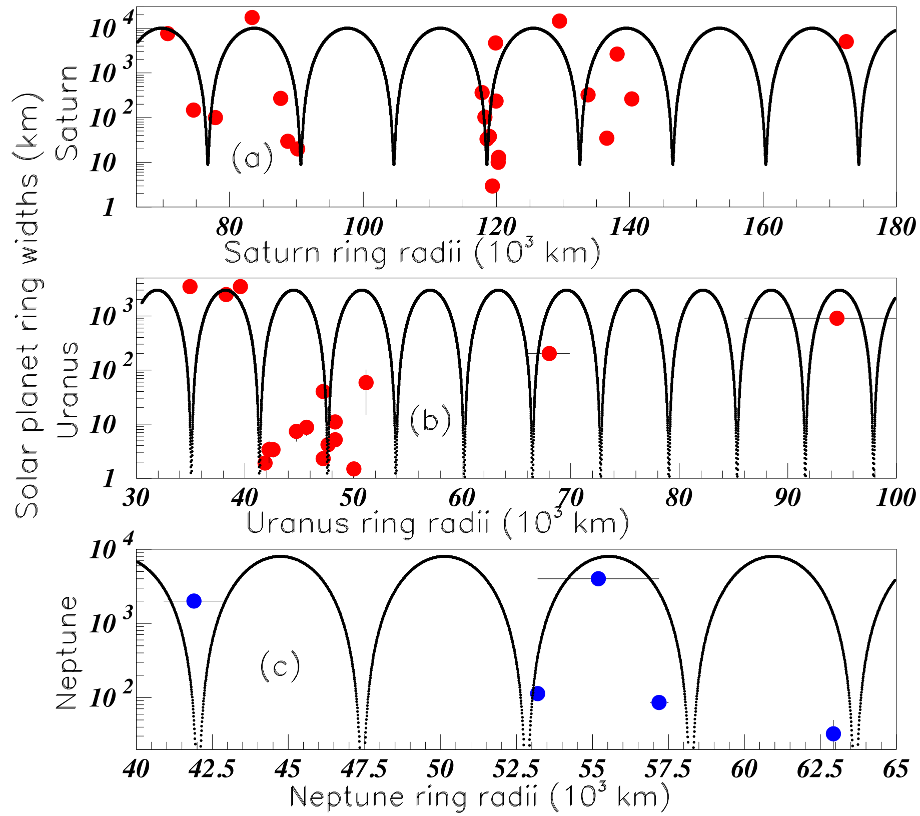
- Hadronic and nuclear excited state masses are solution of a Schrödinger-like equation. What is the corresponding equation underlying the astrophysical properties ?

- The forces acting in these different fields are very different: *the common property is the existence of opposite interactions.*

Solar Planets, Moons, Rings

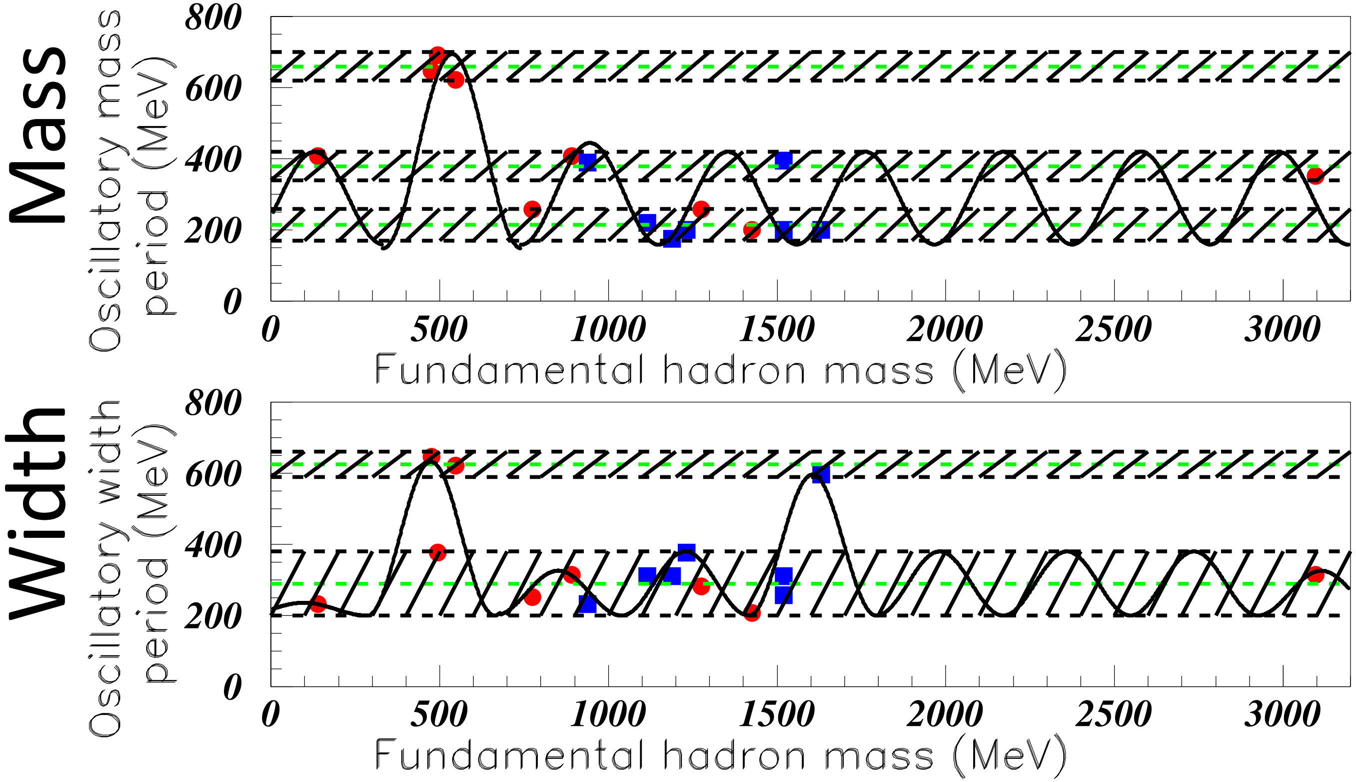


Moon diameter versus moon distance from its planet



Solar planet ring widths versus planet ring radii.

Hadronic oscillatory period variations



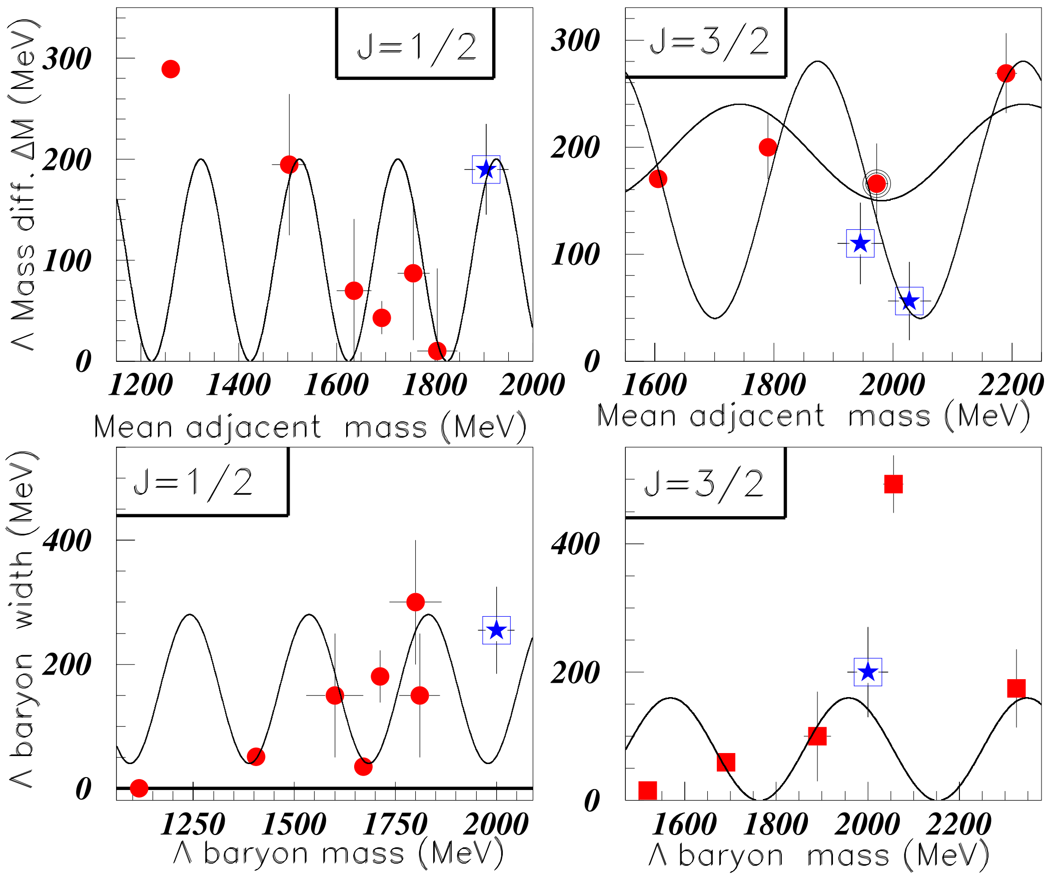
Mass periods
P=408 MeV
Mean periods
215, 380, and 660 MeV

Width periods
P=377 MeV
Mean periods
290 and 625 MeV

Meson period

Baryon period

Λ baryons



Successive mass difference versus mean adjacent masses

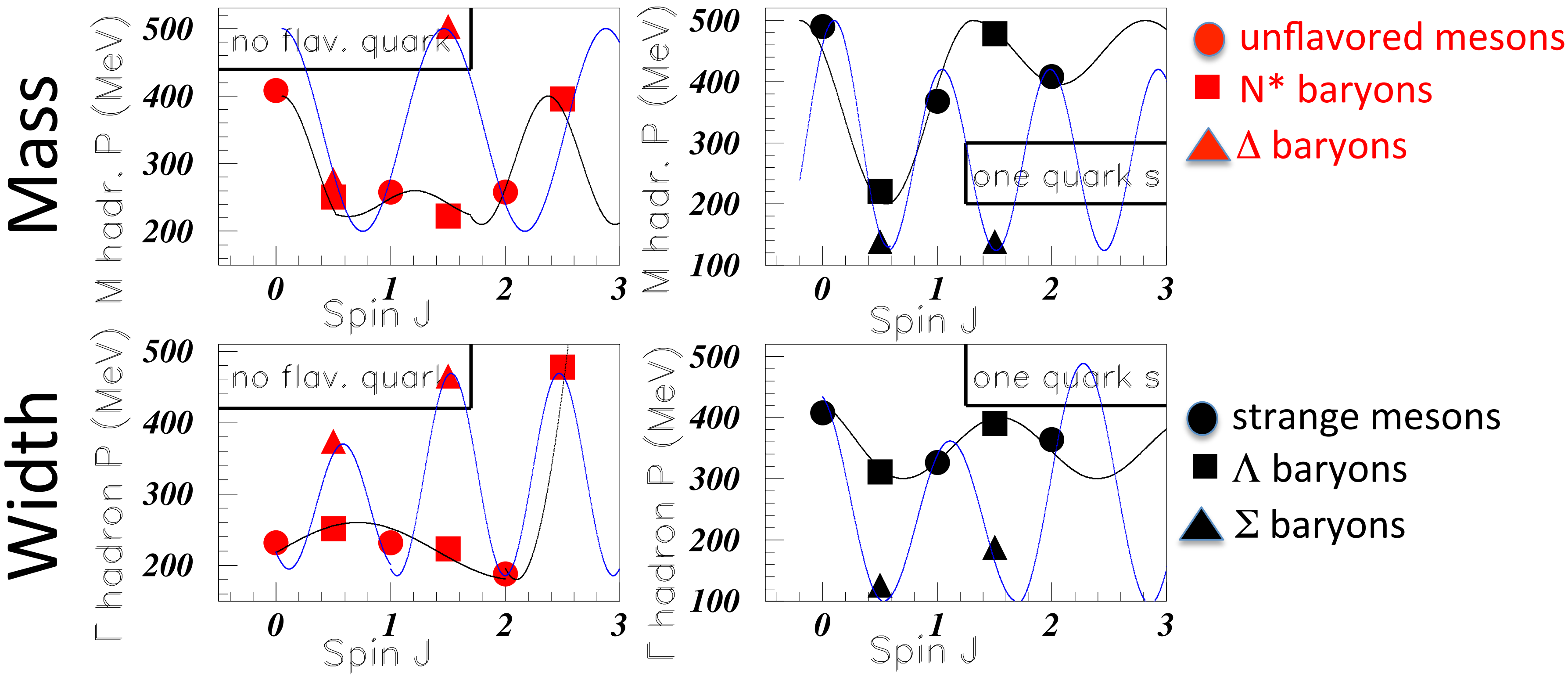
Width versus mean adjacent masses

M(2000) $0^{??}$, (Γ imprecise)

Λ(2000)

Tentative prediction of the Λ(2000) spin: no clear attribution

Hadronic period variations



Unflavored hadrons

black fit: unflav. mesons and N* baryons

P(m)=1.16 J   P(Γ)=2.76 J

blue fit: unflav. mesons and Δ baryons

P(m)=1.41 J   P(Γ)=0.94 J

Strange hadrons

black fit: strange mesons and Λ baryons

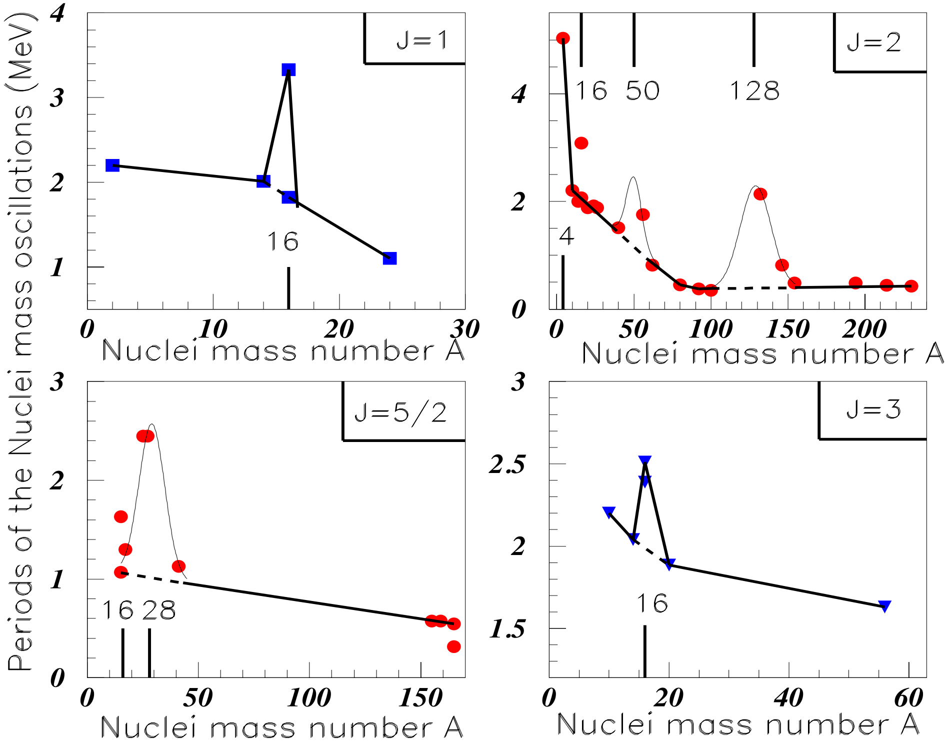
P(m)=1.51 J   P(Γ)=1.70 J

blue fit: strange mesons and Σ baryons

P(m)=0.94 J   P(Γ)=1.16 J

It is not possible to fit all data with a unique function

Period of Nuclear mass oscillations



Same period P = 1.9 J

Same period P = 2.8 J

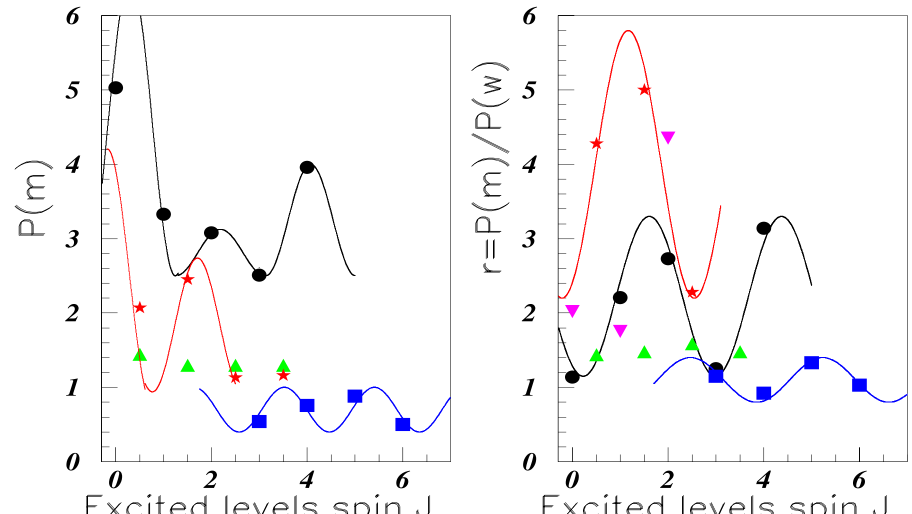
Ratio between periods ≅1.5

^{41}Ca and ^{41}Sc

^{17}O and ^{17}F

^{208}Pb

^{16}O



Nuclear oscillatory period variations