MESON 2006

9th International Workshop on Meson Production, Properties and Interaction
KRAKÓW, POLAND
9 - 13 June 2006

Theory Summary

1) Theory to go.

2) Feynman quotes and anti-quotes.

3) Thanks.

Ted Barnes
Physics Div. ORNL
Dept. of Phys, U.Tenn.

Fri. 9 June 2006

A.Gal

$K^- d \to K^- d$

Elastic K^-d scattering is studied using an improvement on previous approximate treatments of the Faddeev equations, which used almost exclusively a fixed-center approximation. Result is that the (complex) *K^-d scattering length is fairly large, ca. 1-2 [fm].*

This scattering length will be measured at DEAR/SIDDHARTA (DAΦNE) in K^-d atom radiative transitions, and is essential in determining the K^-n scattering length, and in understanding $\bar{K}$N and $\bar{K}$-nucleus physics.

Ultimate goal is perhaps 10% accuracy for theory and 5% for experiment.

MESON 2006

Fri. 9 June 2006

Professor Leutwyler and the Red Dragon

Low energy S-wave $\pi\pi$ scattering is often attributed to a very broad resonance "σ + …" , the rote Drache, with notches due to narrower states such as $f_0(980)$. … but is there a well defined associated pole?

Leutwyler: crossing relates $\pi\pi$ scattering to $\pi\pi$ scattering. This gives the Roy Eqs, which with disp rels can accurately relate low-E $\pi\pi$ scat amps to three numbers a_0, a_2 and a δ. New result – poles on the 2^{nd} sheet can be related to zeros on the 1^{st} sheet, so the location of the low energy "σ" pole, the "*head of the dragon*", can be specified with some precision.

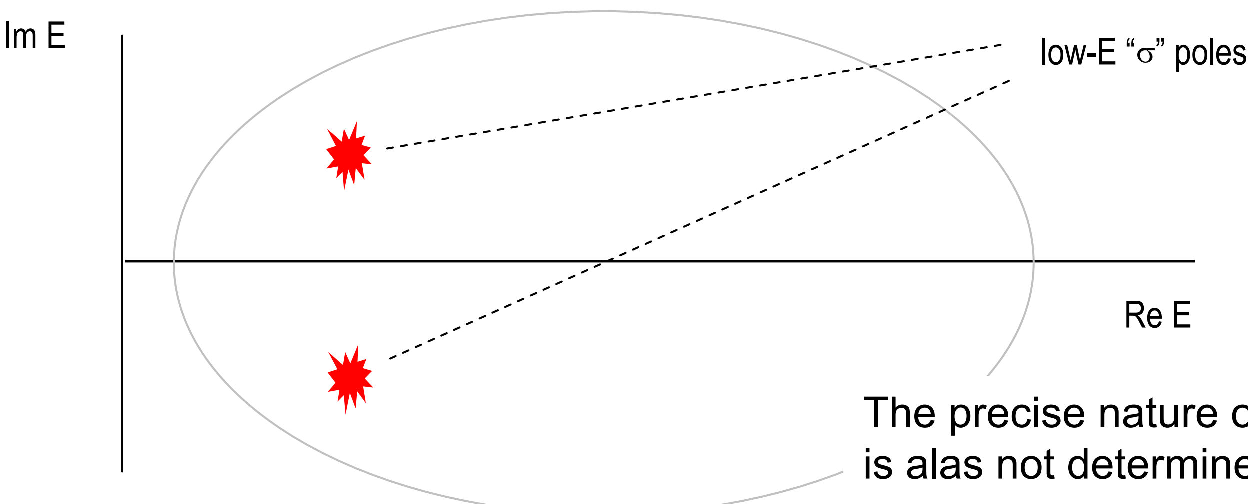
pole position = 441(4) – 272(6) i [MeV].

Fri. 9 June 2006

Professor Leutwyler and the Red Dragon (cont.)

Since there are two such poles with *Re +/ – Im* parts in the dragon’s head, we clearly have learned the location of the **eyes** of the dragon,

Loci Oculorum Draconis Rutili



The precise nature of the associated states is alas not determined by this approach.

Fri. 9 June 2006

J.A.Niskanen

$NN \to d\pi$

One may search for evidence of isospin violation in the strong interaction by comparing pp and pn formation of the d with pion emission.
Naïve charge symmetry predicts

$$\sigma(pp \to d\pi^+) / \sigma(np \to d\pi^0) = 2$$

This will be modified by EM effects and by true SI isospin dependence due for example to $m_p \neq m_n$ and $m_u \neq m_d$.

Tests have complications due to complication of how to compare pp and np, and the poorer quality of n data and beams. New uncertainty principal:

Ease of expt * Ease of theory $\geq$ a constant.

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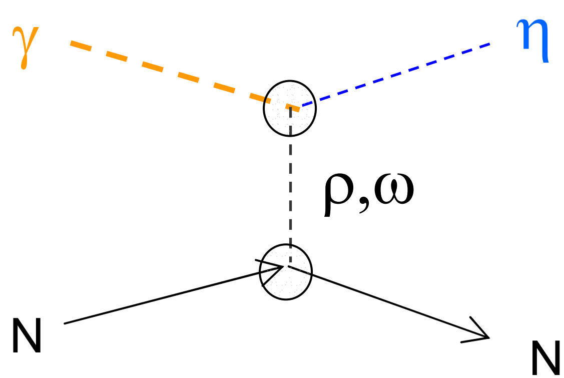
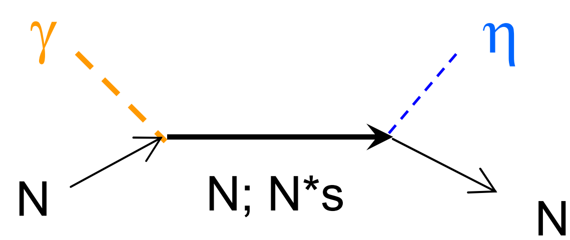
Sat. 10 June 2006

L.Tiator

$\gamma N \rightarrow \eta N$

Discussion of η and η‘ photo and electroproduction, and Mainz isobar analysis programs for Ps production available online.





Two interesting and scary (to me anyway) comments:

1. $D_{15}(1675) \rightarrow \eta N$ couplings vary from 0.7% to 17%, depending on the treatment of the vector t-dependence. (Regge vs form factors).

2. The best fitted $g^2_{\eta NN}/4\pi$ is tiny, < an order of magnitude smaller than **SU(3) flavor** + $NN\pi$.

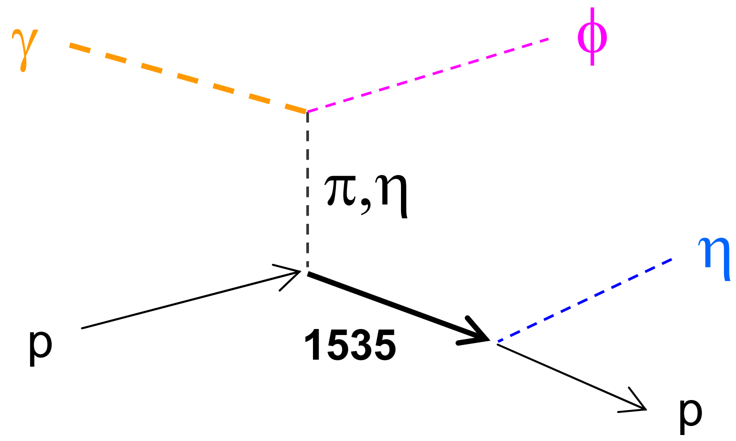
Sat. 10 June 2006

M. Soyeur

$\gamma p \to \phi \eta p$

This reaction is sensitive to interference between π and η exchange diagrams, both of which involve $S_{11}(1535)$ production. This is an example of a strongly coupled-channel problem, with πp and ηp coupled through the $S_{11}(1535)$.

This would be an interesting study for JLAB, at E_γ ca. 4 GeV.



Sun. 11 June 2006

Excursion:

[salt mines, wooden slides, castles, przewodniki, accordions,

and other curious things.]

MESON 2006

Mon. 12 June 2006

K^-- nuclear bound states, medium effects, $q^4\bar{q}$ status.

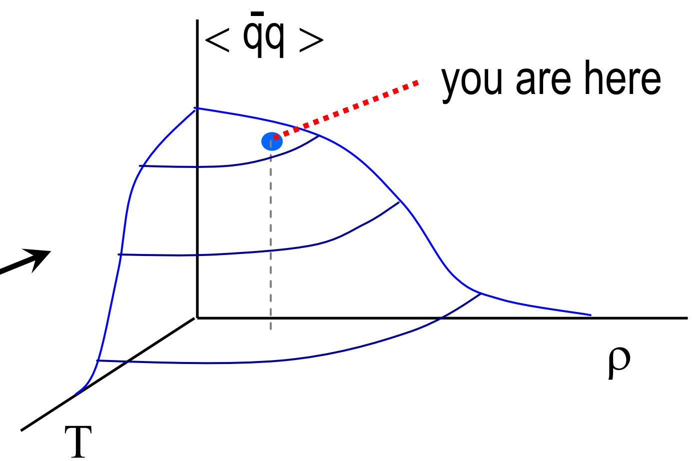
Expt status and plans:

kaon-nucleus:

P.Kienle, J.Zmeskal

medium effects on vectors:

D.Weygand, J.Pietraszko,
S.Yokkaichi, B.Krusche (+σ)



If you show this magic picture often enough it will somehow explain everything about in-medium mass shifts.

Mon. 12 June 2006

(thy, medium effects)

U.Mosel

It’s not magic, it’s (mostly) FSI.

(They have developed codes to generate these effects.)

The well-established medium effect, the Δ width increase (2x) is due to ΔN FSI interactions. (ΔN –> NN and ΔNN –> NNN.)

“A big part of the $\pi\pi$ [downward] mass shift is due to πN rescattering on the way out.”

Previous QCDSR calculations of the ρ mass shift are unjustified.
It could be up or down (broad or narrow), depending on the input.

“The connection of any hadron mass with the fall-off of $\langle \bar{q}q \rangle$ is very indirect.”

Tue. 13 June 2006

New Developments in Meson Spectroscopy

Expt: All sorts of nice stuff that I don’t get to talk about:

Ch.Zhang (BESII)   X(1835)
I.Gough Eschrich (BABAR)   B decays to light mesons
S.Korpar (new c hadrons at Belle)
A.Meyer ($c\bar{c}$ at HERA)
M.Pelizäus (c and $c\bar{c}$ spectroscopy at BABAR)
M.Shepherd (D_s and $c\bar{c}$ at CLEO)
C.Göbel (c physics at FOCUS)

A.Krassnigg

Dyson-Schwinger approach to Meson Spectroscopy

Coupled integral Eqs for self-energy and vertex amplitudes;

with a good choice of the truncation scheme one can develop an analytic description of QCD q-g bound states that incorporates chiral symm (Ward identity) and relativity and is sufficiently accurate to be useful for the study of light and c mesons.

Prev apps mainly Ps and V; now extending to S and A states and radial excitations, which are sensitive to long-distance IR physics. “Work in progress”, e.g. current η_c‘ mass is 3.45 GeV.

Mon. 12 June 2006 (back up)

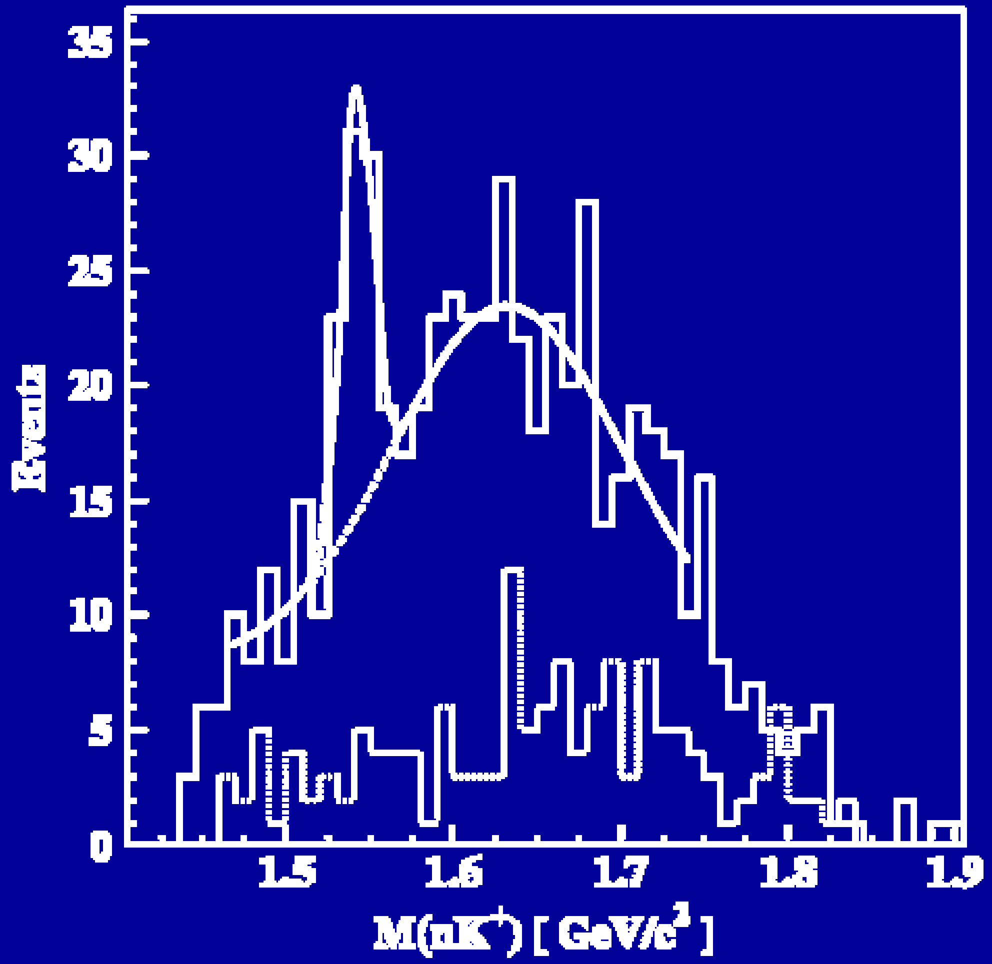
($q^4\underline{q}$ status)

Expt status and plans:

pentaquark:
S.Kabana

… which gives me an excuse to talk about the theoretical problem with multiquark resonances (baryonia, pentaquarks, dibaryons,…).

Θ(1542)



We now know that the assumed background shape was incorrect.

There is a more general theoretical problem with multiquark resonances that should not be forgotten (again).

The multiquark fiasco

"These are very serious charges you're making, and all the more painful to us, your elders, because we still have nightmares from five times before."

village elder, "*Young Frankenstein*"

The dangerous 1970s multiquark logic:

The known hadrons are $q\underline{q}$ and qqq (and $\underline{qqq}$).
These exist because they are color singlets.

Therefore all higher Fock space "multiquark" color singlet sectors will also possess hadron resonances.

$q^2\underline{q}^2$ "baryonia"

q^6 "dibaryons"

$q^4\underline{q}$ "Z*" for $\underline{q} = \underline{s}$ …

MANY theoretical predictions of a very rich spectrum of multiquark resonances.

(Bag model, potential models, QCDSRs, color chemistry,…)

Narrow multiquarks???

Early theoretical claims were that these states would be very narrow.
(Never really justified. Maybe $1/N_c$.)
Alas, strong widths are obscure at the best of times.

Most interest was in $q^2\underline{q}^2$, which motivated $p\underline{p}$ annihilation experiments:

LEAR@CERN was built to find narrow bumps. **They weren't there.**

(Many little 3σ glitches were claimed, which all went away.)

Let's do a quick experiment! $q^2\underline{q}^2$ with **u,d,s** flavor octets has flavors:

$8 \times 8 = 1 + 8 + 8 + 10 + \underline{10} + 27$

| duplicates $q\underline{q}$ | **new "flavor exotics"** |

27 includes an **$I = 2$ $J^{PC} = 0^{++}$ flavor-exotic** state (at 1.2 GeV in the bag model).

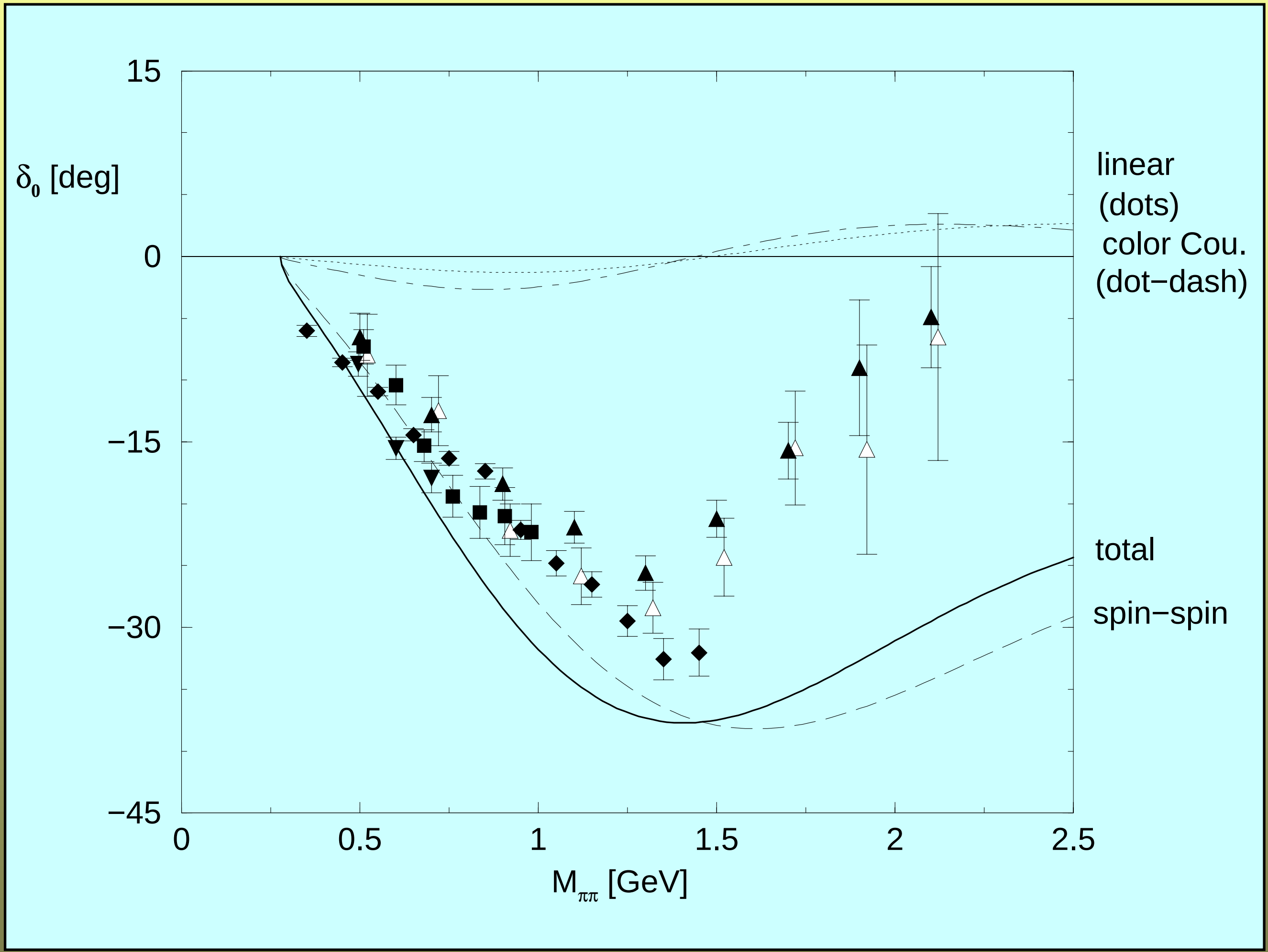
–> **Does $\pi\pi$ scattering really show this resonance???** <–

A flavor-exotic **27** channel.

I=2 ππ S-wave

No I=2 $q^2\underline{q}^2$ resonance at 1.2 GeV.
(Would give $\Delta\delta$ = + 180 [deg].)
This is just repulsive ππ scat.

$\delta_0^{I=2}$ **[deg]**



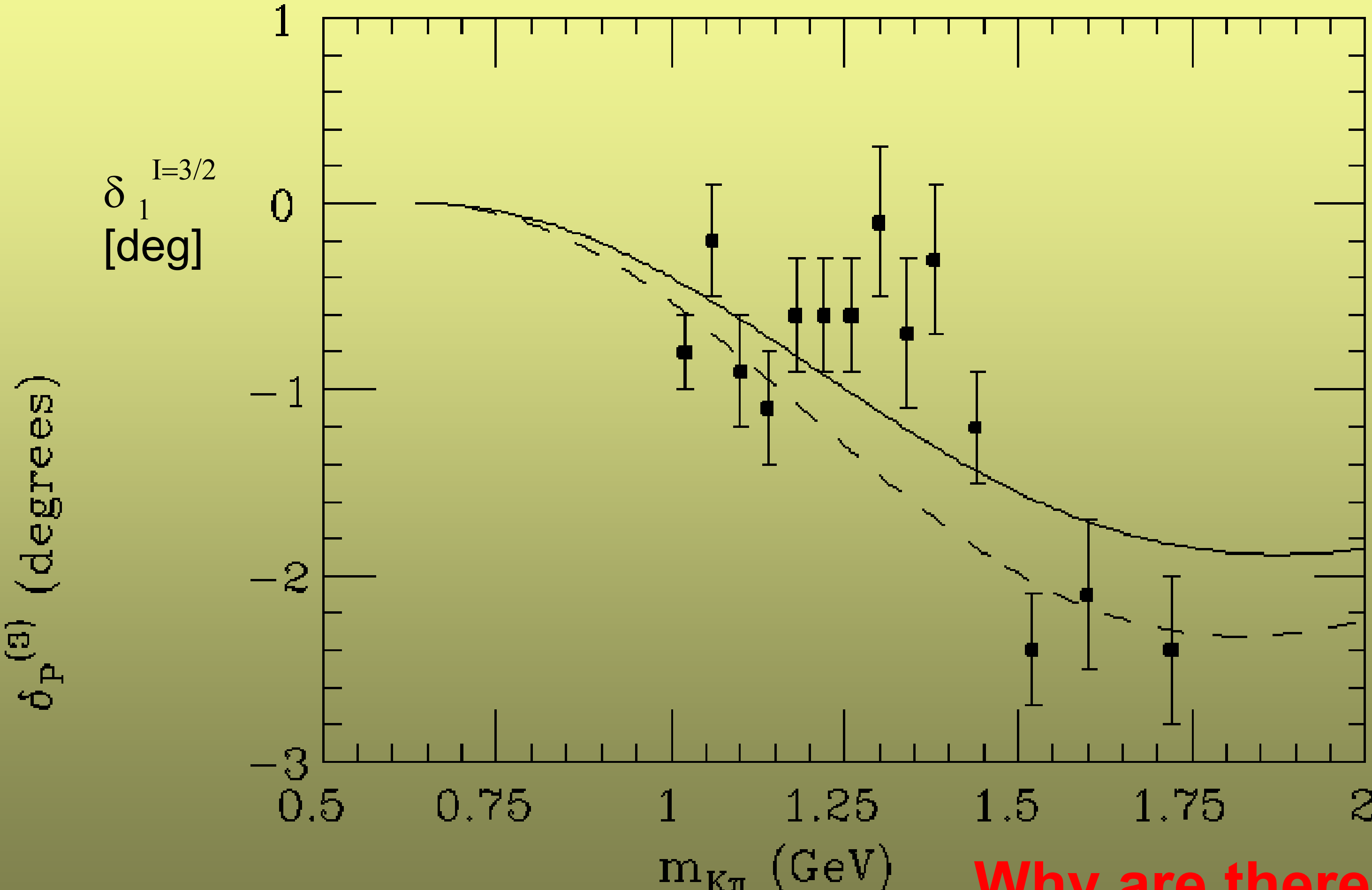
$M_{\pi\pi}$ [GeV]

A flavor-exotic **10** channel.

I=3/2 Kπ P-wave

No $q^2\underline{q}^2$ resonance at 1.3 GeV.
(Would give $\Delta\delta$ = + 180 [deg].)
Just ***very weak*** repulsive Kπ scat.

$\delta_1^{I=3/2}$
[deg]

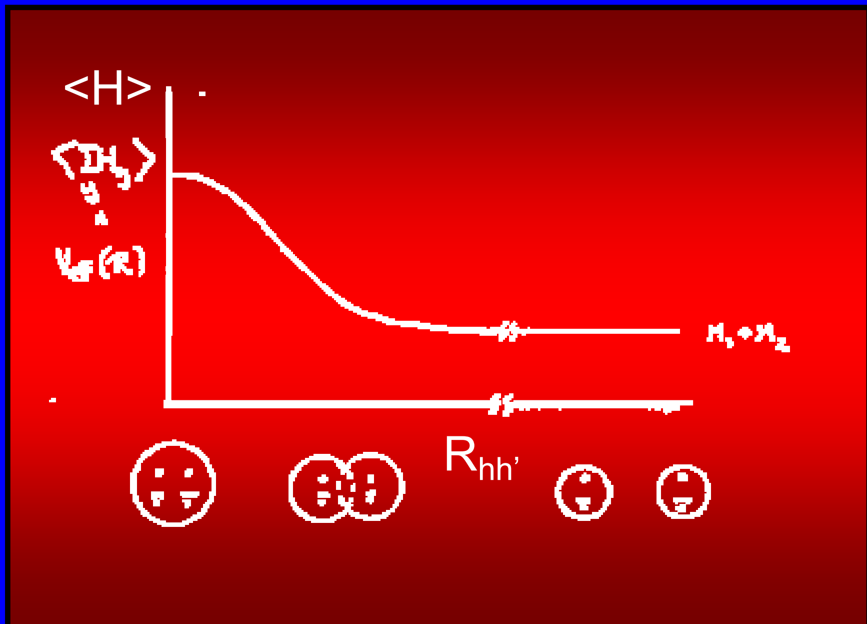


$M_{K\pi}$ [GeV]

Why are there no $q^2\underline{q}^2$ resonances???

"Fall-Apart Effect"

[decay]; actually <u>not a decay at all</u>: no H_I



Most multiquark models found that most channels showed short distance repulsion:

E(cluster) > $M_1 + M_2$.

Thus <u>no bound states or resonances</u>.

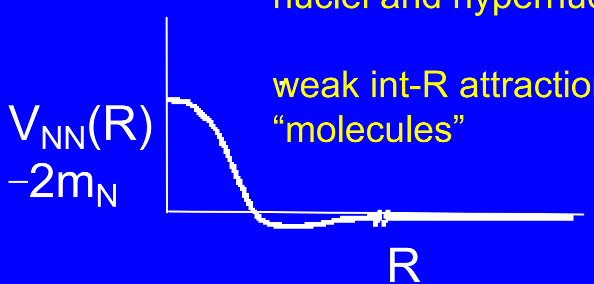
<u>Only 1+2 repulsive scattering</u>.

Hence no pentaquark. (1540 > 940+495).

Exceptions:

nuclei and hypernuclei

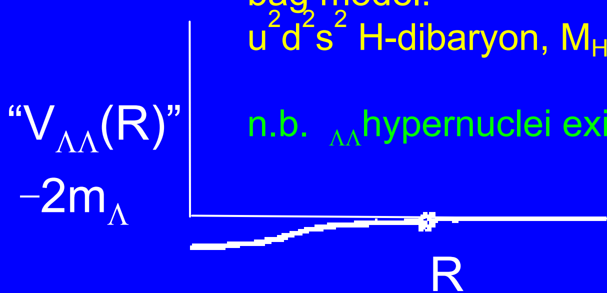
weak int-R attraction allows "molecules"



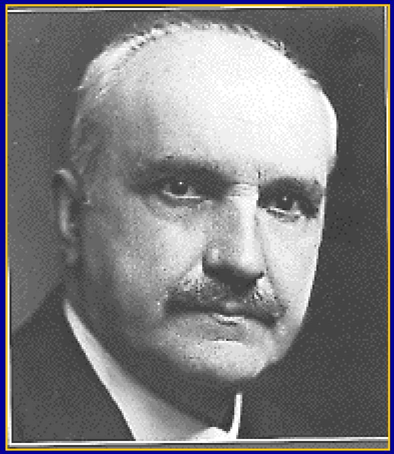
E(cluster) < $M_1 + M_2$,

bag model:
$u^2d^2s^2$ H-dibaryon, $M_H - M_{\Lambda\Lambda} = -80$ MeV.

n.b. $_{\Lambda\Lambda}$hypernuclei exist, so this H was wrong.



Some words of wisdom…

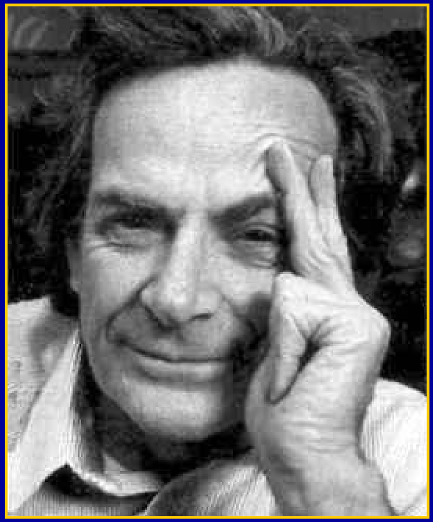


Jorge Agustín Nicolás Ruiz de Santayana (1853-1952)
AB, PhD Harvard (1886,1889). Prof. of Philosophy, Harvard (to 1912).

"Those who cannot remember the past are condemned to repeat it."
Life of Reason, Reason in Common Sense (1905)

"Scepticism is the chastity of the intellect, and it is shameful to surrender it too soon or to the first comer."
Scepticism and Animal Faith (1923)

More words of wisdom…



Richard P.Feynman (1918-1988)
PhD Princeton (1942),
Prof. of Physics, Caltech
(to 1988).

On "Cargo Cult Science" (1974)

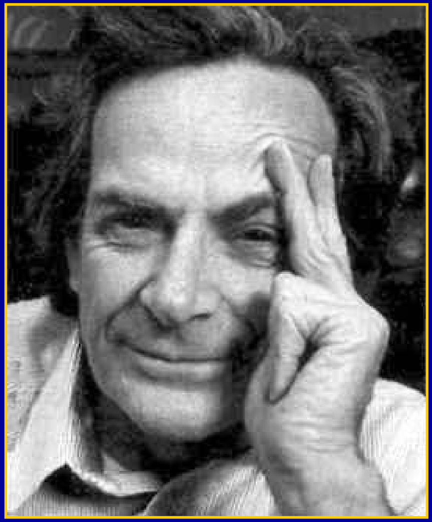
This was mainly about UFOlogists, psychologists, ESPologists, etc. It certainly does not apply to anyone here. However what Feynman had to say is still interesting, some of it consists of useful reminders that we should all keep in mind…

…just good general research habits.

And, some of his points HAVE been encountered in the pentaquark adventure.

"The first principle is that you must not fool yourself – and you are the easiest person to fool."

…

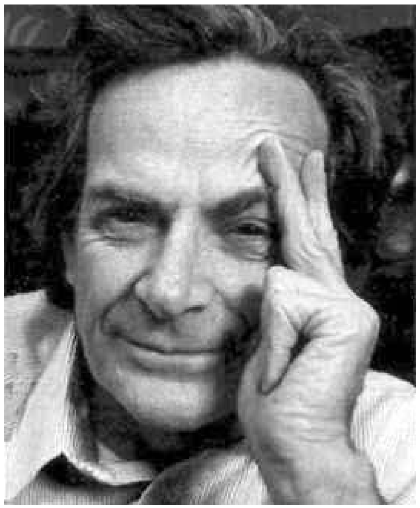


Richard Feynman (1918-1988)
PhD Princeton (1942),
Prof. of Physics, Caltech
(to 1988).

"…there is one feature I notice that is generally missing in cargo cult science…

It's *a kind of scientific integrity, a principle of scientific thought that corresponds to a kind of utter honesty -- a kind of leaning over backwards.*

For example, if you're doing an experiment, you should report everything that you think might make it invalid -- not only what you think is right about it: other causes that could possibly explain your results; and things you thought of that you've eliminated by some other experiment, and how they worked -- to make sure the other fellow can tell they have been eliminated."



Feynman anti-quote:

‘ What’s the idea, messing up a perfectly good lecture by referring to experiment ? ’

MESON 2006

Thanks to our hosts…

Jagellonian University, Kraków

Forschungszentrum Jülich

INFN-LNF, Frascati

INP-PAN, Kraków