Status of and Prospects for N* Spectroscopy

Volker Credé

Florida State University
Tallahassee, FL

Lattice QCD and Experiment

Jefferson Laboratory, 11/21/2008

Outline

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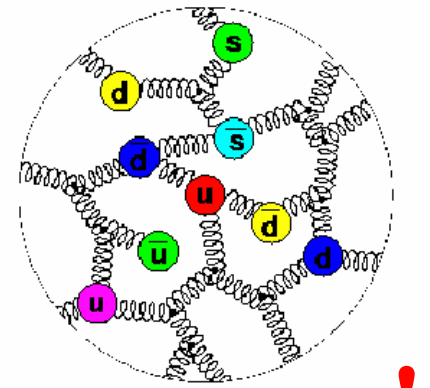
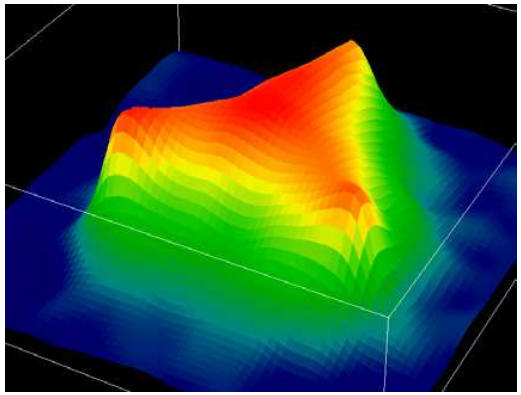
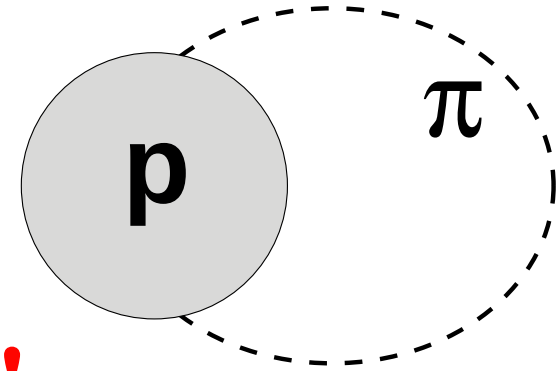
$\ll 0.1$fm | $0.1 - 1.0$ fm | > 1.0 fm







pQCD
q, g, $q\bar{q}$

? ! ↔ ? !

Models
Quarks and Gluons
as Quasiparticles

? ! ↔ ! ?

ChPT
Nucleon and
Mesons

1. What are the relevant degrees of freedom?
2. What are the corresponding effective interactions responsible for hadronic phenomena?

The Excited Baryon Program at JLab

The excited baryon program has two main components:

- Establish the systematics of the spectrum
  - ➜ Provides information on the nature of effective degrees of freedom in strong QCD
- Probe resonance transitions at different distance scales (electron beams are ideal to measure transition form factors)
  - ➜ Provides information on the confining forces of the 3-quark system

Outline

One of the Main Goals of the N^* Program ...

Search for *missing* resonances

Quark models predict many more baryons than have been observed

	****	***	**	*
N Spectrum	11	3	6	2
Δ Spectrum	7	3	6	6

$\Rightarrow$ according to PDG

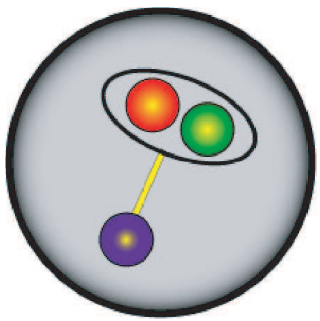
Phys. Rev. **D66** (2002) 010001

$\Rightarrow$ little known

(many open questions left)

Possible solutions:

1. Quark-diquark structure



one of the internal degrees of freedom is frozen

2. Have not been observed, yet

Nearly all existing data result from πN scattering experiments

➜ If the missing resonances did not couple to Nπ, they would not have been discovered!!

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Phys. Lett. B **667**, 1 (2008)

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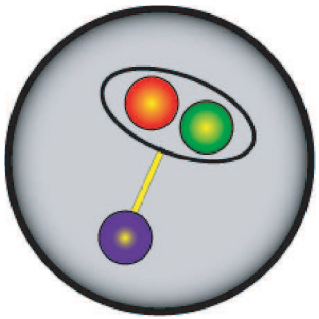

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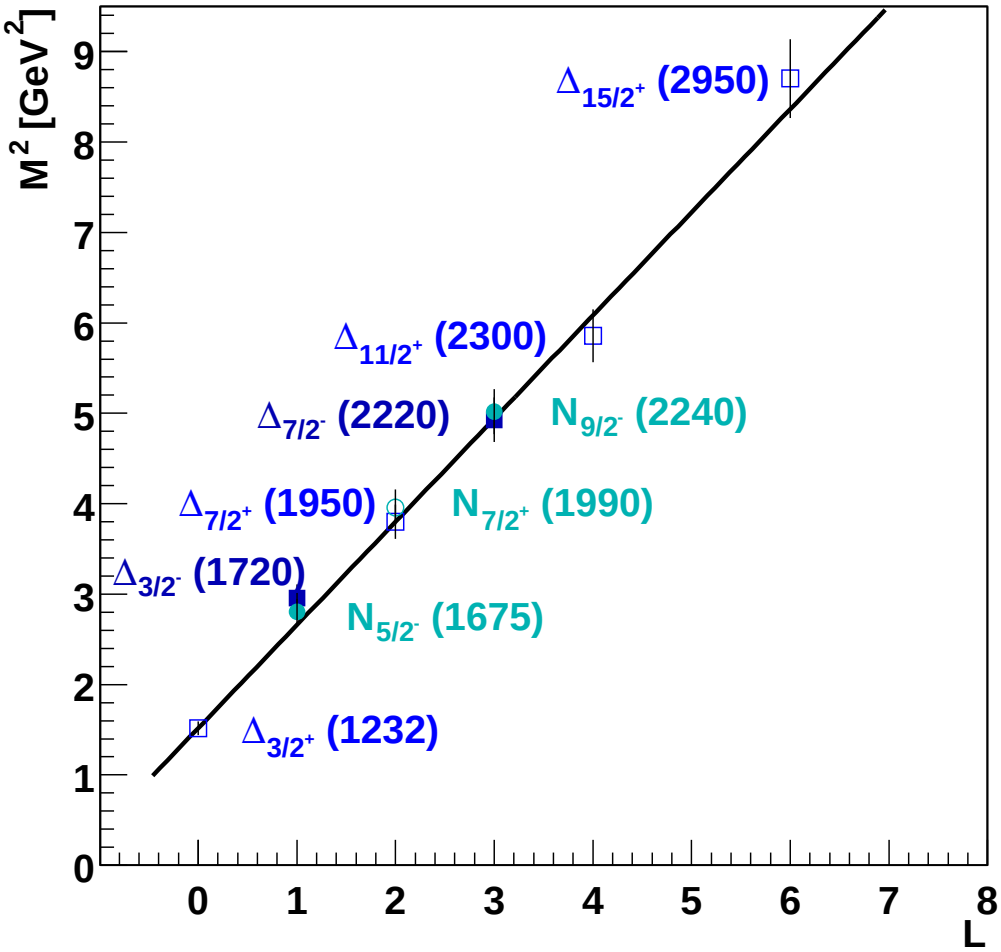
Possible Quark-Diquark Structure?



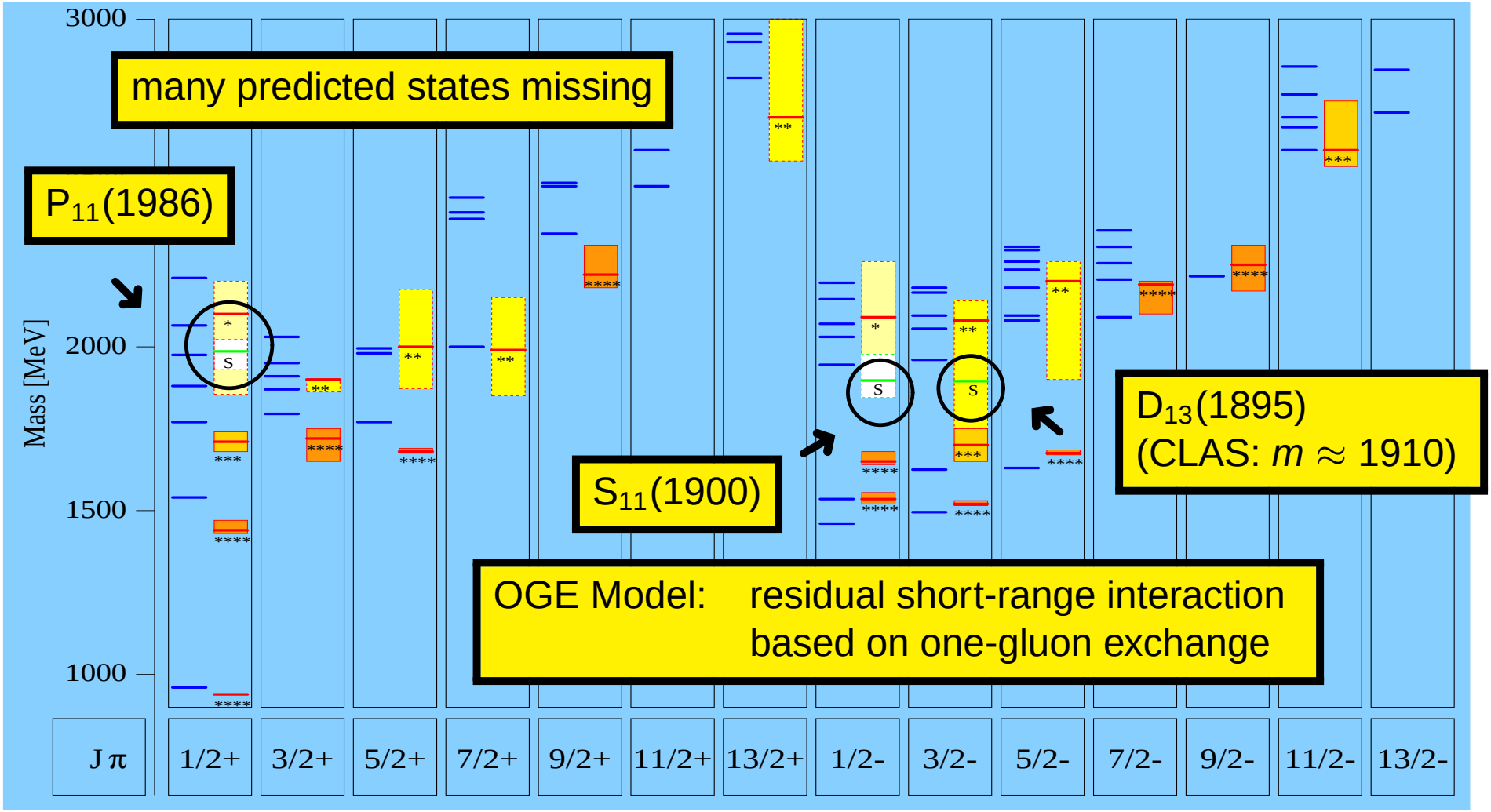
Regge trajectory for Δ^* states with intrinsic spin $S = 1/2$ and $S = 3/2$, and for N* states with spin $S = 3/2$ (M^2 versus L, not J)

1. Common Regge trajectory for N/Δ states with $S = 3/2$
2. Not shown, but slope of the Regge trajectory for meson and Δ excitations is identical

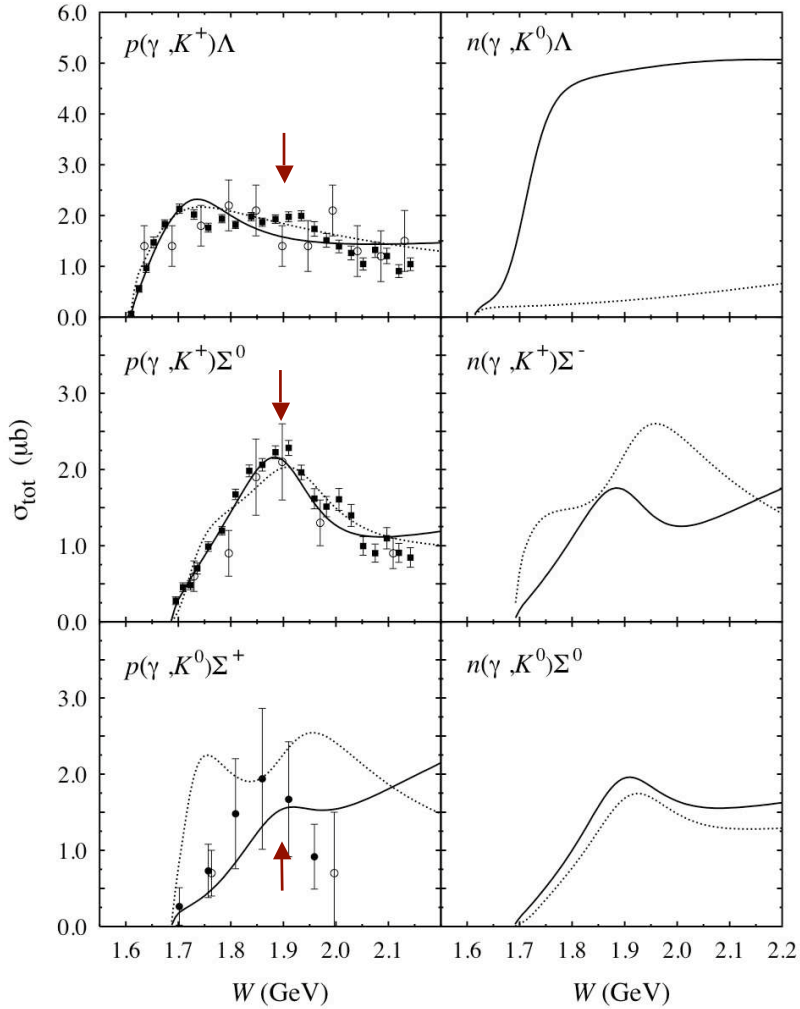
➜ Are baryons quark-diquark excitations?

Nucleon Resonances: Status – 2001

S. Capstick and N. Isgur, Phys. Rev. **D34** (1986) 2809

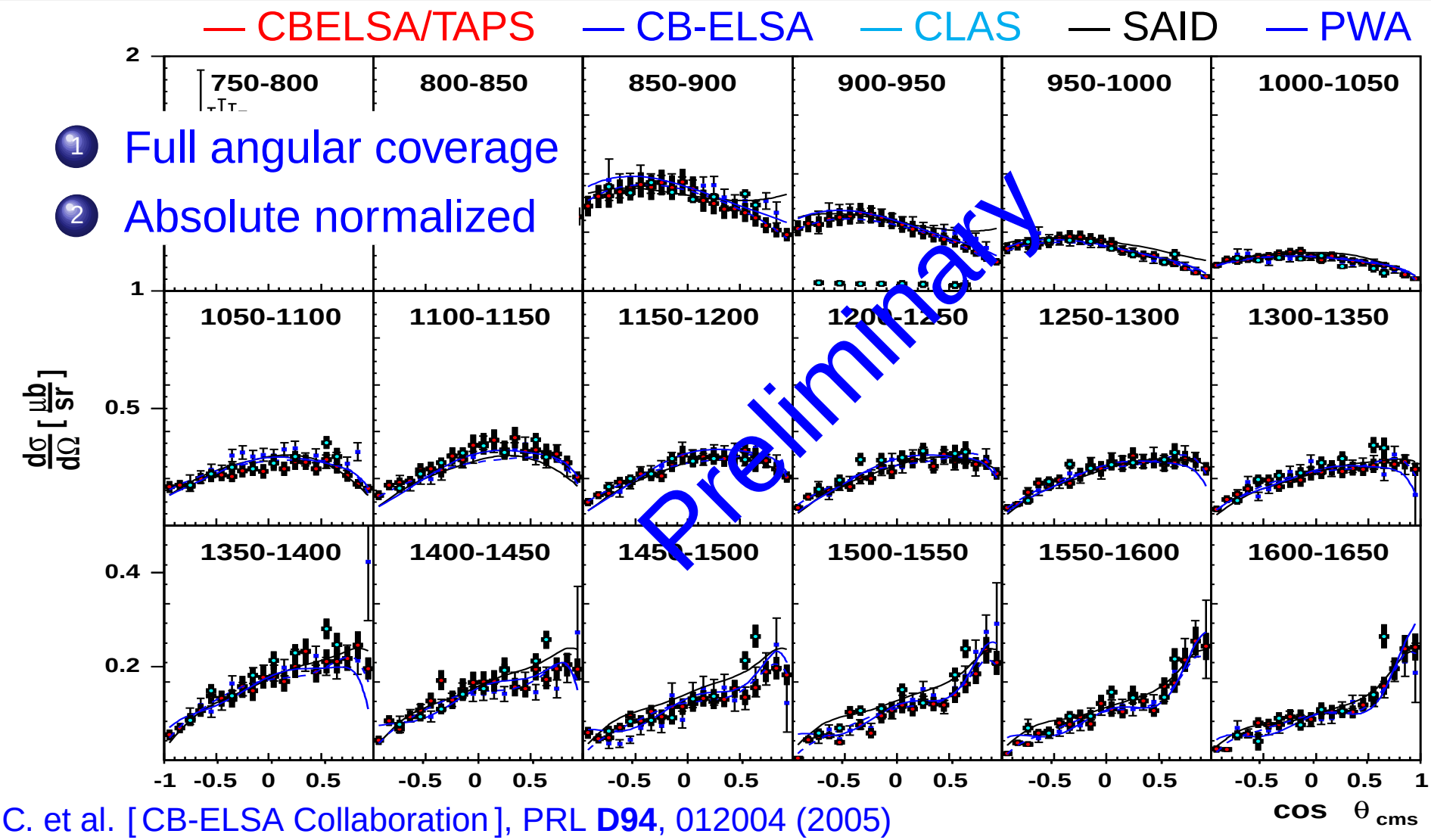


Baryon Resonances in Hyperon Photoproduction



p and n KY-Mart&Bennhold-hst06

Analysis of $\gamma p \rightarrow p\eta$ (New Data from CB-ELSA/TAPS)



V.C. et al. [CB-ELSA Collaboration], PRL **D94**, 012004 (2005)

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