
Theoretical Support for *GlueX*

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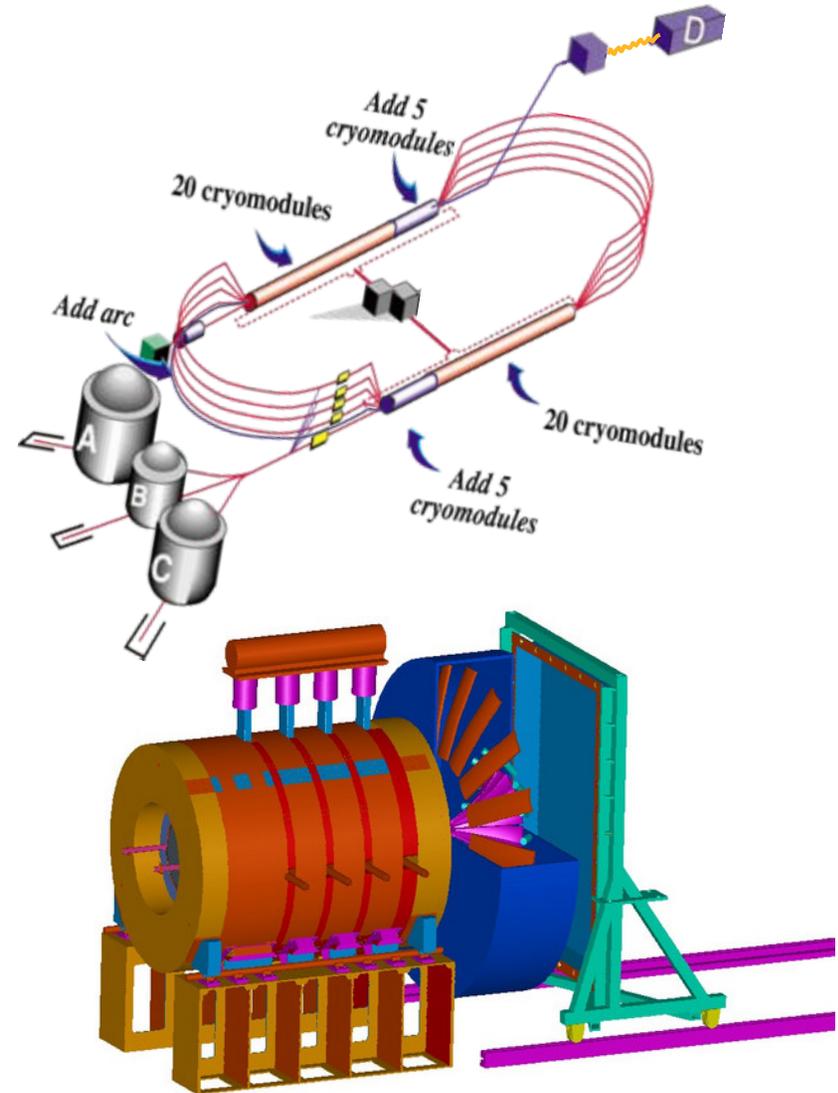


Thomas Jefferson National Accelerator Facility



The *GlueX* experiment

- GlueX is a central feature of the 12 GeV upgrade
 - will utilise 9 GeV real, linearly polarised photons for meson photoproduction
 - dominant aim is to map out the spectrum of gluonic excitations using exotic quantum numbered states

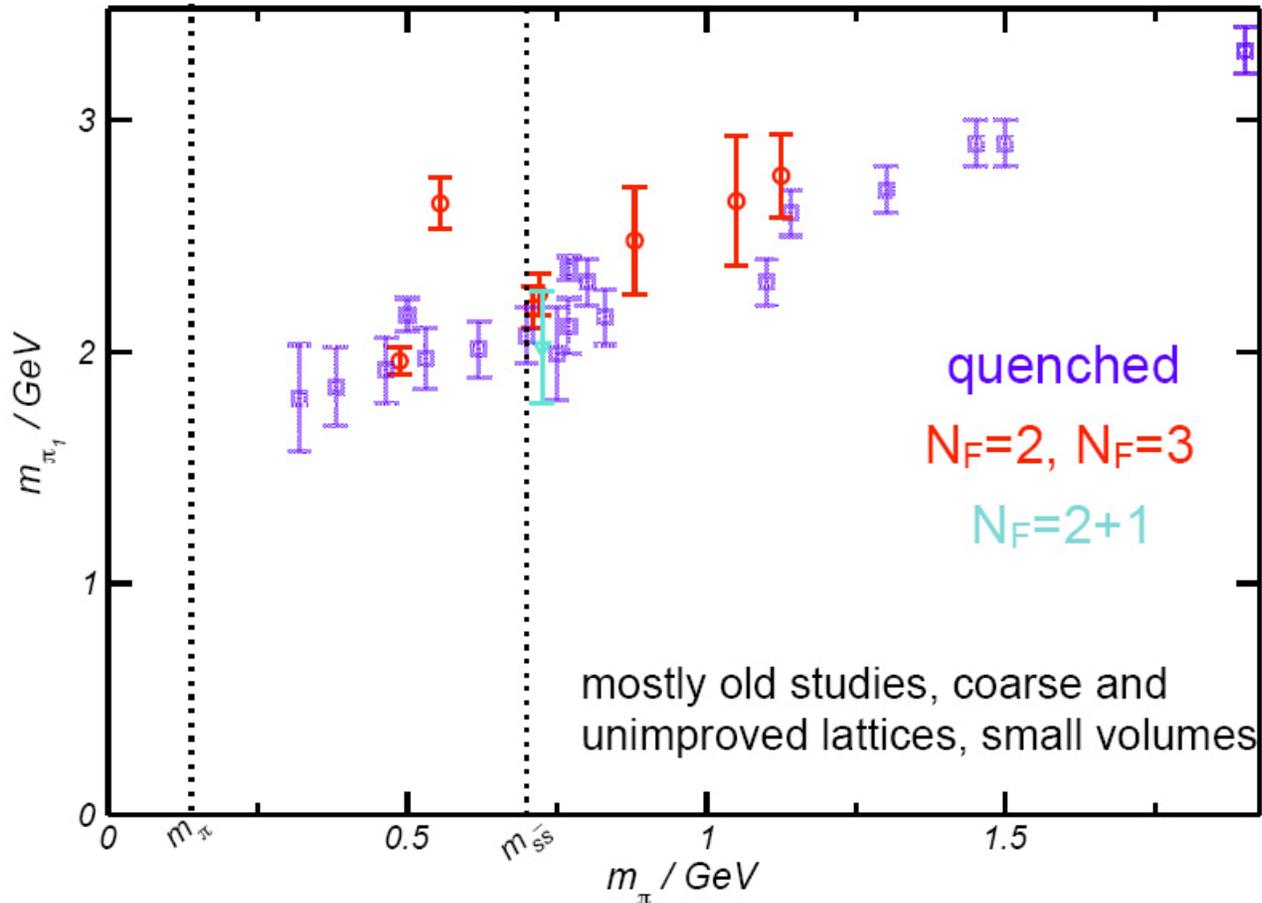


JLab Theory Center and *GlueX*

- JLab Theory Center members increasingly involved in *GlueX* related physics
 - takes advantage of expertise & resources for Lattice QCD
 - growing interest in PWA and reaction modeling
 - *GlueX* Theory Group co-ordinated by JLab Theory Center staff member

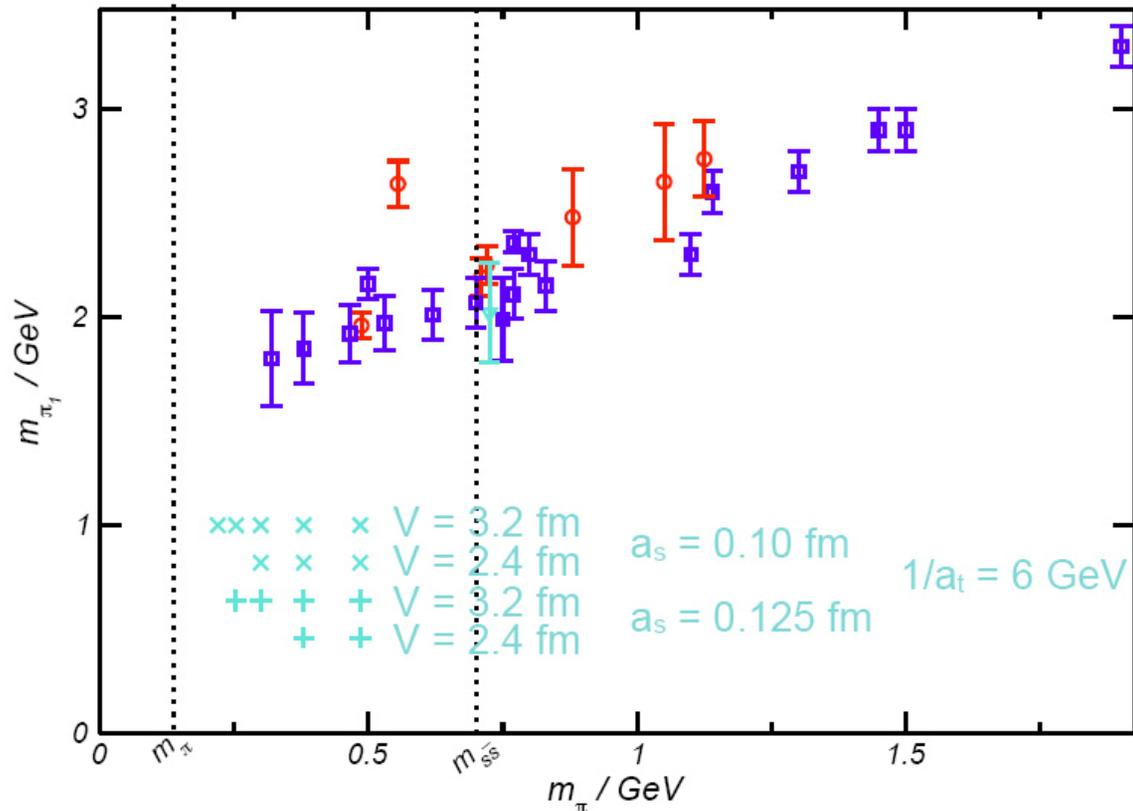
Hybrid Mesons in Lattice QCD

- Only a handful of studies, mainly the mass of the 1^-+ exotic



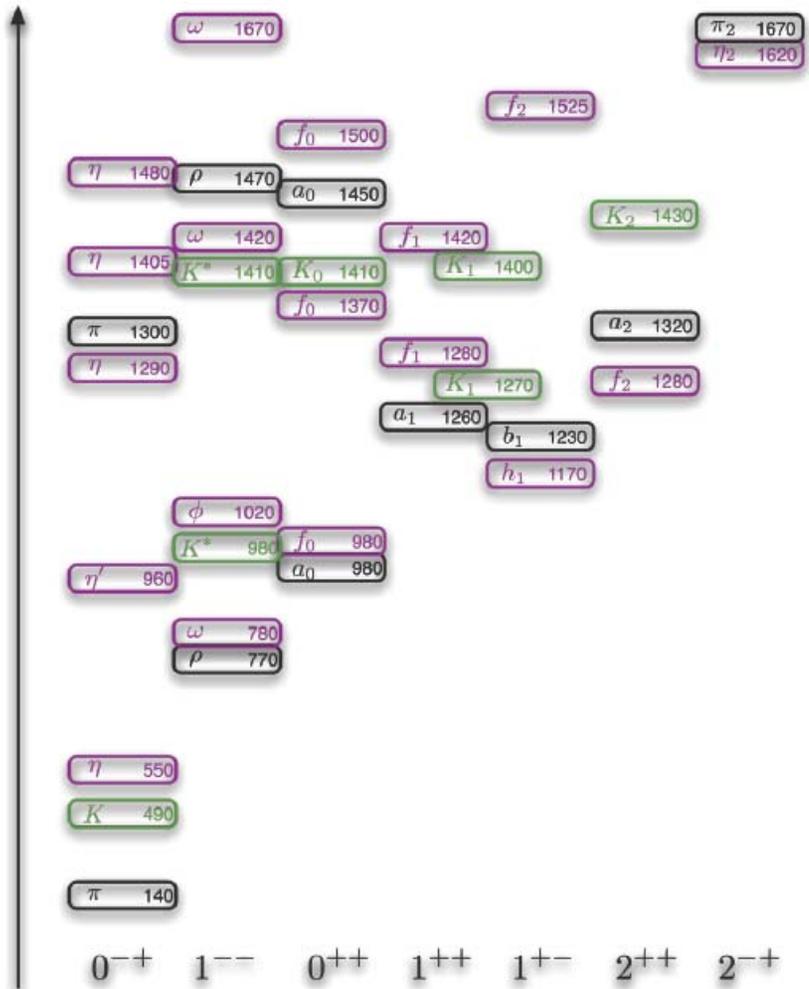
JLab plans in '06-'07

- dynamical anisotropic Clover NF = 2+1 gauge fields in '06, '07
 - ideal for spectroscopy
 - generation time from SciDAC (awarded) + ORNL (requested) [Phase I]



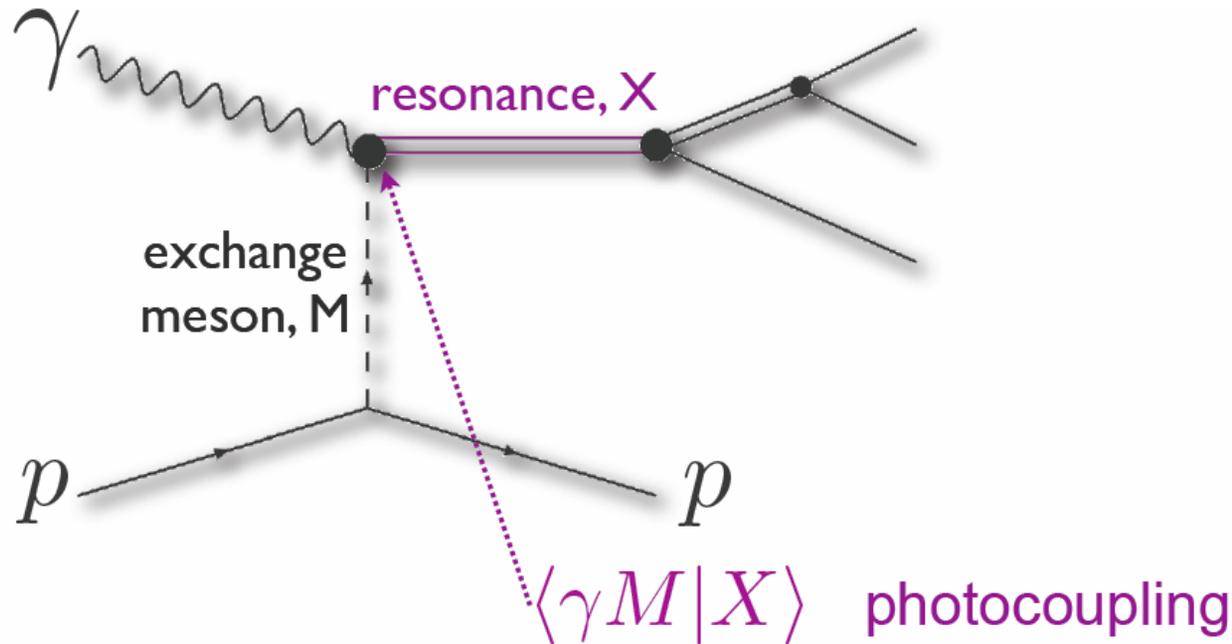
Spectroscopy plans beyond '06

- map out the entire lightquark meson spectrum accessible to *GlueX*
- quark-antiquark operators in development now; will supplement these with multi-meson operators - parallels the work underway on the baryon spectrum
- utilise techniques such as Luscher's at light pion masses



GlueX and Photocouplings

- *GlueX* production rates reliant upon these being 'large'

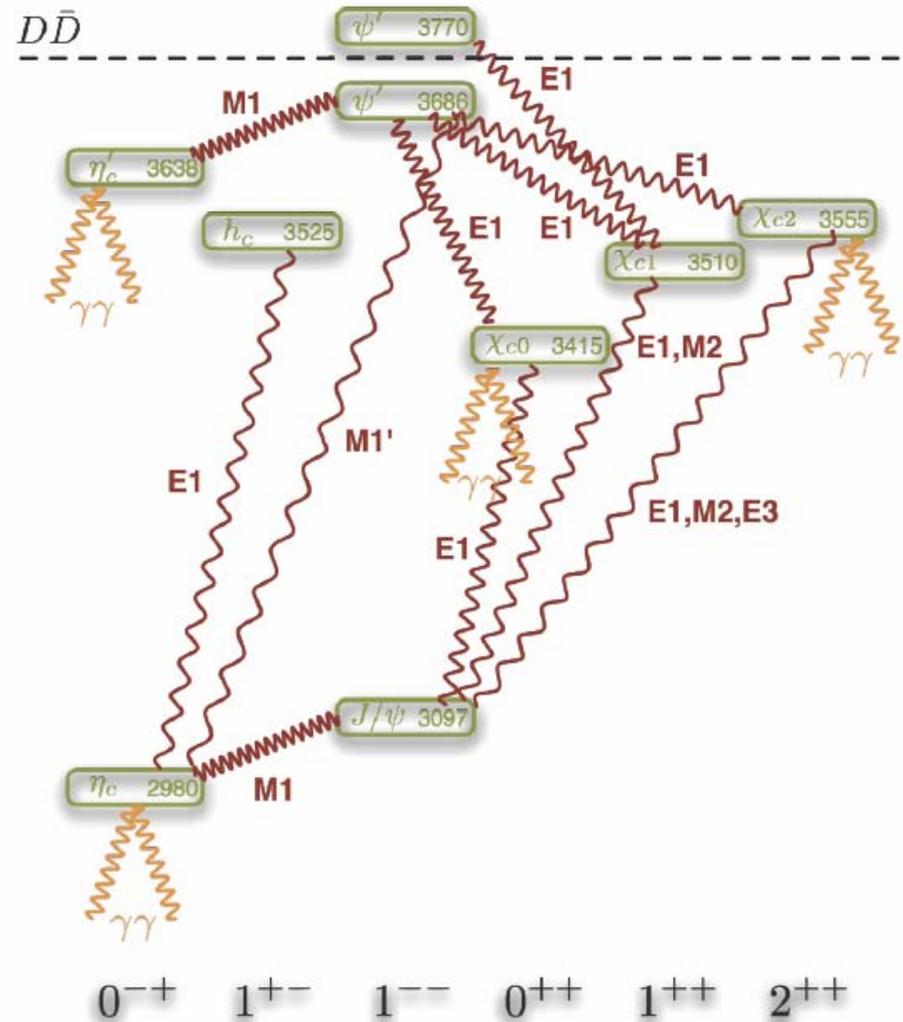


- Photocouplings unknown experimentally for hybrids and most conventional mesons - clear target for LQCD ***predictions***

Photocouplings from Lattice QCD

- extracting transition matrix elements is relatively novel, $\Delta \rightarrow N\gamma$ only well studied example
- pays to test out the new method in a sector with good expt^{al} data that can be simulated 'easily'

-*charmonium* is just that



Charmonium Radiative Transitions

- techniques developed in '05/'06 and applied with considerable success

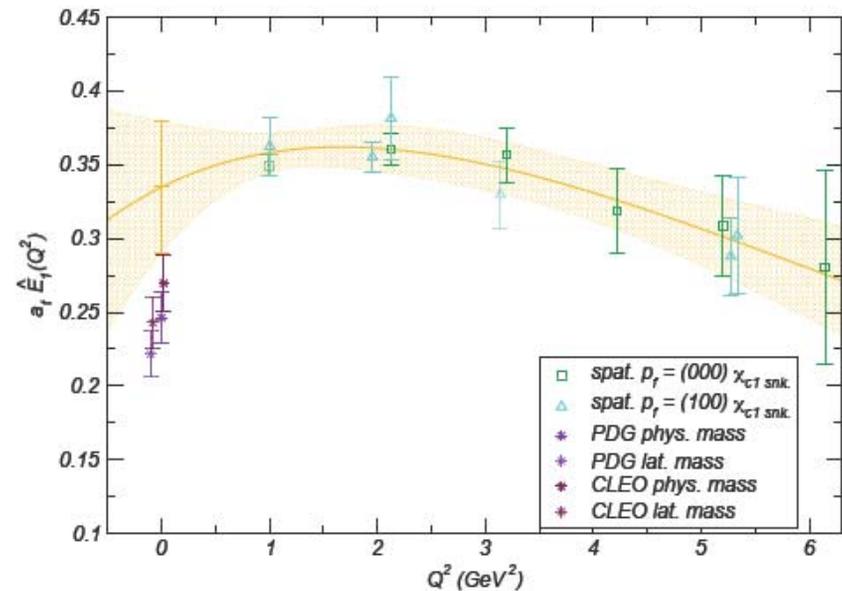
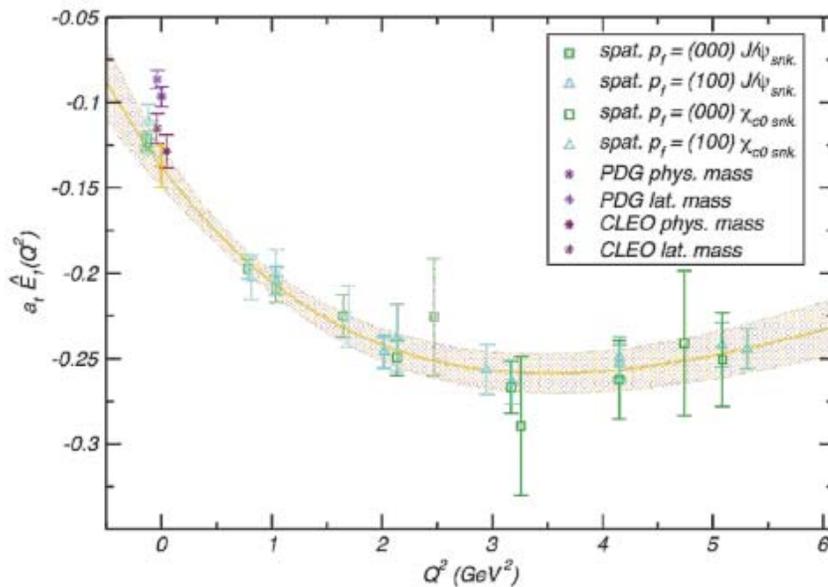
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Radiative transitions in charmonium from lattice QCD

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Plans & Personnel

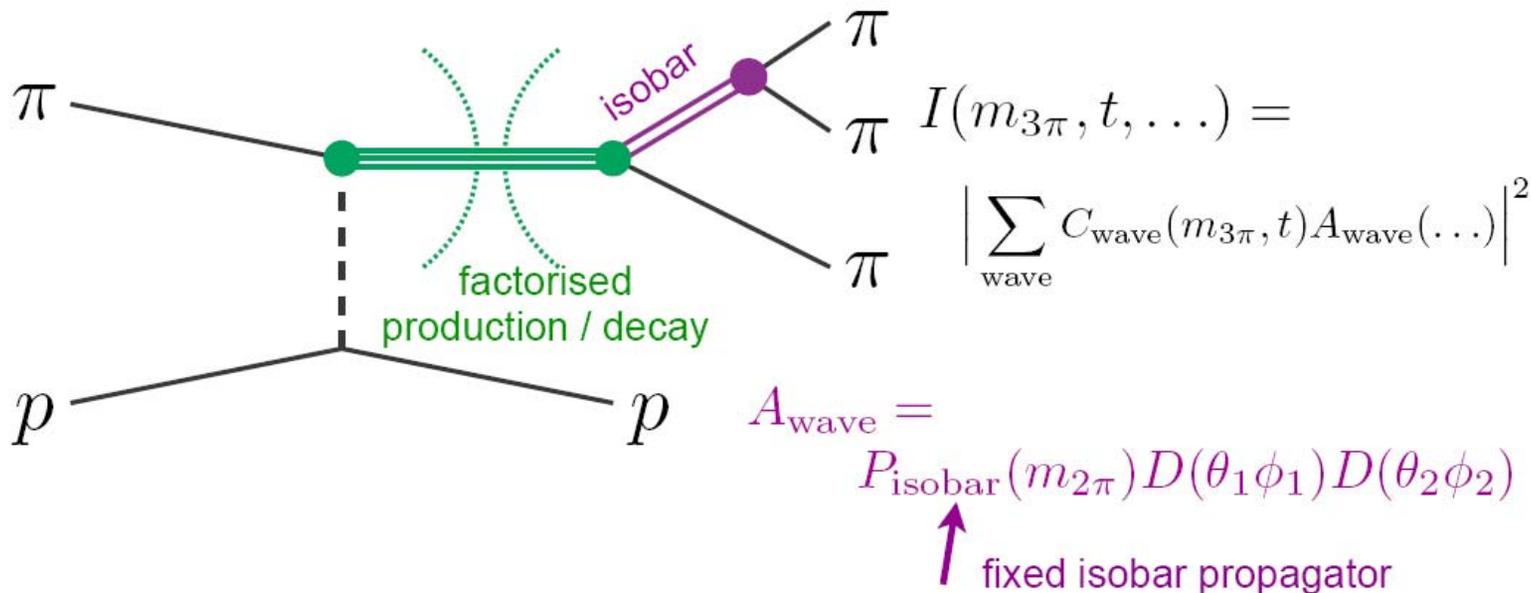
- goal to make predictions pre-*GlueX* and to assist in explanation of *GlueX* results
- lattice QCD personnel working on *GlueX* physics:
 - Jozef Dudek - JLab/ODU staff (from Aug)
 - Robert Edwards, David Richards - JLab staff
 - Nilmani Mathur - JLab postdoc

PWA & Reaction Modeling

- *GlueX* PWA analysis development centered around groups in CMU & IU - actively analysing existing data (CLAS / E852)
- In addition JLab Theory Center collaboration with IU physicists on 'novel' effects
considering 'beyond the isobar model' possibilities

Going Beyond the Isobar Model of PWA

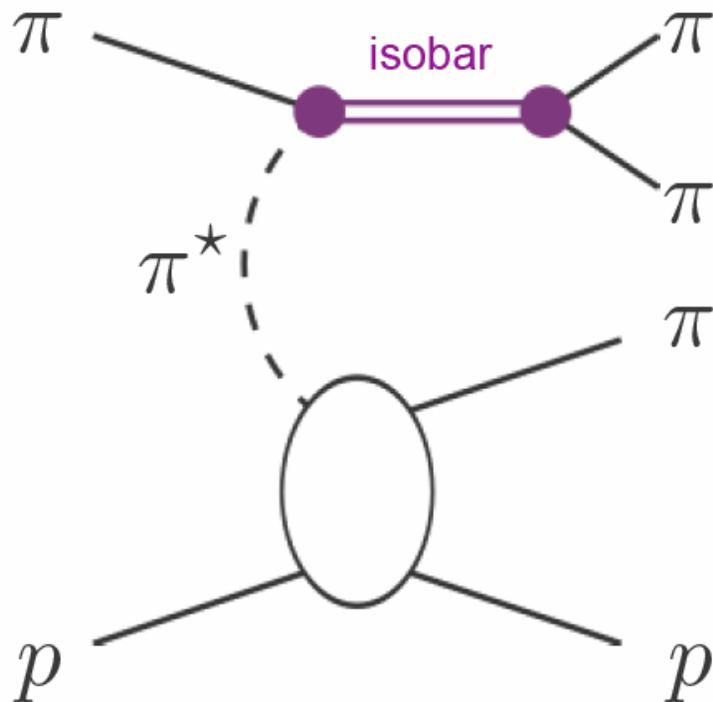
- isobar model makes strong assumptions about the reaction mechanism



- these assumptions are not general, and it has been known since the '70s that there are processes which violate them

The Deck Effect

- classic example of an isobar-model violating process

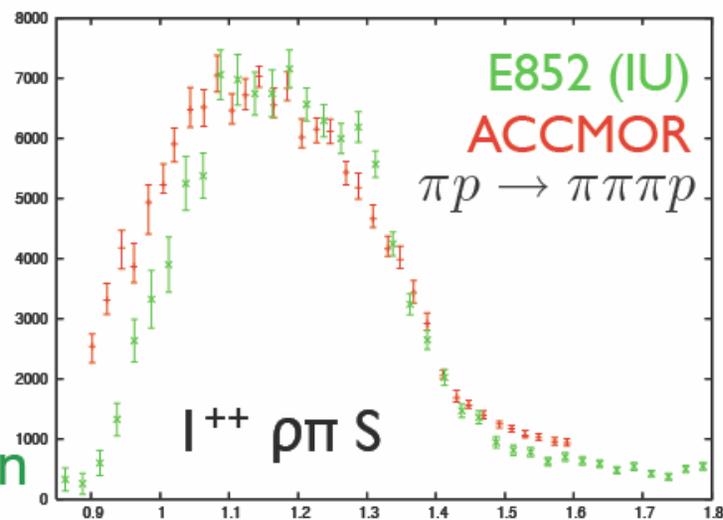


e.g. non Breit-Wigner lineshape of the a_1 meson

$$\pi \rightarrow \pi^* + \text{isobar}$$

$$\pi^* p \rightarrow \pi p$$

peaks at threshold
in isobar- π S-wave



Reaction Models

- work being done now using existing data to understand the effect such processes can have, e.g. on an isobar model PWA
- desire to make the eventual analysis results as unambiguous as possible



In Summary

- JLab Theory Center research aims well aligned with the *GlueX* project
 - pioneering work in Lattice QCD, set to make predictions of great relevance to *GlueX*
 - developing expertise in reaction modeling and PWA ready for the arrival of data