Hadron spectroscopy with the GlueX experiment

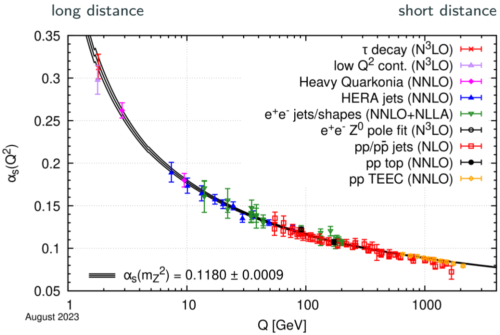
European Nuclear Physics Conference 2025

Farah Afzal for the GlueX Collaboration

Ruhr University Bochum

23.09.2025

Motivation: Understanding QCD



PDG 2024

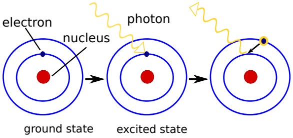
Quantum Chromodynamics (QCD): Theory of strong interactions

- Gluons carry color charge $\rightarrow \alpha_s$ is large at low Q
- Quarks are confined inside of **colorless hadrons**
- Hadrons $\leftrightarrow$ non-perturbative regime of QCD
  $\rightarrow$ Challenging from experimental and theory side
  $\rightarrow$ Theory side: Need to rely on quark models or Lattice QCD calculations

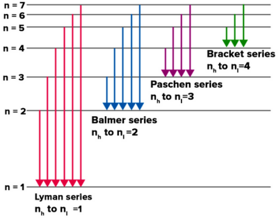
Fundamental open questions in hadron physics:

- How do hadrons emerge?
- What is the role of gluons in in the hadron spectrum?

Atomic spectroscopy

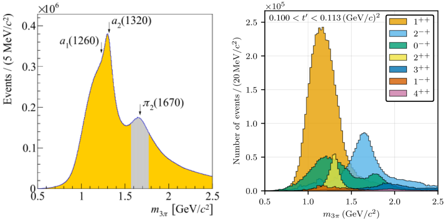


Hydrogen (Balmer series):



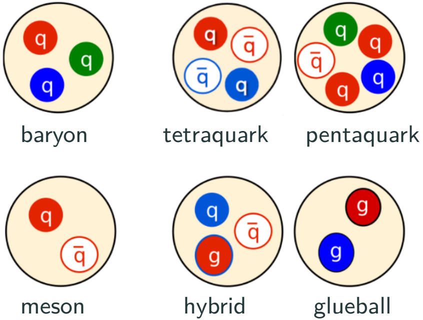
Hadron spectroscopy

- Production of hadrons with high-energy beams
  $\rightarrow$ beam particles: $e, \gamma, \quad \pi, K, p$
- Observe hadrons through different decay modes and study their properties
- Challenge in light hadron spectroscopy:
  Many broad and overlapping states in dense mass spectrum



COMPASS: PPNP 113 (2020) 103755

Exotic hadrons



Hadron spectrum

- Many conventional $q\bar{q}$ and qqq states have been observed
- QCD allows more complicated configurations as well, e.g. multi-quark states, hybrids, glueballs

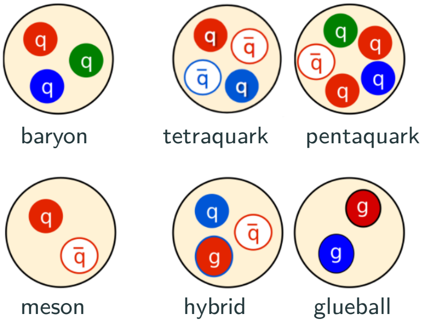
A SCHEMATIC MODEL OF BARYONS AND MESONS *

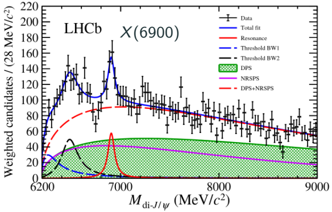
M. GELL-MANN
California Institute of Technology, Pasadena, California

... Baryons can now be constructed from quarks by using the combinations $(q\,q\,q)$, $(q\,q\,q\,q\,\bar{q})$, etc., while mesons are made out of $(q\,\bar{q})$, $(q\,q\,\bar{q}\,\bar{q})$, etc. ...

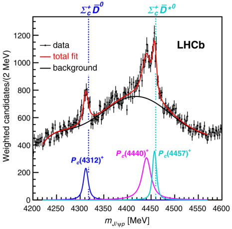
Phys.Lett. 8 214-215,1964

Exotic hadrons

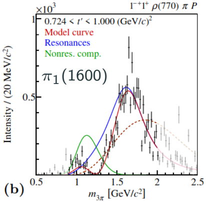




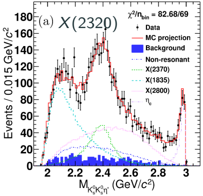
LHCb: Sci.Bull. 65 (2020) 23, 1983-1993



LHCb: PRL 122, 222001 (2019)



COMPASS: PRD 740 (2022) 1, 012005



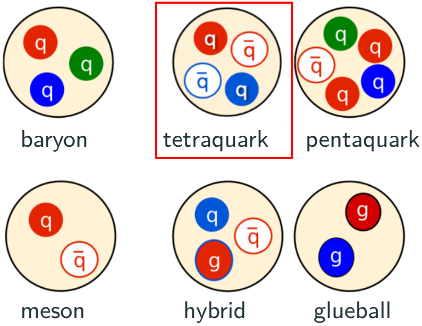
BESIII: PRL 132 (2024) 18, 181901

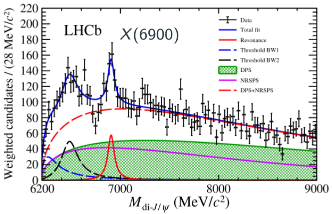
→ see talk by N. Huesken

GlueX experiment:

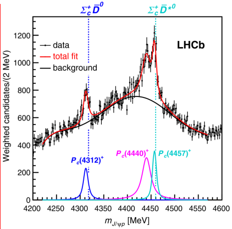
→ Complementary production mechanism

→ Unique opportunity to explore light hadron spectrum with focus on hybrid mesons

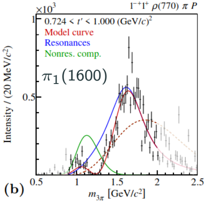




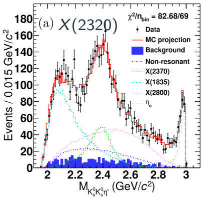
LHCb: Sci.Bull. 65 (2020) 23, 1983-1993



LHCb: PRL 122, 222001 (2019)



COMPASS: PRD 740 (2022) 1, 012005



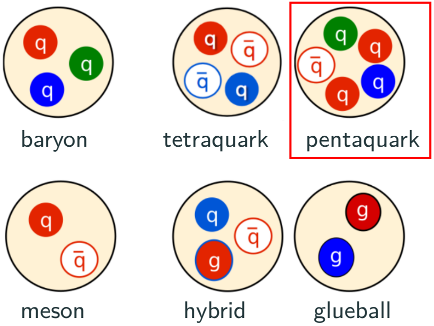
BESIII: PRL 132 (2024) 18, 181901

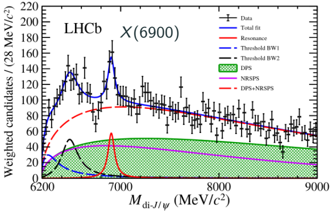
→ see talk by N. Huesken

GlueX experiment:

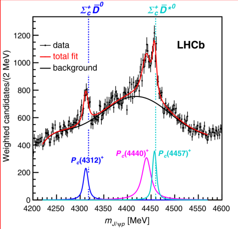
→ Complementary production mechanism

→ Unique opportunity to explore light hadron spectrum with focus on hybrid mesons

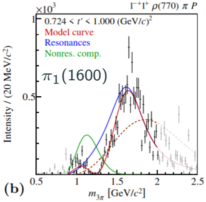




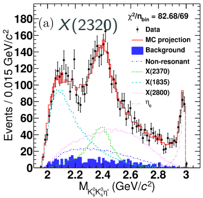
LHCb: Sci.Bull. 65 (2020) 23, 1983-1993



LHCb: PRL 122, 222001 (2019)



COMPASS: PRD 740 (2022) 1, 012005



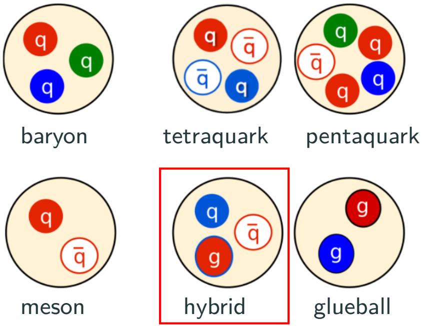
BESIII: PRL 132 (2024) 18, 181901

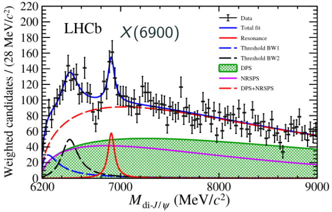
$\rightarrow$ see talk by N. Huesken

GlueX experiment:

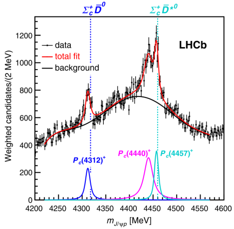
$\rightarrow$ Complementary production mechanism

$\rightarrow$ Unique opportunity to explore light hadron spectrum with focus on hybrid mesons

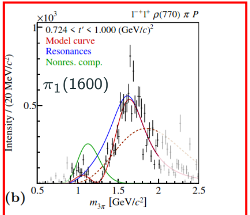




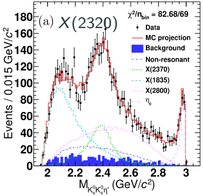
LHCb: Sci.Bull. 65 (2020) 23, 1983-1993



LHCb: PRL 122, 222001 (2019)



COMPASS: PRD 740 (2022) 1, 012005



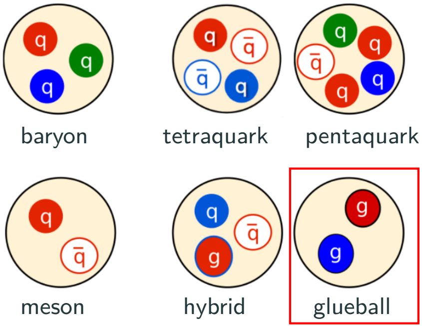
BESIII: PRL 132 (2024) 18, 181901

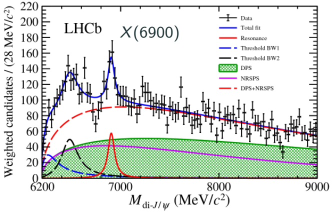
→ see talk by N. Huesken

GlueX experiment:

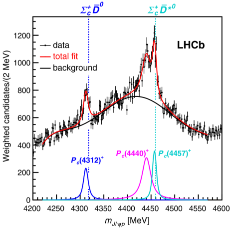
→ Complementary production mechanism

→ Unique opportunity to explore light hadron spectrum with focus on hybrid mesons

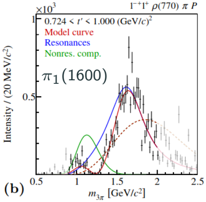




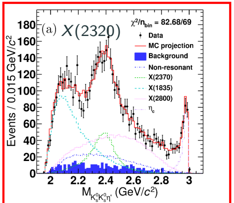
LHCb: Sci.Bull. 65 (2020) 23, 1983-1993



LHCb: PRL 122, 222001 (2019)



COMPASS: PRD 740 (2022) 1, 012005



BESIII: PRL 132 (2024) 18, 181901

$\rightarrow$ see talk by N. Huesken

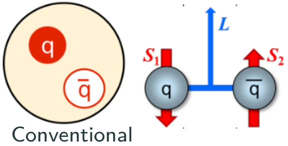
GlueX experiment:

$\rightarrow$ Complementary production mechanism

$\rightarrow$ Unique opportunity to explore light hadron spectrum with focus on hybrid mesons

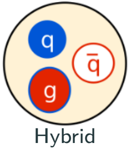
Conventional $q\bar{q}$ mesons:

- Quantum numbers: $J = L + S, P = (-1)^{L+1}, C = (-1)^{L+S}$
- Possible quantum numbers: $J^{PC} = 0^{++}, 0^{-+}, 1^{--}, 1^{+-}, 2^{++}, \ldots$



How to identify exotics in the meson spectrum?

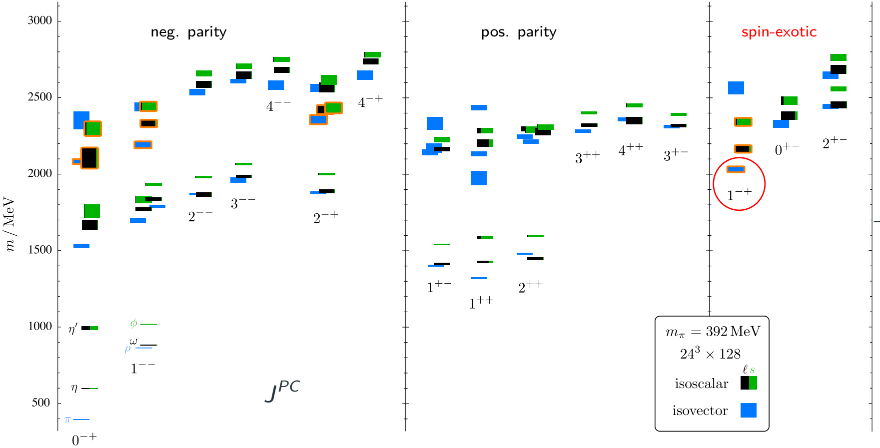
- Supernumerary states
- Spin-exotic: $J^{PC} = 0^{+-}, 1^{-+}, 2^{+-}, 3^{-+} \ldots$ (not allowed for $q\bar{q}$ states!)
  $\rightarrow$ "Smoking gun" for finding evidence for exotic mesons!

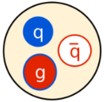


Experimental confirmation of exotic mesons is an essential direct test of QCD!

Predicted light meson spectrum - Lattice QCD

HadSpec: J. Dudek et al. PRD 88 094505 (2013)





Lightest hybrid mesons

$\rightarrow$ test gluonic degrees of freedom of QCD

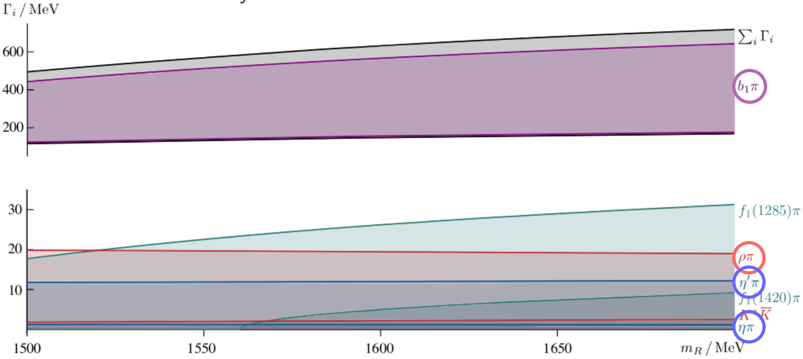
Spin-exotic: $J^{PC} = 0^{+-}, 1^{-+}, 2^{+-}, 3^{-+} \ldots$ (not allowed for $q\bar{q}$ states!)

Clear signature for finding hybrid mesons!

Expected decay modes of the lightest exotic hybrid meson

Recent Lattice QCD calculation ($m_\pi \sim 700$ MeV): Woss, Dudek et al., PRD 103 (2021) 054502

Partial decay widths

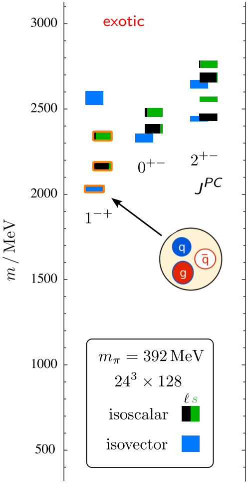


dominant decay mode: $b_1\pi \rightarrow \omega\pi\pi$

other decay modes: $\rho\pi$, $\eta'\pi, \eta\pi$
$\rightarrow$ experimental evidence exists

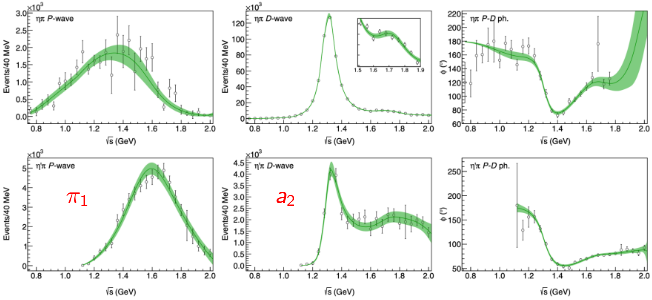
Important to measure different decay modes to compare to predictions from Lattice QCD!

Experimental evidence for light hybrid mesons



HadSpec: J. Dudek et al. PRD 88 094505(2013)

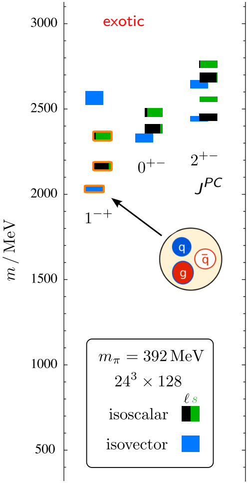
- Experimentally two hybrid meson candidates:
  $\pi_1(1400)$: GAMS, VES, E852, CBAR, COMPASS
  $\pi_1(1600)$: VES, E852, COMPASS
- JPAC: coupled channel analysis of $\eta\pi$ and $\eta'\pi$ requires only a **single pole**



mass $= 1564 \pm 24 \pm 86$ MeV
width $= 492 \pm 54 \pm 102$ MeV

COMPASS: PLB 740 (2015) 303
JPAC: PRL 122 (2019) 042002

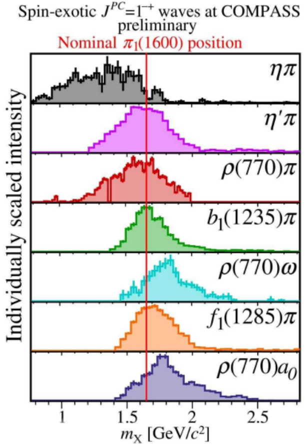
Experimental evidence for light hybrid mesons



HadSpec: J. Dudek et al. PRD 88 094505(2013)

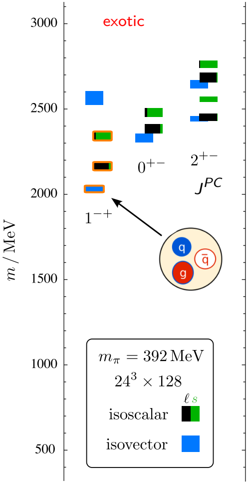
More recent progress

Multiple decay channels of π_1 measured



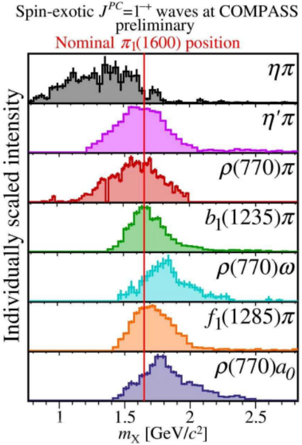
HADRON 2025 talk by J. Beckers

More recent progress



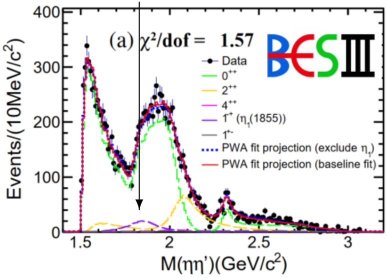
HadSpec: J. Dudek et al. PRD 88 094505(2013)

Multiple decay channels of π_1 measured



HADRON 2025 talk by J. Beckers

Isospin partner $\eta_1(1855)$?



BESIII: PRL 129, 192002 (2022)

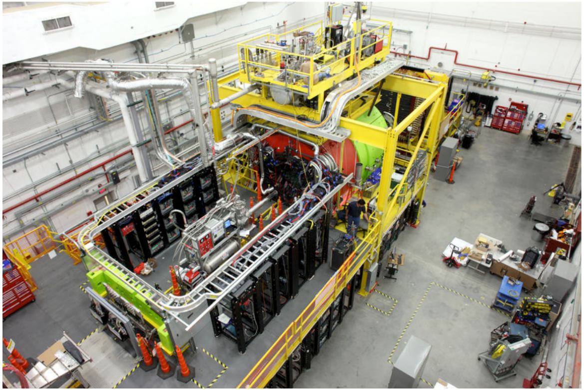
The GlueX experiment

RUB

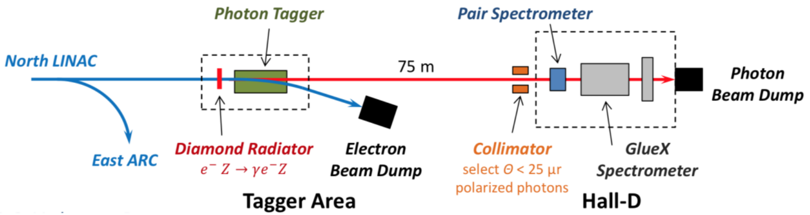
CEBAF accelerator

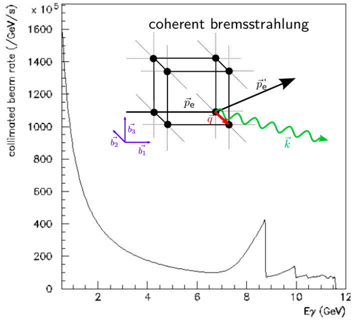
E_{e^-} <12 GeV

Hall D



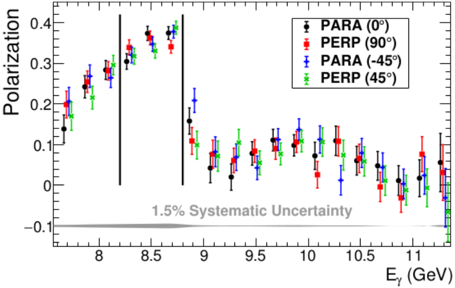
Linearly polarized photon beam





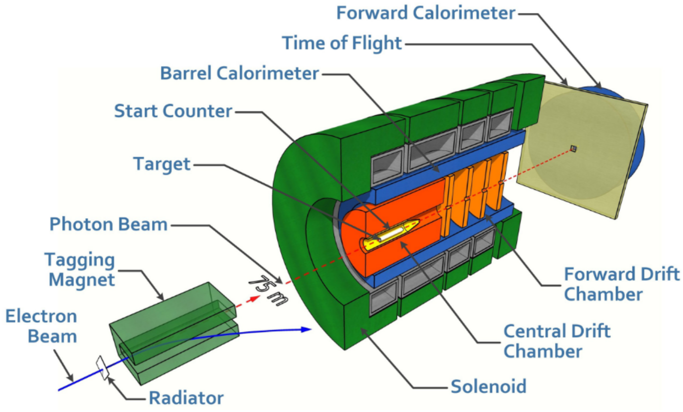
(b) Diamond radiator

linearly polarized photons



Important for understanding production mechanism!

The GlueX experiment



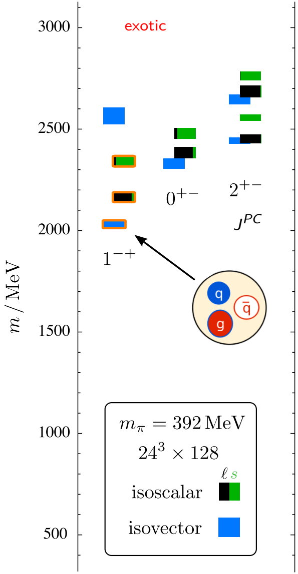
GlueX: NIMA 987 (2021) 164807

Year	Phase	$\int L(\mathrm{pb}^{-1})$	Status
2017	I	22	analyzed
2018	I	103	analyzed
2020	II	132	analyzing
2023	II	$\sim$65	analyzing
2025	II	$\sim$140	calibrating
2026	II	$\sim$60	planned
?	III	800	proposed

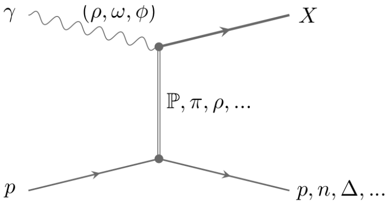
70% GlueX-II data-taking completed!

- Nearly complete angular coverage for charged and neutral final states
  $\rightarrow$ Light meson spectroscopy with wide variety of final states possible!

Photoproduction of exotic final states



Photoproduction is **unique, complementary production mechanism**

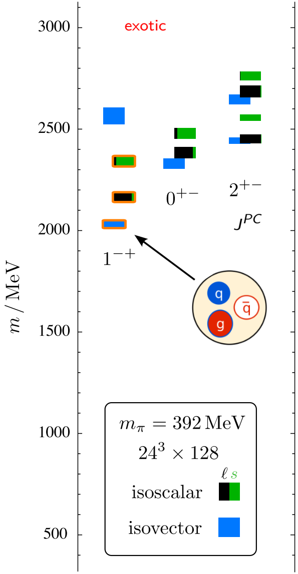


Exchange		Exotic Final States	
$\mathbb{P}$	0^{++}	b, h, h'	$2^{+-}, 0^{+-}$
π^0	0^{-+}	b_2, h_2, h_2'	2^{+-}
$\pi^\pm$	0^{-+}	$\pi_1^\pm$	1^{-+}
ω	1^{--}	π_1, η_1, η_1'	1^{-+}

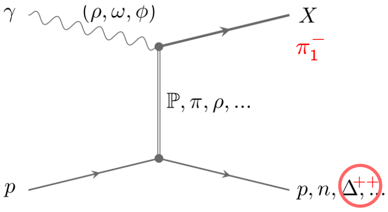
Advantage: Access to **all exotic quantum numbers** J^{PC}!

HadSpec: J. Dudek et al. PRD 88 094505(2013)

Photoproduction of exotic final states



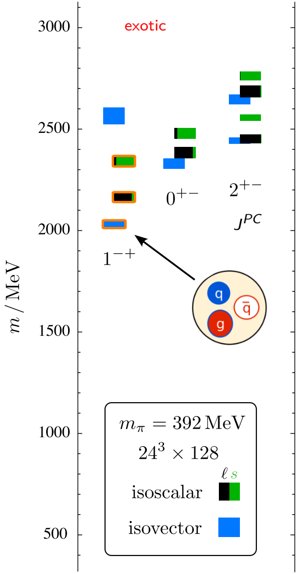
Photoproduction is **unique, complementary production mechanism**



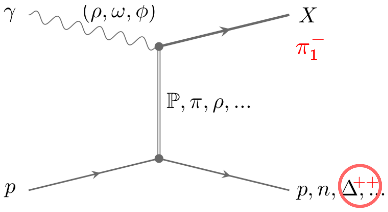
Exchange		Exotic Final States	
$\mathbb{P}$	0^{++}	b, h, h'	$2^{+-}, 0^{+-}$
π^0	0^{-+}	b_2, h_2, h_2'	2^{+-}
$\pi^\pm$	0^{-+}	$\pi_1^\pm$	1^{-+}
ω	1^{--}	π_1, η_1, η_1'	1^{-+}

Advantage: Access to **all exotic quantum numbers** J^{PC}!

HadSpec: J. Dudek et al. PRD 88 094505(2013)



Photoproduction is **unique, complementary production mechanism**



Exchange		Exotic Final States	
$\mathbb{P}$	0^{++}	b, h, h'	$2^{+-}, 0^{+-}$
π^0	0^{-+}	b_2, h_2, h_2'	2^{+-}
$\pi^\pm$	0^{-+}	$\pi_1^\pm$	1^{-+}
ω	1^{--}	π_1, η_1, η_1'	1^{-+}

Advantage: Access to **all exotic quantum numbers** J^{PC}!

Analysis approach to search for e.g. π_1:

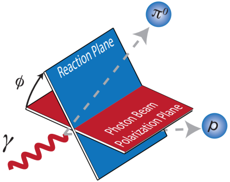
1. Study neutral and charge exchange mechanism
   $\rightarrow$ Linearly polarized photons help to disentangle different production mechanism
2. Study different decay modes of π_1: e.g. $\pi\eta$, $\pi\eta'$, $\pi\rho$
   $\rightarrow$ Disentangle different J^{PC} contributions in mass distributions
   $\rightarrow$ Develop formalism for amplitude analysis

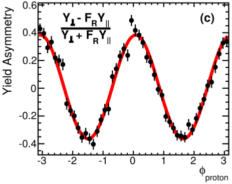
HadSpec: J. Dudek et al. PRD 88 094505(2013)

Probing photoproduction mechanism with beam asymmetry Σ and Spin-Density Matrix Elements (SDMEs)

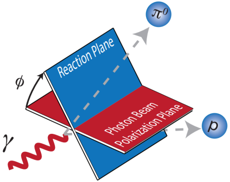
Probing photoproduction mechanism with beam asymmetry Σ

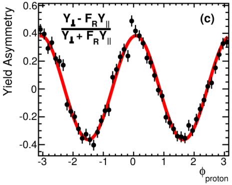
- Σ is sensitive to exchanged particle with J^{PC}
  Sign of $\Sigma \rightarrow$ naturality: $\eta = P(-1)^J$
- **natural** parity exchange ($\eta = +1$):
  $J^P = 0^+, 1^-, 2^+ \ldots$
- **unnatural** parity exchange ($\eta = -1$):
  $J^P = 0^-, 1^+, 2^- \ldots$





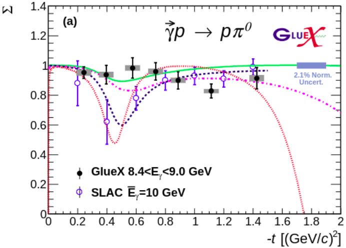
- Σ is sensitive to exchanged particle with J^{PC}
  Sign of $\Sigma \rightarrow$ naturality: $\eta = P(-1)^J$
- **natural** parity exchange ($\eta = +1$):
  $J^P = 0^+, 1^-, 2^+ \ldots$
- **unnatural** parity exchange ($\eta = -1$):
  $J^P = 0^-, 1^+, 2^- \ldots$





neutral exchange:

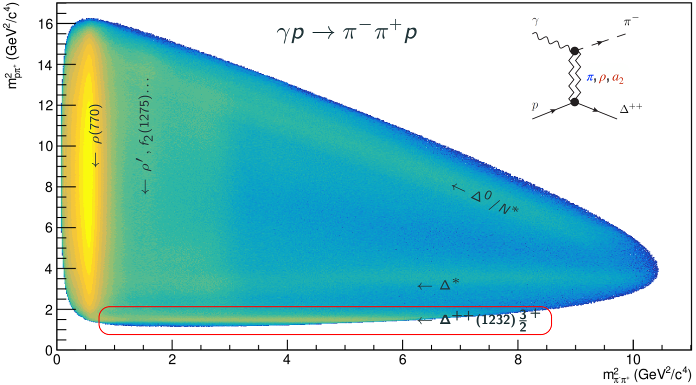
- $\pi^0 p$: natural parity (ρ, a_2) exchange dominates
- Similar observations ($\Sigma \approx 1$) for ηp, $\eta' p$, $K^+\Sigma^0$
  GlueX: PRC 100, 052201 (2019)
  GlueX: PRC 101, 065206 (2020)
- As well as for ρp and $\phi p \rightarrow K_S K_L$ p
  GlueX: PRC 108 055204 (2023)
  GlueX: PRC 112, 025203 (2025)



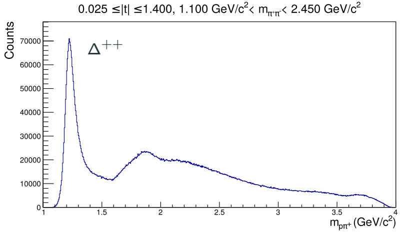
GlueX: PRC 95, 042201 (2017)

Study of charge exchange mechanism $\gamma p \to \pi^- \Delta^{++} \to \pi^- \pi^+ p$

GlueX: Phys.Lett.B 863 (2025) 139368

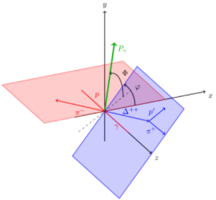


- High statistics available
- Clear Δ^{++} signal with small background contributions from $\pi^+\pi^-$ system



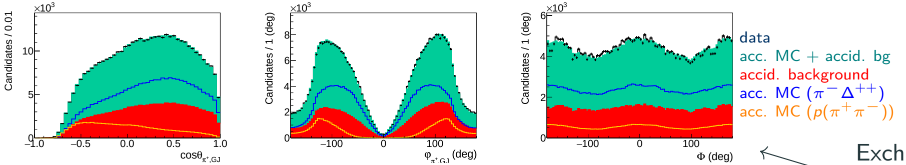
Analyzing decay angles of $\Delta^{++} \to p\pi^+$ gives access to Spin-density matrix elements!

Study of exchange mechanism with SDMEs in $\gamma p \to \pi^- \Delta^{++} \to \pi^- \pi^+ p$



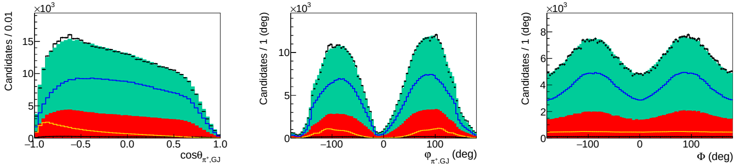
$$
\begin{aligned}
W(\theta,\varphi,\Phi) = {} & \\
& \frac{3}{4\pi}\Big(\rho^0_{33}\sin^2\theta + \rho^0_{11}\left(\frac{1}{3}+\cos^2\theta\right) - \frac{2}{\sqrt{3}} Re[\rho^0_{31}\cos\varphi\sin 2\theta + \rho^0_{3-1}\cos 2\varphi\sin^2\theta] \\
& - P_\gamma \cos 2\Phi \left[\rho^1_{33}\sin^2\theta + \rho^1_{11}\left(\frac{1}{3}+\cos^2\theta\right) - \frac{2}{\sqrt{3}} Re[\rho^1_{31}\cos\varphi\sin 2\theta + \rho^1_{3-1}\cos 2\varphi\sin^2\theta]\right] \\
& - P_\gamma \sin 2\Phi \frac{2}{\sqrt{3}} Im[\rho^2_{31}\sin\varphi\sin 2\theta + \rho^2_{3-1}\sin 2\varphi\sin^2\theta]\Big)
\end{aligned}
$$

$0.100 < |t| \leq 0.125$



Exchange changes from low t to high t region!

$0.640 < |t| \leq 0.850$

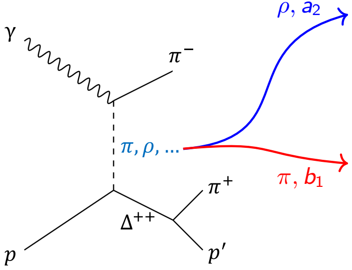


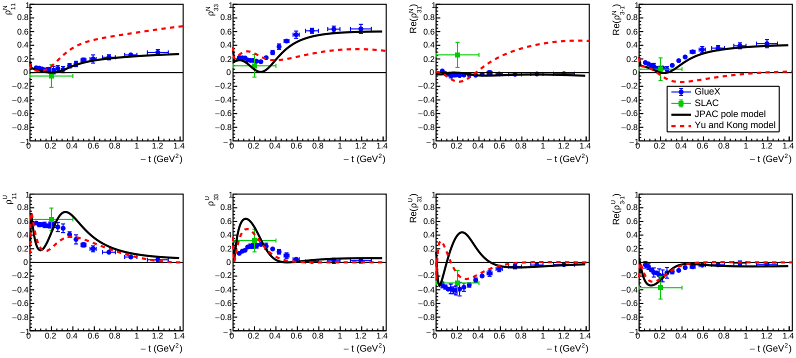
GlueX: Phys.Lett.B 863 (2025) 139368

Separation of natural and unnatural exchanges using combinations of SDMEs

- Separation of unnatural-parity (U) and natural-parity (N) exchanges

$$\rho_{ij}^{N/U} = \rho_{ij}^{0} \pm \rho_{ij}^{1}$$





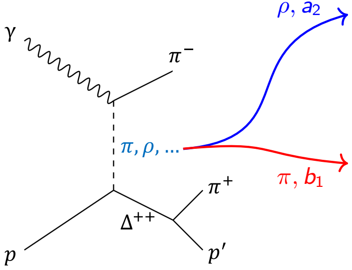
GlueX: Phys.Lett.B 863 (2025) 139368

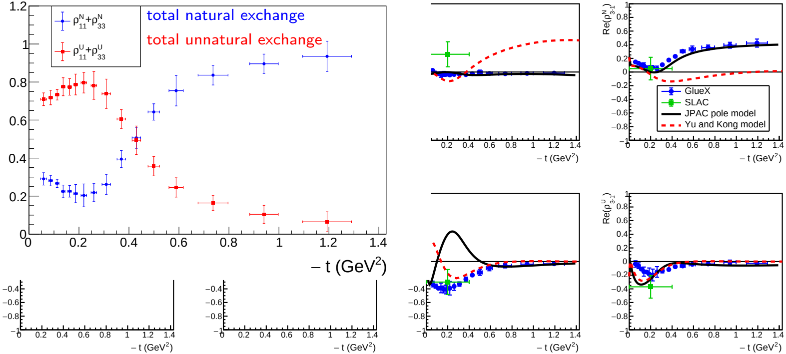
— JPAC: Phys. Lett. B 779, 77-81 (2018)
- - - Yu and Kong: PLB 769, 262-266 (2017)

- JPAC model: π (a_2) is the dominant unnatural (natural) exchange
- Important for charge-exchange reactions e.g. $\gamma p \rightarrow \eta'\pi\Delta^{++}$, $\gamma p \rightarrow 3\pi\Delta^{++}$

Separation of natural and unnatural exchanges using combinations of SDMEs

- Separation of unnatural-parity (U) and natural-parity (N) exchanges
  $\rho_{ij}^{N/U} = \rho_{ij}^{0} \pm \rho_{ij}^{1}$



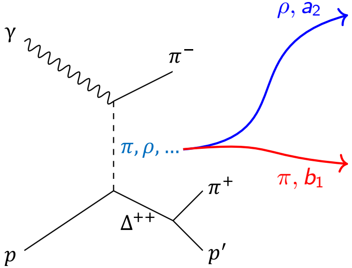


GlueX: Phys.Lett.B 863 (2025) 139368

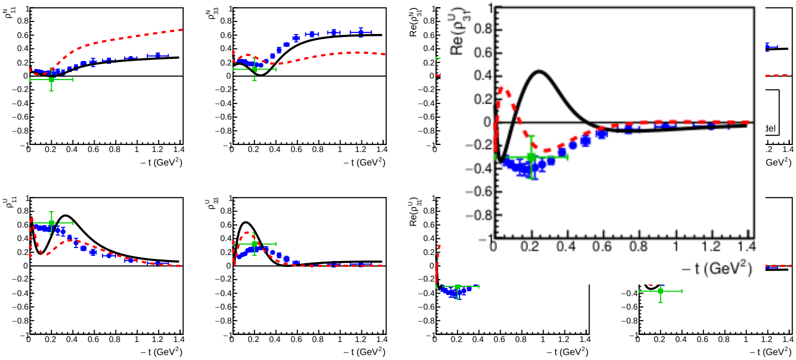
— JPAC: Phys. Lett. B 779, 77-81 (2018)
- - - Yu and Kong: PLB 769, 262-266 (2017)

- JPAC model: π (a_2) is the dominant unnatural (natural) exchange
- Important for charge-exchange reactions e.g. $\gamma p \to \eta' \pi \Delta^{++}$, $\gamma p \to 3\pi \Delta^{++}$

Separation of natural and unnatural exchanges using combinations of SDMEs



- Separation of unnatural-parity (U) and natural-parity (N) exchanges
  $\rho_{ij}^{N/U} = \rho_{ij}^0 \pm \rho_{ij}^1$



GlueX: Phys.Lett.B 863 (2025) 139368

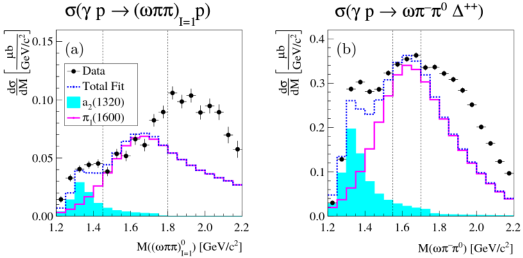
— JPAC: Phys. Lett. B 779, 77-81 (2018)
- - - Yu and Kong: PLB 769, 262-266 (2017)

- JPAC model: π (a_2) is the dominant unnatural (natural) exchange
- Important for charge-exchange reactions e.g. $\gamma p \to \eta' \pi \Delta^{++}$, $\gamma p \to 3\pi \Delta^{++}$

Towards hybrids at GlueX

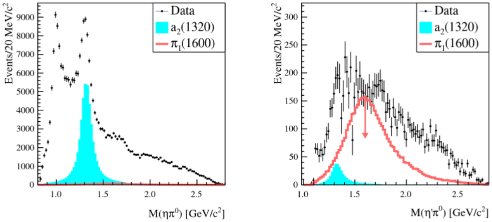
Guided search: $\pi_1(1600)$ photoproduction cross section upper limit

GlueX: Phys.Rev.Lett. 133 (2024) 26, 26

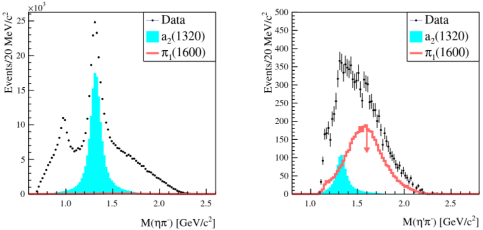


- Upper limit for photoproduction cross section $\gamma p \to p\pi_1^0(1600)$ and $\gamma p \to \Delta^{++}\pi_1^-(1600)$ using $\pi_1 \to b_1\pi \to \omega\pi\pi$
- Fit $\sigma(\omega\pi\pi)_{I=1}$ with fixed BW shapes for a_2 (PDG) and π_1 (JPAC)
- π_1 BR taken from lattice QCD

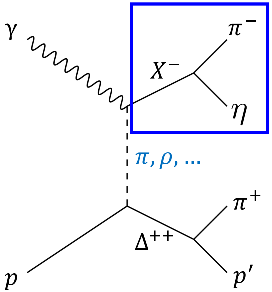
Projections for $\gamma p \to p\eta^{(\prime)}\pi^0$

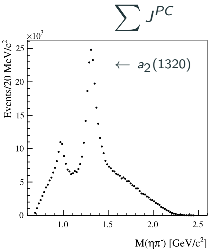


Projections for $\gamma p \to \Delta^{++}\eta^{(\prime)}\pi^-$

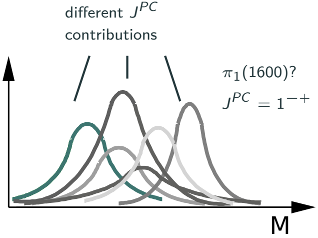


Disentangle different J^{PC} contributions in mass distributions

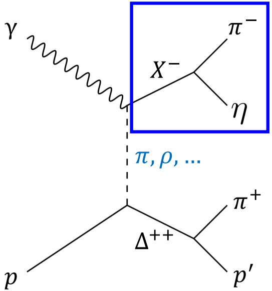


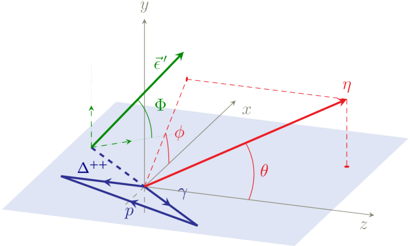


disentangle



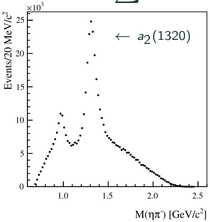
Disentangle different J^{PC} contributions in mass distributions





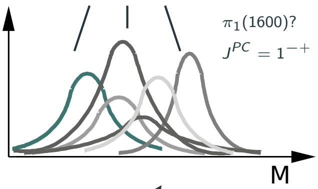
V. Mathieu et al., Phys.Rev.D 100, 054017 (2019)

$\sum J^{PC}$

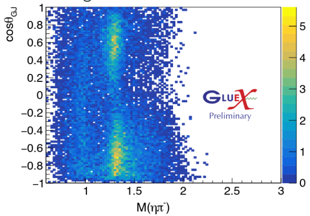


disentangle

different J^{PC} contributions



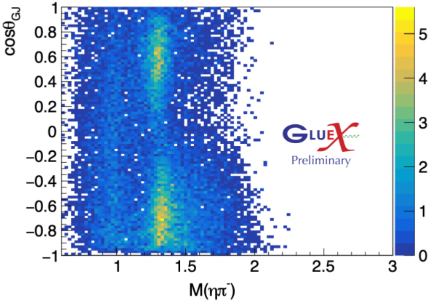
Angular distributions

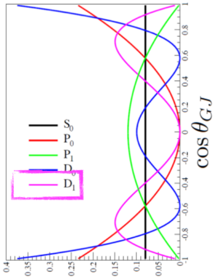


Angular pattern $\leftrightarrow J^{PC}$

$$I(\theta, \phi, \Phi) \propto \left| \sum_{\ell,m} [\ell]^{\epsilon}_{m} Y^{m}_{\ell}(\theta, \phi) e^{-i\Phi} \right|^2$$

Production mechanism of $\gamma p \to a_2^-(1320)\Delta^{++}$





$I(\theta, \phi, \Phi) \propto |\sum_{\ell,m}[\ell]_m^{\epsilon} Y_\ell^m(\theta,\phi)e^{-i\Phi}|^2$

ℓ: orbital angular momentum

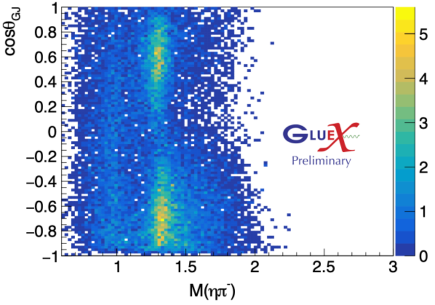
m: spin projection

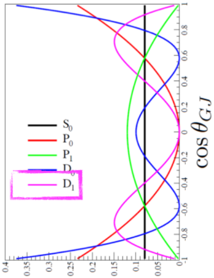
ϵ: reflectivity - product of naturalities of exchanged particle and prod. res.

$[\ell]_m^{\epsilon}$: (interfering) partial waves

$S_0^{\pm}, P_{-1,0,1}^{\pm}, D_{-2,-1,0,1,2}^{\pm}, \ldots$

Production mechanism of $\gamma p \to a_2^-(1320)\Delta^{++}$





$$I(\theta,\phi,\Phi) \propto |\sum_{\ell,m}[\ell]^{\epsilon}_{m} Y^{m}_{\ell}(\theta,\phi)e^{-i\Phi}|^2$$

ℓ: orbital angular momentum

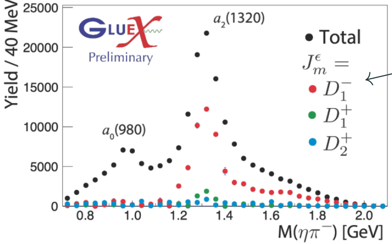
m: spin projection

ϵ: reflectivity - product of naturalities of exchanged particle and prod. res.

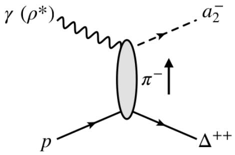
$[\ell]^{\epsilon}_{m}$: (interfering) partial waves

$S^{\pm}_{0}, P^{\pm}_{-1,0,1}, D^{\pm}_{-2,-1,0,1,2}, \dots$

$\gamma p \to \eta\pi^-\Delta^{++}$

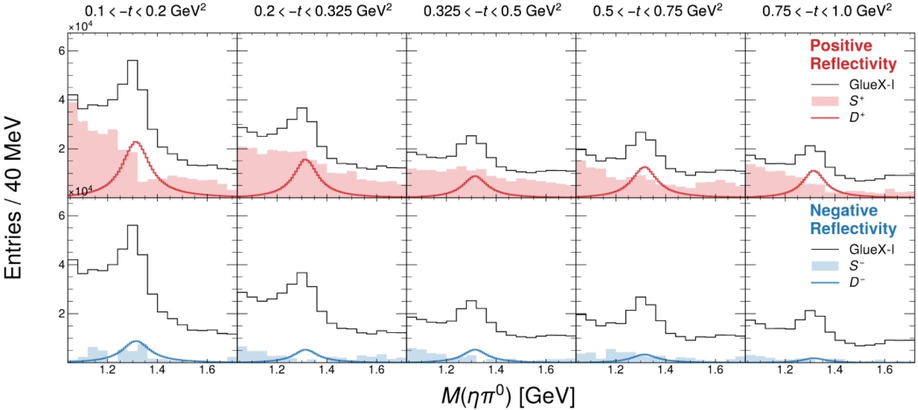


a_2^- is dominantly produced by unnatural parity ($\epsilon = -$) exchange



Production mechanism of $\gamma p \to a_2^0(1320)p$

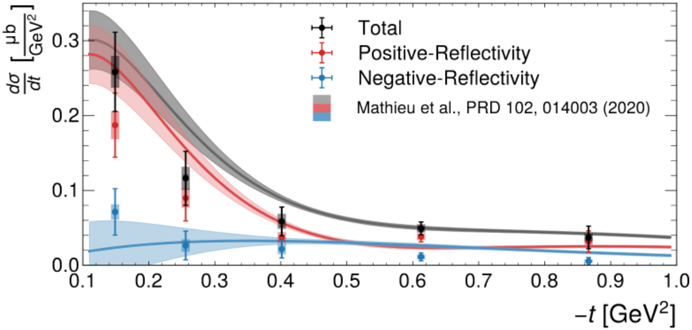
- Semi-mass dependent method using Breit-Wigner to model $a_2^0(1320)$
- $a_2^0(1320)$ is dominantly produced by **natural parity** exchange ($\boldsymbol{D_2^+}$)
- Polarized photoproduction cross section agrees well with theory (tensor meson dominance model)



GlueX: Phys.Rev.C 112 (2025) 1, 015204

Production mechanism of $\gamma p \to a_2^0(1320)p$

- Semi-mass dependent method using Breit-Wigner to model $a_2^0(1320)$
- $a_2^0(1320)$ is dominantly produced by **natural parity** exchange ($\boldsymbol{D_2^+}$)
- Polarized photoproduction cross section agrees well with theory (tensor meson dominance model)

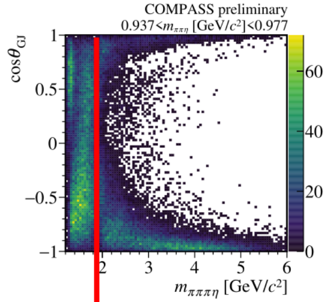


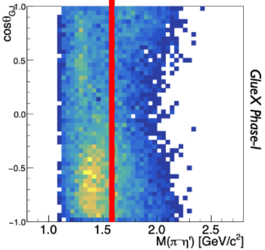
Serves as reference in search for $\pi_1(1600)$ in $\eta'\pi$

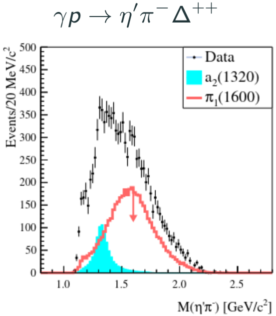
GlueX: Phys.Rev.C 112 (2025) 1, 015204

Ongoing analysis for $\gamma p \to \eta' \pi^- \Delta^{++}$ at GlueX

Talk by Spülbeck, Hadron 2025





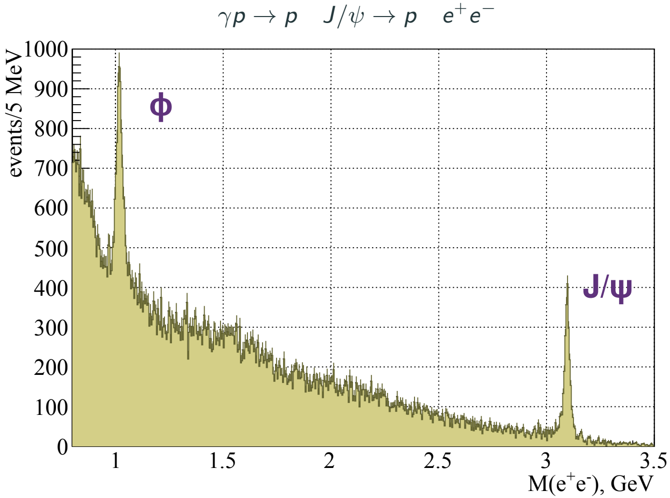


GlueX: Phys.Rev.Lett. 133 (2024) 26, 26

- Similar forward/backward asymmetry seen in GlueX data consistent with COMPASS data
- Potential indication for **interference** between odd (π_1 ***P*-wave**) and even (a_2 ***D*-wave**) partial waves

J/ψ Photoproduction at GlueX

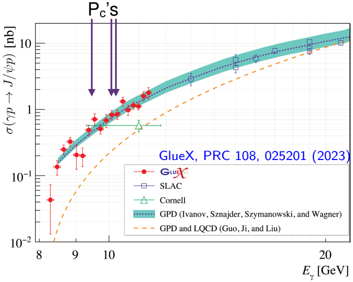
J/ψ Photoproduction at GlueX

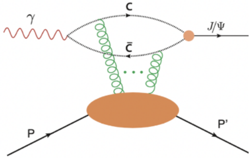


- Full GlueX-I data yields 2270 ± 58 J/ψ's
- J/ψ production near threshold (E_γ = 8.2 - 11.8 GeV) $\rightarrow$ probe of proton structure, search for P_c resonances, etc.

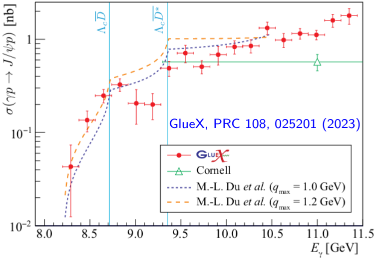
J/ψ Photoproduction at GlueX - Different possible production mechanisms

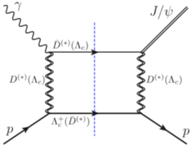
dip structure significance of 2.6σ



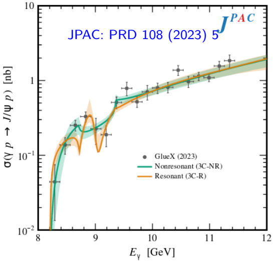


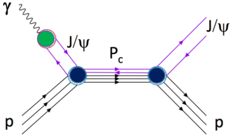
Cusps near open charm thresholds?





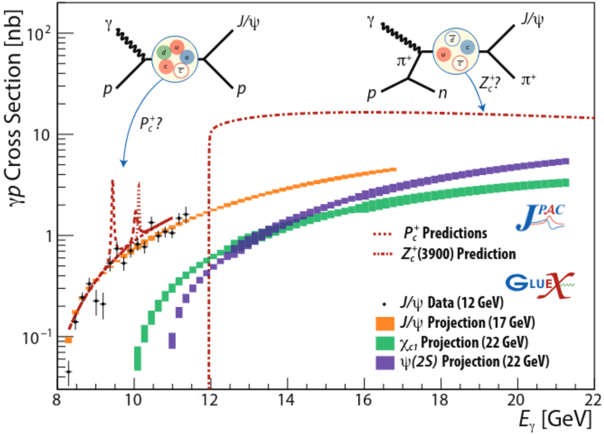
Resonant P_c contribution?





- More data taking (GlueX-III) planned in the future
- Polarization observables desirable to study production mechanism

A natural continuation to the charmonium sector: Spectroscopy of exotic states with $c\bar{c}$



A. Accardi et al., arXiv:2306.09360v2

- Many unexpected resonances XYZ observed in e^+e^- collisions and B decays; decay mostly into charmonium and light quarks
- Not much consistency between different production mechanisms
  $\rightarrow$ Are these states resonances?
- Photoproduction is free from rescattering effects

Summary

- GlueX has measured a unique photoproduction data set to explore the light hadron spectrum
  $\rightarrow$ Complementary to other experiments (e.g. COMPASS, BESIII, LHCb, . . .)
  $\rightarrow$ Essential for global progress in hadron spectroscopy
- Developing amplitude analysis formalism and studying production mechanisms in parallel
  $\rightarrow$ Started with two-pseudoscalar final states: $\pi\pi$, $\eta\pi$, $\boldsymbol{\eta'\pi}$, $K\bar{K}$, $K\pi$,. . .
  $\rightarrow$ Natural extension of formalism to vector-pseudoscalar final states: $\omega\pi$, $\omega\eta$,. . . and 3-body final states: 3π
- Many more exciting analyses ongoing: meson and baryon spectroscopy in strangeness sector, pentaquark and glueball searches, etc.
- GlueX gratefully acknowledges the support of several funding agencies and computing facilities:

gluex.org/thanks/

RUB

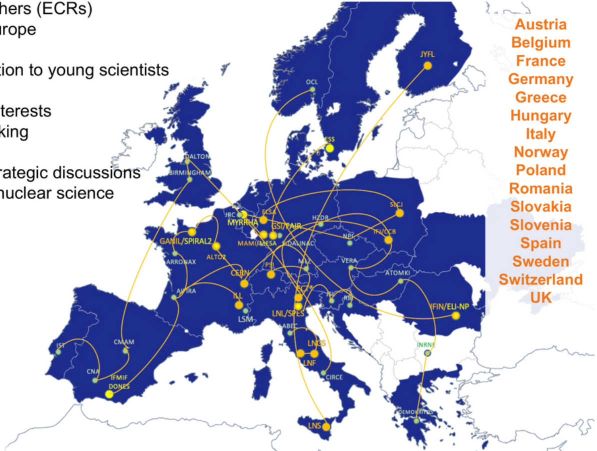
NuFFER - an initiative to connect, support, and promote the work of emerging scientists in nuclear physics across Europe

NuFFER
NuPECC Forum For Early-career Researchers

Our mission

- Support early-career researchers (ECRs) in nuclear physics across Europe
- Provide visibility and recognition to young scientists
- Represent their needs and interests in the NuPECC decision making
- Encourage participation in strategic discussions that determine the future of nuclear science in Europe
- Inform about opportunities for development

Current representative members



Austria
Belgium
France
Germany
Greece
Hungary
Italy
Norway
Poland
Romania
Slovakia
Slovenia
Spain
Sweden
Switzerland
UK

→ NUFFER open session: Friday, 14:30-16:30

How to connect?

Subscribe to the NuFFER mailing list