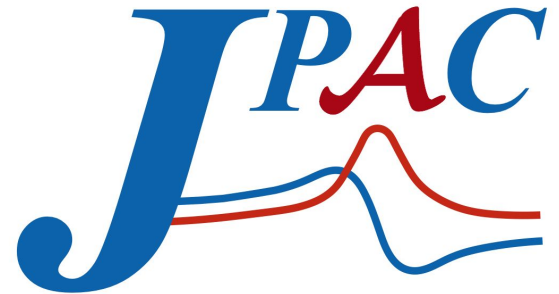
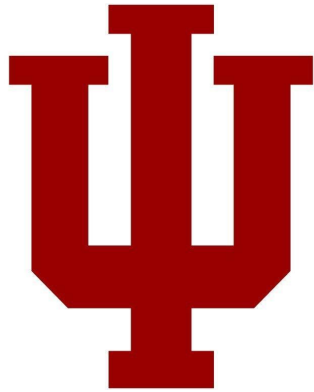


# Exotic Spectroscopy (in Photoproduction) @ EIC

Daniel Winney

29 January 2021



# Exotic Hadrons

- Plethora of quarkonium-like states observed since 2003 which do not fit into conventional  $q\bar{q}$  models.

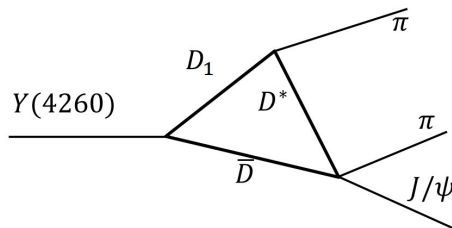
**X(3872)** - large isospin violation

**Y(4260)** - no observed open charm decays

**Z(3900)** - charged, charmonium-like state

- Ambiguous interpretation of signals:

Multi-quark resonances, hadronic molecules, hadrocharmonia, **kinematic singularity**, hybrid

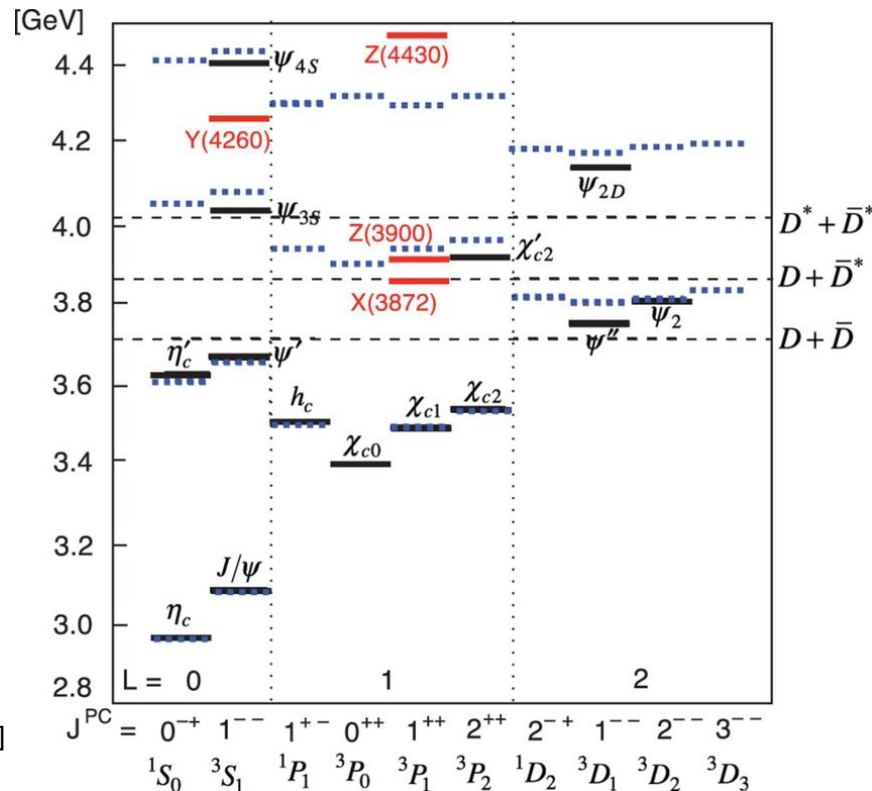


For reviews of XYZs see e.g.:

A. Hosaka et al. [arXiv:1603.09229]

N. Brambilla et al. [arXiv:1907.07583]

F-K. Guo et al. [arXiv:1912.07030]

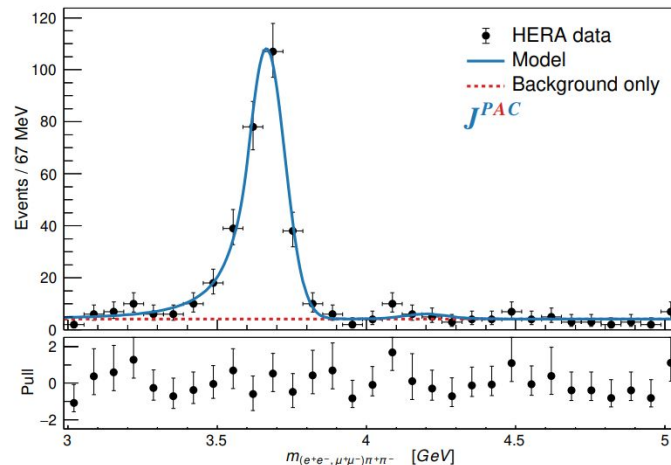
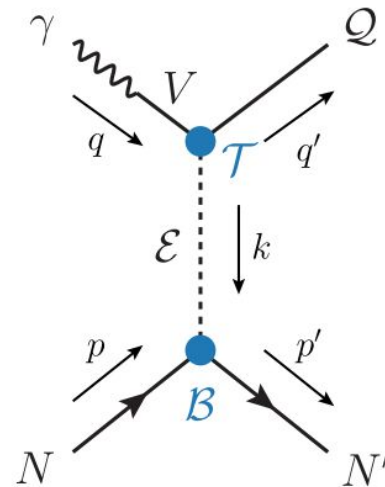


# Exclusive photoproduction

None of the XYZ's have been observed in photon-induced reactions

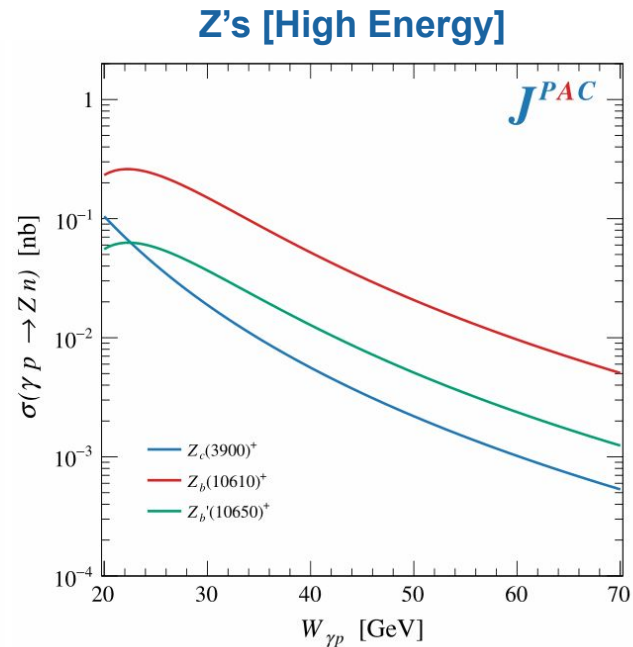
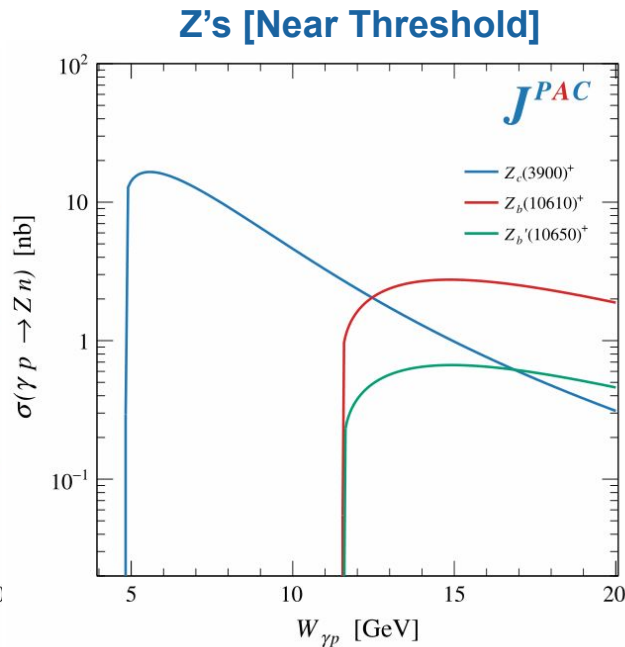
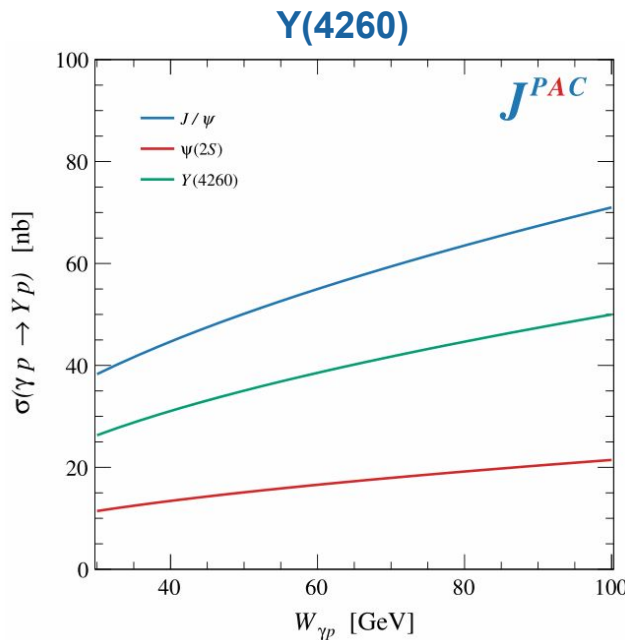
- Constrained kinematics means precise determination of production mechanism  
No additional particles in the final-state eliminate possibility of triangle singularities.
- $2 \rightarrow 2$  reactions very well understood with effective Lagrangian techniques and Regge phenomenology

Couplings for all the main exotic candidates fixed with available experimental data: decay widths, VMD, etc.

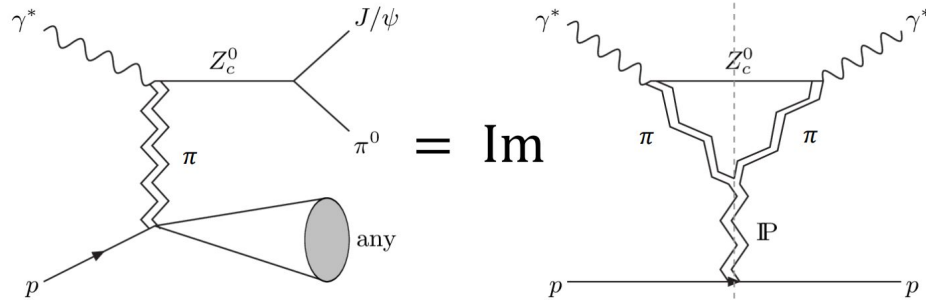


# Exclusive photoproduction

Most relevant for EIC energies include the Y and Z states.

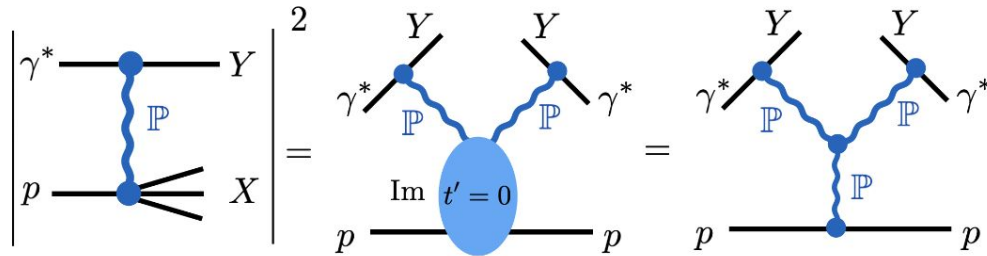


# Semi-inclusive production



Inclusive production at high energies known from Regge phenomenology.

Less constrained kinematics, but much larger cross-sections compared to the exclusive reaction.



Follow-up JPAC publication in preparation.

# Spectroscopy @ EIC Working Group

## Letter of Interest: Hadron Spectroscopy at the Electron Ion Collider

See SNOWMASS 2021 LOI's:

- RF7\_RF0-090 - Hadron Spectroscopy at the EIC
- RF7\_RF0-120 - XYZP spectroscopy at a charm photoproduction factory

As well as talks by:

Justin Stevens (convener) and Alessandro Pilloni

Miguel Albaladejo<sup>12</sup>, Alexander Austregesilo<sup>13</sup>, Marco Battaglieri<sup>7,13</sup>, Raffaella De Vita<sup>7</sup>, Sean Dobbs<sup>6</sup>, J. Matthew Durham<sup>10</sup>, Cristiano Fanelli<sup>9,11</sup>, Derek Glazier<sup>15</sup>, Feng-Kun Guo<sup>8,14</sup>, Astrid N. Hiller Blin<sup>12</sup>, Xuan Li<sup>10</sup>, Vincent Mathieu<sup>2</sup>, Bryan McKinnon<sup>15</sup>, Zisis Papandreou<sup>4</sup>, Alessandro Pilloni<sup>5,7</sup>, Elena Santopinto<sup>7</sup>, Matthew R. Shepherd<sup>3</sup>, Justin R. Stevens<sup>\*16</sup>, Adam P. Szczepaniak<sup>1,3,12</sup>, Ivan Vitev<sup>10</sup>, and Daniel Winney<sup>1,3</sup>

<sup>1</sup>Center for Exploration of Energy and Matter, Indiana University, Bloomington, IN 47403, USA

<sup>2</sup>Departamento de Física Teórica, Universidad Complutense de Madrid and IPARCOS, 28040 Madrid, Spain

<sup>3</sup>Department of Physics, Indiana University, Bloomington, IN 47405, USA

<sup>4</sup>Department of Physics, University of Regina, Regina, Saskatchewan, Canada S4S 0A2

<sup>5</sup>European Centre for Theoretical Studies in Nuclear Physics and related Areas (ECT\*) and Fondazione Bruno Kessler, Villazzano (Trento), I-38123, Italy

<sup>6</sup>Florida State University, Tallahassee, Florida 32306, USA

<sup>7</sup>INFN Sezione di Genova, Genova, I-16146, Italy

<sup>8</sup>Institute of Theoretical Physics, CAS, Beijing, China

<sup>9</sup>Jefferson Lab, EIC Center, Newport News, VA 23606, USA

<sup>10</sup>Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA

<sup>11</sup>Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA

<sup>12</sup>Theory Center, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606, USA

<sup>13</sup>Thomas Jefferson National Accelerator Facility, Newport News, VA 23606, USA

<sup>14</sup>University of Chinese Academy of Sciences, Beijing, China

<sup>15</sup>University of Glasgow, Glasgow, G12 8QQ, United Kingdom

<sup>16</sup>William & Mary, Williamsburg, Virginia 23185, USA

**Thank you!**