

Snowmass Community Planning Meeting
Session 40:
Exotic Hadron Spectroscopy and Interpretation

Rich Lebed (Arizona State), Tomasz Skwarnicki (Syracuse),
Zohreh Davoudi (Maryland)

Introduction

- A lot of fundamental questions in **hadron spectroscopy** have no satisfactory answers yet:
 - Do multiquark hadrons made out of **diquarks** exist (diquark baryons, compact **tetra-** and **penta-quarks**, etc.)?
 - Do mesons bind with mesons or baryons to create hadronic "**molecules**"?
 - Can gluons act as valence constituents, i.e., do **glueballs** and **hybrids** exist?
- **Lattice QCD** modelling of more complicated hadronic structures, especially of unstable ones, is still in its infancy. The experimental measurements, and theoretical modelling to explain the results, are key to providing the answers.
- Many **experimental discoveries** in recent years have been driving a renaissance of hadron spectroscopy as an important topic in particle physics. They produced most cited papers for the heavy-flavor experiments. The **nuclear community** has dedicated experiments to light-hadron spectroscopy.
- RF7 Hadron Spectroscopy Topical Group focuses on **heavy exotic** and **conventional hadrons** and **light hadron exotics**
- There is a large number of experimental and theoretical physicists working on hadron spectroscopy, crossing the boundaries between the high-energy and nuclear communities. Each of three RF7 meetings in September attracted 60-70 participants (94 subscriptions to RF7 mailing list)

Heavy-Quark Conventional Hadrons

Bryan Fulsom PNNL

Alexis Pompili University of Bari

Elena Santopinto INFN Genoa

Heavy-Quark Exotic Hadrons

Liupan An INFN Firenze

Ryan Mitchell Indiana University

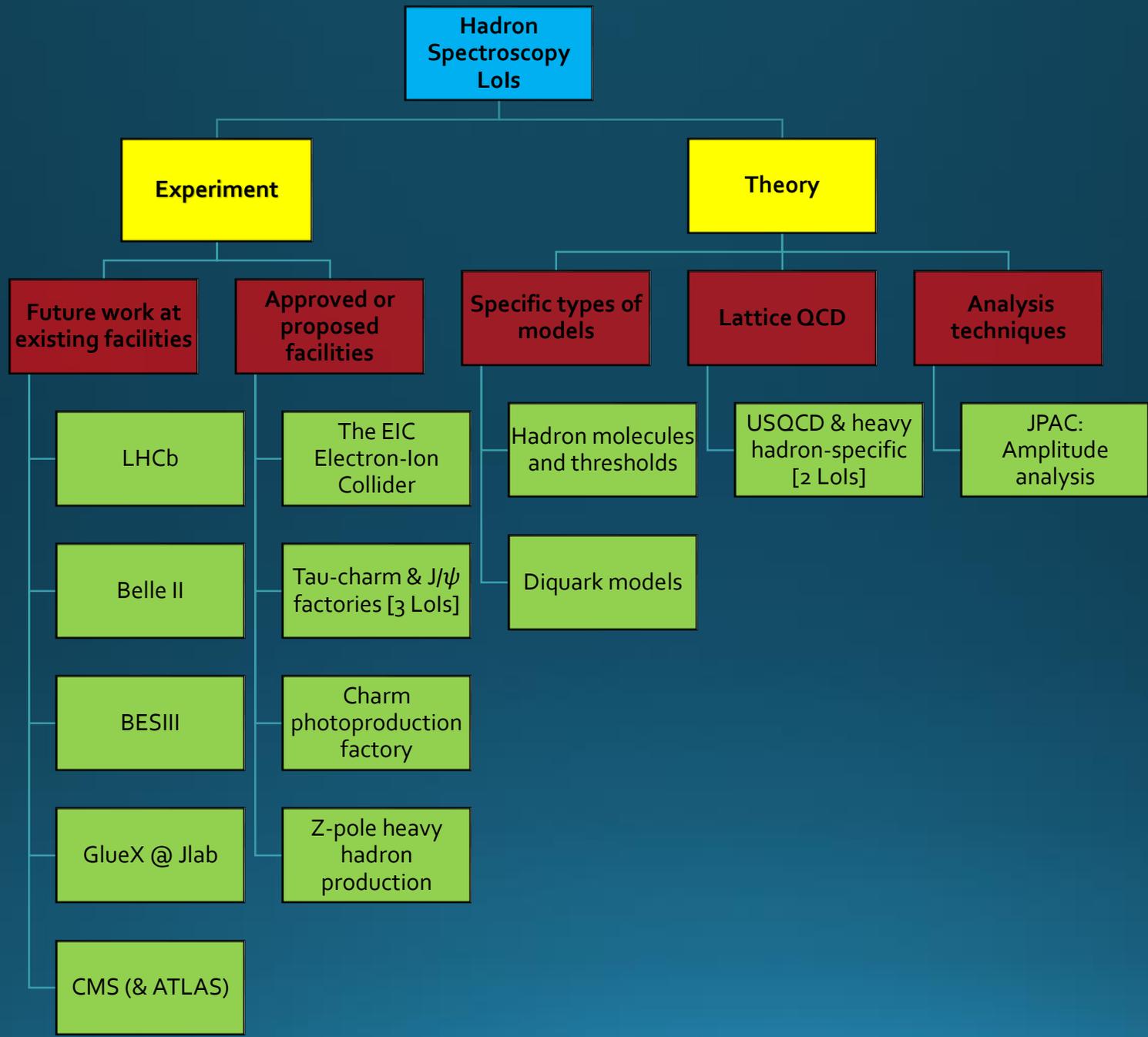
Sasa Prelovsek University of Ljubjana

Light-Quark Exotic Hadrons

Sean Dobbs Florida State University

Justin Stevens College of William & Mary

Adam Szczepaniak Indiana University



Hadron Spectroscopy Lols

Experiment

Theory

Future work at existing facilities

Approved or proposed facilities

Specific types of models

Lattice QCD

Analysis techniques

LHCb

Belle II

BESIII

GlueX @ Jlab

CMS (& ATLAS)

The EIC
Electron-Ion
Collider

Tau-charm & J/ψ
factories [3 Lols]

Charm
photoproduction
factory

Z-pole heavy
hadron
production

Hadron molecules
and thresholds

Diquark models

USQCD & heavy
hadron-specific
[2 Lols]

JPAC:
Amplitude
analysis

Discussion Topics for Session 40

- 1) How do the new 4-quark and 5-quark states intermingle with the conventional quark-model spectrum of excited states (some have the same J^{PC} and might mix, some are clearly exotic)? Will hybrids need to be included as well?
- 2) There is mounting experimental evidence for compact multiquark states built from diquarks, while others seem to work much better as hadron molecules. How much do these structures mix?
- 3) Have we exercised, to full extent, the information on how hadron spectra evolve with the mass of valence quarks? What features of heavy-quark exotics persist for light-quark exotics?
- 4) Lattice QCD and phenomenological models have different ranges of applicability and make different assumptions. How can their respective results be combined in the best way to achieve the greatest utility?
- 5) Is the division in the US between “nuclear physics” and “particle physics” hampering progress in studies of exotic hadrons (collaborations, funding)? If so, what are the remedies?
- 6) Are there areas in which it would be beneficial to include lower-energy experimentalists or theorists to share expertise with particular high-energy experiments? What would be the mechanism?