Exploration of Heavy Hadrons At Thresholds

[EXHAT]

Ivan Polyakov, Mikhail Mikhasenko, et al. __

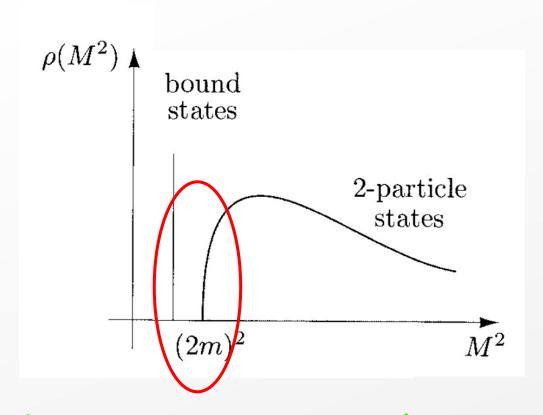
Defining focus

- Heavy quark systems driving force in exploration of the QCD
 - since 1970's: Conventional charmonium
 - since 2000's: Exotic hadrons with heavy quarks
 - **2025:** ?

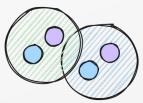
Reference – a key for advancing the precision

Ideal reference

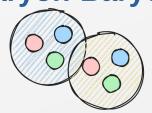
 Thresholds are the references to be used



Meson-Meson



Baryon-Baryon



Meson-Baryon



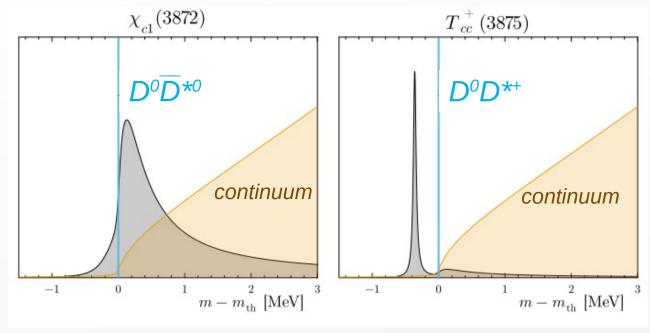
Research objectives, MM

Meson-Meson

Baryon-Baryon

Meson-Baryon

• The $\chi_{c1}(3872)$ and $T_{cc}(3875)^+$ * near $D^0\overline{D}^{*0}$ and D^0D^{*+}



• $T_{cc} \rightarrow D^0 D^0 \pi$ + amplitude analysis, T_{cc} and $\chi_{c1}(3872)$ production in pp and heavy-ion, ...

* we are the ones who discovered the T_{cc} and posses expertise on how it should <u>not</u> be studied

Research objectives, BB

Meson-Meson

Baryon-Baryon

Meson-Baryon

- States of 6 quarks dibaryons/hexaquarks
- Previous studies in light sector $\Lambda\Lambda$, $p\Omega$, $p\Xi$, ... picture not clear ...
- Focus on states with heavy quarks

Short-lived decaying strongly to $\Lambda_c p$, $\Xi_c p$, ... threshold

Long-lived decaying weakly

Linking hadron spectroscopy and nuclear physics

Research objectives, MB

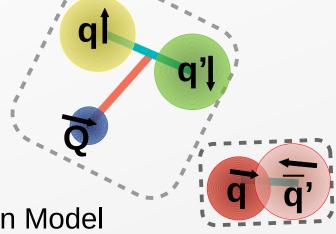
Meson-Meson

Baryon-Baryon

Meson-Baryon

- Heavy baryons is an ideal laboratory for understanding
 - Diquarks
 - Threshold dynamics

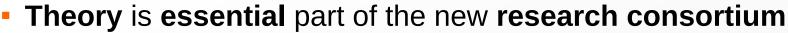
 Input to Statistical Hadronization Model used for the QGP studies

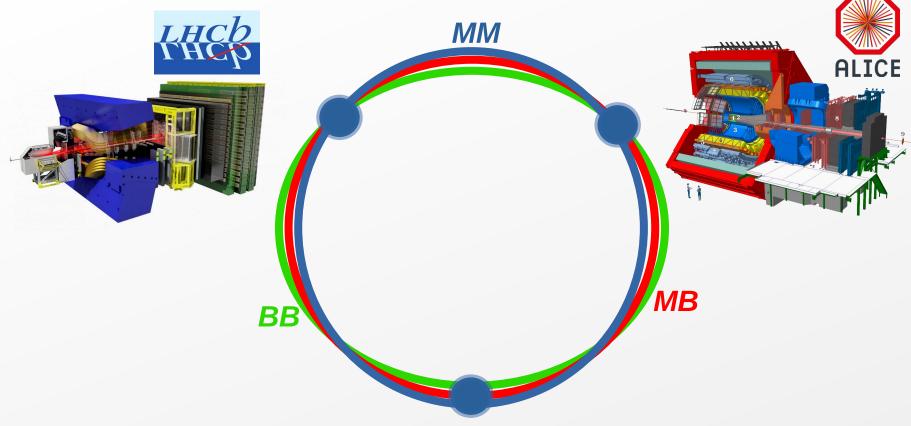


Gaps to be identified by theory and filled by experiment

Infrastructure

 LHC at CERN is the most powerful factory of the states under consideration





$$L_{\scriptscriptstyle QCD} = \sum_{\scriptscriptstyle q} \, \overline{\psi}_{\scriptscriptstyle q} \! \left(i \gamma_{\scriptscriptstyle \mu} D^{^{\scriptscriptstyle \mu}} \! - \! m_{\scriptscriptstyle q}
ight) \! \psi_{\scriptscriptstyle q} \! - \! rac{1}{2} Tr \! \left[\, \overline{G}_{\scriptscriptstyle \mu
u} \, \overline{G}^{^{\scriptscriptstyle \mu
u}}
ight]$$

Coherence in the efforts

LHCb

- University of Manchester,Ivan Polyakov
- Ruhr-Universitaet Bochum,
 Mikhail Mikhasenko
- Univerity of Genova,
 Elisabetta Stadaro Norella
- INFN Sezione di Bari,
 Marco Pappagallo
- Sapienza Universita INFN Roma, Ivan Belyaev

Theory

- University of Ljubljana,Sasa Prelovsek
 - RIKEN iTHEMS, **Takumi Doi, Tetsuo Hatsuda**
- University of Cambridge,
 Christopher Thomas,
 David Wilson
- •

 + attract additional experts for workshops

ALICE

- Technical University of Munich,
 Laura Fabbietti,
 Valentina Mantovani Sarti
- CERN, Switzerland,
 Fabrizio Grosa

connections

• existing

to be established

other proposals:

- Al4HSI
- LHP
-

Coherence in the efforts

Theory ALICE LHCb University of Manchester, University of Ljubljana, Technical University of Munich, Sasa Prelovsek Ivan Polyakov Laura Fabbietti, Valentina Mantovani Sarti Ruhr-Universitaet Bochum, Mikhail Mikhasenko RIKEN ITHEMS, Takumi Doi, Univerity of Genova, CERN, Switzerland, Elisabetta Stadaro Norella **Tetsuo Hatsuda Fabrizio Grosa** INFN Sezione di Bari, University of Cambridge, **Marco Pappagallo** Sapienza Universita INFN Roma, **Christopher Thomas, David Wilson** Ivan Belyaev other proposals: connections + attract additional experts AI4HSI for workshops LHP existing

to be established

SHARE

STRANGE-MATTER

Estimated budget

- PostDoc to boost activities in LHCb/ALICE/theory (4y FTE) €360k we have preliminary agreement with the institutions that each of the positions will get supplementary local funds for another 12-18 months. PhD positions funded by Universities aligned with the project.
- Travel €170k
 for 14 participants: approx. 2 trips/year (€500/trip) and 15 days/year
 stay (€135/day)
- Workshops €50k
 five topic-focused 2-day workshops over four years
- Outreach & training €10k
- Total €590k

Summary

 Focus on Heavy hadrons – systems with most potential for advancing knowledge

Thresholds – to achieve the highest precision

Synergy of experiment (LHCb, ALICE)
 and theory (LatticeQCD, advanced quark models)

and of hadron spectroscopy and nuclear physics

Infrastructure access – LHC at CERN

Backup

Instead of summary

Experiment

Theory

