

Round Table on Hadronic Transitions

- The surprising large hadronic transitions have provided a gateway to study:
 - Lower quarkonium states not otherwise easily accessed in e+e-
 - The new XYZ states
- To use this tool effectively we need to have a better understanding of expected hadronic transitions.
- Panel and Schedule:

Gocha Tatischevili (PNNL)
Chi Zhang (Nanjing University)
Takayuki Matsuki (Tokyo Kasei University)
Feng-Kun Guo (Bonn U.)
Estia Eichten (Fermilab)

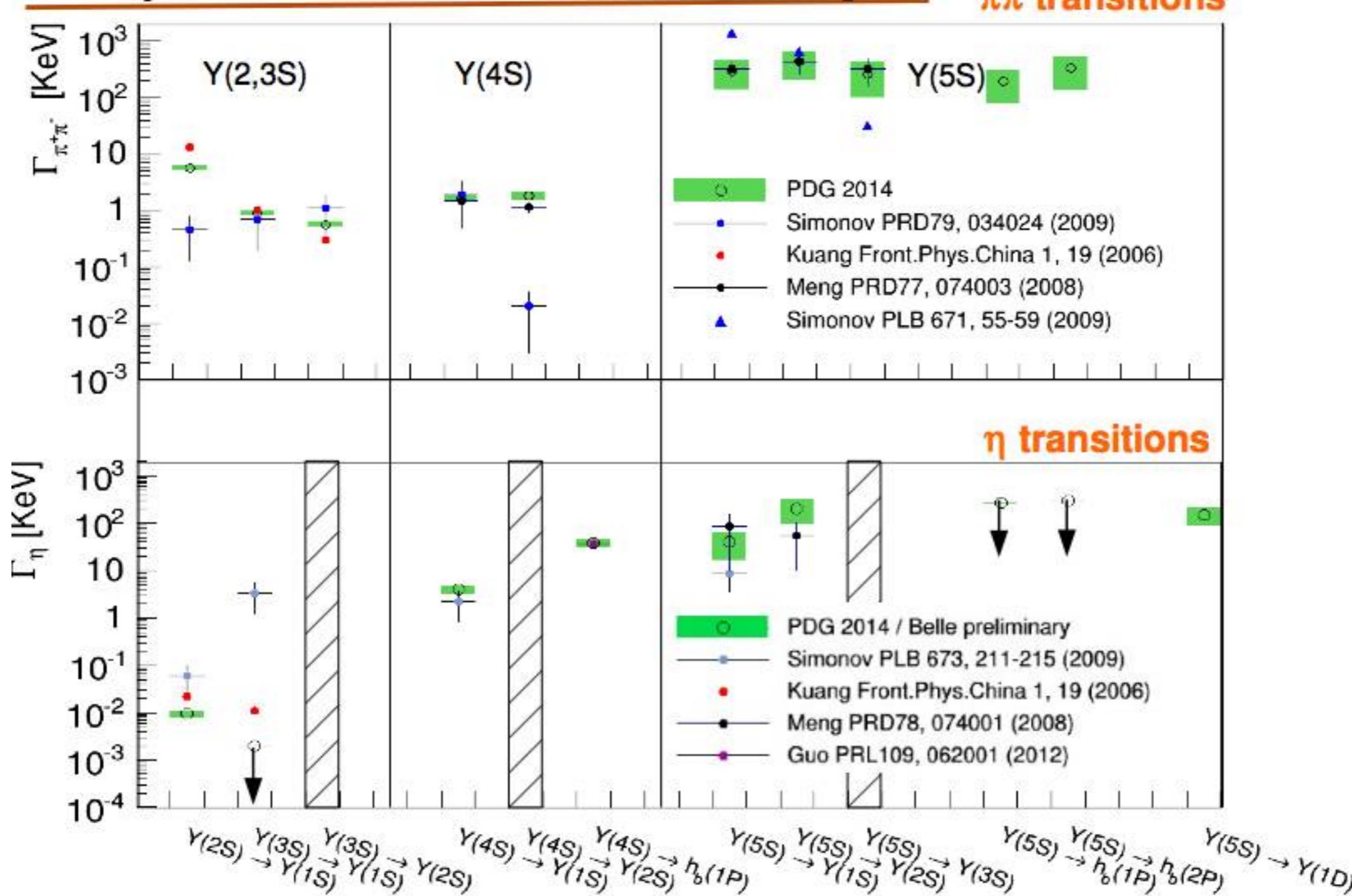
New panel members:

Speaker	Topic	Time
Roberto Musso (INFN Torino)	For quarkonium states below threshold: What are the important measurements for B-Factories? (and BESIII, LHC)	(7 minutes)
Eric Swanson (Pittsburgh)	Cusps and rescattering (phenomenology) What are the important measurements for these threshold effects?	(5 minutes)
Timofey Uglow (ITEP)	Complexity of interpretation: The Z(4430) example.	(5 minutes)
Daniel Mohler (Fermilab)	Lattice Status and Prospects for studying $(Q\bar{q}) + (q\bar{Q})$ near threshold	(5 minutes)
Everyone	Discussion and questions from audience New transitions to look for and what needs to be better measured?	(8 minutes)

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- Roberto Mussa

$\pi\pi/\eta$ transitions: Th. VS Exp



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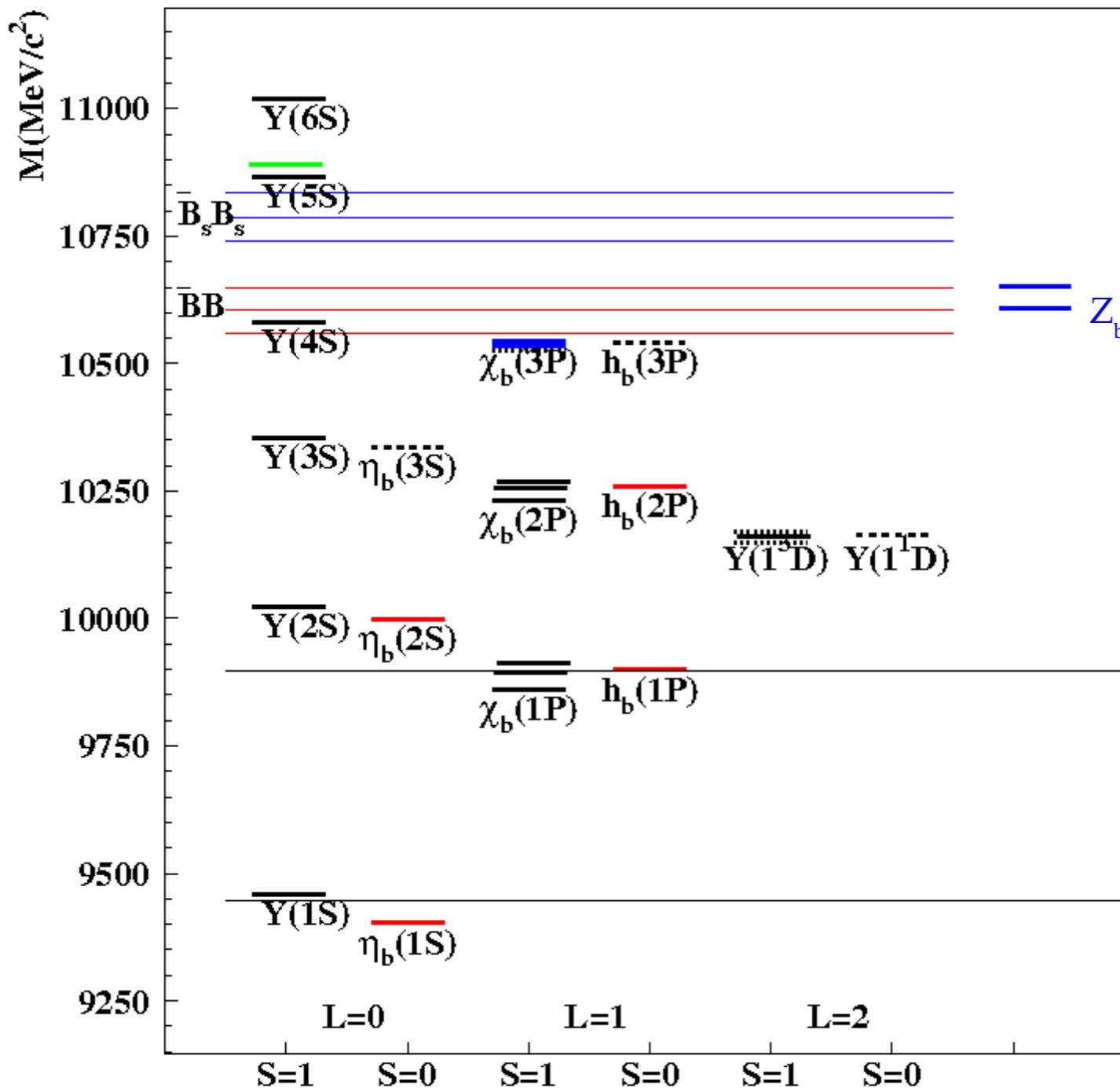
η, π transitions	ΔS	ΔI	L	
$Y(2S) \rightarrow \eta Y(1S)$	0	0	1	
$Y(3S) \rightarrow \eta Y(1S)$	0	0	1	3S suppression due to coupled channel effects?
$Y(3S) \rightarrow \pi^0 h_b(1P)$	-1	1	0	Weak evidence (Babar) to be confirmed
$h_b(1,2P) \rightarrow \pi^0 Y(1S)$	1	1	0	Isospin breaking far from threshold?
$Y(1D) \rightarrow \eta Y(1S)$	0	0	1	Boosted by triangle anomaly? Voloshin: PLB 562, 68(2003)
$h_b(2P) \rightarrow \eta Y(1S)$	1	0	0	Can we learn from $Y(4S) \rightarrow \eta h_b(1P)$?
$\chi_{b0}(2P) \rightarrow \eta h_b(1S)$	-1	0	0	S-wave vs spin flipping suppression
ω transitions	ΔS	ΔI	L	
$\chi_{b1,2}(2P) \rightarrow \omega Y(1S)$	0	0	0	1/6 of radiative BR
$Y(3S) \rightarrow \omega \eta_b(1S)$	1	0	0	Would avoid ISR. No skewed lineshape?
$\eta_b(3S) \rightarrow \omega Y(1S)$	1	0	0	no hope
$\pi\pi$ transitions	ΔS	ΔI	L	
$Y(3S) \rightarrow \pi\pi Y(1S)$	0	0	0,2	$\pi\pi$ mass spectrum at high stat
$\chi_{bJ}(2P) \rightarrow \pi\pi \chi_{bJ}(1P)$	0	0	0,2?	relative ratios

Sizeable coupled channel effects also in angular distributions of radiative transitions (M2,E3)?

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- Eric Swanson

$$\Upsilon(nS) \rightarrow \Upsilon(n'S)\pi\pi$$

mode	expt	$\mathcal{M} = 1$	BB
$5S \rightarrow 3S\pi\pi$	1	1	1
$5S \rightarrow 2S\pi\pi$	1.6(3)	7.8	2.3
$5S \rightarrow 1S\pi\pi$	1.1(2)	14.9	4.7
$4S \rightarrow 1S\pi\pi$	0.0036	20	0.17
$3S \rightarrow 1S\pi\pi$	0.0017	10	0.05
$2S \rightarrow 1S\pi\pi$	0.012	1.7	0.005

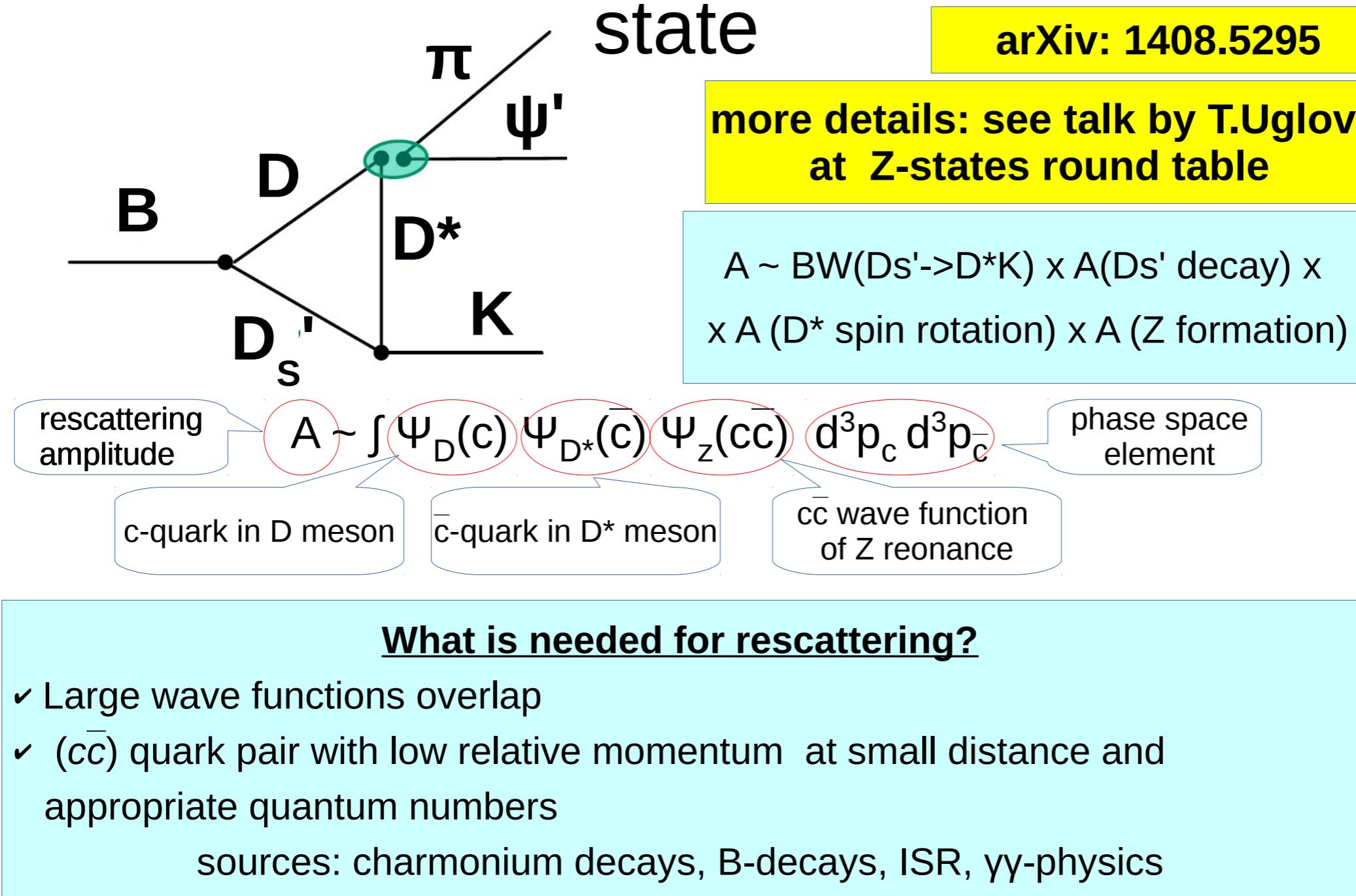
normalize to $5S \rightarrow 3S$

data from Roman Mizuk, La Thuile, 2011

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- Timofey Uglov

Kinematical interpretation of Z(4430) state



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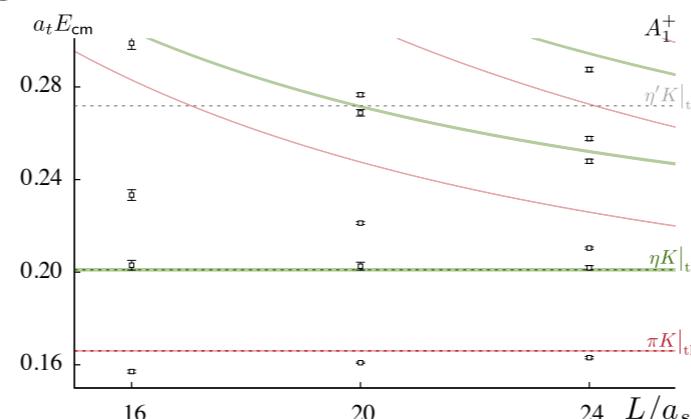
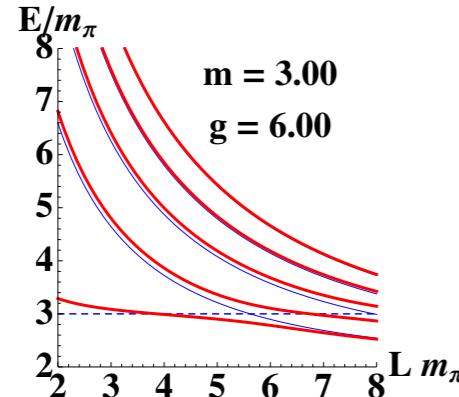
- Daniel Mohler

Coupled channel system close to threshold
–Lattice prospects and challenges

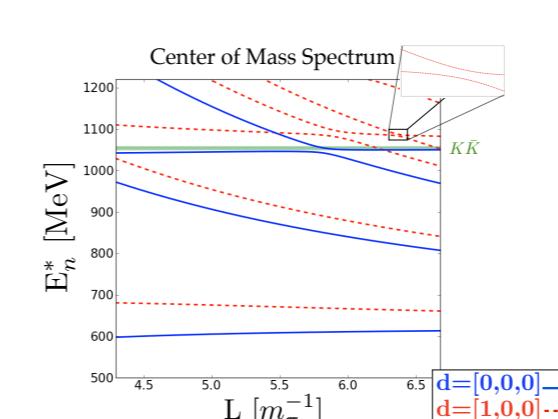
Example: Role of $D\bar{D}^* \leftrightarrow J/\Psi\pi$ in $Y(4260) \rightarrow J/\Psi\pi^+\pi^-$

Information on scattering amplitude from Lüscher's method:

- Finite volume energy shifts \rightarrow phase shift of the continuum scattering amplitude
- We routinely extract such energy levels
- Some illustrations:



Dudek et al. arXiv:1411.2004



Briceño, arXiv:1311.6032

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Challenges in the Lüscher method

- Need data from multiple volumes/ moving frames/ momentum twists
→ need suitable boxes for problem at hand
- Coupled channel case/ partial wave mixing requires interpolation
(Need to interpolate data to the same \sqrt{s})
- Large volumes desirable, but shifts get small and levels dense
(For charm: Small shifts means finite a matters!)
- Open three-particle channel: Formalism is not known
Recent progress: Lattice2014 talk by Raúl Briceño

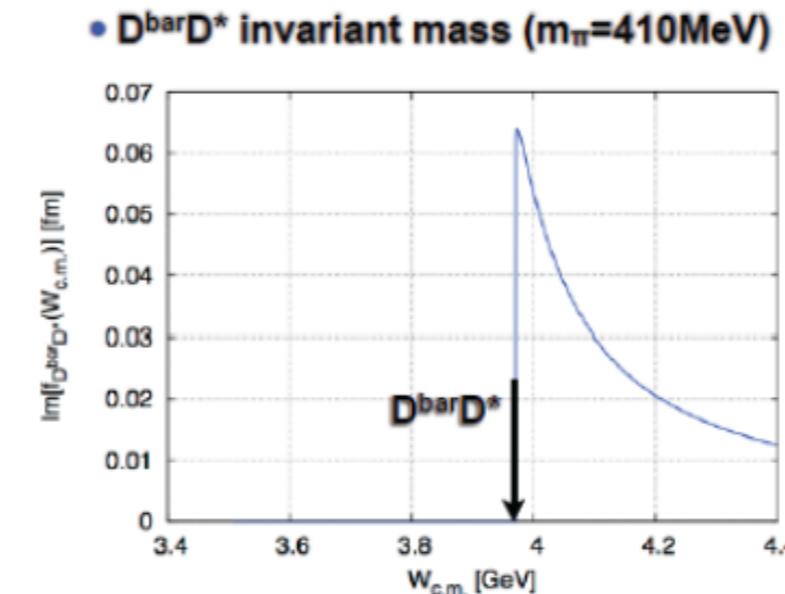
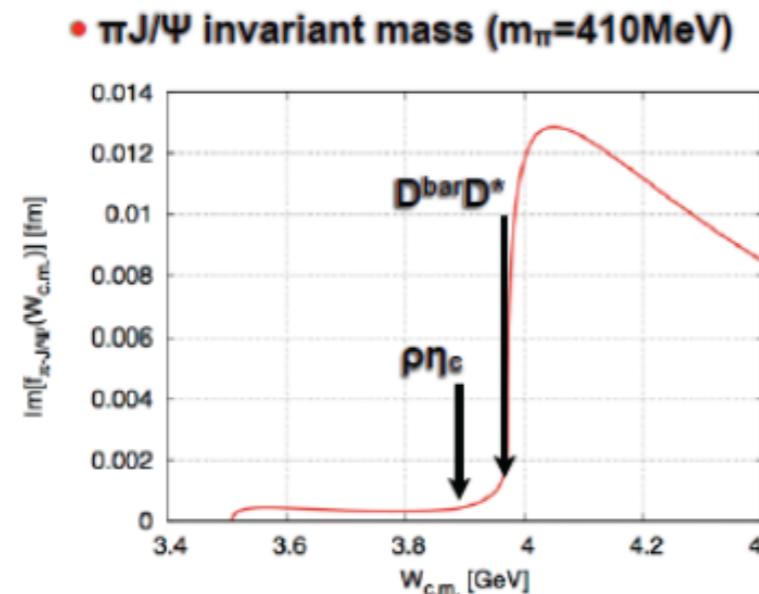
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... or potentials from the HALQCD method?

Prescription:

- Calculate a potential from (spatial) correlations
- Extract physical observables (like phase shifts) from the potential



- For $I = 2$ $\pi\pi$ -scattering: Both methods yield the same phase shift
- For some baryon systems: Contradictory results
- Needs to be validated on an example with non-trivial physics!