

Pentaquark Questions

- Real resonance? Analysis of Argand plot
- Likelihood of higher (12σ) and lower state (9σ)
- Spin-parity assignments ($5/2^+$, $3/2^-$)

- Hadronic molecules?
- Interactions — Coupling with open and hidden channels
- Hadron dynamics vs quark dynamics (Takeuchi)

- Other possibilities
- ϕp scattering?

- Reactions

The LHCb pentaquark as a $\bar{D}^*\Sigma_c - \bar{D}^*\Sigma_c^*$ molecular state

L. Roca

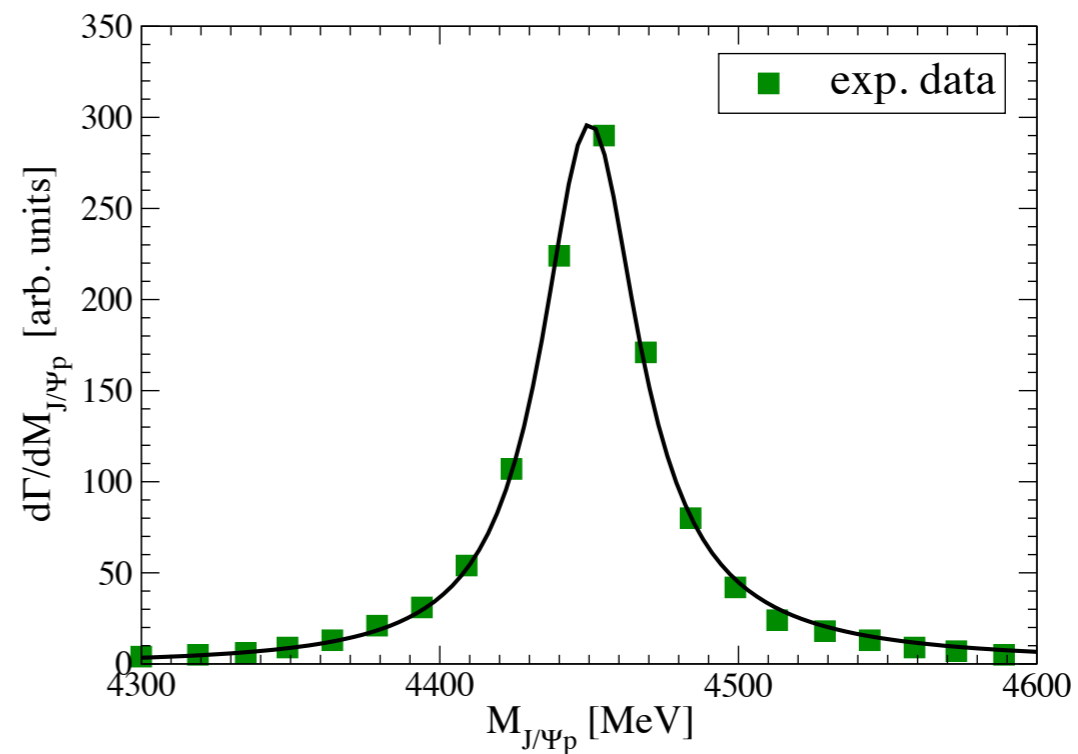
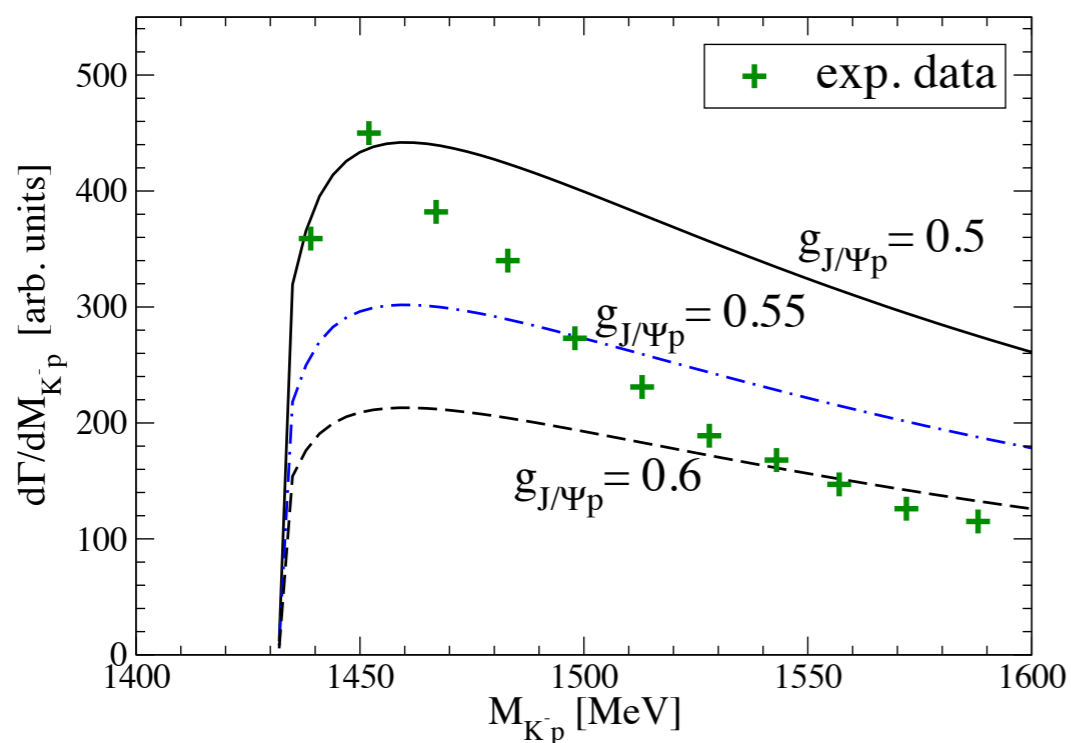
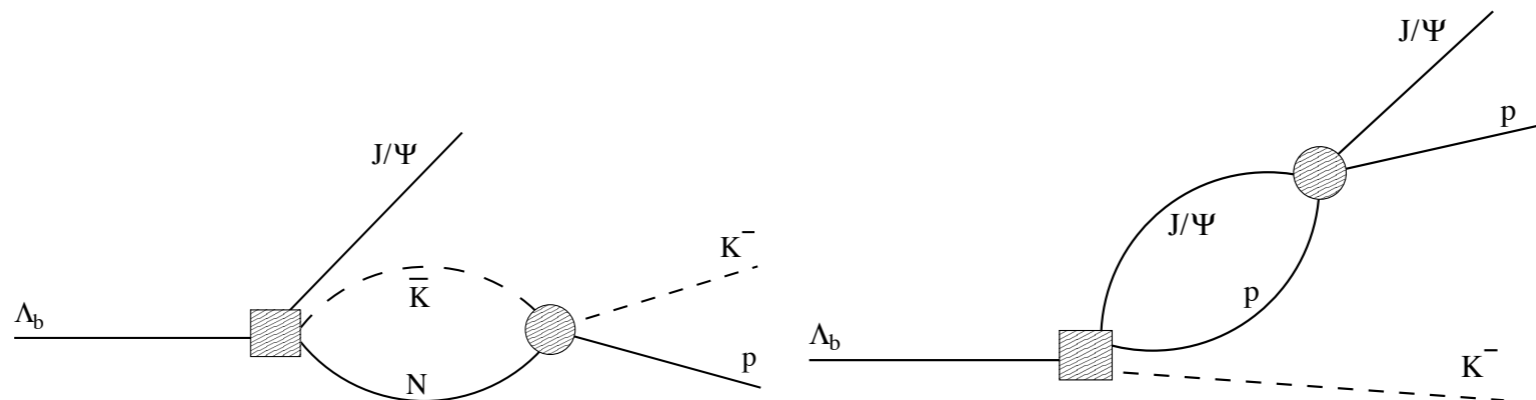
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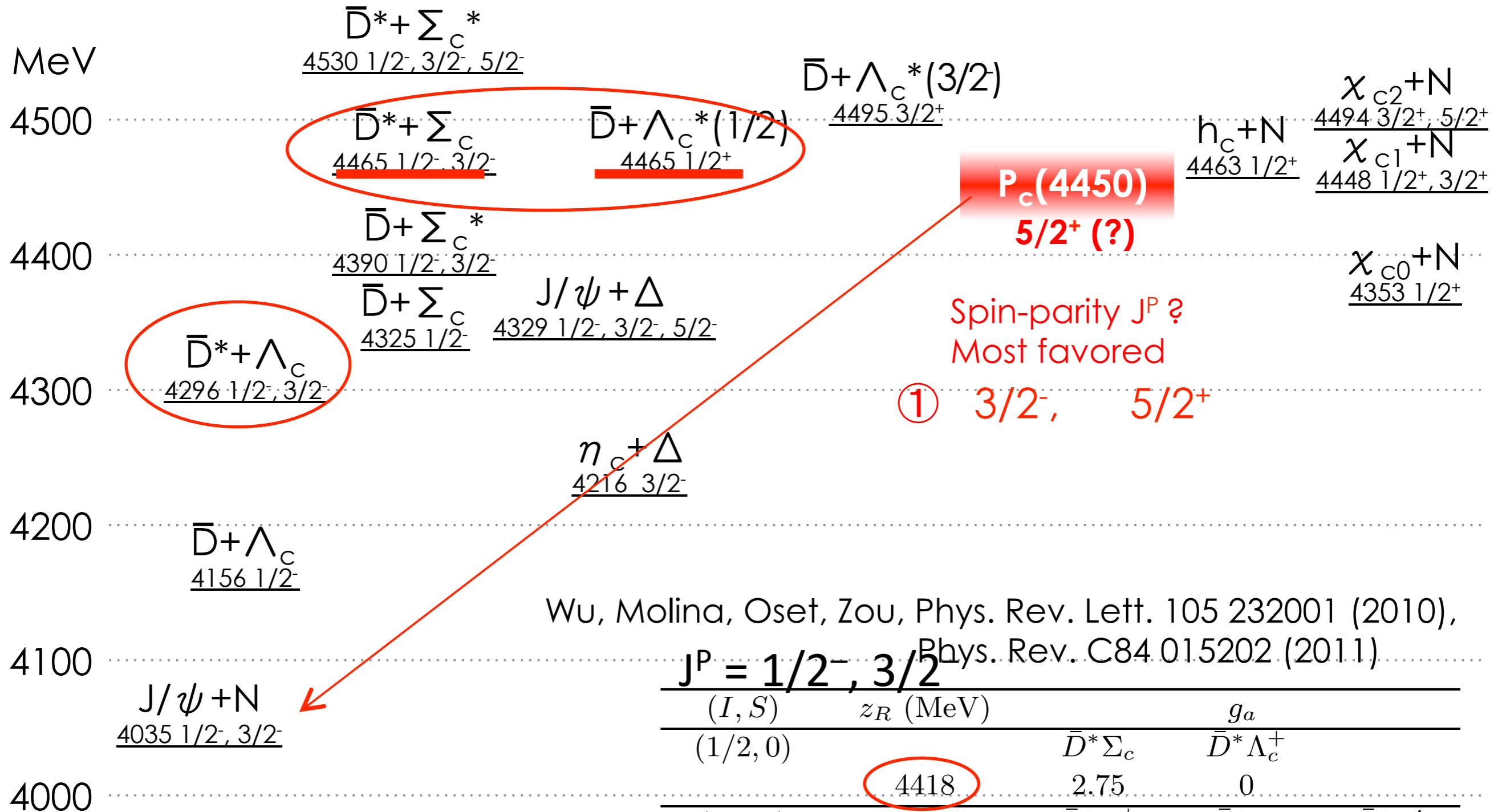
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Thresholds of hadron states above 4 GeV



Wu, Molina, Oset, Zou, Phys. Rev. Lett. 105 232001 (2010),

Phys. Rev. C84 015202 (2011)

$J^P = 1/2^-, 3/2^-$				
(I, S)	z_R (MeV)	g_a		
$(1/2, 0)$	4418	$\bar{D}^* \Sigma_c$	$\bar{D}^* \Lambda_c^+$	
		2.75	0	
$(0, -1)$	4370	$\bar{D}_s^* \Lambda_c^+$	$\bar{D}^* \Xi_c$	$\bar{D}^* \Xi'_c$
	4550	1.23	3.14	0
		0	0	2.53

Can we explain $J^P = 5/2^+$?

We need $l = 1$ or 3

TABLE IV: Pole position and coupling constants for the bound states from $VB \rightarrow VB$.

3. Are there other production processes?

Garzon, He, 1506.06834 [hep-ph]

$\pi^- - p$ reaction of $P_c (=N_{c\bar{c}})$

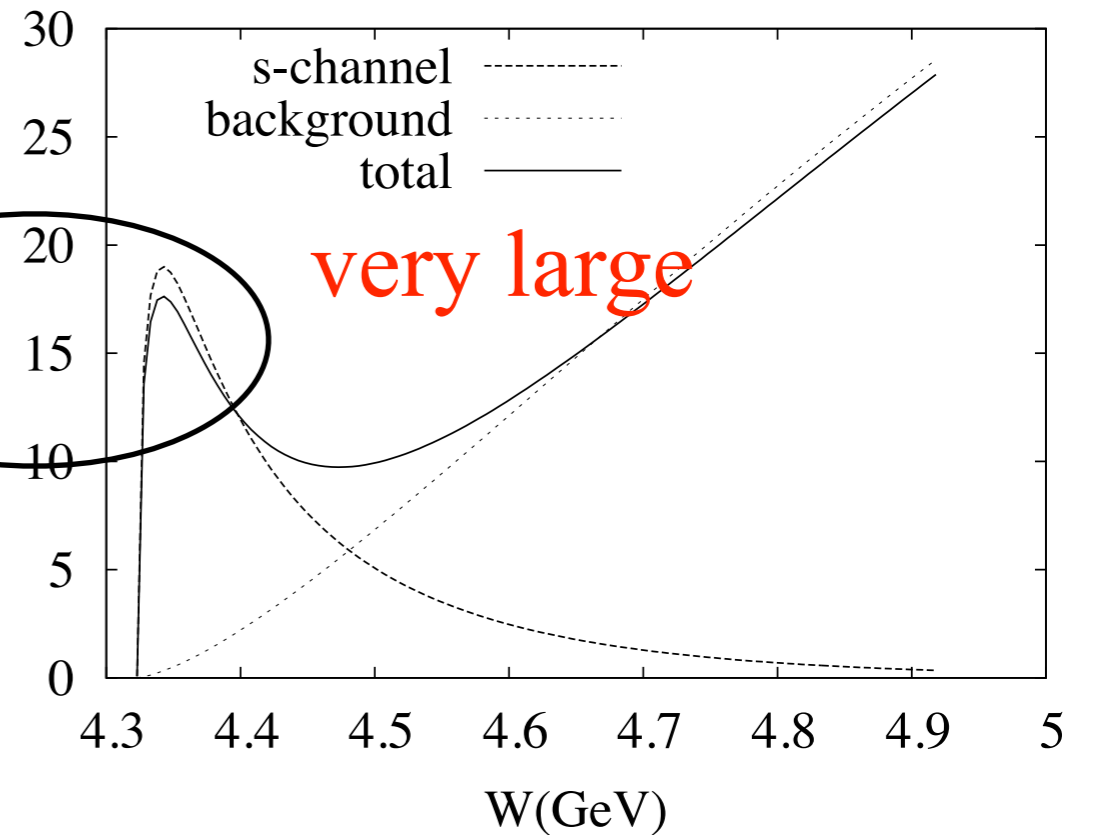
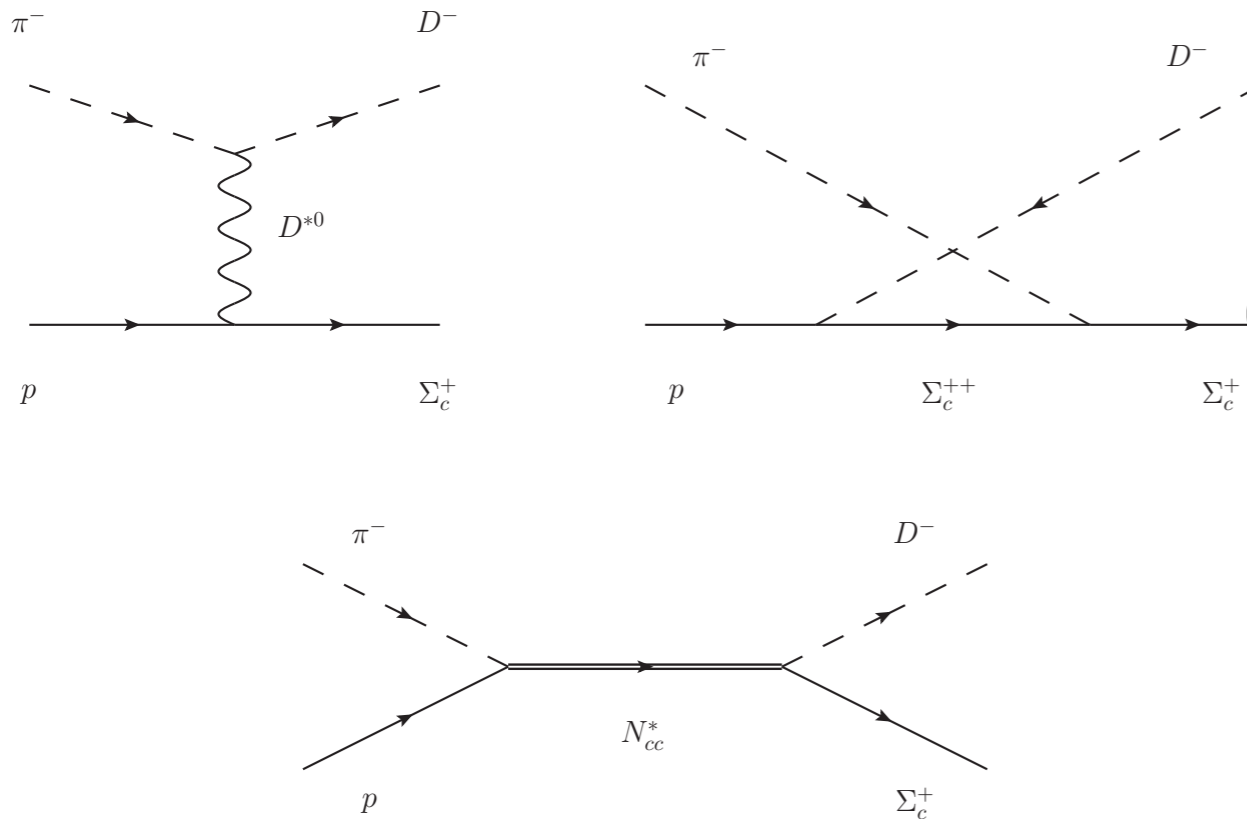


FIG. 2: Comparison of the total cross section of $\pi^- p \rightarrow D^- \Sigma_c^+$ reaction: (solid) total cross section including $N_{c\bar{c}}^*$, (dotted) cross section of the background (t and u -channels) and (dashed) cross section for s -channel ($N_{c\bar{c}}^*$) only.

$$\begin{aligned} \mathcal{L}_{D^* D \pi} &= g_{D^* D \pi} D^{*\mu} (D \partial_\mu \pi - \pi \partial_\mu D), \\ \mathcal{L}_{\Sigma_c p D^*} &= g_{\Sigma_c p D^*} \bar{\Sigma}_c \gamma_\mu N D^{*\mu} + \text{h.c.}, \\ \mathcal{L}_{N_{c\bar{c}}^* N \pi} &= -g_{N^* N \pi} \bar{N}^* \pi N + \text{h.c.}, \\ \mathcal{L}_{N_{c\bar{c}}^* \Sigma_c \bar{D}} &= -g_{N^* \Sigma_c D} \bar{N}^* D \Sigma_c + \text{h.c.}, \\ \mathcal{L}_{D N \Sigma_c} &= -i g_{D N \Sigma_c} \bar{N} \gamma_5 D \Sigma_c + \text{h.c.}, \\ \mathcal{L}_{\pi \Sigma_c \Sigma_c} &= -i g_{\pi \Sigma_c \Sigma_c} \bar{\Sigma}_c \gamma_5 \pi \Sigma_c + \text{h.c.} \end{aligned}$$

J-PARC experiments?