How can we unravel the mysteries of the XYZ states?

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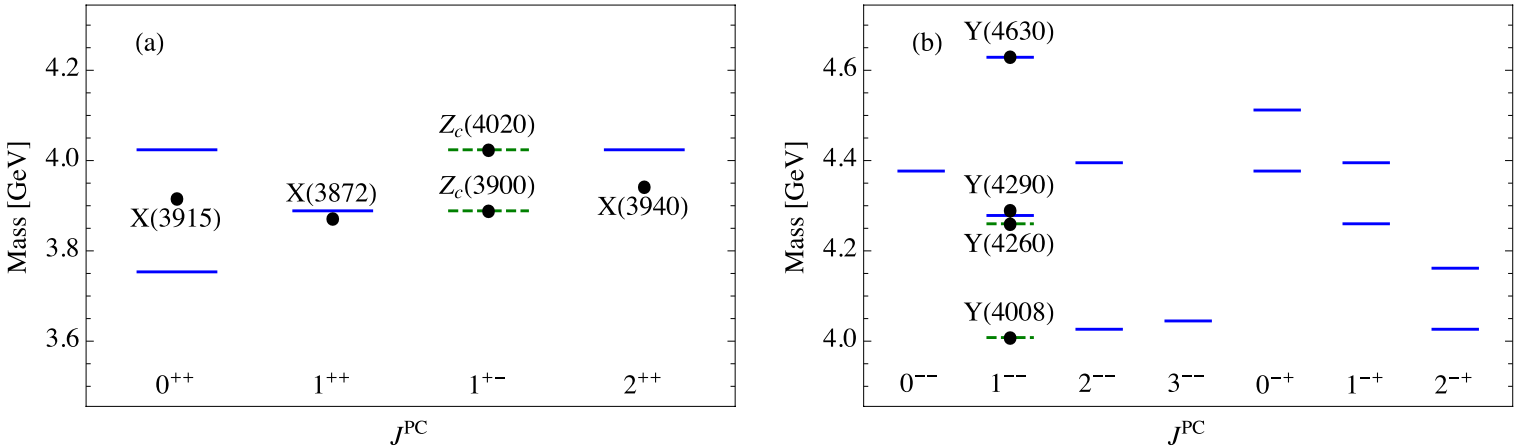
Key reference:

M. Cleven et al., PRD **92**(2015)014005 [arXiv:1505.01771 [hep-ph]].

Spectra

Tetraquarks for the Maiani et al. type

Maiani et al. 2014



Special feature: very light high spin states

Hadrocharmonium

Li & Voloshin, 2014

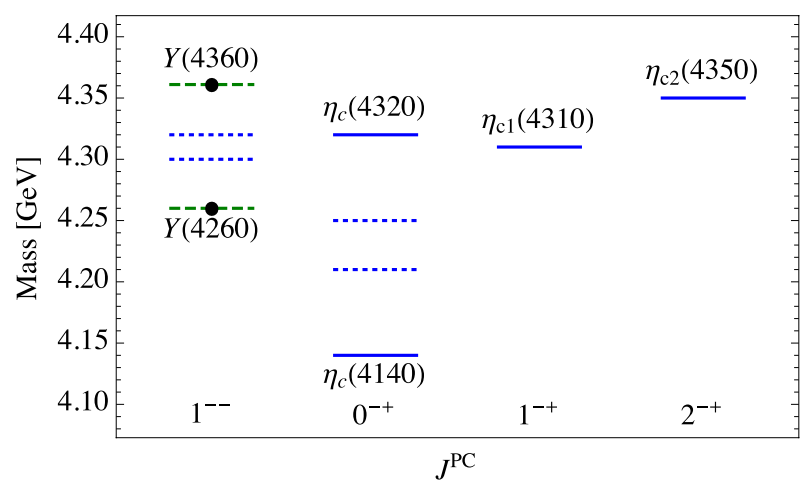
$\Psi_3 \sim (1^{--})_{c\bar{c}} \otimes (0^{++})_{q\bar{q}}$

$\Psi_1 \sim (1^{+-})_{c\bar{c}} \otimes (0^{-+})_{q\bar{q}}$,

with heavy cores ψ' & h_c.

spin partners via

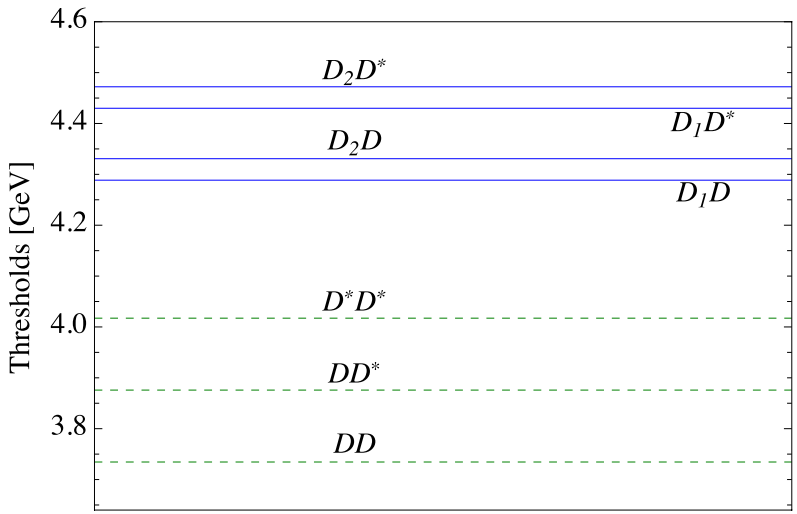
$\psi' \to \eta_c'$ & $h_c \to \{\chi_{c0},\ \chi_{c1},\ \chi_{c2}\}$



Special feature: very light 0^{-+} state that should not decay to $D^*\bar{D}$

Spectra

Molecular states



$3^{-\pm}$: D^*D_2

$0^{-\pm}$: D^*D_1

$2^{-\pm}$: $D^*D_1 - D^*D_2 - DD_2$

$1^{-\pm}$: $DD_1 - D^*D_1 - D^*D_2$ ($Y(4260), Y(4360)$ $(I{=}0)$)

2^{++}: D^*D^*

1^{++}: DD^* ($X(3872)$ $(I{=}0)$)

1^{+-}: $DD^* - D^*D^*$ ($Z_c(3900), Z_c(4020)$ $(I{=}1)$)

0^{++}: $DD - D^*D^*$;

Special feature: $1^{-\pm}$ states as lightest neg. parity states!

Theory: refine the predictions for all approaches

→ Role of spin symmetry violations — Baru et al. 2016

→ Role of $SU_F(3)$ violations

Experiment: search for different quantum numbers

→ unflavored as well as open flavor

→ with as many final states as possible (esp. elastics!)