Roundtable discussion

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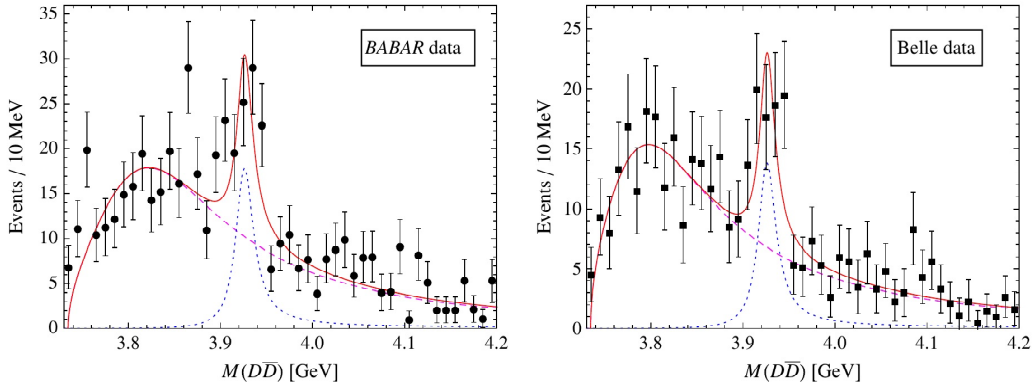
For experimentalist: a broad $\chi_{c0}(2P)$?

If $X(3915)$ and $X(3930)$ are the same tensor state and assigned to $\chi_{c2}(2P)$, the $\chi_{c0}(2P)$ could be a broad resonance

- $\chi_{c0}(2P)$ should be strongly coupled to the $D\bar{D}$ channel (threshold around 3730), this may cause it to be a wide resonance, like $\sigma(0^{++})$ resonance in $\pi\pi$ interaction.
- Guo and Meissner (PRD 86,09150) proposed that the bump in $D\bar{D}$ invariant mass spectrum could be the possible signal of the $\chi_{c0}(2P)$ with $M = (3837 \pm 11.5)$ MeV and $\Gamma = 221 \pm 19$ MeV.



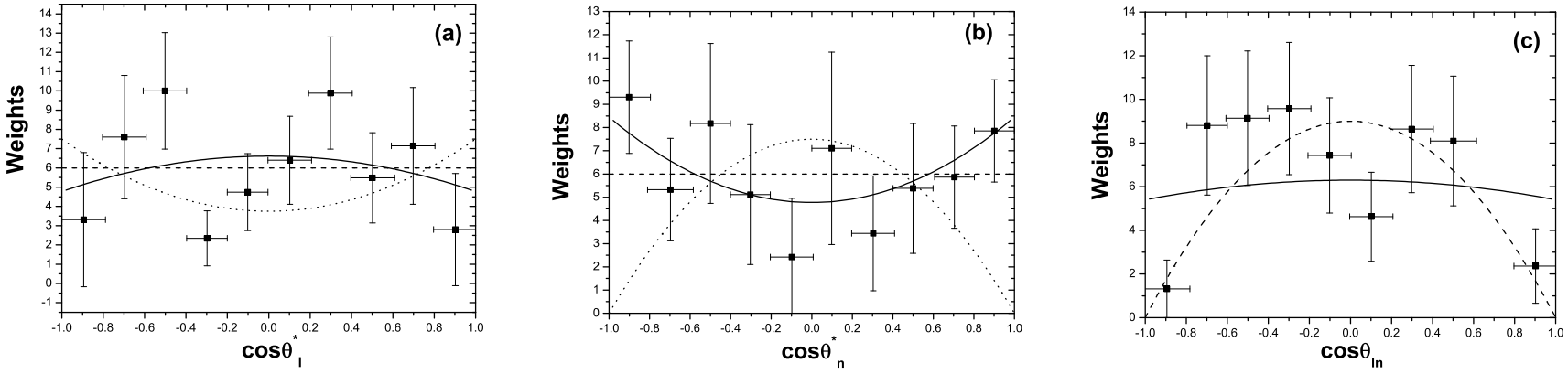
- From our previous work (EPJA,50,165), by including the strong $D\bar{D}$ coupling with the $\chi_{c0}(2P)$, the GI's prediction of the mass is pulled down from 3915 to around roughly 3814^{+13}_{-29} with width 266^{+60}_{-44}
- Could experimentalists reanalyse the $D\bar{D}$ data, to confirm whether the $\chi_{c0}(2P)$ is a broad resonance?

About OZI problem

- $\chi_{c2} \to J/\psi\omega$ is also OZI suppressed. If $X(3915)$ and $X(3930)$ are considered to be the same tensor state, OZI problem could be solved.
  $X(3915)$:
  $Mass = 3918.4 \pm 1.9$MeV, $\Gamma = 20 \pm 5$ MeV
  $\Gamma(X(3915) \to J/\psi\omega) \times \Gamma(X(3915) \to \gamma\gamma)/\Gamma_{\text{total}} = 18 \pm 5 \pm 2$ eV, for 2^{++} (Belle, PRL,104,092001)
  $X(3930)$:
  $Mass = 3927.2 \pm 2.6$ MeV, $\Gamma = 24 \pm 6$ MeV.
  $\Gamma(\chi_{c2}(2P) \to D\bar{D}) \times \Gamma(\chi_{c2}(2P) \to \gamma\gamma)/\Gamma_{\text{total}} = 0.21 \pm 0.04$ keV, from PDGLive.
  So, suppose they are the same state, that is, the same Γ_{total} and $\Gamma(X \to \gamma\gamma)$, thus
  $\Gamma(X(3915) \to J/\psi\omega)/\Gamma(\chi_{c2}(2P) \to D\bar{D}) \sim 0.086$
  This hopefully solves the OZI problem.

For experimentalists: We need more high quality data

The angular distribution data for $X(3915)$

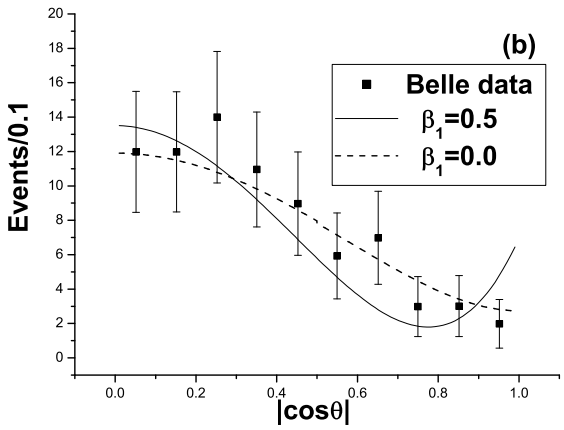


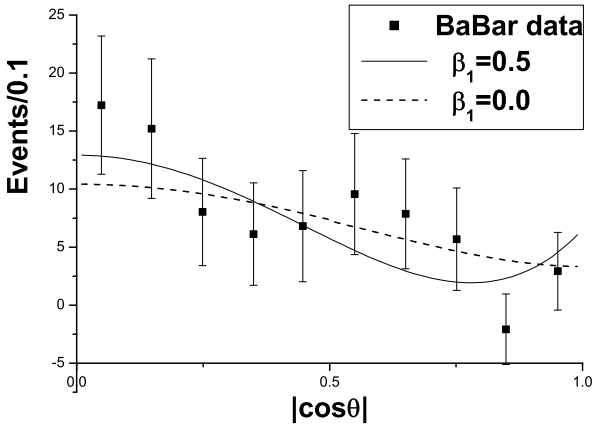
The data in the third diagram has some problems, and we discard this diagram to make our conclusion.

- The data should be left-right mirror symmetric, but there is a point which is strictly zero with no error bar.
- This does not form a good distribution.
- Could experimentalists continue doing this experiment and collect more data?

For experimentalists: Helicity-2-dominance

- The angular distribution used in determining the helicity-2-dominance





- Are there other angular distributions to be used to test helicity-2-dominance?

For theorist: Large Helicity-0 contribution for tensor state

- The Helicity-2 dominance: from $Q\bar{Q}$ perturbative calculation. (Krammer & Krasemann, PLB73,58(1978), Z.Li, F.Close, and T Barne, PRD43,2161).
- How to generate a large helicity-0 contribution for tensor state, by including exotic components or including open-flavor threshold effect?

For experimentalists: reanalyse Z_b data

- In the day before yesterday's Yun-Hua Chen's talk, their coupling are large compared to the original coupling by Belle (arXiv:1209.6450). This is because the original analysis using the Breit-Wigner may not be suitable for resonances with nearby threshold.
- Could the experimentalists reanalyse the Z_b data using Flatté formalism to confirm this large coupling?

Several poles generated by one bare state

- When one bare state is coupled to more channels, there could be more nearby poles generated by one bare state,
- One example: low energy 0^+ resonances, one seed $I = 1$, $n\bar{n}$, threshold $\eta\pi$, $K\bar{K}$, $\eta'\pi$
  Unitarized quark model, we found 3 nearby poles, generated from one seed.