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$Z_c(4430)$, $Z_c(4200)$, $Z_1(4050)$ and $Z_2(4250)$ as triangle singularities

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Recent experimental observations of charged charmonium- and bottomonium-like structures have brought lots of excitements in the field of hadron spectroscopy. If these structures are associated with the existence of the corresponding hadrons, these states includes minimally two quarks and two antiquarks, being objects clearly beyond the conventional quark model picture. Such charged charmonium-like state candidates include $Z_c(4430)$ discovered by the Belle and confirmed by the LHCb in $\bar{B}^0 \to \psi(2S)K^-\pi^+$, $Z_c(4200)$ found in $\bar{B}^0 \to J/\psi K^-\pi^+$ by the Belle, and $Z_1(4050)$ and $Z_2(4250)$ observed in $\bar{B}^0 \to \chi_{c1}K^-\pi^+$ by the Belle. Existing theoretical models, which had not been ruled out by the experiments, all interpreted these candidates as four-quark states, until we recently identified a compelling alternative; this new scenario is what I am going to discuss in my presentation. I discuss that kinematical singularities in triangle loop diagrams induce a resonance-like behavior that can consistently explain the properties (such as spin-parity, mass, width, and Argand plot) of $Z_c(4430)$, $Z_c(4200)$, $Z_1(4050)$ and $Z_2(4250)$ from the experimental analyses. Also, in terms of the triangle singularities, we can naturally understand interesting experimental findings such as the appearance (absence) of $Z_c(4200)(Z_c(4430))$-like contribution in $\Lambda_b^0 \to J/\psi p\pi^-$, and the highly asymmetric shape of the spectrum bump for $Z_1(4050)$; the other theoretical models have not successfully addressed these points. Even though the proposed mechanisms have uncertainty in the absolute strengths which are currently difficult to estimate, otherwise the results are essentially determined by the kinematical effects and thus robust. This contribution is based on two recent papers: arXiv:1901.07385, 1903.08098.

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