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Exotic-hadron signature by constituent-counting rule in perturbative QCD

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There have been reports on exotic-hadron candidates, especially tetraquark and pentaquark hadrons, in the last several years. However, it is not easy to determine whether they are in fact exotics by low-energy experiments on global properties such as masses, decay widths, spins, and parities. It could be appropriate to determine their internal configurations by high-energy reactions because quark and gluon degrees of freedom become apparent. There is a constituent-counting rule suggested in perturbative QCD for hard exclusive reactions to count the number of elementary constituents. The rule could be used for finding the number of constituents in exotic hadrons. It is expected that the number is four and five for tetraquark and pentaquark hadrons, respectively. We proposed this idea in 2013 and have been investigating future possibilities, for example, Lambda(1405) production at the high-momentum beamline of J-PARC [1]. We also analyzed available data on hard hyperon productions including Lambda(1405) in hadron and charged-lepton reactions [1]. We found that the ground Lambda production is consistent with the three-quark nature. However, it is difficult to determine the number of constituents for Lambda(1405) because the current data are not accurate enough and they are within a limited energy range. Nevertheless, we reported an interesting tendency that Lambda(1405) looks like pentaquark at low energies but it seems be a three-quark baryon at high energies. The energy dependence could be important for probing the internal configuration, especially if it is a mixture of three-quark and five-quark states. Future JLab and J-PARC experiments could clarify this issue of internal configurations for Lambda(1405) by the constituent counting rule. Reference: [1] W.-C. Chang, S. Kumano, T. Sekihara, Phys.Rev. D93 (2016) 034006; H. Kawamura, S. Kumano, T. Sekihara, Phys. Rev. D88 (2013) 034010; H. Kawamura, S. Kumano, Phys. Rev. D89 (2014) 054007.

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