Physicists reveal connection between two nonperturbative parameters to help predict heavy meson production

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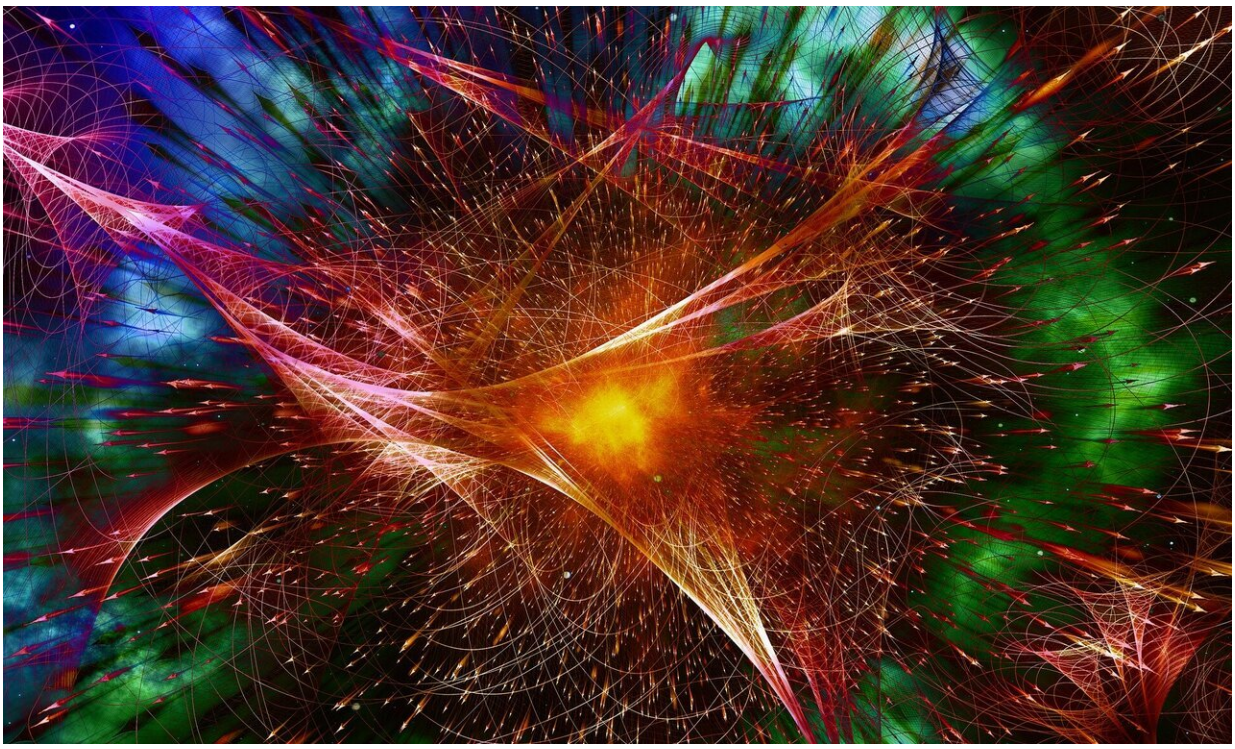

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Prof. Jia Yu from the Institute of High Energy Physics of the Chinese Academy of Sciences, and his collaborators, unveiled for the first time some deep connections between two fundamental nonperturbative

parameters that characterize the intrinsic properties of heavy mesons—helpful for predicting heavy meson hard exclusive production processes with better accuracy. The study was published in *Physical Review Letters*, following up on a study published in *Physical Review D* in 2019.

Quantum chromodynamics (QCD) is the fundamental theory to describe the strong interaction in nature, and heavy meson refers to a hadron composed of a heavy quark and a light antiquark bound by the strong force.

The study of the heavy hadron production mechanism is an important subject in the field of perturbative QCD. On the one hand, the heavy meson light-cone distribution amplitude (LCDA) defined in heavy quark effective theory (HQET) is the basic nonperturbative input parameter, which ubiquitously appears in predicting B meson exclusive decays, and plays a vital role in heavy flavor physics. On the other hand, the collinear factorization theorem failed to tackle B meson exclusive production and instead utilizes the heavy meson LCDA defined in QCD, which is poorly constrained at present.

Over the past three decades, it was commonly believed that these two sets of nonperturbative B meson LCDAs were independent of each other.

Due to asymptotic freedom in QCD, physicists have realized that, although these two nonperturbative functions have drastically different ultraviolet behavior, they possess identical infrared behavior.

Then they proposed a novel factorization theorem to link these two set of functions together: The QCD LCDA of B meson can be expressed as a convolution between the HQET LCDA of B meson and a perturbatively calculable short-distance coefficient.

This factorization program not only helps to cleanly separate the physical effects affiliated with three important energy scales intrinsic to hard exclusive B production processes, but expedites the resummation of large logarithms. The novel theorem also employs the HQET LCDA of B meson as the input parameter, which has already been extensively studied in innumerable B meson decay channels, so that one can greatly improve the accuracy of theoretical predictions.

More information: Saadi Ishaq et al. Factorization Theorem Connecting the Light-Cone Distribution Amplitudes of Heavy-Flavor Mesons in QCD and Heavy-Quark Effective Theory, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.125.132001

Saadi Ishaq et al. W radiative decay to heavy-light mesons in HQET factorization through O(αs), *Physical Review D* (2019). DOI: 10.1103/PhysRevD.100.054027

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