A New Field-Theoretical Formulation for Partons

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The concept of partons was introduced by R. Feynman in 1959 as a fundamental degree of freedom of protons (or any hadron) with infinite momentum in order to describe high energy scattering, such as electron-proton scattering. Partons are now identified as quarks or gluons, though the notion of a parton is still commonly used as a convenient conceptual framework in nuclear and high-energy physics.

Dr. Xiangdong Ji invented a new field-theoretical formulation of partons in 2013. Before that, theoretical formulations of partons had encountered some difficulties that may be traced back to a strong assumption that partons must have infinite momenta. His new theory, however, relaxed the condition and allowed partons to have finite momenta, so that parton theory could be formulated for the first time as a sensible effective field theory with a well-defined expansion parameter.

By applying this new method in patron theory, Xiangdong Ji showed many advantages. For example, it has made it possible for the first time to calculate observables appearing in scattering phenomena using Euclidean lattice QCD simulation, a most powerful first-principle calculation method. This theory is also very useful for calculations over a wide range of the *x* region, where *x* is defined as $p_{parallel} / p_{max}$. It should be particularly useful for new electron-ion collider experiments where the *x*-dependence will be determined experimentally (and will show a gluon contribution to proton spin of 1/2).

In ref. [1], Xiangdong Ji presents a review of his work. His description is original, starting from elementary notions such as idealizations, effective field theories in general and so on, and making this article a pedagogical review of his original work for non-experts and students.

References

[1] Xiangdong Ji, AAPPS Bulletin, 30 (4), 58-67 (2020).