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# Parton Structure from the QCD Vacuum and Its Connection to LaMET

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Partons provide a natural language for hadron structure at high energies in QCD. However, direct light-front (LF) quantization leads to severe infrared singularities. These divergences reflect the absence of an intrinsic IR scale and nontrivial vacuum structure, thus placing QCD at a critical point. As a result, well-defined parton distributions are constructed through renormalization prior to the infinite momentum limit $P_z \to \infty$. To address this, we propose a gradient-flow framework based on the instanton liquid model (ILM), an effective UV-finite QCD ensemble emerging at a finite flow-time resolution scale $t$. In this approach, the UV modes are removed by renormalization at the corresponding scale $\mu_0 \sim 1/(8t)^{-1/2}$, yielding a well-defined light-front formalism with key nonperturbative phenomena well addressed, including chiral symmetry breaking, anomalies, and confinement. Thus, parton observables can be systematically computed at $\mu_0$ in ILM, matched to the MS bar scheme with small-flow-time expansion, and then evolved to high energy perturbatively. This construction parallels LaMET, where finite $P_z$ plays an analogous role to $t$, providing a different Wilsonian description of parton structure that well addresses the topological origin for nonperturbative QCD.

**Primary authors:** Prof. SHURYAK, Edward (Stony Brook University); ZAHED, Ismail (Stony Brook University); LIU, Wei-Yang (Stony Brook University)

**Presenter:** LIU, Wei-Yang (Stony Brook University)

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