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From C to Parton Sea: How Supercomputing Reveals Nucleon Structure[1]

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Studying the structure of nucleons is not only important to understanding the strong interactions of quarks and gluons, but also to improving the precision of new-physics searches. Since a broad class of experiments, including the LHC and dark-matter detection, require interactions with nucleons, the mission to probe femtoscale physics is also essential for disentangling Standard-Model contributions from potential new physics. These SM backgrounds require parton distribution functions (PDFs) as inputs. However, after decades of experiments and theoretical efforts, there still remain many unknowns, especially in the sea flavor structure and transversely polarized structure. In a discrete spacetime, we can make a direct numerical calculation of the implications of QCD using sufficiently large supercomputing resources. A nonperturbative approach from first principles, lattice QCD, provides hope to expand our understanding of nucleon structure, especially in regions that are difficult to observe in experiments. In this work, we present a first direct calculation of the Bjorken-x dependence of the PDFs using Large-Momentum Effective Theory (LaMET) and comment on the surprising result revealed for the nucleon sea-flavor asymmetry.

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