Partonic Structure by Quantum Computing

We present a systematic quantum algorithm, which integrates both the hadronic state preparation and the evaluation of the real-time light-front correlations, to study the parton distribution functions (PDFs). As a proof-of-concept, we realize the first direct simulation of the PDFs in the 1+1 dimensional Nambu-Jona-Lasinio (NJL) model. We show the results obtained by numerical diagonalization and by quantum computation using classical hardware. The agreement between these two distinct methods and the qualitative consistency with the QCD PDFs validate the proposed quantum algorithms. Our work suggests the feasibility of calculating the QCD PDFs on current and near-term quantum devices. The presented quantum algorithm is expected to have many applications in high energy particle and nuclear physics.

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Track Classification: 3. 重离子物理