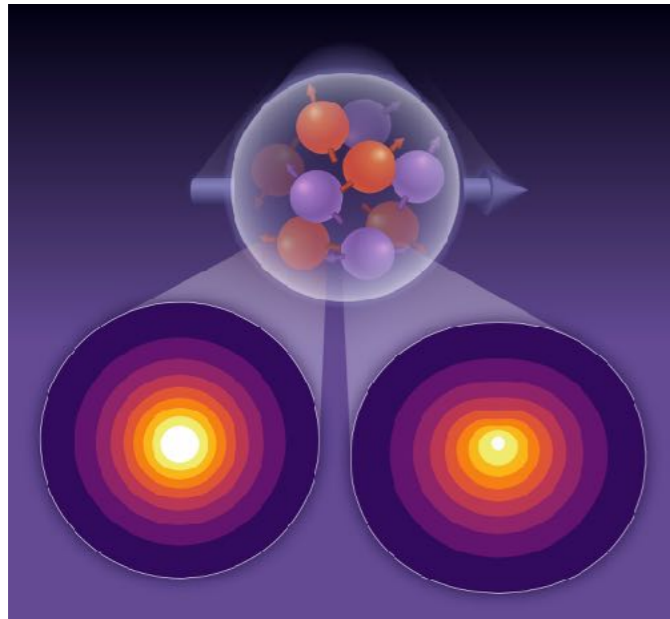


# High-Resolution Mapping of Quark Distributions in Protons



u-quark  
spatial dist

d-quark  
spatial dist

**DOE SC Highlight:**  
**Calculations reveal high-resolution view of quarks inside protons**

[Phys. Rev. D, 106\(11\):114512, 2022](#) & [PHYS.ORG](#)  
[Phys. Rev. D, 108\(1\):014507, 2023.](#)

This graphic illustrates a proton moving at nearly the speed of light toward the viewer with its spin aligned along the horizontal direction (large arrow). The two views of concentric circles at the bottom show the spatial distributions of the momentum of up quarks (left) and down quarks (right) within this proton (white is high; violet is low).

***Accomplishment:*** Revealed the differences in spatial distributions of up and down quarks within protons.

***Methods:*** SciDAC developed 10x faster new formalism for LQCD calculations of generalized parton distribution (GPD).

***Impact:*** Provide guidance for interpretation and extraction of GPDs from JLAB12 and EIC experiments.