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Mapping the inner structure of the Proton

The proton is the most common element of the visible universe, yet we don't know how to reconstruct its macroscopic properties (mass, spin,...) from the elementary degrees of freedom of the Strong Interaction, the quarks and gluons (collectively, partons) of QCD. Partons are not visible, they are confined inside hadrons because at hadronic mass scales QCD is highly nonlinear and not calculable. From phenomenological analyses of experimental data one can extract nonperturbative maps of the dynamics of confined partons. In particular, transverse-momentum dependent parton distributions (TMDs) generalize the standard collinear parton distribution functions (PDFs) by informing on partonic 3D momenta. Recent extractions of unpolarized TMDs have reached a theoretical accuracy comparable to modern PDFs. Our group is recognized world leader in the study of TMDs and (polarized) "exotic" PDFs, that are relevant for Standard Model precision studies at the LHC and for explorations of new physics beyond it, respectively.

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