Abstract

Hidden-Color Effects in Deuteron

The deuteron, as the simplest nuclear bound state, serves as an ideal system for investigating the strong interactions among quarks and gluons inside nuclear matter. Moving beyond the traditional proton–neutron description, we present the first attempt to model the deuteron's internal structure by incorporating hidden-color degrees of freedom. Within the light-front framework, the deuteron is treated as an effective mixture of color-singlet–singlet and octet–octet clusters, allowing us to examine how these non-nucleonic components influence its properties.

Using a separation-of-variables approach to the light-front two-cluster bound-state equation, we incorporate both transverse and longitudinal dynamics through two Schrödinger-like equations: light-front holography for confinement in the transverse plane and the 't Hooft equation for the longitudinal direction. This framework enables the investigation of a broad range of observables, including unpolarized and polarized structure functions, the tensor-polarized structure function, and electromagnetic form factors.

Our findings demonstrate that hidden-color correlations play a crucial role in shaping the deuteron's spin and partonic structure, and the calculated observables show good agreement with available experimental data.