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Relativistic dynamics of charmonia in strong magnetic fields

In this talk, I present our recent investigation of charmonium systems in strong external magnetic fields using a relativistic light-front Hamiltonian approach within the basis light-front quantization (BLFQ) framework. By solving the eigenvalue problem for the invariant mass squared operator —incorporating confinement potentials and one-gluon-exchange interactions —we compute the mass spectrum and wave functions across varying magnetic field strengths. Our results reveal significant spectral modifications driven by the Zeeman effect, including η_c-J/ψ mixing and splitting of magnetic sublevels. Analysis of the momentum density distributions shows pronounced wave function deformation: transverse momentum broadening and longitudinal compression in strong fields, along with notable structural changes in parton distribution profiles —such as the emergence of double-hump structures in excited states. We find that relativistic corrections and center-of-mass coupling play a crucial role in these dynamics, underscoring the necessity of a fully relativistic treatment for accurately describing QCD bound states in extreme electromagnetic environments and vorticity.

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