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Anatomy of nucleon self-energy from equal-time to light-front

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Light-front dynamics (LFD) has been of particular interests in hadron physics with the effort of developing the 3D femtography of the nucleon. In this respect, it is important to trace the instantaneous contribution to the fermion propagator in the LFD which involves the constraint degrees of freedom of the fermion. Interpolating the ordinary instant form dynamics (IFD) to the LFD in quantum electrodynamics [1], we have previously identified that the instantaneous contribution to the fermion propagator in the LFD corresponds to the backward moving fermion propagator in the IFD. In this presentation, we discuss this correspondence between the IFD and the LFD in the loop level analyzing the pion loop contribution to the nucleon self-energy in the chiral effective theory. Specifically, we calculate the backward and forward nucleon self-energy interpolating between the IFD and the LFD and trace each part of the contributions to correspond with the light-front instantaneous (LFI) contribution and the on-mass-shell (OMS) contribution in the LFD. The nonanalytic behavior of the pion loop contribution in the nucleon self-energy is anatomically analyzed to confirm the correspondence of each part between the IFD and the LFD unambiguously. Our numerical results exhibiting the entire profile of the interpolating parameter and the momentum (p^z) dependence of the forward and backward moving parts further clarify any conceivable confusion in the prevailing notion of the equivalence between the LFD and the infinite momentum frame ($p^z \to \infty$) approach in the IFD. We also discuss the light-front zero-mode issue contrasting the results in $p^z \to \infty$ and $p^z \to -\infty$.

[1] C.-R.Ji, Z.Li, B. Ma and A. Suzuki, Phys. Rev. D98, 036017(2018)

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