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Covariant two-body currents in light front quantum mechanics

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Light-front quantum mechanics is an alternative to light-front quantum field theory for modeling strongly interacting systems at relativistic energies. The advantages are that (1) rotational covariance is exact, so there are no problems identifying states of a given spin or applying arbitrary Poincar\'e transformations to these states (2) it is possible to construct realistic models of strongly interacting systems that reproduce experimental binding energies and phase shifts (3) numerically exact calculations of bound and scattering states can be performed (4) it has the same kinematic symmetries as light-front field theory and (5) there are irreducible sets of kinematic operators. The disadvantages are (1) there is no direct connection to light-front quantum field theory so the dynamical models are representation dependent (2) two-body currents required by current covariance and current conservation are necessary, representation dependent, and not unique. The lack of understanding on how to construct dynamically consistent two-body currents is the most serious problem with applications of light-front quantum mechanics to calculations of electroweak observables at relativistic momentum transfers. In this work I construct two-body currents consistent with the dynamics by (1) representing the light-front Hamiltonian in the Weyl representation (using the irreducible set of kinematic operators) (2) replacing the light-front momentum operators by gauge covariant derivatives and (3) extracting the coefficient of the term linear in the vector potential. This provides a candidate for the two-body current that is consistent with the dynamics that is determined by requiring local gauge invariance in the Weyl representation.

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