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Light-Front Quark Model Analysis of Meson-Photon Transition Form Factor

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Hadronic distribution amplitudes (DAs) provide essential
information on the QCD interaction of quarks, antiquarks and gluons inside the hadrons and play an essential role in applying QCD to hard exclusive processes such as the pion-photon transition form factor (TTF).
As the discrepancy of $Q^2F_{\pi\gamma}(Q^2)$ data between
the BaBar and Belle measurements has not been
resolved yet, more studies on the meson-photon TTF are called for. In particular,
the pion-photon TTF still motivates more theoretical studies using various forms of pion DAs.
The general agreement on the analysis of the pion DA is that the broader the
pion DA the steeper the slope of $Q^2F_{\pi\gamma}(Q^2)$ as Q^2 is getting larger.
For instance, the flat pion DA $\phi(x) = 1$
shows the agreement with the BaBar data which kept rising over the Belle data
as Q^2 gets larger. However, the flat pion DA $\phi(x) = 1$ is severely different from
the twist-2 asymptotic DA $\phi(x) = 6x(1-x)$ which has been frequently discussed
based on the collinear factorization and QCD scaling.
Contrary to the pion-photon TFF,} the subsequent BaBar
data for the $(\eta, \eta') \to \gamma^*\gamma$ TFFs
have shown the consistency predicted by the perturbative QCD, where the use of flat DA for η and η' distributions
appears strongly disfavored by the datasets of $\eta(\eta') - \gamma$ TFFs.
Thus, the careful analysis of $(\eta, \eta') \to \gamma^*\gamma$ transitions is especially
important under the circumstance of a prolonged dispute over the pion-photon TFF results.

In this talk, we investigate the $P \to \gamma^*\gamma(P = \pi^0, \eta, \eta')$ transitions using
the light-front quark model (LFQM)
based on the QCD motivated effective LF Hamiltonian.
We shall also show both timelike and spacelike TFF using the analytic
continuation method of changing $Q^2 \to -Q^2$ in the form factor.
The $\eta - \eta'$ mixing scheme is analyzed to obtain the optimum values of the $\eta(\eta') - \gamma$ TFFs and compared with the current available experimental data.

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