Meson cloud effects in the electromagnetic nucleon structure

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We study electron–nucleon scattering within a constituent quark model with instantaneous confinement and a hyperfine interaction that is caused by dynamical one-pion exchange between the quarks. To this aim we employ a Poincaré-invariant coupled-channel formulation which is based on the point-form of relativistic quantum mechanics [1]. The $eqqq(+\pi)$ system is described by a Bakamjian-Thomas-type mass operator with the usual quantum field-theoretical vertices for pion and photon emission and absorption. The electromagnetic nucleon current and, in the sequence, the nucleon form factors are directly extracted from the invariant one-photon exchange amplitude. For dynamical pion exchange the current and the form factors are then sums over two contributions, one coming from the 3-quark component of the nucleon, the other one from the 3-quark + one-pion component. The latter is just the effect of the meson cloud on the nucleon structure we are mainly interested in. The physical picture of the electromagnetic nucleon structure emerging from such a model is that of a quark core which is surrounded by a pion cloud. However, we truncate our Fock space so that only one pion can be exchanged at a time.

For purely instantaneous binding forces such a coupled-channel approach has already been applied to calculate electromagnetic form factors of π, ρ, D and B mesons as well as weak $B \to D^{(*)}$ decay form factors [2,3]. In that light the present work can be seen as an extension to baryons and to binding forces which are (partly) caused by dynamical particle exchange. We will present analytical expressions and first numerical results for the nucleon current and electromagnetic nucleon form factors (including the pion cloud) and compare the outcome of our work with analogous calculations done in the front form of relativistic quantum mechanics [4,5].

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