Reply to “Comment on Octet baryon magnetic moments in the chiral quark model with configuration mixing”

Tommy Ohlsson* and Håkan Snellman†

Theoretical Physics, Department of Physics, Royal Institute of Technology, SE-100 44 Stockholm, Sweden

(Received 19 August 1998)

We respond to Jerrold Franklin’s Comment on our article “Octet baryon magnetic moments in the chiral quark model with configuration mixing”.

In the preceding Comment [1], Jerrold Franklin criticizes an earlier paper [2] by us in collaboration with Johan Linde on the magnetic moments of the octet baryons in the chiral quark model (χ QM). Below we answer some of the points raised by Franklin in his Comment.

The main point of Franklin’s criticism is that our paper claims that the sum-rule Eq. (3) in Ref. [2], that has been pioneered by Franklin [3], is not broken by arbitrary SU(3) breakings in the interaction Lagrangian. This, according to Franklin, depends on the fact that we have left out exchange currents, which must be present in perturbation theory and which will break the sum-rule. This theme is then developed with some variations in the Comment, ending with a criticism of our using SU(3) breaking configuration mixings.

Let us first clarify that our calculations are made to first order in the coupling constant of the interaction Lagrangian that effectuates the Goldstone boson (GB) emission, that gives rise to the change in the quark spin polarizations. We also notice in Ref. [2] that further iterations of GB emission (in an uncorrelated way) do not change the situation, and the sum-rule is still unbroken.

We agree with Franklin that inclusion of exchange currents (second order in the quark-GB coupling constant), would in principle formally break the sum-rule if the interaction Lagrangian breaks the SU(3) symmetry. However, such currents cannot, in our opinion, be arbitrarily parameterized in the χ QM, since they are determined by the form and magnitude of the interaction Lagrangian. Furthermore, Franklin has not produced any calculations in the χ QM that give evidence to his claim that effects of these currents would be large enough to account for the large breaking of the sum-rule.

The contribution from exchange currents, which necessarily include effects of the baryon wave function, have in fact been calculated in the chiral quark model by Dannbom *et al.* [4]. In their paper, the contribution to the exchange currents are found to be quite small and cannot therefore alone account for the large breaking of the sum-rule. In Ref. [4], the contribution to the sum-rule from the exchange currents coming from the pseudoscalars cancel, since the authors work with an SU(3)

symmetric interaction Lagrangian. Our point is that the individual contributions by themselves are small, and would therefore remain small in the presence of SU(3) symmetry breaking.

In view of this, it seems natural to look for other alternatives to break the sum-rule. That such possibilities exist are discussed at some length in the introduction of our paper, but those methods are found wanting in other respects. We have therefore looked at the possibility of configuration mixing in the baryon wave functions.

In our models, which are elaborations of ideas already presented in the literature, the configuration mixing breaks the SU(3) symmetry in the wave functions, and thus the sum-rule. It is not the quark-GB interaction Lagrangian that breaks the SU(3) symmetry in the wave functions, but the mass terms in the Lagrangian. In a toy model in Ref. [2], we show how this can take place in a perfectly natural way.

Finally, Franklin also argues that our transition probabilities in Eqs. (A3)-(A5) do not depend upon which baryon the quark is in. This is correct, and is in our opinion what makes the quark model useful. If the GB emission probability to first order would be strongly environment dependent, then the χ QM would be rather useless. The baryon dependence should come from the influence of the baryon wave function on the quarks, and not from the interaction.

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