Monopoles and Knots in Skyrme Theory

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We show that the Skyrme theory actually is a theory of monopoles which allows a new type of solitons, the topological knots made of monopole-anti-monopole pair, which is different from the well-known skyrmions. Furthermore we derive a generalized Skyrme action from the Yang-Mills action of QCD, which we propose to be an effective action of QCD in the infra-red limit. We discuss the physical implications of our results. The proposal that the Skyrme theory could describe an effective theory of QCD in the low energy limit has become very popular [1, 2]. In this view the skyrmions are interpreted as the baryons, and numerous evidences have been put forward which support this view [3]. Motivated by the success of the proposal many people have tried to derive the Skyrme action from QCD. But a concrete theoretical proof of the proposal, that one can actually derive the Skyrme action from QCD, has remained very difficult [4].

The purpose of this Letter is two-fold. First we show that the Skyrme theory actually has a much richer soliton spectrum. Indeed we show that it is a theory of self-interacting non-Abelian monopoles, and prove that it allows a new type of knotted solitons very similar to the topological knots in the Skyrme-Faddeev theory of non-linear sigma model [5]. The other purpose is to present a new evidence that the Skyrme theory is indeed very closely related to QCD. In fact, by reparametrizing the gauge potential, we derive a generalized Skyrme action from the Yang-Mills action of QCD which we propose to be an effective theory of QCD in the low energy limit. The assertion that the Skyrme theory could be derived from QCD is perhaps not suprising. But the fact that the Skyrme theory has a new type of solitons is really unexpected, which put the Skyrme theory in a completely new perspective.

References

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