Multibaryons in the chiral quark soliton model

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In this work, we explore higher baryon-number states based on quark dynamics. *The chiral quark soliton model* (CQSM) is the simple quark model that incorporates the basic features of QCD, e.g. the chiral symmetry and its breakdown or the appearance of the Goldstone bosons. For $B = 1$ and 2, the model has spherically symmetric and axially symmetric solutions. From the study of the Skyrme model, it is expected that the minimal energy solutions for the high winding numbers have some particular discrete symmetries. For example, $B = 3$ soliton has a tetrahedral symmetry, and $B = 4$ has a cubic, $B = 5$ possesses the symmetry D_{2d} and $B = 7$ has dodecahedral symmetry, and so on. We shall impose the same symmetry on the chiral fields to our calculations of CQSM using rational map ansatz [1]. For $B = 3$, we obtain the stable tetrahedral solutions (Fig.1(a)). Particularly interesting property of the result is the triple degeneracy of the valence quark states. For $B = 5$ we investigate for the following fields: solution with D_{2d} symmetry and octahedron (Fig.1(b)). In case of the octahedron, the valence quark states consist of $3+2$ degeneracy. Also in $B = 7$ dodecahedron, they have $3+3+1$ degenerate structure. Such degeneracy plays an important role for the stability of the solitons. We expect that in all other states the symmetries of background pions provide the large degeneracy of the underlying fermionic states.

(a) (b)

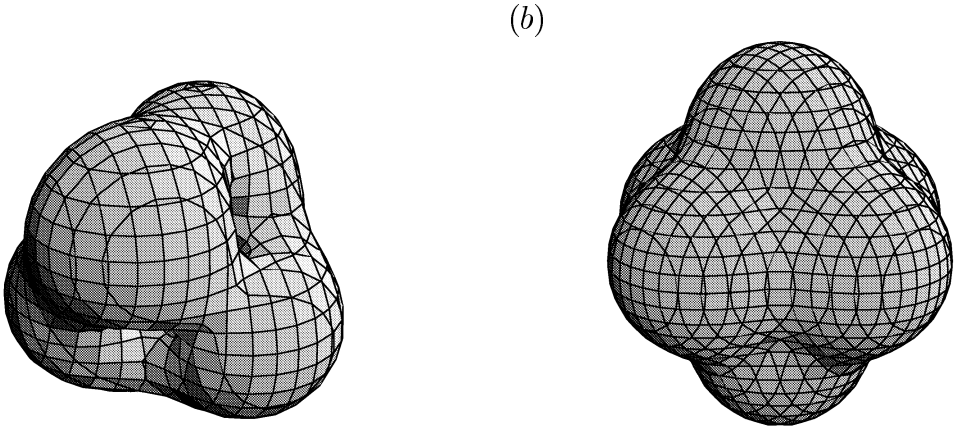

Figure 1: Surfaces of baryon-number density of, (a) $B = 3$ tetrahedron and (b) $B = 5$ octahedron .

References

[1] C. J. Houghton, N. S. Manton and P. M. Sutcliffe, Nucl. Phys. **B510**, 507 (1998).
[2] Nobuyuki Sawado, Noriko Shiiki, hep-ph/0204198.