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Heavy baryons and doubly heavy tetraquarks in the chiral effective QCD model

Our present understanding of baryons, *i.e.* particles such as neutron or proton, is based on the quark picture invented in 1960's. The quark model assumes that baryons consist of three quarks but does not address the force that binds them together. Today we know that this force is very strong and it is a real puzzle why the oversimplified quark model works quantitatively. In the present project we propose to investigate the model that takes these strong interactions into account in a way, which is consistent with Einstein's special relativity. In this approach the quarks form a tightly bound object, called *soliton*, that is heavy and can rotate both in ordinary space and in the abstract space corresponding to the so called quantum numbers. This model has been constructed to describe baryons built from the light quarks (known as u, d and s) in an abstract limit, in which the number of constituents is not three, but tends to infinity.

In the present project we would like to apply this model to describe baryons with one heavy quark. This approach is based on an observation that if one constituent is removed from the infinite system, the *soliton* will not be affected. The empty space left can be filled with a heavy quark (we know two such quarks denoted as c or b). In this way we construct a model that can be applied to calculate properties of heavy baryons. Our preliminary studies have shown that such a model describes well experimentally known states. The purpose of the present project is to perform detailed studies of the *soliton* applied to heavy baryons including a specific prediction concerning exotic baryons, *i.e.* particles built from four quarks and one antiquark, known as *pentaquarks.*

Recently the LHCb Collaboration at CERN announced a discovery of five excited Ω_c^0 sates (*i.e.* particles that contain one heavy quark c and two s quarks). However, in the present approach two of them may be interpreted as *pentaquarks.* The remaining three correspond to some specific excitations inside the soliton.

Additionally, using the fact that the *soliton* is not affected by interactions with a heavy quark, we propose to test a possibility where heavy quark is replaced by two heavy antiquarks. Such particles, known as *tetraquarks*, are postulated also in other theoretical models.