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Concinnitas Project - “Color” SU3 Symmetry Group Exactly Conserved

The discovery of the neutron in 1932 introduced the idea of nuclei composed of neutrons and protons. When we look deeper we see that each neutron or proton is composed of three quarks, roughly speaking one of each "color." It is the color force that binds quarks together to form the neutrons and protons. The color variable takes three different values, nicknamed "red," "green," and "blue." "Colored" objects are confined. They cannot escape to be detected singly. The theory is perfectly symmetrical under the transformation group SU3(color) that transforms the three colors into one another.

The expression presented here embodies the Lagrangian of quantum chromodynamics ("QCD"), the mathematical representation encoding the dynamics of the strong interaction, one of the fundamental physical forces along with gravitation and the weak, and electromagnetic forces. It is "beautiful" because it contains some truth. There is also a beauty in its succinctness, but that terseness sweeps a bit under the rug. We have here three terms, where the first two Lgl,Lq, encode the effects (fields) due to gluons and quarks respectively, and Laddl, contains the "additional" terms and includes, among other things, the fields that ultimately predicted the recently discovered Higgs boson.

I recall that in arriving, along with some colleagues, at this formulation, it came not as a burst of intuition, but rather as an accretion of steady work, and this expression summarizes not just a truth about the world, but a lot of hard work over a long period of time, each term "plucked" from a body of discoveries over a number of years. As time went by, I and other people had insights about what would be included in this description. I might add that we were thinking about the strong interaction in a way that was a bit different from many in the community. At any stage we might have stopped, leaving more for the "additional" term, but this formulation felt good. It was self-contained and satisfied the symmetry conditions imposed by the group SU3. This kept us from venturing into territory that was at that time not yet fully explored. So, even though it is true, it is also in a sense not final, there are always more details to add -- there are various scalar fields, not just the Higgs, that we know are there, but we don’t yet know what to do with them -- so there is still more to be discovered and there is a beauty in that too.