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Spontaneous mass generation and the small dimensions of the Standard Model gauge groups $U(1)$, $SU(2)$ and $SU(3)$

The gauge symmetry of the Standard Model is $SU(3) \times SU(2) \times U(1)$ on unknown reasons. One aspect that can be addressed is the low dimensionality of all its subgroups. Why not much larger groups like $SU(7)$, or for that matter, $SP(38)$ or E_7 ?

We observe that fermions charged under large groups acquire much bigger dynamical masses, all things being equal at a high e.g. GUT scale, than ordinary quarks. Should such multicharged fermions exist, they are too heavy to be observed today and have either decayed early on (if they couple to the rest of the Standard Model) or become reliquial dark matter (if they don't).

The result follows from strong antiscreening of the running coupling for those larger groups (with an appropriately small number of flavors) together with scaling properties of the Dyson–Schwinger equation for the fermion mass.

Experimental Collaboration

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