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Tensor Chiral Gauge Theories: Dynamics, Generalized Symmetries and Natural Anomaly Matching

The introduction of the concept of generalized symmetries around ten years ago by Seiberg, Kapustin, Gaiotto, Willett and others, has given new inputs in the studies of strongly-coupled theories. In particular, the idea of gauging some 1-form discrete center symmetries such as $\mathbb{Z}_N$ $SU(N)$, allows us to formulate a stronger form of the 't Hooft anomaly matching criteria than in the conventional approach. Furthermore, simultaneous considerations of the new type of symmetries together with conventional ones lead to novel types of anomalies, i.e., the mixed anomalies and, as in the original 't Hooft construction, these obstruction of gauging symmetries must be appropriately reflected in the IR.

These ideas have been applied in the last several years to a large class of strongly-coupled chiral gauge theories. In all of them, many non-trivial, new results have been discovered.

The aim of this work is to extend these investigations and to explore a different class of chiral gauge theories: "tensor chiral gauge theories". These models are built by using the matter fermions in the 2-index symmetric and 2-index anti-antisymmetric tensor representations, without the fundamentals. A few models with $SU(5)$, $SU(6)$ and $SU(8)$ gauge groups are studied in detail as illustrative examples, and the generalized, mixed anomalies in these models are exhibited.

In all the models, the mixed anomaly involving the 1-form center symmetry $\mathbb{Z}_N$ and a certain non-anomalous $U(1)$ symmetry is found to be present. We interpret this anomaly as an indication of the spontaneous breaking of the $U(1)$ symmetry, due to the formation of some bifermion condensate. The presence of such a condensate implies Higgs mechanism and flavor symmetry breaking, bringing, at low energies, the system either in a color-flavor-locked dynamical Higgs phase or into systems with IR-free Abelian or non-Abelian gauge groups. In particular, the study of a system with a certain IR-free non-Abelian gauge symmetry is new.

The idea of the Natural Anomaly Matching is discussed, which shows how, in both types of phases mentioned, the conventional as well as the new, generalized anomaly matching conditions with respect to the unbroken symmetries, are fully satisfied by the massless fermions present in the IR.

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