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Large Charge 't Hooft Limit

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N=4 super Yang-Mills (SYM) in four dimensions is integrable in the planar limit, allowing exact computations of a variety of observables. In this talk, I will provide evidence that the large charge sector of N=4 SYM with the SU(2) gauge group provides another interesting solvable corner, which is far from the planar limit but nevertheless exhibits similar structures. Specifically, we consider non-BPS operators obtained by small deformations of half-BPS operators with large charge J, and analyze their spectrum in the double-scaling limit where J is sent to infinity with $\lambda_J \equiv g_{\rm YM}^2 J$ fixed. We find that the spectrum in this limit is governed by the centrally-extended $SU(2|2)^2$ symmetry—the symmetry that played a crucial role in integrability in the planar limit. At the leading order in the $1/J$ expansion, it is fully fixed by the symmetry, and is given by the celebrated magnon dispersion relation. At the next leading order, the symmetry constrains the spectrum up to a few overall constants, most of which can be determined by a simple semi-classical analysis around a BPS background. I also present the result for the structure constant of two large charge operators and a Konishi operator up to order $1/J$, but exact in λ_J. The result exhibits a rich structure that interpolates between the perturbation series at weak coupling and the worldline instantons at strong coupling. I will also briefly mention the relation to the physics on the Coulomb branch and discuss potential generalizations, such as the higher-rank gauge groups, the large spin 't Hooft limit, the combination of large N and large J limits, and application to operators dual to black holes.

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