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Spiky strings and single trace operators in gauge theories

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Abstract: We consider single trace operators of the form $\mathcal{O}_{l_1 \dots l_n} = \mathrm{Tr} D_+^{l_1} F \dots D_+^{l_n} F$ which are common to all gauge theories. We argue that, when all l_i are equal and large, they have a dual description as strings with cusps, or spikes, one for each field F. In the case of $\mathcal{N} = 4$ SYM, we compute the energy as a function of angular momentum by finding the corresponding solutions in AdS_5 and compare with a 1-loop calculation of the anomalous dimension. As in the case of two spikes (twist two operators), there is agreement in the functional form but not in the coupling constant dependence. After that, we analyze the system in more detail and find an effective classical mechanics describing the motion of the spikes. In the appropriate limit, it is the same (up to the coupling constant dependence) as the coherent state description of linear combinations of the operators $\mathcal{O}_{l_1 \dots l_n}$ such that all l_i are equal on average. This agreement provides a map between the operators in the boundary and the position of the spikes in the bulk. We further suggest that moving the spikes in other directions should describe operators with derivatives other than D_+ indicating that these ideas are quite generic and should help in unraveling the string description of the large-N limit of gauge theories.

Keywords: spin chains, string theory, QCD.