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SYM on Quotients of Spheres and Complex Projective Spaces

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We introduce a generic procedure to reduce a supersymmetric Yang-Mills (SYM) theory along the Hopf fiber of squashed S^{2r-1} with $U(1)^r$ isometry, down to the $\mathbb{CP}^{r-1}$ base. This amounts to fixing a Killing vector v generating a $U(1) \subset U(1)^r$ rotation and dimensionally reducing either along v or along another direction contained in $U(1)^r$. To perform such reduction we introduce a $\mathbb{Z}_p$ quotient freely acting along one of the two fibers. For fixed p the resulting manifolds $S^{2r-1}/\mathbb{Z}_p \equiv L^{2r-1}(p, \pm 1)$ are a higher dimensional generalization of lens spaces. In the large p limit the fiber shrinks and effectively we find theories living on the base manifold. Starting from $\mathcal{N} = 2$ SYM on S^3 and $\mathcal{N} = 1$ SYM on S^5 we compute the partition functions on $L^{2r-1}(p, \pm 1)$ and, in the large p limit, on $\mathbb{CP}^{r-1}$, respectively for $r = 2$ and $r = 3$. We show how the reductions along the two inequivalent fibers give rise to two distinct theories on the base. Reducing along v gives an equivariant version of Donaldson-Witten theory while the other choice leads to a supersymmetric theory closely related to Pestun's theory on S^4. We use our technique to reproduce known results for $r = 2$ and we provide new results for $r = 3$. In particular we show how, at large p, the sum over fluxes on $\mathbb{CP}^2$ arises from a sum over flat connections on $L^5(p, \pm 1)$. Finally, for $r = 3$, we also comment on the factorization of perturbative partition functions on non simply connected manifolds.

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Primary author: RUGGERI, Lorenzo

Presenter: RUGGERI, Lorenzo