論文の内容の要旨

On superconformal field theories at large charge

(超対称共形場理論における電荷の大きな極限について)

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We study superconformal field theories (SCFTs) with a one-complex-dimensional moduli space of vacua in three and four dimensions. We develop an effective field theory on moduli space to describe the large-R-charge sector of the theories, and by using it we calculate physical quantities associated to operators carrying large R-charge.

In the case of a $\mathcal{N} = 2$ SCFT in three dimensions, we compute the anomalous dimension of certain low-lying operators carrying large R-charge J. We find that the lowest and second-lowest scalar primary operators have vanishing anomalous dimension up to and including $O\big(J^{-3}\big)$, and this result is consistent with the fact that they are in protected supermultiplets. We also show that that the anomalous dimension of the third-lowest primary operator carrying large R-charge must be nonpositive, making use of unitarity of moduli scattering and the absence of superluminal signal propagation in the effective dynamics of the complex modulus.

In the case of $\mathcal{N} = 2$ SCFTs of in four dimensions with a one-complex-dimensional Coulomb branch, we show that two-point functions of chiral primary operators have a nontrivial but universal asymptotic expansion at large R-charge. In particular, the asymptotic expansion depends on the difference between the a-coefficient of the Weyl anomaly of the underlying SCFT and that of the effective theory of the Coulomb branch. For Lagrangian SCFT, we check our predictions for the logarithm of the two-point functions against exact results from supersymmetric localization, and find reasonably good agreement. In this way, we show the large-R-charge expansion serves as a bridge from the world of unbroken superconformal symmetry and SCFT data, to the world of the low-energy dynamics of the moduli space of vacua.