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Holographic realms of quantum electrodynamics

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We recently proposed a holographic duality between massive theories in 4D flat spacetime and massless ones on its conformal (lightlike) boundary, where Poincare maps to conformal symmetry. The dual boundary space is really the conformal class of $\mathbb{S}^2 \times \mathbb{R}$ cylinders, which is also the conformal (timelike) boundary of AdS_4. This leads to a triality between three holographic realms $-\mathbb{R}^4$, $\mathbb{S}^2 \times \mathbb{R}$ and AdS_4- all supporting equivalent particle theories. As an illustration, we match the path integrals for free fermions across all three realms. We then identify the Landau levels of the $\mathbb{R}^4$ realm with a monopole problem on the cylinder, and with the spectrum of an extremal magnetic black hole in the AdS_4 realm. Finally, we suggest that QED with N_f flavors of fermions is dual to an Abelian Chern-Simons-matter theory coupled to $2N_f$ massless fermions on the boundary, which in turn should be dual, for large N_f, to a higher-spin theory in AdS_4.

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