Contribution ID: **171** Type: **not specified**

U(1) Holography and a Continuum Dark Photon

Tuesday 10 May 2022 16:45 (15 minutes)

We consider an Abelian gauge field in $(d+1)$-dimensional anti-de Sitter space (AdS). The gauge symmetry is Higgsed by a bulk scalar with symmetry breaking triggered from an ultraviolet brane that regulates the AdS boundary. We show that the bulk mass of the Higgs field controls whether the d-dimensional spectrum of the gauge field is a continuum, gapped continuum, or a discretuum. When the Higgs field has no bulk mass, the dual conformal field theory (CFT) has a non-conserved $U(1)$ current whose anomalous dimension is proportional to the square of the Higgs vacuum expectation value. Studying the theory around this point, we introduce a WKB approximation to compute the gauge field boundary action and find that the anomalous dimension of the $U(1)$ current runs logarithmically with energy.

As an application, we present a holographic model of a continuum dark photon in AdS_5. The mixing with the visible photon is computed exactly via dressing. We present a method for extrapolating existing dark photon bounds to a continuum dark photon.

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Session Classification: Theory II