

# Gravity is holographic

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The two main lessons we obtain from this are:

- One cannot separate the asymptotic behavior of the spacetime from the properties of the spectrum of fundamental degrees of freedom. Long-distance physics enters the fundamental definition of the theory at the highest energies (UV/IR connection).
- The number of degrees of freedom needed to fully describe a region of radius  $R$  grows like the area  $\sim R^{D-2}$  of the boundary of that region.

It is then natural to suggest that quantum theories of gravity must be formulated in terms of degrees of freedom localized on surfaces, and not at points (or over regions of Planckian size): GR is not a local QFT, but instead a *holographic* theory.

Moreover, the low-energy effective QFT of gravity is deceptive, in that a seemingly low-energy, long-distance parameter like the cosmological constant, which one would think of as an effective one that receives contributions from physics at all scales, is actually a fundamental parameter that enters the microscopic definition of the theory.