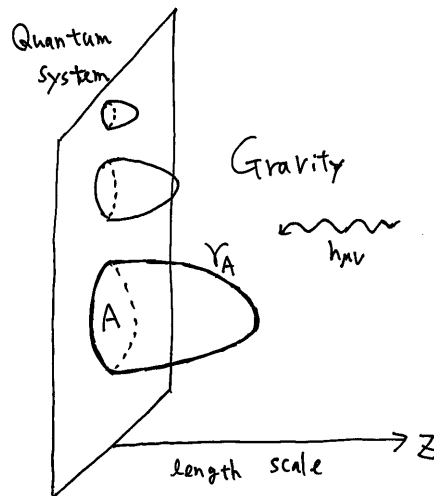


Holographic Principle

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The entropy of a black hole, which was discovered by Bekestein and Hawking, is proportional to its area instead of its volume. In this way, the effective degrees of freedom in gravity theories, such as the general relativity and superstring theory, look like those live in one dimesion less. This is called *holographic principle*. Thanks to this idea, we can compute physical quantities in complicated quantum many-body systems using differential geometry. For example, we can calculate the entanglement entropy, which measures the degrees of freedom in a given region of a quantum many-body system, as the area of minimal area surfaces.



$$S_A = \min_{\gamma_A} \left[\frac{\text{Area}(\gamma_A)}{4 G_N} \right]$$

$\partial \gamma_A = \partial A$
 $\gamma_A \cap A = A$