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Gravitational Screens as Quasi-local Observers

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The anti-de Sitter/conformal field theory correspondence and the membrane paradigm have illuminated many aspects of string and field theory, giving key insights into what a quantum theory of gravity might look like, while also providing tools to study a wide range of strongly coupled systems. In essence, these ideas are a statement of the holographic principle: a fundamental observation about our universe which states that all of the information contained in a bulk region of space-time can be encoded on the boundary of that region. However, these approaches are generally restricted to situations where knowledge of the boundary of space or the entire future history of the universe is required. From a practical point of view this is unsatisfactory. As local observers, we are not generally able to access these types of boundaries.

In an attempt to address these issues we use 'gravitational screens' as quasi-local observers. A gravitational screen is a two dimensional space-like hypersurface surrounding an arbitrary region of space-time. Projecting Einstein's equations onto the screen results in the equations of non-equilibrium thermodynamics for a viscous fluid, which encode all of the information present inside the screen in terms of the holographic fluid on the surface, without being restricted to the event horizon of a black hole or to spatial infinity. In this project we study the dynamics and equations of state for screens in various space-times. Of particular interest are screens/geometries which have fluids obeying the second law of thermodynamics, since it is not obvious that an arbitrarily chosen screen will behave physically. We determine the properties of the fluids that arise from different background geometries, discuss their interpretation, and clarify the relationship between the gravitational degrees of freedom in the bulk, and the thermodynamic degrees of freedom on the screen.

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