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Vacuum entanglement in the presence of gravitational waves

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— A remarkable fact about the vacuum state of a quantum field theory is that it is entangled across spacelike separated regions. This entanglement is strong enough to violate a Bell inequality and is ultimately responsible for some of the most important predictions of quantum field theory on curved space, such as the Unruh and Hawking effects. In this talk, I will introduce the entanglement harvesting protocol as an operational way to probe vacuum entanglement. This protocol relies on two atoms, modeled by Unruh-DeWitt detectors, that are initially un-entangled. These atoms then interact locally with the field and become entangled. Because the atoms do not interact with one another, any entanglement between the atoms is a result of entanglement that is 'harvested' from the field, and thus quantifying this entanglement serves as a proxy for how entangled the field is across the regions in which the atoms interacted. Using this protocol, I will show that while the local statistics of each atom are unaffected by the presence of a gravitational wave, the entanglement between them depends sensitively on both the amplitude and frequency of the gravitational wave. This suggests that the entanglement signature left by a gravitational wave may be useful in characterizing its properties.

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