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Broken bridges: A counter-example of the ER=EPR conjecture

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In this paper, we provide a counter-example to the ER=EPR conjecture. In an anti-de Sitter space, we construct a pair of maximally entangled but separated black holes. Due to the vacuum decay of the anti-de Sitter background toward a deeper vacuum, these two parts can be trapped by bubbles. If these bubbles are reasonably large, then within the scrambling time, there should appear an Einstein-Rosen bridge between the two black holes. Now by tracing more details on the bubble dynamics, one can identify parameters such that one of the two bubbles either monotonically shrinks or expands. Because of the change of vacuum energy, one side of the black hole would evaporate completely. Due to the shrinking of the apparent horizon, a signal of one side of the Einstein-Rosen bridge can be viewed from the opposite side. We analytically and numerically demonstrate that within a reasonable semi-classical parameter regime, such process can happen. Therefore, the ER=EPR conjecture cannot be generic in its present form and its validity maybe restricted.

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