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Entanglement between pair-created universes bridged by a Euclidean wormhole

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What happens if our universe was created from an Euclidean instanton? The no-boundary proposal is not the unique choice; instead, a more natural option is to introduce Euclidean wormholes, but as a result, we need to accept that our universe was indeed an outcome of a pair creation. Invoking the Klebanov-Susskind-Banks Euclidean wormhole as a bridge, we investigate the power spectrum and the entanglement between two pair-created universes. We construct a suitable global vacuum for the perturbations of the inflaton field in the Euclidean regime, which becomes a mixed state when restricted to one of the paired universes. This mixed state leads to an enhancement of the power spectrum for long-wavelength modes. In addition, entanglement between the two universes is realized by the existence of the wormhole. Thus, the power spectrum enhancement in the long-wavelength regime might be evidence of our universe being created from a Euclidean wormhole that was entangled with a partner universe, and hence our universe does not begin with a pure state.

Author: Prof. YEOM, Dong-han (Pusan National University)Presenter: Prof. YEOM, Dong-han (Pusan National University)Session Classification: Parallel 2