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Nash Equilibrium from Quantum-Field Entanglement

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Entanglement harvesting transfers quantum field correlations to localized probes, yet whether these correlations can alter stable strategic behavior has remained unclear. We formulate a quantum-input game in which two Unruh–DeWitt detectors harvest vacuum entanglement from a free massless scalar field in $(3+1)$-dimensional Minkowski spacetime. A referee converts this state into payoffs using independent question qubits and phase-calibrated local Bell measurements. To leading perturbative order, the mean reward is proportional to the signed entanglement margin $\sqrt{\mathcal{H}^2+\mathcal{Q}^2}-\mathcal{P}$, where $\mathcal{H}$ is the Hadamard correlation contribution, $\mathcal{Q}$ is the Pauli–Jordan causal contribution, and $\mathcal{P}$ is the local excitation noise. Away from payoff degeneracies, allowing each player to exit or to choose an early or late interaction yields $1+2n_+$ trembling-hand perfect equilibria, where n_+ counts the positive-reward timing equilibria. For one fixed protocol, five analytically certified settings realize the sequence $7 \to 3 \to 1 \to 7 \to 1$. They represent the spacelike region, the first commutator lobe, central carrier cancellation, the second lobe, and the post-wavefront Huygens regime. Thus, within this fixed quantum-input verification protocol, distinct field-correlation regimes generate different stable strategic structures.

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