Relativistic quantum information

Timothy C. Ralph, S. Jay Olson, Casey Myers, and Jacques Pienaar

University of Queensland, Department of Physics, Brisbane, 4072, Australia

Relativistic quantum information science investigates new effects that emerge when information encoded on relativistic quantum systems is studied. I will discuss two new results: entanglement between the future and the past; and a consistent quantum field theory for closed timelike curves.

It is known that the quantum vacuum of flat space is entangled between spacelike separated regions. This is the basis of the Unruh effect [1] in which accelerated observers see thermalization of the vacuum due to this entanglement. We have recently shown that vacuum entanglement also exists between timelike regions of space time, i.e. between the past and the future [2]. We will describe how this entanglement can be efficiently extracted via stationary detectors with scaled energy levels [3] and discuss applications.

Closed timelike curves, i.e. time machine to the past, are allowed by exotic solutions of general relativity but are incompatible with quantum field theory. A consistent treatment of qubits interacting with CTC's exists [4], but it is not a field theory. We describe a non-standard quantum field theory [5] and prove that it reduces to ref. [4] in the limit of point like 2-level systems [6]. We investigate the behaviour of this theory for different field states and simple CTC interactions.

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