

Title: Localised Detection of the Unruh Effect

Date: Jun 26, 2012 10:20 AM

URL: <http://pirsa.org/12060052>

Abstract: I will discuss a new proposal with the potential to experimentally probe the validity of Rindler quantisation from the recent completely localized framework of non-inertial projective detectors of quantum fields.

Criticisms of previous models: RQI-N Madrid (2011)

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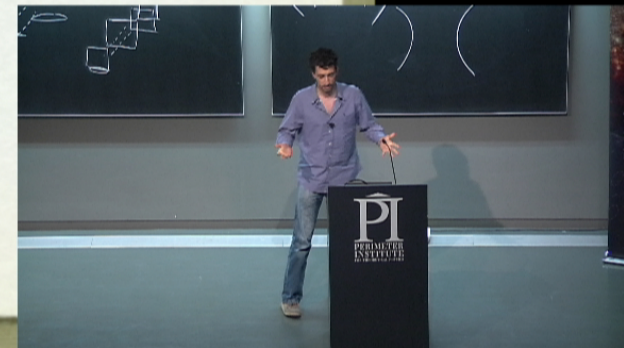
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For a given acceleration, a , the mode has a Rindler decomposition:

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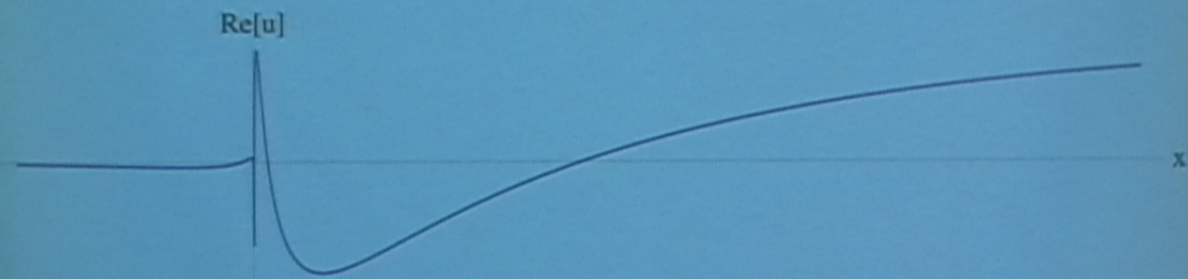
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Previous studies claimed that entanglement degraded with acceleration, but what they really found was that the entanglement degradation in the Rindler frame varied for a family of inertial (Unruh) modes.

2. There is nothing physically relevant about the family of initial state modes (Unruh modes) that were being investigated.



$$u_R(\Omega) \propto x^{i\Omega}$$

SETTING UP THE PROBLEM

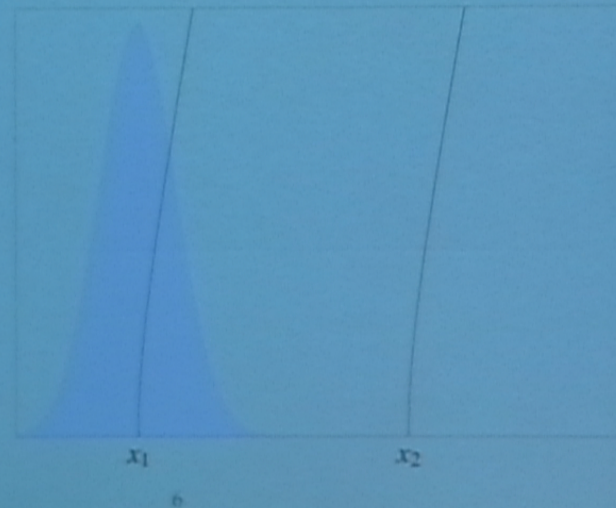
How is entanglement degraded by acceleration?

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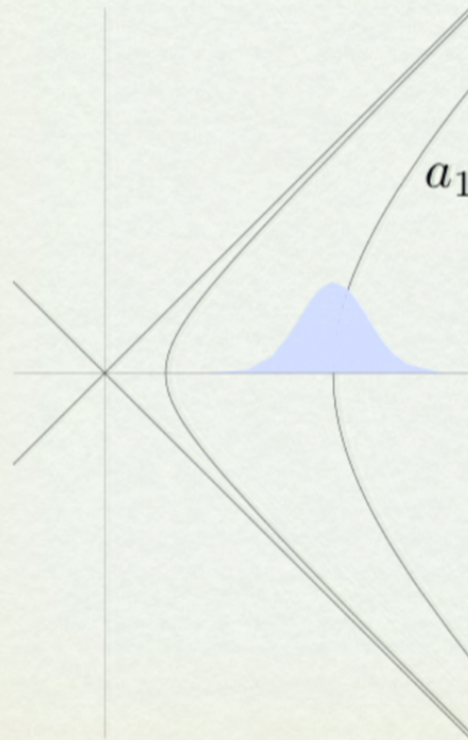
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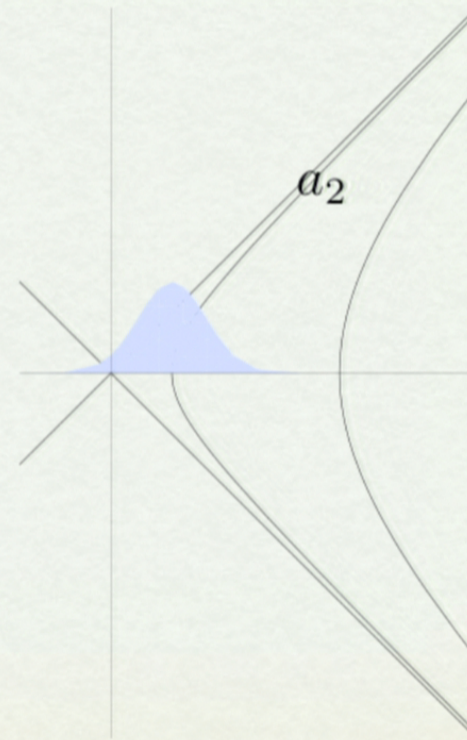
Consider some general initial mode state that is localized to a size, L :



Low accelerations

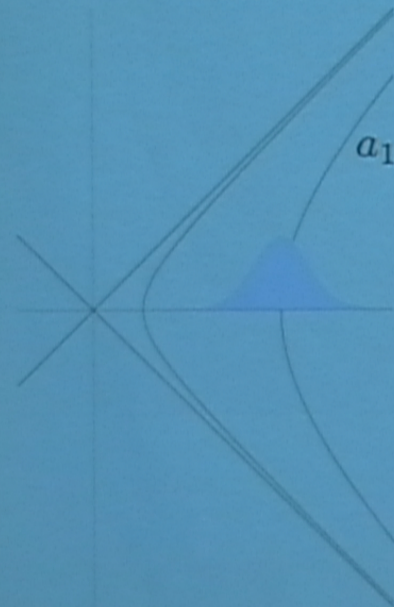


Large accelerations

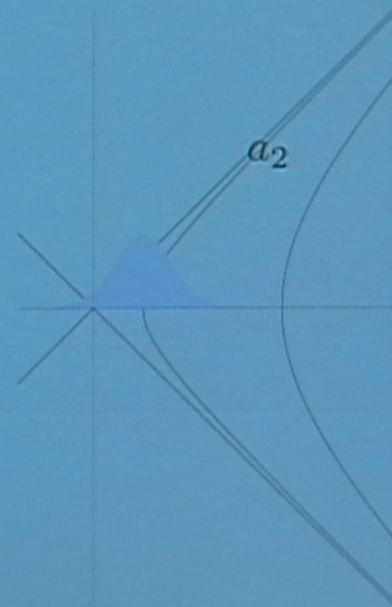


$$\phi(x) \rightarrow \phi(x - \frac{1}{a})$$

Low accelerations



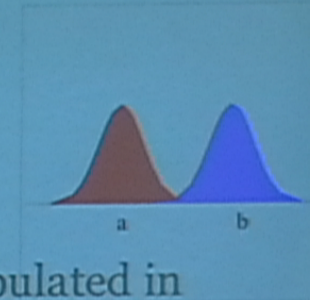
Large accelerations



Entanglement Setup

- Two mode squeezed state:

$$\exp(s(a^\dagger b^\dagger - ab))|0\rangle_M$$



- Easy to compute.
- Such states are readily produced/manipulated in the lab.
- We simply calculate the covariance matrix.

$$\sigma_{ij} = \langle \hat{X}_i \hat{X}_j - \hat{X}_j \hat{X}_i \rangle; \quad \hat{X} = (\hat{x}_a, \hat{p}_a, \hat{x}_r, \hat{p}_r);$$

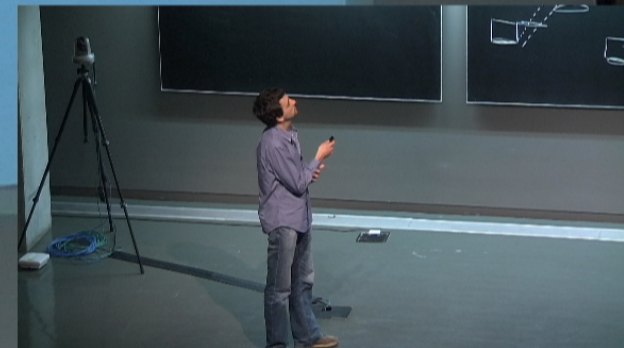
- Then evaluate the logarithmic negativity: Adesso, Serafini, Illuminati, PRA70,022318 (2004)

$$E_{\mathcal{N}} = \max[0, -\ln \tilde{\nu}_-]$$

OPTIMIZED DETECTORS

Consider a general initial field mode prepared in the inertial frame

$$\begin{aligned}\phi &= \sum_k (u_k, \phi) u_k \\ &= \sum_k (w_{Ik}, \phi) w_{Ik} + (w_{IIk}, \phi) w_{IIk} - (w_{Ik}^*, \phi) w_{Ik}^* - (w_{IIk}^*, \phi) w_{IIk}^*\end{aligned}$$



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The optimal detector mode detector is defined:

$$\psi_{opt} \equiv |N| \sum_k (w_{Ik}, \phi) w_{Ik}; \quad |N| = \frac{1}{\sqrt{\sum_k |(w_{Ik}, \phi)|^2}}$$

The magnitude (ψ, ϕ) is maximized for the optimal detector:

$$\begin{aligned}|(\psi', \phi)|^2 &= \left| \sum_k (w_{Ik}, \psi') (w_{Ik}, \phi) \right|^2 \\ &\leq \sum_k |(w_{Ik}, \psi')|^2 \sum_j |(w_{Ij}, \phi)|^2 = \sum_k |(w_{Ik}, \phi)|^2 \\ &= (\psi_{opt}, \phi)^2\end{aligned}$$

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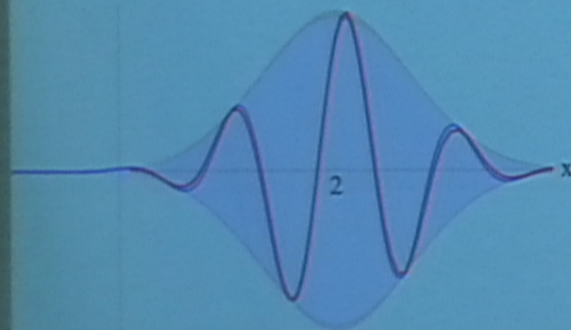
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Results:

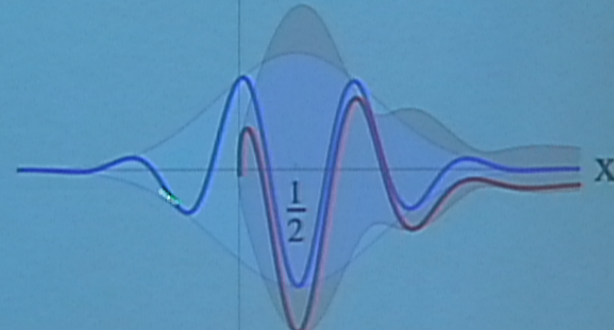
$$\phi(x, 0) = \frac{1}{\sqrt{N}\sqrt{2\pi}} \exp \left[-\frac{(x - \frac{1}{a})^2}{L^2} + i\frac{N}{L}x \right]$$

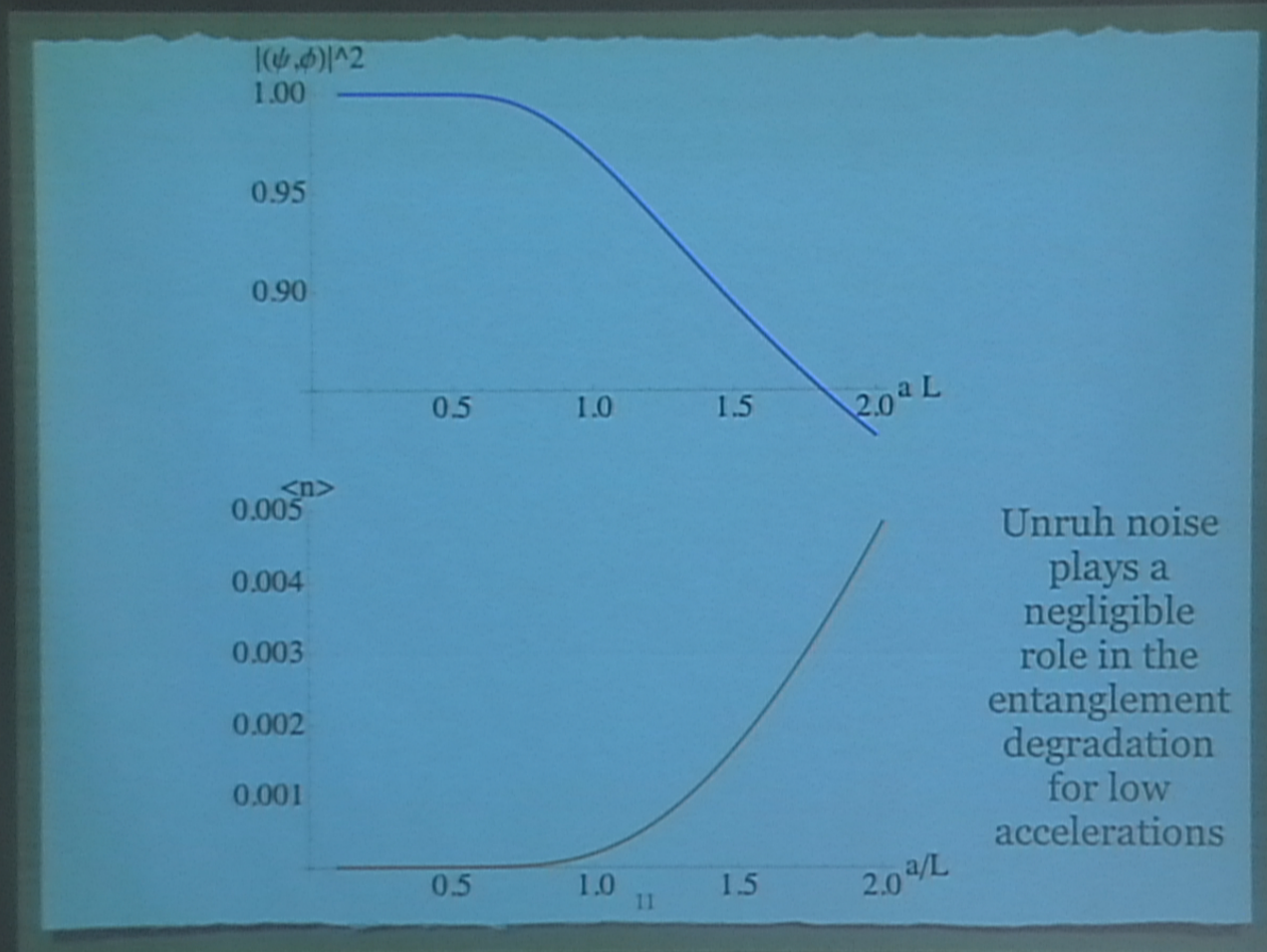
$$\partial_t \phi(x, 0) = -i\frac{N}{L} \phi(x, 0),$$

Low accelerations:
a L=1/2



Bigger accelerations:
a L=2





Mode-mismatch dominated degradation (low accelerations)

