Title: Localised Detection of Relativistic Quantum Fields in Non-Inertial Frames

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Abstract: We introduce a novel approach to measurements in QFT in non-inertial frames. A simple, localised, analytical model of state detection allows us to study all the standard questions of RQI and yielding simple answers with a clear physical interpretation. We apply the model to investigate extraction of the entanglement from the vacuum, completely characterize entangled state of two localised inertial wave-packets in the accelerating frame and study the entanglement degradation as a function of the proper acceleration of the detector.

Localised projective measurement on a quantum field near a Black hOle

Andrzej Dragan / Warsaw
Jason Doukas / Tokyo
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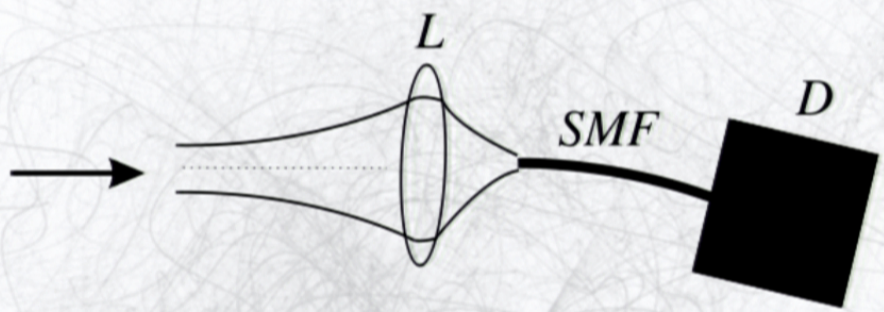
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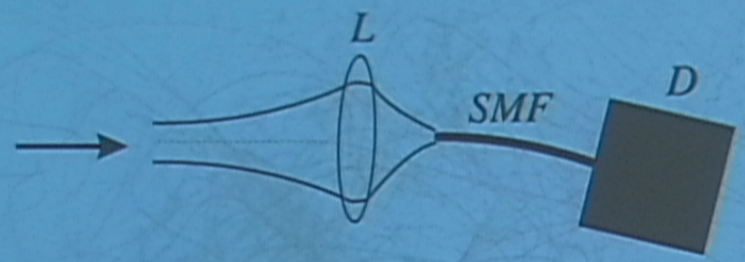

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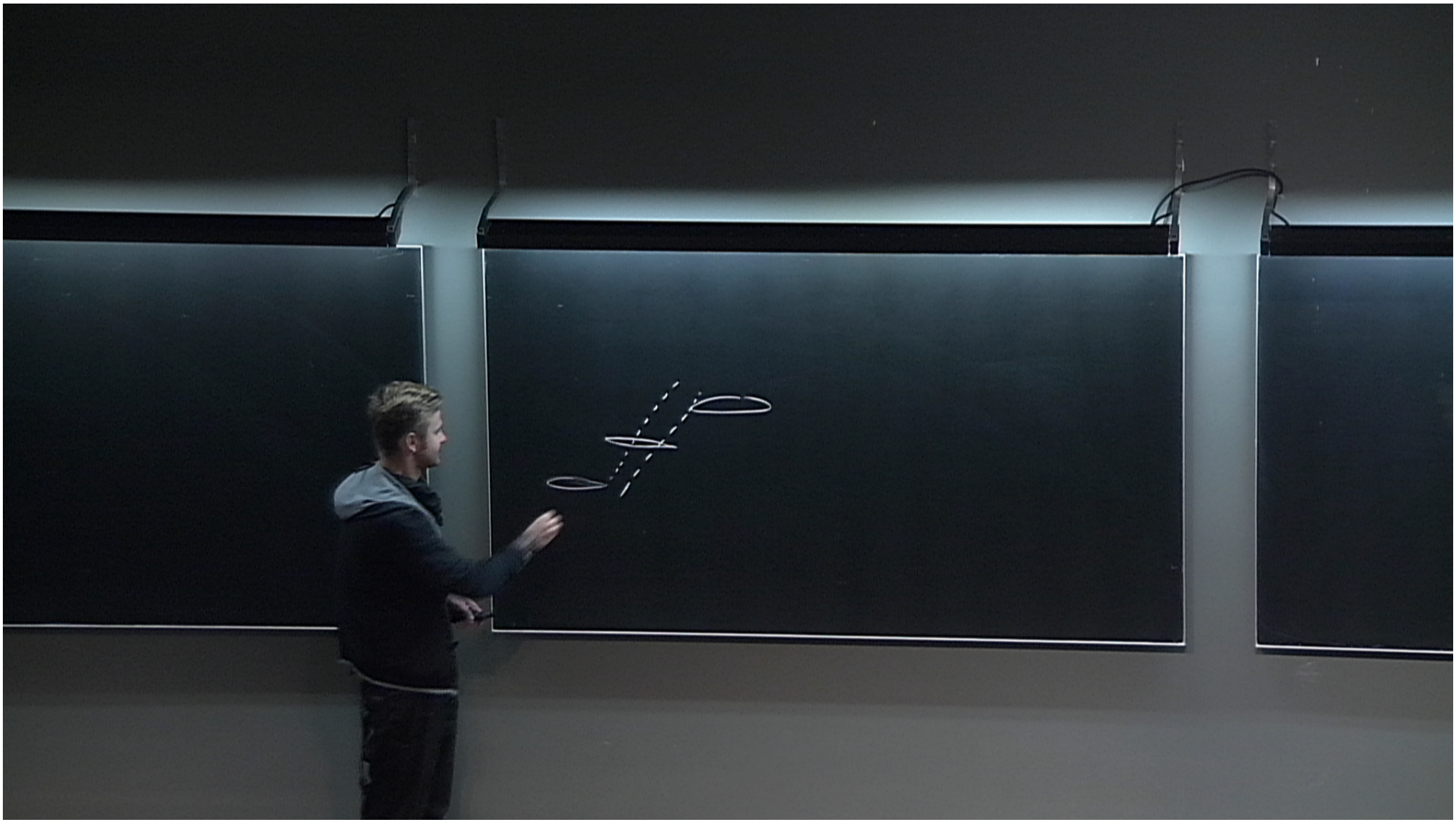

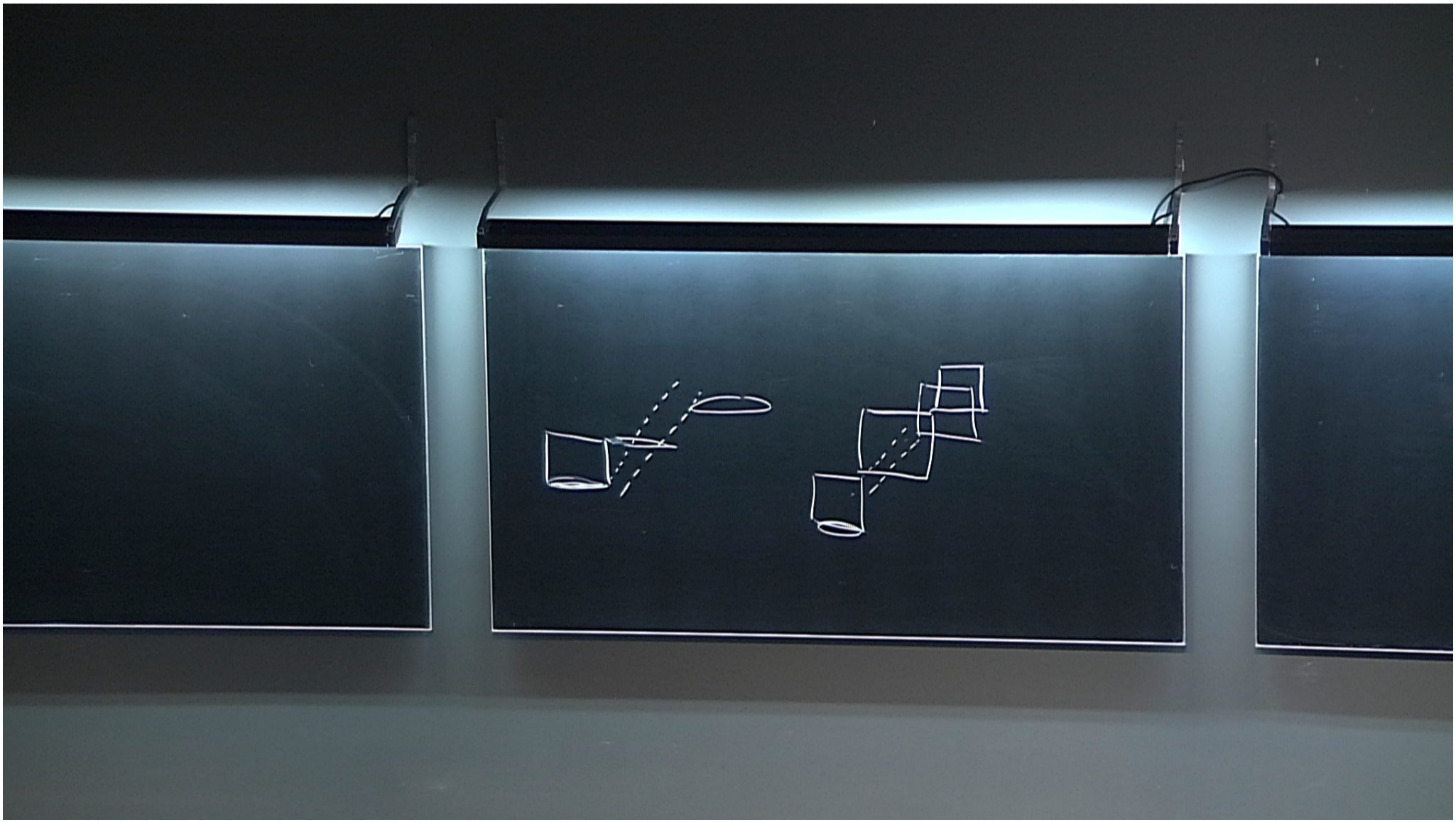

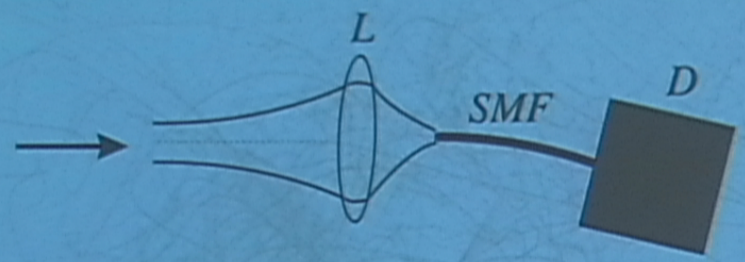

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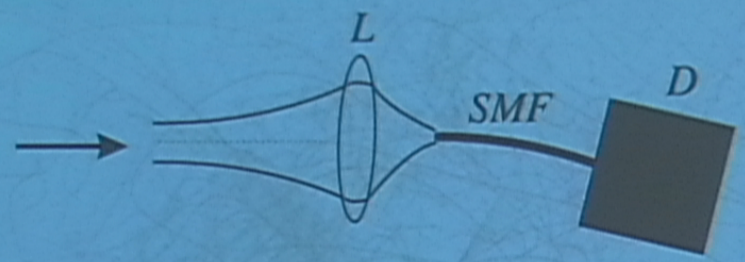
* We analyse the classical outcome and the particles are absorbed



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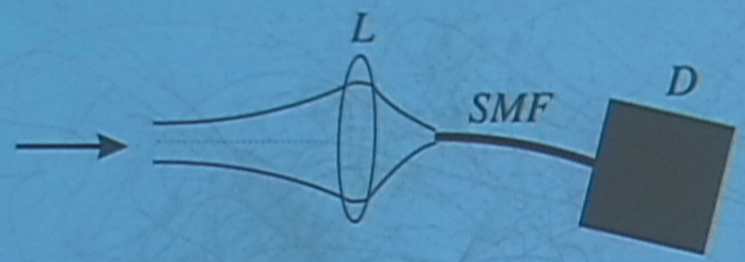

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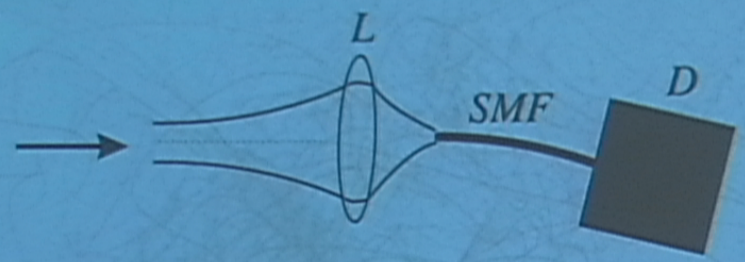

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Two counter-accelerating detectors in the vacuum

$$\left\langle \hat{d}^\dagger \hat{d} \right\rangle = \sum_k \langle \hat{n}_k \rangle |(\psi_{\mathrm{D}}, w_{k,I})|^2$$

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$$E = \sum_k \hbar\omega_k |(\psi_{\mathrm{D}}, w_{k,I})|^2$$

Two counter-accelerating detectors in the vacuum

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

Two counter-accelerating detectors in the vacuum

$$kT \approx \frac{\hbar a}{2\pi c} \frac{1}{1 - \pi c^2 / aLN}$$

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$$\left\langle (\hat{x}_I + \hat{x}_{II})^2 \right\rangle \left\langle (\hat{p}_I - \hat{p}_{II})^2 \right\rangle < 1$$

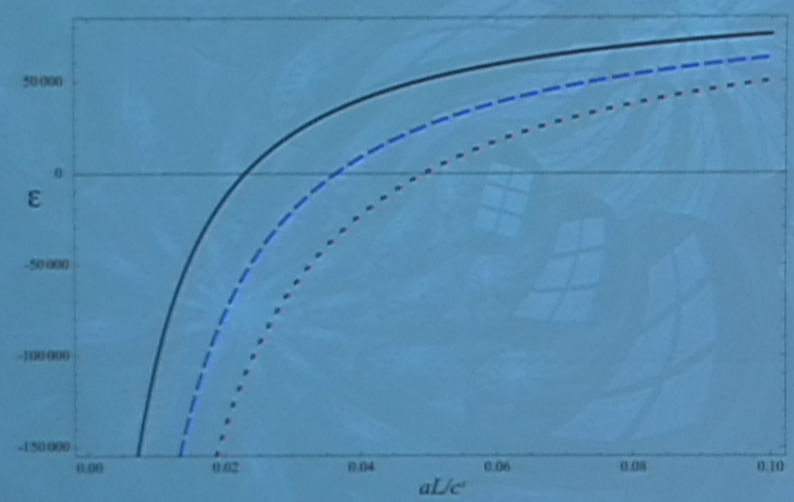

FIG. 2: Entanglement estimator $\mathcal{E}$ as a function of the dimensionless parameter $\frac{aL}{c^2}$ for $N = 800$ (solid line), $N = 1200$ (dashed line) and $N = 1600$ (dotted line).

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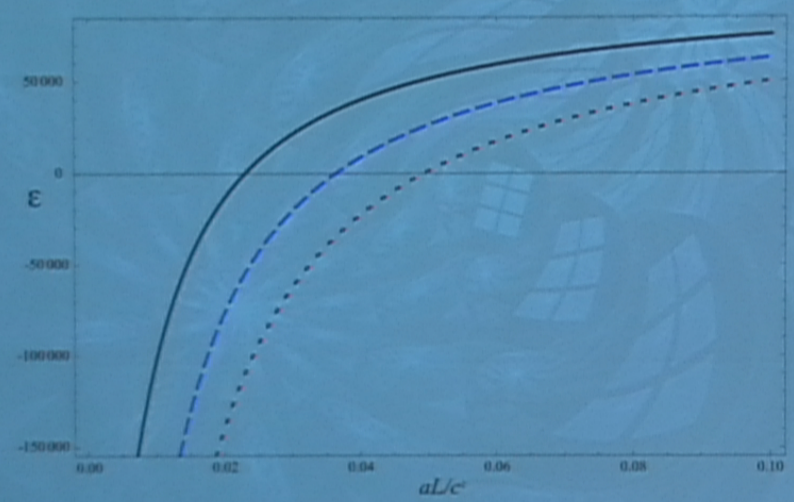

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Entanglement degradation near black hole

$$\sigma = \mathbb{1} + 2\langle\hat{n}\rangle_U \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} + 2\sinh^2 s \begin{pmatrix} |\alpha|^2 & 0 & 0 & 0 \\ 0 & |\alpha|^2 & 0 & 0 \\ 0 & 0 & |\beta+\beta'^*|^2 & 2\,\mathrm{Im}(\beta\beta') \\ 0 & 0 & 2\,\mathrm{Im}(\beta\beta') & |\beta-\beta'^*|^2 \end{pmatrix}$$

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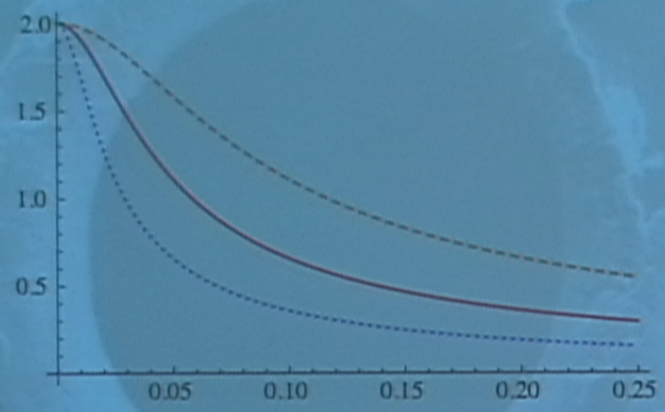

FIG. 2: Logarithmic negativity $E_{\mathcal{N}}$ as a function of the dimensionless parameter $\frac{aL}{c}$ for the same degree of initial squeezing ($s = 1$) and different detector gaps: $N = 50$ (dashed line), $N = 100$ (solid line) and $N = 200$ (dotted line).

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