Department of Physics "E. Fermi"
University of Pisa

# Title

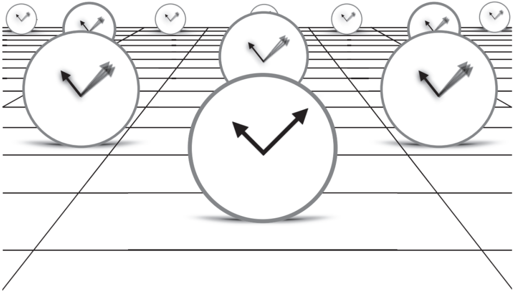
## Subtitle

Supervisors:
Prof. Tizio
Dott. Caio

Candidate:
Author

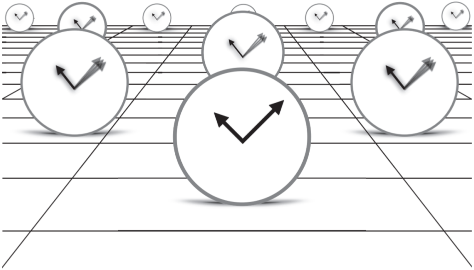
Introduction

Results



# Introduction

**mass-energy equivalence** $\Longrightarrow$
locally undefined metric background.



The clocks get entangled!
[Maggiore, 2005]

Conventional time-dilation can be recovered via a semi-classical coupling.

**mass-energy equivalence** $\Longrightarrow$
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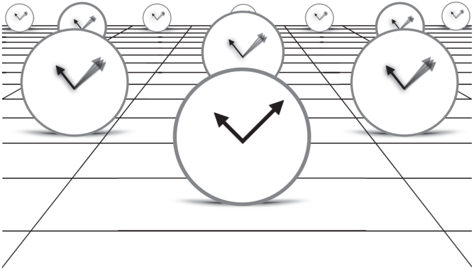

The clocks get entangled!
[Maggiore, 2005]

Conventional time-dilation can be recovered via a semi-classical coupling.

In the present work, we consider the following **Research Questions**:

(1.) Can?

How?

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(1.) Can?

(2.) How?

# Results

# Result 1



The Redshift operator takes the form

$$\hat{R} = \left(\mathbb{1} - g\hat{\sigma}^x_B\right) \implies \lambda = \begin{cases} 1+g & \text{on } \left|-\right\rangle_B \\ 1-g & \text{on } \left|+\right\rangle_B \end{cases} \quad . \tag{1}$$

When $g \neq 1$, i.e. $\hat{R}$ is invertible, we observe two new effects...

$$i\hbar(1-g^2)\frac{\mathrm{d}}{\mathrm{d}\tau}\left|\psi^{(A)}(\tau)\right\rangle_{U/A} = $$
$$= \hbar w g + \alpha \hbar w \hat{\sigma}^x_B \quad \hat{\mathcal{H}}_\Gamma + g\hat{\sigma}^x_B \hat{\mathcal{H}}_\Gamma \left|\psi^{(A)}(\tau)\right\rangle_{U/A} \tag{2}$$

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When $g \neq 1$, i.e. $\hat{R}$ is invertible, we have $\mathrm{d}\tau = \left(1 - g^2\right)\mathrm{d}t$

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$$= \hbar w g + \alpha\hbar w\hat{\sigma}_B^x + \hat{\mathcal{H}}_\Gamma + g\hat{\sigma}_B^x\hat{\mathcal{H}}_\Gamma \left|\psi^{(A)}(\tau)\right\rangle_{U/A} \tag{2}$$

Time-Dilation!

# Result 1



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When $g \neq 1$, i.e. $\hat{R}$ is invertible,

$$i\hbar\left(1 - g^2\right)\frac{\mathrm{d}}{\mathrm{d}\tau}\left|\psi^{(A)}(\tau)\right\rangle_{U/A} =$$

$$= \hbar w g + \alpha\hbar w\hat{\sigma}_B^x + \hat{\mathcal{H}}_\Gamma + g\hat{\sigma}_B^x\,\hat{\mathcal{H}}_\Gamma\left|\psi^{(A)}(\tau)\right\rangle_{U/A} \tag{2}$$

Interaction Transfer!

# Result 1



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$$\hat{R} = \left(\mathbb{1} - g\hat{\sigma}_B^x\right) \implies \lambda = \begin{cases} 1 + g & \text{on } \left|-\right\rangle_B \\ 1 - g & \text{on } \left|+\right\rangle_B \end{cases} \quad . \tag{1}$$

When $g \neq 1$, i.e. $\hat{R}$ is invertible, we have $\mathrm{d}\tau = \left(1 - g^2\right)\mathrm{d}t$

$$i\hbar\left(1 - g^2\right)\frac{\mathrm{d}}{\mathrm{d}\tau}\left|\psi^{(A)}(\tau)\right\rangle_{U/A} = \\ = \hbar w g + \alpha\hbar w\hat{\sigma}_B^x + \hat{\mathcal{H}}_\Gamma + g\hat{\sigma}_B^x\,\hat{\mathcal{H}}_\Gamma\left|\psi^{(A)}(\tau)\right\rangle_{U/A} \tag{2}$$

*Time-Dilation-induced Interaction Transfer (TiDIT) mechanism*

# Conclusion

**Take home messages**:

(1.) Result 1.

Result 2.

**Perspectives**:

Test.

Generalization.

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(1.) Result 1.

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**Perspectives**:

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**Take home messages**:

(1.) Result 1.

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(1.) Result 1.

(2.) Result 2.

**Perspectives**:

(?) Test.

(?) Generalization.

**Take home messages**:

(1.) Result 1.

(2.) Result 2.

**Perspectives**:

(?) Test.

(?) Generalization.

Thank you for your time!

# References

# References I



[Maggiore, 2005] Maggiore, M. (2005).
*A Modern Introduction to Quantum Field Theory*.
Oxford University Press.

Backup

# The main criticisms



The argument of Page:

> *"I simply wish to argue that all of the testable predictions of quantum mechanics appear to arise from one-time conditional probabilities. [...] We can never directly test what happened yesterday, but we can check the consequences that a hypothetical scenario for yesterday has on the situation today."*

Analogously, in the words of Wheeler:

> *"It is wrong to think of the past as 'already existing' in all detail. The 'past' is theory. The past has no existence except as it is recorded in the present."*