Title: The Quantum Tip of the Two-Vector Iceberg

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Abstract:

The TSVF Iceberg Beneath the Quantum Tip:
Converging Clues from Recent Advances

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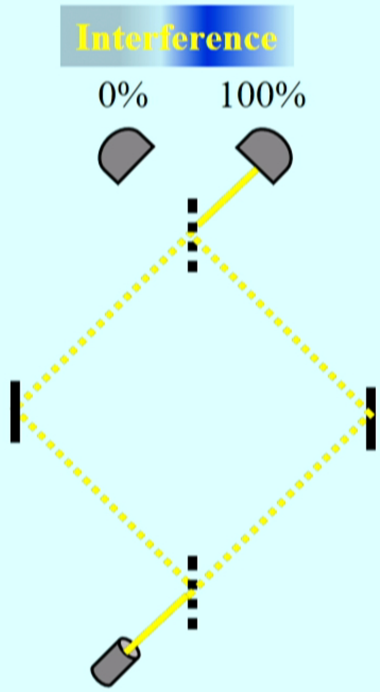
Outline

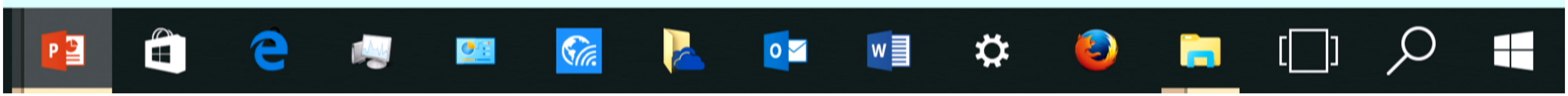
1. The Basic Oddity
2. Quantum Lies Revealing Deeper Truth
3. Time Arrows
4. What Next?



2

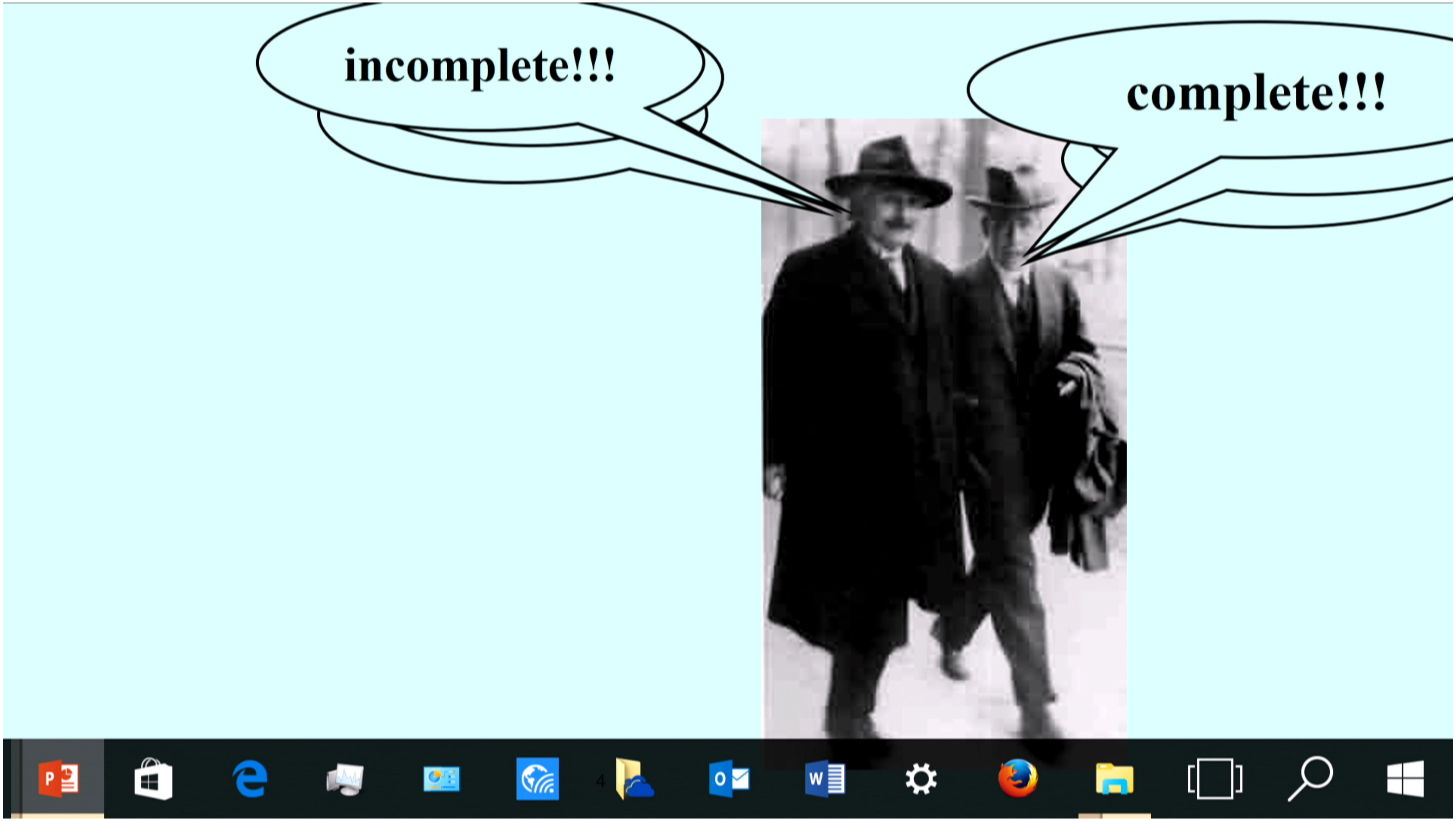
$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

Nam et Ipsa Scientia Potestas Est



$$\Delta x \Delta p \geq \frac{\hbar}{2}$$

Nam et Ipsa Ignorantia Potestas Est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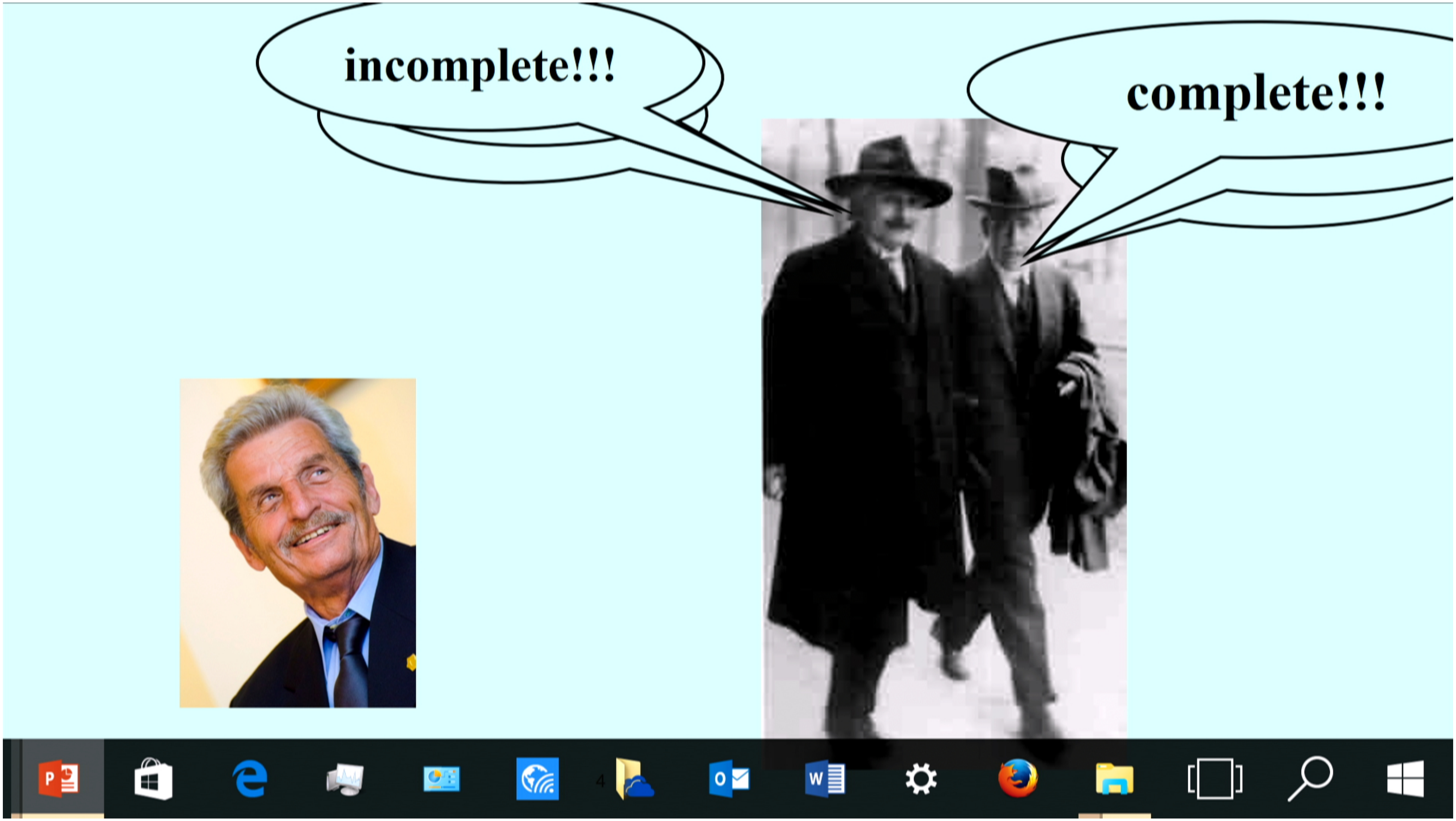
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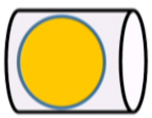
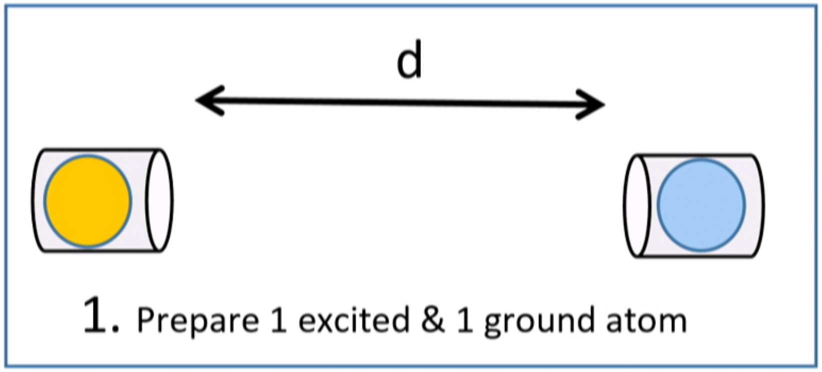
The Quantum Liar Paradox version 2



1. Prepare 1 excited & 1 ground atom

More precisely, the state in Version 2, stage 2 is $\frac{1}{\sqrt{2+\delta}}\left[\sqrt{1+\varepsilon}\,|A_1\rangle|A_2{}^*\rangle+\sqrt{1-\varepsilon}\,|A_1{}^*\rangle|A_2\rangle+\sqrt{\delta}\,|A_1\rangle|A_2\rangle\right]$
where ε, $\delta \ll 1$.

The Quantum Liar Paradox version 2



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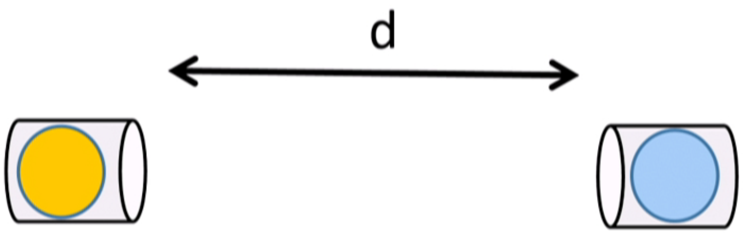
where ε, δ << 1.

The Quantum Liar Paradox version 2

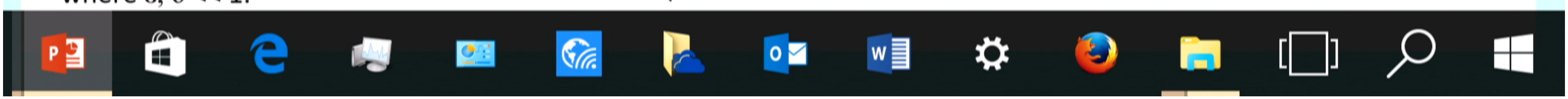


1. Prepare 1 excited & 1 ground atom

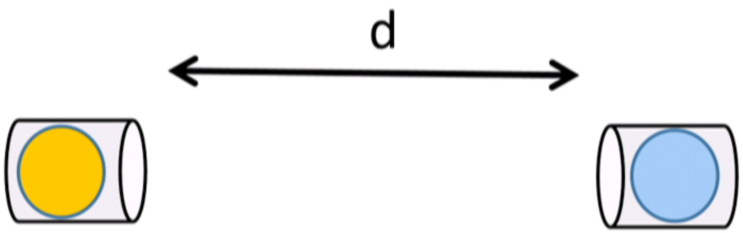
2. Close the left cavity after time τ and the right after time $\tau + d/c$. You get:

$$\frac{1}{\sqrt{2}}\left(|A_1\rangle|A_2{}^*\rangle + |A_1{}^*\rangle|A_2\rangle\right)$$

More precisely, the state in Version 2, stage 2 is $\frac{1}{\sqrt{2+\delta}}\left[\sqrt{1+\varepsilon}\,|A_1\rangle|A_2{}^*\rangle + \sqrt{1-\varepsilon}\,|A_1{}^*\rangle|A_2\rangle + \sqrt{\delta}\,|A_1\rangle|A_2\rangle\right]$ where $\varepsilon, \delta \ll 1$.



The Quantum Liar Paradox version 2



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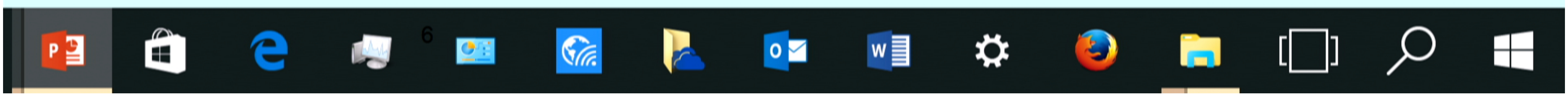
$$\frac{1}{\sqrt{2}}\left(|A_1\rangle|A_2{}^*\rangle + |A_1{}^*\rangle|A_2\rangle\right)$$

3. Measure for excited/ground.
Whence the entanglement?

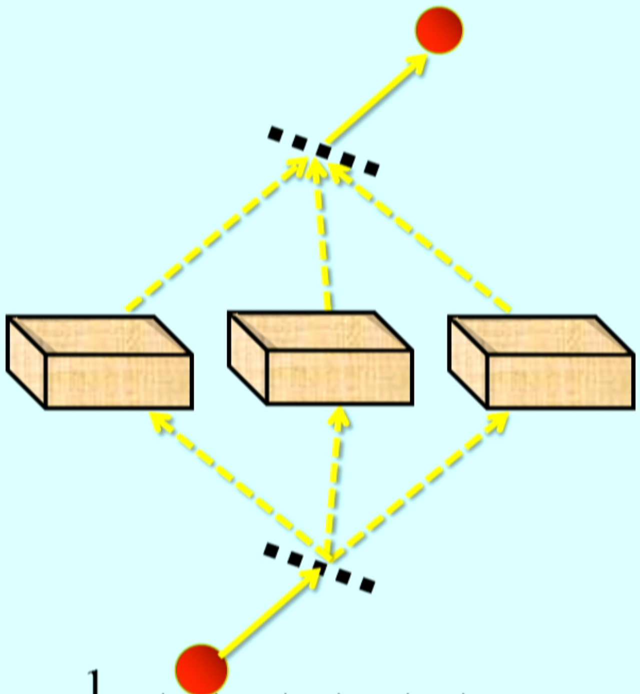
More precisely, the state in Version 2, stage 2 is $\frac{1}{\sqrt{2+\delta}}\left[\sqrt{1+\varepsilon}\,|A_1\rangle|A_2{}^*\rangle + \sqrt{1-\varepsilon}\,|A_1{}^*\rangle|A_2\rangle + \sqrt{\delta}\,|A_1\rangle|A_2\rangle\right]$
where $\varepsilon, \delta \ll 1$.

Modular momentum receives a new from denoting the relative phase between the excited-ground and ground-excited states



The 3-Boxes Paradox

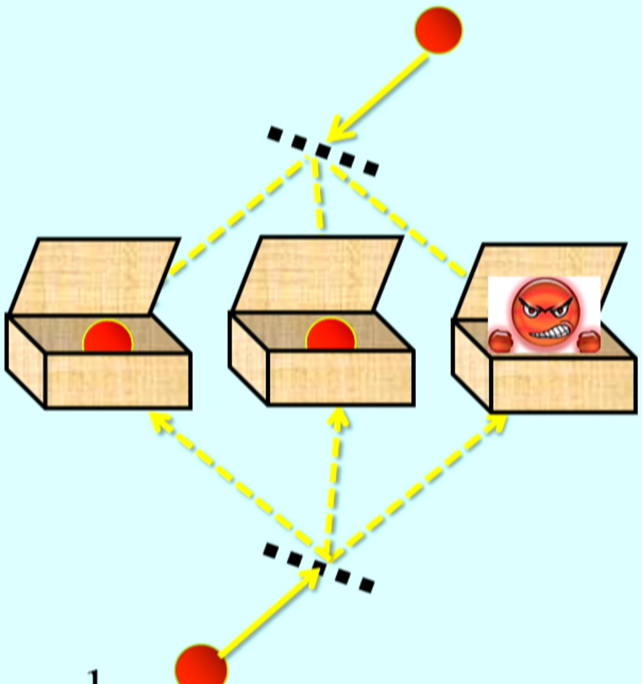
$$|\psi_{fin}\rangle = \frac{1}{\sqrt{3}}(|A\rangle + |B\rangle - |C\rangle) \qquad \Pi_i \equiv |i\rangle\langle i|$$



$$|\psi_{in}\rangle = \frac{1}{\sqrt{3}}(|A\rangle + |B\rangle + |C\rangle)$$

The 3-Boxes Paradox

$$|\psi_{fin}\rangle = \frac{1}{\sqrt{3}}(|A\rangle + |B\rangle - |C\rangle) \qquad \Pi_i \equiv |i\rangle\langle i|$$



$$\langle \Pi_A \rangle_W = 1 \quad \langle \Pi_B \rangle_W = 1 \quad \boxed{\langle \Pi_C \rangle_W = -1}$$

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The 3-Boxes Paradox

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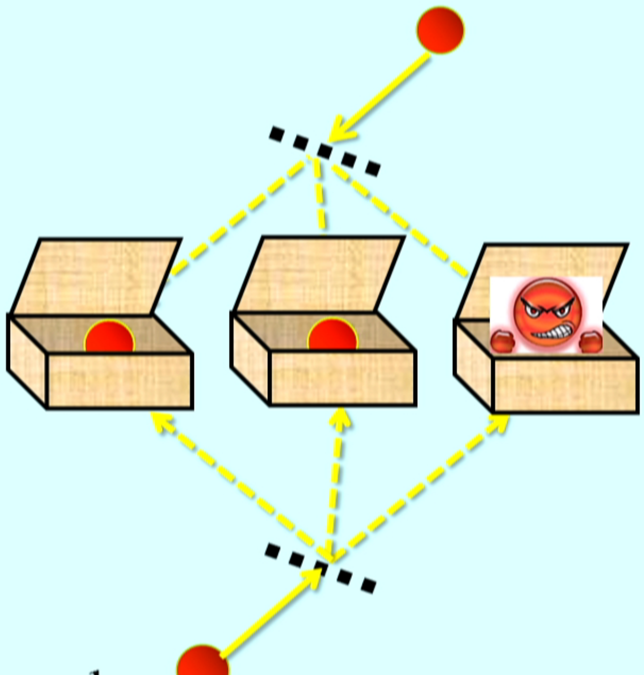

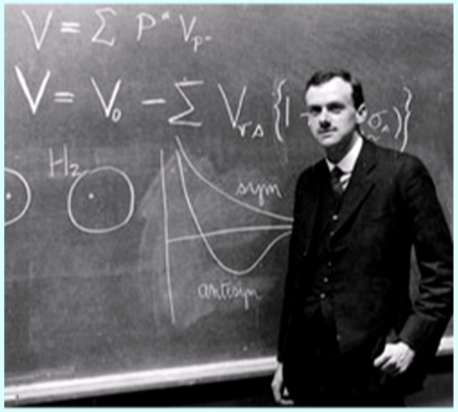

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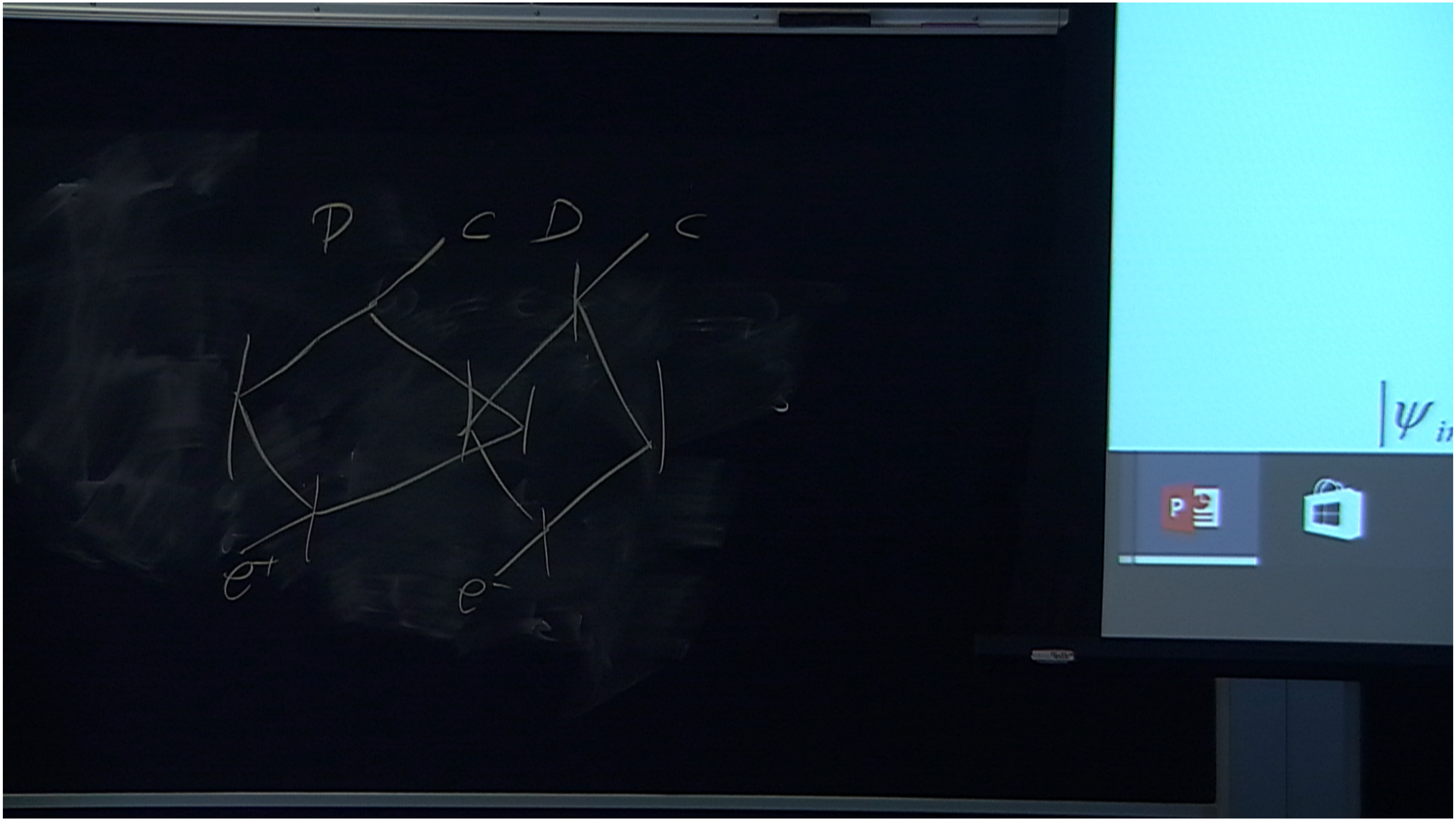
$$|\psi_{in}\rangle = \frac{1}{\sqrt{3}}(|A\rangle + |B\rangle + |C\rangle)$$



P
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e+
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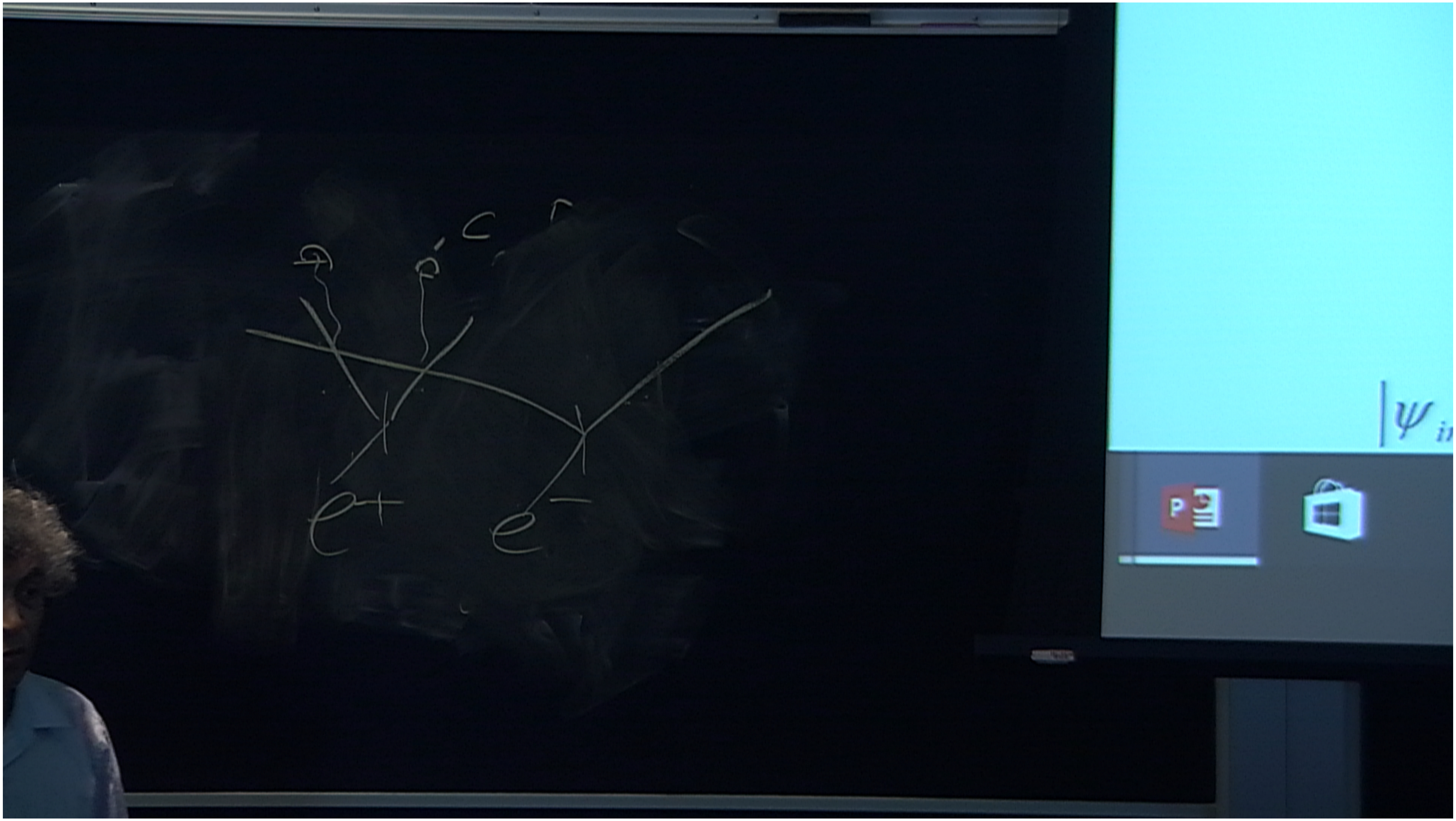
e^+
e^-

Brodutch-Cohen

Nonlocal Measurements via Quantum Erasure

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Nonlocal observables play an important role in quantum theory, from Bell inequalities and various postselection paradoxes to quantum error correction codes. Instantaneous measurement of these observables is known to be a difficult problem, especially when the measurements are projective. The standard von Neumann Hamiltonian used to model projective measurements cannot be implemented directly in a nonlocal scenario and can, in some cases, violate causality. We present a scheme for effectively generating the von Neumann Hamiltonian for nonlocal observables without the need to communicate and adapt. The protocol can be used to perform weak and strong (projective) measurements, as well as measurements at any intermediate strength. It can also be used in practical situations beyond nonlocal measurements. We show how the protocol can be used to probe a version of Hardy's paradox with both weak and strong measurements. The outcomes of these measurements provide a nonintuitive picture of the pre- and postselected system. Our results shed new light on the interplay between quantum measurements, uncertainty, nonlocality, causality, and determinism.

Brodutch-Cohen

PRL **116,** 070404 (2016) PHYSICAL RE

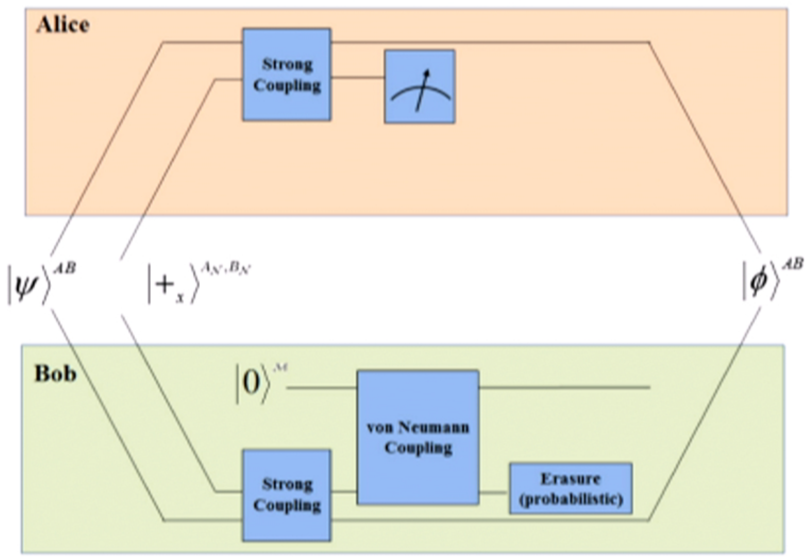

FIG. 1. Nonlocal measurement based on quantum erasure. The strong measurement requires Alice and Bob to locally couple their system to an entangled meter (the ancilla $\mathcal{N}$). Alice then measures her part $\mathcal{N}_A$, effectively "pushing" the result of the strong measurement to Bob's $\mathcal{N}_B$. Bob performs the weak measurement of $\mathcal{N}_B$ using $\mathcal{M}$ and then erases the information encoded on $\mathcal{N}$ (undoing the initial coupling). If successful they induce the von Neumann Hamiltonian (1)


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רבינא
יָמִים עַל יְמֵי מֶלֶךְ תּוֹסִיף
שְׁנוֹתָיו כְּמוֹ דֹר וָדֹר
Psalms 61, 7
Jeff Tollaksen
Benni Reznik
Avshalom Elitzur
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