The Shortest Time for a State to Turn Over Is Set Not by the Energy's Size but by Its Mean from the Ground State

— a two-level system on 0 and 1 eV reaches the bound exactly, but measuring energy from an origin 10 eV lower makes the formula return 9.846828×10^{-17} s while the actual time is unchanged — the separator is whether energy is measured from the ground state or from an arbitrary origin — [Paper 772]

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September 2026

— From thinking to syncing. —

Abstract

A quantum state takes time to turn into another, and more energy is said to allow faster turnover.That shortest time is counted with the bound and a two-level calculation, and the origin from which the energy in the formula must be measured is checked.No new theorem or law is claimed. First, the bound is short even for small energies——1.033917×10^{-15} s for a mean of 1 eV (Section 2). **Second, turning all mass into energy gives a ceiling on operations——5.425570×10^{50} per second for 1 kg** (Section 2). **Third, a two-level system reaches the bound exactly——its overlap vanishes at 2.067710×10^{-15} s, the bound being 2.067834×10^{-15} s** (Section 3). **Fourth, and this is the core. The energy in the formula must be measured from the ground state——with the origin 10 eV lower, the formula returns 9.846828×10^{-17} s, while the actual time the overlap takes to vanish does not change** (Section 3). **Fifth, shifting the origin throws the bound off by orders——the formula's value becomes 0.047619 times as large** (Section 3). **Sixth, the separator is whether energy is measured from the ground state or from an arbitrary origin——"more energy means faster change" has no truth value until one says from where the energy is measured** (Section 4). **Keywords**: Margolus-Levitin bound, quantum speed limit, orthogonal states, mean energy, origin of energy, ceiling on computing speed.

Scope of this paper (scope note): **No new theorem or law is claimed——the Margolus-Levitin bound, that a two-level system reaches it, and deriving a ceiling on computing speed from the energy of mass are all known (Margolus and Levitin 1998, Lloyd 2000).The other bound is not treated——the Mandelstam-Tamm bound, set by energy spread, is only named.The ceiling is ideal——the 1 kg computer is an ideal ceiling using all its mass; it is not claimed to be buildable.No real machine is claimed——real computers and quantum computers are not treated.Checked on two levels——reaching the bound was confirmed by following the overlap of a two-level system on a time grid; the time is off by the grid step.Relation to earlier papers**: **Paper 131 showed that of $k_B T \ln 2$, only the T is physics——there the bound on the cost of erasure was sorted into convention and fact. Here, for the bound on the speed of turnover, it is counted how dropping the convention of measuring energy from the ground state makes the formula lose its physics. Both bounds contain a convention about what is measured.**What is added is **deriving the bound for 1 eV, 1 kg and $kT \ln 2$ at 300 K, confirming on a grid that a two-level system reaches the bound, showing that shifting the origin by 10 eV makes the formula return 0.047619 times the value**, and **placing the separator on where the energy is measured from**.

1. Notation and the Question

Setting: **let $\langle E \rangle$ be the mean energy measured from the ground state. The shortest time to reach an orthogonal state and the ceiling on operations per second are as below. For a two-level system with equal weights on 0 and E, the size of the overlap changes with time as follows.**

$$\tau \geq \frac{\pi \hbar}{2\langle E \rangle}, \qquad \nu_{\max} = \frac{2\langle E \rangle}{\pi \hbar}, \qquad \left| \langle \psi(0) \mid \psi(t) \rangle \right| = \left| \cos \frac{Et}{2\hbar} \right|$$

In the two-level system $\langle E \rangle = E/2$, and the overlap first vanishes at $t = \pi \hbar / E$.

Question: **from where is the energy that sets the speed of turnover measured?**

2. Values of the Bound

Computation 2.1: **shortest times and the ceiling on operations were derived from the bound for three cases.**

case	value
shortest time at a mean of 1 eV	1.033917×10^{-15} s
ceiling on operations, 1 kg fully converted	5.425570×10^{50} per s
$kT \ln 2$ at 300 K	2.870979×10^{-21} J (0.017919 eV)
shortest time at that energy	5.769870×10^{-14} s

> **Observation 2.2**
>
> **the bound is short even for small energies.1.033917×10^{-15} s at 1 eV, and still 5.769870×10^{-14} s at 0.017919 eV, about the energy of room-temperature heat——what sets the ceiling on speed is $\hbar$, a different constant from the kT that sets the price of erasure.**

3. Two Levels Reach It, and the Origin Matters

Computation 3.1: **the overlap of a two-level system with equal weights on 0 and 1 eV was followed on a time grid and its vanishing time compared with the bound. Then the same state's energy was measured from an origin 10 eV lower and put into the formula.**

quantity	value
time the overlap vanishes (grid)	2.067710×10^{-15} s
formula $\pi\hbar/E$	2.067834×10^{-15} s
bound at a mean of 0.5 eV	2.067834×10^{-15} s
formula with the origin 10 eV lower	9.846828×10^{-17} s
its factor	0.047619

Observation 3.2

a two-level system reaches the bound exactly.The relative difference between the grid's vanishing time and the bound is 6.000×10^{-5}, the size of the grid step——the bound is not an unreachable guide but a wall that can be reached.

Observation 3.3

this is the core: the energy in the formula must be measured from the ground state.Measured from an origin 10 eV lower, the formula returns 9.846828×10^{-17} s, but the actual time for the overlap to vanish stays 2.067834×10^{-15} s——the energy origin changes no physics, yet changes the formula's value by a factor of 0.047619.

4. The Separator

Observation 4.1

the separator is whether energy is measured from the ground state or from an arbitrary origin.Measured from the ground state, the bound is a wall a two-level system reaches; from an arbitrary origin, it returns a meaningless value shorter than reality——"more energy means faster change" has no truth value until one says from where the energy is measured.

Observation 4.2

beside Paper 131.Paper 131 showed that of $k_B T \ln 2$, only T is physics and the rest convention——here, for the bound on speed, the convention of the origin from which energy is measured holds the meaning of the formula. Both bounds, on the price of erasure and on the speed of turnover, contain a convention about what is measured.

Observation 4.3

what is not said.The other bound set by energy spread and the speed of real computers are not treated, and the 1 kg computer is an ideal ceiling——what is shown is that the bound is a reachable wall, and that the energy in its formula has a fixed origin.

5. Roll Call and Closing

1. $\mathbf{1.033917 \times 10^{-15}}$ **s at 1 eV** (Computation 2.1): **the shortest time.**
2. $\mathbf{5.425570 \times 10^{50}}$ **per s for 1 kg** (Computation 2.1): **ceiling on operations.**
3. $\boldsymbol{kT \ln 2 = 0.017919}$ **eV** (Computation 2.1): **room-temperature heat.**
4. $\mathbf{5.769870 \times 10^{-14}}$ **s there** (Observation 2.2): **still short.**
5. **vanishing at** 2.067710×10^{-15} **s** (Computation 3.1): **two levels.**
6. **bound** $\mathbf{2.067834 \times 10^{-15}}$ **s** (Observation 3.2): **reached exactly.**
7. $\mathbf{9.846828 \times 10^{-17}}$ **s with the origin shifted** (Observation 3.3): **the core.**
8. **factor** $\mathbf{0.047619}$ (Observation 3.3): **a meaningless value.**
9. $\boldsymbol{\hbar}$ **and** $\boldsymbol{kT}$ (Observation 2.2): **separate constants for speed and price.**
10. **energy measured from where** (Observation 4.1): **the separator; Paper 131.**

Closing: **The shortest time for a state to turn over is set not by the size of the energy but by its mean measured from the ground state.By the Margolus-Levitin bound, a mean of 1 eV allows 1.033917×10^{-15} s, 1 kg fully converted caps computing at 5.425570×10^{50} operations per second, and even 0.017919 eV, about room-temperature $kT \ln 2$, allows 5.769870×10^{-14} s——what sets speed is $\hbar$.A two-level system with equal weights on 0 and 1 eV loses its overlap at 2.067710×10^{-15} s, reaching exactly the bound of 2.067834×10^{-15} s for a mean of 0.5 eV; yet measured from an origin 10 eV lower, the formula returns 9.846828×10^{-17} s, a factor of 0.047619, while the actual time is unchanged——the energy in the formula is physics only under the convention of measuring from the ground state.The separator is whether energy is measured from the ground state or from an arbitrary origin.Placed among the earlier papers——Paper 131 sorted the bound on erasure into convention and fact; this counts, for the bound on speed, the convention of the origin.To be honest——the other bound and real computers are not treated, and the 1 kg computer is an ideal ceiling.**

References

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