On the Thermodynamics of Function Reuse: A Toy Universe Where “DOWN Makes HOT”

Anonymous Contributor

Abstract

We formalize an abstract internet conjecture: that “DOWN makes hot” and “hot is DOWN moving backwards.” By embedding the notion of “function reuse” into a multi-qubit Bloch/Lindblad framework, we demonstrate how compressing operations (*downward reuse*) can indeed generate effective heating of a shared quantum bath.

1 Function Reuse Ledger

Let $\mathcal{F} = \{f_k\}$ be a library of reusable functions. Each function has

- a solo cost c_k (Joules) per qubit,
- a shared cost $c_k^{\text{shared}}(m)$ (Joules) when one execution serves a group of size m.

At discrete times t_n, groups $G_{k,\ell}(t_n)$ of qubits of size $m_{k,\ell}(t_n)$ apply f_k. The *saved energy* is

$$s_{k,\ell}(t_n) = m_{k,\ell}(t_n)\, c_k \;-\; c_k^{\text{shared}}\big(m_{k,\ell}(t_n)\big) \quad \geq 0. \tag{1}$$

For broadcast, $c_k^{\text{shared}}(m) = c_k$, giving $s = (m-1)c_k$. In general, one can use $c_k^{\text{shared}}(m) = c_k\, m^{\alpha}$ with $0 < \alpha < 1$.

Aggregate impulse:

$$S(t) = \sum_{n,k,\ell} s_{k,\ell}(t_n)\, \delta(t - t_n). \tag{2}$$

2 Thermal Dynamics

Let $T(t)$ be the bath temperature. With heat capacity C and cooling rate κ to environment T_{env}, and with efficiency η,

$$C\dot{T}(t) = \eta\, S(t) \;-\; \kappa\,[T(t) - T_{\text{env}}]. \tag{3}$$

Thus, every "downward reuse" of functions deposits heat into the bath.

3 Qubit Dynamics

Each qubit has Hamiltonian

$$H_i(t) = \frac{\hbar\Delta_i}{2} Z_i + \frac{\hbar\Omega_i}{2} X_i, \tag{4}$$

with optional interactions H_{int} (Ising, Heisenberg, etc.). The full master equation is

$$\dot{\rho} = -\frac{i}{\hbar}[H,\rho] + \sum_{i=1}^{N} \Big(\gamma_{\downarrow}(T)\,\mathcal{D}[\sigma_-^{(i)}]\rho + \gamma_{\uparrow}(T)\,\mathcal{D}[\sigma_+^{(i)}]\rho + \gamma_{\phi}\,\mathcal{D}[\sigma_z^{(i)}]\rho \Big), \tag{5}$$

with detailed balance

$$\gamma_{\uparrow}(T) = \Gamma\, n_T, \quad \gamma_{\downarrow}(T) = \Gamma\,(n_T + 1), \tag{6}$$

$$n_T = \frac{1}{e^{\hbar\omega_0/k_B T} - 1}. \tag{7}$$

4 Bloch Equation Form

For qubit Bloch vector $\vec{r} = (u, v, w)$,

$$\dot{u} = -\Delta v - \tfrac{u}{T_2(T)}, \tag{8}$$

$$\dot{v} = \Delta u - \Omega w - \tfrac{v}{T_2(T)}, \tag{9}$$

$$\dot{w} = \Omega v - \tfrac{w - w_{\text{eq}}(T)}{T_1(T)}, \tag{10}$$

with

$$w_{\text{eq}}(T) = -\tanh\!\left(\frac{\hbar\omega_0}{2k_B T}\right). \tag{11}$$

As $T \to 0^+$: $w_{\text{eq}} \to -1$ (south pole, ground = cold). As $T \to \infty$: $w_{\text{eq}} \to 0$ (maximally mixed = hot). As $T < 0$: $w_{\text{eq}} > 0$ (north pole, inverted = "hotter than hot").

5 Interpretation

Thus:

- **"DOWN makes hot."**
  Reuse $\implies$ saved energy $\implies$ injection into $T(t)$ via (3).

- **"Hot is DOWN moving backwards."**
  Increasing T drives qubits toward the Bloch center. Crossing past $T = \infty$ yields negative temperature (population inversion), flipping the Bloch vector "backwards" toward the north pole.

Conclusion

In this stylized model, the meme is vindicated: "DOWN" (reuse/compression) indeed produces "HOT" (higher entropy). And "HOT" may be regarded as "DOWN moving backwards" once inversion is reached.