

Quantum Key Reuse Has a Hard Limit

Not a gradual decline—security fails at a sharp threshold.

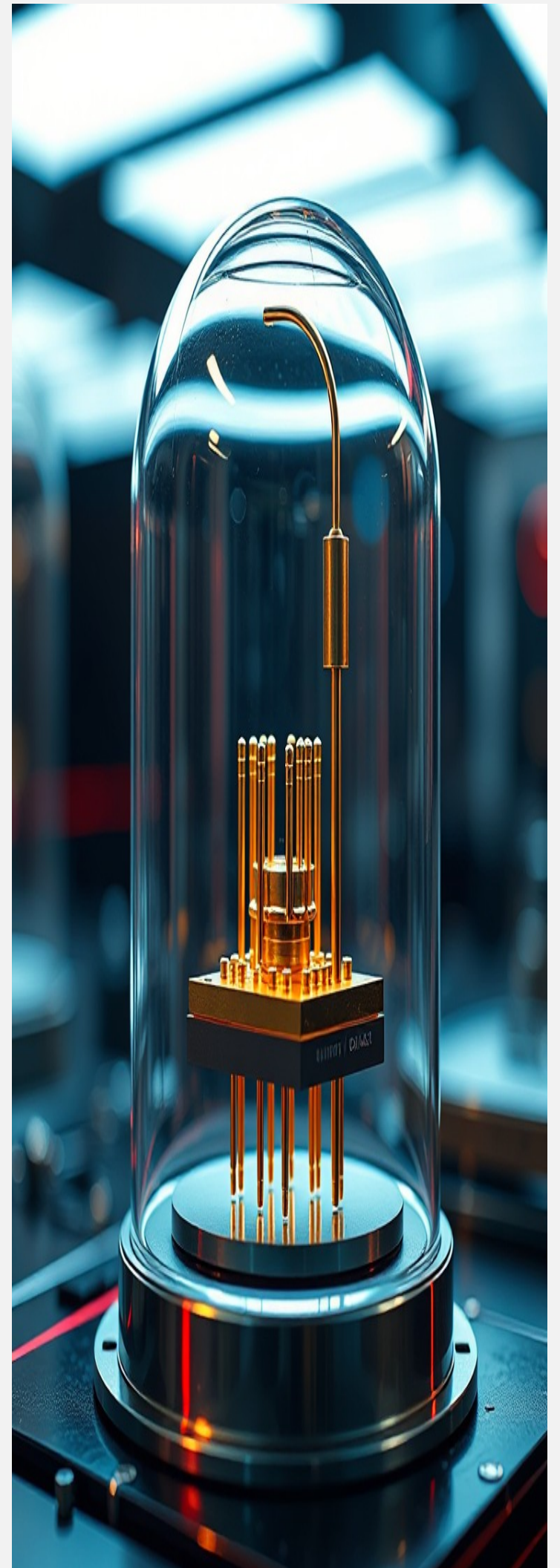
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$$\alpha = 1$$

Threshold for Key Reuse Failure

The point at which forgery probability transitions from near-zero to near-certain under a single-signature-exposure model.

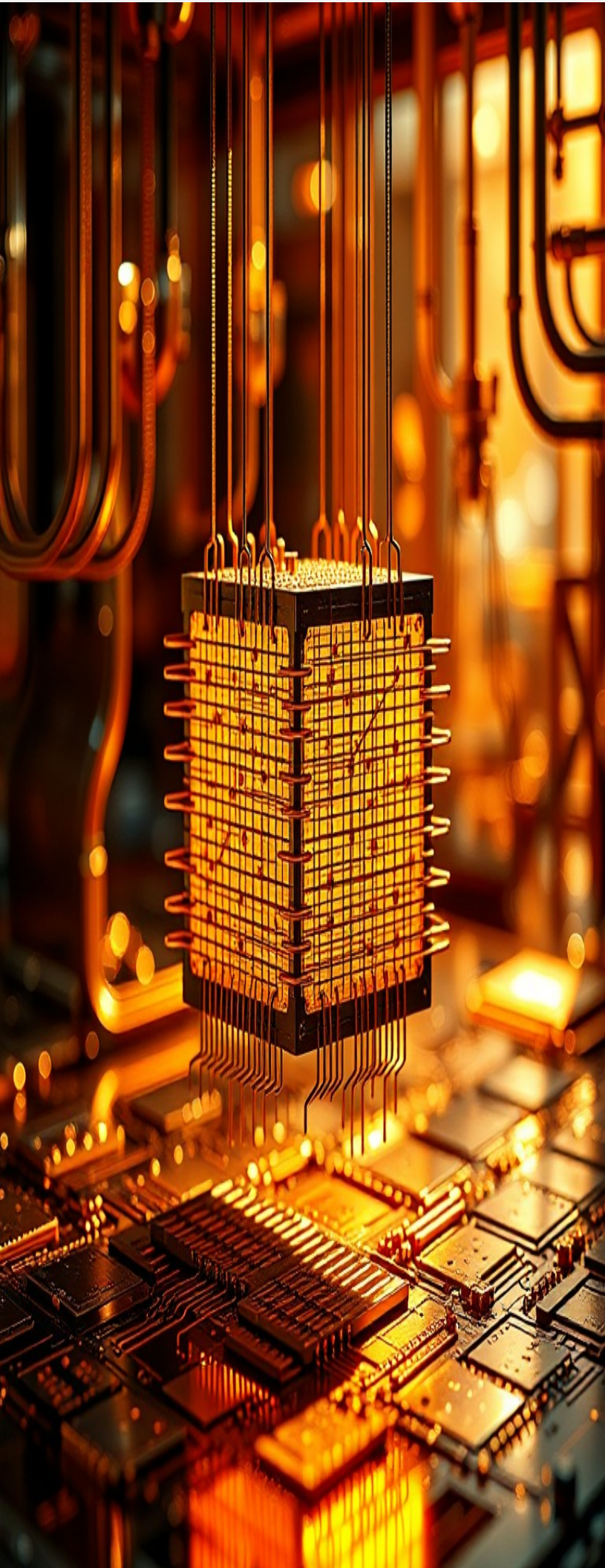
When an adversary processes N public-key copies relative to the residual qudit count r , security holds only if $N/r < 1$. Once N/r exceeds 1, the system becomes fundamentally insecure. This is not a soft degradation—it is a phase transition.



01

Trust in Quantum Systems Is Not Incremental

For AI systems using quantum authentication, this implies that 'safe' thresholds must be enforced with absolute precision. Even a single excess key copy beyond the threshold can render a system vulnerable to exploitation.



02

The Residual Qudit Count Is the True Security Metric

In practical terms, this means that future AI-quantum systems must track and protect residual information space as a core architectural constraint, not just key volume or encryption strength.

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Director, ALEX Companies

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george@alex.realestate · +1 713.918.9951



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