Below is a step‑by‑step derivation of an “entropy‑form” of

E = m\,c^{2}

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1. Start with the First Law (Thermodynamic Identity)

In differential form, for a system with only entropy exchange (no work or particle number changes),

dE \;=\; T\,dS.

2. Substitute

Treating as a variable that carries energy:

dE \;=\; d\bigl(m\,c^{2}\bigr)

\;=\; c^{2}\,dm.

3. Equate the two expressions for

T\,dS \;=\; c^{2}\,dm

\quad\Longrightarrow\quad

dS \;=\;\frac{c^{2}}{T}\;dm.

This is the entropy version of :

> An incremental mass contributes an entropy

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4. Integration & Black‑Hole Example

If depends on ,

S(m)\;=\;\int \frac{c^{2}}{T(m')}\,dm'.

T\_{\!H}(m)

=\frac{\hbar\,c^{3}}{8\pi\,G\,k\_{B}\,m},

S(m)

=\int \frac{c^{2}}{\,\frac{\hbar c^{3}}{8\pi G k\_{B}m'}\,}\;dm'

=\frac{8\pi\,G\,k\_{B}}{\hbar\,c}\int m'\,dm'

=\frac{4\pi\,G\,k\_{B}}{\hbar\,c}\,m^{2}

\;+\;\text{const.}

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5. Why ?

1. Conversion of Units:

In classical mechanics . Taking yields .

2. Metric Signature & Lorentz Invariance:

Special relativity’s invariant interval

forces energy–momentum relations of the form .

3. Thermodynamic Consistency:

The first‐law substitution makes the only constant of proportionality converting mass–units into energy–units—and hence into entropy via .

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6. Takeaways & Next Steps

Entropy–Mass Mapping:

is the fundamental bridge.

Squared Speed Role:

It arises because energy at the relativistic limit is the kinetic form evaluated at , and because Lorentz invariance demands a quadratic conversion.

Further Exploration:

Examine other equations of state to see how scales.

Generalize to your Primality–Network by replacing with a “logical temperature” and with logical entropy.

Let me know if you’d like to push this through your Primality‑Descent Engine or embed it in a fractal‑topological spine!