

Emergent Gravity

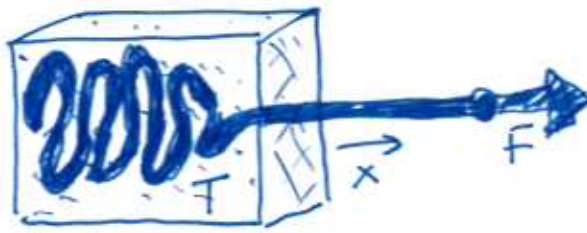
"Emergence" is when large-scale characteristics arise from small-scale ones, with the small-scale interactions not exhibiting those characteristics.

Verlinde in 2010/2011 wrote a paper treating gravity as an emergent property of microscopic quantum vacuum.

He uses the analogy of a polymer immersed in a heat bath:

EXAMPLE:
Viscosity

flow characteristics depend on molecular interactions. One H₂O molecule has no "flow"



Randomly coiled configuration statistically favored (more likely) than being aligned straight.

Applied force pulls polymer out of equilibrium state.

Thermodynamics of polymer in bath gives rise to a resisting force. Entropic/emergent force caused by smaller interactions that don't have that force.

Verlinde's Picture

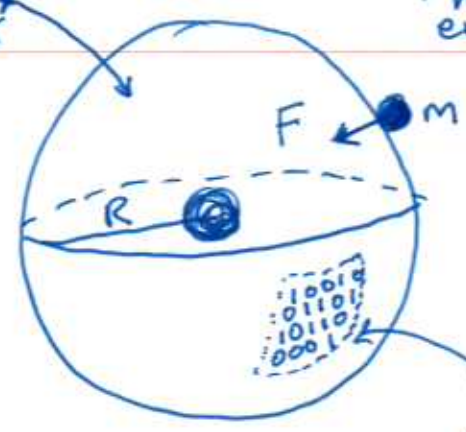
Applying concepts from:

- Holography - Entropy associated w/ info.
- Relativity - info stored on 2D boundary
- Entropy - Mass-energy equivalence
- Unruh relation for accelerated observers
- force across boundary due to thermodynamics
- Equipartition of states

Verlinde derives $F=ma$, $F = \frac{GMm}{r^2}$, and Einstein field equations

inside of sphere spacetime not yet emerged, described by string theory or other new QFT

Outside of sphere spacetime has emerged



Information about inner space stored on boundary

Per Bekenstein:

Once mass m is a Compton wavelength from boundary it contributes to entropy of information on boundary. Entropically favorable to go toward boundary, so force emerges. (increases)

Verlinde equates emergent force w/ gravitation