



Time in a Sparse-Information Universe

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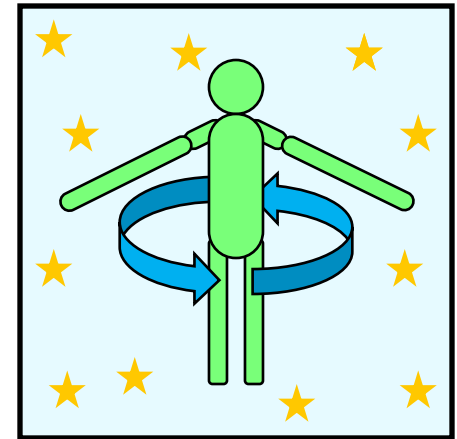
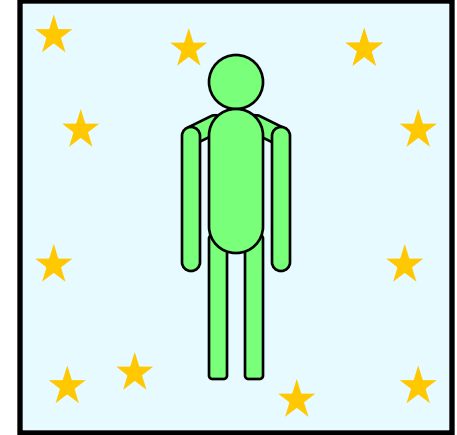
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Let's Go for a Spin

- Stand outside on a starry night. You feel no forces but gravity.
- Next, spin in a circle. Your arms feel a familiar outward pull:
The centrifugal force.
- Picture yourself deep in space. You realize physics requires you to feel the same centrifugal forces even if there is nothing but empty space around you, all the way to those distant stars and galaxies.
- **An odd question occurs to you:** Since Einstein said empty space is featureless and looks the same to all viewers, motion is possible only relative to other bodies or energy fields. How, then, can spinning in an empty void move your arms outward?
- Suddenly, you see it: **Your rotation links you to distant stars.**
- Your actions have uncovered a deep mystery: **Mach's Principle.**



Mach's Principle

Ernst Mach first described the link between spin and distant galaxies in 1893 [1]:

*“When, accordingly, we say, that a body preserves unchanged its direction and velocity *in space*, our assertion is nothing more or less than an abbreviated reference to *the entire universe*.”*

Albert Einstein, fascinated by this idea, later coined the phrase **Mach's Principle**.

Steven Weinberg described the spin-vs-stars thought experiment in 1972 [2]:

“There is a simple experiment that anyone can perform on a starry night, to clarify the issues raised by Mach's principle. First stand still, and let your arms hang loose at your sides. Observe that the stars are more or less unmoving, and that your arms hang more or less straight down. Then pirouette. The stars will seem to rotate around the zenith, and at the same time your arms will be drawn upward by centrifugal force. It would surely be a remarkable coincidence if the inertial frame, in which your arms hung freely, just happened to be the reference frame in which typical stars are at rest, unless there were some interaction between the stars and you that determined your inertial frame.”

[1] Ernst Mach, “The Science of Mechanics,” 2nd ed. The Open Court Publishing Company, 1893.

<https://books.google.com/books?id=4OE2AAAAMAAJ&pg=PA233>. Page 233.

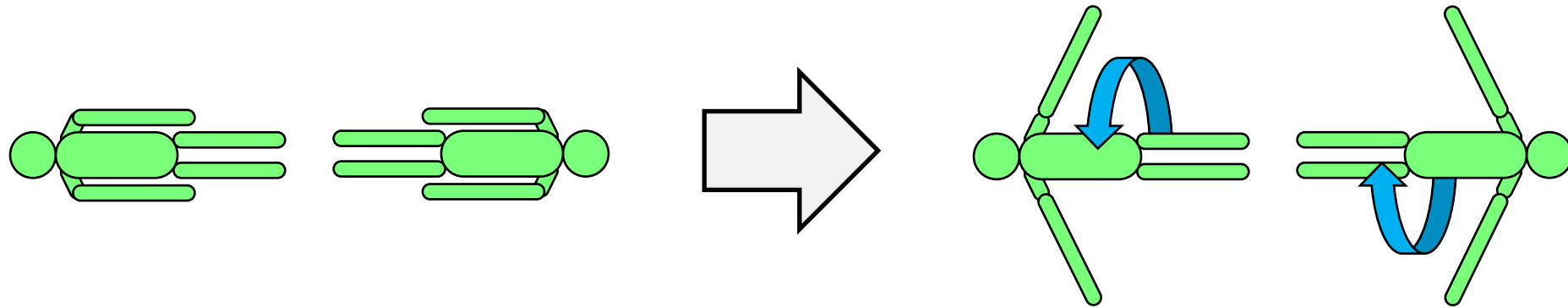
[2] Steven Weinberg, “Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity.” John Wiley & Sons, 1972.

<https://archive.org/details/WeinbergS.GravitationAndCosmology..PrinciplesAndApplicationsOfTheGeneralTheoryOf/page/n44/mode/1up>. Page 17.

Mach's Paradox

- Mach's Principle has a serious problem — a paradox
- Einstein expounded *two* principles relevant to Mach's Principle
 - Motion is relative *only* to other objects (empty space has no “texture”)
 - One body can affect another *only* at the speed of light (even gravity)
- **Mach's Paradox** (why Einstein “mostly” abandoned Mach)
 - A featureless local space *cannot* hold data about distant galaxies
 - If space is featureless, instantly feeling centrifugal forces means there is an *instantaneous link* between you and the rest of the universe. But ...
 - Any such instantaneous linkage *violates the speed of light*
 - Finding a solution compliant with both SR and GR has proven difficult

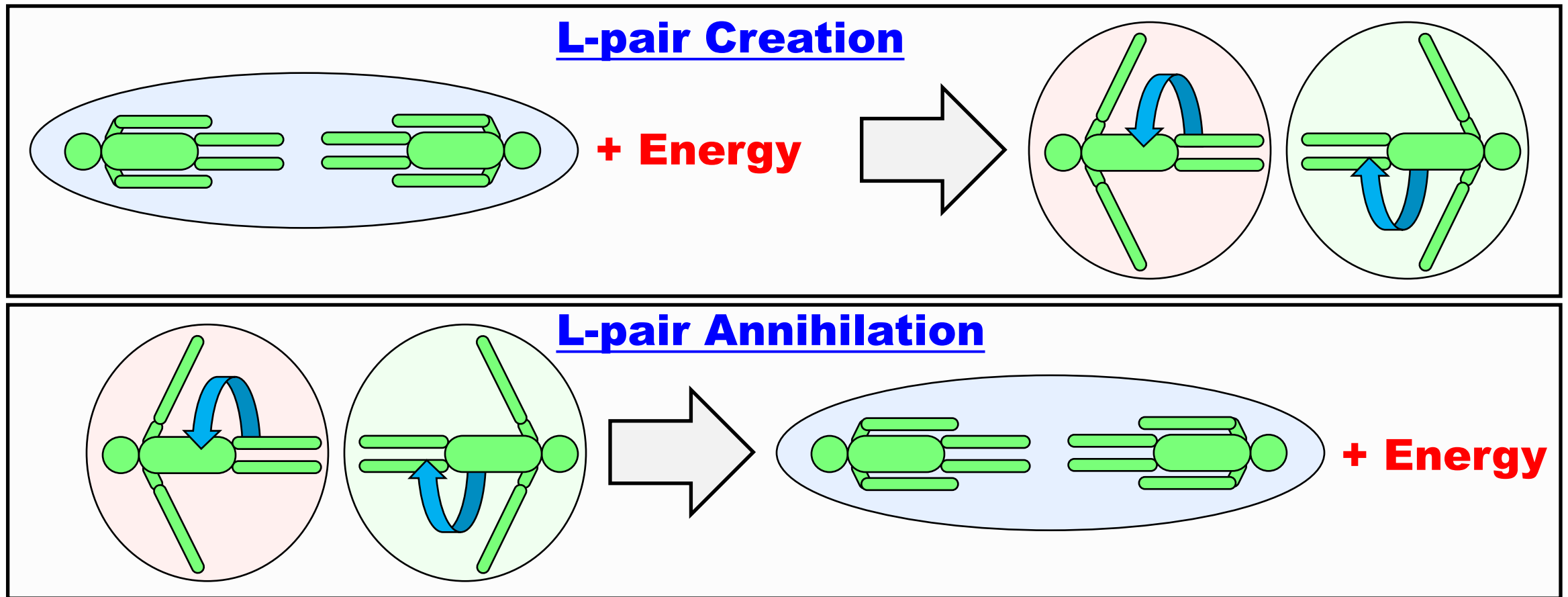
A Different Strategy: *Remember the Past*



- A surprising number of “beautiful” maths in physics, especially symmetries, obtain their beauty by *forgetting or ignoring the past*
- Forgetting the past is like eating the center out of the pie: You get perfection only by *pretending* no larger context exists
- For Mach’s Principle, looking only at an object’s spin *now* requires pretending it has no past history with the rest of the universe
- The needed link to the past is ***angular momentum conservation***

Resolving Spin Locally (No Lightspeed Violation)

- Borrowing the “creation” operator motif from quantum field theory:
- Apply torque energy to create *pairs* of angular momentum vectors (\vec{L}_1, \vec{L}_2)
 - Recombine pairs to recover the ancestral $L_\Sigma = 0$ (“unspun”) and energy



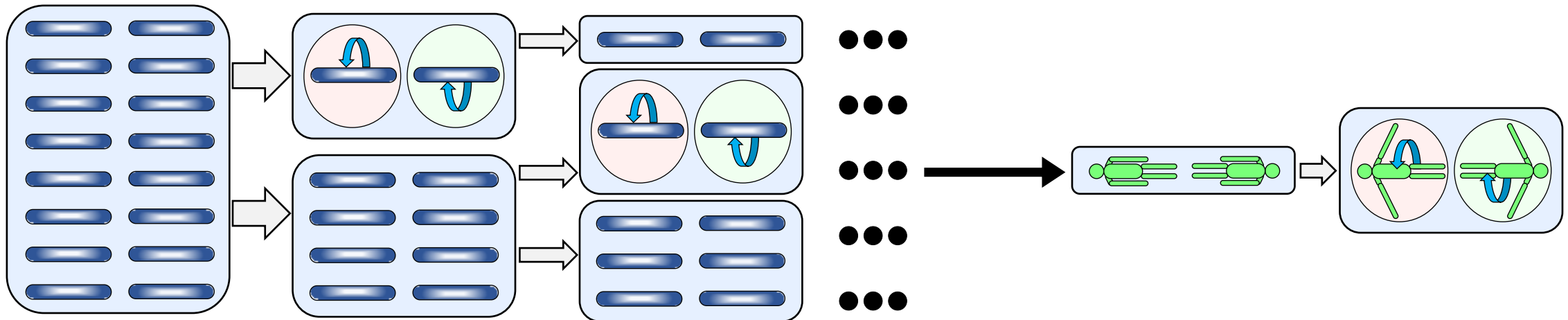
The Odd Situation of Centrifugal Forces

- L-Pair Mach's Principle appears to resolve the source of centrifugal forces without violating lightspeed
 - Centrifugal forces become relative only to the nearby *pair partner*
 - The need for indefinitely distant links seems to disappear (at first)
- Alas, there's *still* a problem
 - Over time, a paired-spin partner can drift *indefinitely far away*
 - Centrifugal forces that depend on that partner thus *still* violate lightspeed
- Resolution: **Make centrifugal forces properties of each L-pair unit**

Implication: Centrifugal forces are both **energy excitations** and **inherent properties** of each local unit of spacetime

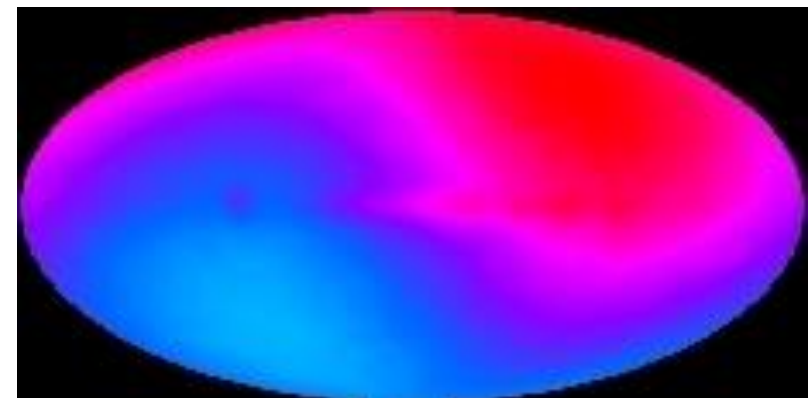
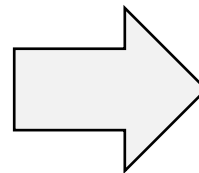
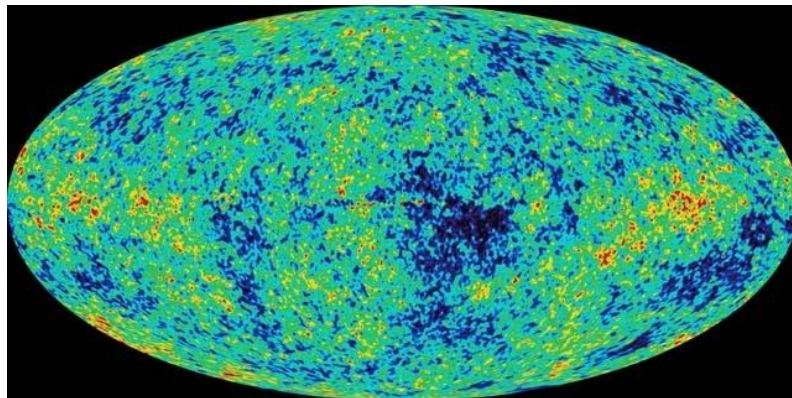
Advantages of the L-Pair Mach's Principle

- L-pair creation with local centrifugal *never* violates lightspeed limits
 - L-pair creation is fast for small objects, but is *never* instantaneous
 - The original “unspun” state is never lost; it is only *dissected* into two parts
 - Important: L-pairs *always* occur, but asymmetric masses can obscure them
- But what about all those galaxies? The unspun state is local only!
 - This is where *history* is critical
 - A local unspun state is one tiny fragment from *billions of years of history*
 - A related ancient state exists: *The Cosmic Microwave Background (CMB)*



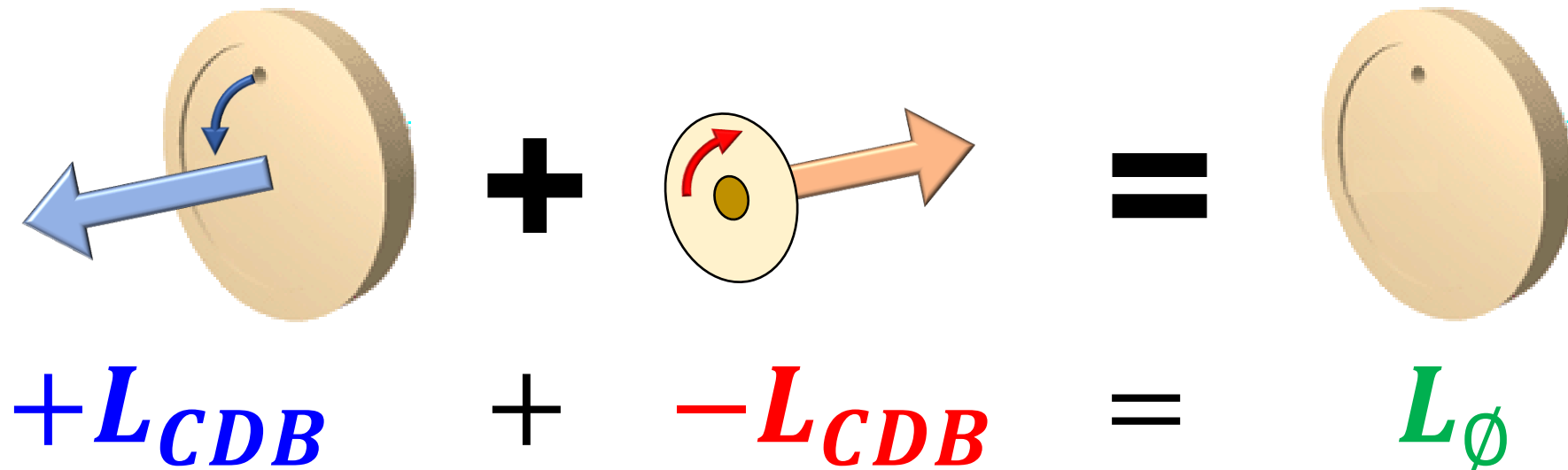
The Cosmic Microwave Background (CMB) *Cosmic* Dipole

- The **Cosmic Microwave Background (CMB)** has a *temperature dipole* that most believe defines the original inertial frame of the entire universe. Accelerating to reduce this apparent dipole to zero makes your frame clocks the *fastest possible clocks in the cosmos*
- The CMB deals with **linear momentum**. Like angular momentum (L-pairs), it implies billions of years of inertial-frame pair (p-pairs) creation history
 - The CMB dipole was *hard to find*, requiring years of difficult measurements



The Cosmic Despun Background (CDB) *Local* Dipole

- The **Cosmic Despun Background (CDB)** has a *local, per-object angular momentum dipole* L_{CDB} whose negative points to the still-shared despun state L_{\emptyset} of the early compact universe. Despinning by applying $-L_{CDB}$ to the object returns it original shared universal state, which is also the *average* spin state of the current universe.
- The CDB parallels the CMB, but deals with **angular momentum**



Resolving Mach's Paradox: Dissected Spacetime



- We got the early Big Bang wrong: It's not a "singularity," but a *sharing*
- What we call "space" is the *dissection* of a mathematically compact and shared unspun state — a state that was "small," but *never* a point

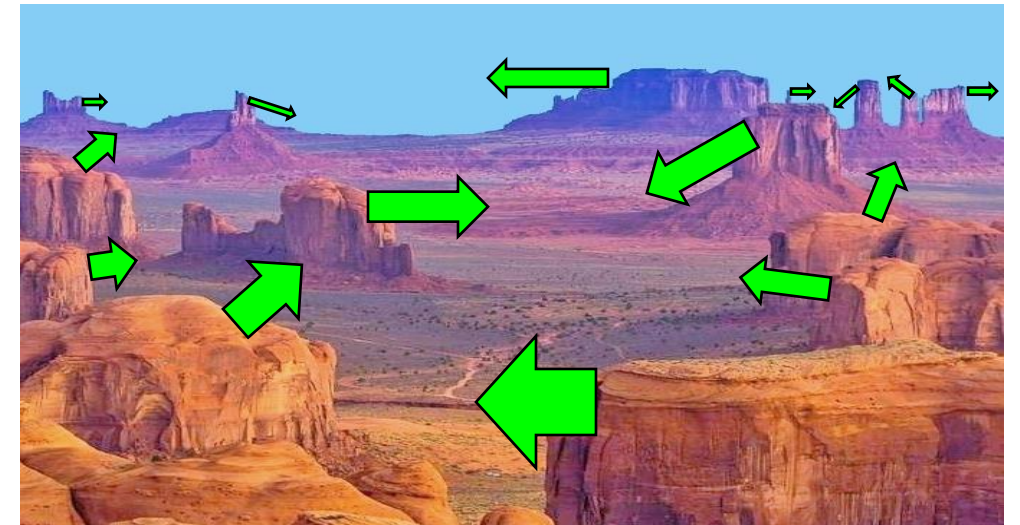
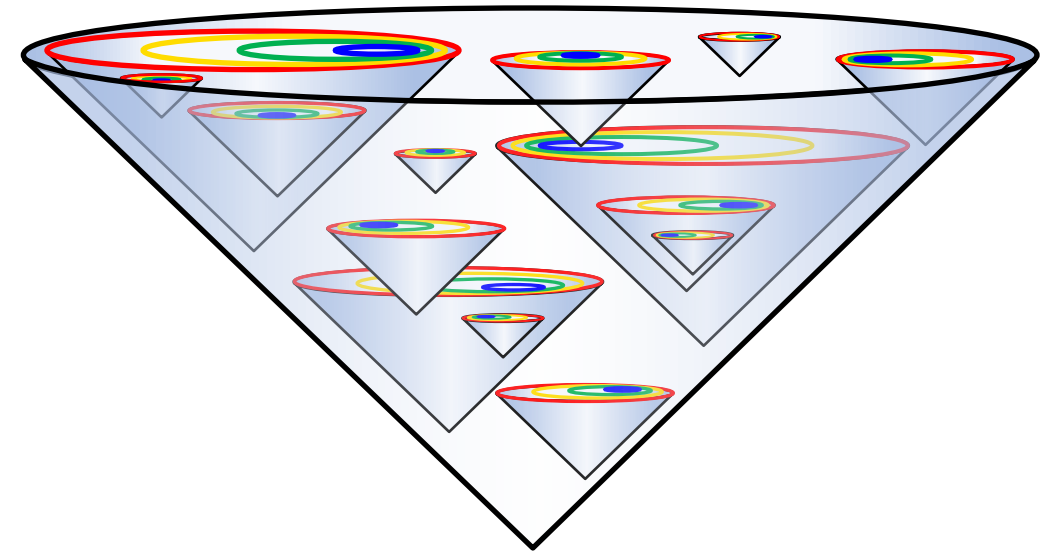
Special Relativity Also Dissects Spacetime

- Adding object length l to the Einstein time coordinate equation...

$$t' = \gamma \left(t - \frac{v}{c^2} (x - l) \right)$$

... limits the applicability of Poincaré spacetime transformations to the *interior space of each accelerated object*.

- Spacetime becomes a *per-object* concept
- The “mesas” of special relativity (linear momentum) **move**, versus Mach angular momentum mesas that are static (but can move when combined with linear velocity)



Casimir's Final Insights on Spacetime

➤ The **Casimir Paradox**:

Casimir's 1998 self-summary of a lifetime of work:

“... the existence of electromagnetic zero-point energy ... has been established beyond doubt... [but] the Casimir force... is [also] the last ... trace of [internal] cohesion energy.”

➤ Think about that a bit...

➤ Casimir is saying that the space defined by quantum field theory is *created and constrained by bonds within matter, not by spacetime*

- Quantum field theory assumes energy goes to infinity at small scales
- Casimir's **QFT driven by residual bonding** tosses field infinities out the window

➤ Conclusion: **Mature inertial units of matter generate QFT spacetime**

The Strange Power of Vacuum Shattering

- Instead of a Big Bang Singularity, dissected spacetime argues the universe rose from a **Compact Shared Universe (CSU)**
- The universe *now* is fragmented by the featureless Einstein vacuums
- All fragments retain “pointers” to CSU states such as “unspun”
- Clumping, acceleration, and despinning *locally* rebind earlier states with varying degrees of fidelity, but these then often shatter again
- **This dance of spacetime shattering and binding drives complexity**
- Hypothesis: *All* quantum numbers that occur in pairs, including color and electric charges, point back to unique CSU “shared plateaus”
- **Properties that do not shatter fully give rise to quantum behaviors**

Wasn't this Talk Supposed to be About Time?

- Time is one component of spacetime
- If spacetime is a local property of a vacuum-shattered universe, **time is a fractal, bottom-up phenomenon** (with CSU sharing)
- So, where does time begin? Here's Roger Penrose, Nov 10, 2016:

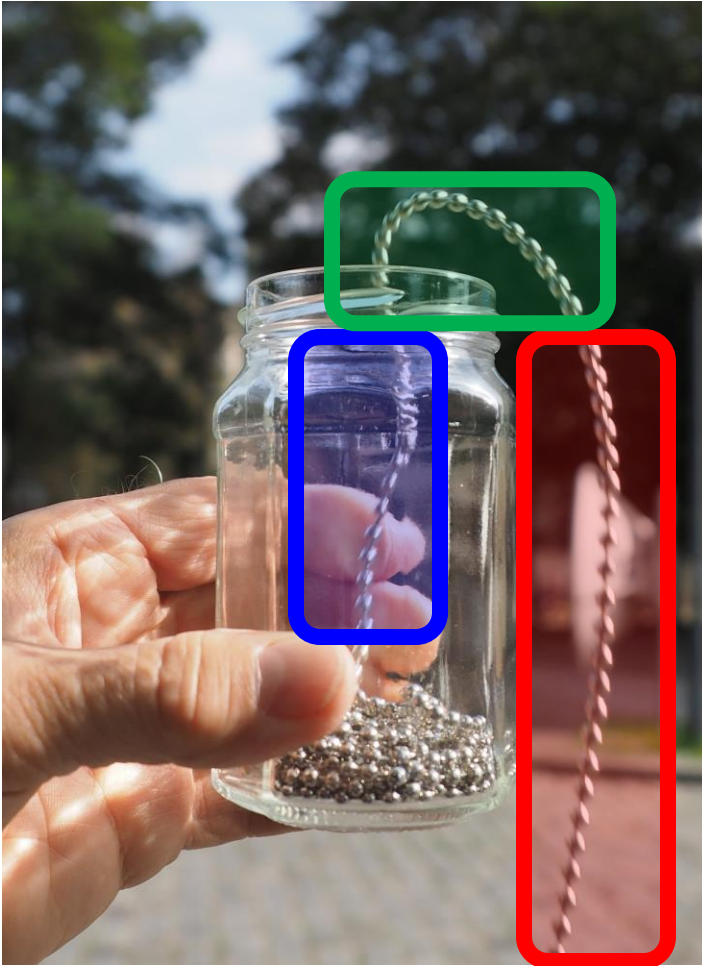
“Why are clocks so precise? Well, because they depend on the two most fundamental equations of 20th-century physics. One of them has to be Einstein's $E = mc^2$. The other is $E = h\nu$; the ν is a frequency. That's Max Planck's. Energy and frequency are equivalent. Einstein says energy and mass are equivalent. Put the two together, and **mass and frequency are equivalent**. So, that means **if you have a particle** — a stable particle of a definite mass — **it is a little clock ... with an extraordinarily precisely defined frequency.**”

— <https://youtu.be/3OsE8NETbNQ?t=1h12m42s>
- *Time fragmentation extends all the way down to particles-as-clocks*
- Frequency is another way of saying “a *repeating loop*,” much like angular momentum. Clock particles thus “break” a CSU plateau

A Modeling Challenge with Tech Impacts

- In a shattered, fractal universe where spacetime is nothing more than a low-energy local emergent effect of matter, what are the implications of time starting at the particle level?
 - (1) Time defines space by its orthogonality to it. Until time begins, space has no meaning.
 - (2) Each particle *begins* an instance of shattered time, and thus, spacetime
 - (3) Forget astrophysics: Condensed matter scientists are creating remarkable micro-scale combinations of spacetime units all the time, only under the deceptively mild moniker of “structural chemistry.”
- Micro-scale spacetime fabrication provides new “spins” on issues such as
 - How high-temperature superconductors work, and how to design new ones
 - Accessing quantum computing through more powerful paths than qubits
 - The curious ability of biomolecules to generate order out of chaos

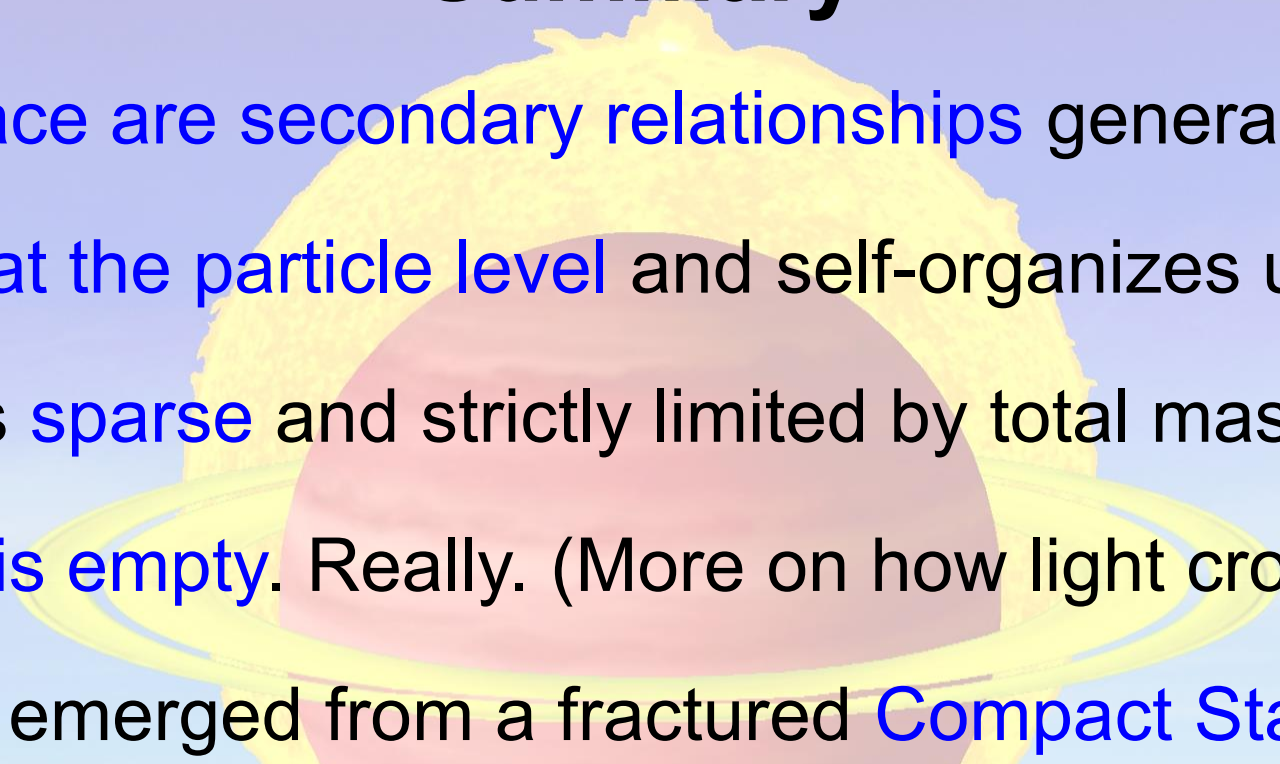
MST (Micro Space Time) Design: The Chain Fountain



Wikipedia KaiMartin, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=35973602>

- As emergent phenomena capable of energetic excitation, spacetime instances have a degree of independence from the matter that creates them
- Spacetime instances can, for example, exist as *solitons* by isolating them topologically from the moving matter that creates them:
 - **Blue — Upwards momentum spacetime soliton**
 - **Green — *Incomplete* angular momentum soliton**
 - **Red — Descending linear momentum soliton**
- **Notable:** By engineering an *incomplete* angular momentum spacetime soliton half-loop, the centrifugal force of the Green MST provides a highly unexpected levitation effect.

Summary

- 
- Time and space are **secondary relationships** generated by matter
 - Time begins at the **particle level** and self-organizes upward
 - Information is **sparse** and strictly limited by total mass-energy
 - **The vacuum is empty.** Really. (More on how light crosses it later.)
 - Our universe emerged from a fractured **Compact State Universe**
 - **Symmetry maths** that disregard history are **necessarily incomplete**
 - **Micro Space Time (MST)** design has potential for emerging tech

