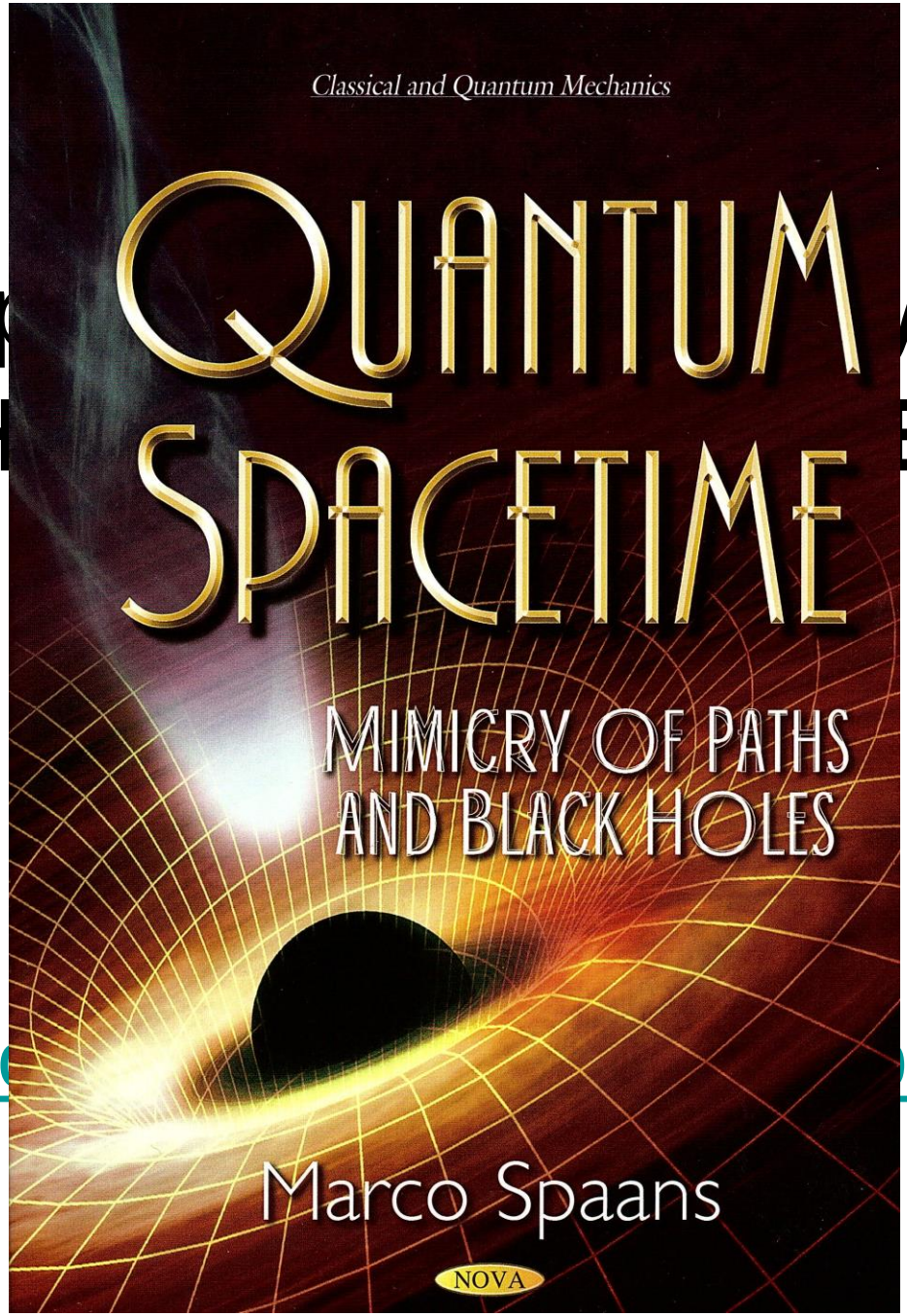
Sp y:
Black H Energy



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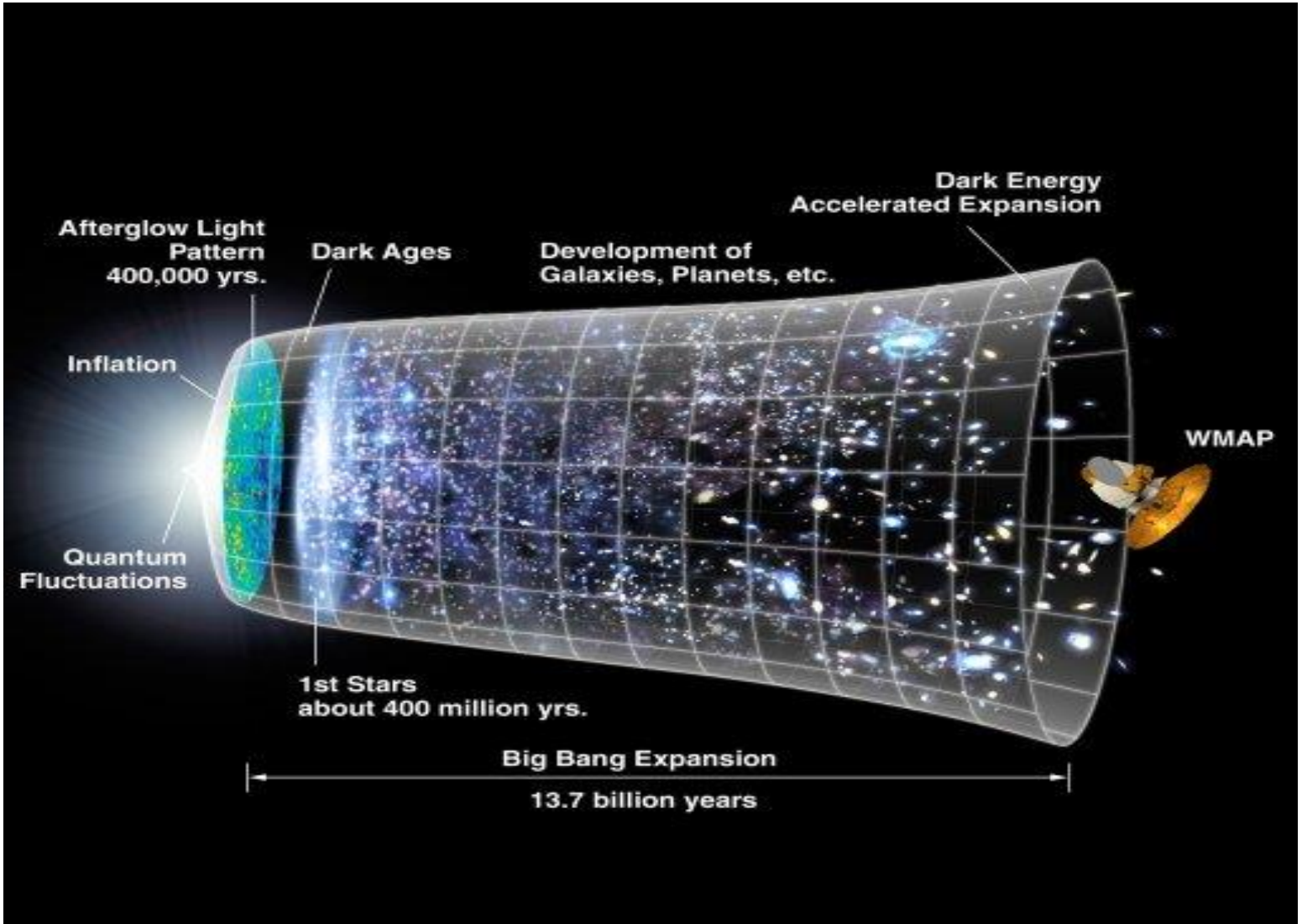
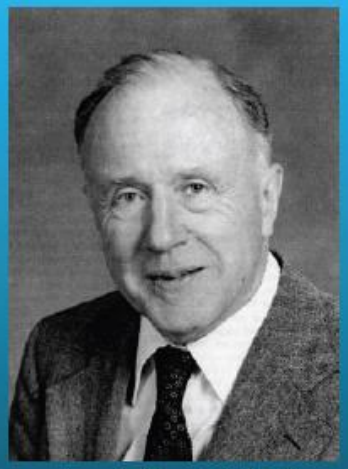
Cosmic evolution appears to involve inflation and dark energy



A Bit of General Relativity

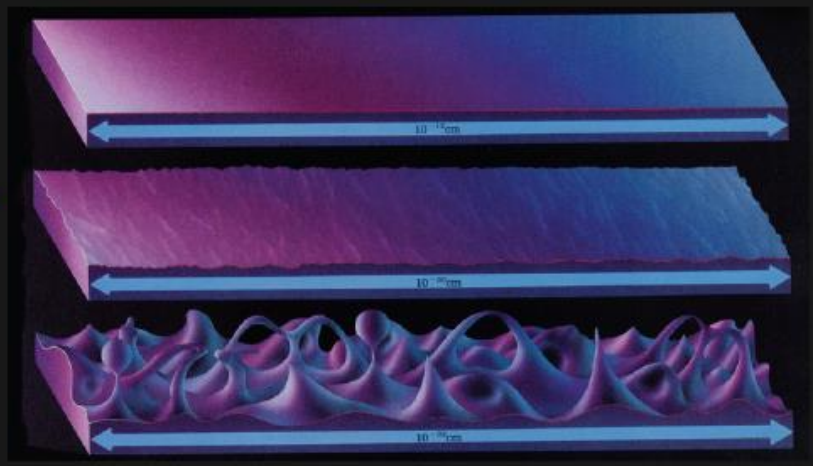
- Equivalence principle: Einstein's local interpretation of Mach's global principle.
- GR not invariant under local conformal transformations → singular metric fluctuations on the Planck scale:
  Wheeler's **quantum foam** of wormholes.
- The Einstein equation $G_{\mu\nu} = 8\pi G_N T_{\mu\nu}$
  does not specify local and global **topology.**

Topology of Quantum Space-Time

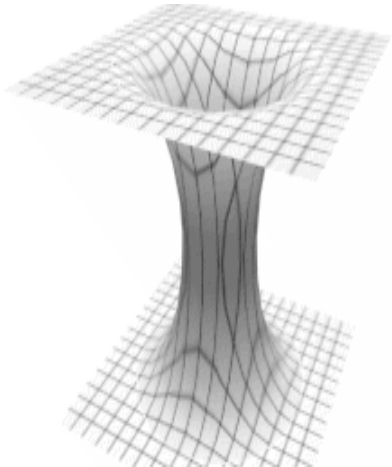


John Archibald Wheeler
1911-2008

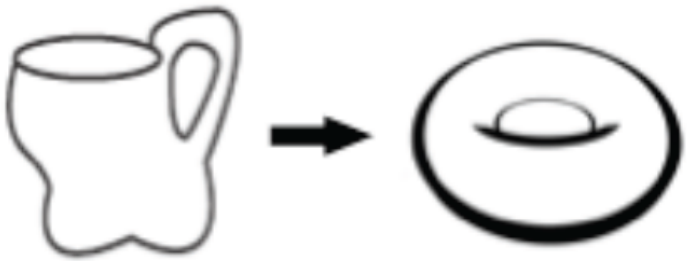
Quantum Foam



On the **plank scale**, the universe might be multiply connected: wormholes (handles) S^1xS^2; m_P, l_P, t_P



Topology of Quantum Space-Time

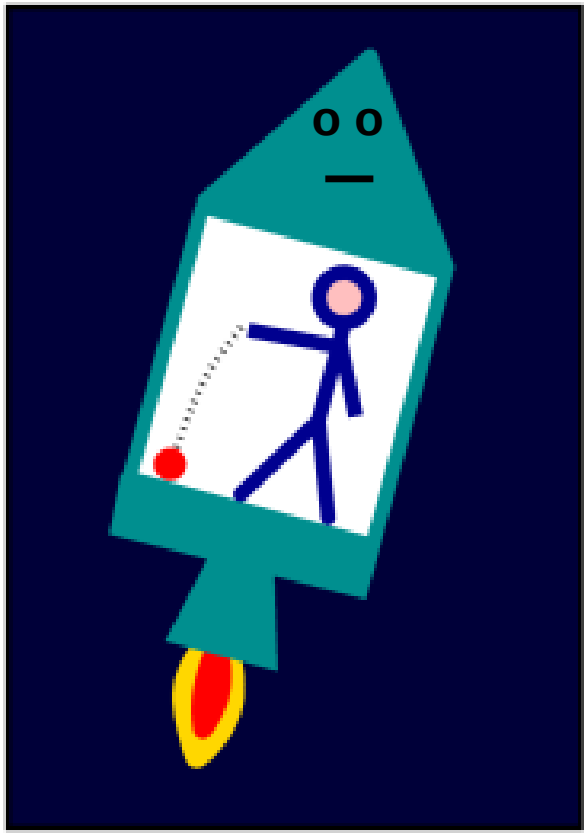


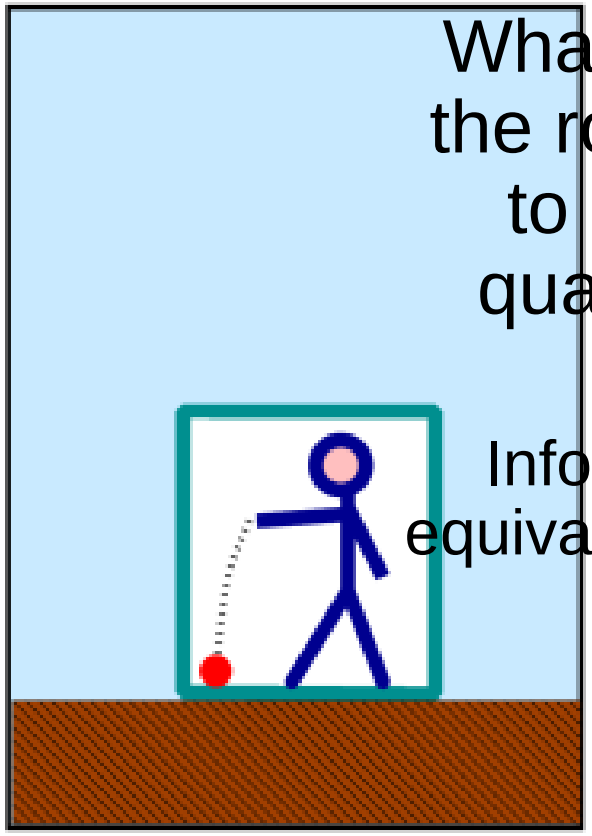
In topology, shapes or surfaces are considered to be equivalent if any continuous change can be continuously undone, this is called a homeomorphism.

A continuous deformation between a donut and a coffee cup.

This also means that there is no topological difference between a large and a small wormhole: same information M, Q, S.

The Equivalence Principle: consider observer **and** observed





What **information** does the rocket operator need to **mimic** the proper quantum experience?

Information that is locally equivalent yet globally distinct.

Proposal:
Identity by Mimicry

- The collective existence of observers and observed derives from one **mimicking** the other unremittingly: They can adopt each other's role, so observers and observed are always **equivalent yet distinct**.
- No entity, like a particle or even a history, has individual significance; one needs a proper example to compare to.
- This mimicry also holds for black holes…
- Under the observational act of mimicry Wheeler's quantum foam of **mini wormholes** is then globally **induced by macroscopic black holes**.

Topological induction of mini BHs because of mimicry

- Every t_P a **pair** of mini wormholes is induced by a BH because it Hawking evaporates and thus behaves as a wormhole in a topological sense: the entrance and exit both require a BH mimic for their 4D (historical) identity.
- Planckian wormholes evaporate in about $t_{ev} \sim t_P$.
- **Macroscopic** BHs live longer than a Hubble time and generate globally **stable** quantum foam mass density Λ.
- $\mathbf{\Lambda = 2N_{BH}\, m_P / L_f^3}$, with L_f the size of the universe when the first BH with $t_{ev} > t_{univ}$, forms: **L_f is frozen in** when a global 4-space topology in the sense of Mach emerges.
- In fact: $N_{BH} = Y_{star}\, ß_{BH}\, (þ_c\, L_f^3)/\mu_{BH}$ yields $þ_c \sim 10^{14}$ g cm^{-3} for $Y_{star} \sim 10^{-2}$, $ß_{BH} \sim 10^{-3}$, $\mu_{BH} \sim 3M_o$, $N_{BH} \sim 10^{19}$ today
  = a global density that matter experiences gravitationally
  = a typical neutron star density…!

Dark Energy

- Cosmological observations suggest an accelerated expansion of the universe, usually attributed to some form of vacuum energy Λ: Einstein's cosmological constant in the form of dark energy (Riess ea 98, Perlmutter ea 98), with $\rho_0 \sim 10^{-29}$ g cm^{-3}.
- About $N_{BH} \sim 10^{19}$ today, in the observable universe.
- Topological induction yields dark energy that follows the **number** of macroscopic BHs in the universe.

  Induced Planckian BHs require an increase in 4-volume for their embedding: $L_f \approx 2 \times 10^{14}$ cm from ρ_0 and N_{BH}.
- Observed star/BH formation history of universe yields: $\Lambda(z)/\Lambda(0) \sim (1+z)^{-0.36}$, $z<1$; a ~30% decline: **$w \approx -1.1$**, not constant, consistent with observations.
  In fact, **$w = -1.08 \pm 6\%$** (Hinshaw ea 13; Planck: Ade ea 15).

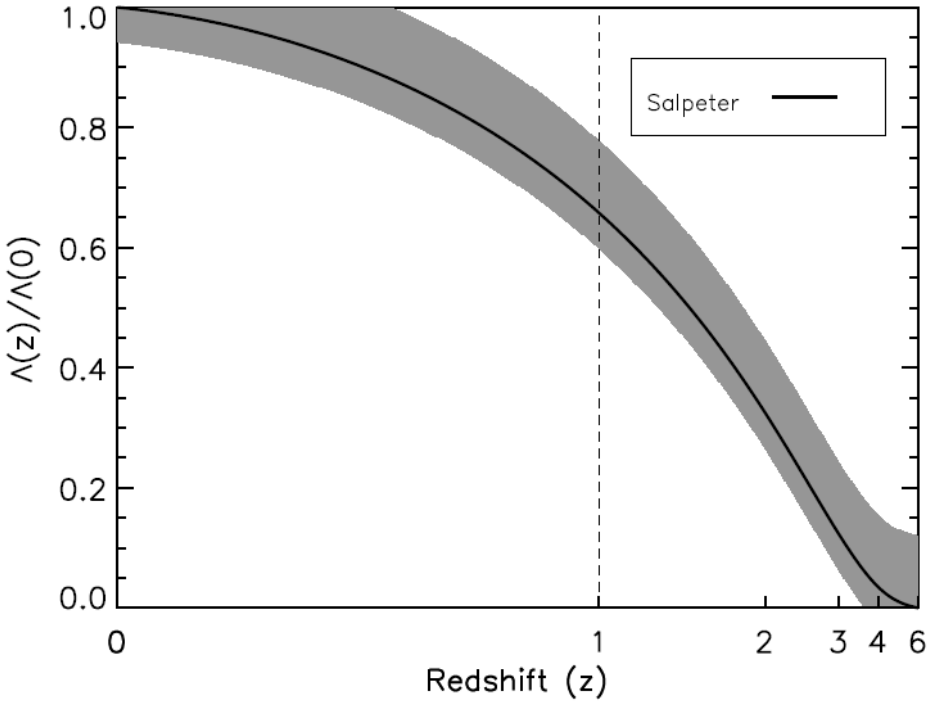


Fig. 1.— Redshift evolution of Λ derived from the type II SN rate data of Hopkins & Beacom (2006). The shading represents the observational uncertainty in deriving the type II SN rate.

Summary

- Observer-observed mimicry, implicit in Einstein's elevator thought experiment, expresses what equivalent yet distinct information is needed for gravity.
- This mimicry principle applied to black holes leads to the induction of Wheeler's quantum foam by the **number** of macroscopic BHs.

Thank You!

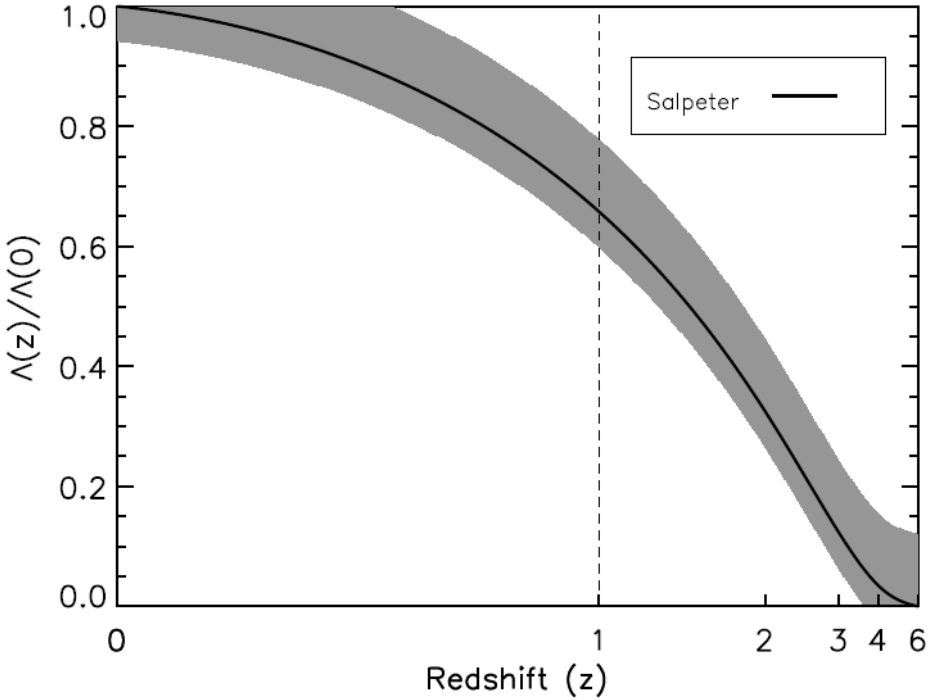
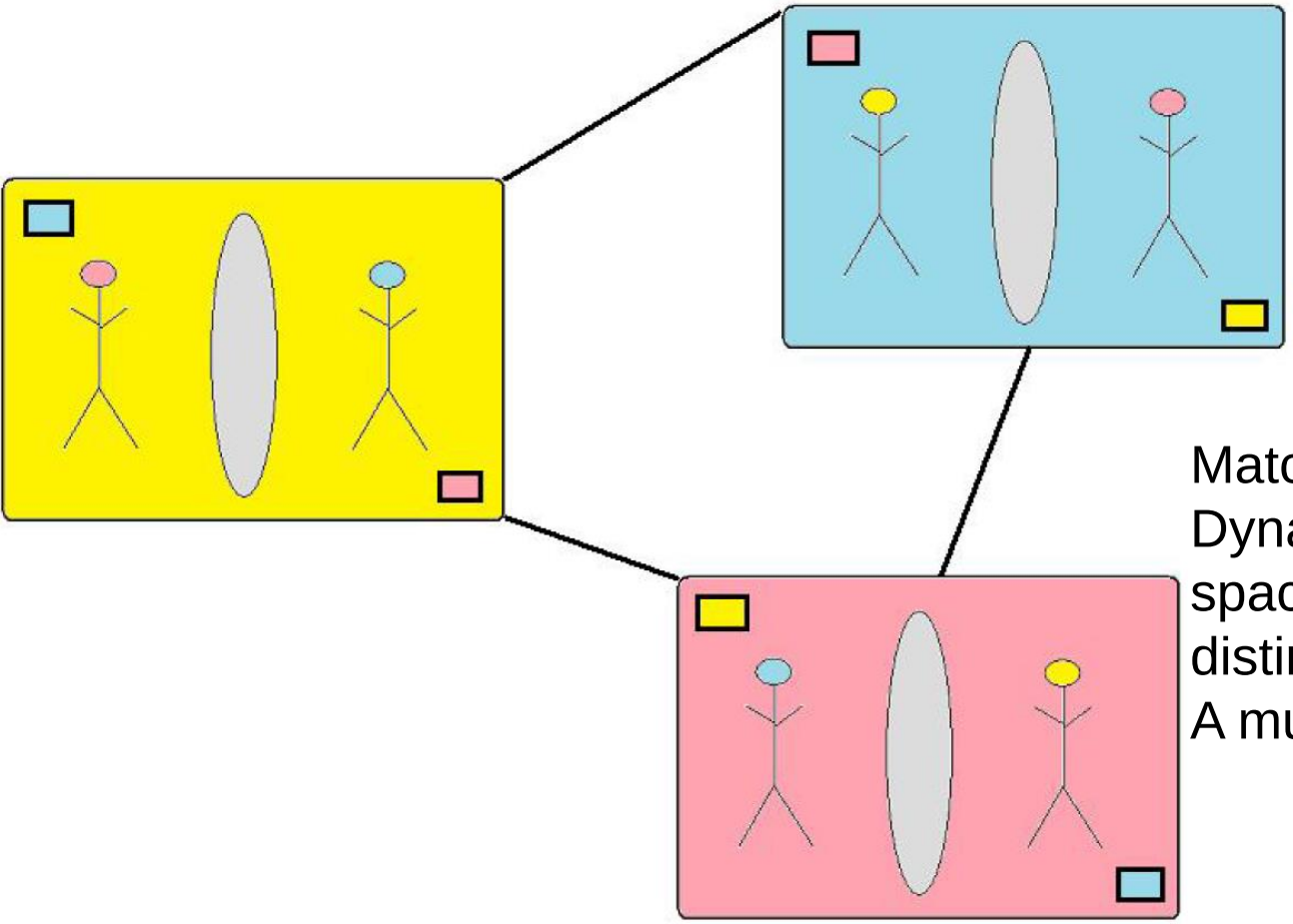


Fig. 1.— Redshift evolution of Λ derived from the type II SN rate data of Hopkins & Beacom (2006). The shading represents the observational uncertainty in deriving the type II SN rate.

The **Mimicry Principle:**

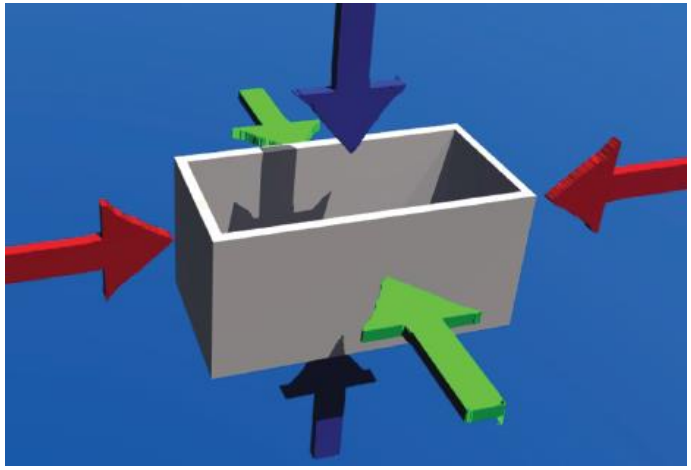
Any observer can mimic any observed's identity in terms of locally causal events, but only through the **induction** of four-space histories that are always globally distinct.

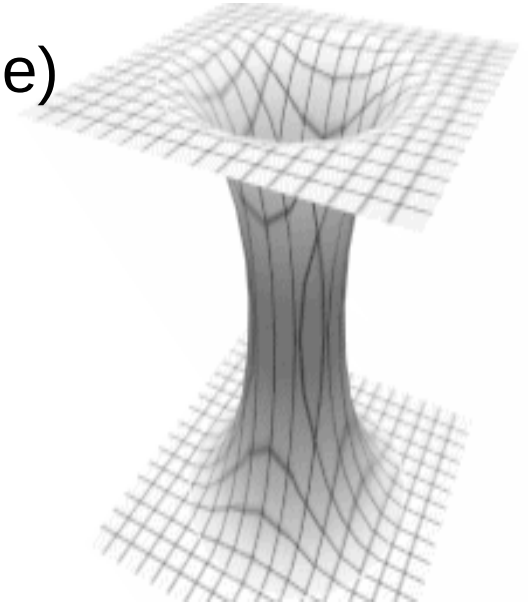


Matching colored squares = Dynamical S^1 loops through 4-space yield the induction of distinct entangled histories = A multiply connected universe

Multiply Connected Space-Time

- Topologically distinct paths, under **homeomorphisms**, between any two points:
- Use **loops** in T^3, S^1xS^2 (and S^3 as glue)

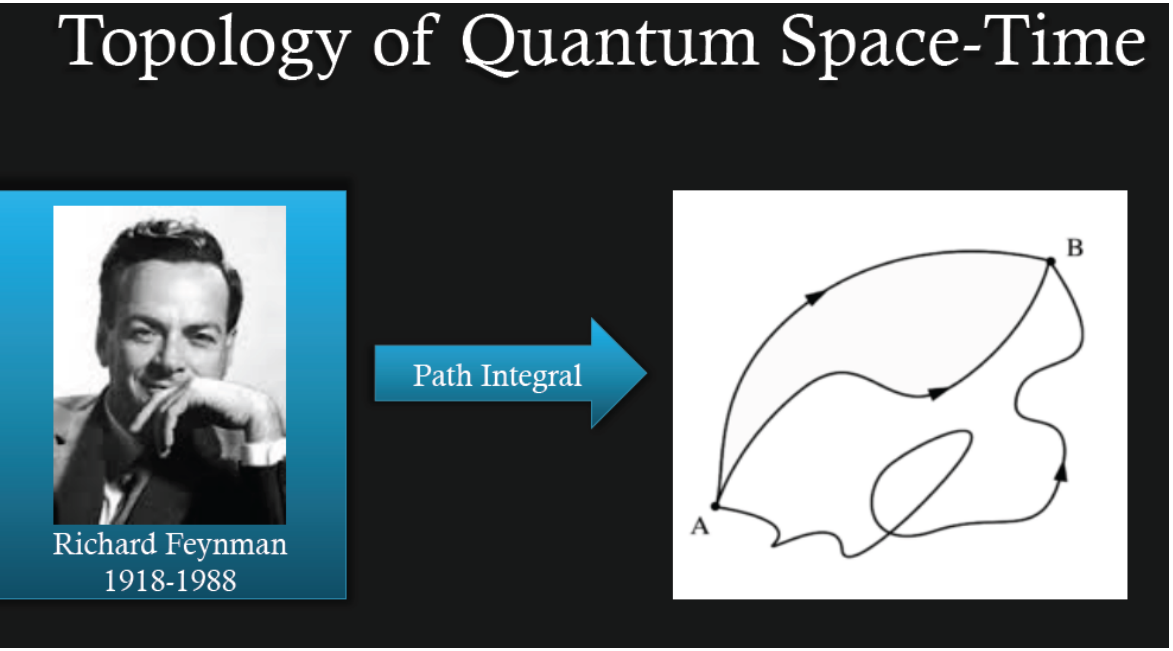




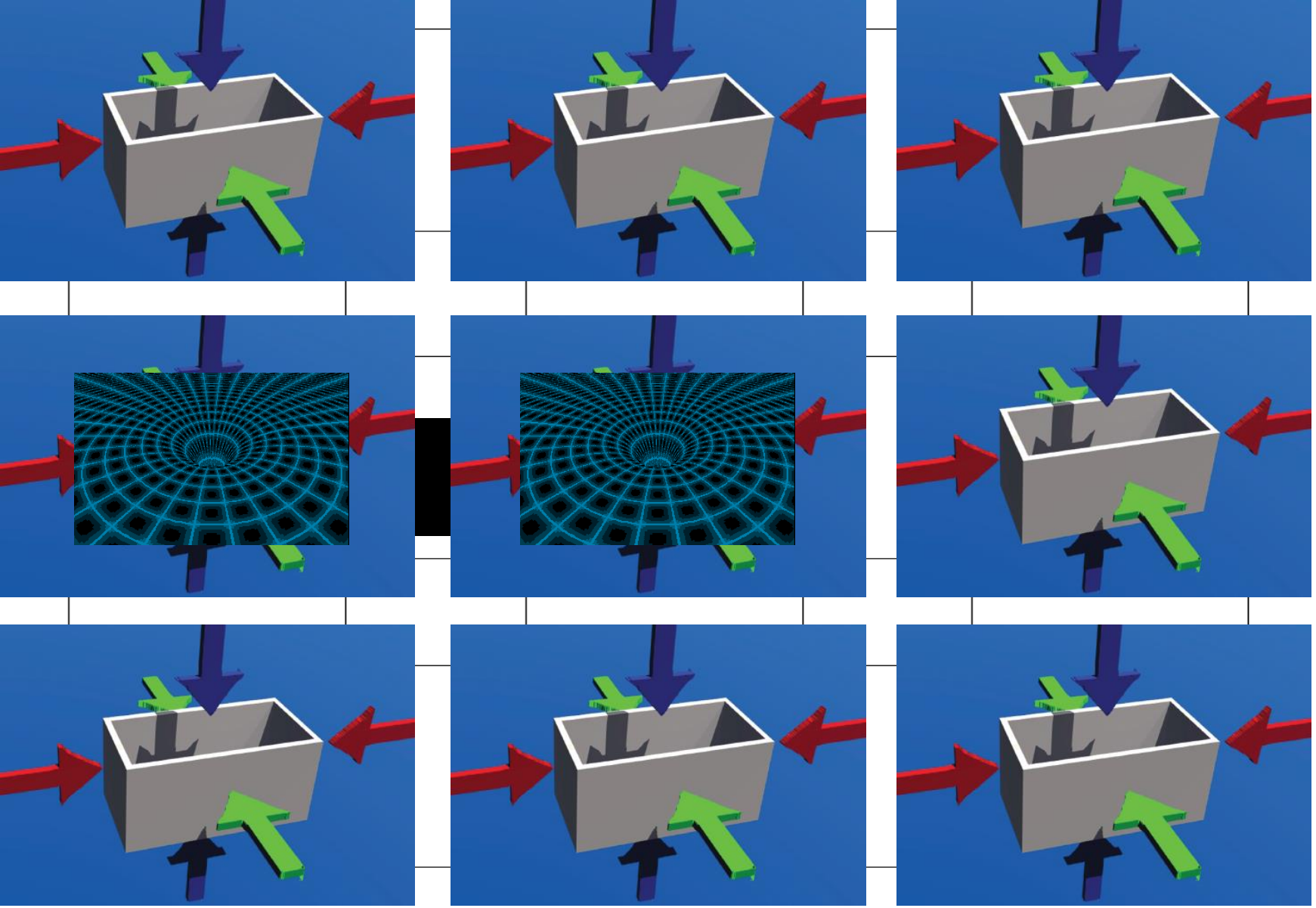
- Build a **lattice** of three-tori, with spacing L_{Planck}, to travel through **4D** space-time as an expression of the superposition principle and attach Wheeler's handles: Quantum paths that connect points are then **globally identified** through **non-contractible** loops.

Such a lattice of three-tori yields Feynman's path integral

- A particle/wave travels along many paths as an expression of the **superposition principle:** connect any A to any B.
- $\int_{\text{paths}} e^{iS}$ leads to a semi-classical world line and a large scale limit for GR. But, how to distinguish paths on L_P?



Observers cannot tell paths apart **locally**!



Summary

- Observer-observed mimicry, implicit in Einstein's elevator thought experiment, expresses what equivalent yet distinct information is needed for gravity.
- The mimicry principle applied to black holes leads to the induction of Wheeler's quantum foam by the **number** of macroscopic BHs, i.e., a testable form of dark energy.

- Inflation driven by induced mini BHs: n≥55 e-foldings, $n \sim \ln(L_f/L_{Planck})^{1/2} \sim \ln N_{BH}^{1/6}$.
- Further scrutiny of the lattice of three-tori leads to: quantum fluctuations with $\mathbf{n_s = 1 - r \approx \ln(7)/n = 0.96}$.