Physics on a Branched Knotted Spacetime Manifold

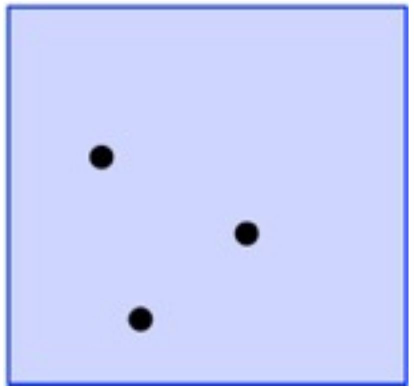
Short Presentation

C. Ellgen
G. Biehle

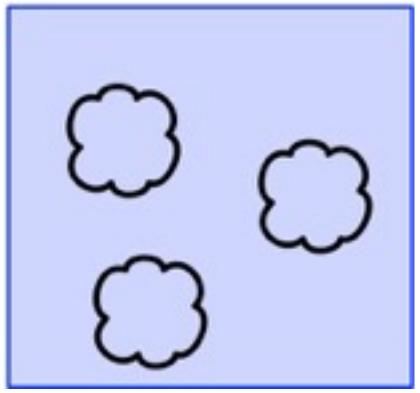
cellgen@gmail.com

Brief historical context

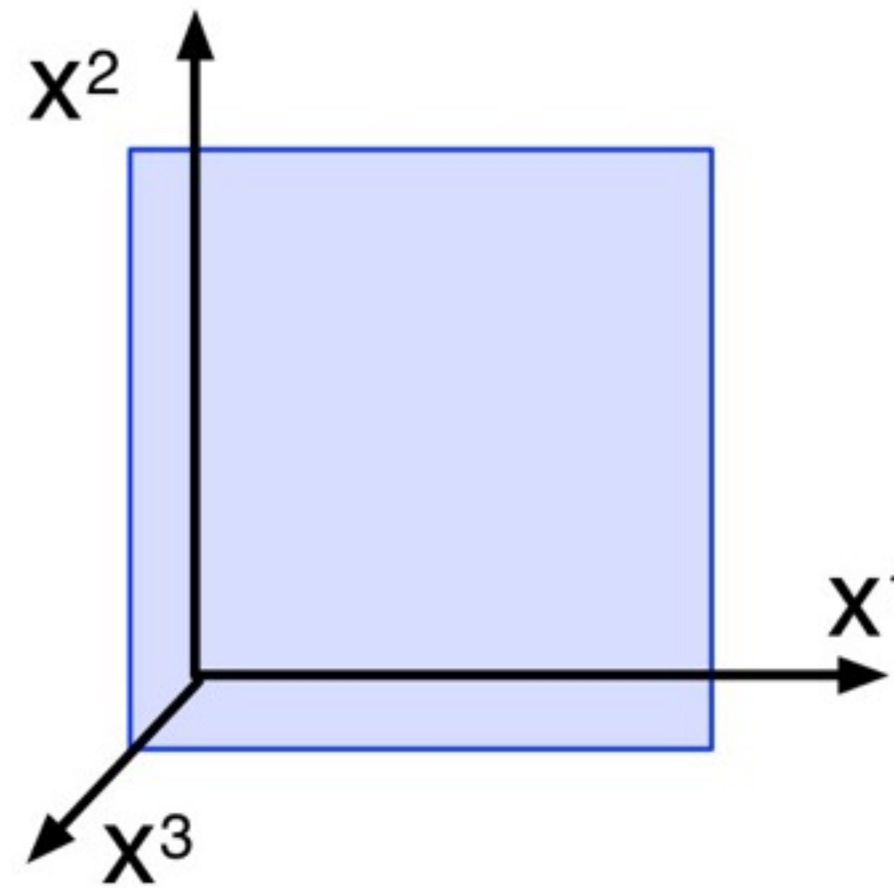
General relativity:
Pointlike particles produce infinities.



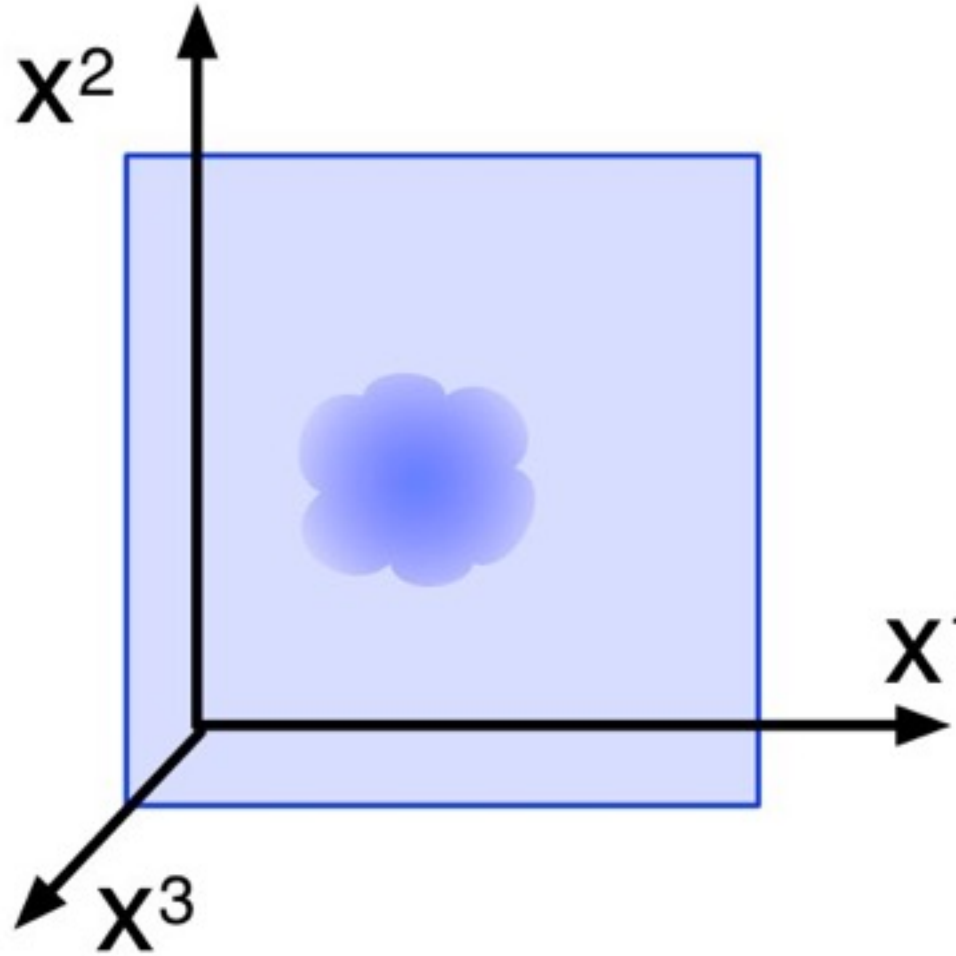
M-theory:
Stringy particles maintain finiteness, but the diversity of Calabi-Yau spaces makes predictions difficult.



This theory:
Particles are knots in spacetime, never pointlike. Prediction is possible.

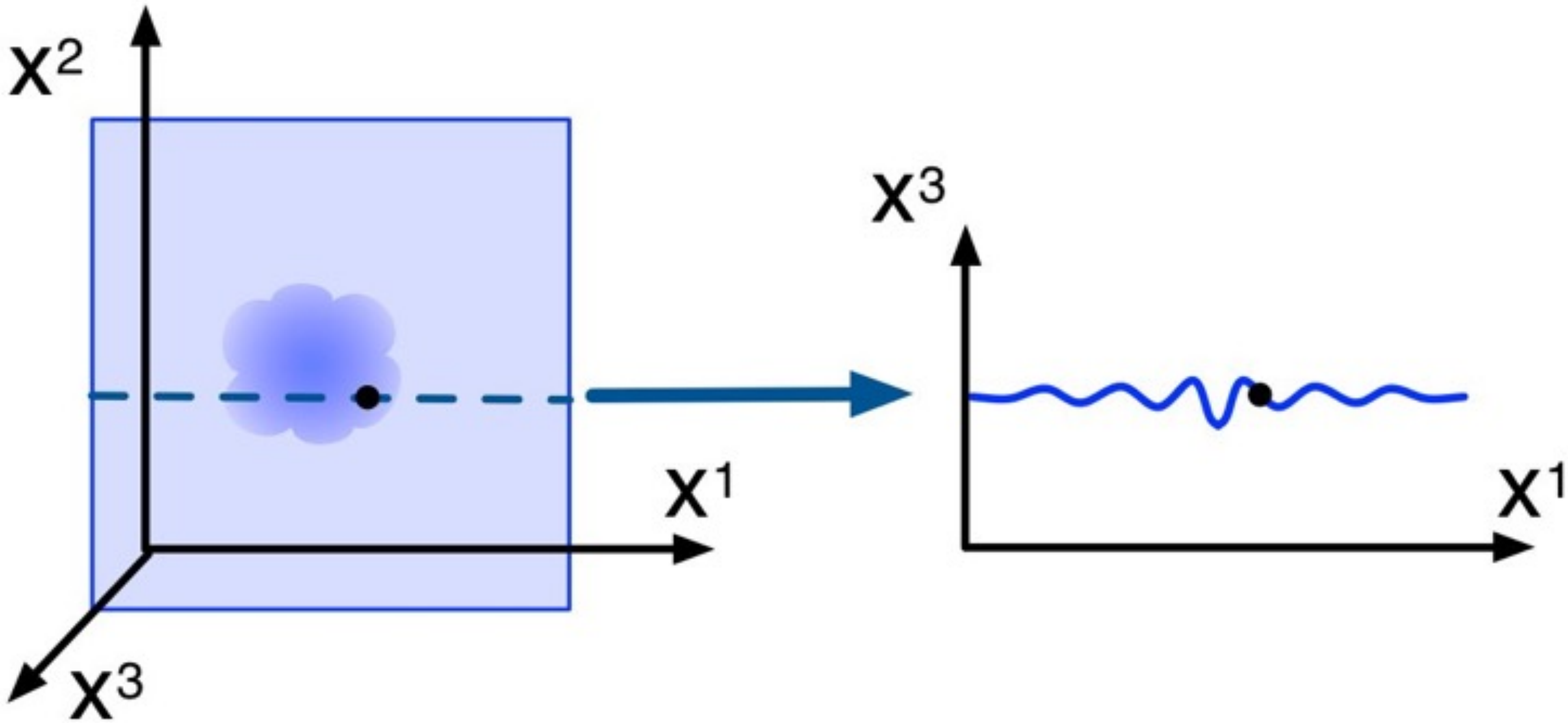


M is the spacetime 3+1-manifold.
M is embedded in a Minkowski 5+1-space Ω .
The metric on Ω is $\eta_{\mu\nu}$.
The inherited metric on M is $\bar{\eta}_{\mu\nu}$.



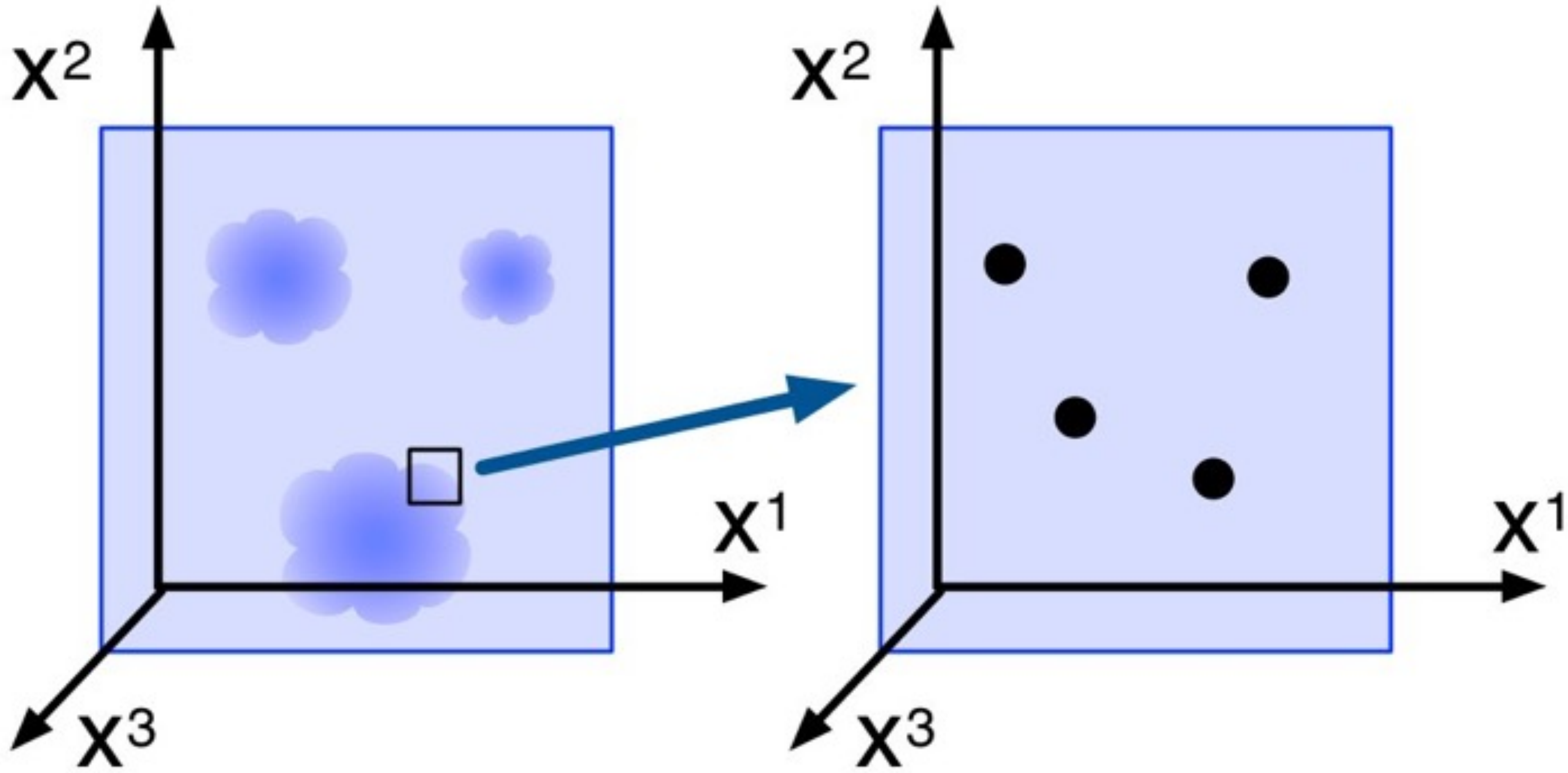
Begin at an astronomical scale. We look at the manifold as observers in the Minkowski space Ω .

In this diagram we see a massive object. Mass affects the curvature of M by changing the shape of M as an embedding in Ω .

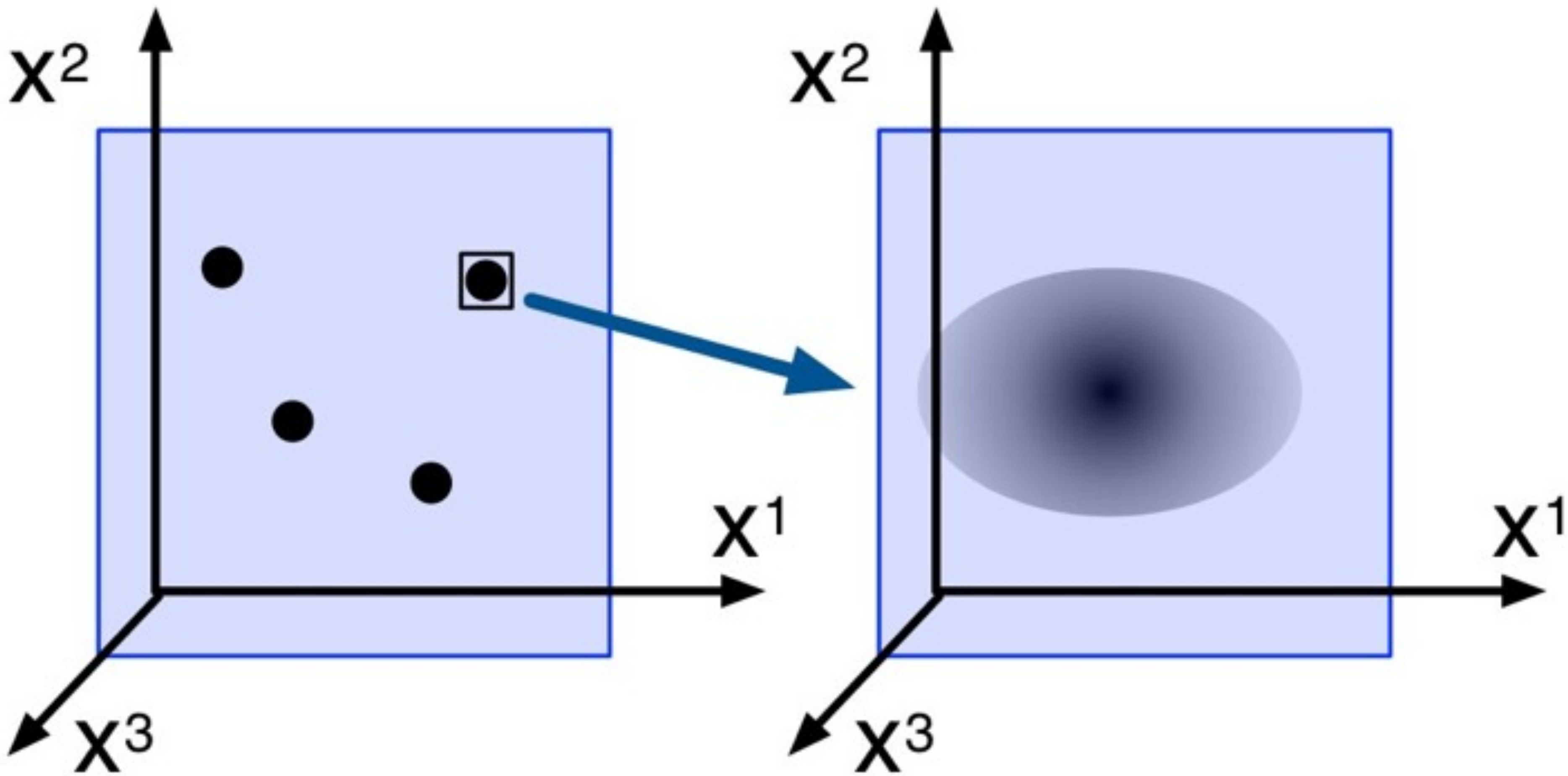


We can see how mass changes the shape of M by taking a slice through the manifold.

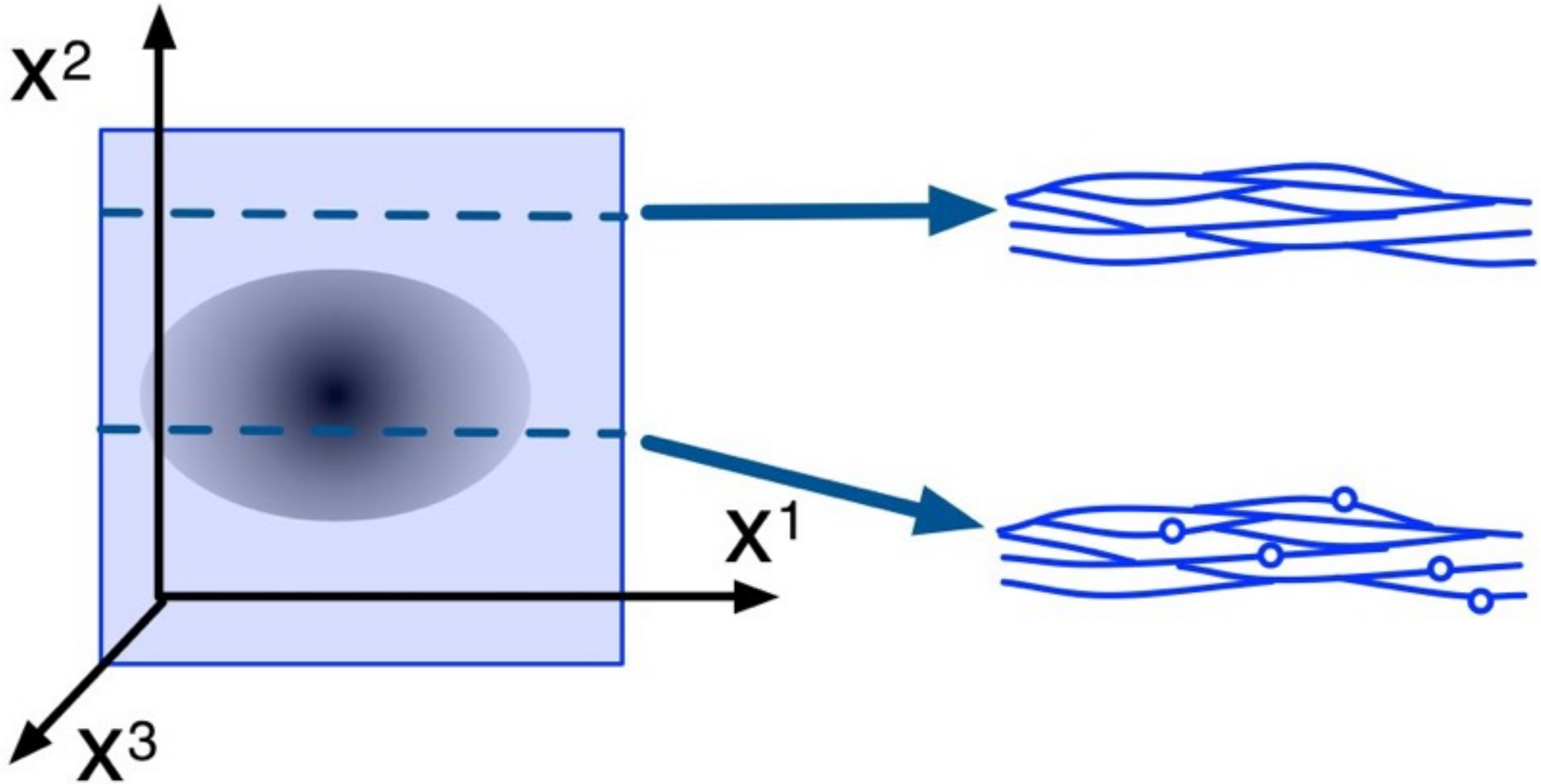
The manifold M also changes in time. It is moving in a Minkowski space. Therefore a clock on the spacetime manifold will experience time dilation.

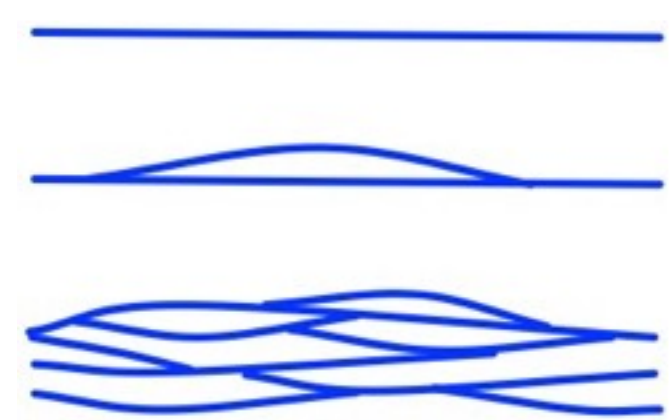


Getting closer to the masses, we see that they consist of individual particles, like protons and electrons.

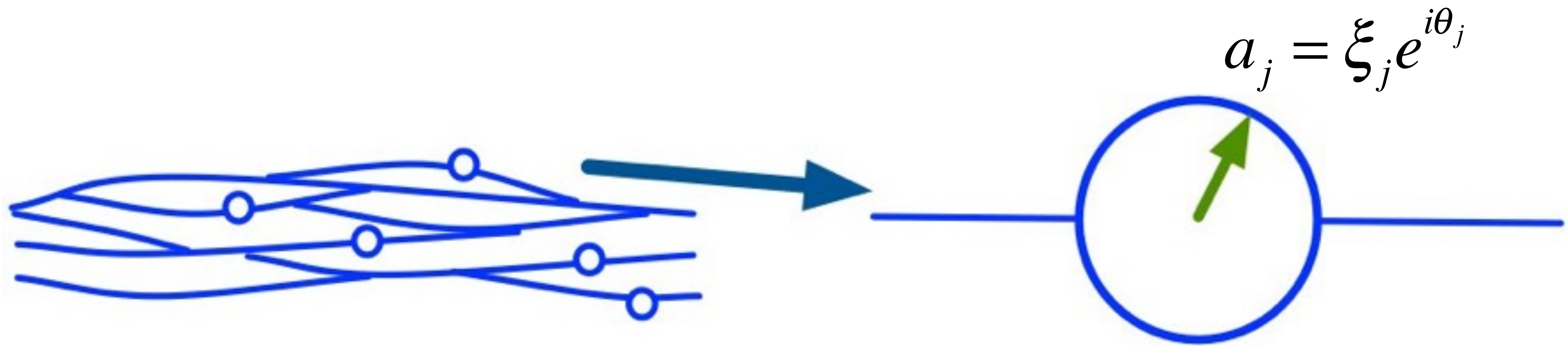


Getting closer to an individual particle, we see that it has a quantum probability distribution that describes its location.

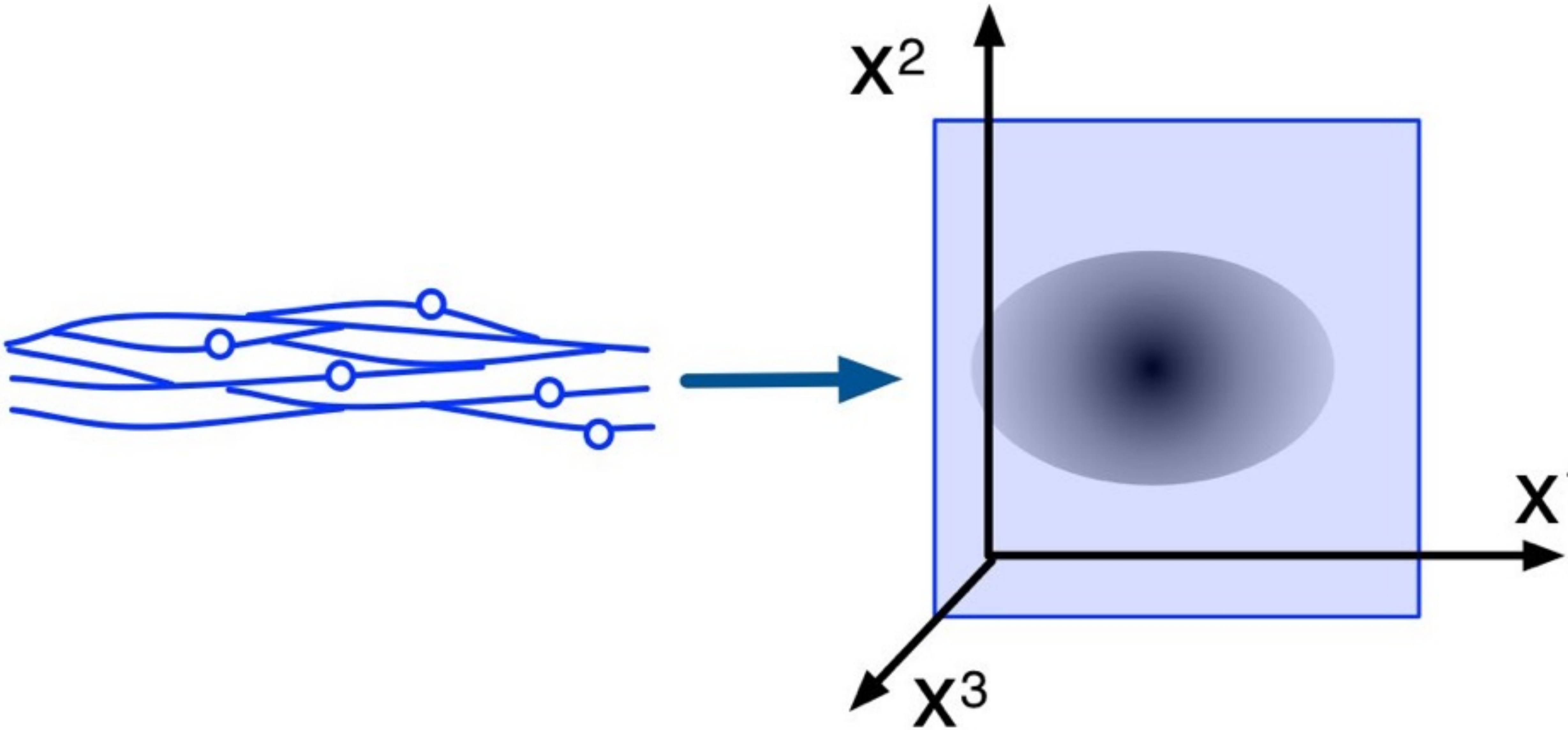




Getting still closer, we see that the manifold is branched. The branches have knots. One particle has a knot on each branch. The quantum distribution is a distribution of knots.



The knots have geometry that can change in magnitude and in angle. In co-dimension 2, represent that magnitude and angle using a 2-vector or a single complex number.



Interaction of the branches causes interaction of the knots on the branches. The knot geometries are affected by the interaction, producing interference. We can model the discrete interacting branches using a continuous model, a path integral.

Assumptions:

M is a branched 3+1-manifold.
M is embedded in a Minkowski 5+1-space.

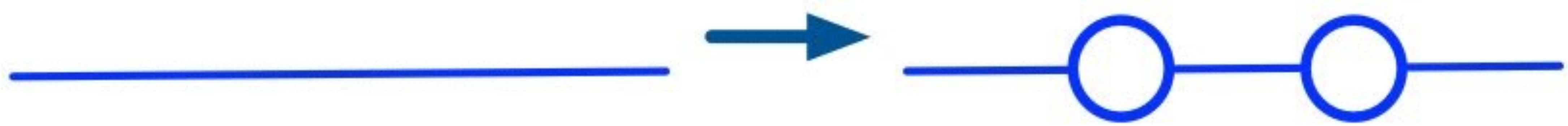
A^{ν} is a vector field on M such that $\det(A_{\alpha,\mu}A^{\alpha}_{\ ,\nu}) = -1$.
ρ is a conformal factor on M.
Define the metric $g_{\mu\nu} = \rho^2 A^{\alpha}_{\ ,\mu} A_{\alpha,\nu}$.

For all points p, the future cone g^{+} must intersect η^{+}.

The metric $g_{\mu\nu}$ is Ricci flat, $\hat{R}^{\mu\nu} = 0$.

Branch weight $w = \sqrt{|\det g|} = \rho^4$ is preserved at branching and $w \geq 1$ everywhere.

Knots



Our assumptions allow the manifold to spontaneously produce pairs of knots, that have topology $\mathbb{R}^3 \# (S^1 \times P^2)$.

These knots are the elementary fermions. Different embeddings of $\mathbb{R}^3 \# (S^1 \times P^2)$ give different generations of fermions.

Dynamics

The spacetime manifold M is under-constrained.

M maximizes entropy S.

Use a Lagrangian L to calculate the entropy

$$S = \int L\, dM$$

The entropy is the action for that Lagrangian.

Forces

We derive a Lagrangian that estimates the entropy.

R is scalar curvature relative to $\bar{\eta}_{\mu\nu}$.
Define $F^{\mu\nu} = A^{\nu,\mu} - A^{\mu,\nu}$. Then

$$L = w((1/2)F^{\mu\nu}F_{\mu\nu} - R)$$

There are terms for **electromagnetism** and **gravity**.

The knots $\mathbb{R}^3\#(S^1 \times P^2)$ can link. Linked $\mathbb{R}^3\#(S^1 \times P^2)$ are quarks. They cannot be separated. That topological effect is the **strong force**.

Electroweak unification results from knot geometry.

Calculation

An electron is $\mathbb{R}^3 \#(S^1 \times P^2)$. We use the Lagrangian to find a relationship between the electron's charge and its spin angular momentum. This gives a comparison between electron charge and Planck's constant.
We can therefore derive the fine structure constant.

$\alpha_{est}^{-1} \approx 136.85$ error 0.13% ($\alpha_{\exp}^{-1} \approx 137.04$ actual)

Probably more Feynman diagrams will give more accuracy.

The coupling runs because the Lagrangian is only a leading order approximation.

Summary

M is a branched 3+1-manifold.
M is embedded in a Minkowski 5+1-space.
The metric $g_{\mu\nu} = \rho^2 A^{\alpha}{}_{,\mu} A_{\alpha,\nu}$ is constrained.

Topology change produces knots $\mathbb{R}^3 \# (S^1 \times P^2)$.

Interaction of branches produces quantum interference.

Maximization of entropy produces fields and forces.

Further information

www.knotphysics.net

Physics on a Branched Knotted Spacetime Manifold
Knot physics: Neutrino helicity
Knot physics: Deriving the fine structure constant

C. Ellgen B.S. Mathematics Caltech
G. Biehle Ph.D. Physics Caltech

cellgen@gmail.com