Abstract: I will discuss explorations of fundamental physics via the LHC, as well as smaller experiments which will play a leading role in the future.
Experiments
Big and Small

Scale in meters

Hubble

10^{26}

Neutrinos
Dark Energy

10^{-4}

Standard
Model

10^{-12}

LHC

10^{-18}

Planck

10^{-35}

Savas Dimopoulos
Stanford University
The Scales in our Universe

Hubble

$10^{26}$

Neutrinos
Dark Energy

$10^{-4}$

Standard
Model

$10^{-12}$

LHC

$10^{-18}$

Planck

$10^{-35}$

Scale in meters

The Hierarchy Problem
Why is Gravity so weak?
Mechanisms to keep scales apart

- Fine-Tuning
- Natural
- Environmental
- Historical
Why Supersymmetry?

Gauge Coupling running at two loops

SM

SUSY

Inverse Gauge Coupling Strength

Log(Energy in GeV)
The Environmental Approach

"the whole evolutionary process, both cosmic and organic, is one, and ... the universe in its very essence is biocentric"

L. J. Henderson
How Do You Probe The Low Energy Frontier?

- Cantilever experiments
- LIGO/Advanced LIGO
- Electromagnetic Cavities
- Atom Interferometry
- Optomechanical Oscillators
- Precision Magnetometry
- New Forces-New dimensions
- Gravitational Waves
- Axions - Photons
- Gravitational Waves
- New Forces and Gravitational Waves
- Axion(s)
**Light vs Atom Interferometry**

**Light**

\[ \frac{\delta L}{L} \approx \frac{\lambda}{L} \times \text{phase resolution} \]

**Atoms**

For atoms \( T \approx 1 \text{ sec} \)

\[ L = cT \approx \text{Earth-Moon distance!} \]
Gravitational Wave Detection with Atom Interferometry

SD, Graham, Hogan, Kasevich, Rajendran
2008

\[ L \sim 1000 \text{ km} \]

Physical Distances between atoms oscillate with the GW amplitude:
\[ L = L_0 (1 + h \cos(\omega t)) \]

- Currently funded by NASA NIAC grant (NASA Innovative Advanced Concepts)
- MIGA - Philip Bouyer: Ground based GW detector in Bordeaux
Scattered Experiments

Light Through Walls

Optically Levitated Objects

Atom Interferometry

ADMX

Cantilever Experiments

NMR