Abstract: Our present Core Theory of matter (aka ‘standard model’) was born in the 1970s, a Golden Age for fundamental physics. To date it has passed every experimental test, extending ‘by many orders of magnitude’ to higher energies, shorter distances, and greater precision than were available in the 1970s. Yet we are not satisfied, because the Core Theory postulates four separate interactions and several different kinds of matter, and its equations are lopsided. In this lecture, Prof. Wilczek will describe powerful and extremely beautiful ideas for restoring unity and symmetry to the fundamental laws. These ideas are firmly rooted in empirical reality, but at present the evidence for them is circumstantial. The Large Hadron Collider (LHC) will provide critical tests. If Nature has been teaching, not teasing, discoveries at the LHC will inaugurate a new Golden Age, bringing our fundamental understanding of the physical world to a new level. <kw> Standard model, fundamental physics, experiment, LHC, unification, particle physics, supersymmetry, vacuum fluctuation </kw>
Public Lecture Series

Frank Wilczek
Nobel Laureate
MIT
Anticipating a New Golden Age
The Large Hadron Collider (LHC)
What It Does
LHC is an ultrastroboscopic nanomicroscope for studying deep inner space.
This is what our equations tell us we’d see, everywhere and everywhen, if we had nimbler eyes:
“Empty” space (= ether Grid) has it all, virtually.
“Empty” space (= ether Grid) has it all, virtually.

BUT
In the quantum world, to see something you must *disturb* it.
In the quantum world, to see something you must *disturb* it.

In the deep quantum world, to see something you must *create* it.
Specifically:

To produce a particle of mass $m$, you must supply at least the minimum energy $E$ which that particle can have, namely $E = mc^2$. 
My Vision
1月 2006
月火水木金土日
2 3 4 5 6 7 8
9 10 11 12 13 14 15
16 17 18 19 20 21 22
23 24 25 26 27 28 29
30 31
Cut along solid line; score and fold along dotted lines.
What we see

strength of interaction ↓

- electromagnetic
- weak
- strong

short distance →
What we see

strength of interaction ↓

short distance →

What we calculate*

*
What we see

What we calculate*

strength of interaction ↓

short distance →

*Assuming SUSY
electron  ↔  quarks

photon  ↔  gluons
What we see

strength of interaction ↓

What we calculate*

short distance →

*Assuming SUSY
It only works if we expand our model of the world to include another powerful unifying idea: supersymmetry.
electron ↔ quarks

photon ↔ gluons
Supersymmetry brings in new fluctuations, new corrections ...
Supersymmetry brings in new fluctuations, new corrections ...

... and new particles, which must be produced at the LHC.
Unification ♡ SUSY

\[ \alpha_i^{-1}(\mu) \]

\[ \alpha_1^{-1}(\mu) \text{ electric} \]
\[ \alpha_2^{-1}(\mu) \text{ weak} \]
\[ \alpha_3^{-1}(\mu) \text{ strong} \]

MSSM
\[ M_{\text{SUSY}} = M_Z \]

↑ inverse coupling strength

large energy, short distance →
Unification ♡ SUSY

Gravity fits too! (roughly)

 invers coupling strength

short distance→

\[ \alpha_1^{-1}(\mu) \text{ electric} \]

\[ \alpha_2^{-1}(\mu) \text{ weak} \]

\[ \alpha_3^{-1}(\mu) \text{ strong} \]
Nature is singing a Siren’s song.
Nature is singing a Siren’s song.

Is she teaching, or teasing?
The trial by fire:

Do SUSY’s new particles show up at LHC??
It’s an exciting time to be a physicist!
It’s an exciting time to be a physicist!

It’s an exciting time to be a thinking being!
Suggested Questions
What about dark matter and dark energy?

Will LHC destroy the world?
What about dark matter and dark energy?

Will LHC destroy the world?

What’s it like to win a Nobel Prize?