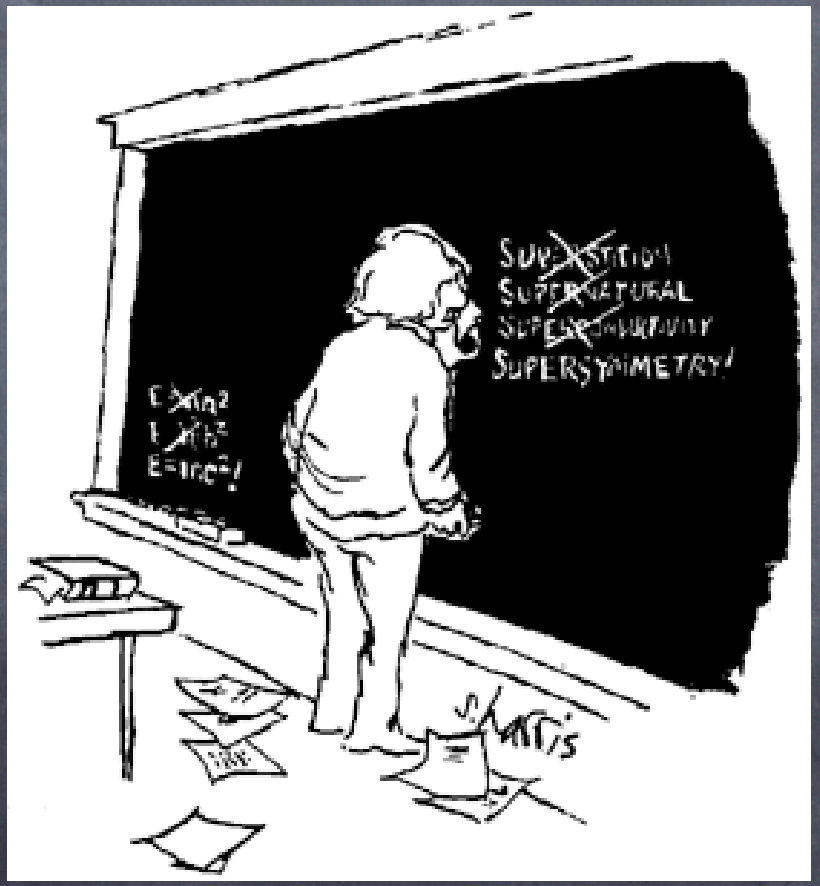
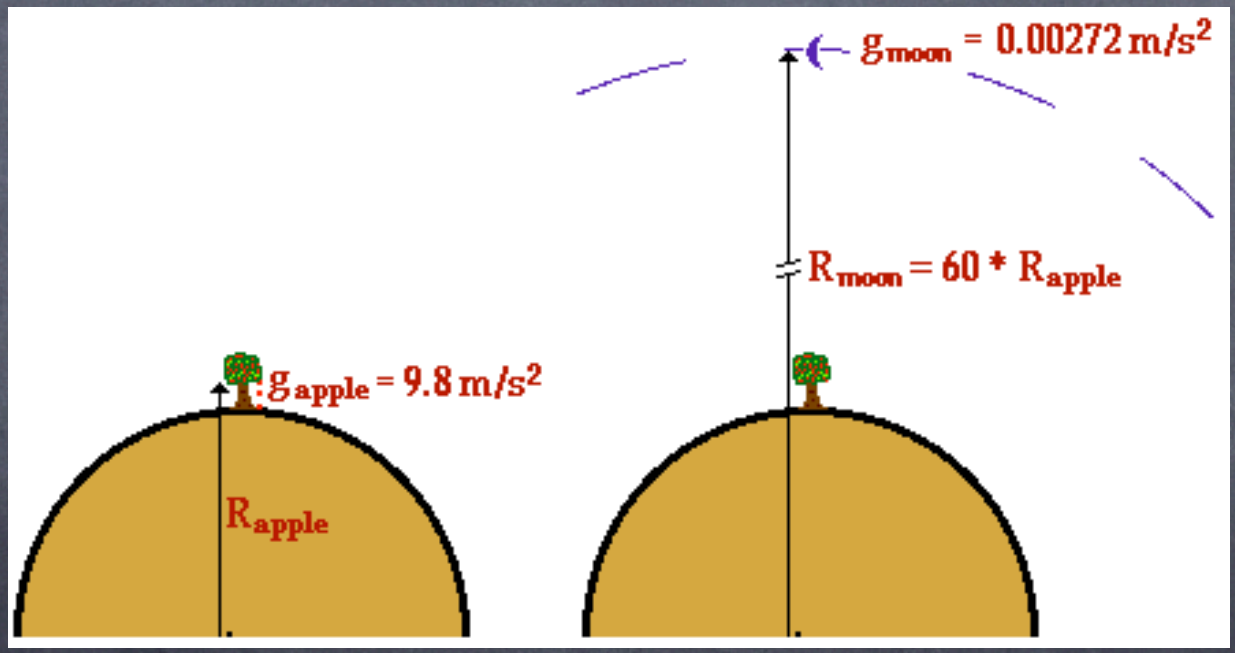
Chapter 13: Supersymmetry

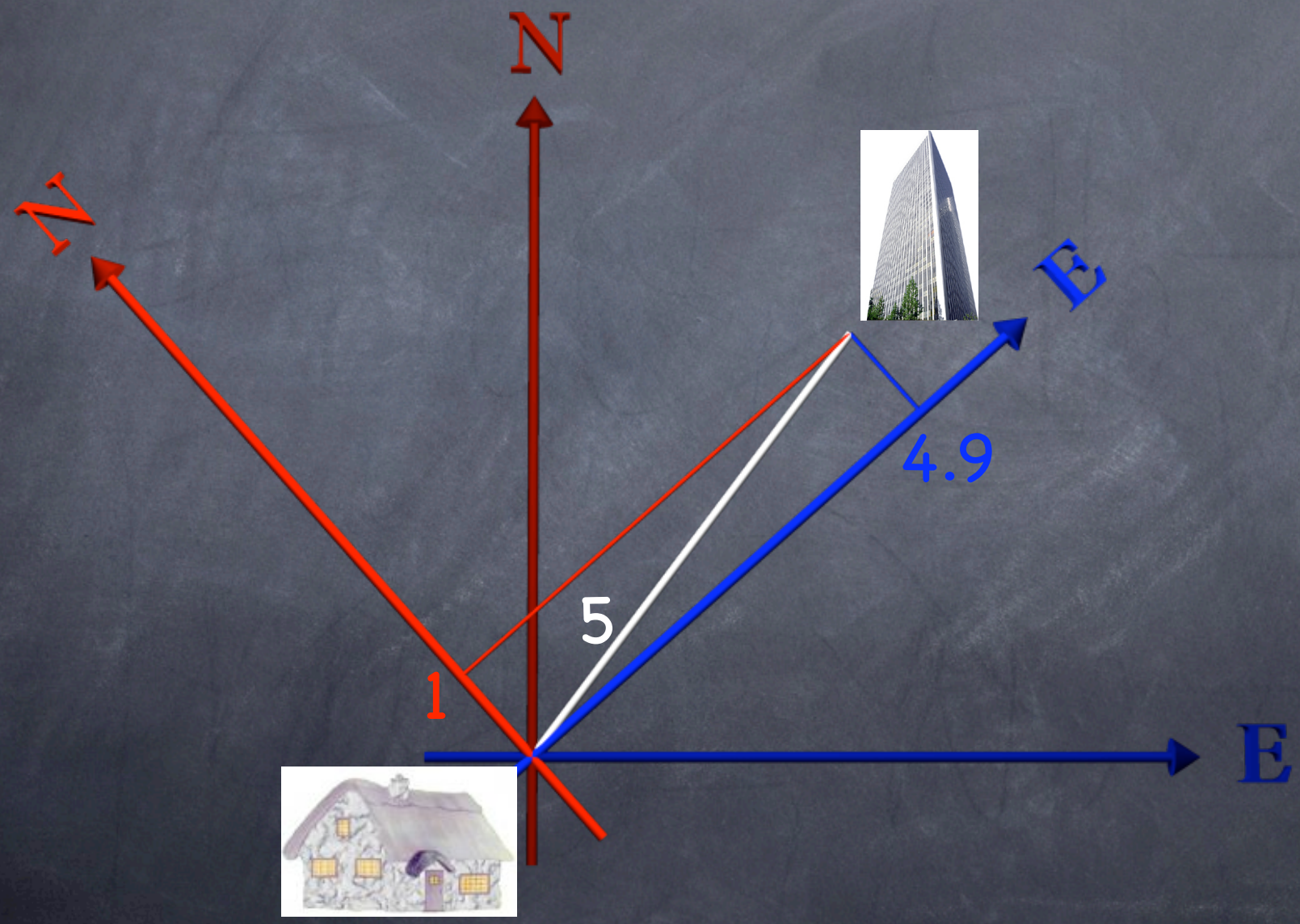
Supersymmetry



Translational and Rotational Symmetry



Rotations Mix North and East

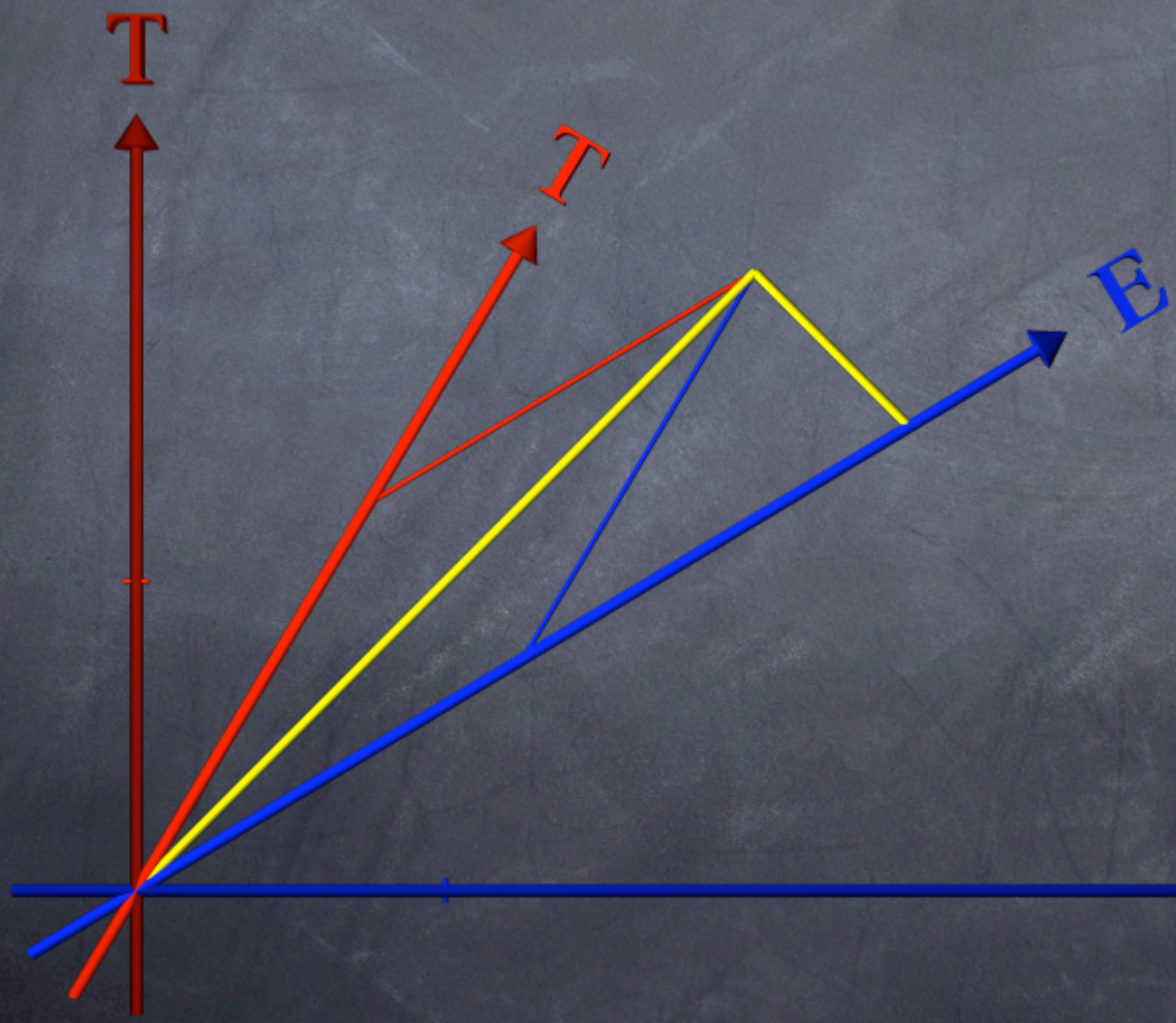


Einstein: New Symmetry

Changing velocity is also a symmetry!

Called a "boost"

Boosts mix space and time



Coleman-Mandula Theorem

No more new symmetries of spacetime
Einstein finished the job!

Loophole

except for symmetries that mix
particles of different spin
SUPERSYMMETRY

fermion  boson

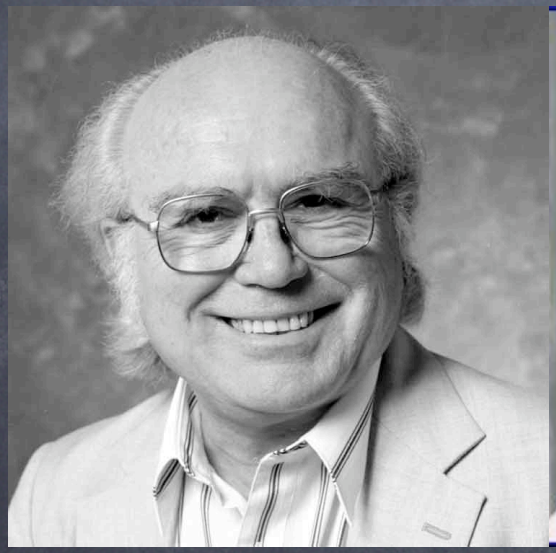
SUSY

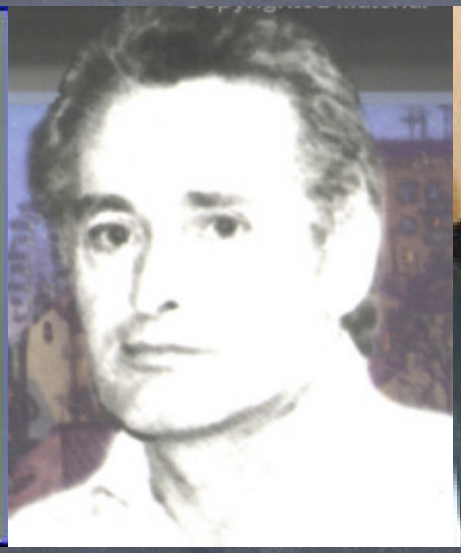
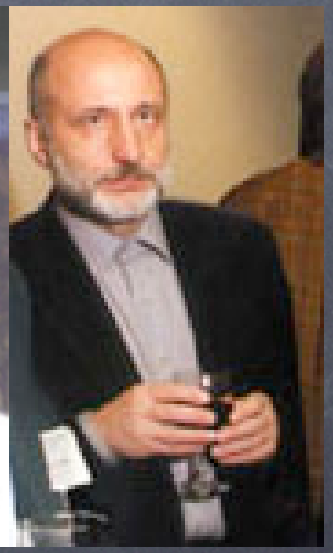
fermion  boson

needed for string theory

solves hierarchy problem

Wess, Zumino, Golfand, Lichtmann



Superpartners

fermions	electron	⟷	selectron	bosons
	quark	⟷	squark	
	neutrino	⟷	sneutrino	
bosons	photon	⟷	photino	fermions
	gluon	⟷	gluino	
	graviton	⟷	gravitino	

Hierarchy Problem

cancellation

Broken SUSY

top squark
Wino boson

up squark
selectron

top quark $\longleftrightarrow$ top squark
W boson $\longleftrightarrow$ Wino boson
photino, sneutrino

up quark $\longleftrightarrow$ up squark
electron $\longleftrightarrow$ selectron

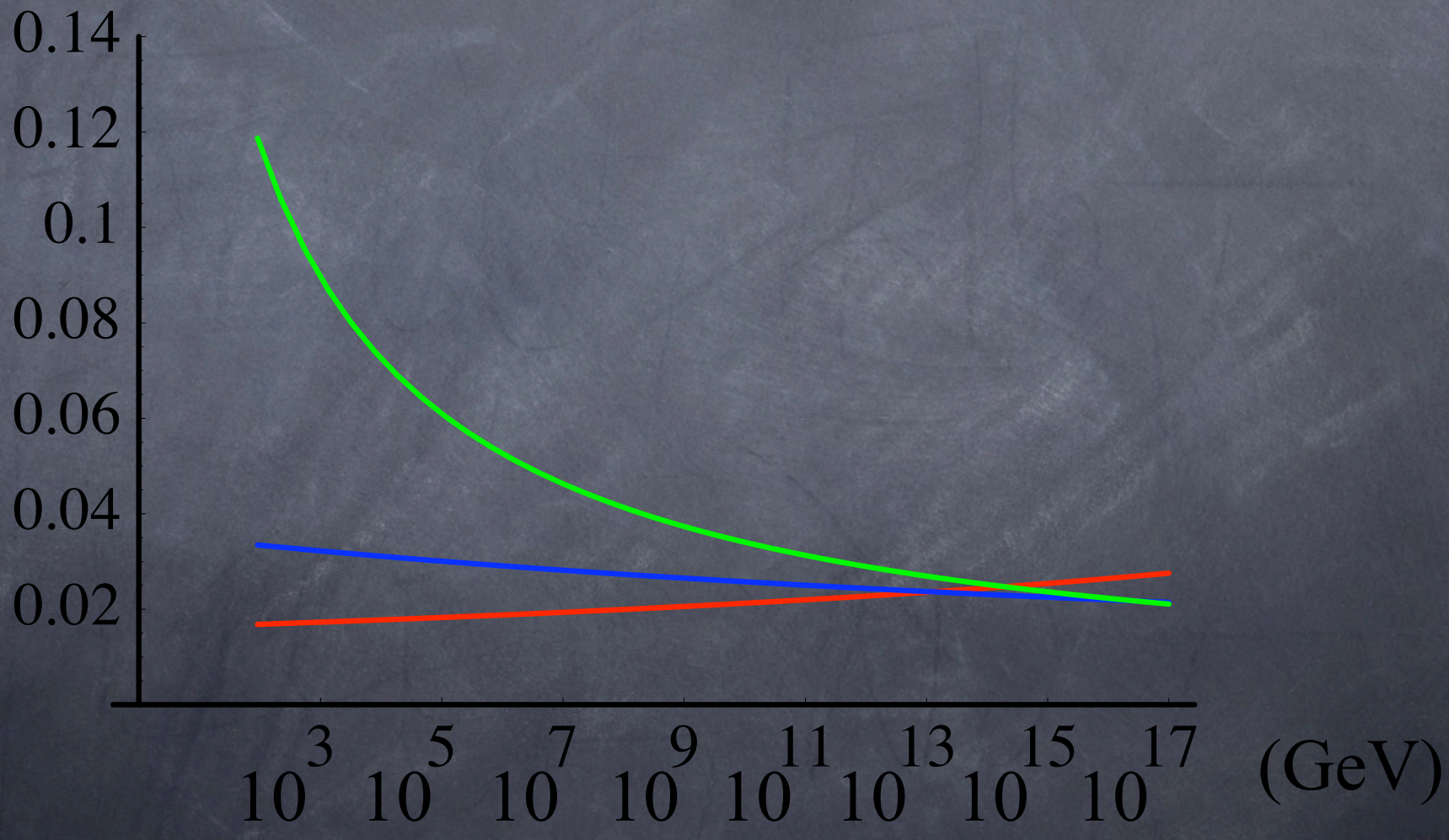
photon, neutrino $\longleftrightarrow$ photino, sneutrino

Broken SUSY

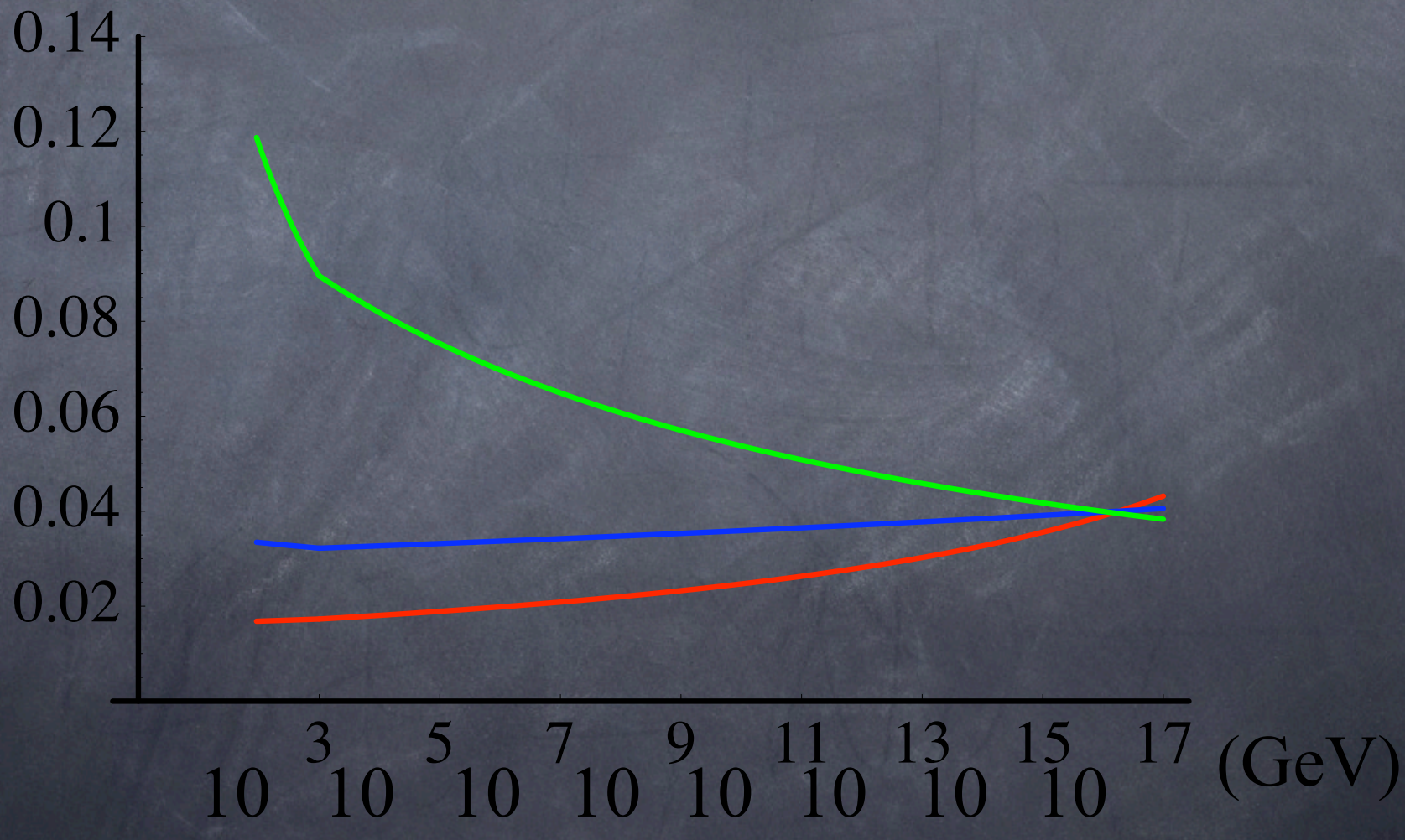
$M_{Higgs} \approx M_{top\ squark}$

accessable at LHC

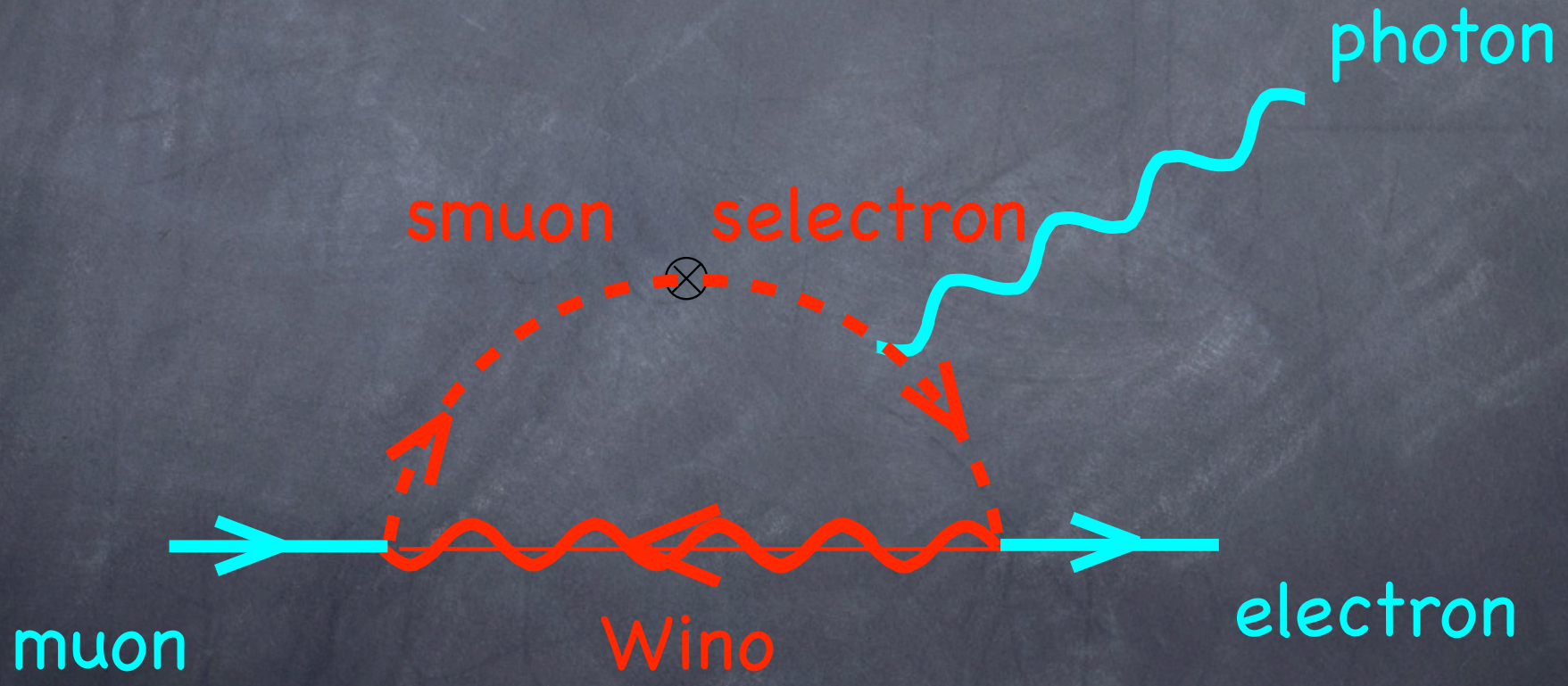
GUT?


0.14
0.12
0.1
0.08
0.06
0.04
0.02
10^3 10^5 10^7 10^9 10^11 10^13 10^15 10^17
(GeV)

SUSY GUT?


0.14
0.12
0.1
0.08
0.06
0.04
0.02
10^3 10^5 10^7 10^9 10^11 10^13 10^15 10^17 (GeV)

SUSY Flavor Problem



Pros and Cons

lightest superpartner could be dark matter

improves unification of forces

Higgs and superpartners should have been seen

have to break SUSY without messing up flavor symmetry