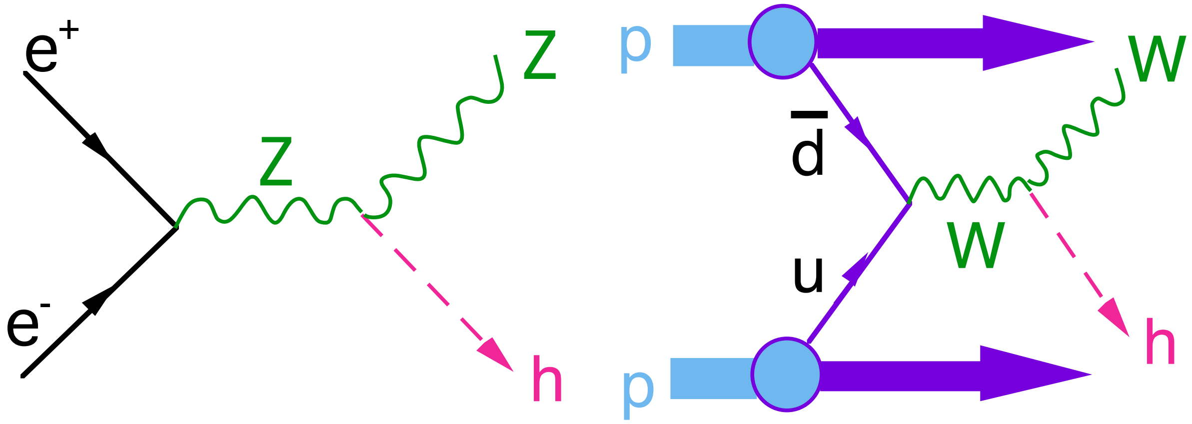
Overview of ILC project

Toshiaki Tauchi (KEK), Special Mini-Workshop
"Undergroud Space Design", KEK, 19th October 2017

Particle Colliders and Experiments

comparison : e^+e^- and pp collisions

The total energy is used in an elementary process at e^+e^-, but a fraction of O(10%) at pp.



e.g. Higgs production at LC LHC

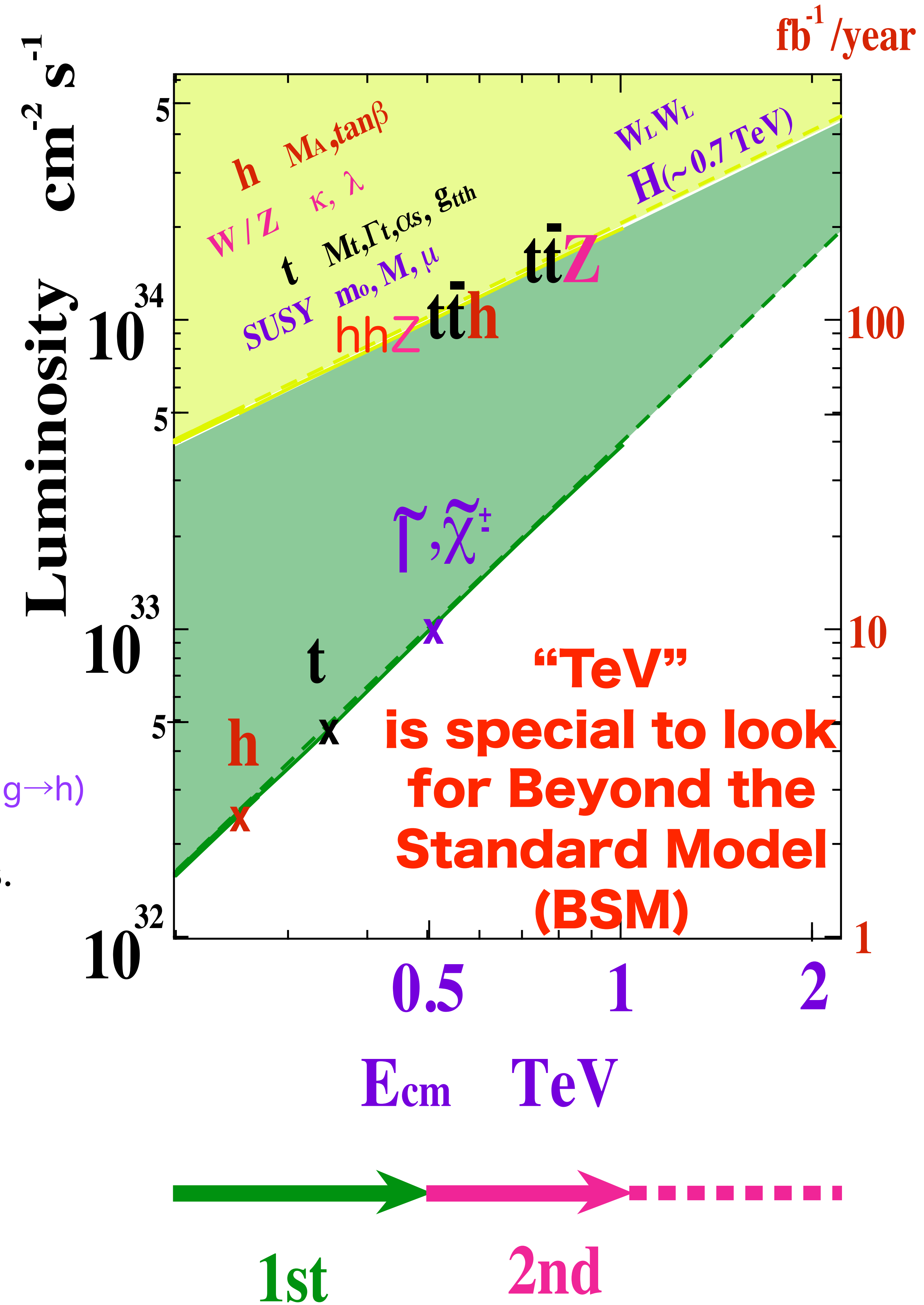
(dominant process is gg→h)

Their cleanness are certainly seen in simulations.

(1) Clear identification of the final state

(2) Precision measurements

Caveat : There could be "un-expected backgrounds" at Linear colliders for frontier machines as well as experiments. (1995)



Particle Colliders all in Undergroud

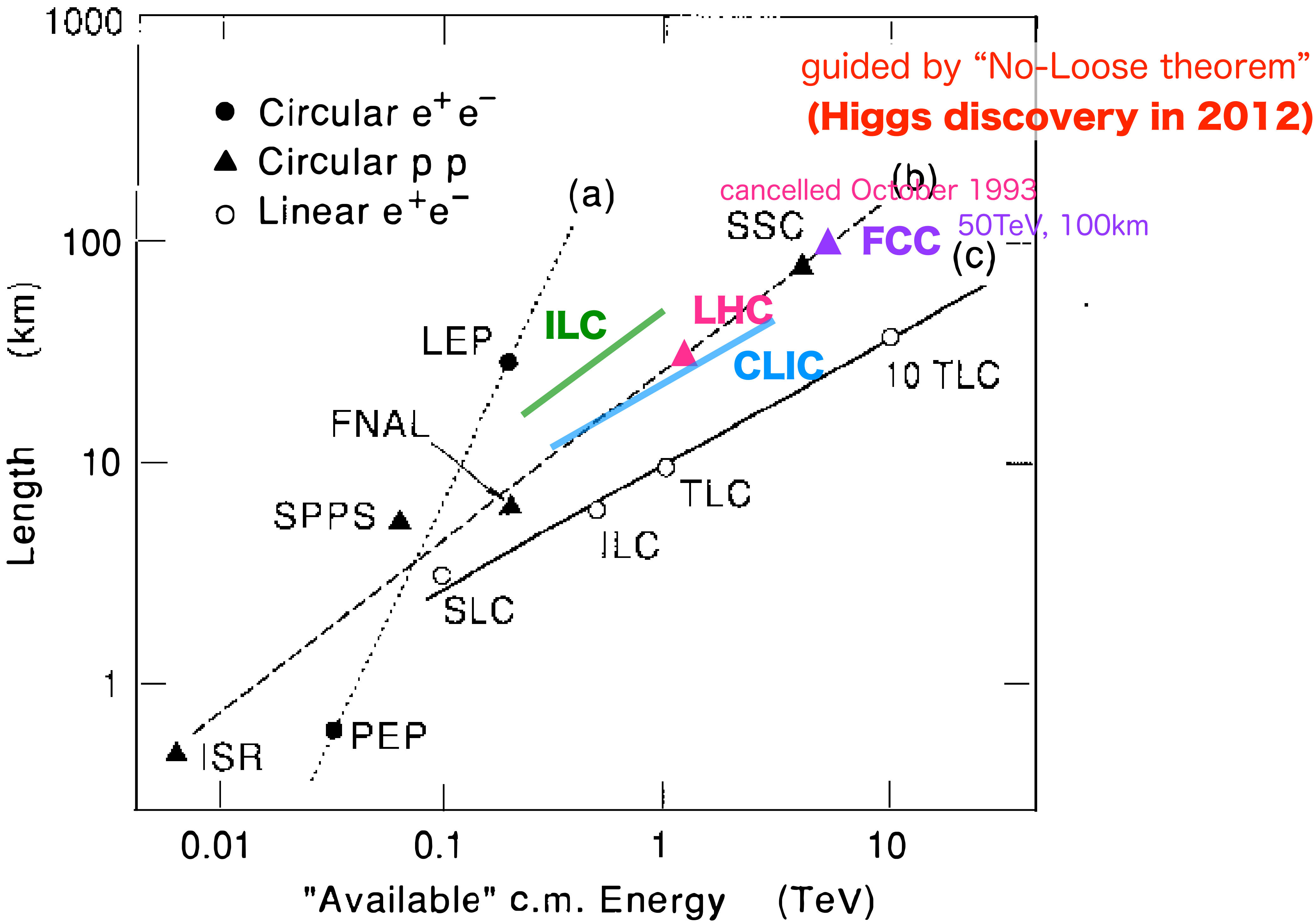
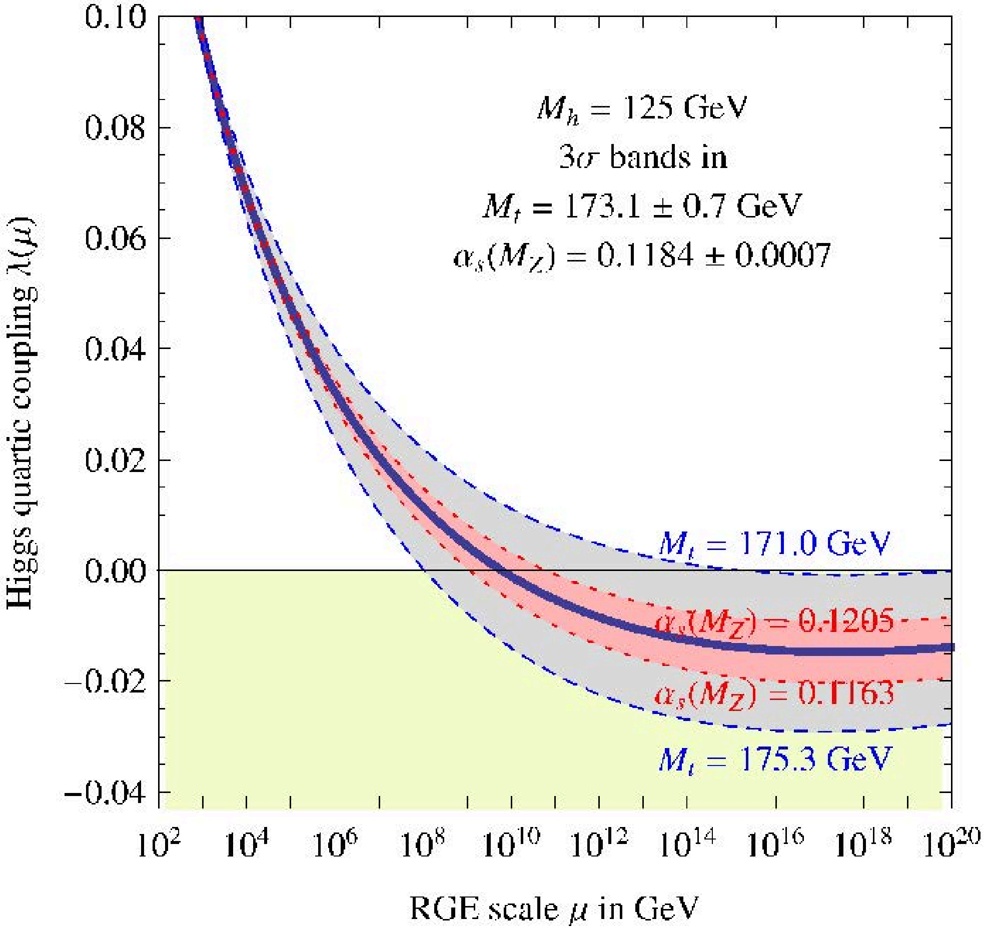


Figure 2 The “available” center-of-mass energy of various colliders, plotted against the circumference or total length of each machine. The available energy for proton or antiproton machines is taken to be one tenth of the total energy. For (*a*) circular electron-positron machines; (*b*) circular proton or antiproton machines; and (*c*) linear electron-positron machines.

R.B. Palmer, "Prospects for high energy e+e- linear colliders", Annu. Rev. Nucl. Part. Sci. 1990. 40: 529-92

Status after the Higgs discovery, 4th July 2012



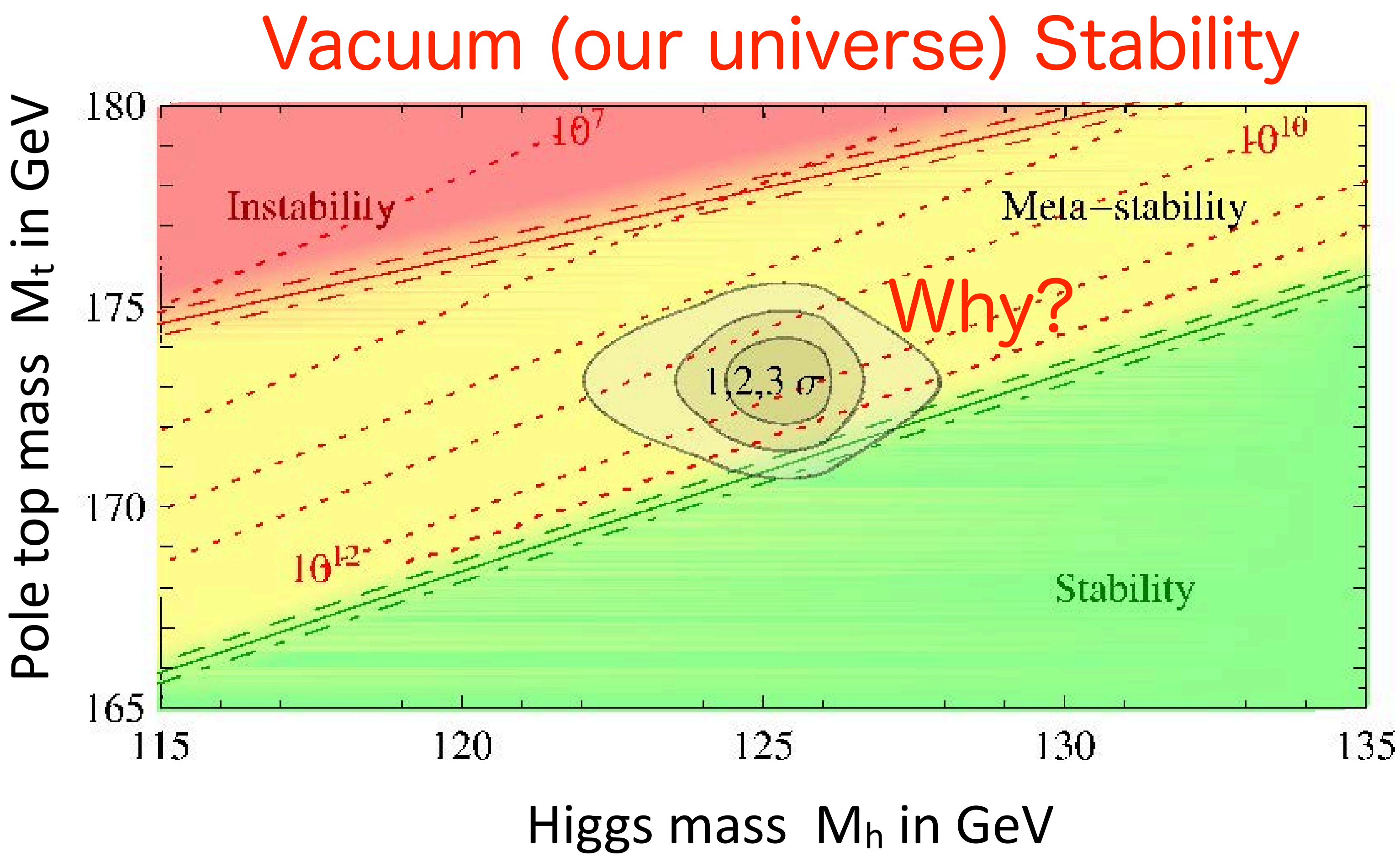


Figure 1.6. *Left*: RG evolution of λ varying M_t and α_s by $\pm 3\sigma$. *Right*: Regions of absolute stability, metastability and instability of the SM vacuum in the M_t–M_h plane in the region of the preferred experimental range of M_h and M_t (the gray areas denote the allowed region at 1, 2, and 3σ). The three boundaries lines correspond to $\alpha_s(M_Z) = 0.1184 \pm 0.0007$, and the grading of the colors indicates the size of the theoretical error. The dotted contour-lines show the instability scale Λ in GeV assuming $\alpha_s(M_Z) = 0.1184$. ICHEP2012 : m_t=173.18±0.94GeV by CDF,D0

$$m_h = 125.09 \pm 0.24 \text{ GeV PDG2016}$$

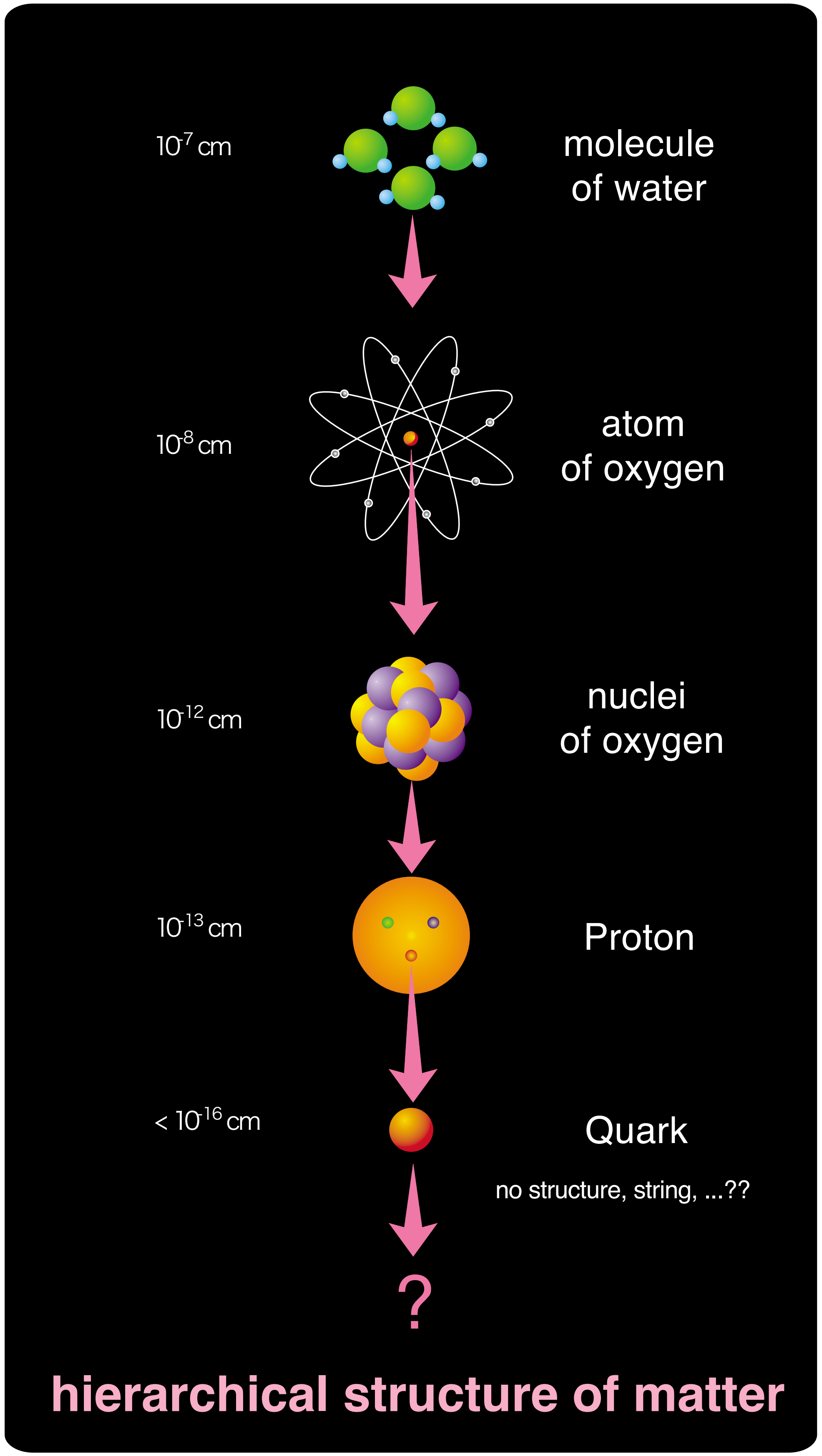
$$m_t = 173.21 \pm 0.51 \pm 0.71 \text{ GeV PDG2016}$$

top quark discovery in 1995

D.M. Asher et al., ILC Higgs White Paper, arXiv:1310.0763v3 [hep-ph], December 2013

What is an elementary particle?

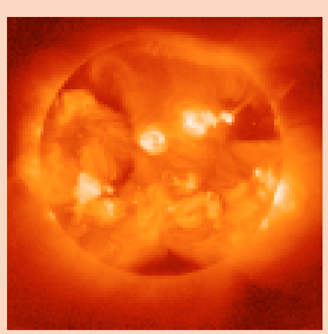
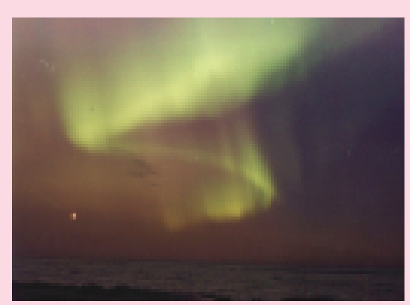
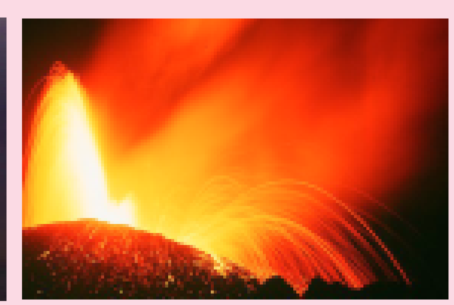
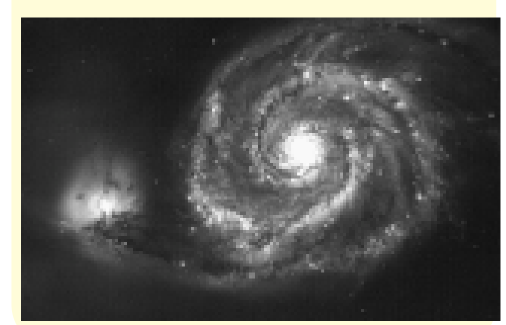
questing for the origin of matter.



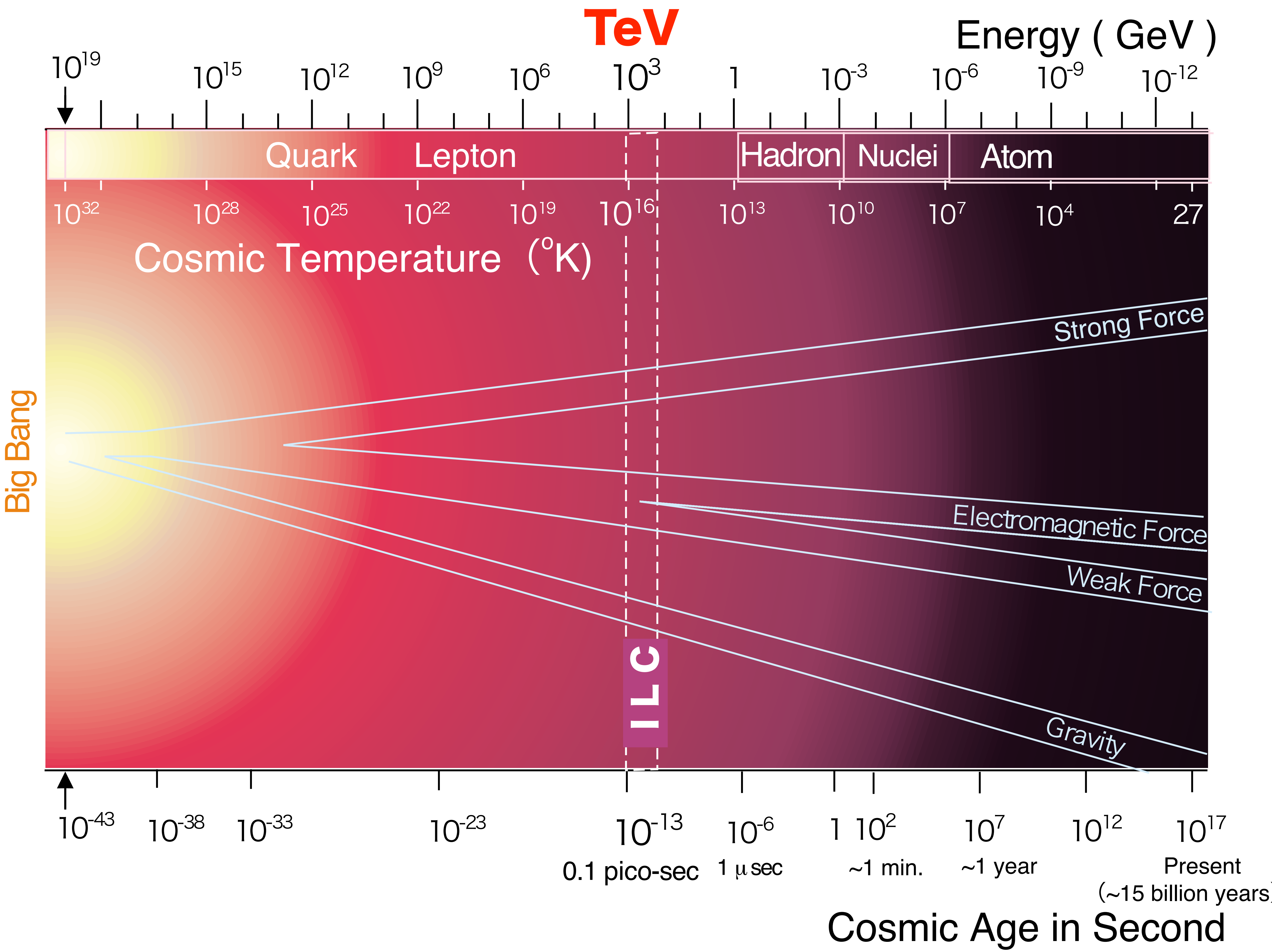
High Energy Physics has aimed and proceed to probe and unravel foundamental questions in our universe

Why are they so different ?

4 Kinds of Forces in Nature

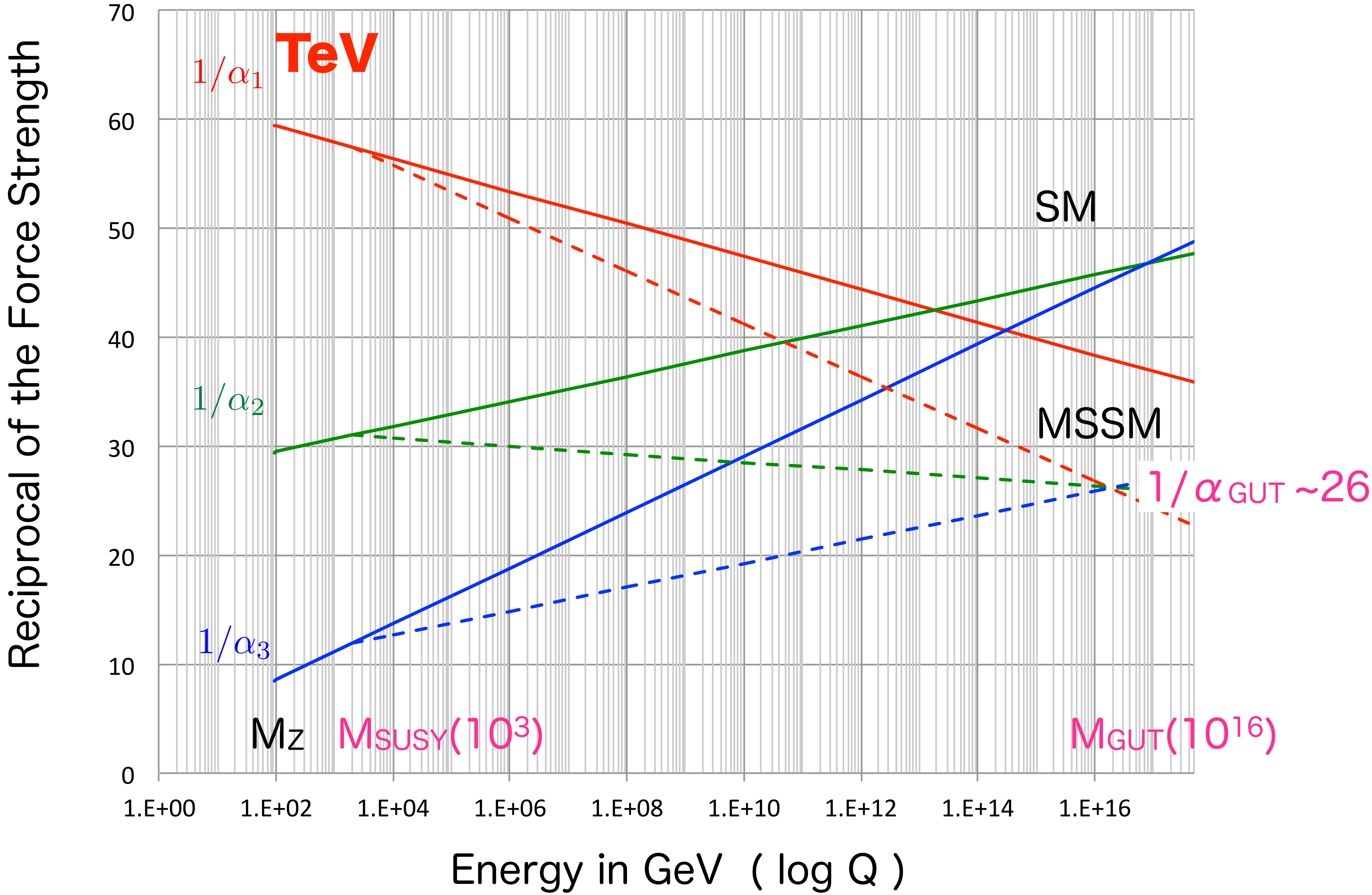
		Electro-weak force		
Forces	Strong force	Electro-magnetic force	Weak force	Gravity
Exchanged particles	Gluon	Photon	W,Z bosons	Graviton
Magnitude	1	0.01	10^{-5}	10^{-40}
	Nulcei Hadron Nuclear fusion Solar energy	Molecule, Atom Electronics Synchrotron rad. Aurora	Neutron decay Nuclei decay Neutrino Geothermy	Gravitation Galaxy Black Hole Stellar Pinwheel
				

Cosmic Creation as seen below?



Unification of the Coupling Constants ?

$$(\alpha_1, \alpha_2, \alpha_3) \to (M_{SUSY}, M_{GUT}, \alpha_{GUT})$$



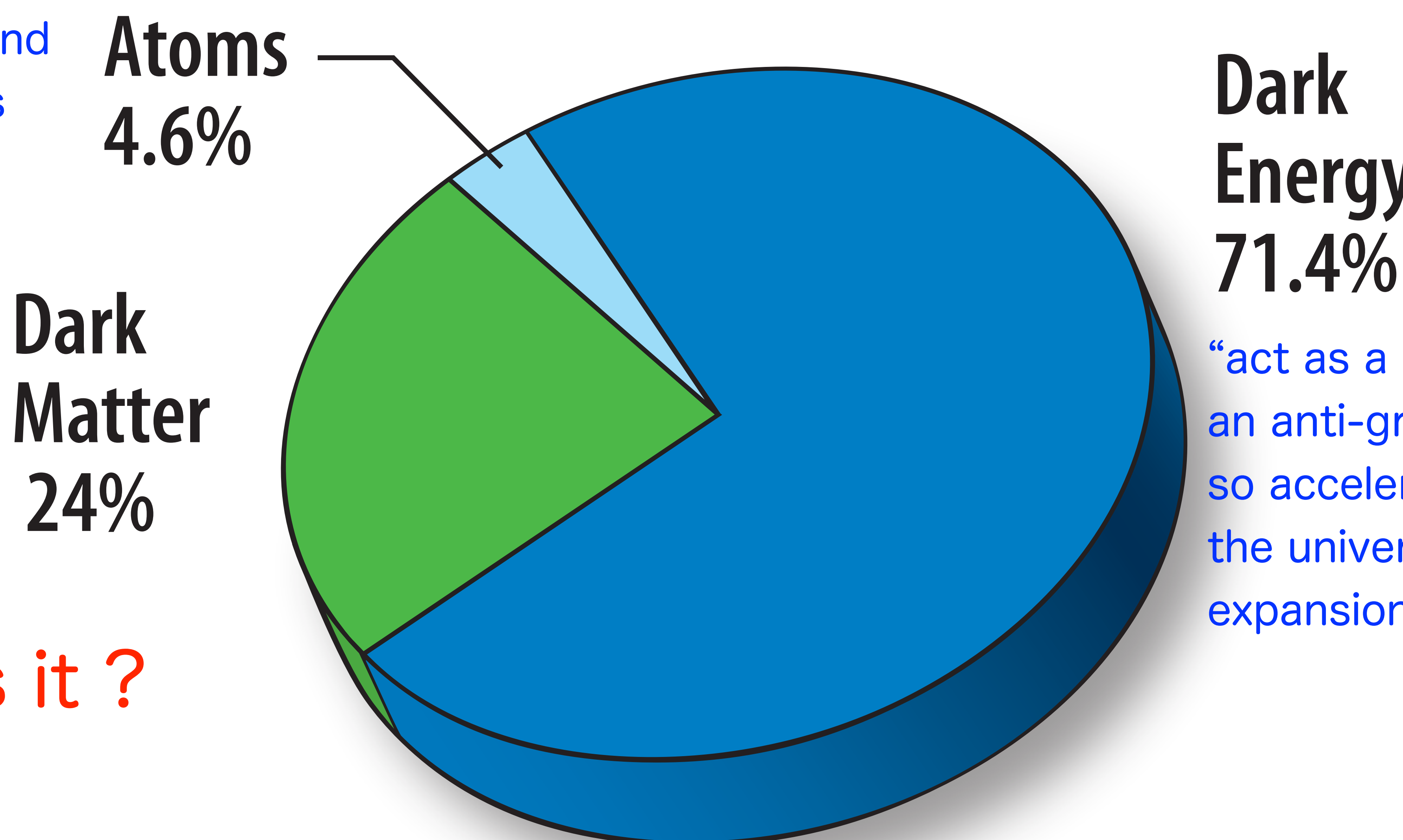
Universe Content

- WMAP 9yr Pie Chart -

stars and planets

no emission, no absorption of lights, but it has only been detected indirecly by its gravity.

What is it ?



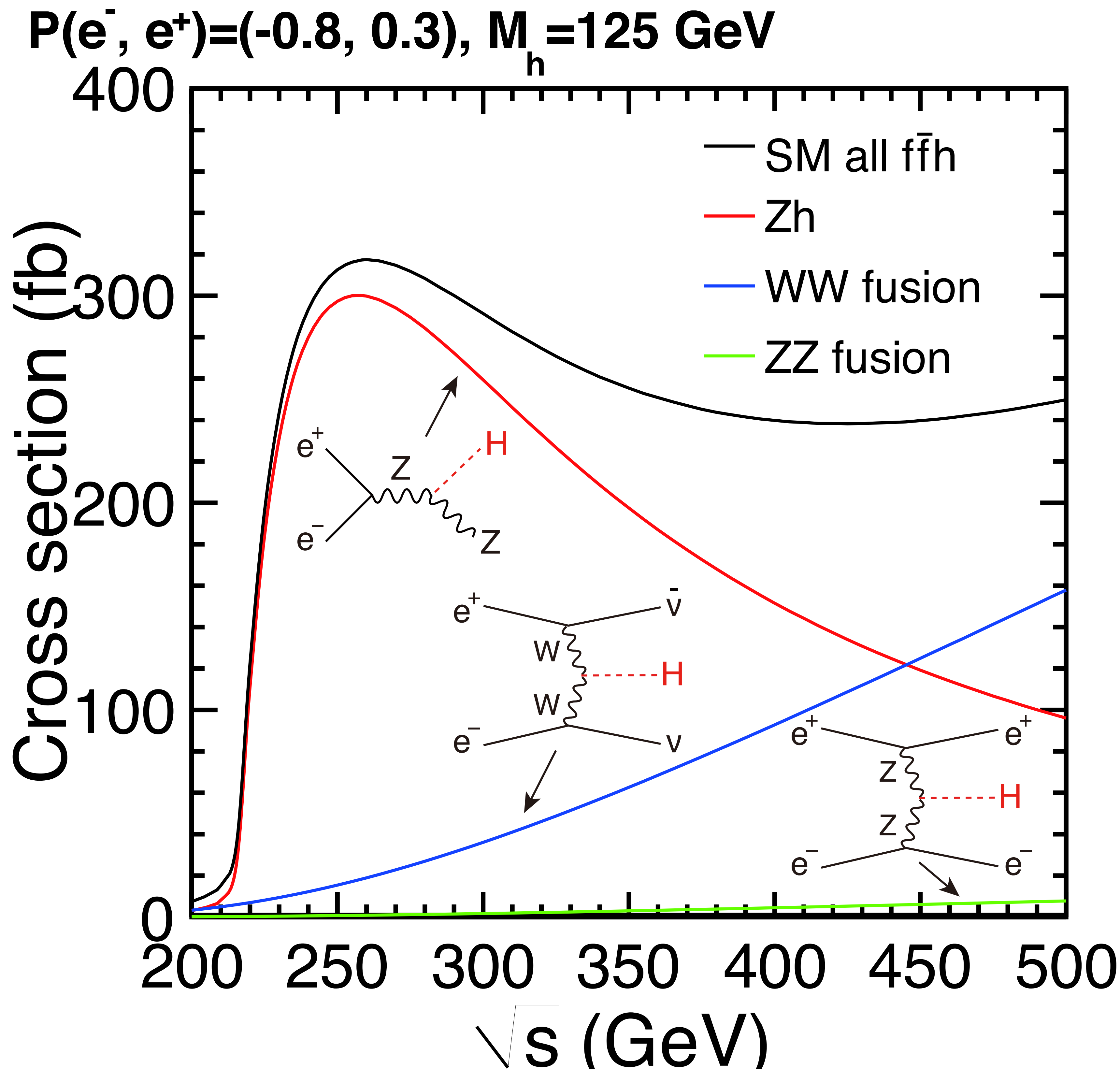
“act as a sort of an anti-gravity” so acceleration of the universal expansion

TODAY

from https://map.gsfc.nasa.gov/media/121236/index.html

Higgs boson Production at ILC

Figure 2.7
Production cross section for the $e^+e^- \to Zh$ process as a function of the center of mass energy for $m_h = 125\,\text{GeV}$, plotted together with those for the WW and ZZ fusion processes: $e^+e^- \to \nu\bar{\nu}H$ and $e^+e^- \to e^+e^-H$.



Is it the origin of masses of elementary particles ?

H. Baer, et al., “The International Linear Collider Technical Design Report - Volume 2: Physics,”