

Higgs, the Standard Model and Beyond

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Particle Physics
Summer 2016

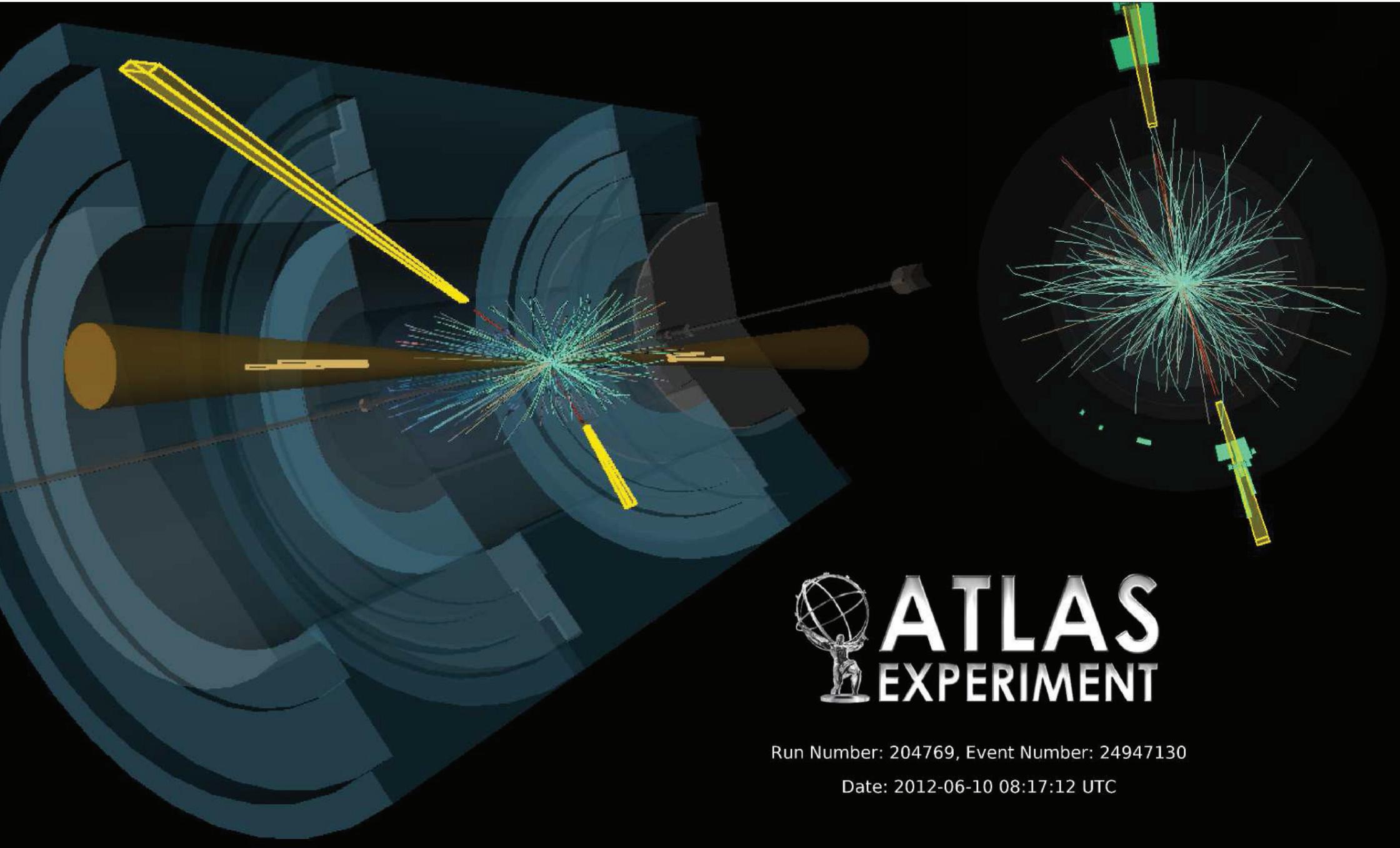


Cluster of Excellence Precision Physics,
Fundamental Interactions and Structure of Matter

PRISMA



Higgs discovery



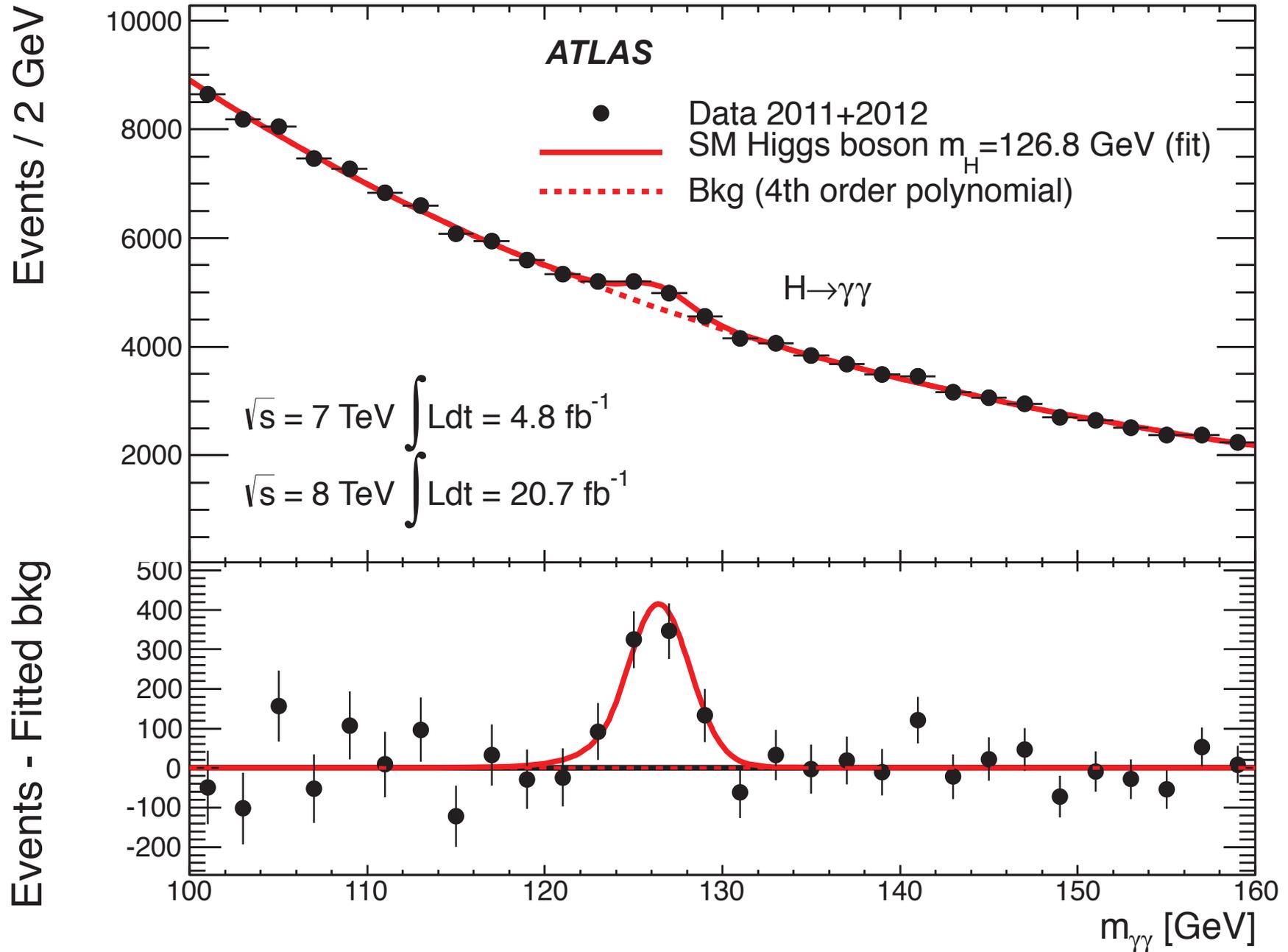
ATLAS
EXPERIMENT

Run Number: 204769, Event Number: 24947130

Date: 2012-06-10 08:17:12 UTC

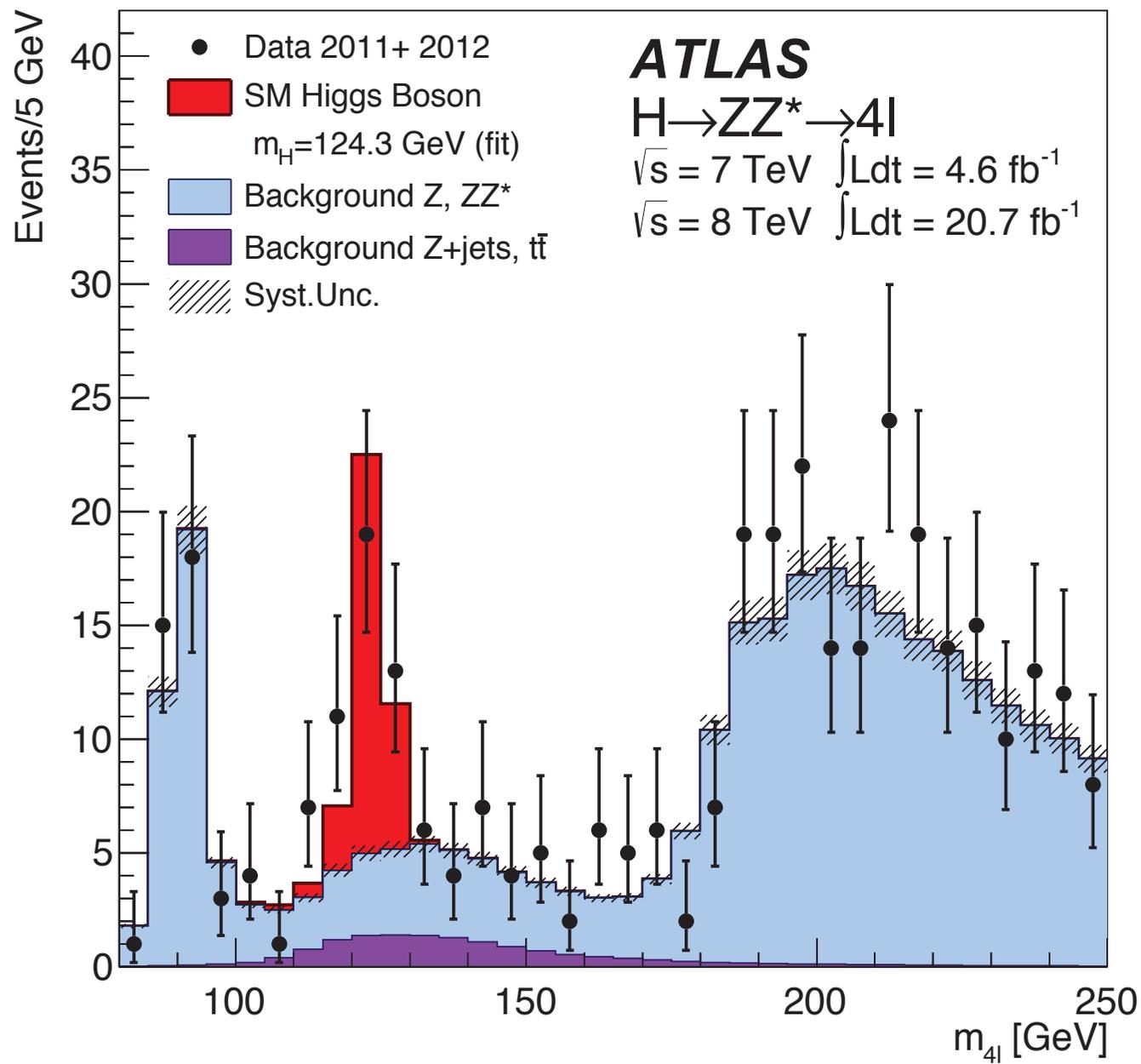


Higgs discovery



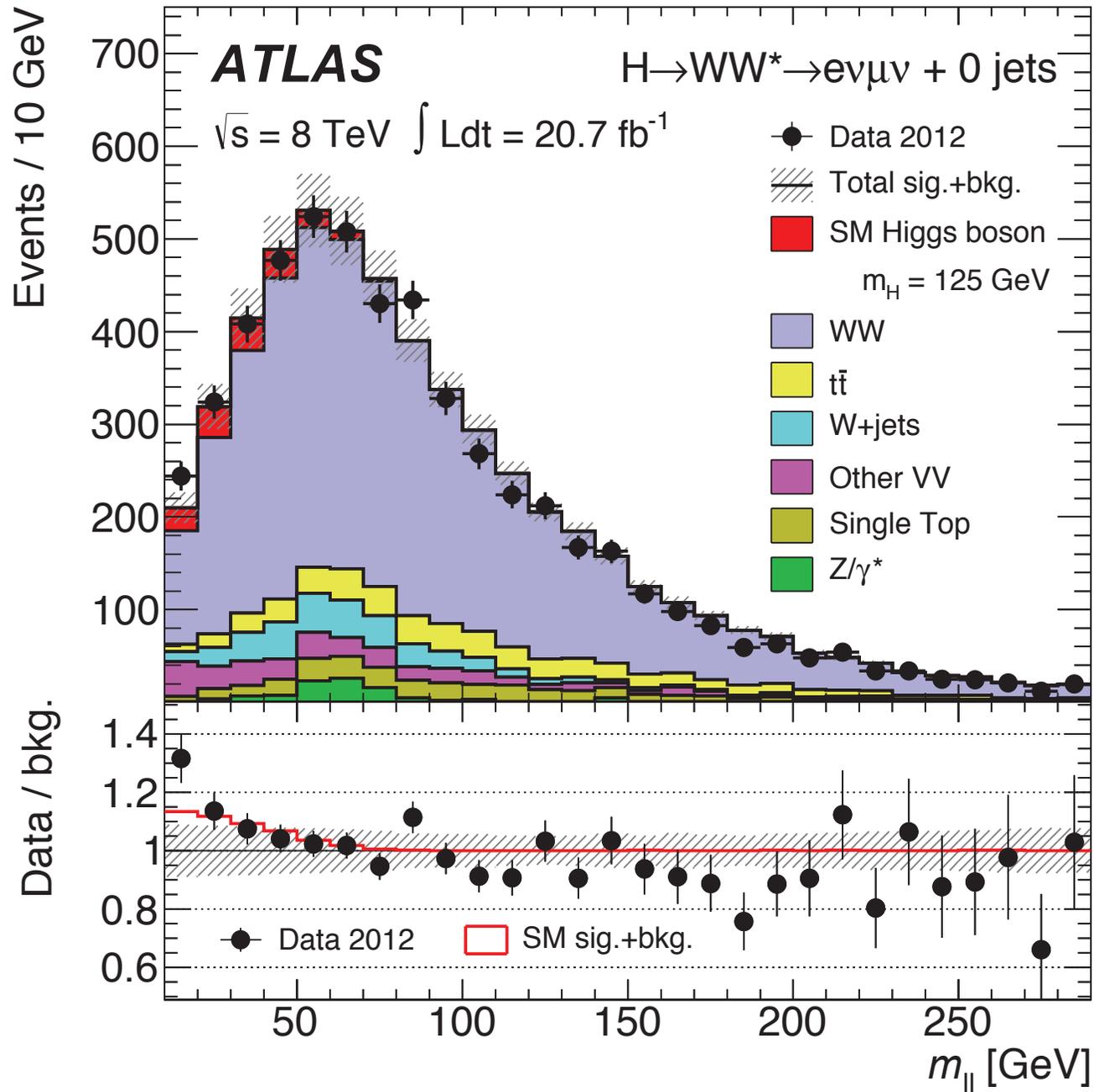


Higgs discovery





Higgs discovery





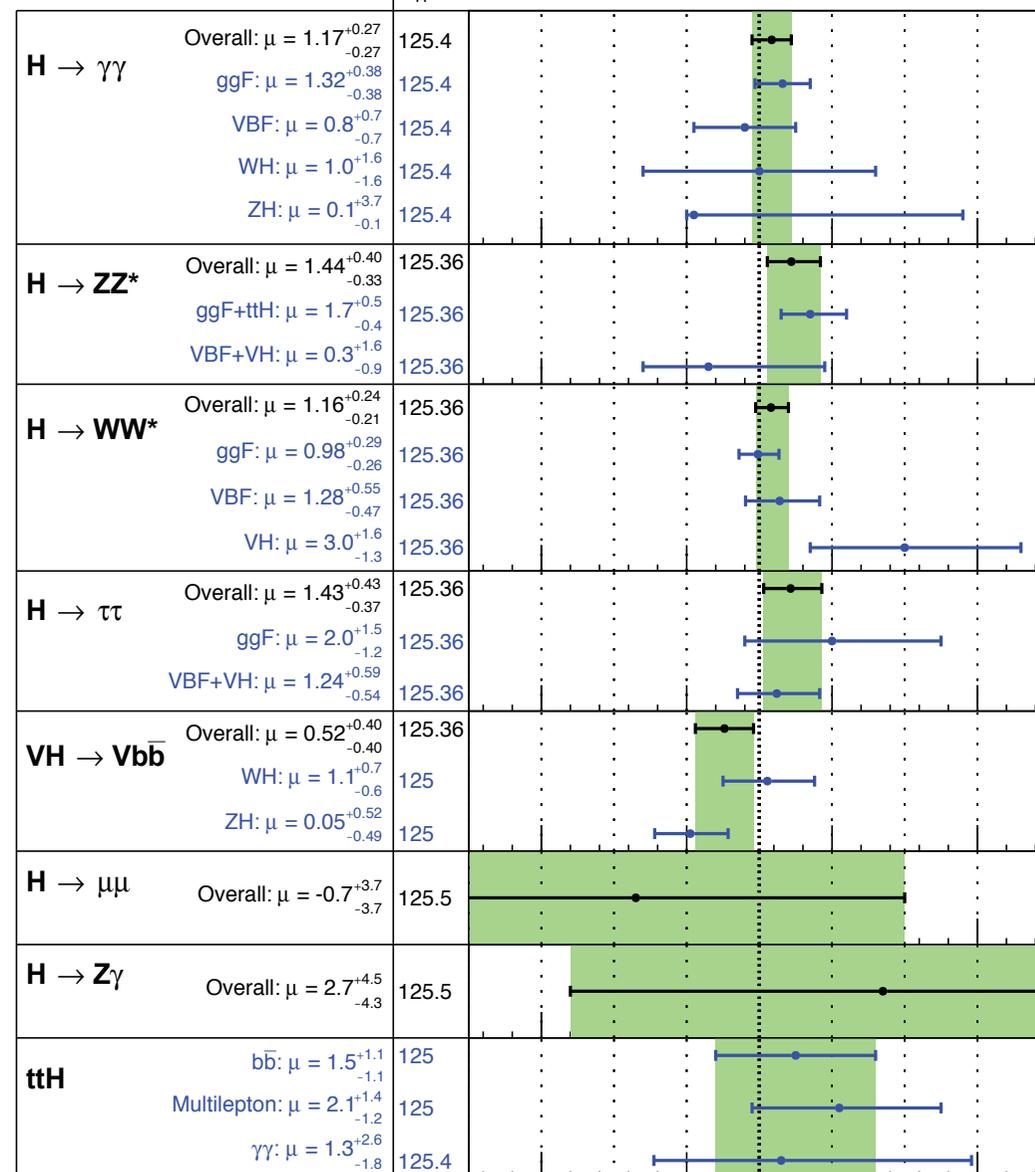
Higgs couplings

ATLAS Preliminary

$m_H = 125.36$ GeV

Input measurements

■ $\pm 1\sigma$ on μ



$\sqrt{s} = 7$ TeV, 4.5-4.7 fb^{-1}

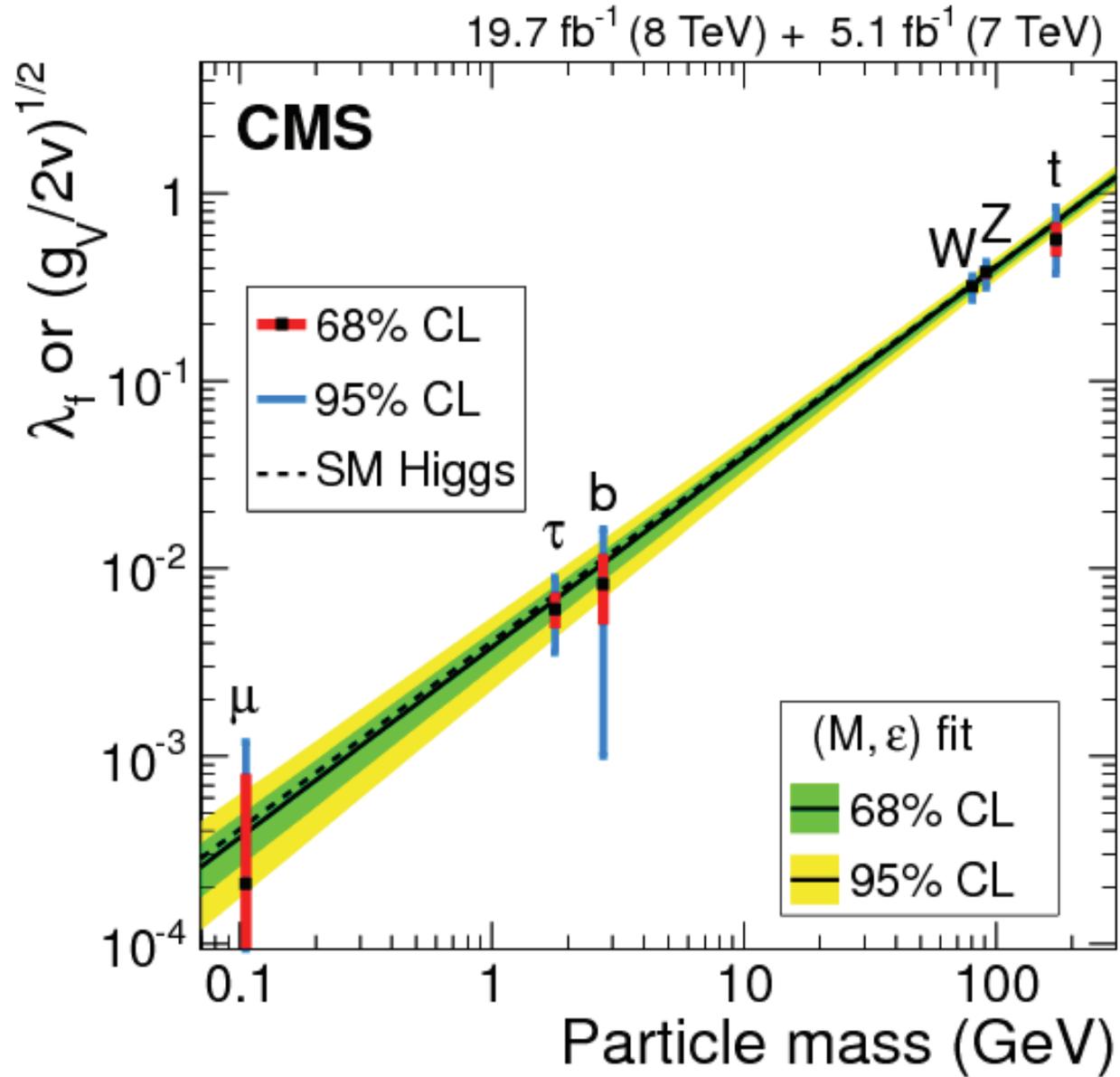
$\sqrt{s} = 8$ TeV, 20.3 fb^{-1}

-2 0 2 4

Signal strength (μ)



Higgs couplings

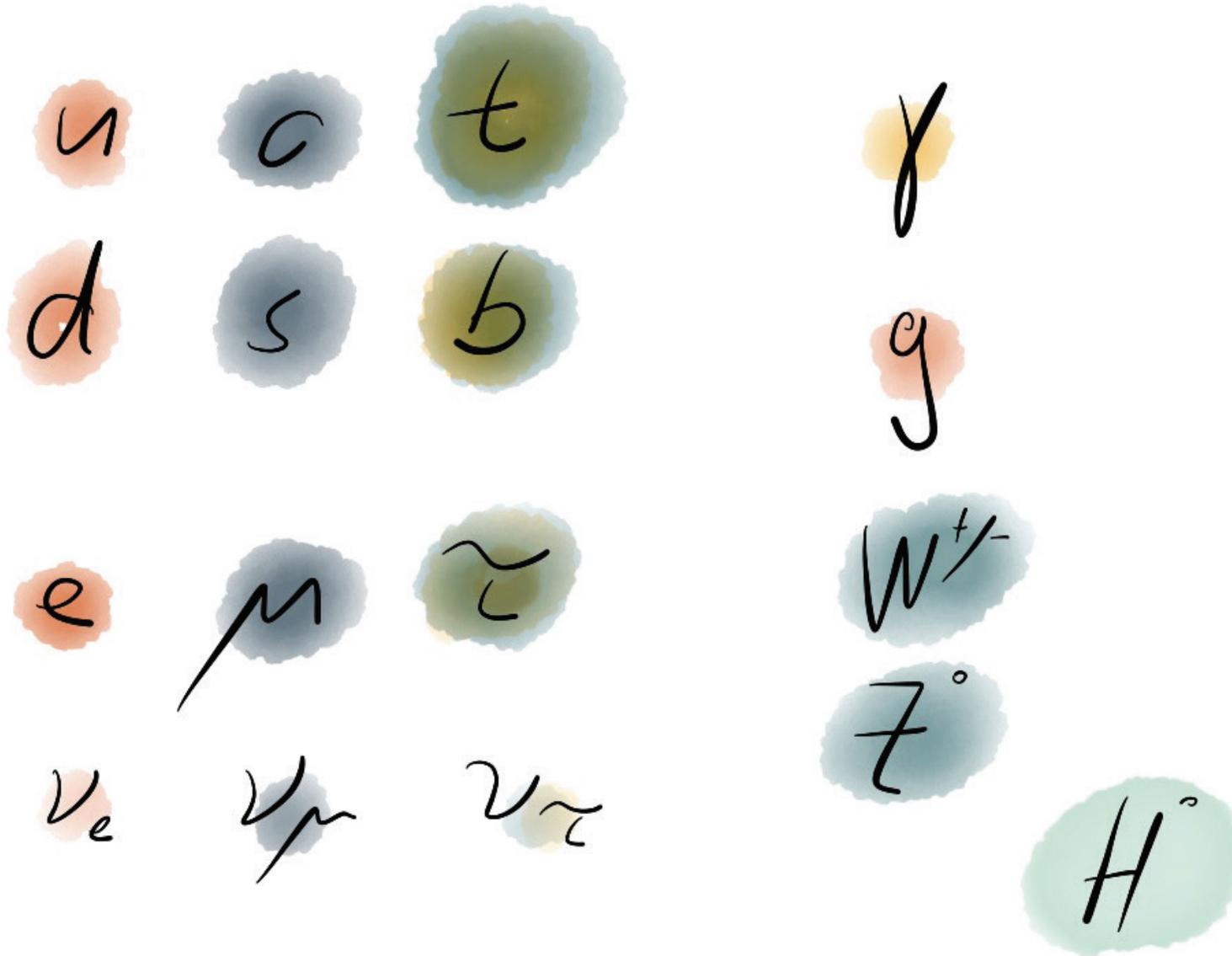


Particle Physics:

What are the fundamental constituents of matter
and how do they interact?

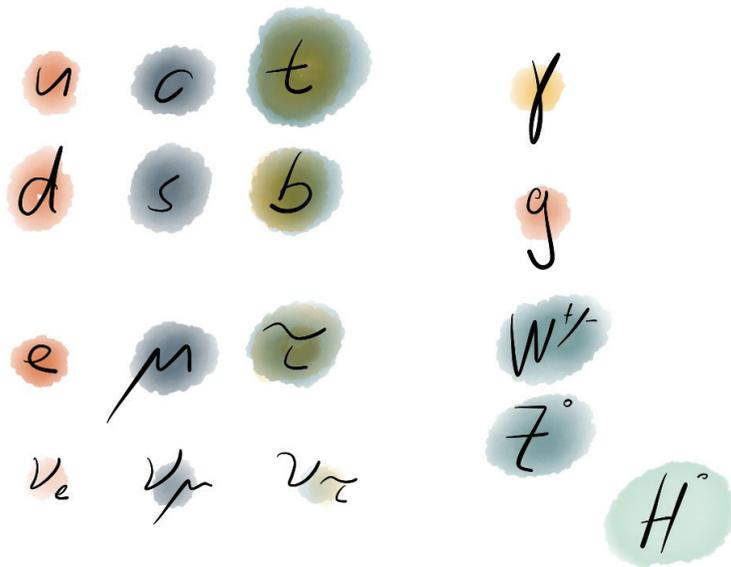


The Standard Model of Elementary Particles





Hugely successful



Magnetic moment of the electron:

- Theory:

$$g_e = -2.002\,319\,304\,363\,56\,(154)$$

(Aoyama et al., PRL 109, 111807 (2012))

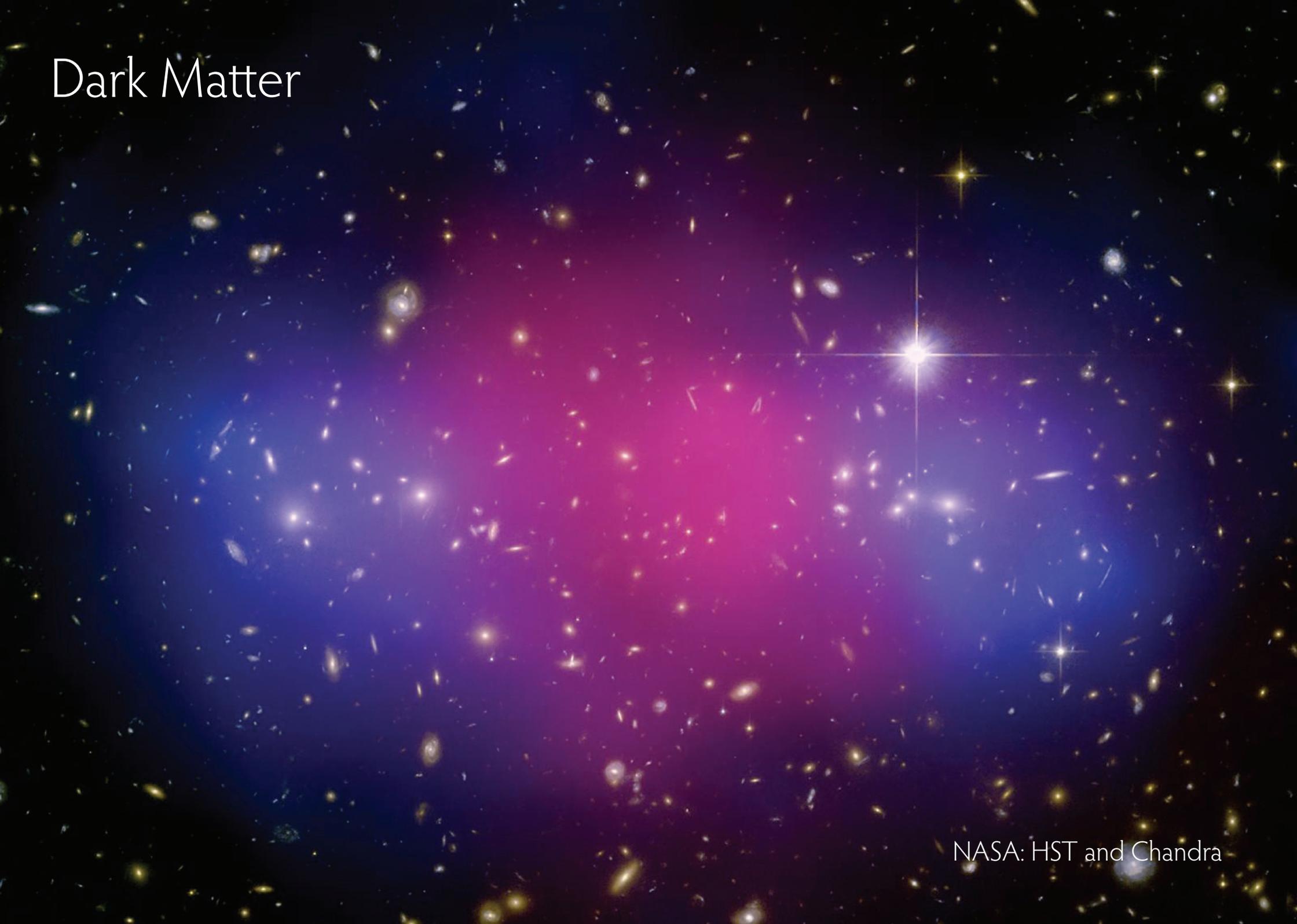
- Experiment:

$$g_e = -2.002\,319\,304\,361\,53\,(53)$$

(Hanneke et al. PRL 100, 120801 (2008))

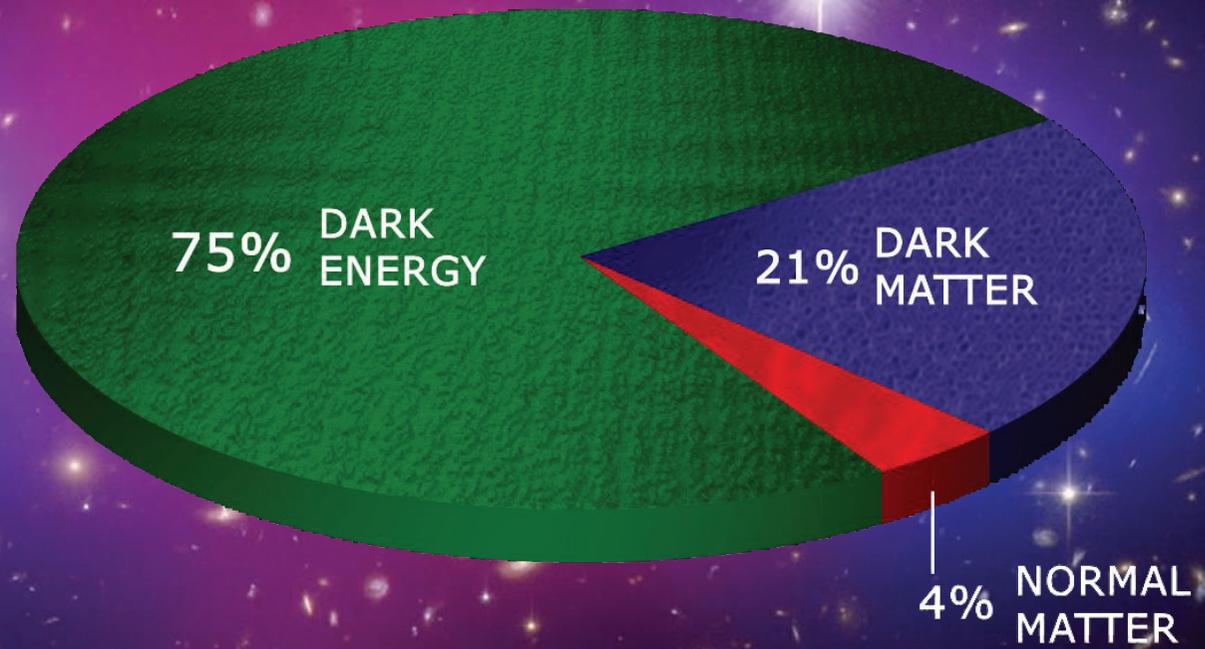
Open Questions?

Dark Matter

A composite image of a galaxy cluster. The background is a dense field of galaxies, with a central region highlighted in red and orange. A bright white star with a crosshair is visible on the right side.

NASA: HST and Chandra

Dark Matter



NASA: HST and Chandra



Matter-Antimatter Asymmetry

10'000'000'000

Antimatter

10'000'000'001

Matter

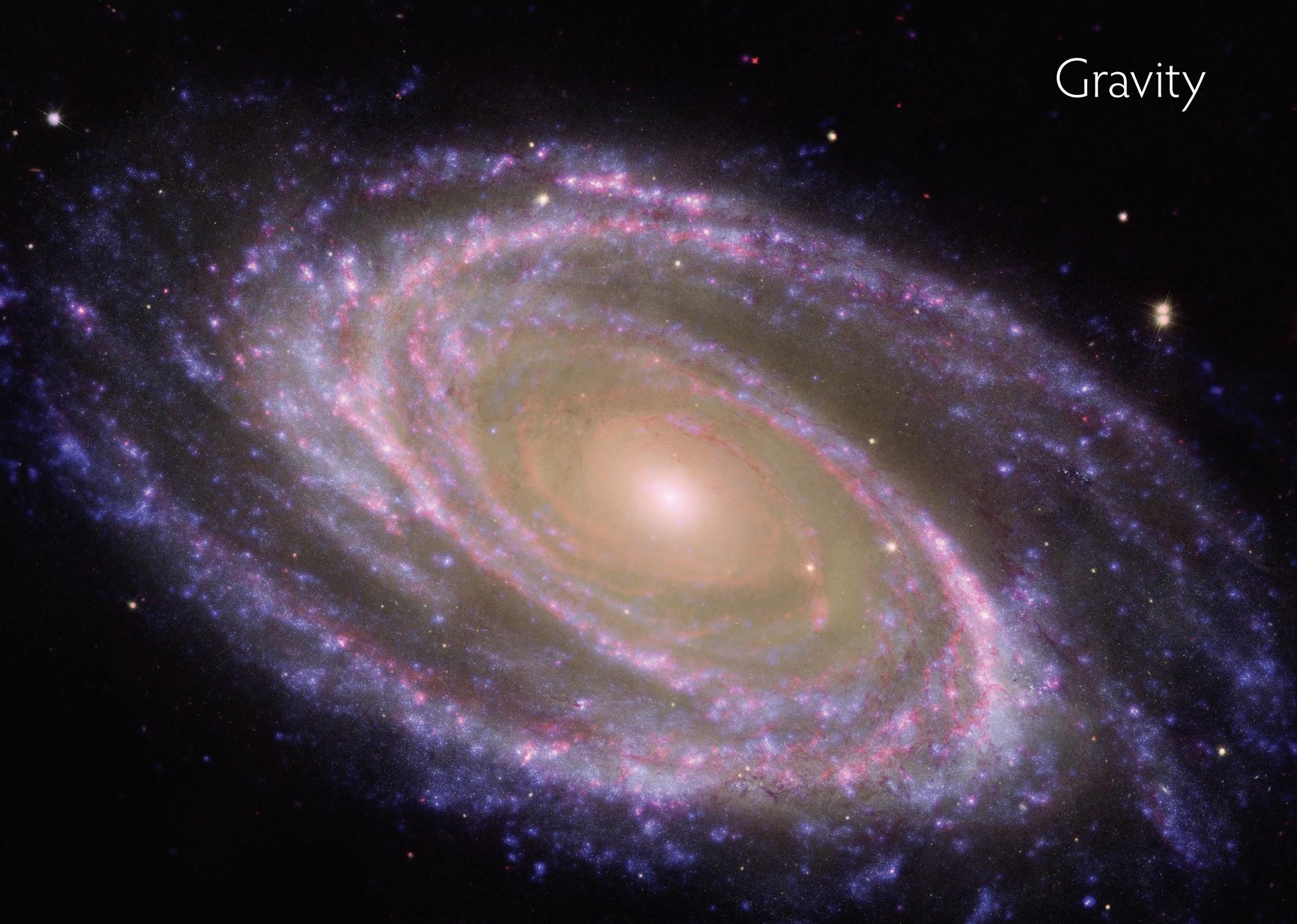
Matter-Antimatter Asymmetry

Radiation

■
1

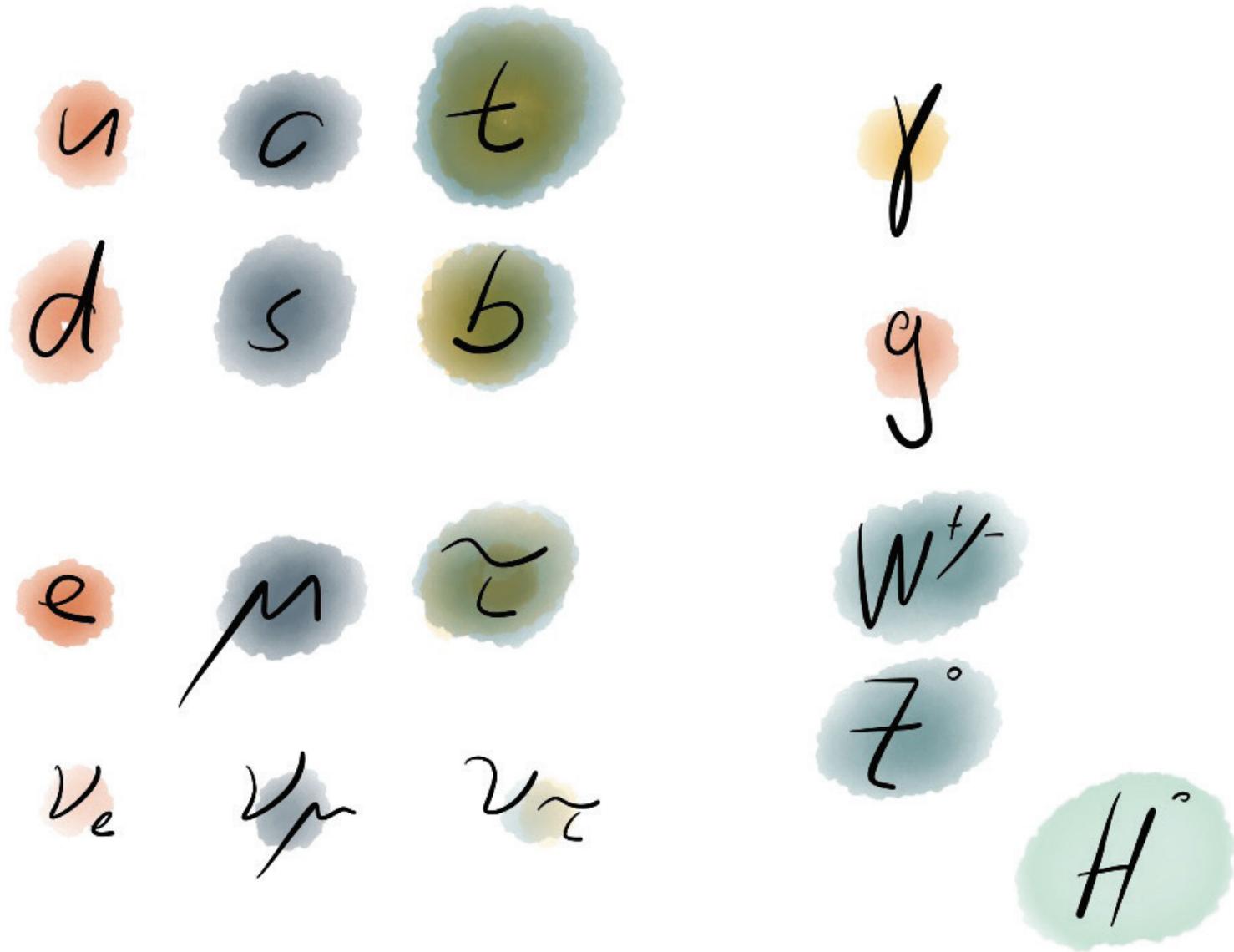
Us

Gravity



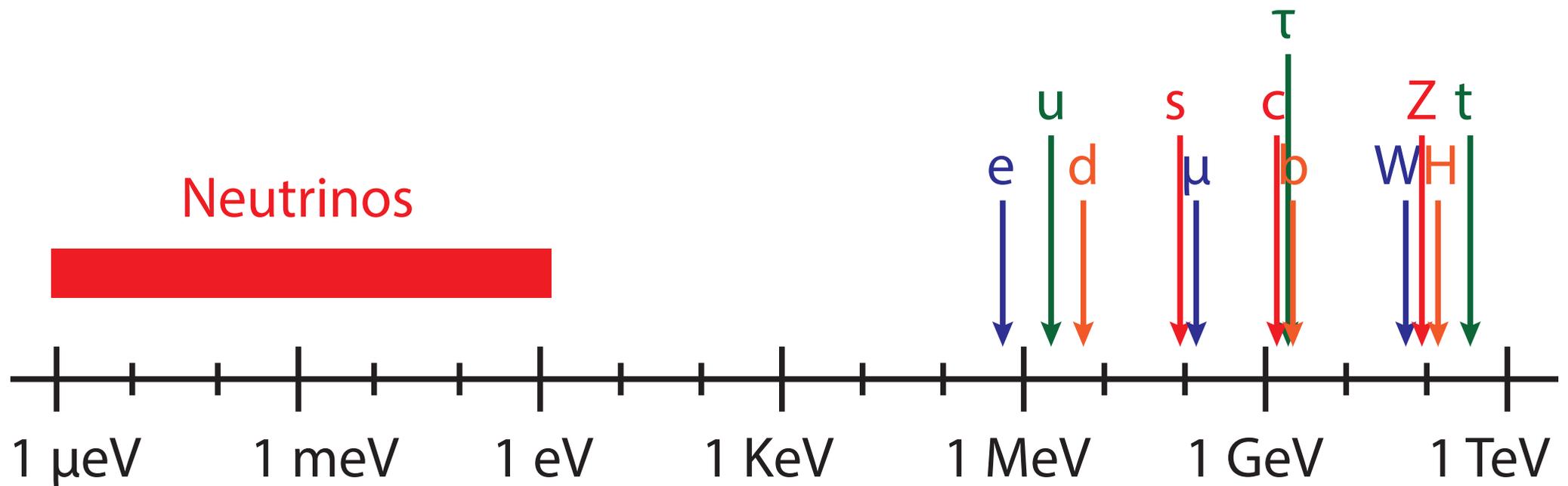


The Structure of the Standard Model



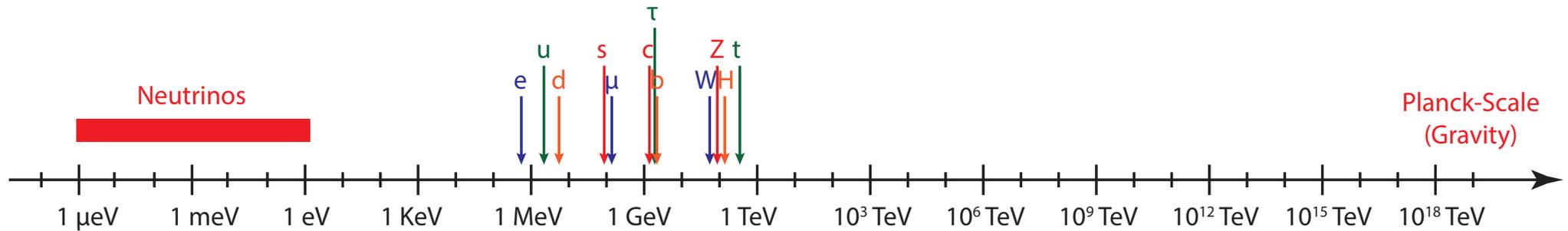


The Structure of the Standard Model



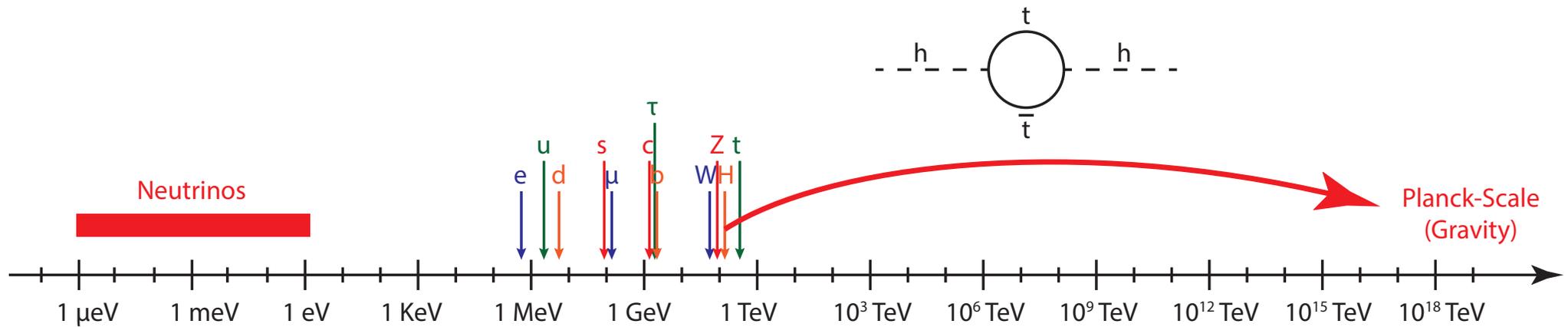


The Structure of the Standard Model



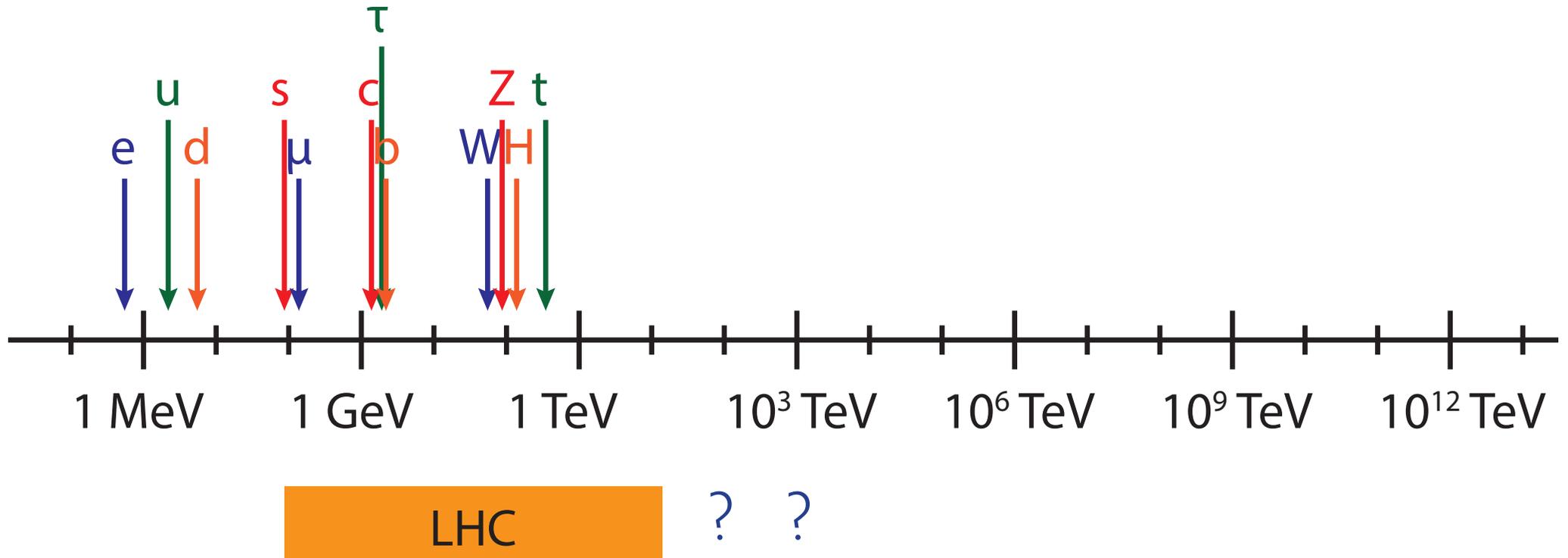


The Structure of the Standard Model



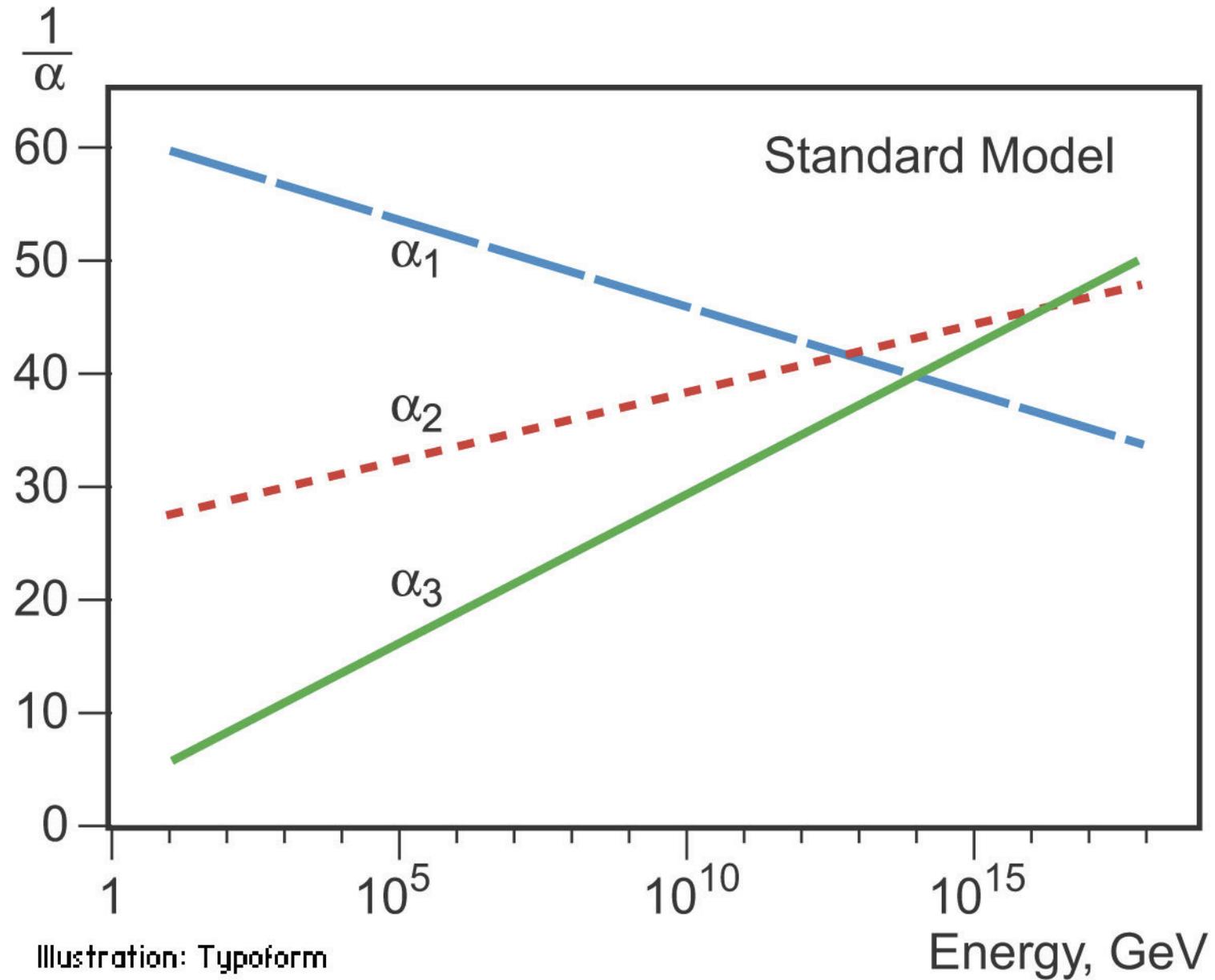


The Structure of the Standard Model





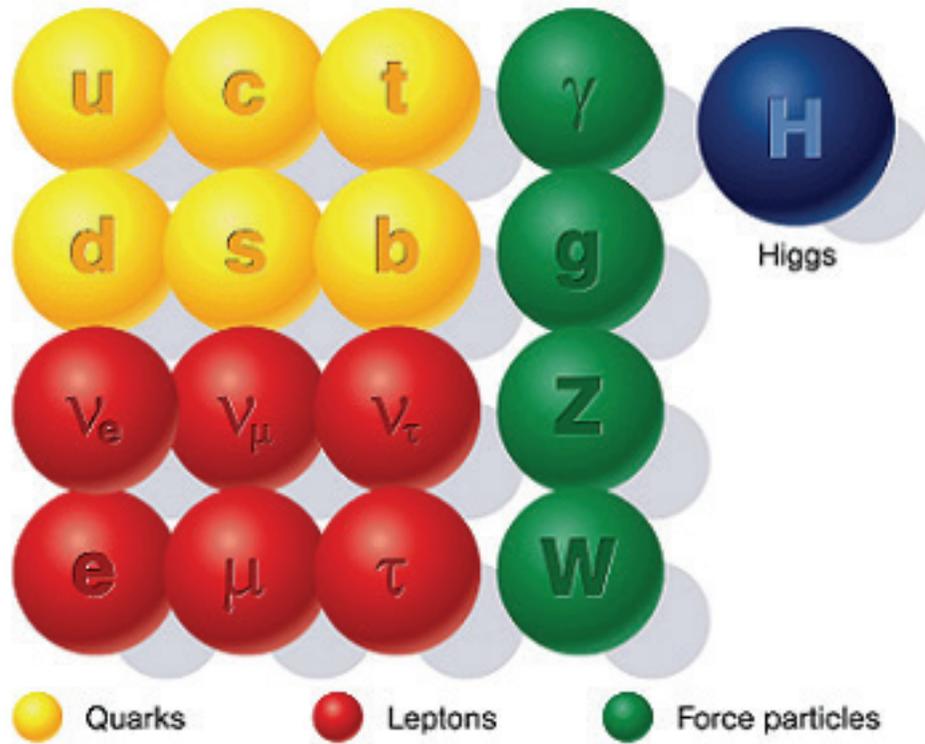
Unification of forces



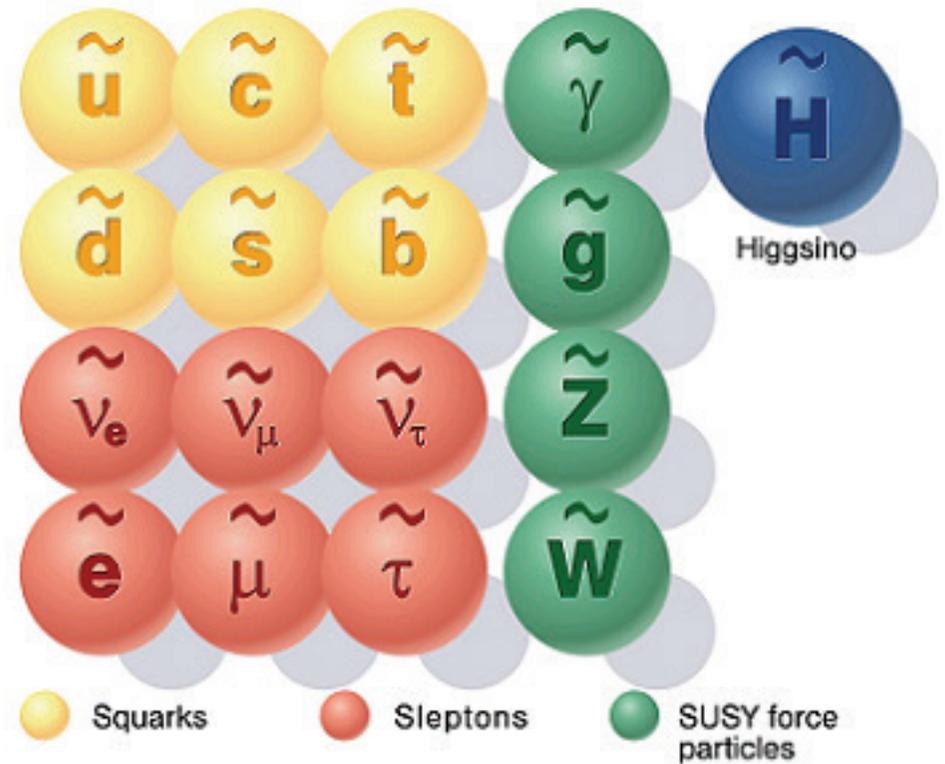


SUSY

Standard particles

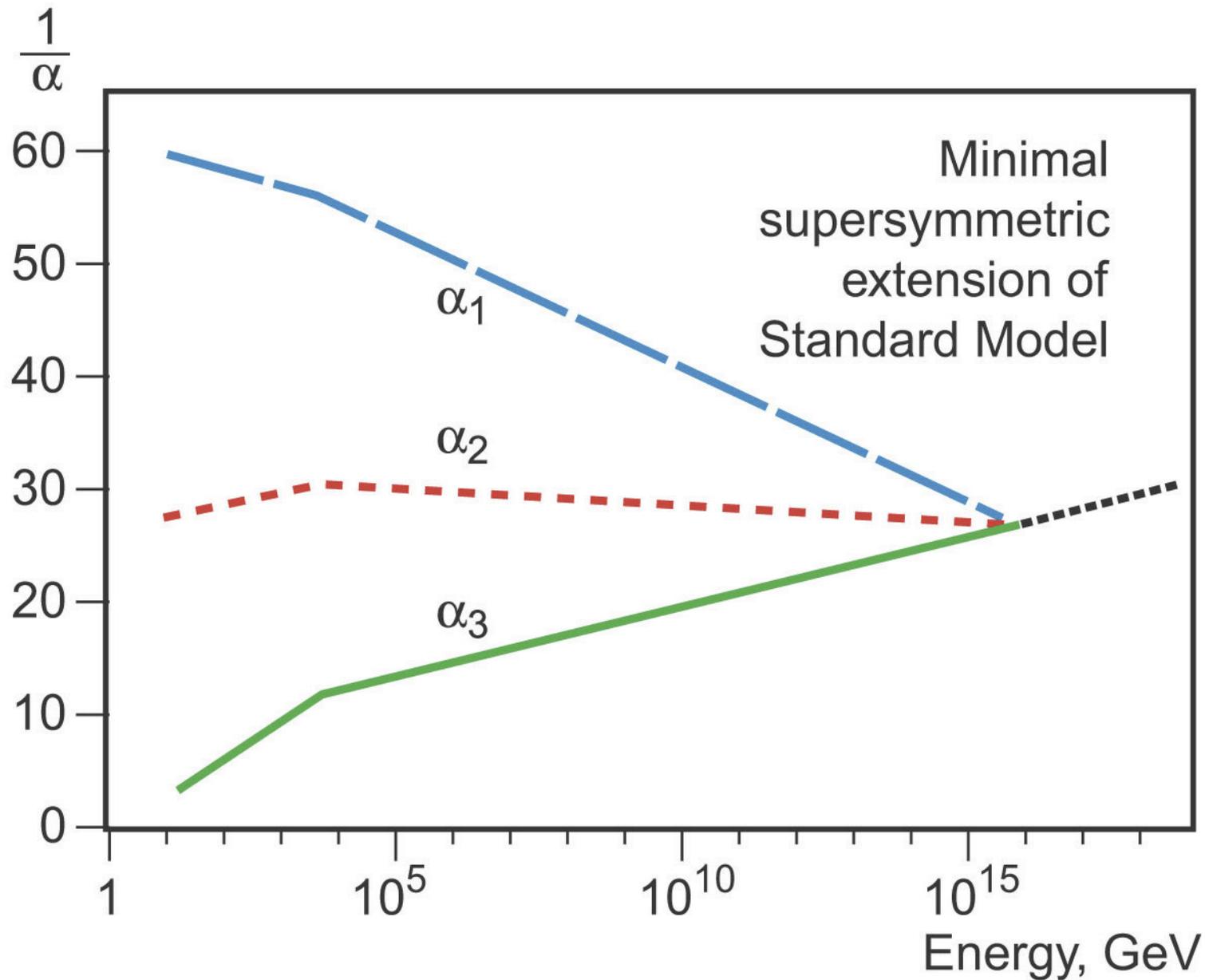


SUSY particles

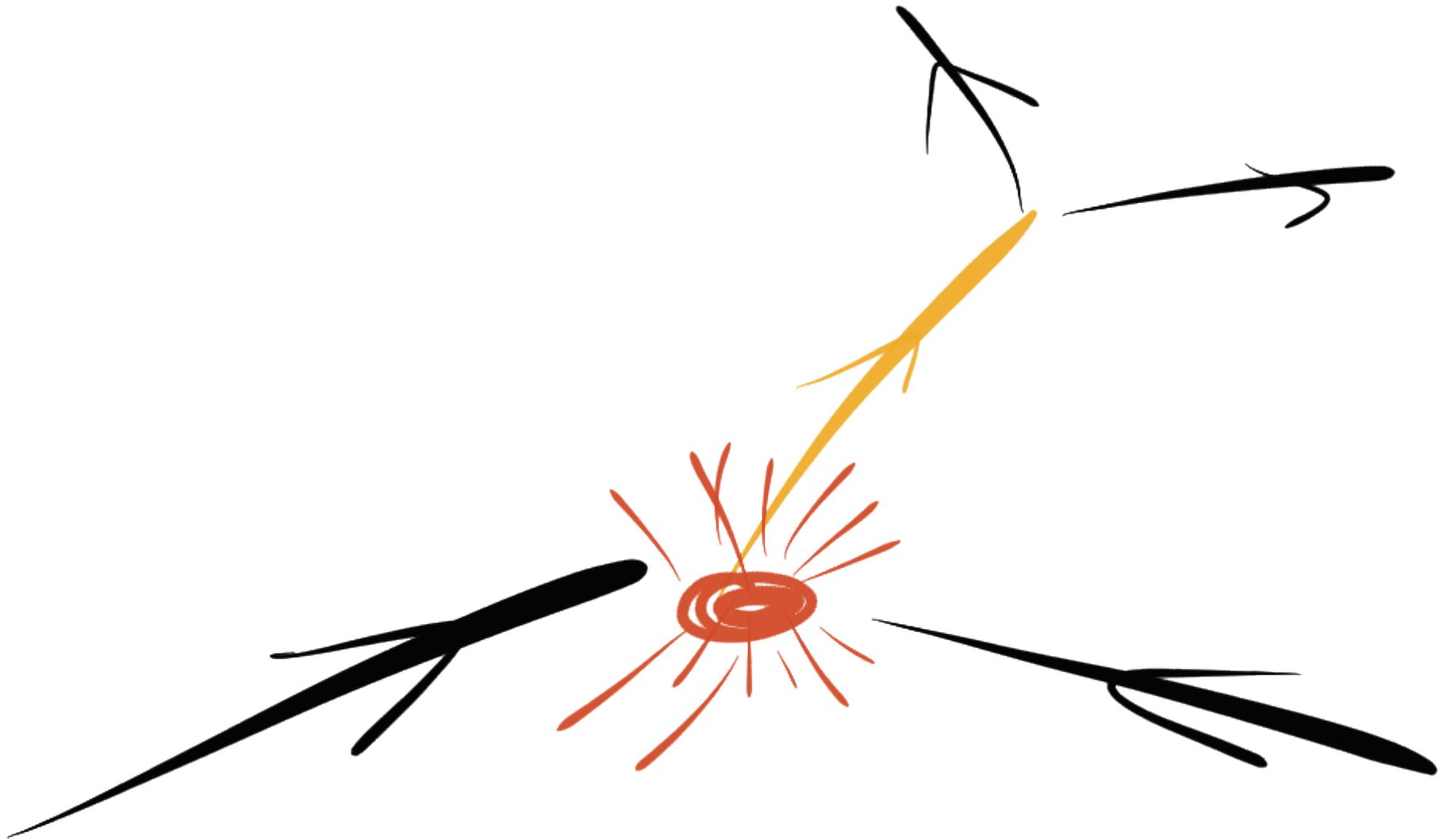




Unification of forces



Direct production



Indirect effects in quantum loops

