SO(10) unification at next-to-leading order

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Proton decay: theoretical uncertainties vs experiment

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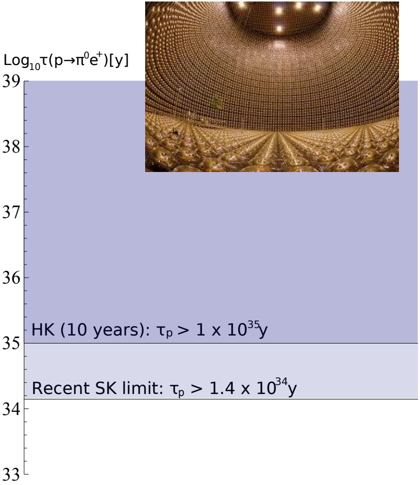
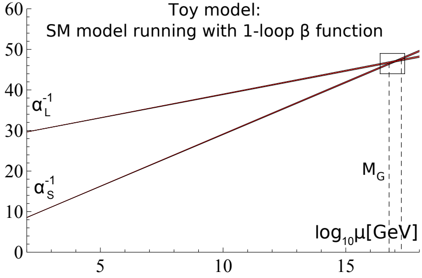
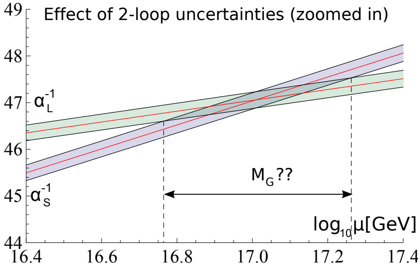
- grand unified theories (GUTs) predict baryon number violation
- non-SUSY GUTs: “golden” channel for proton decay: $p \to \pi^0 e^+$
- recent experimental limit
  [Super-Kamiokande, S.Mine talk]
  $\tau(p \to \pi^0 e^+) \geq 1.4 \times 10^{34}$ y
- new experiments planned to reach up to $\tau(p \to \pi^0 e^+) \geq 1 \times 10^{35}$ y
  [Hyper-Kamiokande, S.Mine talk]

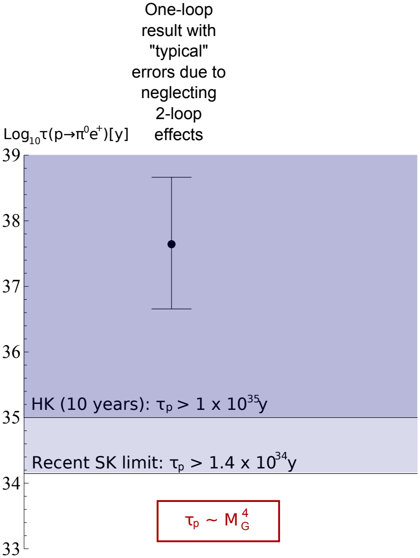
What about the theory side?



Proton decay: theoretical uncertainties vs experiment







$\tau_p \sim M_G^4$

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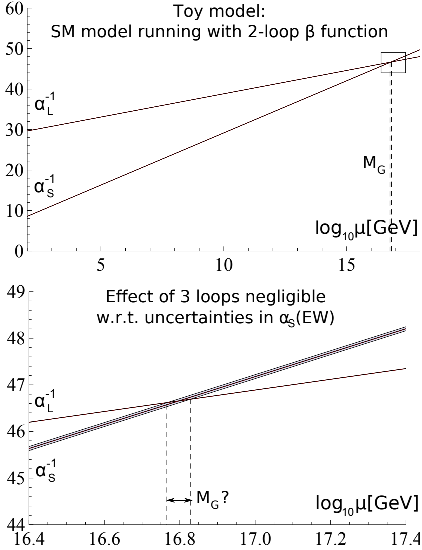
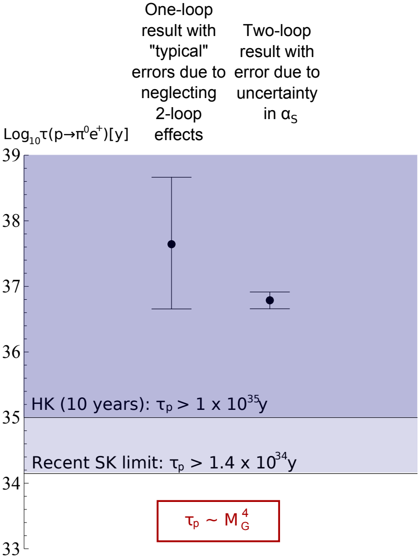




Proton decay: theoretical uncertainties vs experiment

Still other sources of uncertainties!

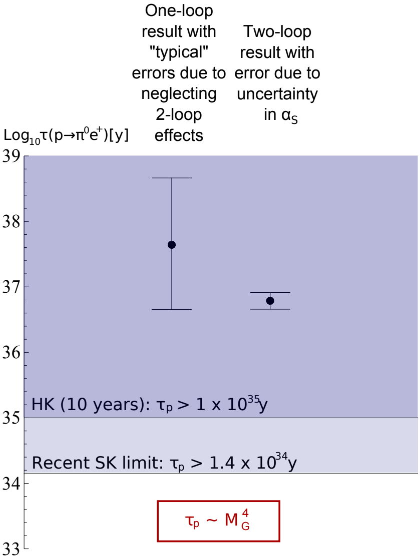
- threshold effects ($\sim$ size of 2-loop corrections) $\Rightarrow$ knowledge of the heavy spectrum needed
- SUSY GUTs: m_{SUSY} uncertainty
- Planck induced effective operators
  [Calmet, Hsu, Reeb, 2008, arXiv: 0805.0145]

$$\frac{c}{M_{\mathrm{pl}}} \mathrm{Tr}\left(G_{\mu\nu} G^{\mu\nu} H\right)$$

$\langle H \rangle = M_G \Rightarrow$ redefinition of gauge couplings $\Rightarrow \alpha_i$ measured $\times$ unification condition:

$$(1 + k_i \varepsilon)\alpha_i(M_G) = (1 + k_j \varepsilon)\alpha_j(M_G)$$

$\varepsilon \sim M_G / M_{\mathrm{pl}}, \; k_i \sim \mathcal{O}(1)$



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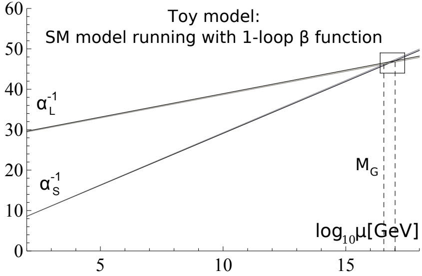

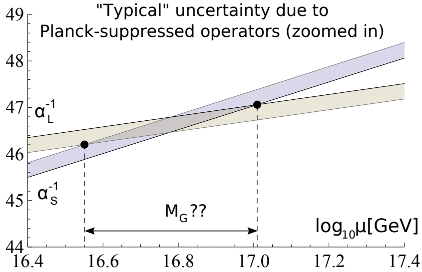

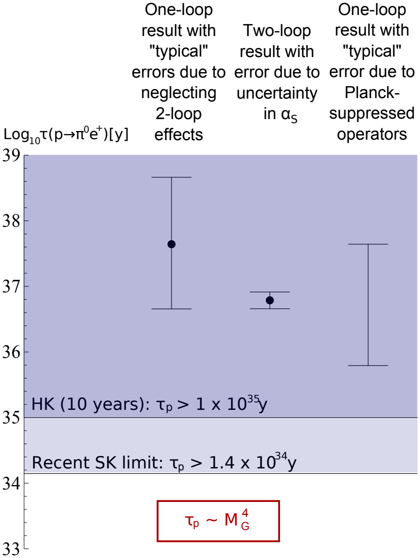

Non-SUSY SO(10) broken by $\langle 45_H \rangle$

- SO(10) $\xrightarrow{\langle (1,1,1,0)_{45_H} \rangle \equiv \omega_{BL}} SU(3)_c \times SU(2)_L \times SU(2)_R \times U(1)_{B-L}$ or
  SO(10) $\xrightarrow{\langle (1,1,3,0)_{45_H} \rangle \equiv \omega_{R}} SU(4)_C \times SU(2)_L \times U(1)_R$
- Abandoned due to tachyonic instabilities, however, cured @ quantum level!
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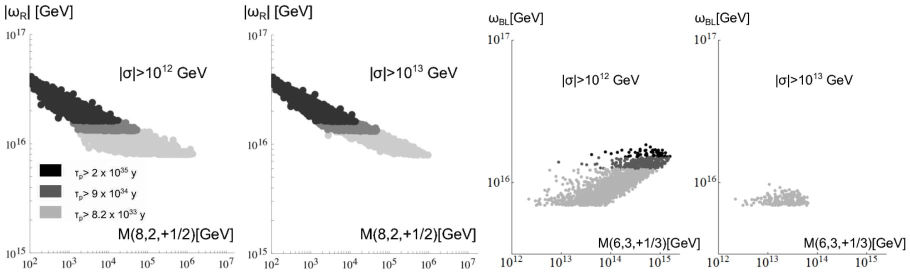

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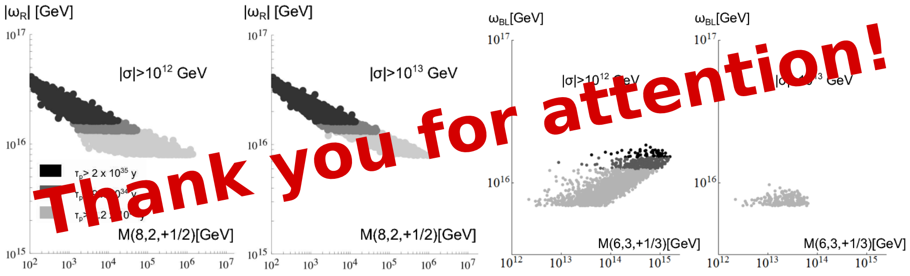

Thank you for attention!