

# Proton decay in some realistic grand unified theories

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In this short letter we show proton decay predictions in different scenarios. For all relevant aspects of the proton stability in grand unified theories, in strings and in branes see reference [1].

Since proton decay is the most dramatic prediction coming from theories where matter is unified ( GUTs, Strings, ..), we hope to test those scenarios at future experiments.

Recently, a model-independent upper bound on the total proton decay lifetime has been pointed out [2]:

$$\tau_p^{upper} = \left\{ \begin{array}{ll} 6.0 \times 10^{39} & \text{(Majorana case)} \\ 2.8 \times 10^{37} & \text{(Dirac case)} \end{array} \right\} \times \frac{(M_X/10^{16} GeV)^4}{\alpha_{GUT}^2} \times (0.003 GeV^3/\alpha)^2 \text{ years} \quad (1)$$

where  $M_X$  is the mass of the superheavy gauge bosons,  $\alpha_{GUT} = g_{GUT}^2/4\pi$ ,  $g_{GUT}$  is the gauge coupling at the grand unified scale, and  $\alpha$  is the matrix element. In order to understand the possible grand unified theories which are not ruled out, see Figures (1) and (2) where the present parameter space allowed by the experiments is shown.

Most of the (supersymmetric or non-supersymmetric) grand unified models predict a lifetime  $\tau_p$  below those upper bounds ( $10^{33-37}$  years). Notice that this is basically the possible range of the proposed experiments.

In order to have an idea of the proton decay predictions let us list the results in different models.

Model	Decay modes	Prediction	References
Georgi-Glashow model	-	ruled out	[3]
Minimal realistic non-SUSY $SU(5)$	all channels	$\tau_p^{upper} = 1.4 \times 10^{36}$ years	[4]
Two Step Non-SUSY $SO(10)$	$p \rightarrow e^+ \pi^0$	$\approx 10^{33-38}$ years	[5]
Minimal SUSY $SU(5)$	$p \rightarrow K^+ \bar{\nu}$	$\approx 10^{32-34}$ years	[6]
SUSY $SO(10)$ with $10_H$ , and $126_H$	$p \rightarrow \bar{\nu} K^+$	$\approx 10^{33-36}$ years	[7]
M-Theory( $G_2$ )	$p \rightarrow e^+ \pi^0$	$\approx 10^{33-37}$	[8]

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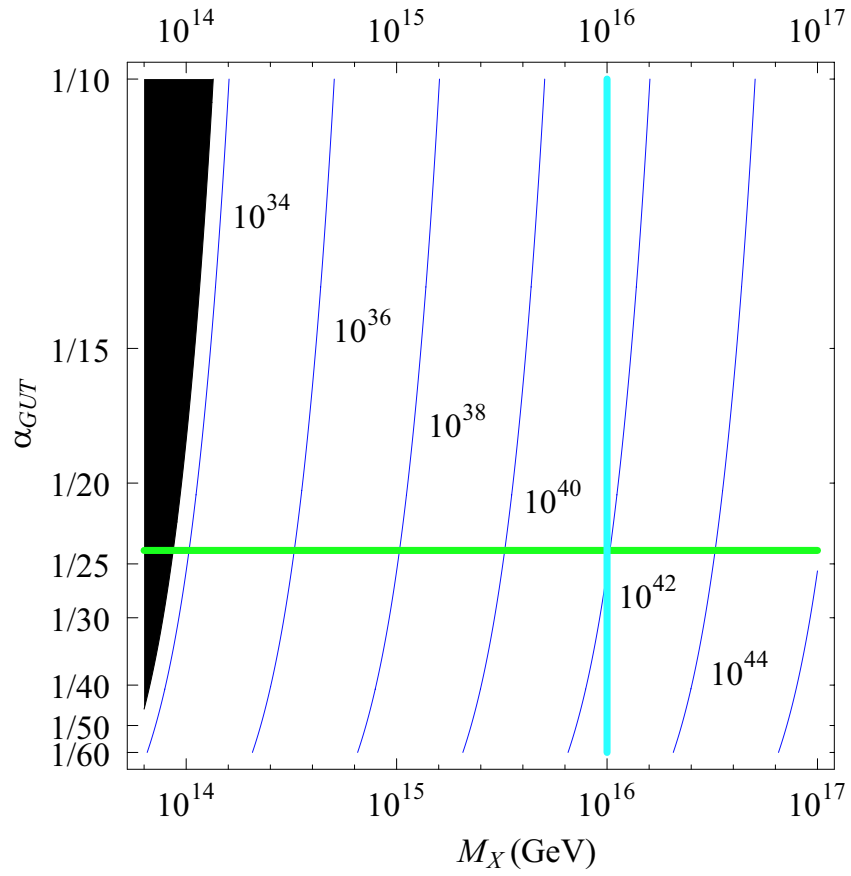


FIG. 1: Isoplot for the upper bounds on the total proton lifetime in years in the Majorana neutrino case in the  $M_X$ - $\alpha_{GUT}$  plane. The value of the unifying coupling constant is varied from 1/60 to 1/10. The conventional values for  $M_X$  and  $\alpha_{GUT}$  in SUSY GUTs are marked in thick lines. Experimentally excluded region is given in black [2].

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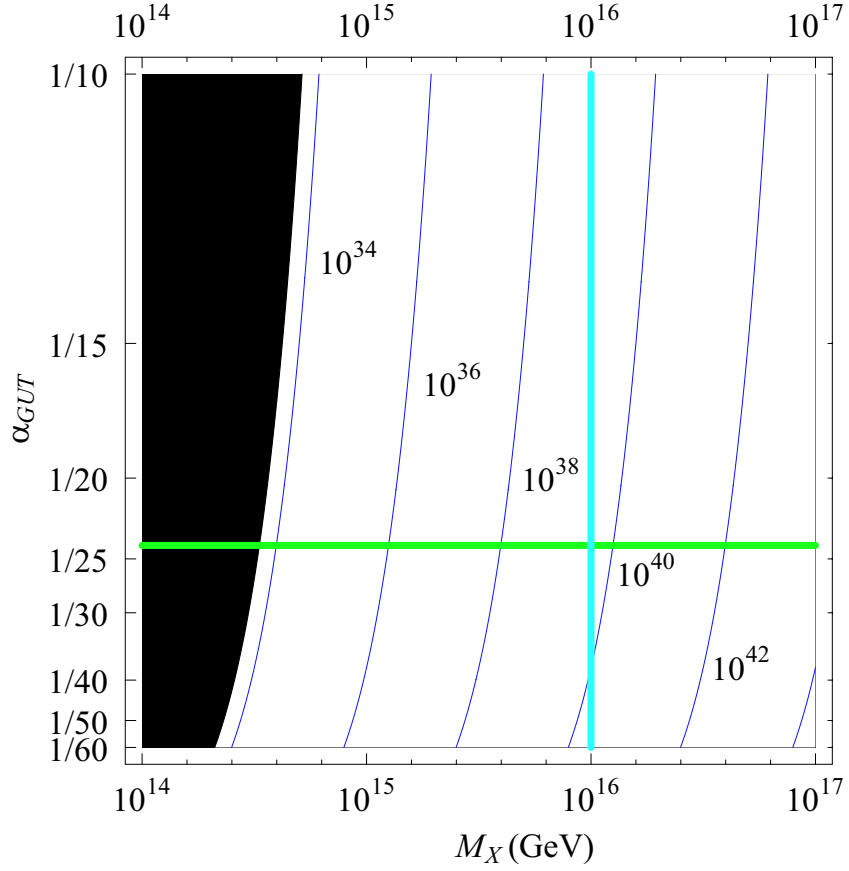


FIG. 2: Isoplot for the upper bounds on the total proton lifetime in years in the Dirac neutrino case in the  $M_X$ - $\alpha_{GUT}$  plane. The value of the unifying coupling constant is varied from  $1/60$  to  $1/10$ . The conventional values for  $M_X$  and  $\alpha_{GUT}$  in SUSY GUTs are marked in thick lines. Experimentally excluded region is given in black [2].

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