

Proton decay in some realistic models

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In this short letter we show the 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 the 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, $\alpha_{GUT} = g_{GUT}^2/4\pi$, where g_{GUT} is the gauge coupling at the grand unified scale, and α is the matrix element. In order to understand which are the possible grand unified theories which are ruled out, see Figures (1) and (2) for the present parameter space allowed by the experiments. Notice that those theoretical upper bounds on the lifetime of the proton are very important to know about the possibilities of future experiments.

Most of the models (Supersymmetric or non-Supersymmetric) predict a lifetime τ_p below those upper bounds (10^{33-37} years). This is very interesting since it is the possible range of the proposed detectors.

In order to have an idea of the proton decay predictions, let us list in Table 1 the results in different models.

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Model	Decay modes	Prediction	References
Georgi-Glashow model	-	ruled out	[3]
Minimal realistic non-SUSY $SU(5)$	-	$\tau_p^{upper} = 1.4 \times 10^{36}$ 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]

TABLE I: Summary of some recent predictions on proton partial lifetimes.

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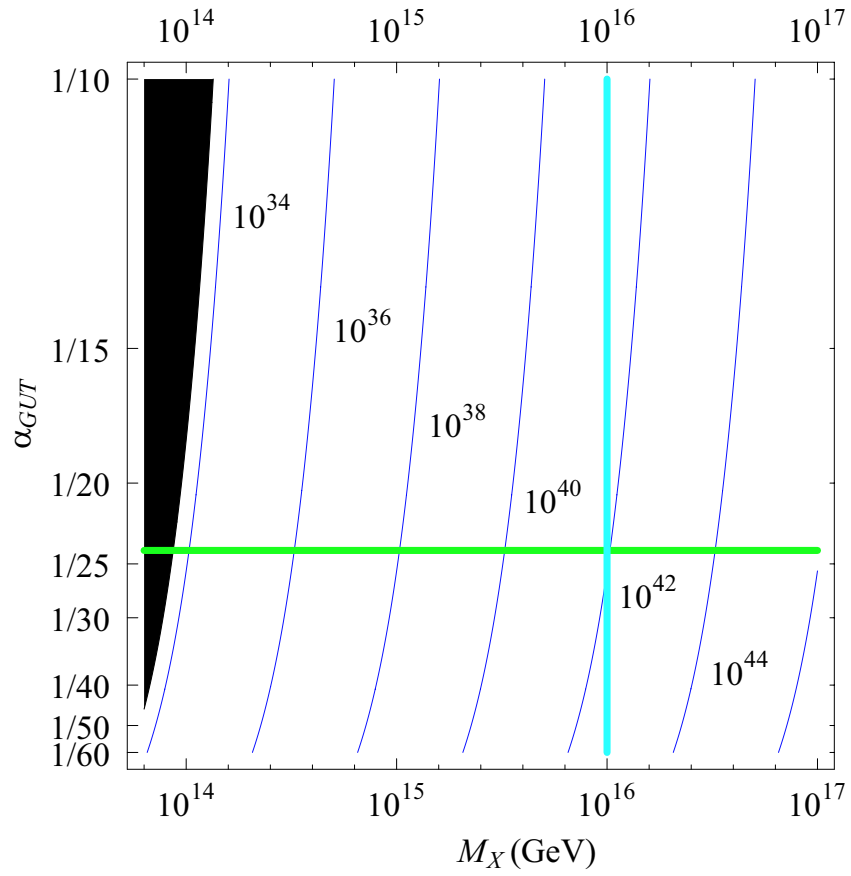


FIG. 1: Isoplot for the upper bounds on the total proton lifetime in years in the Majorana neutrino case in the M_X - α_{GUT} plane. The value of the unifying coupling constant is varied from $1/60$ to $1/10$. The conventional values for M_X and α_{GUT} in SUSY GUTs are marked in thick lines. Experimentally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

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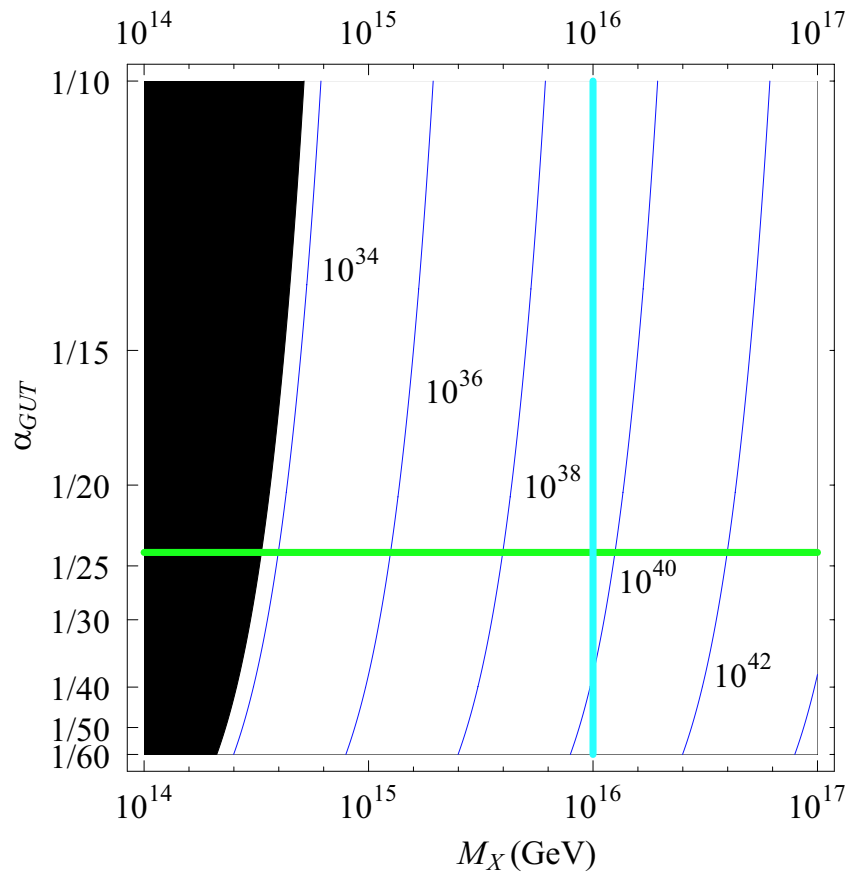


FIG. 2: Isoplot for the upper bounds on the total proton lifetime in years in the Dirac neutrino case in the M_X - α_{GUT} plane. The value of the unifying coupling constant is varied from 1/60 to 1/10. The conventional values for M_X and α_{GUT} in SUSY GUTs are marked in thick lines. Experimentally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