$\mu \longrightarrow e\gamma$ and massive neutrinos

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Theory Group

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Outline

The lepton sector in the "old" Standard Model

The seesaw mechanism
- A short introduction
- Lepton Flavour violation

The SUSY + seesaw model
- Aspects of SUSY
- Lepton flavour violation
- A lower bound for $\mathrm{BR}(\mu \longrightarrow e\gamma)$

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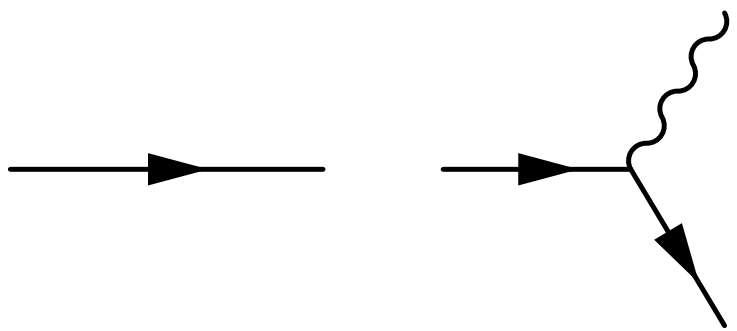

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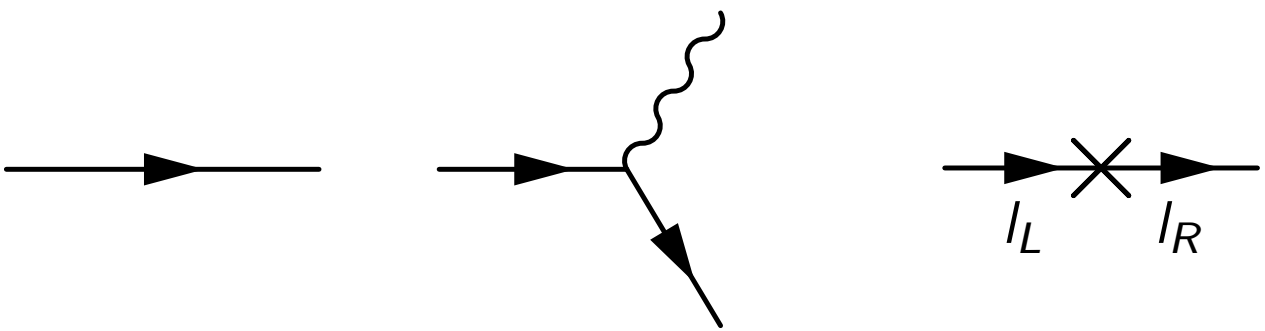
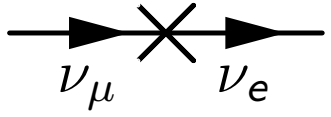


Short introduction to the seesaw mechanism

- Assume there are righthanded neutrinos ν_R
- and that they are very very heavy
  $\Rightarrow$ They can't be generated in collider experiments
- The ν_R's are not a degree of freedom in present physics, but lead to an additional term in the Lagrangian:

$$\mathcal{L}_{leptonic} = \bar{L}\not{D}L + \bar{l}_R\not{D}l_R + \bar{l}_L\mathcal{M}_e l_R + \bar{\nu}_L\mathcal{M}_\nu\nu_L$$

- $\mathcal{M}_e$ and $\mathcal{M}_\nu$ can't be diagonalised both in flavour space:
  $\mathcal{M}_e = \mathrm{diag}(0.5\,\mathrm{MeV}, 0.1\,\mathrm{GeV}, 2\,\mathrm{GeV})$ and $|\mathcal{M}_{\nu\,ij}| < 2\,\mathrm{eV}$



Flavour violation in the seesaw model

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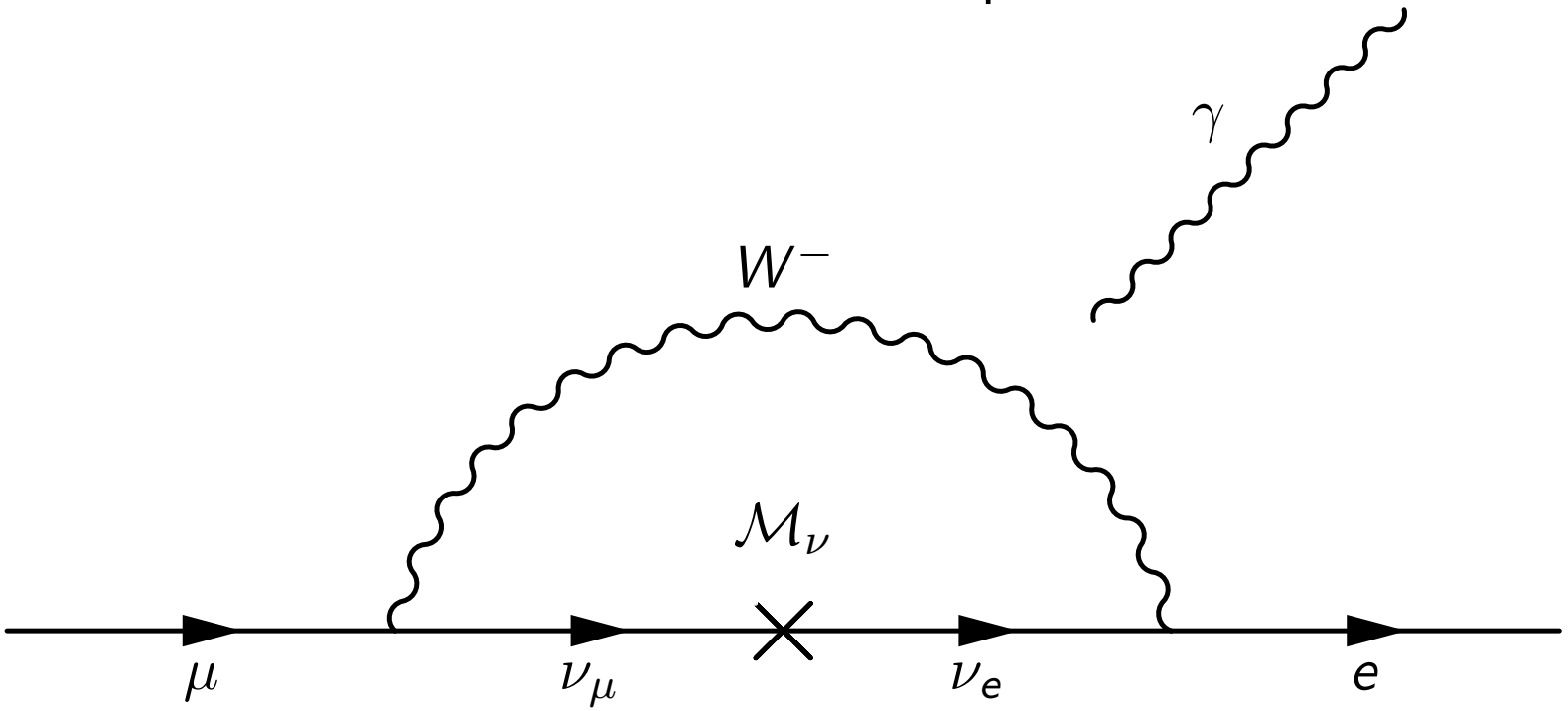

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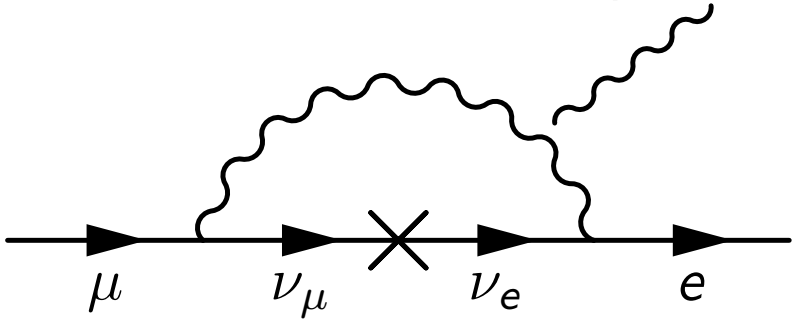

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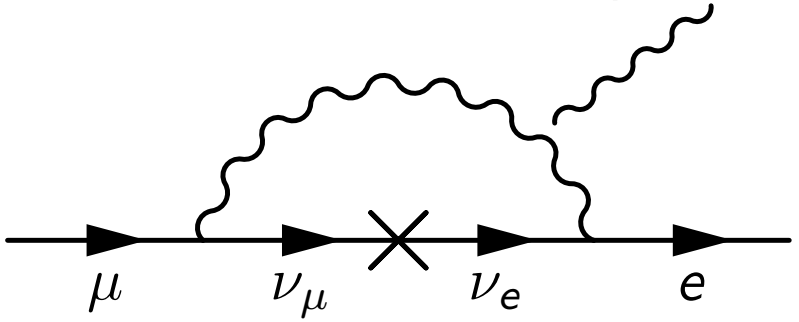

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Experimental bounds on lepton flavour violation

trans.	$\mu \longrightarrow e\gamma$	$\tau \longrightarrow \mu\gamma$	$\tau \longrightarrow e\gamma$
BR	$< 10^{-11}$	$< 10^{-7}$	$< 10^{-7}$

Aspects of SUSY

name	symbol	spin	name	symbol	spin
leptons	L, l_R	$1/2$	sleptons	$\tilde{L}, \tilde{l}_R$	0
gauge bosons	$\gamma, W^{\pm}, Z$	1	charginos	$\tilde{\chi}^{\pm}_A$	$1/2$
Higgs	H_1, H_2	0	neutralinos	$\tilde{\chi}^0_B$	$1/2$

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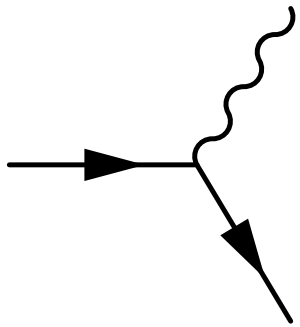

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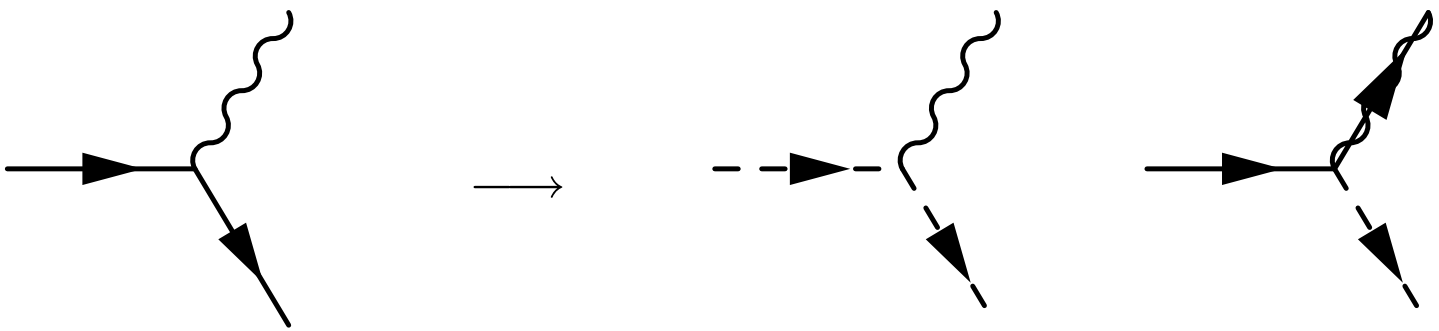

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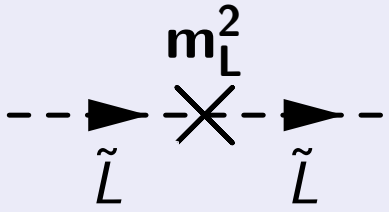

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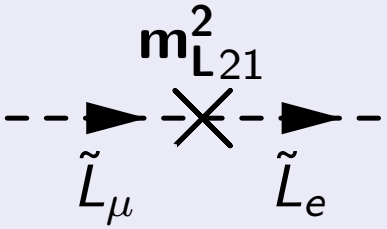

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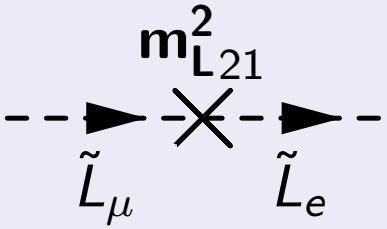
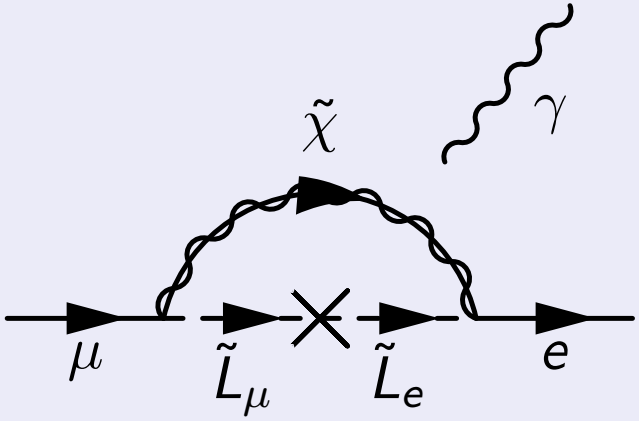


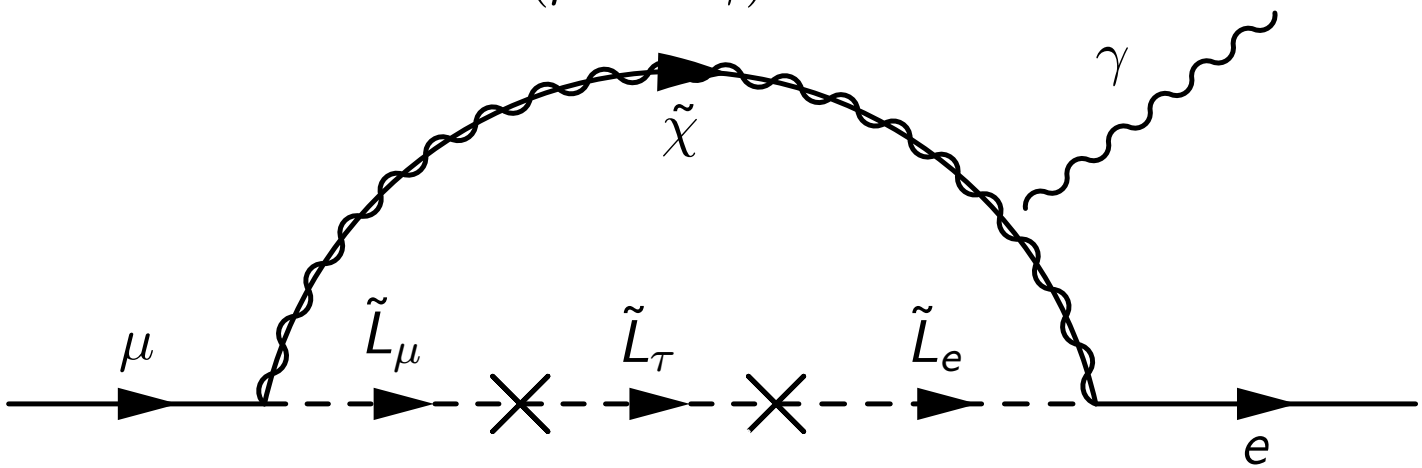
New sources of flavour violation



- no mass suppression
- this allows for sizable flavour violation
- measured LFV constrains $\mathbf{m}_{\mathbf{L}}^{\mathbf{2}}$

What I did...

- The $\mathbf{m}^2_{\mathbf{L}21}$ is most restricted by experiment
- Thus I assumed that it is ≈ 0 at some mass scale
- Nevertheless the $\mathrm{BR}(\mu \to e\gamma)$ is not zero:



- I get a lower bound for $\mathrm{BR}(\mu \to e\gamma)$ of the form:

$$\mathrm{BR}(\mu \to e\gamma) > \text{const.}\ \mathrm{BR}(\tau \to e\gamma) \cdot \mathrm{BR}(\tau \to \mu\gamma)$$

- Because the calculation is done in generality, this inequality is a test for the seesaw + SUSY scenario