Novel bilinear R-parity violating Sneutrino decays

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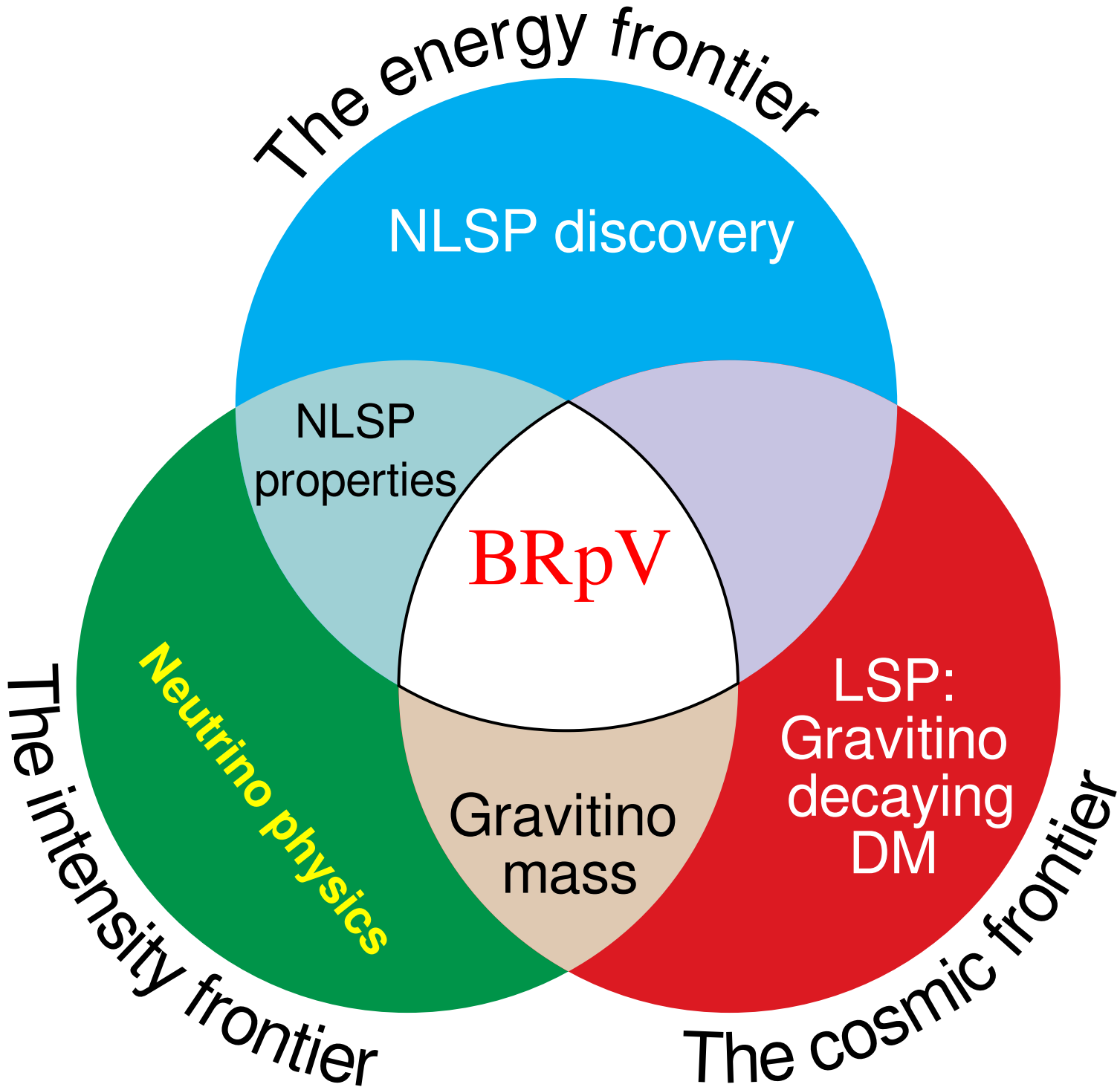
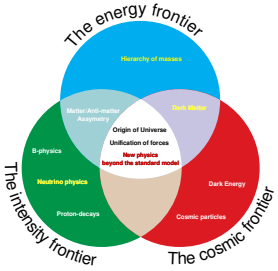
Based on

JHEP 1305(2013)046, arXiv:1212.3310

In collaboration with

D. Aristizabal Sierra (IFPA, Liege U, BE) & S. Spinner (SISSA, IT & Kansas)

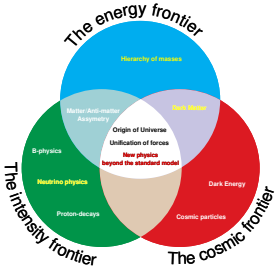

The energy frontier
NLSP discovery
NLSP properties
BRpV
Neutrino physics
Gravitino mass
LSP: Gravitino decaying DM
The intensity frontier
The cosmic frontier



Bilinear R-parity Violation ($\mathrm{BR_pV}$) Supersymmetric Model

$$W = W_{\mathrm{MSSM}} + \epsilon_i L_i H_u$$

$$i = 1, 2, 3$$



Bilinear R-parity Violation ($\mathrm{BR_pV}$)

Supersymmetric Model

$$W = W_{\mathrm{MSSM}} + \epsilon_i L_i H_u$$

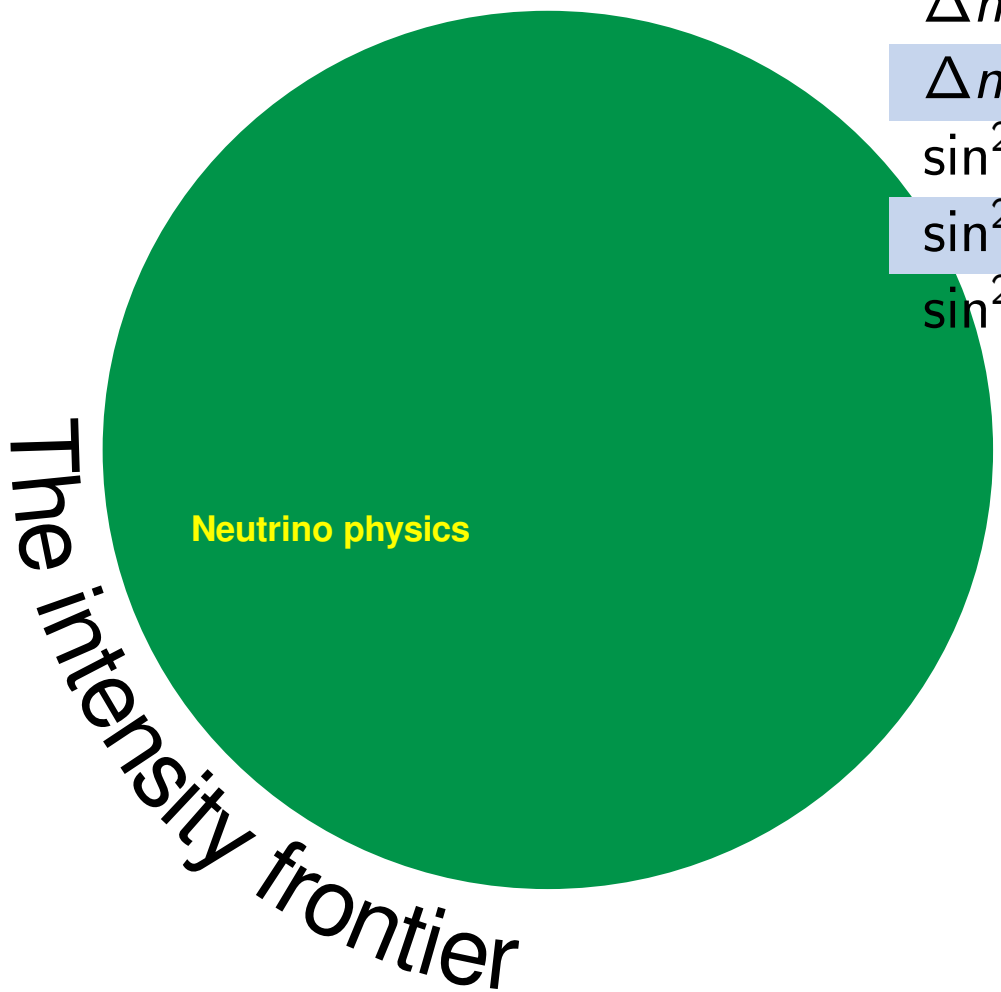
$$\downarrow$$

$$v_i$$

$$i = 1, 2, 3$$

$$\frac{\Lambda_i}{\mu\, v_d} = \frac{\epsilon_i}{\mu} + \frac{v_i}{v_d}$$

6 new parameters



Parámetro	1σ
$\Delta m^2_{32}[10^{-3}\mathrm{eV}^2]$	$2.50^{+0.09}_{-0.16}$
$\Delta m^2_{21}[10^{-5}\mathrm{eV}^2]$	$7.59^{+0.20}_{-0.18}$
$\sin^2\theta_{23}$	$0.52^{+0.06}_{0.07}$
$\sin^2\theta_{12}$	$0.312^{+0.017}_{-0.015}$
$\sin^2\theta_{13}$	$0.013^{+0.007}_{-0.005}$

Valle et al, arXiv:1108.1376

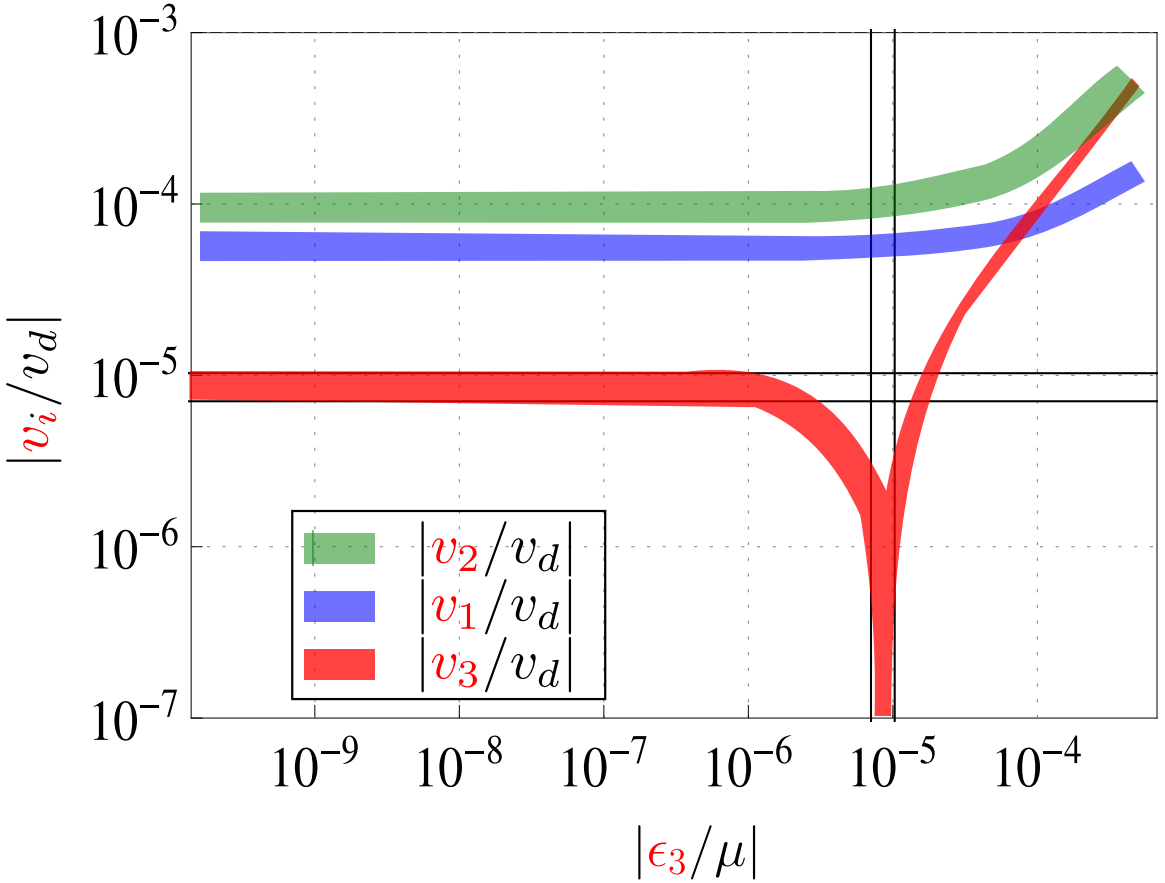
$$\Delta m_{32} = \frac{M_{\tilde{\gamma}}}{4|M^0_\chi|}\,|\Lambda|^2$$

$$\tan^2\theta_{i3} = \frac{\Lambda_i^2}{\Lambda_3^2} \qquad i = 1,2$$

$$\Delta m_{21} = \frac{3}{8\pi^2}\sin 2\theta_{\tilde{b}}\frac{m_b^3}{v^2\,c_\beta^2} \times \Delta B_0^{\tilde{b}_2\tilde{b}_1}\frac{(\bar{\epsilon}_1^2+\bar{\epsilon}_2^2)}{\mu^2}$$

$$\tan^2\theta_{12} = \frac{\bar{\epsilon}_1^2}{\bar{\epsilon}_2^2}\,.$$

$$\bar{\epsilon}_i = f_i(\Lambda_i,\epsilon_i)$$



Fully implemented in SPheno [by W. Porod]

$$\Delta m_{32} = \frac{M_{\tilde{\gamma}}}{4|M^0_\chi|}\,|\Lambda|^2$$

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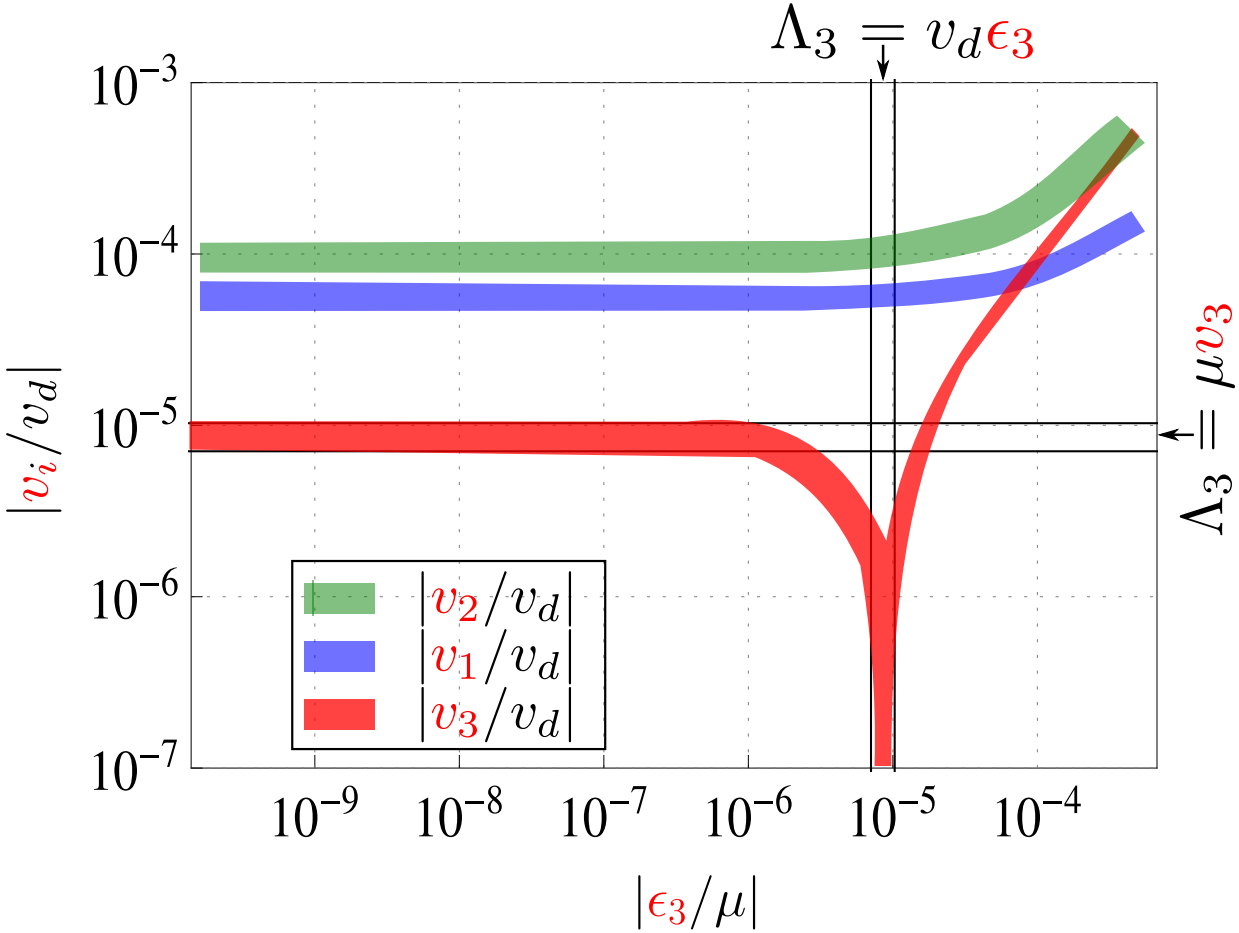
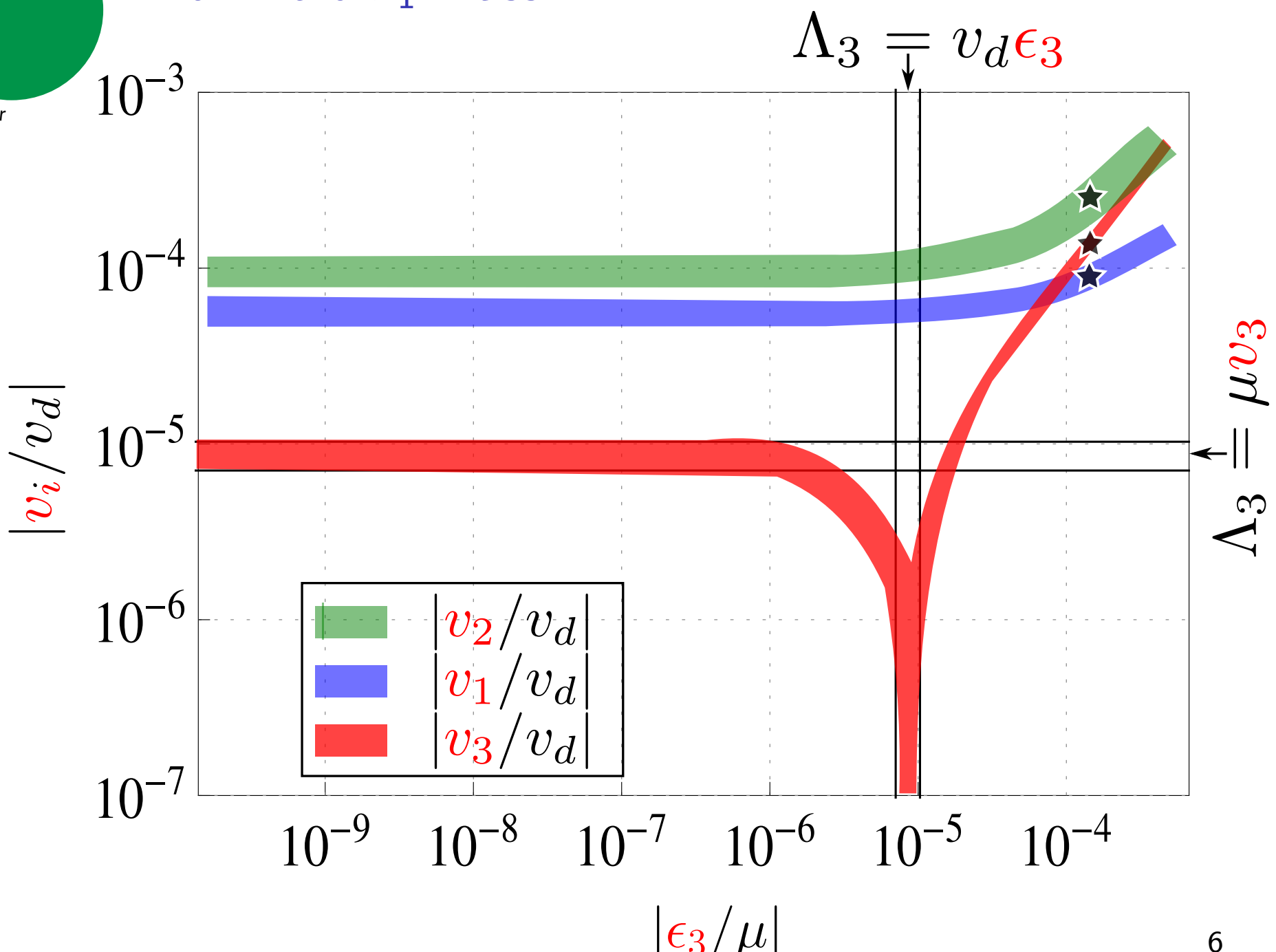
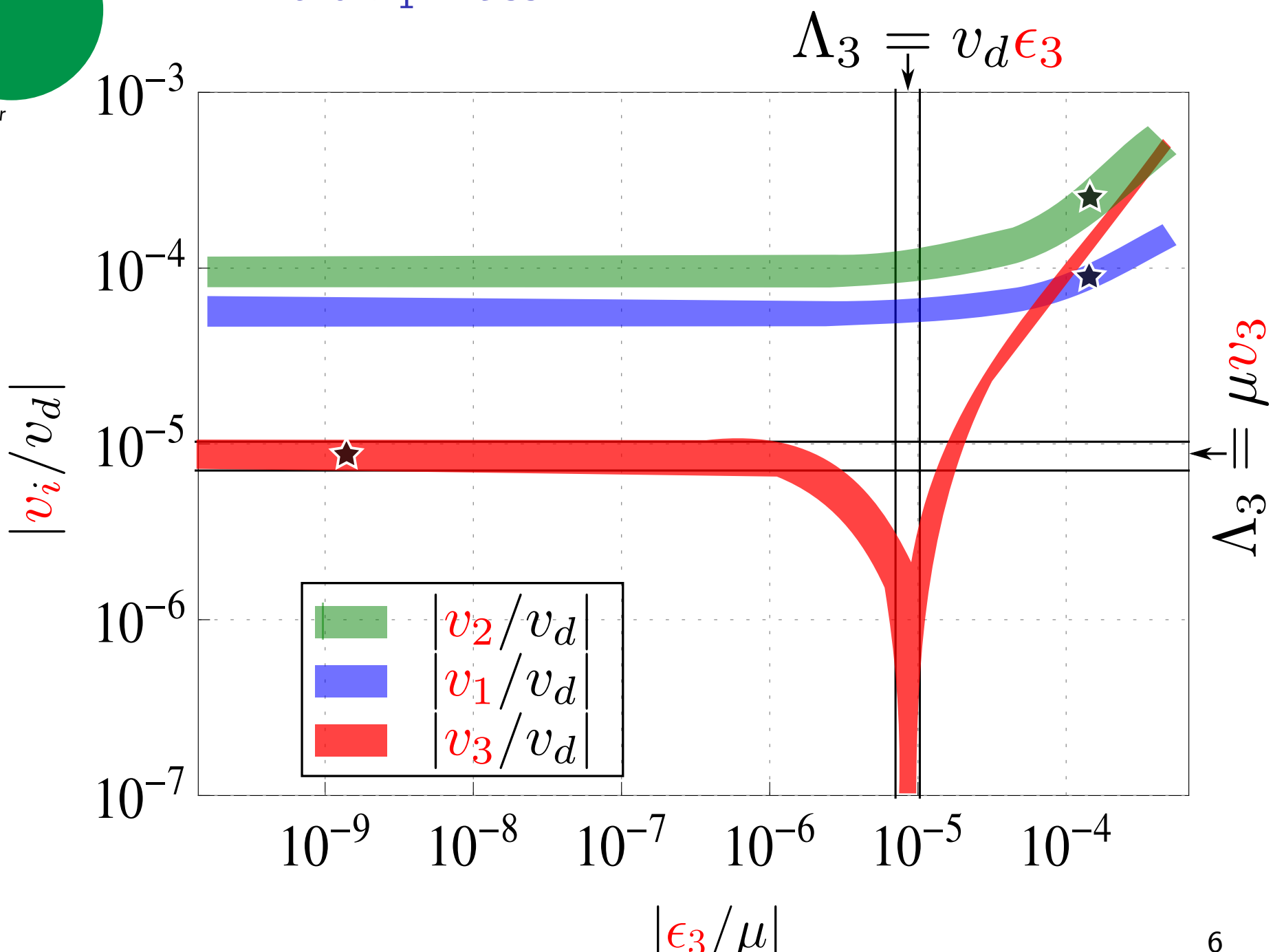


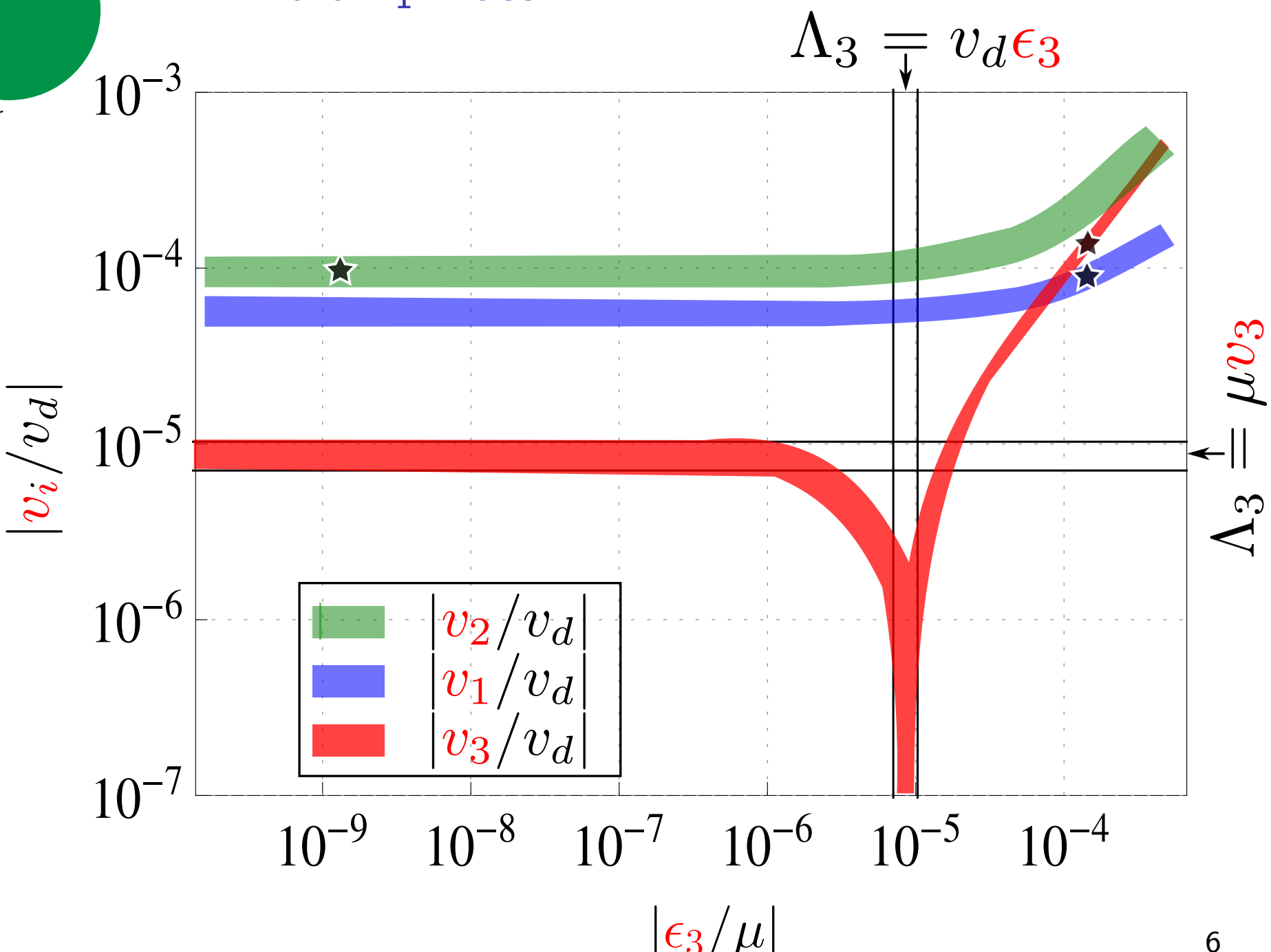
Non Zero ν_1 mass



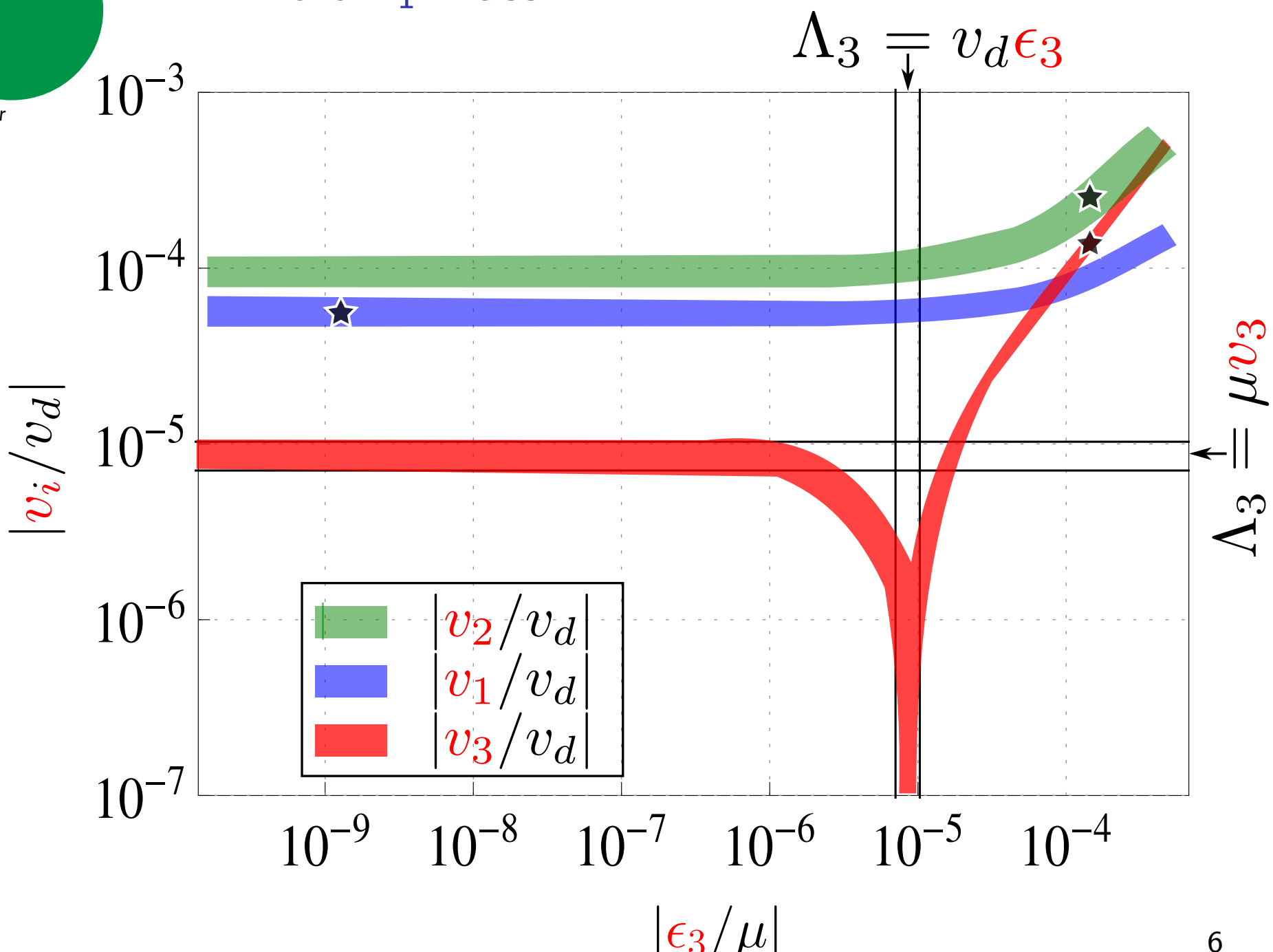
Zero ν_1 mass

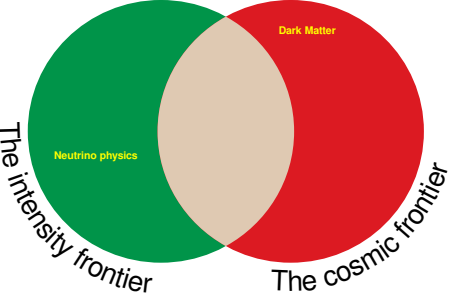


Zero ν_1 mass



Zero ν_1 mass



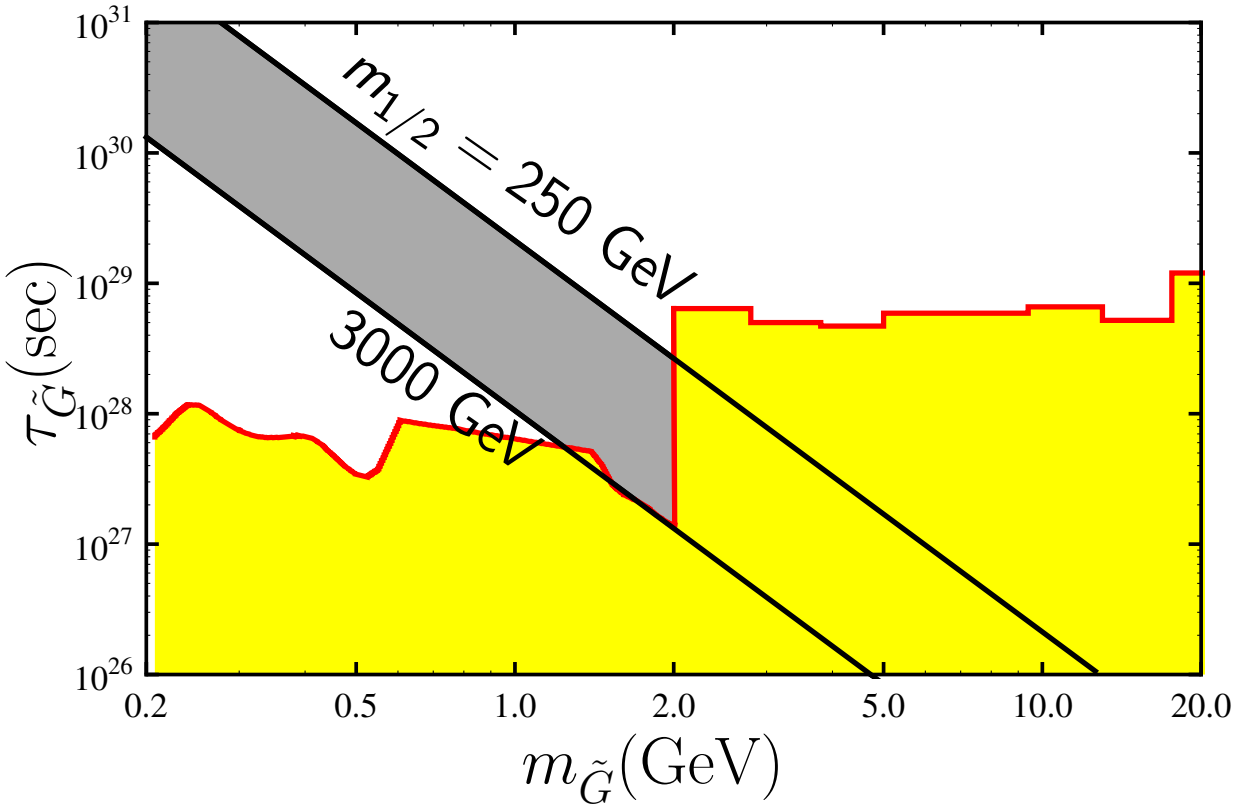


Inestable gravitino dark matter

D.R, M. Taoso, JWF. Valle, O. Zapata, PRD

$$\Gamma = \Gamma(\tilde{G} \to \sum_i \nu_i \gamma) \simeq \frac{1}{32\pi} |U_{\tilde{\gamma}\nu}|^2 \frac{m_{\tilde{G}}^3}{M_P^2}$$

$$|U_{\tilde{\gamma}\nu}|^2 \approx \frac{\mu^2 g^2 \sin^2\theta_W}{4|M_\chi^0|}(M_2 - M_1)^2 |\vec{\Lambda}|^2$$

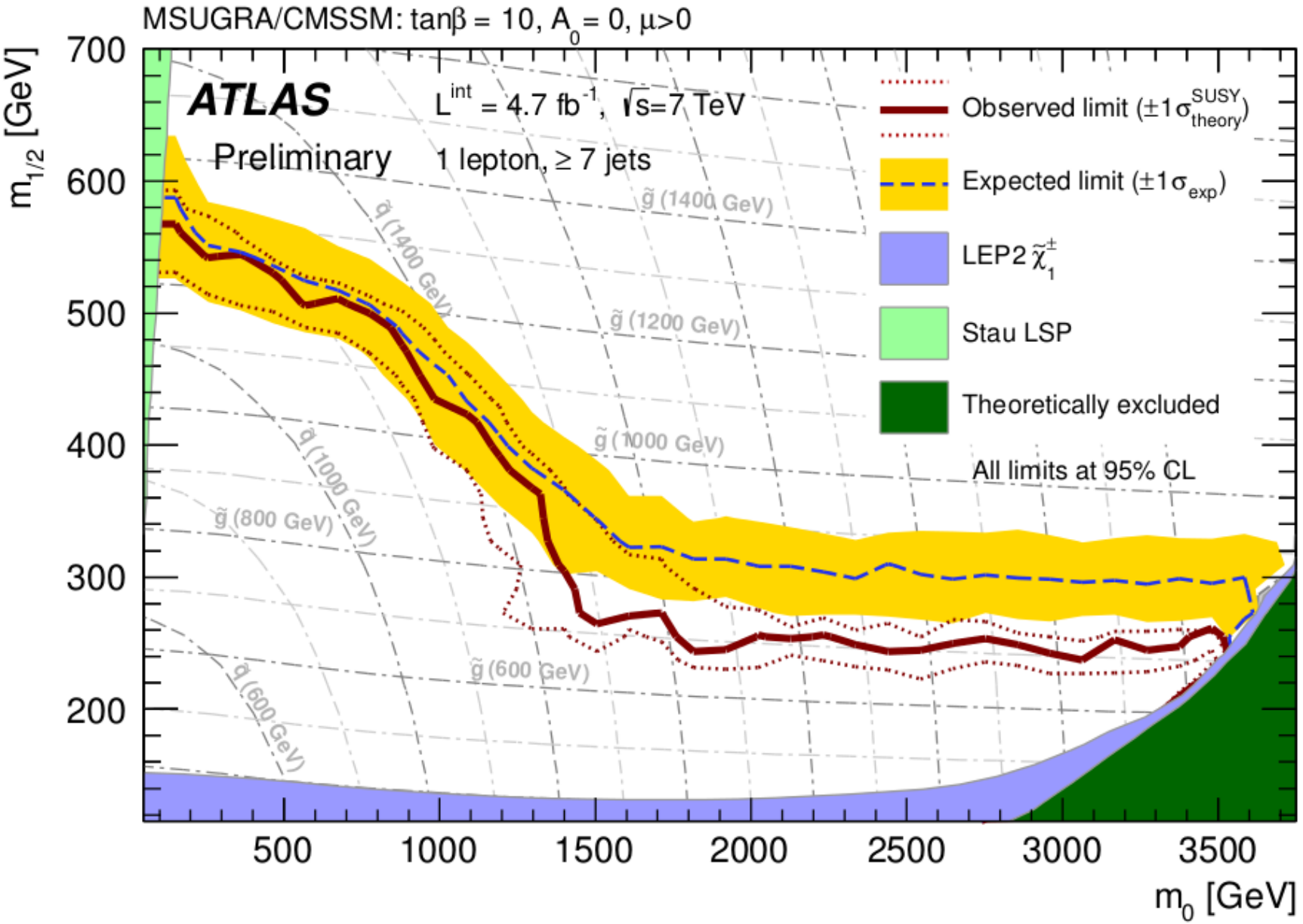


$T_R < 10^{-8}$ GeV

The energy frontier

New physics beyond the standard model

ATLAS-CONF-2012-140 (Oct)



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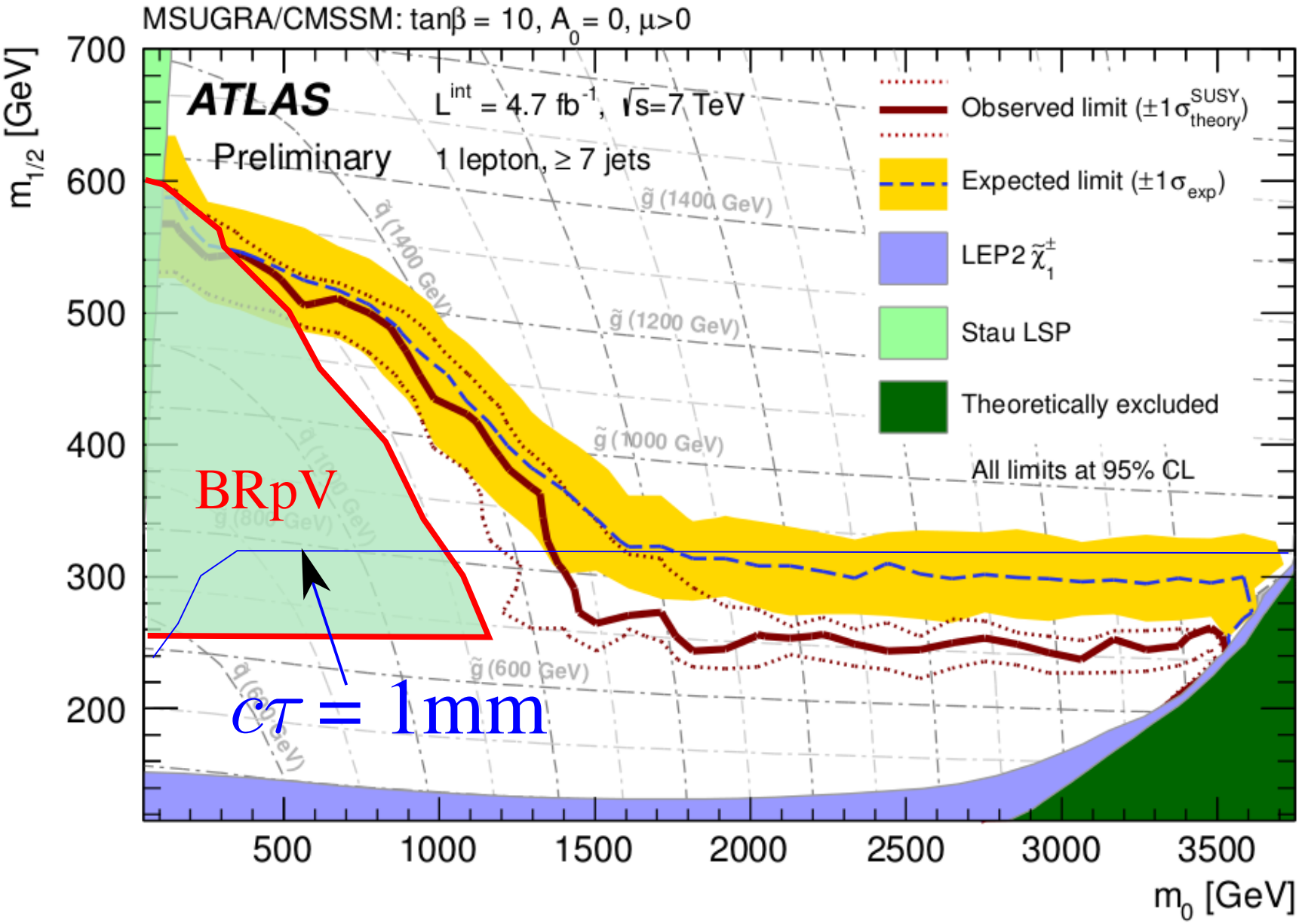
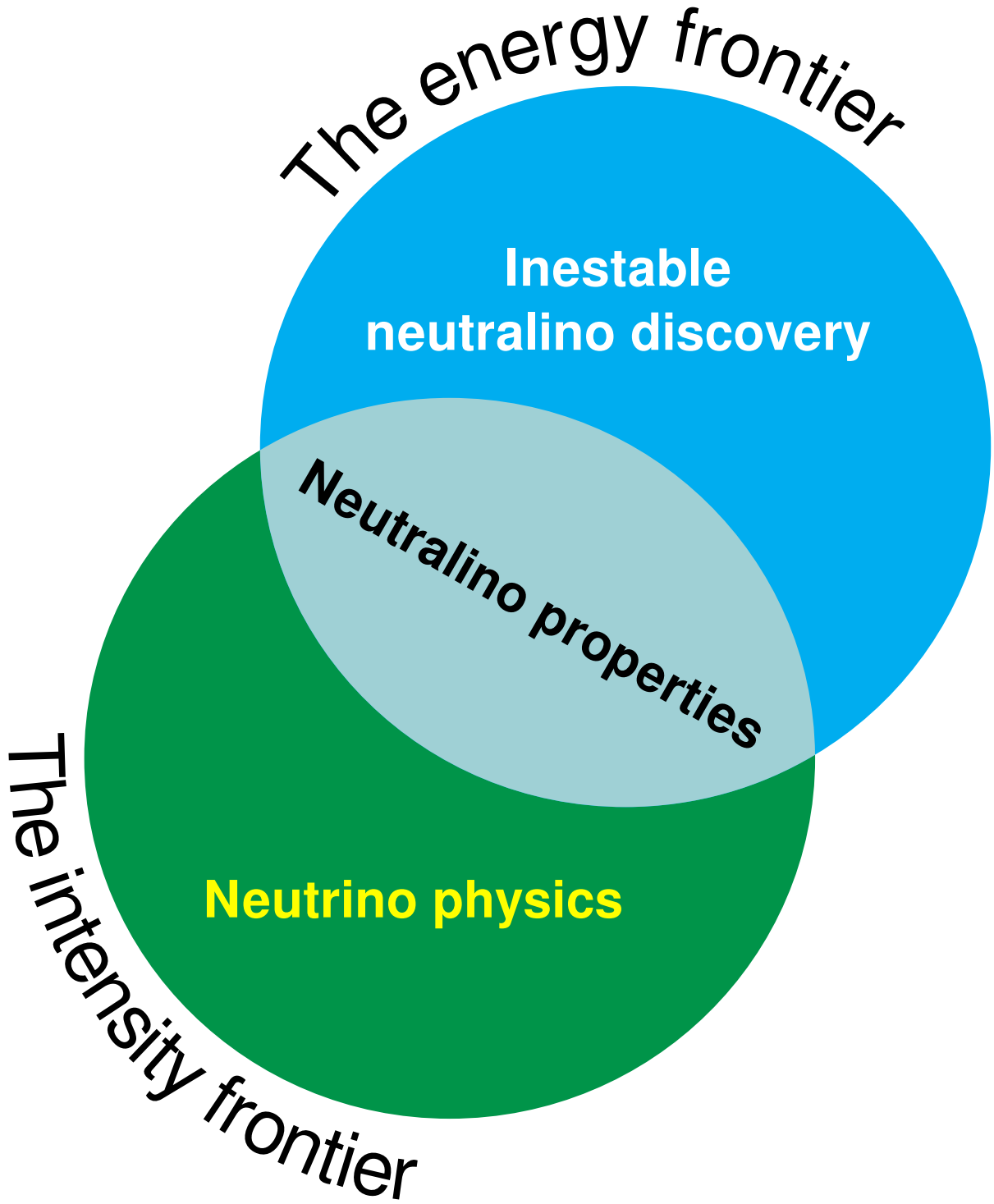
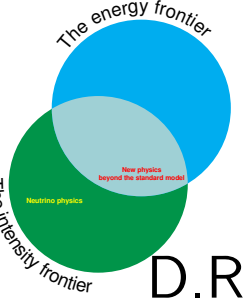
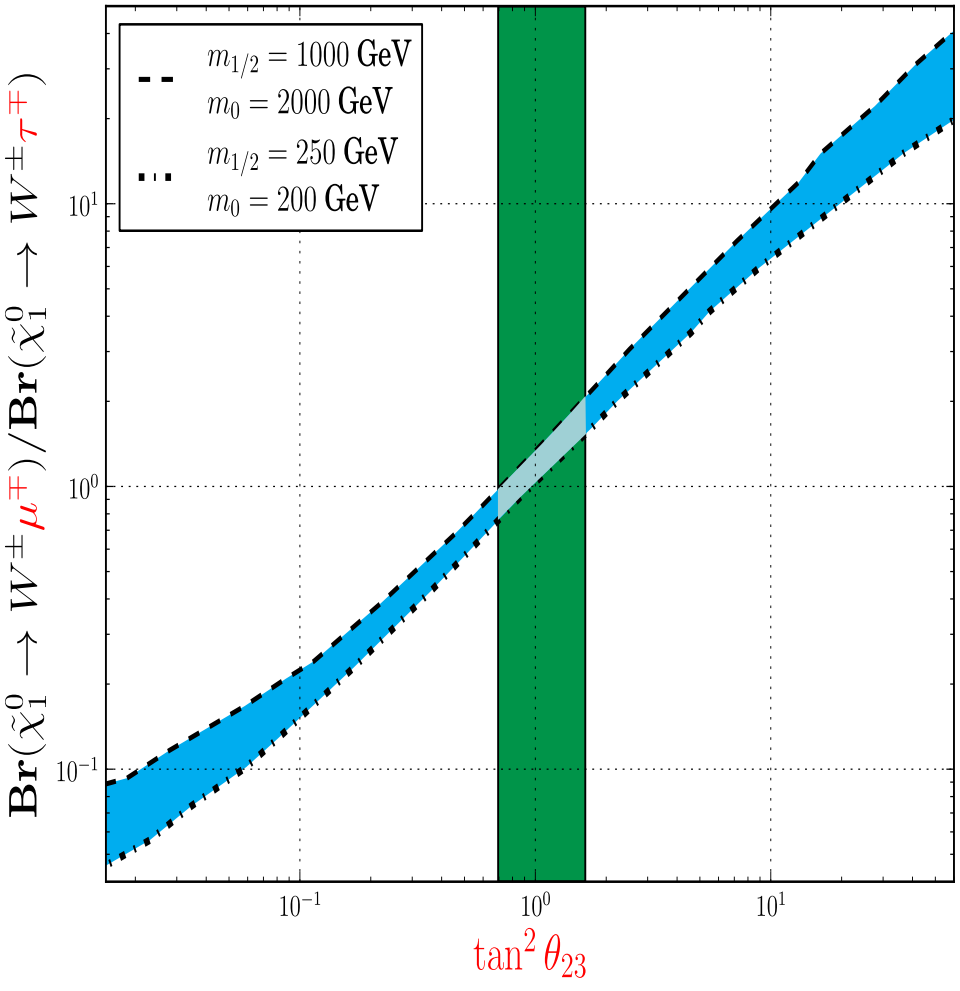



The energy frontier
Inestable
neutralino discovery
Neutralino properties
Neutrino physics
The intensity frontier

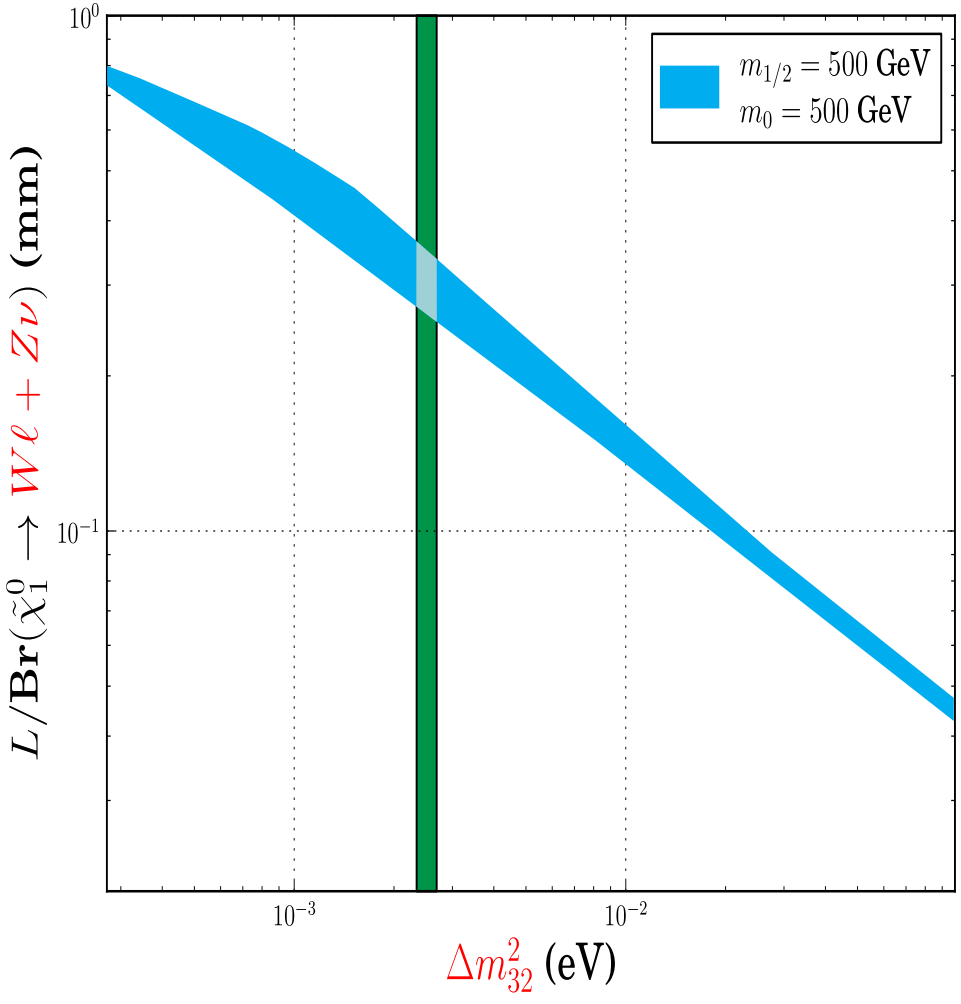


Neutralino properties

D.R. *et al*: arXiv:1006.5075 [PRD]

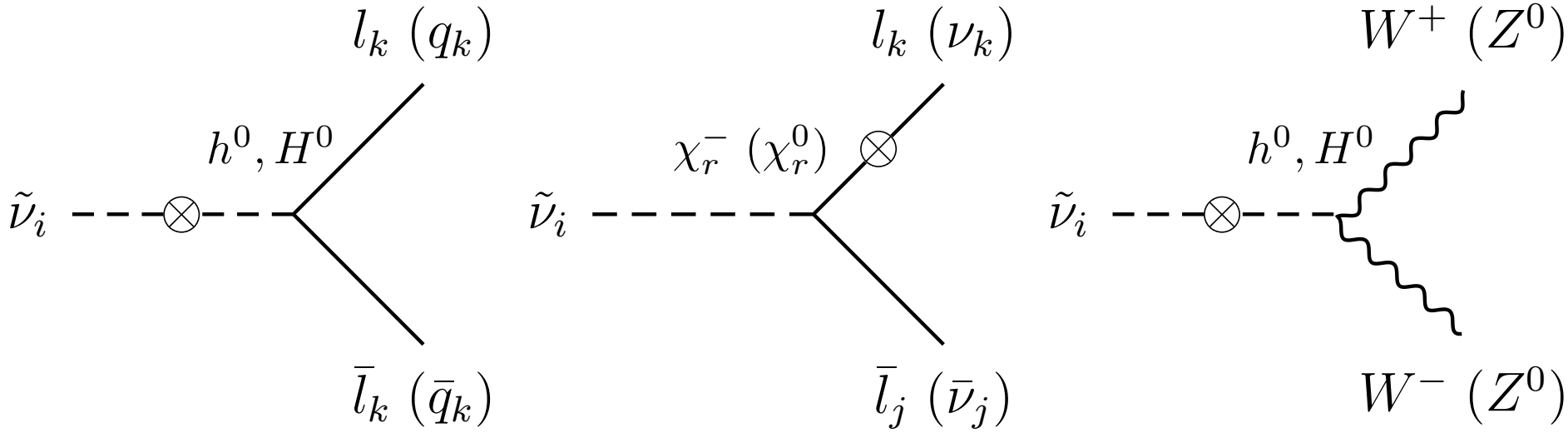


arXiv:1206.3605 [PRD]

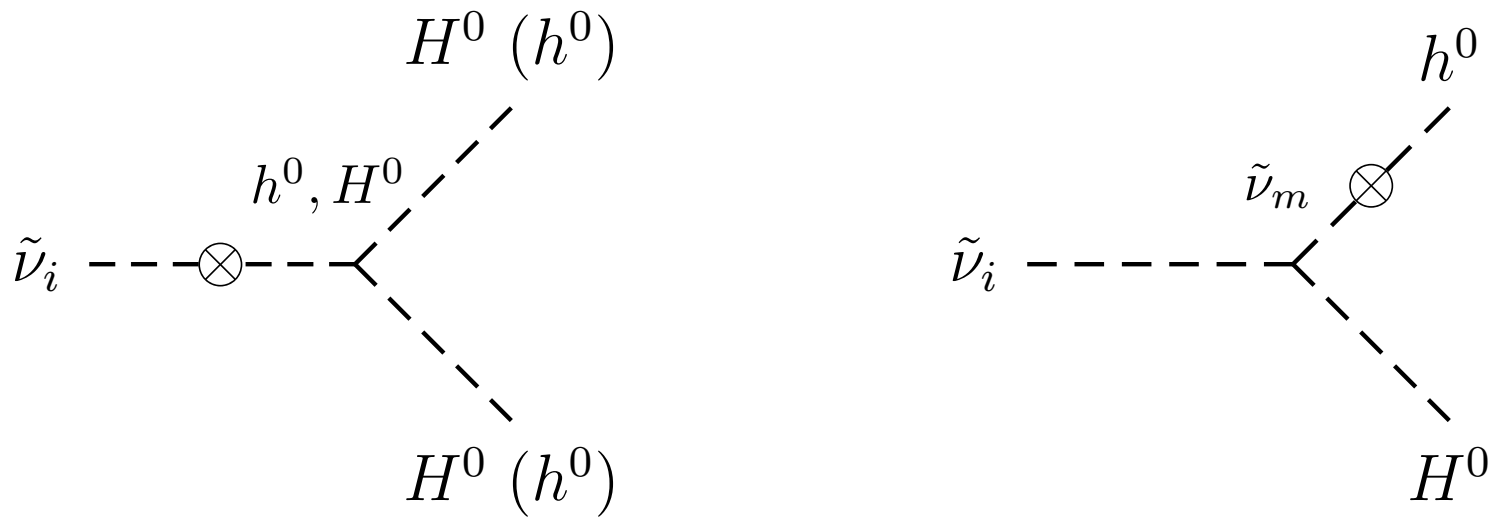


Only depend in Λ_i

Sneutrino RPV decays

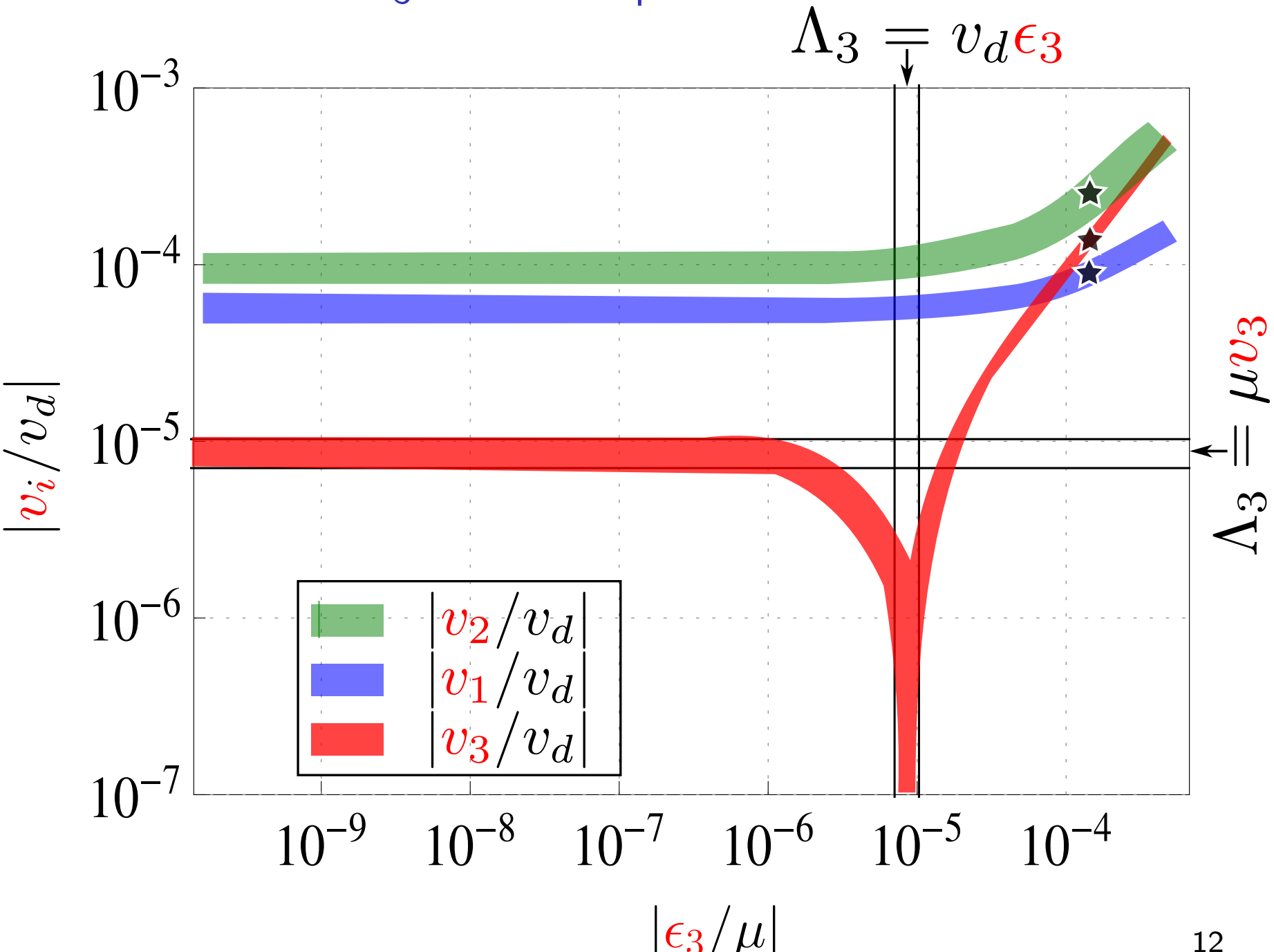


(a) (b) (c)

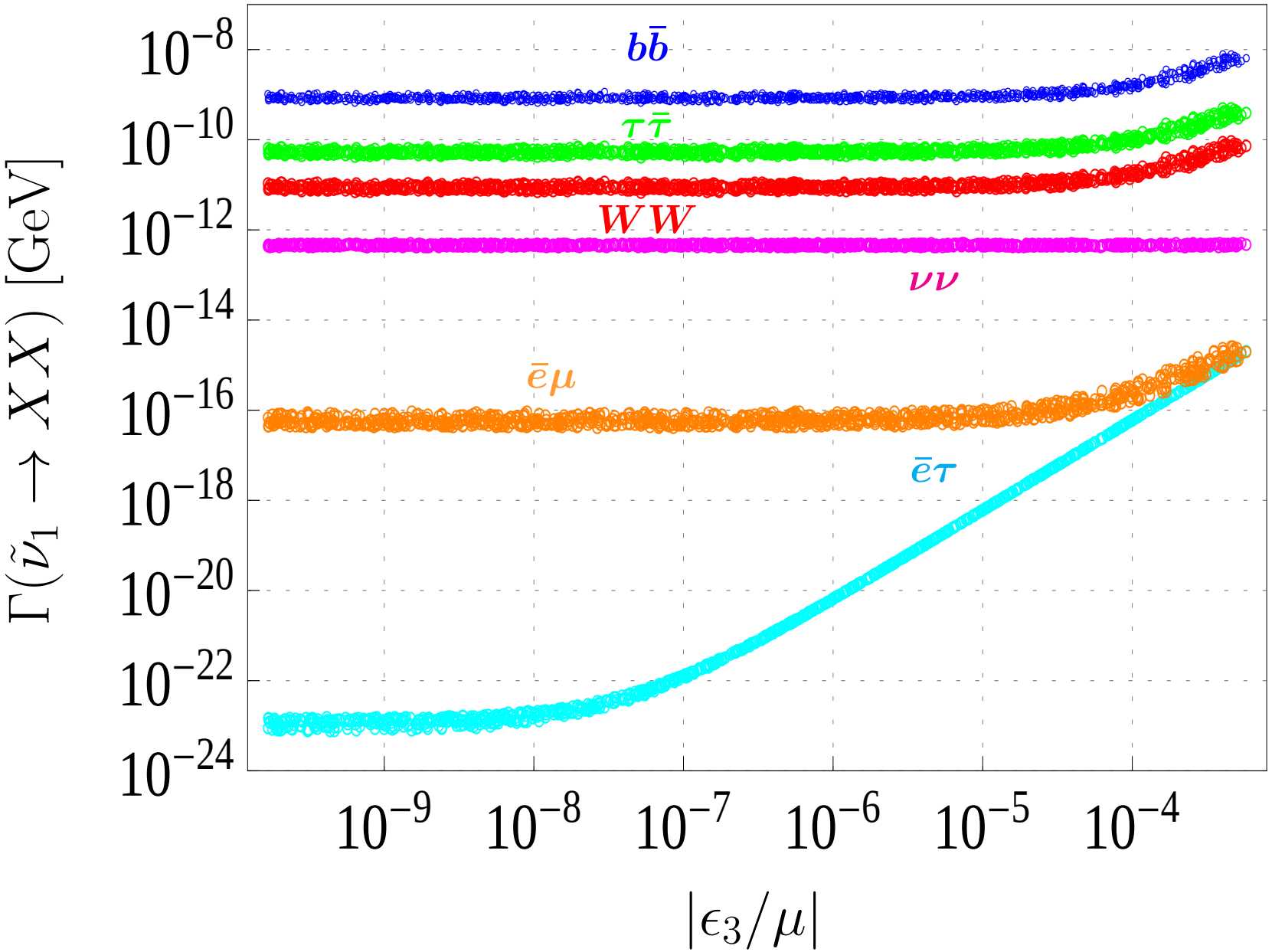


(a) (b)

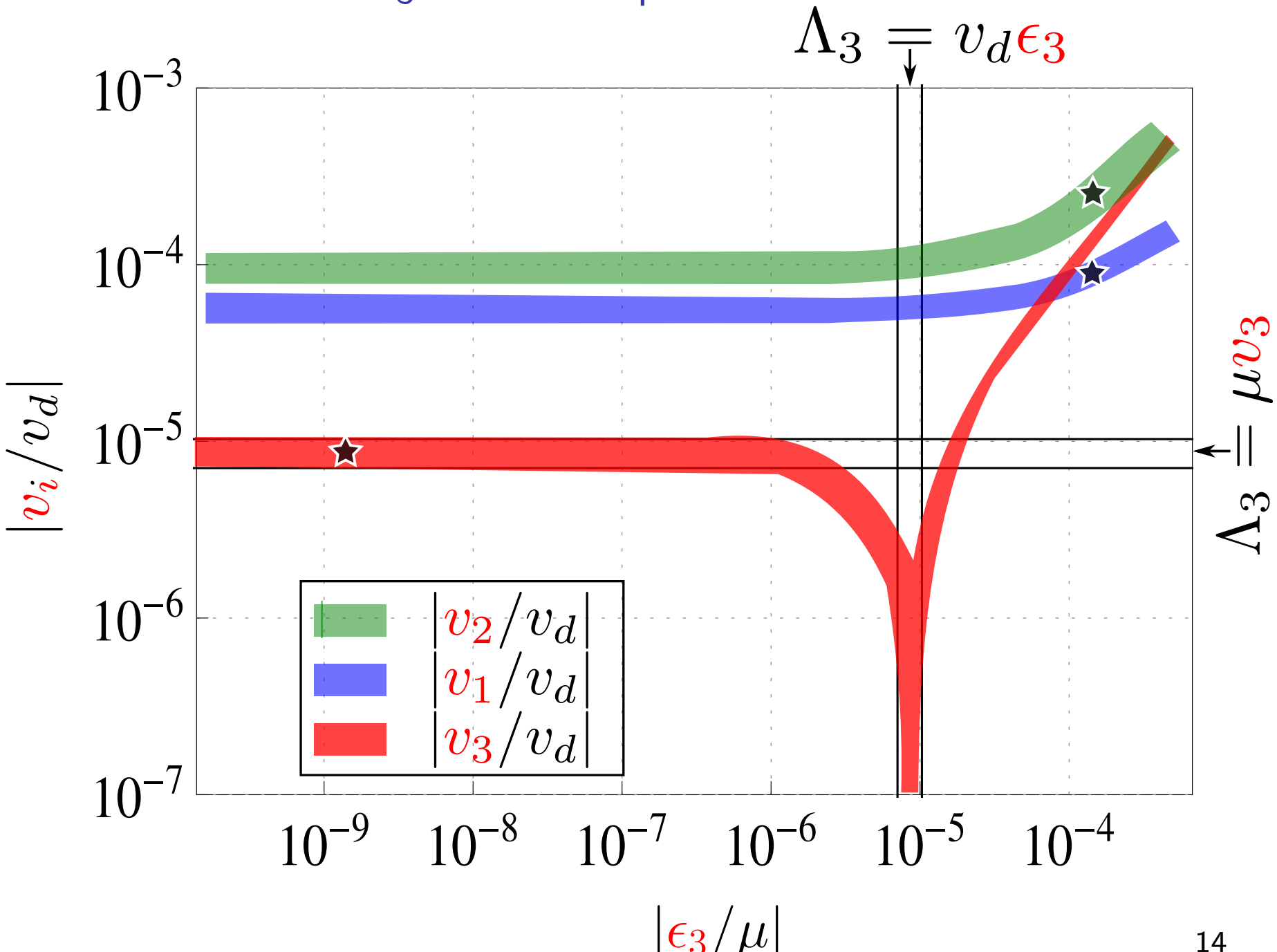
Sneutrino LSP with ϵ_3 as a free parameter



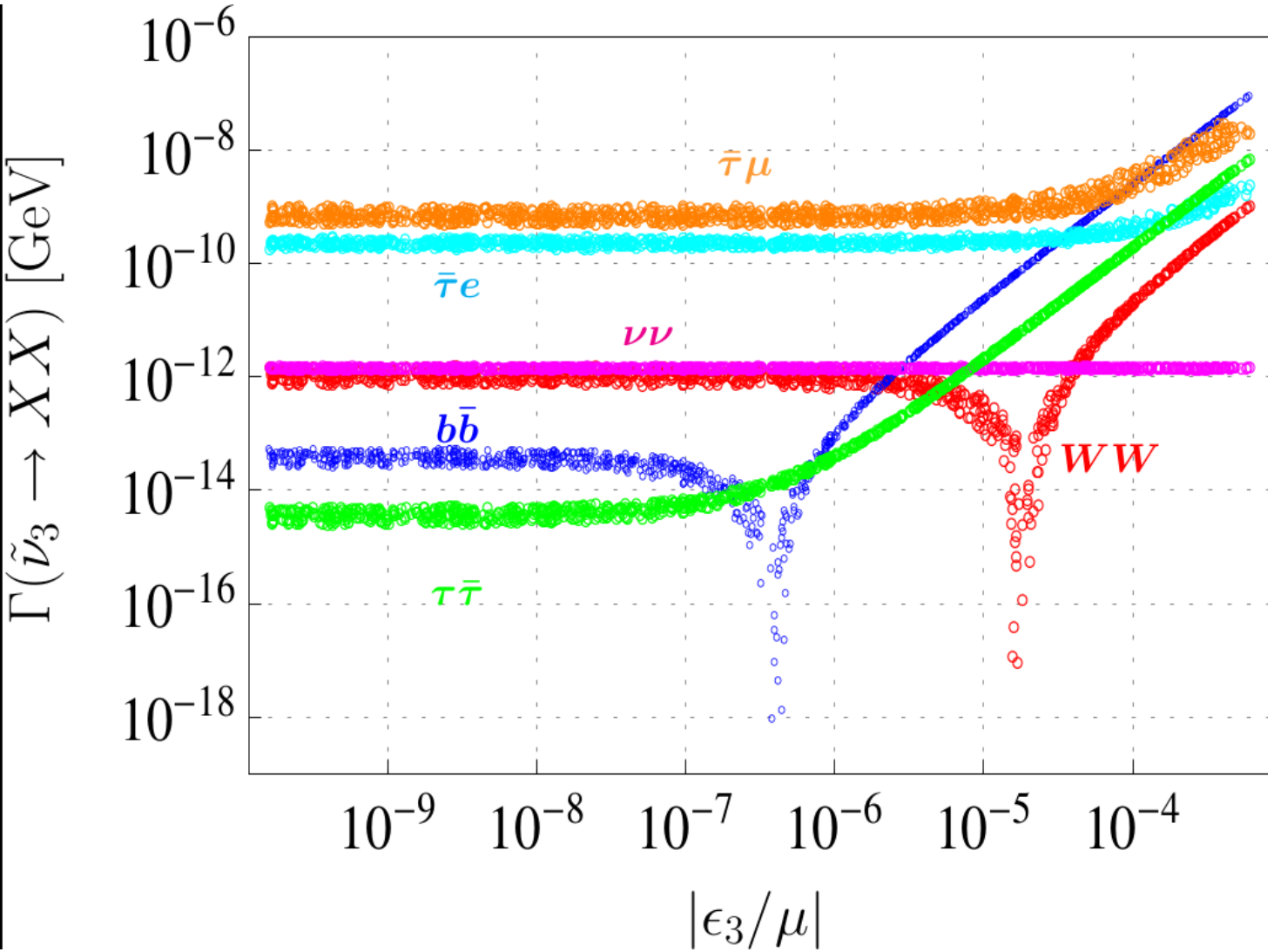
$\tilde{\nu}_1$ RPV decays with large ϵ_1



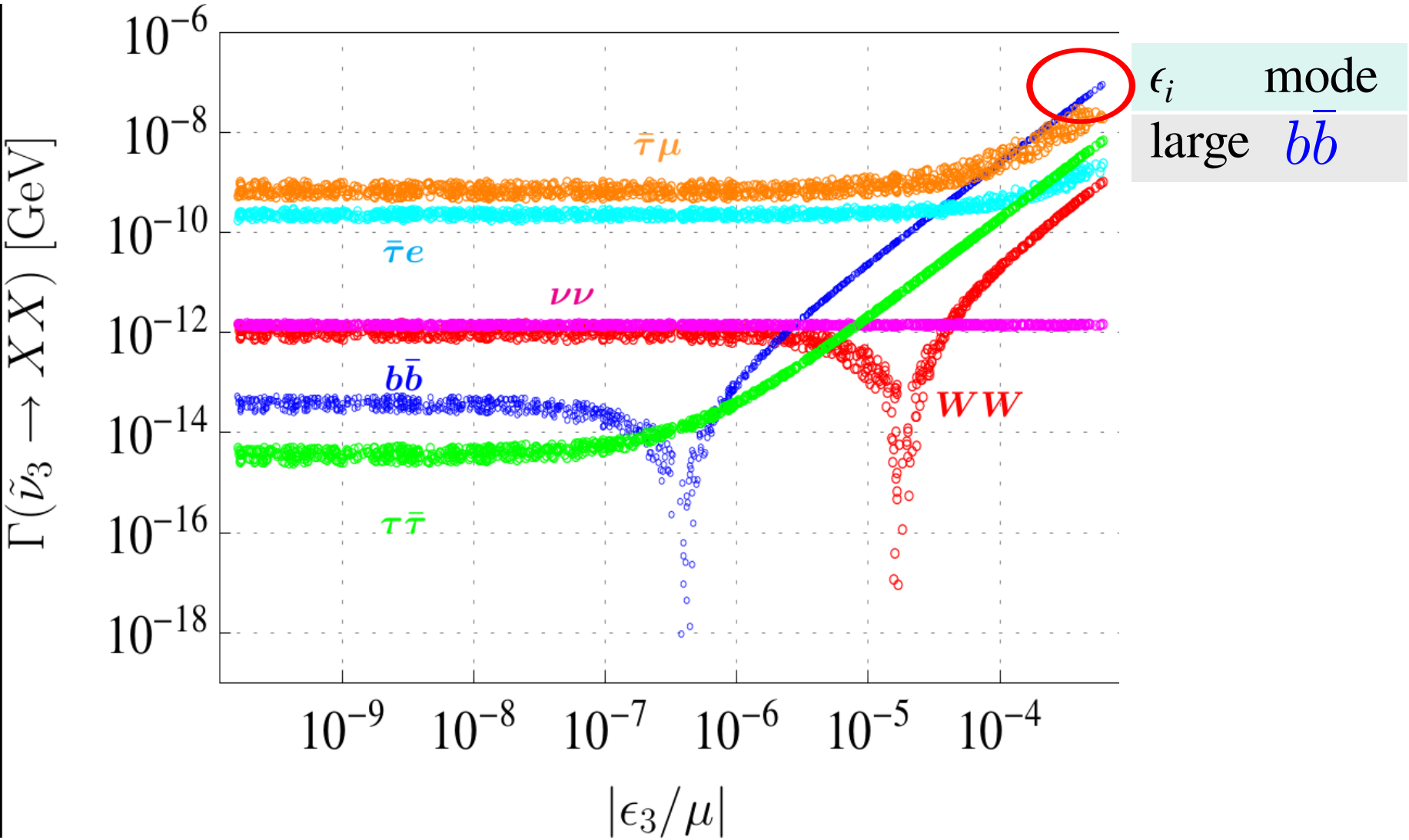
Sneutrino LSP with ϵ_3 as a free parameter



Sneutrino novel decays

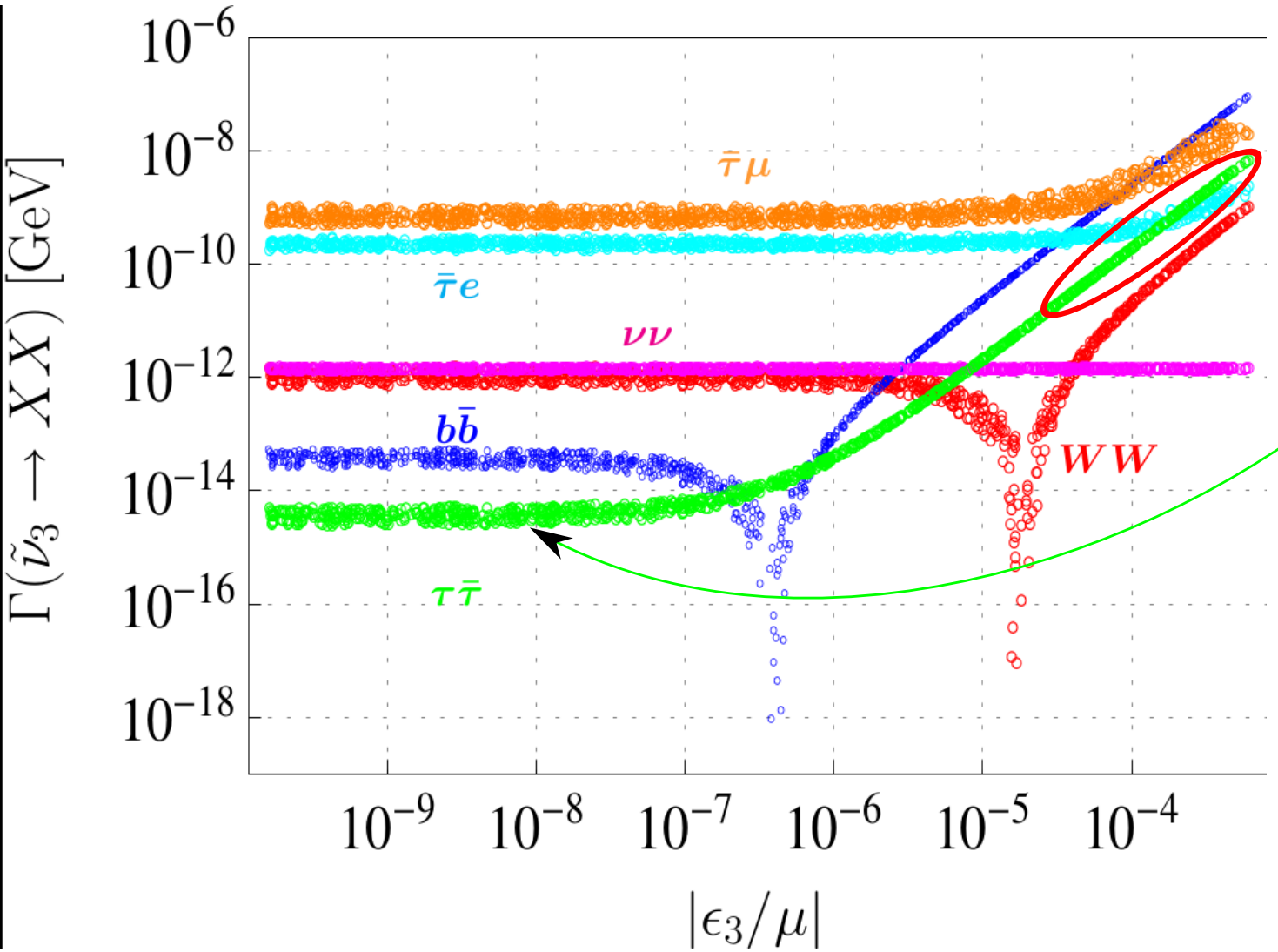


Sneutrino novel decays



ϵ_i	mode
large	$b\bar{b}$

Sneutrino novel decays



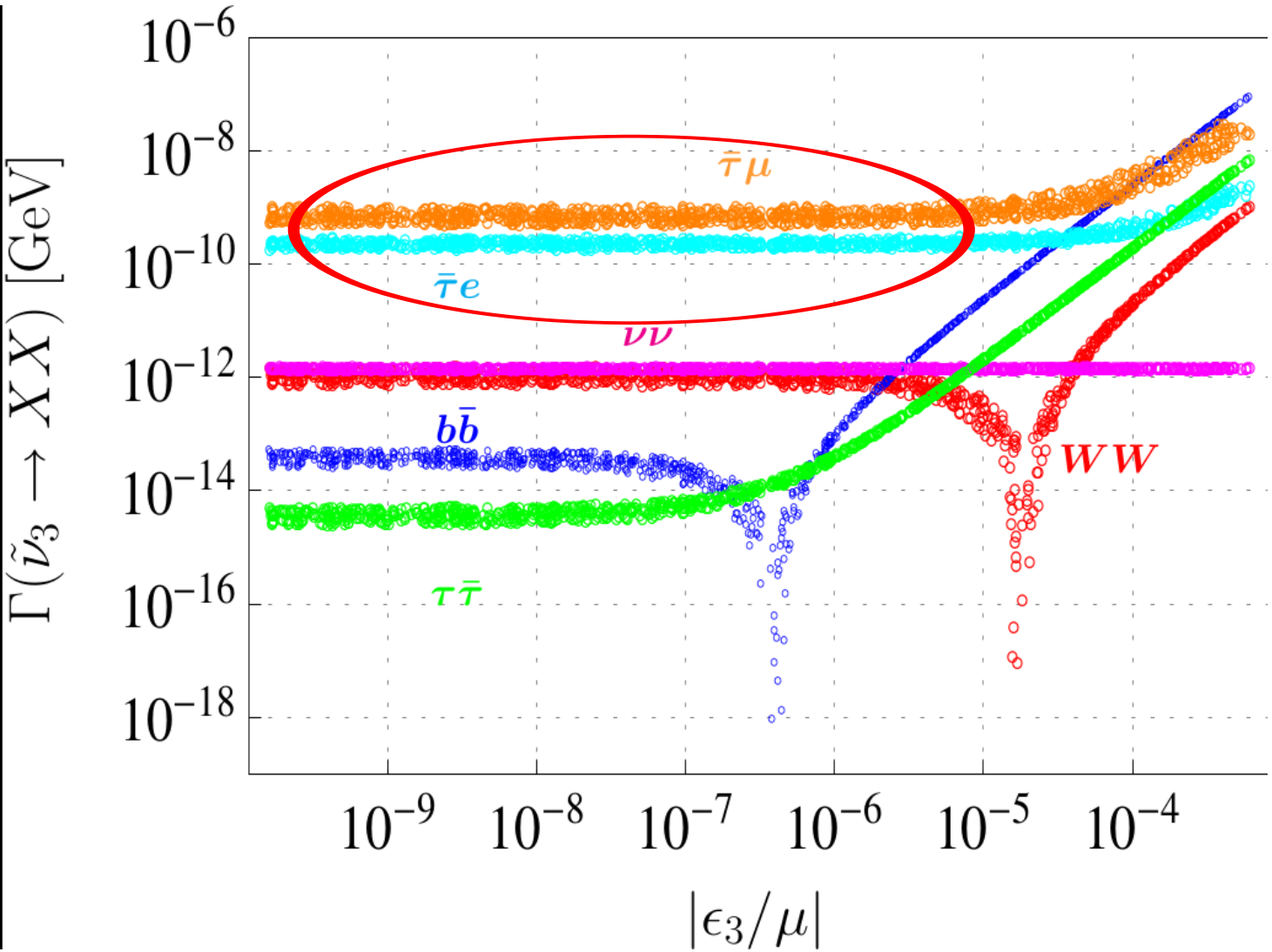
ϵ_3	mode
large	$\tau^+\tau^-$

$\lambda_{33k} = h_\tau \epsilon_k$

$k \neq 3$

Pure bilinear mode!

Sneutrino novel decays



ϵ_3	mode
small	$\tau^+ l_k^-$

$\lambda_{33k} = h_\tau \epsilon_k$

$k \neq 3$

ϵ_2	mode
small	$\mu^+ l_k^-$

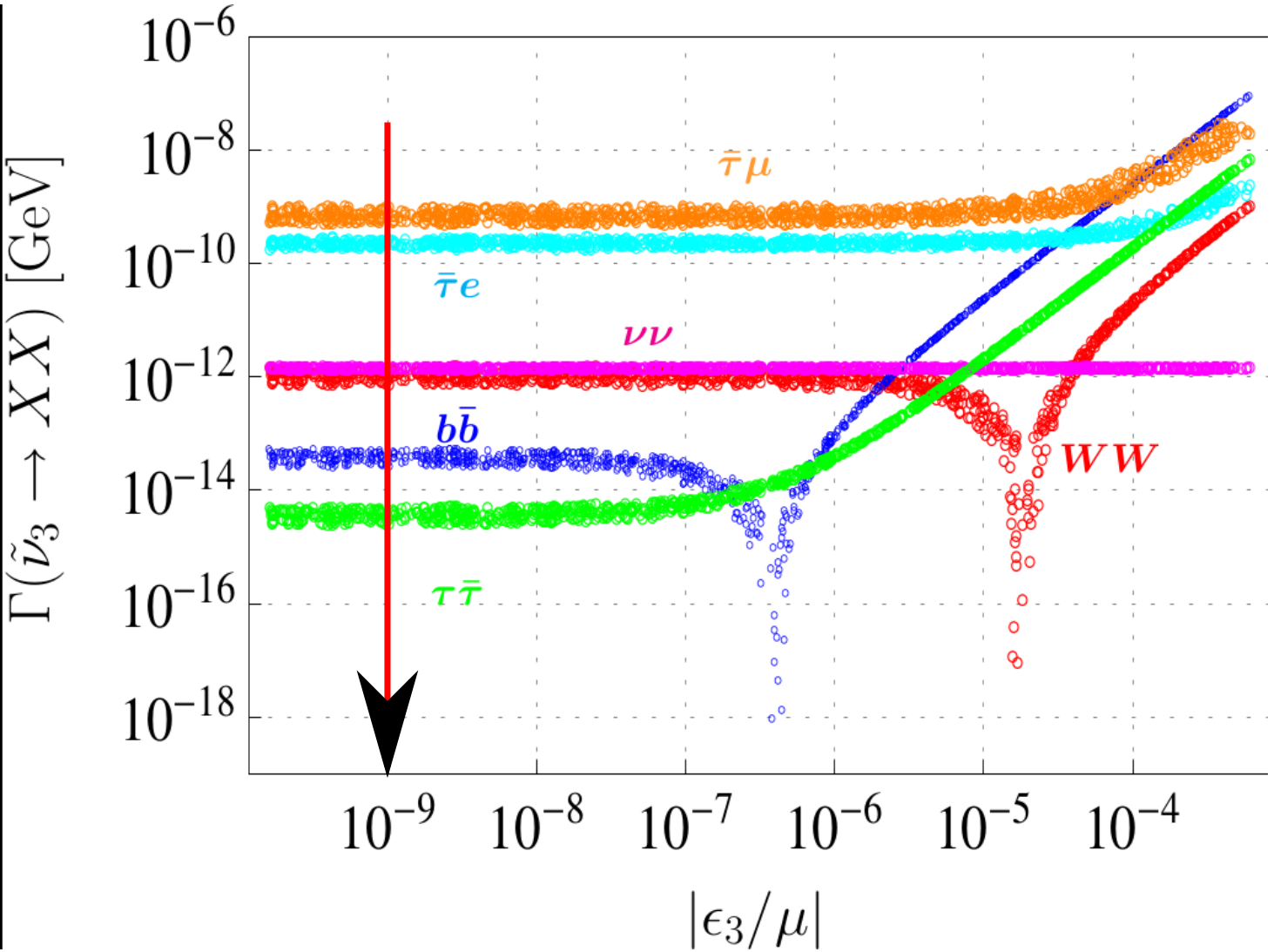
$\lambda_{22k} = h_\mu \epsilon_k$

$k \neq 2$

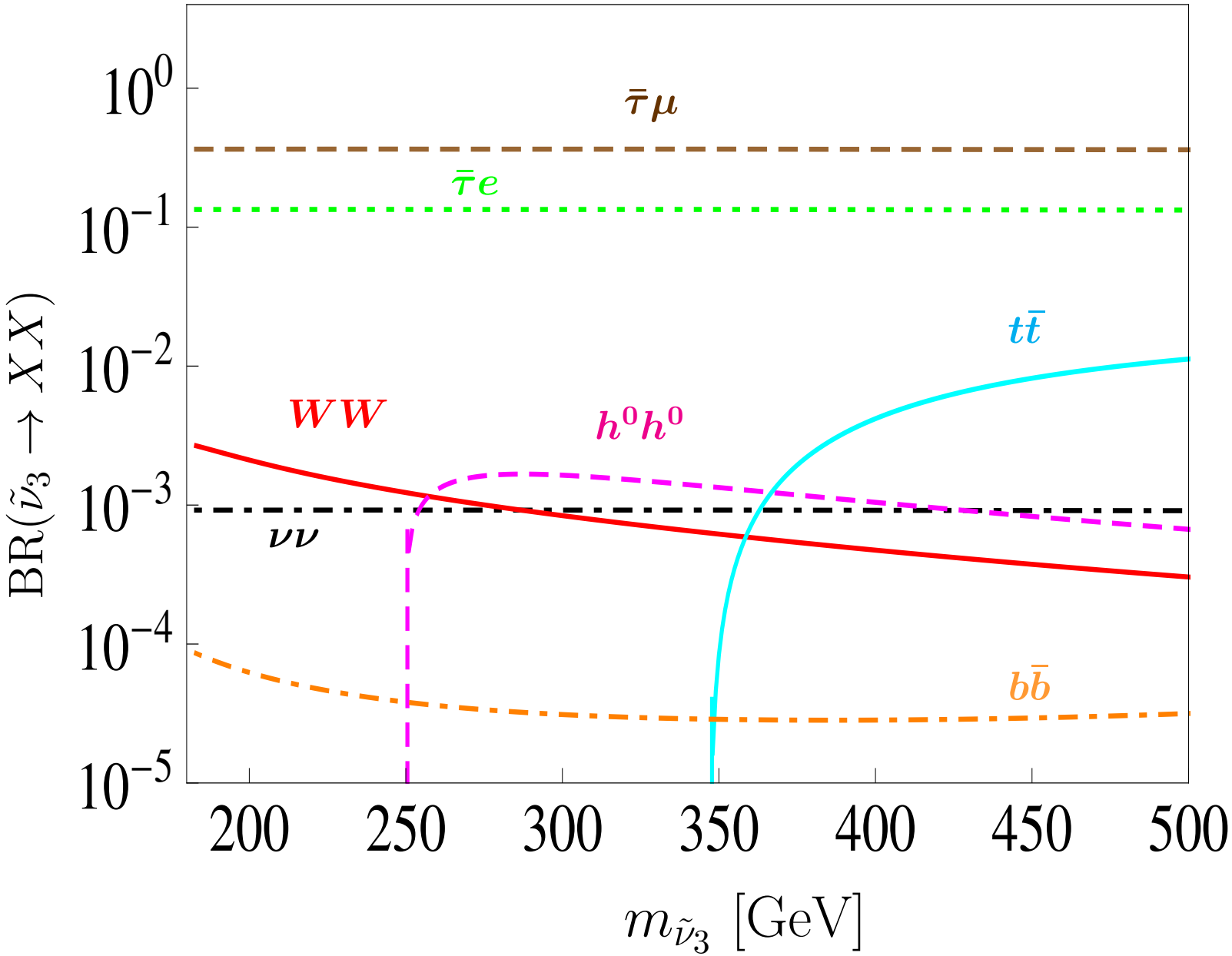
ϵ_1	mode
small	WW

$\lambda_{11k} \approx 0$

Sneutrino novel decays



$\tilde{\nu}_3$ RPV decays with $\epsilon_3 = 10^{-9}$ GeV



Conclusions

- Gravitino does provide a viable radiatively decaying dark matter particle, provided its mass and reheat temperature are bounded as $m_{\widetilde{G}} < 1 - 10$ GeV and $T_R < 10^{-8}$ GeV,
- NLSP properties at LHC are fixed by neutrino physics.
- In the sneutrino case, a non-universal leptophilic scalar is possible.