Low-scale seesaw from neutrino condensation

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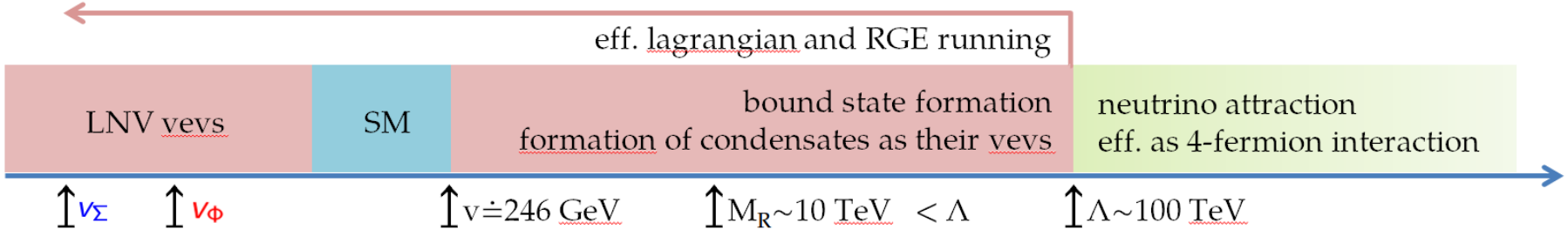
$$\begin{pmatrix} \nu_L \\ \nu_R^c \\ S_R^c \end{pmatrix} \qquad L = \begin{bmatrix} +1 \\ -1 \\ +1 \end{bmatrix} \qquad M = \begin{pmatrix} 0 & \frac{y_H v_H}{2} & \frac{y_\Sigma v_\Sigma}{2} \\ \frac{y_H v_H}{2} & 0 & M_R \\ \frac{y_\Sigma v_\Sigma}{2} & M_R & \frac{y_\Phi v_\Phi}{2} \end{pmatrix}$$

$$\begin{aligned} \mathcal{L} &= \mathcal{L}'_{SM} - (y_H \overline{\ell_L} \tilde{H} \nu_R + \overline{S_R^c} M_R \nu_R + h.c.) \\ &\quad - G_{\rm inv} (\overline{S_R^c} S_R)(\overline{S_R} S_R^c) - G_{\rm lin} (\bar{\ell}_L S_R)(\overline{S_R} \ell_L) \end{aligned}$$

2 Higgs doublet + 1 Higgs singlet effective model



Parameter fixing

from leptogenesis

$M_R = 10\,\mathrm{TeV}$

$y_H = 10^{-7}$

out-of-equilibrium

N ν + h

$v_\Phi = 100\,\mathrm{keV}$

close to CP violation

resonance

$v_\Sigma = 0.1\,\mathrm{meV}$

out-of-equilibrium

N ν + H

Model predictions

dark matter

$$m_s = \sqrt{\lambda_\Phi}\, v_\Phi \approx 100\,\mathrm{keV}$$

$$s \to \nu + \nu$$

$$\Gamma_s = \frac{y^2_{s\nu\nu}}{8\pi} m_s \approx 10^{-32}\,\mathrm{eV}$$

almost $10^{-33}\,\mathrm{eV}$ that is needed!!!

light neutrino mass

$$m_\nu \simeq \frac{v_\Phi}{\sqrt{2}} \frac{m_D}{M_R} \left(\frac{m_D}{M_R} y_\Phi - \frac{2}{r_{\Phi\Sigma}} y_\Sigma \right) \approx 10^{-13}\,\mathrm{eV}$$

Hierarchy of scales

$\Lambda > M_R \gg v_H \gg v_\Phi \gg v_\Sigma$

Why???

How does it change in 3 generations???