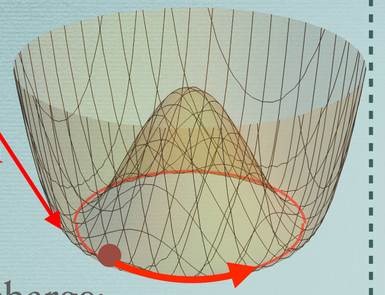
Axiogenesis from $SU(2)_R$ phase transition - 2107.09679, R.Wang and K.Harigaya

- Strong CP problem
- Dark matter problem
- Baryogenesis problem

} Axion → New dynamics

Axiogenesis

$$P = \frac{1}{\sqrt{2}}(f_a + S)\exp(i\frac{a}{f_a})$$



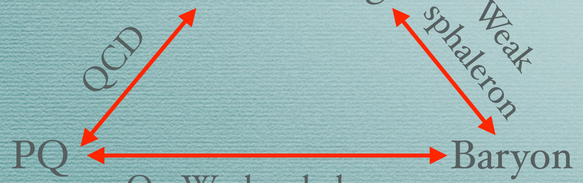
$U(1)$ symmetry in potential: Peccei-Quinn (PQ) symmetry

Noether's charge:

$$n_{PQ} = iP\dot{P}^* - iP^*\dot{P} = \dot{\theta}f_a^2, \theta \equiv \frac{a}{f_a}$$

Charge transfer

Chiral charge



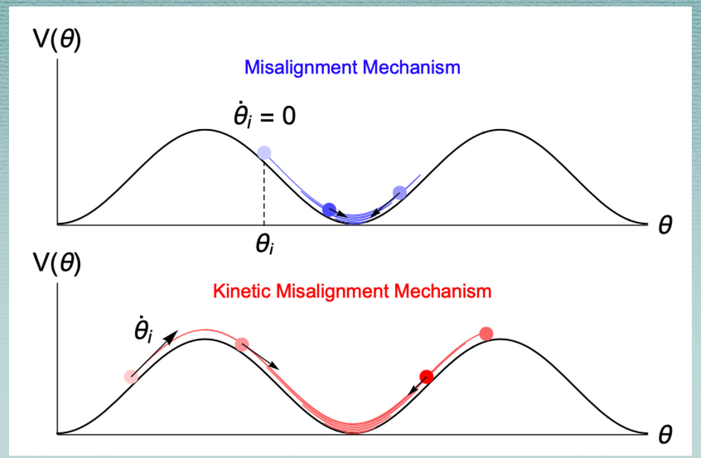
Or: Weak sphaleron

$$n_B = c_B\dot{\theta}T^2, Y_B = 2\times10^{-3}\left(\frac{c_B}{0.1}\right)\frac{\dot{\theta}(T_{ws})}{T_{ws}}$$

T_{ws}: weak sphaleron decoupling temperature

c_B: model-dependent

R.Co, K.Harigaya: 1910.02080



The motion becomes oscillation when the kinetic energy is smaller than the potential barrier at T'

$$\dot{\theta}(T') = 2m_\phi(T')$$

Enhanced DM abundance together with axiogenesis:

$$\frac{\Omega_a h^2}{\Omega_{\rm DM}h^2} \simeq 70\left(\frac{f_a}{10^8\ {\rm GeV}}\right)\left(\frac{130\ {\rm GeV}}{T_{ws}}\right)^2\left(\frac{0.1}{c_B}\right)$$

DM is overproduced!

Solution: higher T_{ws}

$$SU(3)\times SU(2)_L\times SU(2)_R\times U(1)_X$$

$$\downarrow$$

$$SU(3)\times SU(2)_L\times U(1)_Y$$

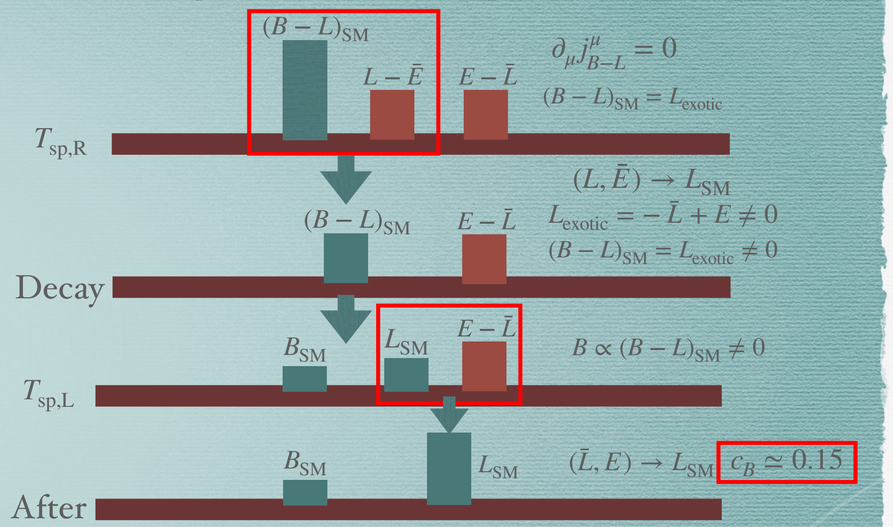
$$\bar{\ell} = \begin{pmatrix}\bar{\nu}\\ \bar{e}\end{pmatrix} : (1,1,2,\frac{1}{2}) \quad \bar{q} = \begin{pmatrix}\bar{u}\\ \bar{d}\end{pmatrix} : (3,1,2,-\frac{1}{6})$$

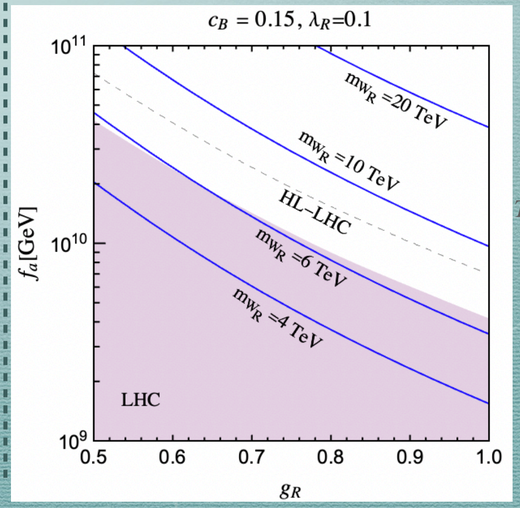
Avoid washout: effective chiral matter

Extra vector-like leptons:

$$L = (1,1,2,-\frac{1}{2})_1, \bar{L} = (1,1,2,\frac{1}{2})_{-1},$$
$$\bar{E} = (1,1,1,1)_{-1}, E = (1,1,1,-1)_1$$

Remind: $B-L$ is conserved under weak sphaleron





Require consistency with DM abundance and baryon asymmetry

$$T_{\rm sp,R} = (1.1\ {\rm TeV})\left(\frac{f_a}{10^8\ {\rm GeV}}\right)^{1/2}\left(\frac{0.1}{c_B}\right)^{1/2}$$

Prediction

$$m_{W_R} = (1.1\ {\rm TeV})\left(\frac{g_R}{\sqrt{2}}\right)\left(\frac{v_R(T=0)}{T_{\rm sp,R}}\right)\left(\frac{f_a}{10^8\ {\rm GeV}}\right)^{1/2}\left(\frac{0.1}{c_B}\right)^{1/2}$$