

# ArXiv review

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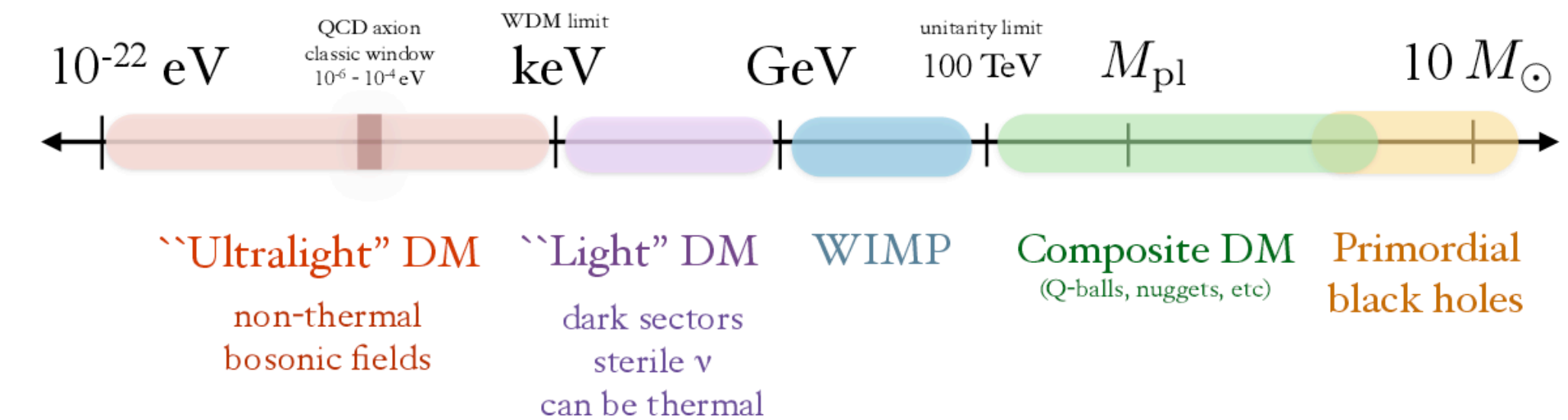
**July 22 2024**

# Primordial Black Holes in Induced Gravity Inflationary Models with Two Scalar Fields

<https://arxiv.org/pdf/2407.00999>

- PBH as candidates of dark matter.
- Two-field inflationary model with the induced gravity term.
- Conformal transformation of the metric to get a chiral cosmological model (CCM).
- Analyzed the behavior of scalar fields during inflation by numerical calculations.

## Mass scale of dark matter (not to scale)



$$S = \int d^4x \sqrt{-\tilde{g}} \left[ \frac{\xi}{2} \sigma^2 \tilde{R} - \frac{1}{2} \tilde{g}^{\mu\nu} \partial_\mu \sigma \partial_\nu \sigma - \frac{1}{2} \tilde{g}^{\mu\nu} \partial_\mu \chi \partial_\nu \chi - \tilde{V}(\sigma, \chi) \right]$$

+

$$g_{\mu\nu} = \frac{\xi \sigma^2}{M_{\text{Pl}}^2} \tilde{g}_{\mu\nu},$$

$$S_E = \int d^4x \sqrt{-g} \left[ \frac{M_{\text{Pl}}^2}{2} R - \frac{1}{2} g^{\mu\nu} \partial_\mu \phi \partial_\nu \phi - \frac{y}{2} g^{\mu\nu} \partial_\mu \chi \partial_\nu \chi - V_E \right],$$

With

$$\phi = M_{\text{Pl}} \sqrt{6 + \frac{1}{\xi}} \ln \left( \frac{\sigma}{M_{\text{Pl}}} \right),$$

$$y = \frac{M_{\text{Pl}}^2}{\xi \sigma^2} = \frac{1}{\xi} \exp \left( -2 \sqrt{\frac{\xi}{6\xi + 1}} \frac{\phi}{M_{\text{Pl}}} \right),$$

$$V_E = y^2(\phi) \tilde{V}(\sigma(\phi), \chi).$$

# Primordial Black Holes in Induced Gravity Inflationary Models with Two Scalar Fields

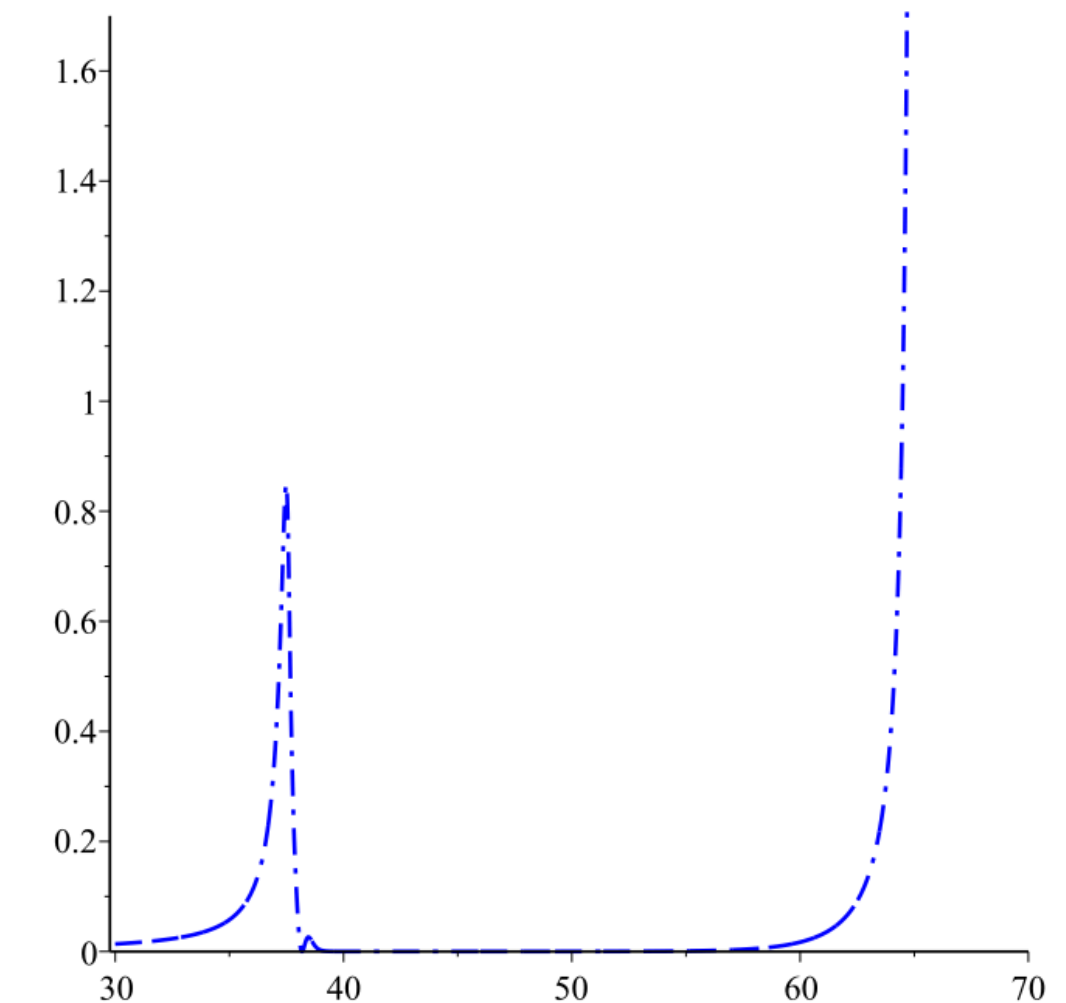
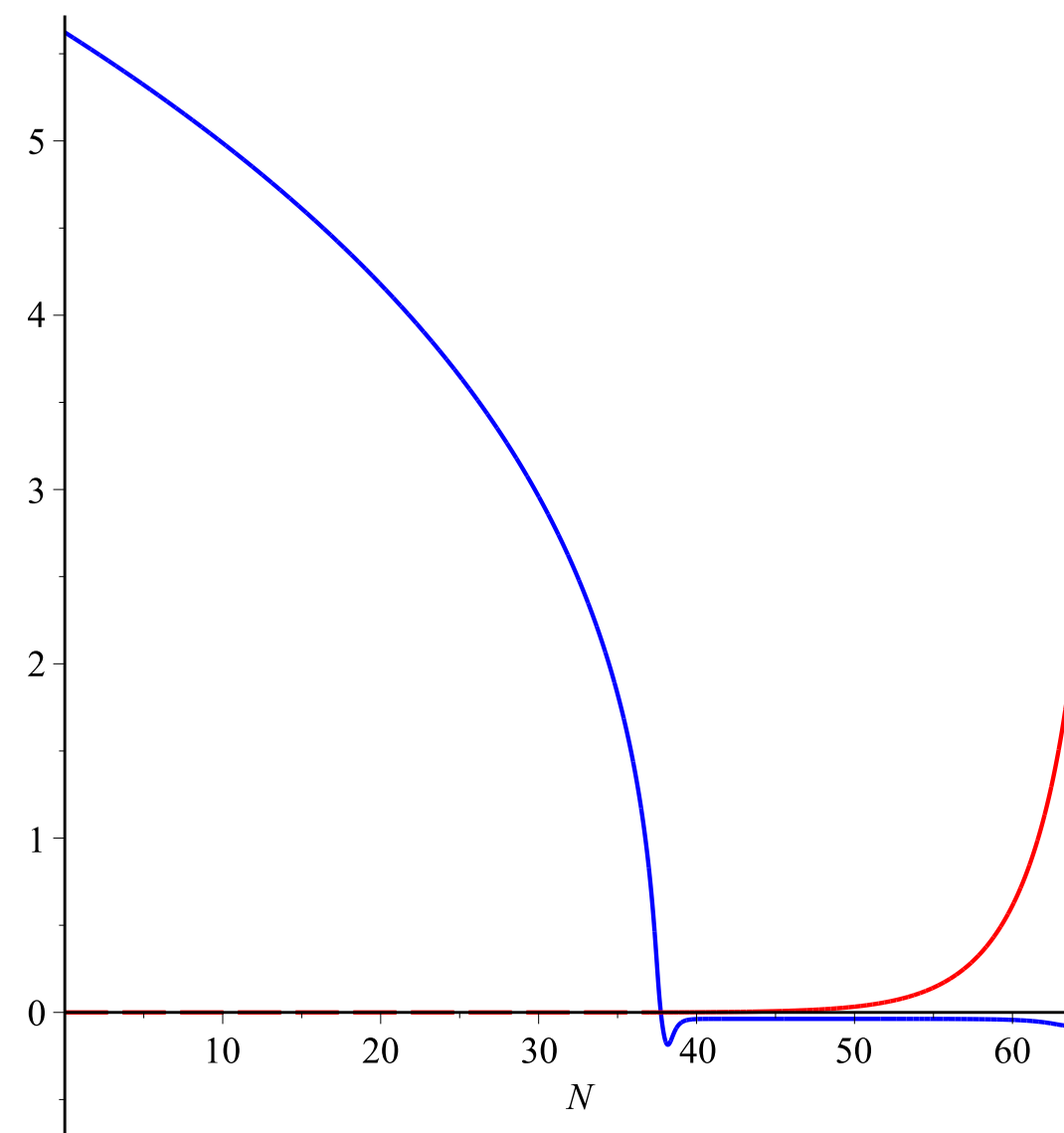
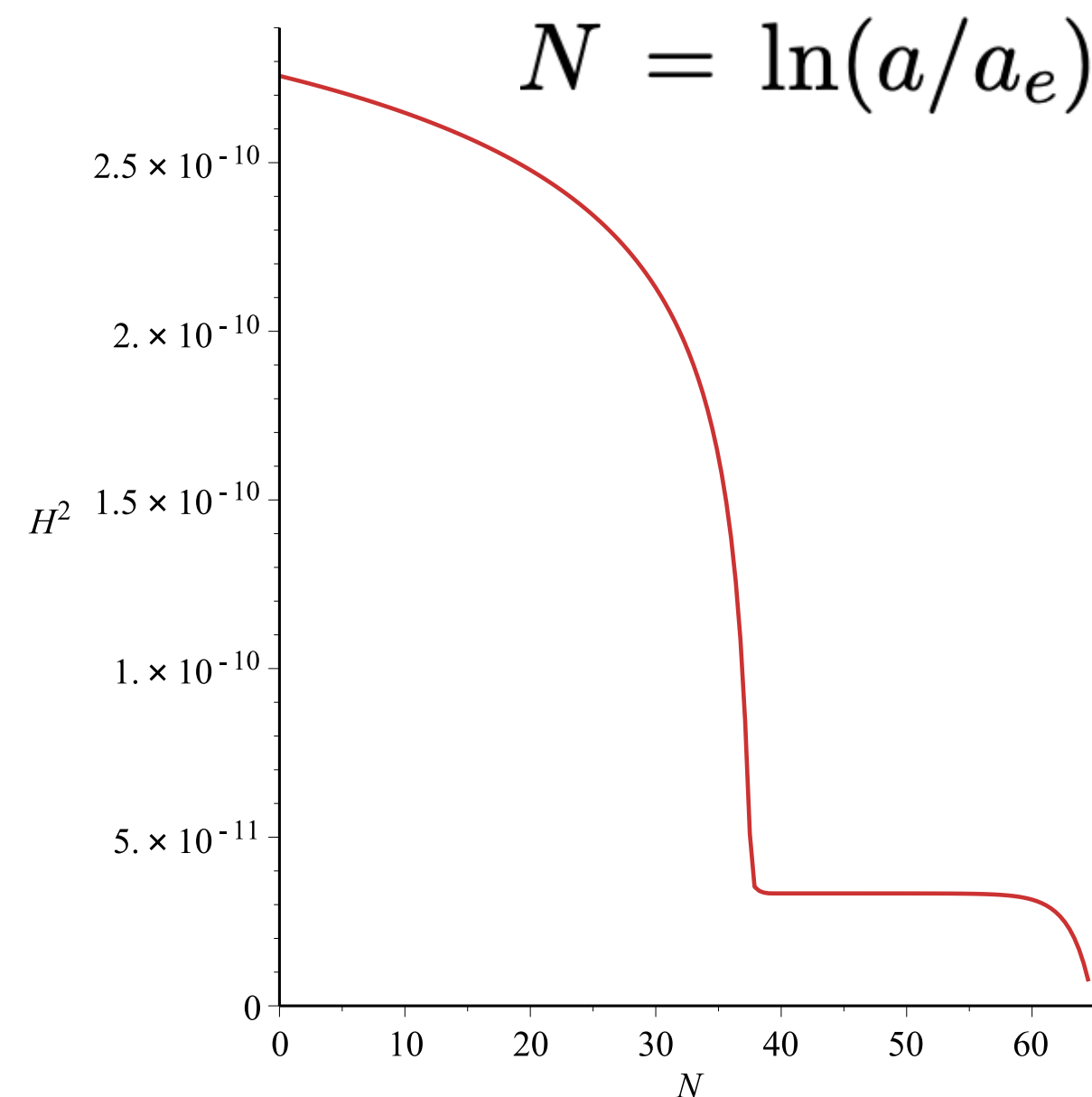
<https://arxiv.org/pdf/2407.00999>

- Evolution equation in the Einstein Frame (Friedmann–Lemaître–Robertson–Walker metric).
- Solve system of equations numerically.

$$ds^2 = - dt^2 + a^2(t) (dx_1^2 + dx_2^2 + dx_3^2),$$

$$H^2 = \frac{2V_E}{6M_{\text{Pl}}^2 - \phi'^2 - y\chi'^2},$$

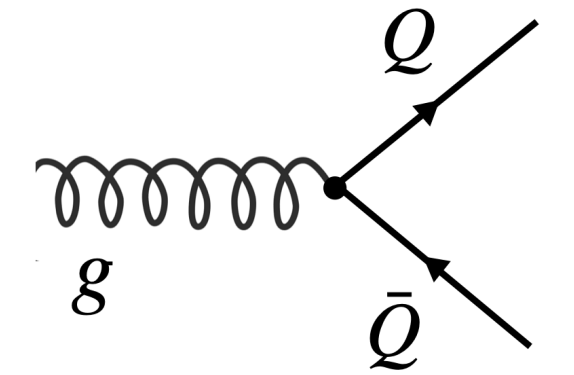
$$\begin{aligned} \phi'' &= (\epsilon_1 - 3)\phi' + \frac{1}{2} \frac{dy}{d\phi} \chi'^2 - \frac{6M_{\text{Pl}}^2 - y\chi'^2 - \phi'^2}{2V_E} \frac{\partial V_E}{\partial \phi}, \\ \chi'' &= (\epsilon_1 - 3)\chi' - \frac{1}{y} \frac{dy}{d\phi} \chi' \phi' - \frac{6M_{\text{Pl}}^2 - \phi'^2 - y\chi'^2}{2yV_E} \frac{\partial V_E}{\partial \chi}. \end{aligned}$$



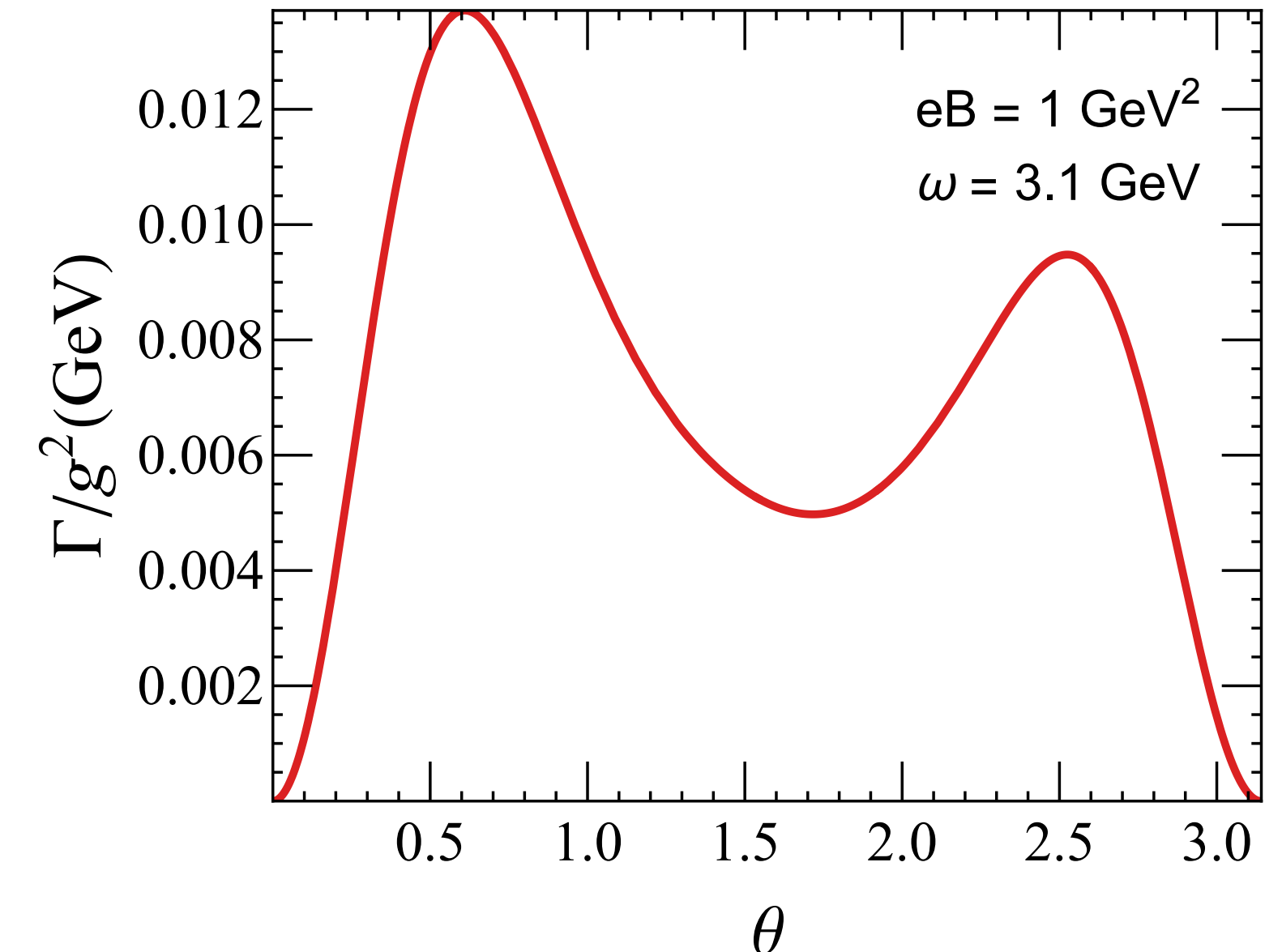
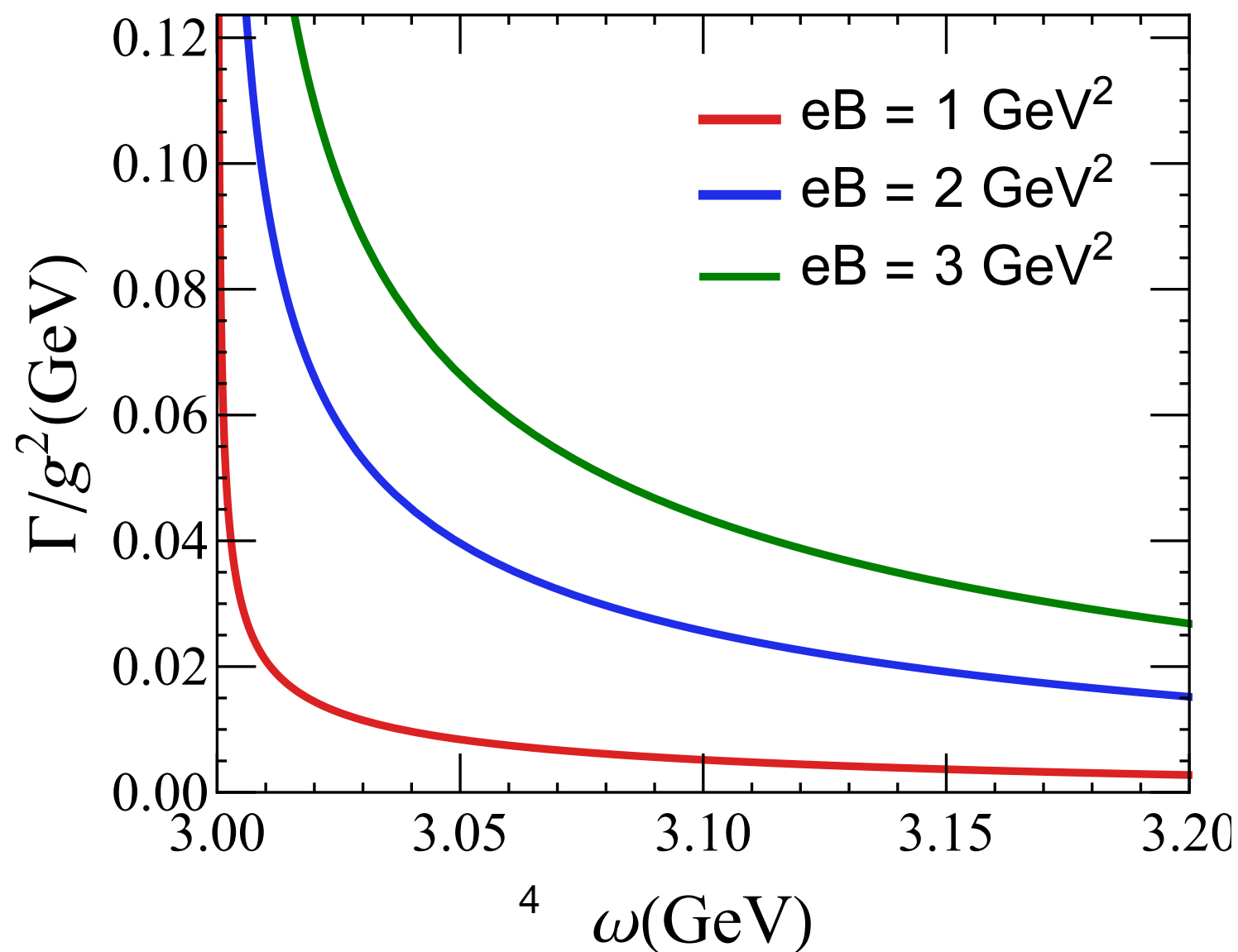
# Gluon decay into heavy quark pair under a strong magnetic field

<https://arxiv.org/pdf/2407.03586>

- The strongest electromagnetic field in nature is generated in high energy nuclear collisions; Au+Au collisions ( $0.1 \text{ GeV}^2$ ) at top RHIC energy and Pb+Pb collisions ( $1.0 \text{ GeV}^2$ ) at LHC energy.
- In the vacuum this process is forbidden due to the energy-momentum conservation.
- Magnetic field  $B$  in the direction of z-axis, and Landau Gauge  $A_0 = 0$  and  $\vec{A} = Bx\vec{e}_y$ .



$$\begin{aligned} \Gamma &= g^2 \sum_c \frac{1}{T} \int L \frac{dp_{z+}}{2\pi} \int L \frac{dp_{z-}}{2\pi} \int L \frac{da_+}{2\pi\lambda_B^2} \int L \frac{da_-}{2\pi\lambda_B^2} |S_{fi}|^2 \\ &= g^2 \frac{4q^2 m^2}{12\pi E^2 \omega \lambda_B^2} e^{-\lambda_B^2 \omega^2 / 2} \int \frac{da_-}{L} \int dp_{z-} \delta(\omega - 2E) \\ &= g^2 \frac{4qBm^2}{3\pi\omega^2 \sqrt{\omega^2 - 4m^2}} e^{-\lambda_B^2 \omega^2 / 2} \end{aligned}$$

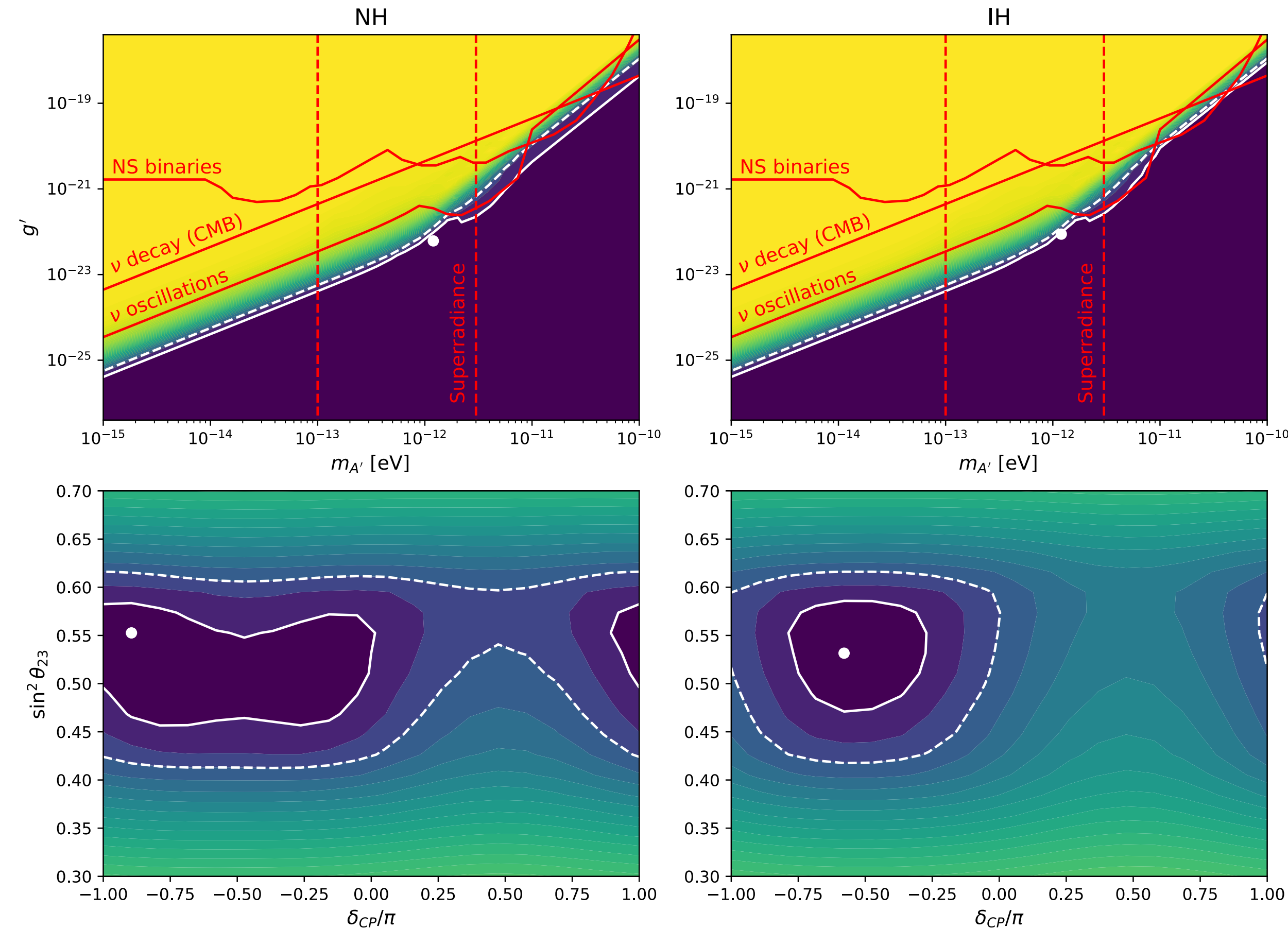


# Dark photon distortions of NOvA and T2K neutrino oscillations

<https://arxiv.org/pdf/2407.13817>

- If the dark photon is a gauge boson, can coupling to  $L_\mu - L_\tau$  lepton number different.
- Combine the neutrino oscillation data from MINOS, NOvA and T2K, fixing the solar parameters at  $\theta_{12} = 33.41^\circ$  and  $\Delta m_{21}^2 = 7.41 \times 10^{-5} \text{eV}^2$ .
- On the NH plane, the tension between T2K and NOvA cannot be reduced by the neutrino-dark photon interaction

$$g' \lesssim \begin{cases} 6.3 \times 10^{-11} (m_{A'}/\text{eV}), & m_{A'} \ll 10^{-12} \text{ eV} \\ 100 (m_{A'}/\text{eV})^2, & m_{A'} \gg 10^{-12} \text{ eV} \end{cases},$$



**Thank you**