Shimmering gravitons in the gamma-ray sky

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MINISTRY OF EDUCATION,
YOUTH AND SPORTS

⁘ take home message ⁘

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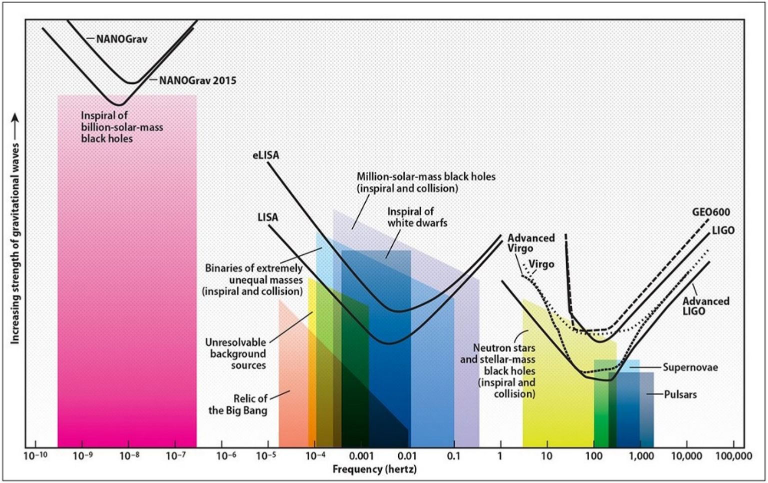
JCAP06 (2023) 019

S. Ramazanov, R. Samanta, G. Trenkler, F. R. Urban

what we know

:: observations ::



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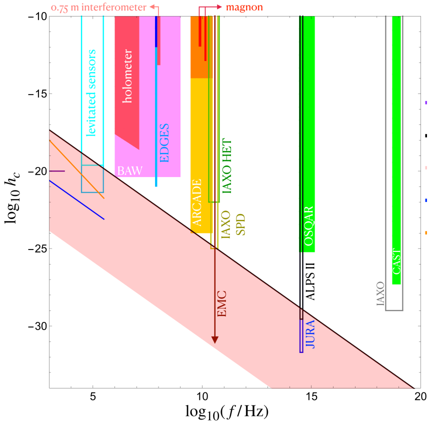
○○ The observed nHz to kHz range of the SGWB and BBH mergers

○○○ The 10^{-16} Hz range of the CMB B-mode polarisation

○○○○ The MHz-GHz-THz range of repurposed ALP detectors

(Aggarwal + '20; Ita, Kohri, Nakayama '23)

:: very-ultra high freqs ::



10^{18} Hz is about 1 keV

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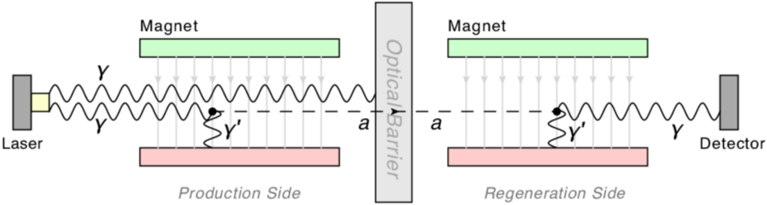
:: light shining through the wall ::



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$$\boxed{\mathcal{L} = \sqrt{|g|}\, g^{\mu\rho} g^{\nu\sigma} F_{\mu\nu} F_{\rho\sigma}}$$

which generates the coupling

$$\boxed{h \cdot A \cdot A}$$

(Raffelt and Stodolsky 1987 and many more)

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iv. The conversion probability is similar to axion-photon

$$\boxed{P_{h\to\gamma} = B^2 L^2 / 2M_{\rm P}^2}$$

∷ not so simple ∷

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  - $\frac{\alpha^2}{90 m_e^4}\left[(F_{\mu\nu}F^{\mu\nu})^2 + \frac{7}{4}\left(\tilde{F}_{\mu\nu}F^{\mu\nu}\right)^2\right]$

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  - $\Delta_{\rm QED} = \frac{\alpha}{45\pi}\left(\frac{B}{B_{\rm cr}}\right)^2\omega \approx 0.15\omega_{\rm PeV}\left(\frac{B}{6\mu{\rm G}}\right)^2\,{\rm kpc}^{-1}$

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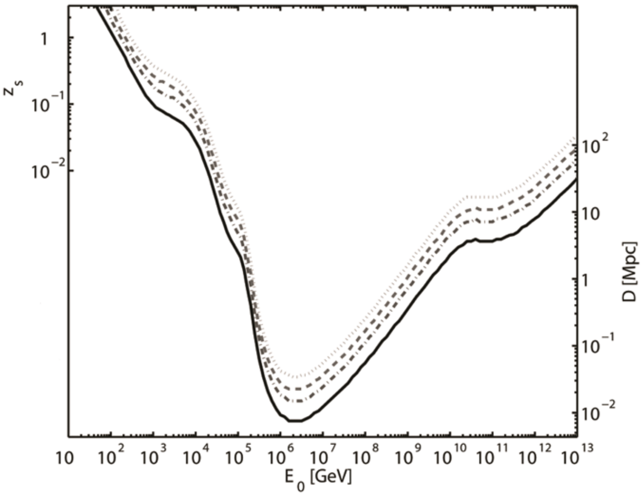
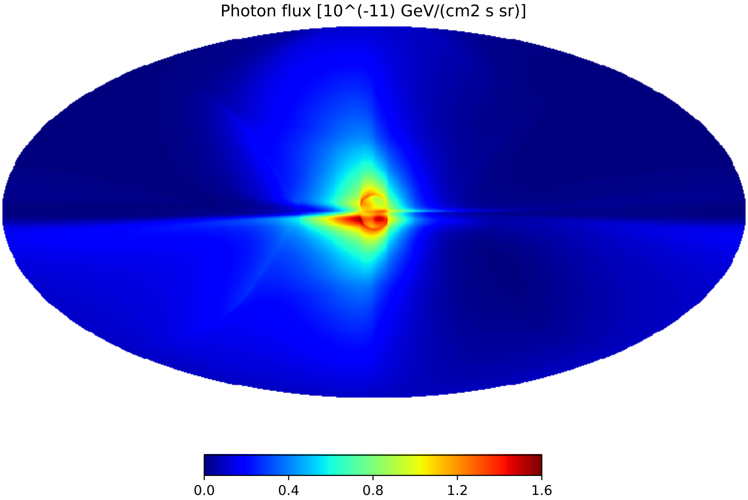
Beyond the PeV we find $P_{h\to\gamma} \simeq \frac{N_{\rm corr}B^2}{M_{\rm P}^2\Delta_{\gamma\gamma}^2} \sim \frac{1}{\omega^2}$

:: optical depth ::

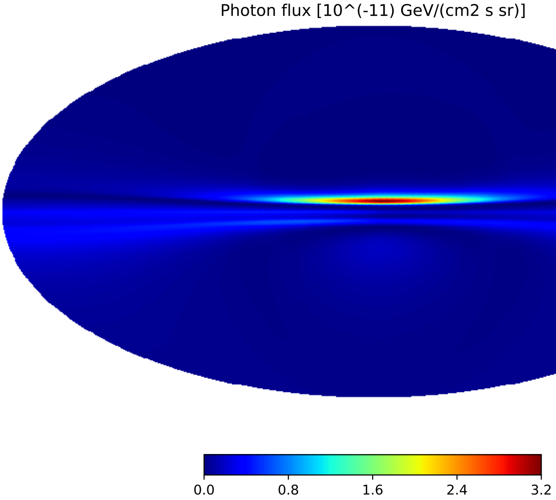


results



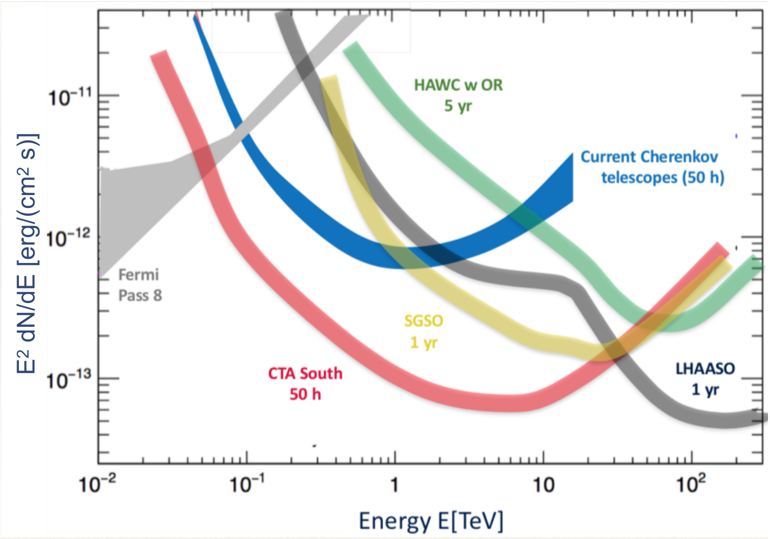
From the GMF of Jansson and Farrar, 2012

:: the flux ::



From the GMF of Pshirkov, Tinyakov, Kronberg, Newton-McGee, 2011

:: sensitivities ::



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∷ detect? ∷

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  $\Phi_\gamma = \text{few} \times 10^{-11}\,\mathrm{GeV/cm^2 sec\, sr} \cdot \Omega_h h_0^2$

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- The question now is: how to make these GWs?
  We study the late decay of SHDM

:: produce ::

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S is still decaying (and is all of DM): $\Omega_h h_0^2 \approx 0.01$

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:: summary ::

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Ideas welcome for how to make $h \longrightarrow \gamma$ work for EeV+!