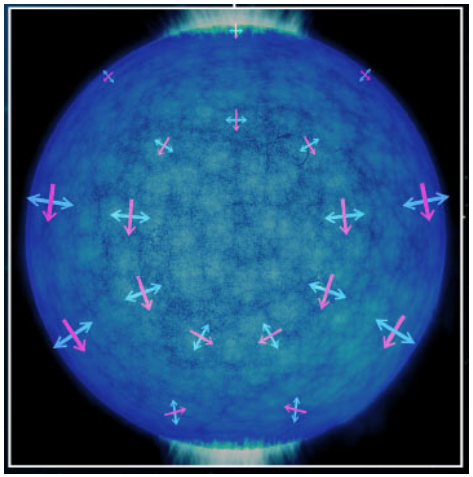
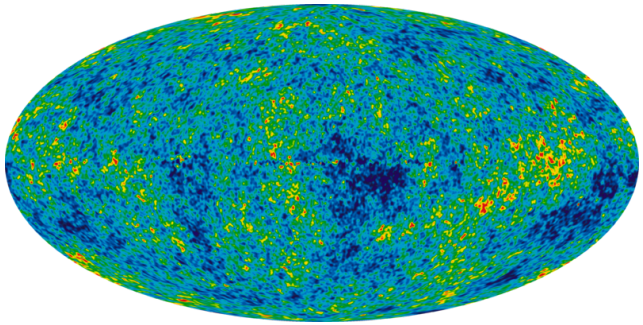
Strong field Astro/Cosmo arena



Magnetar Vacuum birefringence



CMB signatures

Vacuum birefringence

- Strong field effects in observation of polarised light from Magnetar
- Possible evidence of strong field vacuum birefringence (10^{13} G)
- Polarisation should be correlated with magnetic field relative to Earth
- Reported by arxiv:1610.08323. Rebutted by arxiv:1705.01540

Cosmological Schwinger effect

- Non pert QED $\leftrightarrow$ QED in curved space-times (Hollands, Wald arxiv:1401.2026)
- Strong field provided by gravity in early universe (Martin arxiv:0704.3540)
- Two point correlation function linked to CMB fluctuations
- Hawking radiation has a strong field analogue: Unruh radiation

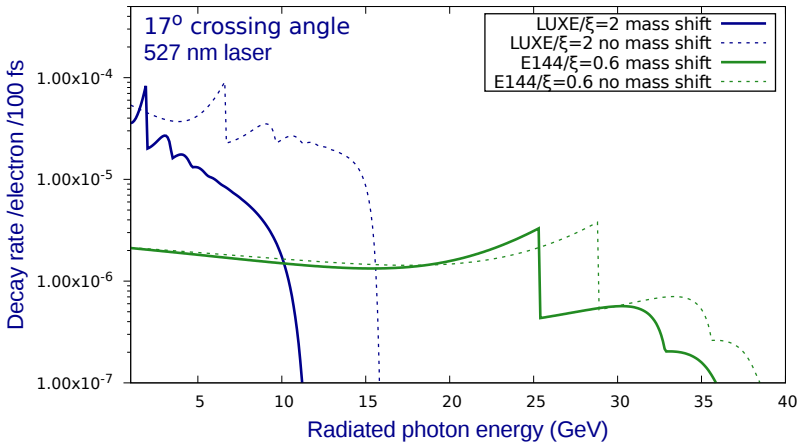
Non perturbative QED predicts rest mass shift

- Non perturbative QED takes into account vacuum polarisation
- Electrons/positrons see an electromagnetically non neutral background.
- Extra energy required for particles to exist and interact in such backgrounds

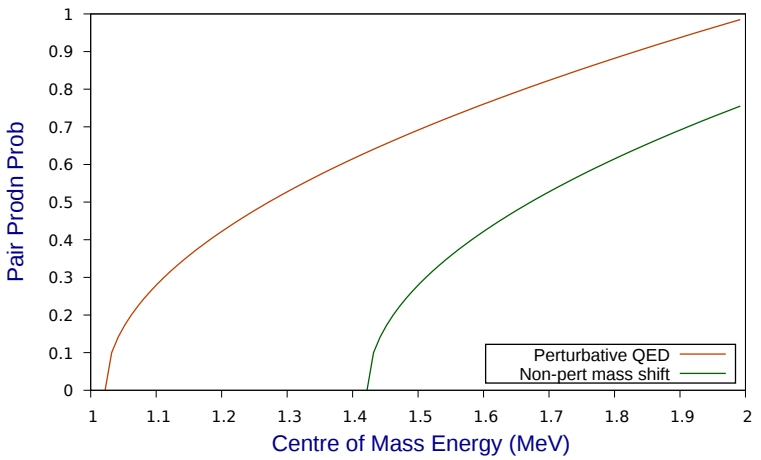
$$p_\mathrm{i} + k\frac{\xi^3}{2\chi_\mathrm{i}} \to p_\mathrm{i}^2 = m_e^2(1+\xi^2) \equiv m_e^{*\,2}$$

- Nonlinear Compton scatterng results in Compton edge shift
- $\xi^2 \sim 1$ **Big shift!** in principle
- Nonlinear Pair Production, shows shift in threshold.
  Not twice $2m_e$, but $2m_e^*$
- **Vacuum polarisation in the lab!**

HICS with mass shift for LUXE and E144



Nonlinear pair production threshold shift



Infinite plane wave vs finite pulse

- Intense laser has a finite pulse length
- Infinite plane wave assumes integer nk momentum contributions from external field

  Prob $= \delta(I - F + nk)\, M(I, F, nk)$
- Finite pulse smears out momentum transfer

  Prob $= \mathrm{sinc} N\pi\, (I - F + nk)\, M(I, F, nk)$

  N is the number of wavelengths in the pulse
- Large N limit, IPW$\leftrightarrow$ finite pulse
- Resonant trident process (virtual strong field particle is unstable state) also depends on pulse length
- LUXE 800 nm in 30 fs is $\approx$N=10
- Deliberately make long pulse to reproduce IPW

Number of wavelengths in laser pulse, N=1,2,4 [Heinzl, Marklund, Ilderton]