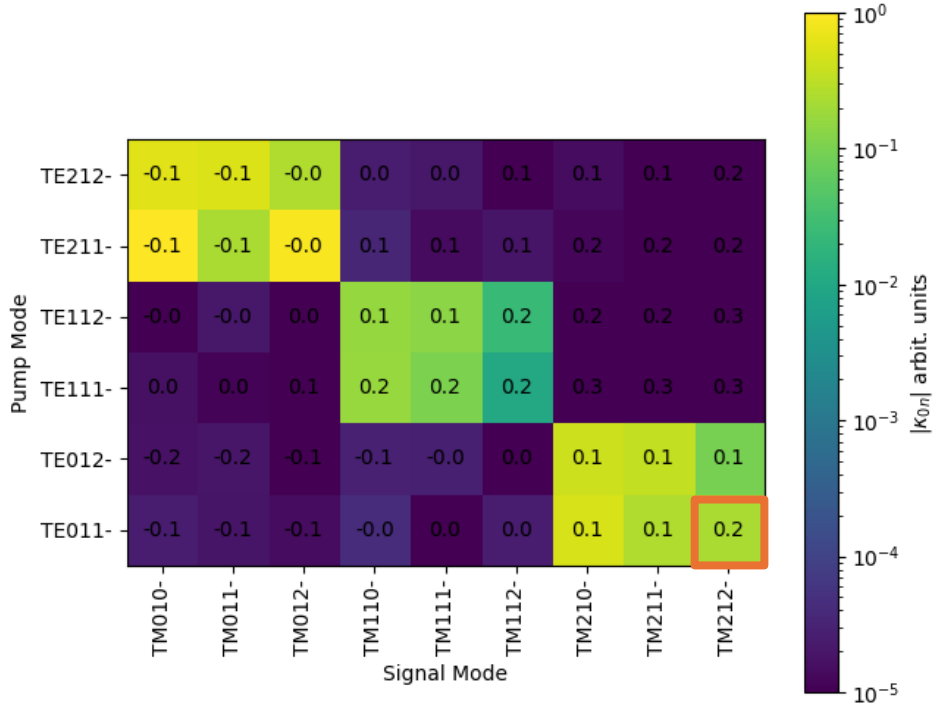
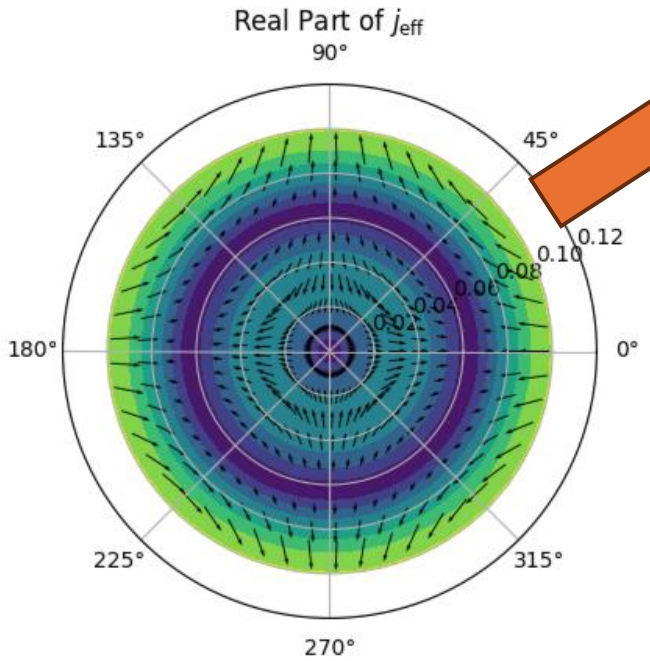
Optimal Modes for Heterodyne Detection with Cylindrical Cavities

Monochromatic GW travelling in z-direction.

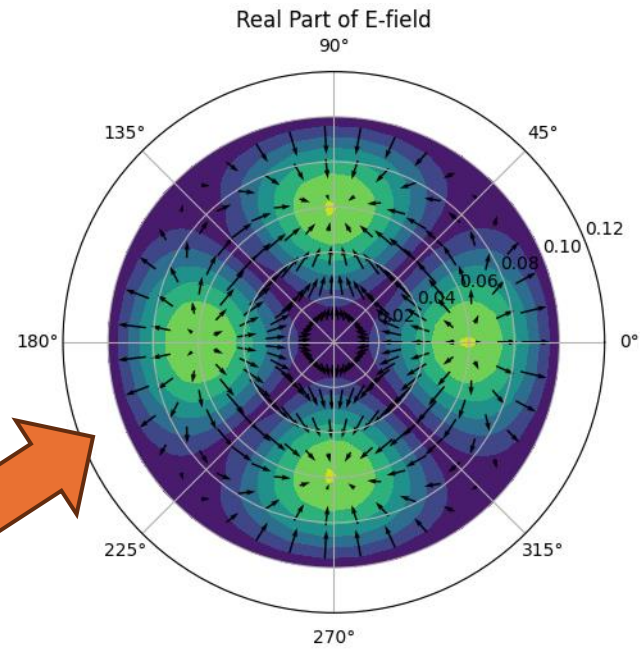


$$\kappa_{0n} = \frac{\omega_n^{-1}}{\mu_0 \sqrt{U_n U_0}} \int_{V_{\text{cav}}} d^3x \vec{E}_n^*(\vec{x}) \cdot \vec{j}_{\text{eff}}(\vec{x})$$

Effective Current for TE011-

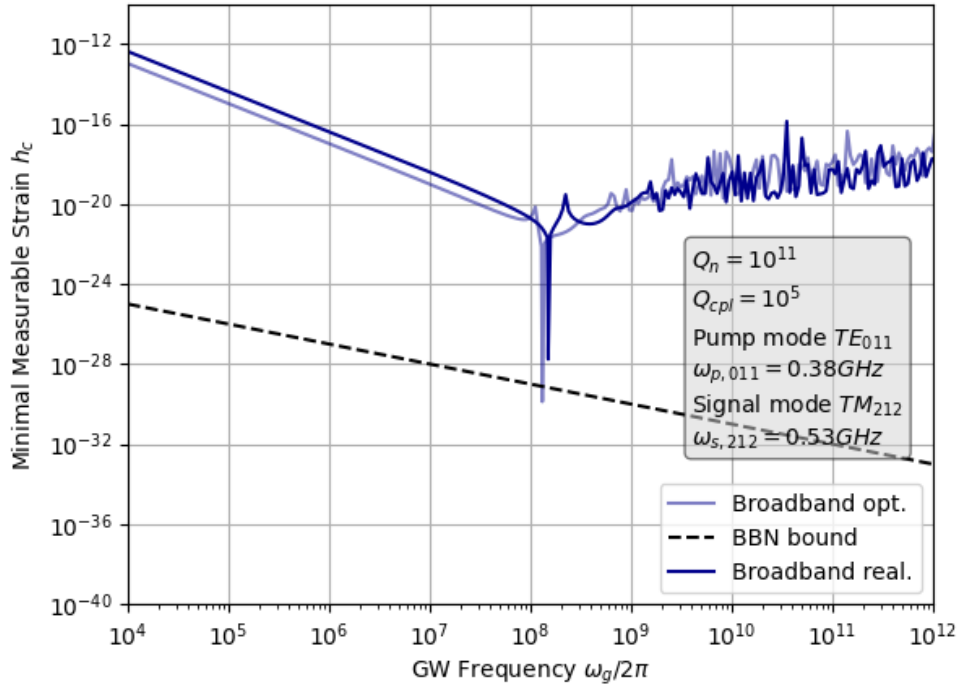


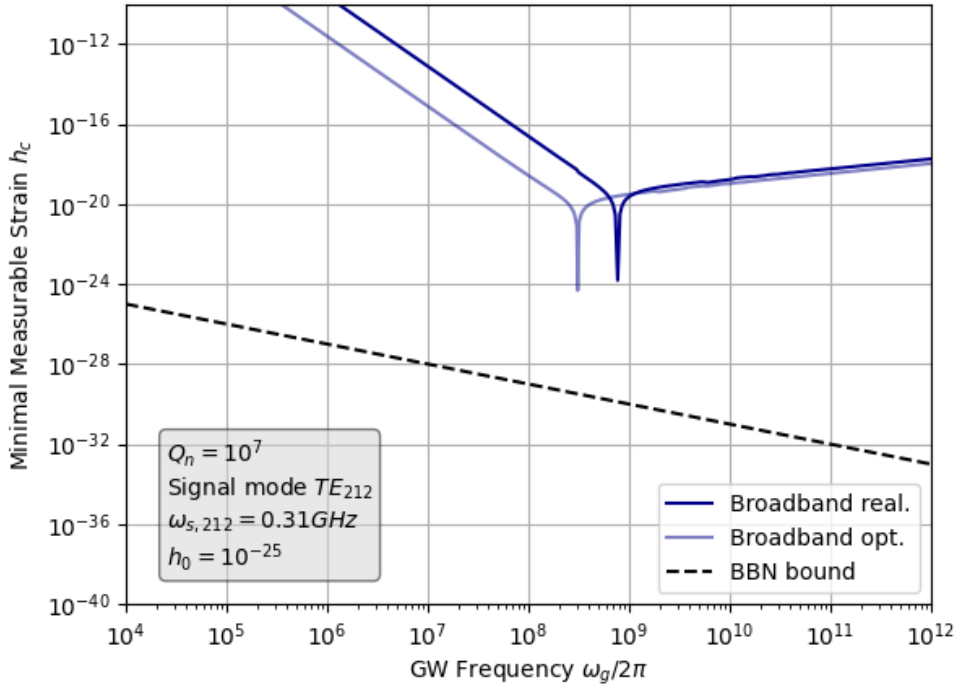
E-field of TM212-



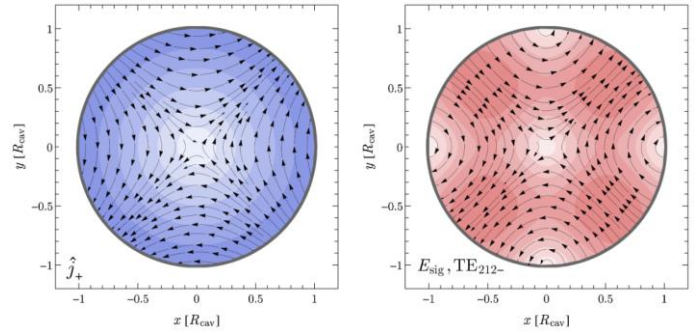
Sensitivity: Heterodyne vs. Static B

Sensitivity for two detectors

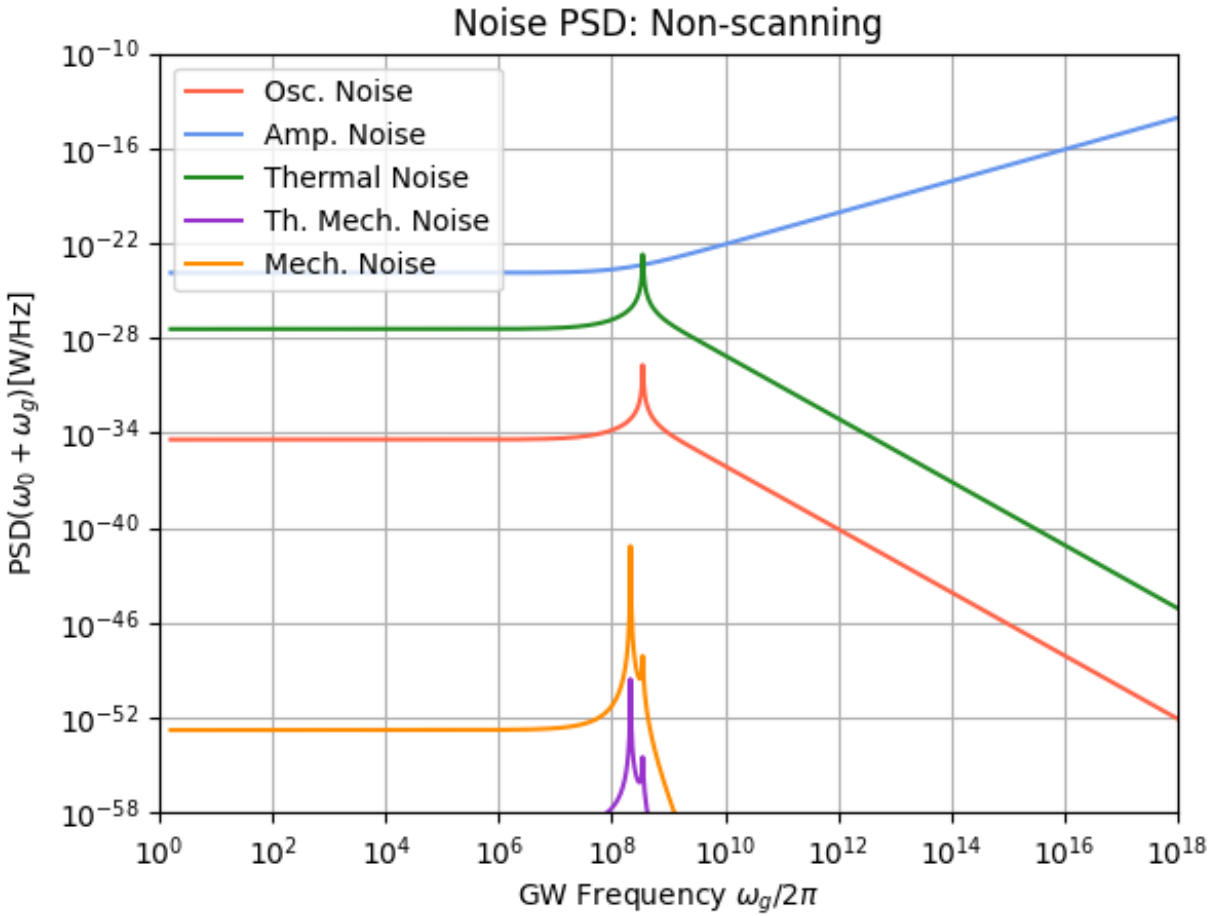


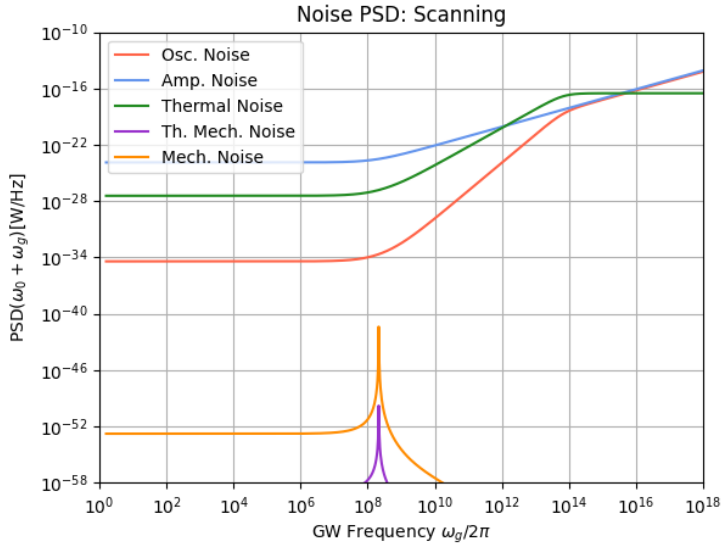


- GW background regime
- PBH mergers of very low mass
- Also good for axions?
- Shorter ring-up time ~O(10s)



Noise PSD





- Mech. noise neglectable at high frequencies
- Amp. noise dominant OFF resonance
- Thermal noise dominant ON resonance

Signal Power: Heterodyne vs. Static B

Heterodyne Experiment

$$P_{\text{sig}} = \frac{U_0}{2Q_n} \cdot \frac{h_0^2 \omega_n^3 (\omega_g \pm \omega_0)^2 |\kappa_{0n}|^2}{((\omega_n^2 - (\omega_g \pm \omega_0)^2)^2 + (\omega_n (\omega_g \pm \omega_0)/Q_n)^2)}$$

Static B-field Experiment

$$P_{\text{sig}} = \frac{\omega_n}{4Q_n} \epsilon_0 B_0^2 h_0^2 V_{\text{cav}}^{5/3} \omega_g^6 \frac{|\kappa_n|^2}{((\omega_n^2 - \omega_g^2)^2 + (\frac{\omega_n \omega_g}{Q_n})^2)}$$