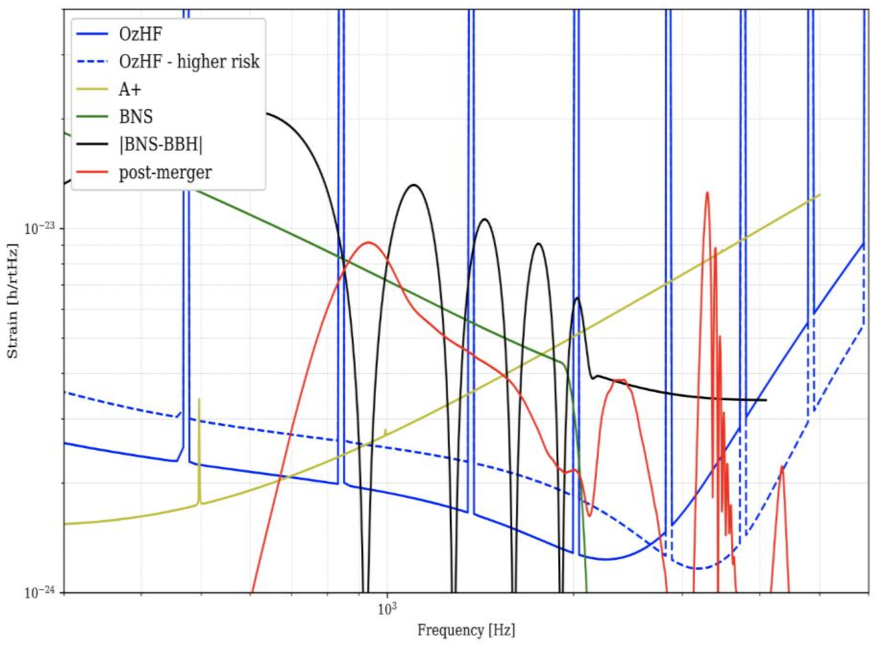
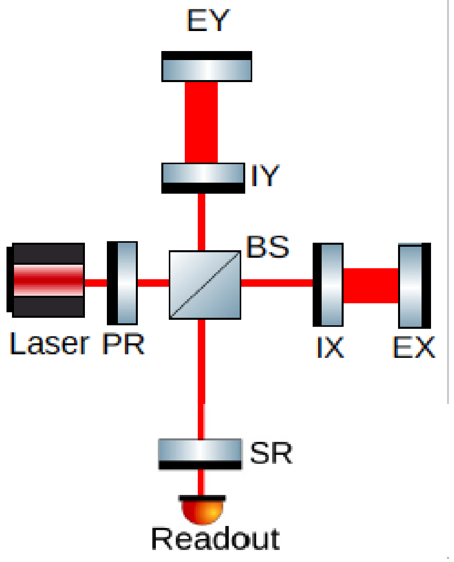
$10^3\,Hz$: OzGrav HF

Key Parameter	Value
Arm Length	4 km
Laser power	500 W
Arm power	5 MW
Test mass material	Silicon
Coating	GaAs/AlGaAs
Coating Phi	3e-5
Mirror Spot Size	5.5 cm radius
Long SRC	350 m
Squeezing	10 dB - Phase

"Simplified" 3G:
- Vacuum length considerably shorter
- Seismic Isolation requirements relaxed
- Scattered light control relaxed
- Temperature Core Optics: 123 – 160 K

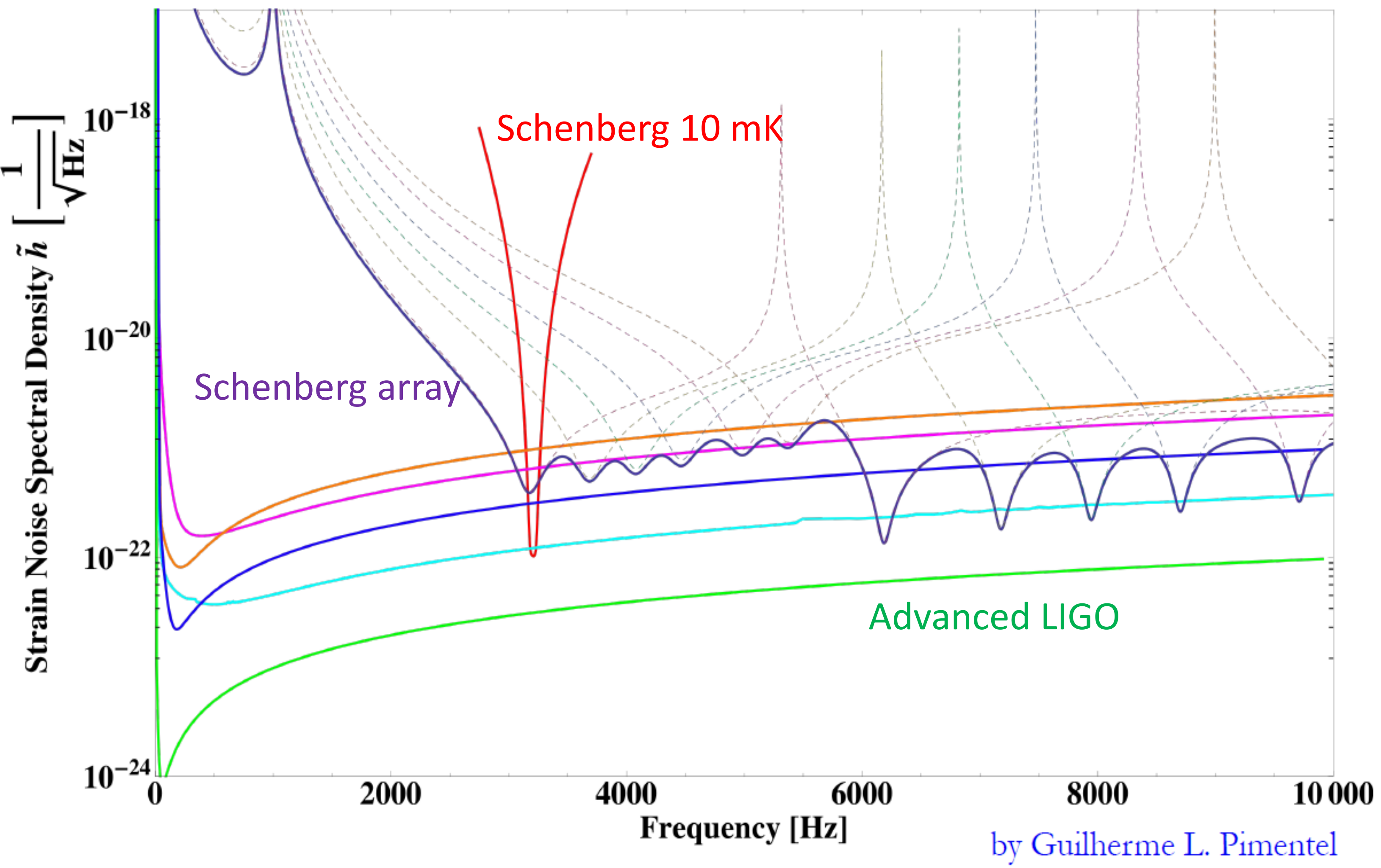


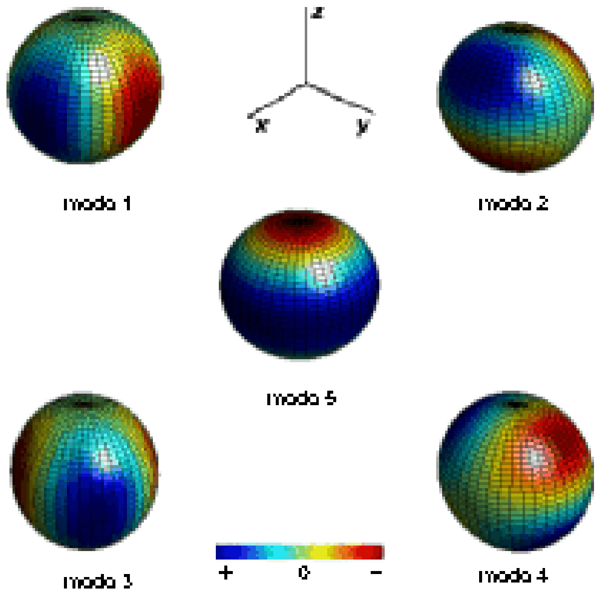


Main science case: merger and ring-down phase of NS/NS mergers
- EOS
- Cosmology

See D. Ottaway talk

Spherical resonant masses

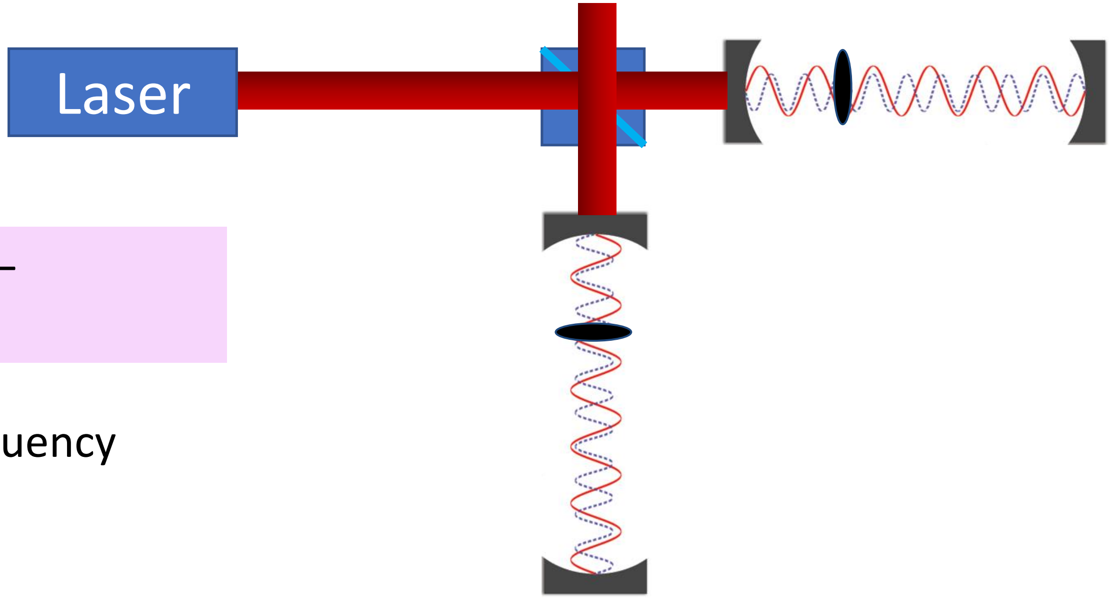




- Reconstruction of the components of the strain h_{ij}
- High sensitivity Niobium parametric transducer
- Improvement with squeezing at 10 GHz?

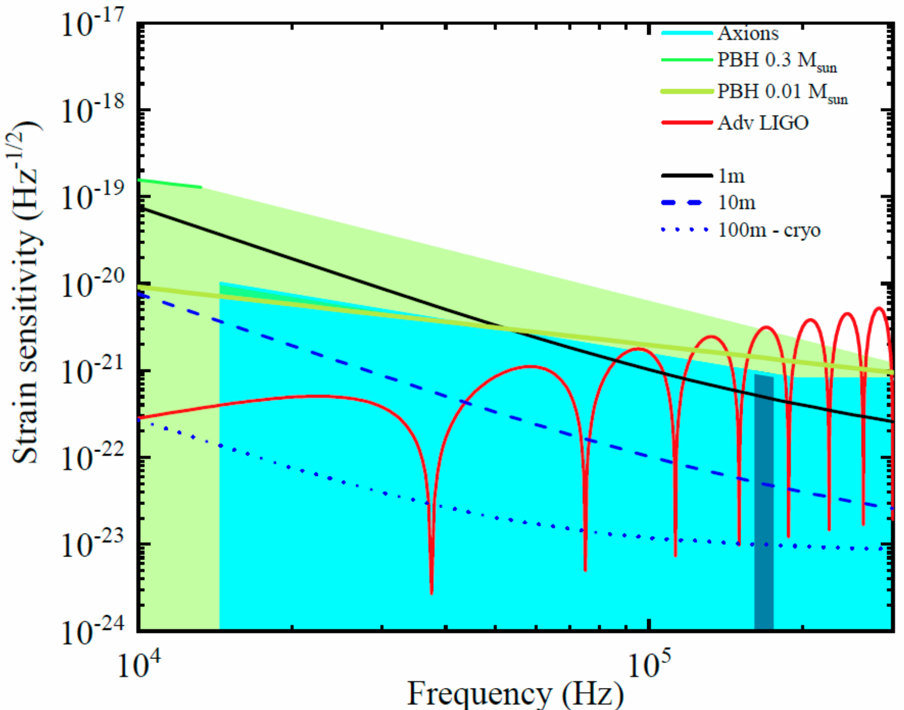
Talk of Odylio D. Aguiar

Optically-levitated sensors



Optically-levitated particles in vacuum have very little friction –
Ideal for ultrasensitive force detection

- Laser intensity changed to match trap frequency to GW frequency
- For a 10m cavity, $h \sim 10^{-22}$ Hz $^{-1/2}$ at high frequency (100kHz)
- Limited by thermal noise in sensor (not laser shot noise) → much better at high frequency!!

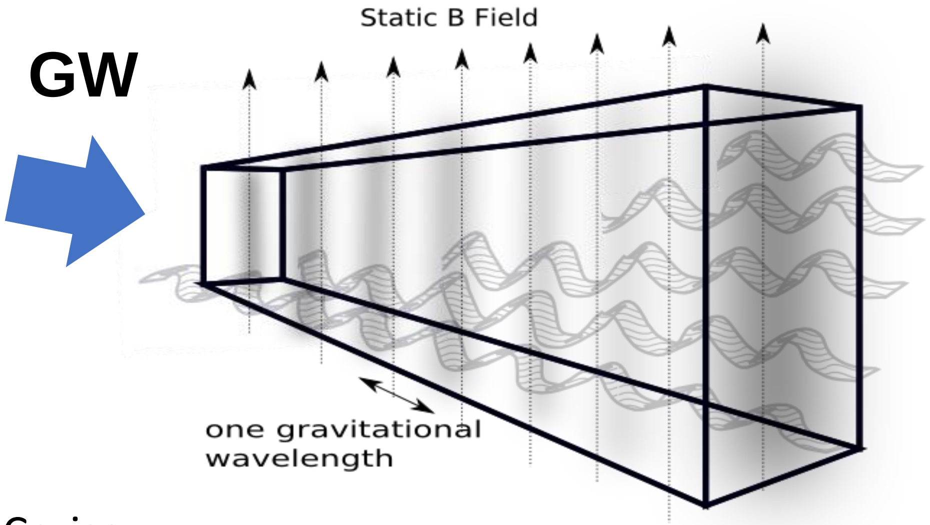


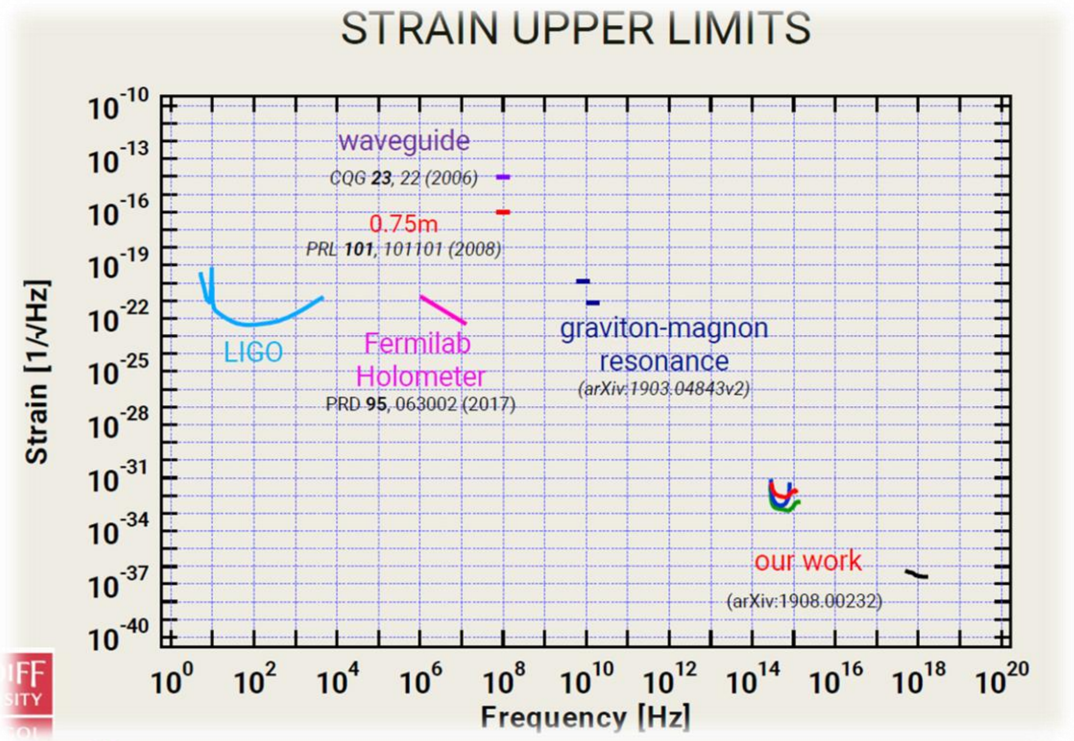
LIGO sensitivity decreases at high frequency (laser shot noise limited)
levitated sensors improve (thermal noise limited)

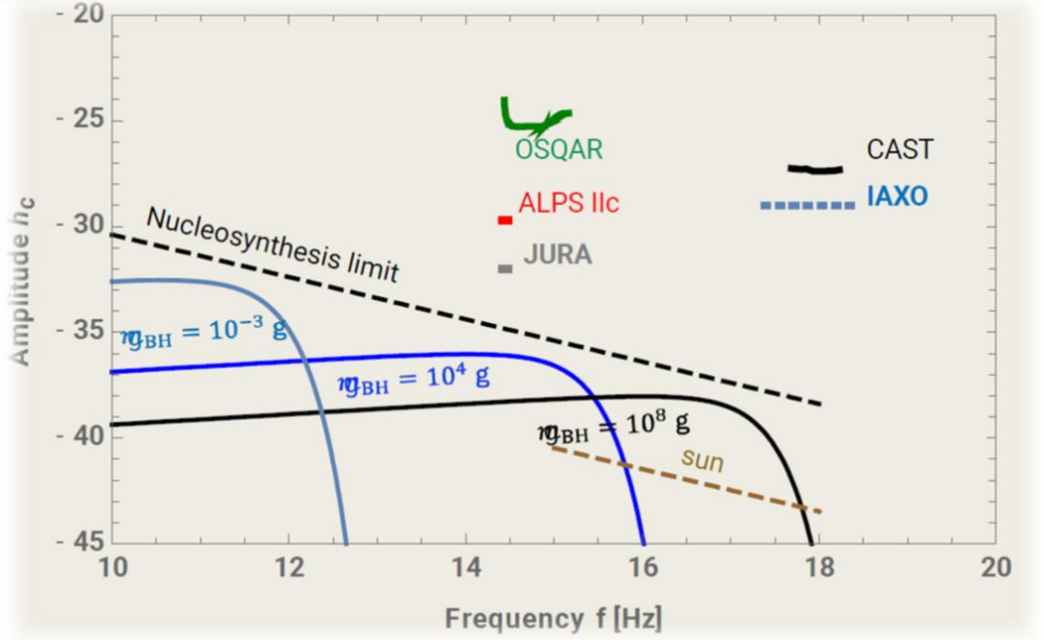
Geraci's Talk

Inverse Gertsenshtein effect etc.

- Upper limits on stochastic UHF GWs with axion experiments data
- PBH
- At present, the magnetic conversion detectors seem to be the simplest to understand and might reach 10^{-24} at 10^{10} Hz. A 10^6 factor still needed.







See Grote, Cruise

Possibilities above 1 GHz

- GW Effect on EMW Direction (Fakir, Labeyrie & Bracco)
- GW Effect on EMW Frequency (Baierlein)
- GW Effect on EMW Amplitude (Zipoy)
- GW Effect on Polarisation (Cruise)
- GW Resonant Effect on EMW Polarisation (Cruise)
- Conversion of GW to EMW in static Magnetic Field (Gershenstein)
- Conversion of GW to EMW in static Electric Field (Lupanov)
- Bulk acoustic wave resonator (Goryachev & Tobar)
- Superconducting rings/Sagnac effect (Anandan and Chiao)
- Heterodyne amplification of magnetic conversion signals (Li)
- (See Cruise's Talk)

Today

- **Bulk Acoustic Wave Devices (Goryachev's talk)**
  - Transducer (BAW)+Amplifier (SQUID)
  - 1-1000 MHz. $Q = 10^{10}$: higher than other technologies
  - Coupling to mw & optics (R/D)
  - Losses at very low T (<1K) (R/D)
  - Nonlinearities (R/D)
  - Several advantages, poor accuracy
  - BAW as a GW antenna $10^{-22}@100\ MHz$
  - Bandwidth limited by broadband SQUID noise
  - Moving to 20 mK

- **Parametric signal amplification (Harada's talk)**
  - Motivation: improve detection in kHz band
  - Optical spring: optomechanical mixing of mechanic and optical modes
  - Active medium at the dark port, to get parametric amplification
  - The effect can be tuned to improve kHz sensitivity (by moving there optical spring resonance)

Questions

- It is worth to pursue the Gertsenshtein road?
- Cavity effect: it works with magnetic conversion?
- Strong enough scientific case for magnetic conversion facilities?
- What is the value of a Hertz experiment?
  - Laboratory sources look very difficult but they would generate controllable, predictable single frequency signals.
- Use of correlations?
  - Difficult at high frequency.
  - Hopeless?
  - Co-located interferometers (up to 100 MHz)
- Can Fabry Perot cavities enhance the sensitivity of magnetic conversion detectors sufficiently?
- Li-Baker detectors?
- Could other detector concepts be more relevant?
  - Superconducting rings/Sagnac effects
  - Bulk acoustic wave resonators
  - ……

Technical concept	Frequency of operation	Sensitivity	Reference	Disqualification
Resonant bar	600Hz–1 kHz	$4 \cdot 10^{-21}$	Astone	frequency
Laser interferometer on ground	10 Hz–10 kHz	10^{-22}	Gershenstein	frequency
Laser interferometer in space	0.1–100 mHz	$3 \cdot 10^{-20}/\sqrt{\mathrm{Hz}}$	Faller & Bender	[none]
Displacement noise-free laser interferometer in space	100 Hz	$2 \cdot 10^{-23}/\sqrt{\mathrm{Hz}}$	Wang	frequency
Atom interferometer on ground	1–10 Hz	10^{-19}	Dimopoulos	frequency
Atom interferometer in space	0.1–100 mHZ	$5 \cdot 10^{-20}/\sqrt{\mathrm{Hz}}$	Dimopoulos	low TRL (2?)
Mechanical deformation of high Q microwave cavity	1 MHz	10^{-17}	Reece	frequency
Conversion of GW to EM waves in static magnetic field	frequency independent	10^{-21}	Gershenstein	TRL0
Conversion of GW to EM waves in static electric field	frequency independent	no prediction	Lupanov	TRL0
GW effect on EM wave direction	frequency independent	no prediction	Fakir, Labeyrie & Bracco	TRL0
GW effect on EM wave frequency	frequency independent	no prediction	Baierlein	TRL0
GW effect on EM wave amplitude	frequency independent	no prediction	Zipoy	TRL0
GW effect on EM wave polarisation	frequency independent	no prediction	Cruise	TRL0
Resonant polarisation rotation	100 MHz	10^{-17}	Cruise	frequency
Seismic stimulation of the Earth	0.05–1 Hz	10^{-13}	Coughlin & Harms	sensitivity
Seismic stimulation of the Earth	60.1 Hz	10^{-17}	Levine & Stebbins	frequency
Seismic stimulation of the Sun	20–100 μHz	$6 \cdot 10^{-9}$	Seigel & Roth	frequency
Suspended dielectric particles	50–300 kHz	10^{-21}	Arvanitakis & Geraci	frequency
Pulsar timing	10^{-9} Hz	10^{-15}	Jenet	frequency
Bulk accoustic wave resonators	1 MHz–GHz	$10^{-22}/\sqrt{\mathrm{Hz}}$	Goryachev & Tobar	frequency
Heterodyne amplification of magnetic conversion signals	3 GHz	10^{-32}	Li	frequency
Cosmic microwave background polarisation	10^{-16} Hz	$R > 0.22$	Polnarev	frequency
Interaction with binary orbits	$10^{-8} - 10^{-6}$ Hz	10^{-11}	Mashoon	frequency
Spacecraft Doppler tracking	$10^{-5} - 10^{-8}$ Hz	$10^{-14} - 10^{-15}$	Armstrong	frequency
Superconducting rings/Sagnac effect	GHz	no prediction	Anandan, Chiao	frequency
Oscillation of Cosserat rods	$10^{-4} - 1$ Hz	$2 \cdot 10^{-21}$	Tucker & Wang	TRL0
Torsion bar	10^{-2} Hz	$3 \cdot 10^{-19}$	Ando	sensitivity
Skyhook	10^{3} Hz	$3 \cdot 10^{-17}$	Braginsky & Thorne	sensitivity