To detect dark matter with gravitational wave interferometers

Federico Urban

CEICO

Institute of Physics
Czech Academy of Sciences
Prague

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MINISTRY OF EDUCATION,
YOUTH AND SPORTS

:: Variety ::

Spin 0. $\mathcal{L} = (\partial\phi)^2/2 - m^2\phi^2/2$

Spin 1. $\mathcal{L} = -F^2/4 + m^2 A^2/2$

Spin 2. $\mathcal{L} = M\mathcal{E}M - m^2(M \cdot M - M^2)/2$

The spin-2 field is special:

$$S_{\text{int}}[g, M_{ij}, \Psi] \sim \alpha \int \mathrm{d}^4x \sqrt{-g}\, M_{ij}\, T_{\Psi}^{ij}$$

It is in fact an extension of general relativity

>> Bimetric gravity <<

:: bimetric theory ::

$S =$

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- The interaction $V(g, f)$ depends on 5 parameters β_n

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The coupling to matter breaks the symmetry:

$$S_m = \int \mathrm{d}^4x \sqrt{|g|}\, \mathcal{L}_\mathrm{m}(g, \Phi)$$

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This action contains **no ghosts!** ~80 yrs to get right

:: Perturb ::

The dark matter field is described by

$$M_{ij}(t) = \frac{\sqrt{2\rho_{\mathrm{DM}}}}{m} \cos\left(mt + \Upsilon\right)\varepsilon_{ij}(\mathrm{r})$$

where

$$M_{\mu\nu} \propto \alpha \left(\delta g_{\mu\nu} - \delta f_{\mu\nu}\right) \quad \textbf{aka} \quad \delta g_{\mu\nu} \propto G_{\mu\nu} - \alpha M_{\mu\nu}$$

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This looks like a continuous gravitational wave

:: ContinuouS ::

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Persistent

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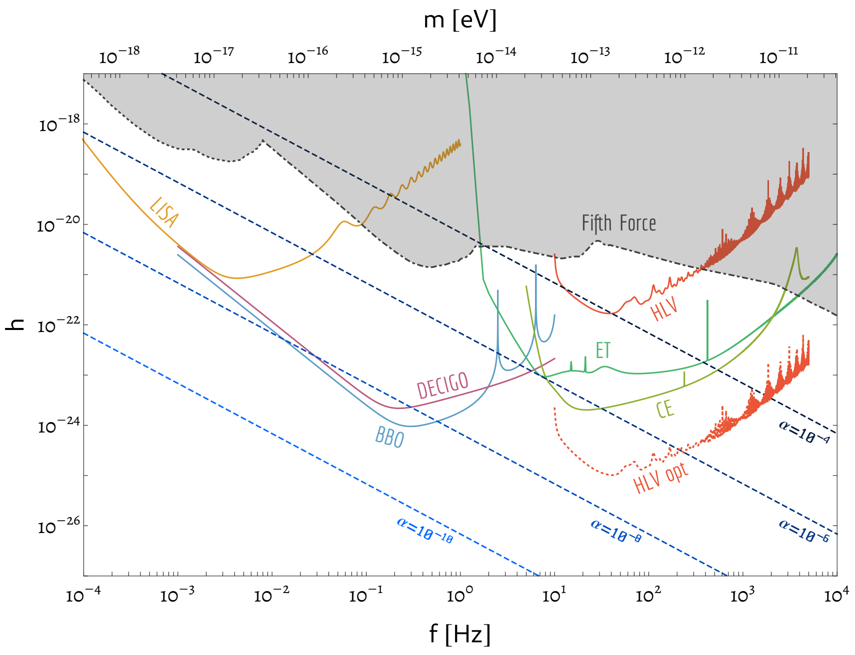
The overall magnitude scales as $1/m$ thanks to α

C.f. the $1/m^2$ for spin-0 and spin-1 (without fifth forces)



m [eV]
10^−18
10^−17
10^−16
10^−15
10^−14
10^−13
10^−12
10^−11
h
10^−18
10^−20
10^−22
10^−24
10^−26
LISA
Fifth Force
HLV
ET
DECIGO
BBO
CE
HLV opt
α=10^−4
α=10^−6
α=10^−8
α=10^−10
10^−4
10^−3
10^−2
10^−1
10^0
10^1
10^2
10^3
10^4
f [Hz]

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