

## Theory remarks for Grav Net





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AGENCIA ESTATAL DE INVESTIGACIÓN





# Milky Way in visible band

# Milky Way in X rays

Spektr-RG-eROSITA all-sky map Nature volume 588, pages 227–231 (2020).





## High frequency GWs (>10 kHz)

### **Exploring all possibilities!**

Living Reviews in Relativity (2021) 24:4 https://doi.org/10.1007/s41114-021-00032-5

**REVIEW ARTICLE** 

### Challenges and opportunities of gravitational-wave searches at MHz to GHz frequencies

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2011.12414 [gr-qc] (v2 2501.11723 [gr-qc])

## Directions

### 1. Sources and waveform production

### 2. Response single antenna: analytics + simulations (realistic)



- 3. Optimization and network
- 4. Data analysis
- 5. New ideas





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## WG1. Sources and waveform production





# WG1. Sources and waveform production Luca Vis



### Tasks:

### Have templates ready to use



## WG2. Response single antenna: analytics + simulations

### From templates, derive signal



 $\eta_{sm} = \frac{\int_{V} dV \boldsymbol{E}_{sm}^{*}(\boldsymbol{x}) \left( i\omega_{G} \boldsymbol{J}_{\text{eff}}(\boldsymbol{x}) \right)}{\int_{V} dV \left| \boldsymbol{E}_{sm}(\boldsymbol{x}) \right|^{2}}$ 

### Understand read out INCLUDING GWs! 0



### Get a multimode readout









José Reina Younggeun Kim Jordan Gué

### Implement simulations

For all WGI examples

Do it

## Explore it and do it

## Maybe 1 quanta?

Bi weekly meeting





## Interaction of GWs with your sensors $h_{+,\times} \approx h_0 \cos \left( 2\pi f(t-z) + \phi \right)$ UNIVERSALITY! Every sensor feels them! **Spin coupling** Energy/mechanical coupling **EM** coupling





 $\delta\omega \sim h\omega$ 

modify clocks at different locations



## WG3. Optimization and network

### Cavities/experiments of different kind $\bigcirc$



### Orientation/distribution 0

### Networking $\bigcirc$

Tasks:

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## Implement simulations

### Simulate SNR and optimize

### Quantum vs classical Network





# A Global Network of HFGW Detectors

### Further enhance sensitivity by combining HFGW detectors

Initial sites: Bonn, Mainz, Frascati, PSI









# A Global Network of HFGW Detectors

Further enhance sensitivity by combining HFGW detectors

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GPS based data-acquisition scheme Experience from GNOME Network

- Nine small resonant cavities (5-9 GHz) operation of three cavities in one magnet
- One large resonant cavity (100 MHz)

GravNet







## WG4. Data analysis

### Tasks:

### Generation of mock data $\bigcirc$

### We need WG1/WG2/WG3 -> baby steps

Analysis of mock data

ML to be exploited

### SGWBs vs coherent

### Some correlations to exploit?



## WG5. New ideas



Aggarwal et al. 2501.11723 [gr-qc])





Aggarwal et al. 2501.11723 [gr-qc])



### Clear message:

### Most likely we are not working with the best concept

- Broadband
- Fast

### Tasks:

Get organized (get funds)

## Reach the sensing community\*

## Map devices to signals

## WG5. New ideas

- Mature enough (learn by doing)
- Network/escalation

Journal club

 $A^{\nu}\partial_{\nu}\left(\frac{1}{2}hF^{\mu\nu} + h^{\nu}_{\alpha}F^{\alpha\mu} - h^{\mu}_{\alpha}F^{\alpha\nu}\right) + B_{i}h_{ij}\left(t_{\psi}\right)\Sigma^{j} + m_{\psi}\ddot{h}_{ij}\left(t_{\psi}\right)x^{i}_{\psi}x^{j}_{\psi}$