

IFT UAM-CSIC

Group leader: Juan Garcia-Bellido

Instituto de Física Teórica
UAM-CSIC

EXCELENCIA SEVERO OCHOA
JULIO 2013 - JUNIO 2031

Universidad Autónoma de Madrid

CSIC
Consejo Superior de Investigaciones Científicas

Gobierno de España
Ministerio de Ciencia, Innovación y Universidades

Comunidad de Madrid

Sachiko Kuroyanagi

ET-Spain meeting @ BSC

The group

- Main background as Theoretical Cosmologists (Early Universe, GW, CMB, LSS)
- Expertise on Experimental Collaborations (LVK, ET, LISA, DES, PAUS, DESI, Euclid, etc.)
- @ET: Members of Fundamental Physics (Div 01), Cosmology (Div 02), and Data analysis (Div 10)
- Contributed to the ET blue book 2.2.1 GWs from inflation
  2.2.6 GWs as probes of the early Universe expansion history



Cosmology group



Monthly GW seminar with IEM & UCM

Members



Juan Garcia-Bellido

Catedrático

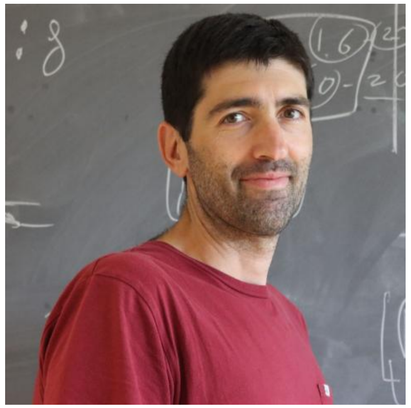
Cosmology
Virgo/ET-IFT Group leader



Sachiko Kuroyanagi

Cientifico Titular

GWs from the Early Universe
GW data anaysis in LVK



Matteo Fasiello

Cientifico Titular

GWs from the Early Universe



Miguel Zumalacarregui

Ramon y Cajal
(+ ERC consolidator)

GW lensing

Savvas Nesseris
Cientifico Titular
GW, LSS
beyond GR

Yashar Akrami
Cientifico Titular
CMB, LSS
Topology

+ 7 Postdocs
9 PhD students



Alex Papageorgiou



Cristóbal Zenteno

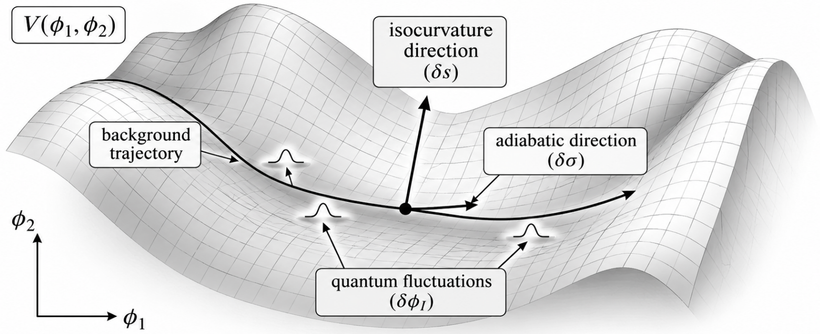


Matteo Fasiello



Sukannya Bhattacharya

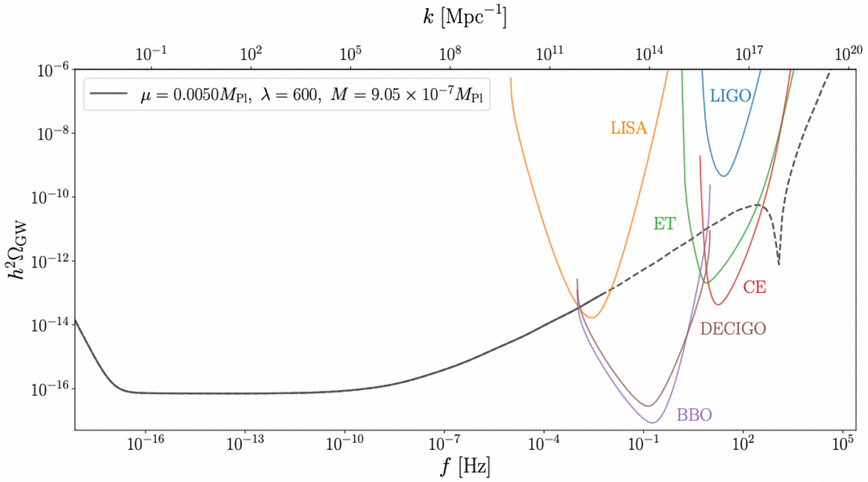
Axion Inflation

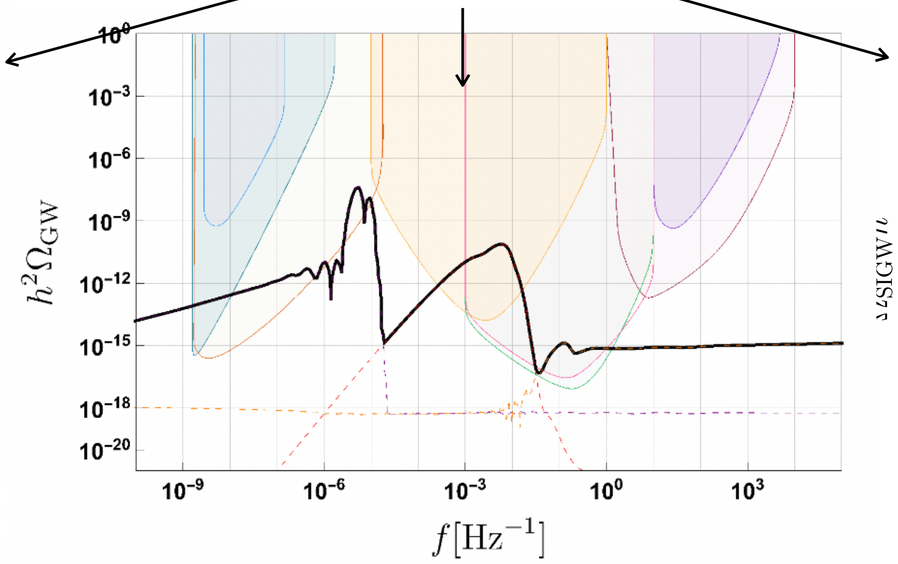


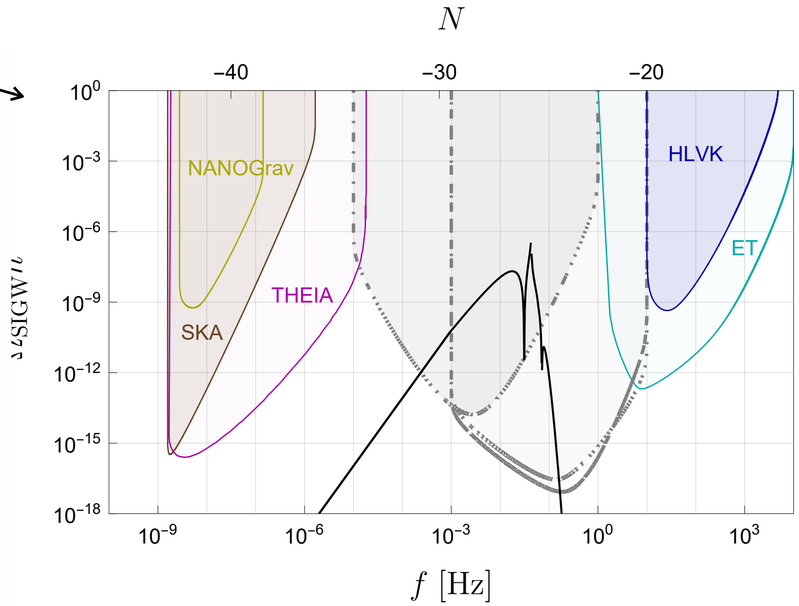
Gauge Fields

Well-motivated (top-down) multi-field inflation models that support striking & testable GW signatures

same class of models

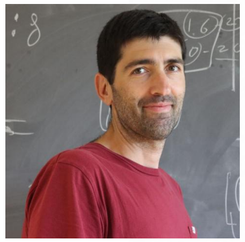






Primordial GW anisotropies

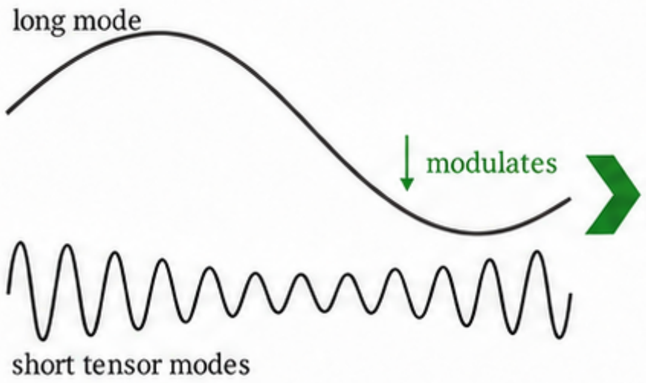
An angular fingerprint of inflationary interactions — beyond the SGWB monopole



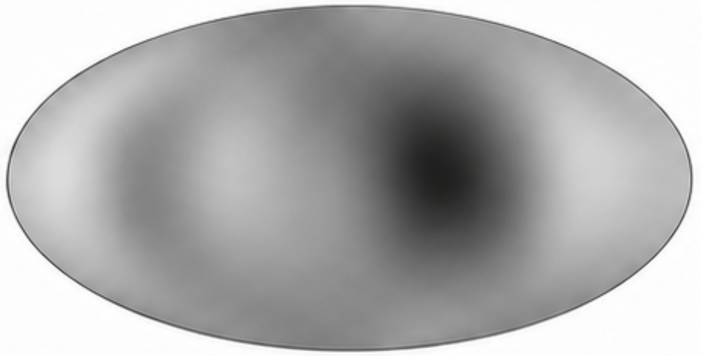
$$\Omega_{\rm GW}(f,\hat{n}) \;=\; \bar{\Omega}_{\rm GW}(f)\,\left[1+\delta_{\rm GW}(f,\hat{n})\right]$$

direction-dependent stochastic background

Squeezed primordial coupling



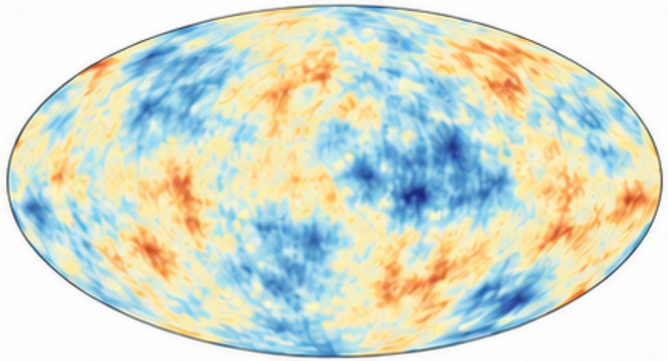
GW anisotropy sky



$\delta_{\rm GW}(f,\hat{n})$

cross-correlate

CMB temperature sky



$\Delta T(\hat{n})/T$

Cosmological SGWB × CMB

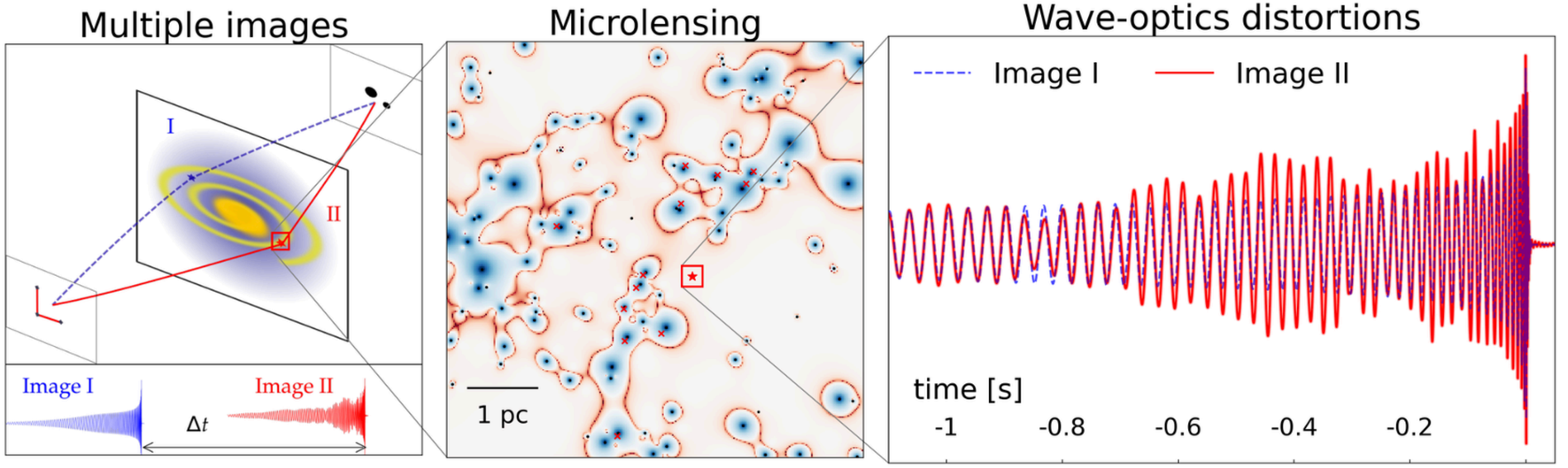
Primordial origin • squeezed non-Gaussianity • isocurvature / early-universe physics

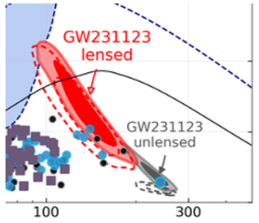
Lensing of gravitational waves @ IFT Madrid

GLOW Gravitational Lensing of Waves

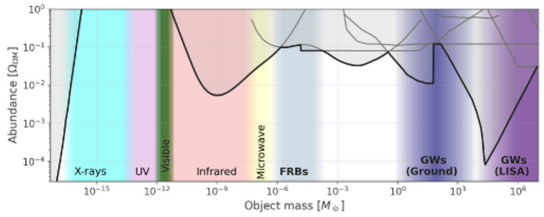
For ET: *lower frequencies & deeper reach → more lensed signals, diffraction by heavier lenses*



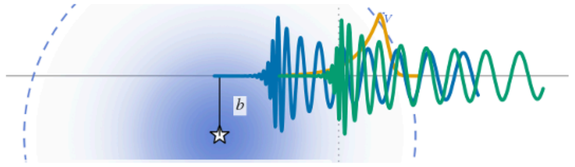




Black holes beyond the horizon
GW231123: lensed candidate



Dark matter on small scales
halos & compact objects



Tests of gravity
GW propagation through lenses

GLoW Gravitational Lensing of Waves

Public tools
GLoW code, searches, inference

M. Zumalacárregui · H. Villarrubia-Rojo · H. G. Choi · X. Shan · D. Ballard · J. Urrutia · E. Alberici · M. van Zyl + students

ift Instituto de Física Teórica UAM-CSIC
Funded by the European Union
erc European Research Council





Data analysis activities in LVK

- **Subsolar mass search**

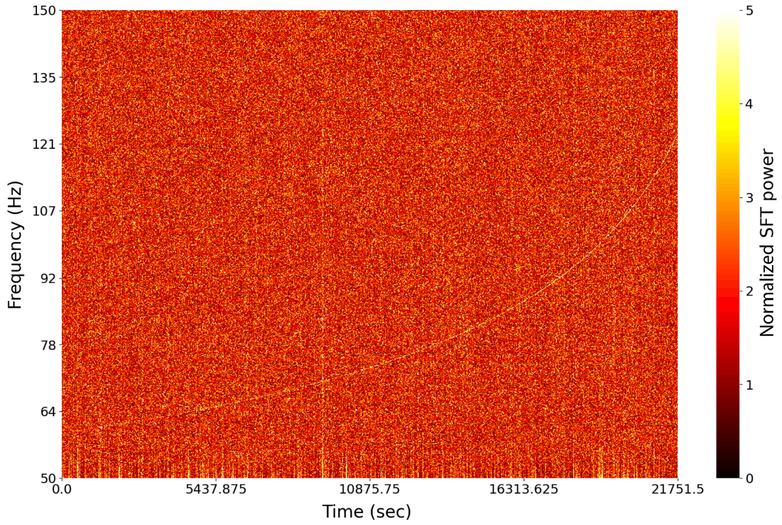
M. Prunier et al. PDU 46 101582 (2024), arXiv:2311.16085
G. Morras et al. PRD 107 2, 023027 (2023), arXiv:2209.05475

- **Waveform modeling for encounter events**

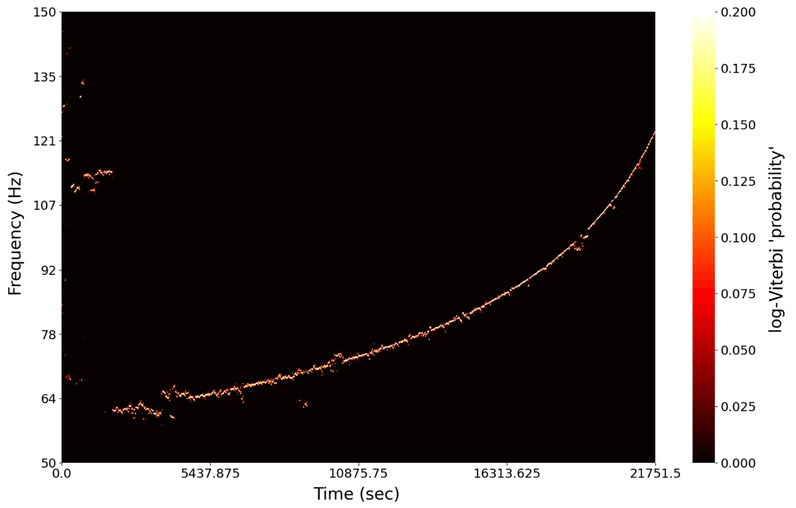
M. Caldarola et al., PRD 109 (2024) 6, 064001, arXiv:2307.00915
S. Jaraba & J. Garcia-Bellido, PDU 34 100882 (2021), arXiv:2106.01436

- **Lighit mass PBH search with Viterbi algorithm**

G. Alestas et al., PRD 109 12, 123516 (2024), arXiv:2401.02314
R. Rodriguez et al., arXiv:2607.18352



Spectrogram



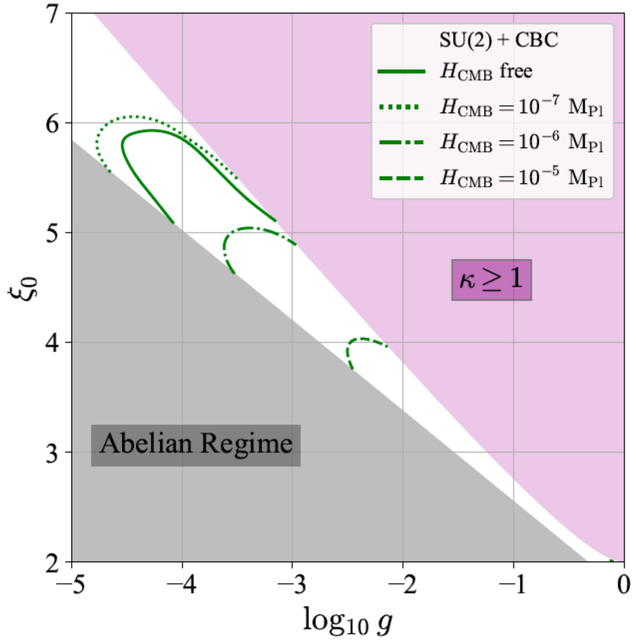
Track recovered by Viterbi



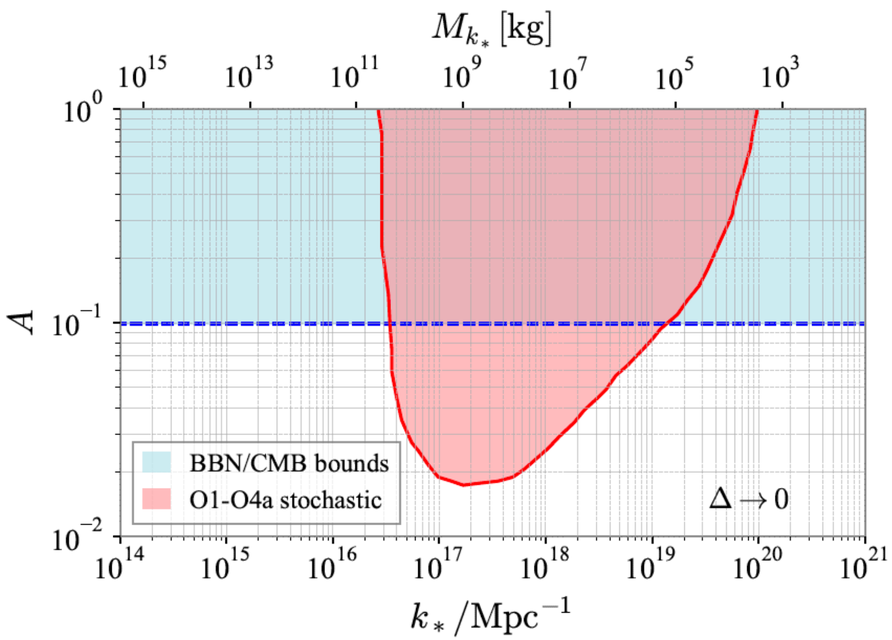
Data analysis activities in LVK

- **Cosmology & High energy implications from stochastic upper bound**

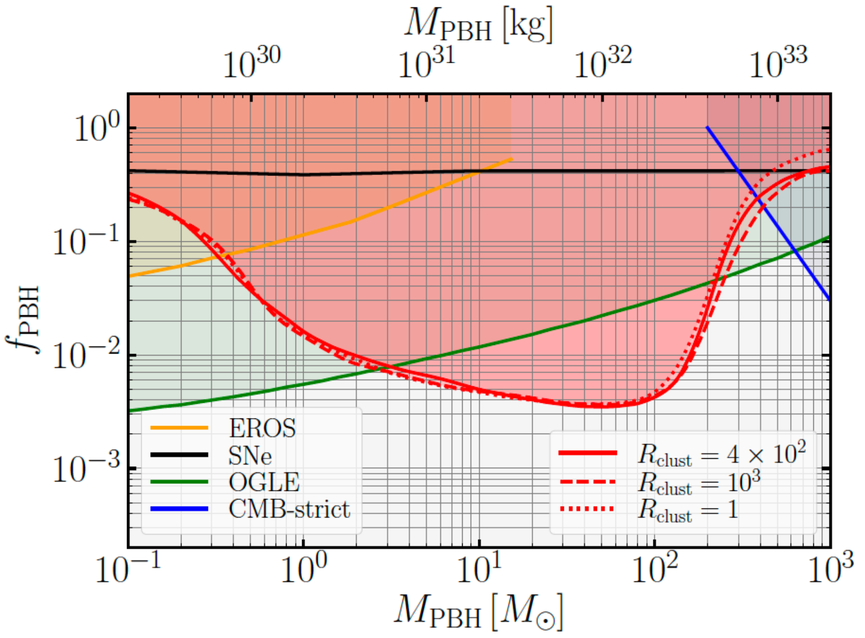
Main contributor as a member of the paper writing team
LVK collaboration, Phys. Rev. X 16, 041023 (2026), arXiv:2510.26848



Axion inflation



Scalar-induced



PBH binaries

- **Intermittent GW background search**
  targeting popcorn-like BBH backgrounds

X. Liu and S. Kuroyanagi, arXiv: 2601.10428

Summary and Plan

ET-IFT Madrid contribution currently under reorganization (FTE update pending)

Expected contributions to ET

- Div 01 Fundamental Physics: Nature of Dark Matter (PBH) & Dark Energy (GREA)
- Div 02 Cosmology: Early Universe GWs (Inflation, PBH, Gauge fields)
- Div 10 Data analysis: PBH search, SGWB, transfering experience in the LVK

Any suggestions or ideas for collaborative efforts are welcome!