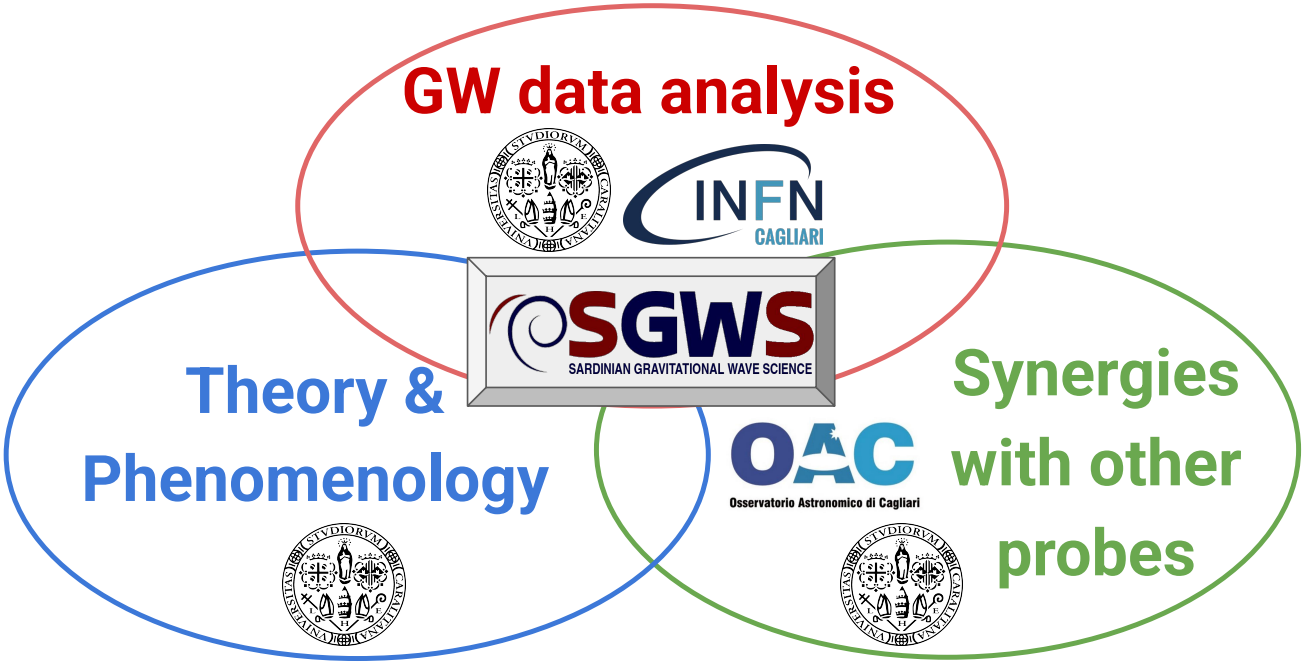
Overview of the research activities within the Sardinian GW Science Community



Riccardo Murgia (UniCa, INFN, INAF-OAC)

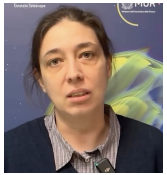
ET-Sardinia Monthly Meeting, Casteddu, 02.10.2025

The SGWS Community

1. Gravitational theory




2. GW data analysis




3. GW & multi-probe cosmology

+ many Post-Docs, grad & undergrad Students

4. GRB and multi-messenger astrophysics


5. PTA, FRBs, GW–radio synergies




Goals

1. **Updating each other** on the current status of the GW-related research activities underway in Sardinia.
2. **Supporting and coordinating teamwork** among grad and undergrad students based in / related to Sardinia.
3. **Planning synergies and cross-disciplinary projects** that make use of our different areas of expertise.
4. Defining **joint potential thesis (bachelor's, master's, PhD) and internship projects** with a view to strengthening the mobility program for research & outreach launched in Feb 2024 involving: UniCa, GSSI, INFN Cagliari, INAF-OAC and Ass. IDeAS

Joint GSSI-Sardinia Program

Starting from February 2024:

- **20+** visiting scientists involved (**10** Universities/Institutes)
- **5** academic courses @ UniCa (24 hours each)
- **1** academic course @ GSSI (12 hours)
- **2** joint OAC-GSSI research proposals approved (P.I. M. Marongiu)
- **15** joint seminars (13 in-person, 2 webinars)
- **1** PhD project @ GSSI (U. Dupletsa)
- **1** ongoing PhD project @ UniCa (M. Pitzalis)
- **2** ongoing PhD projects @ GSSI (A. Cozzumbo, M. Schulz)
- **2** ongoing Master projects @ UniCa (M. Cordaro, L. Sotgiu)
- **2** internships @ GSSI (M. Cordaro, I. Usai)
- **20+** outreach events (with Ass. IDeAS)
- **3** SGWS Community meetings (+ 1 planned in Oct 2025)
- **1** international mini-workshop (Sept 24th-25th 2025)

SGWS Community Meetings

23.05.25: SGWS Kick-Off Meeting @ Physics Dept. UniCa
Overview of the SGWS research activities

04.07.25: 2nd SGWS Community Meeting @ Physics Dept. UniCa
Multi-messenger Astrophysics and Cosmology across different wavelengths

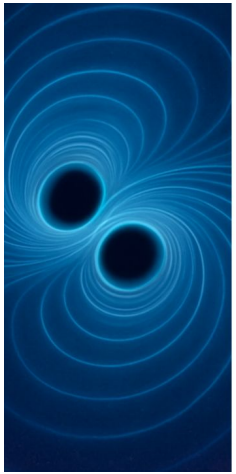
16.09.25: 3rd SGWS Community Meeting @ INAF-OAC
GW data analysis and multi-probe synergies

??.10.25: 4th SGWS Community Meeting @ Physics Dept. UniCa
Pulsar Timing Arrays (PTAs)

Feel free to subscribe to the SGWS mailing list for timely updates

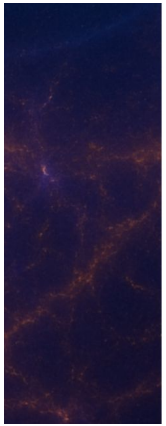
SGWS Mini-Workshops

25.09.25: 1st SGWS Mini-Workshop @ Phys Dept. UniCa



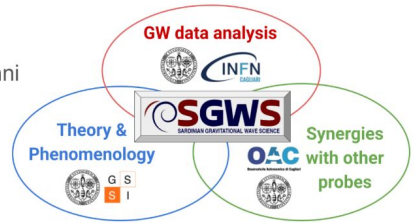
Cosmology and Black Hole Physics with GWs and 21cm intensity mapping

A discussion-driven round table to address recent advances at the intersection of cosmology and black hole physics, focusing on the role of gravitational waves and the large-scale structure of the Universe through the 21 cm intensity mapping of neutral hydrogen. Topics include the use of binary black hole mergers for cosmological inference, exploiting correlations with large-scale structure, compact binary population modeling, and the potential cosmological coupling of black hole masses.



with

Andrea Cozzumbo
Ulyana Dupletsa
Simone Mastrogiovanni
Mirko Pitzalis
Tommaso Ronconi
Filippo Santoliquido
Matteo Schulz
Marta Spinelli



Contact: Riccardo Murgia (riccardo.murgia89@unica.it)

Feel free to subscribe to the SGWS mailing list for timely updates

SGWS research lines

Black holes & fundamental physics

M. Cadoni, L. Modesto, M. Pitzalis, L. Orlando, L. Herres

- Potential signatures of quantum gravity effects in the GW signal of the ringdown phase of binary black hole (BH) mergers, based on deriving of the QNM spectrum, in view of ET
- Potential signatures of the existence of nonsingular BHs or mimickers in the GW waveform (e.g existence of echoes, QNM spectrum) in the ringdown phase, in view of ET
- Potential signatures of the presence of additional BH hair (e.g. scalar hair) in the GW in the ringdown phase in view of ET
- Potential signatures of non-local gravity or conformal gravity in the GW waveform in view of ET

- *participation in ET OSB div1, contribution to ET bluebook*

SGWS research lines

GW population studies & cosmology

R. Murgia, M. Pitzalis, I. Usai (+ A. Cozzumbo, M. Schulz)

- Model-independent, data-driven inference on cosmology and modified gravity theories in view of Einstein Telescope (collab: GW group @ GSSI)
- Simultaneous inference on compact binary population properties and cosmological parameters through Hierarchical Bayesian analyses (collab: S. Mastrogiovanni, A. Colombo @ INFN Roma)
- Inference on the binary BH mass spectrum at different redshifts from LVK data, and forecast for ET, to test the hypothesis of cosmological coupling (collab: GW group @ GSSI)
- Constraints on primordial BHs from LVK data and forecast for ET (collab: P. Pani @ Sapienza Univ.)

- *participation in ET OSB div2, contribution to ET bluebook*

SGWS research lines

GW data analysis

E. Codazzo, L. Mirasola, C. Lazzaro, S. Cotza, A. De Falco, A. Sanna

- Search for GW burst signals in LVK data, without assumptions on the signal morphology, targeting both short- and long- duration bursts
- Upgrade of the methods for unmodeled GW searches in view of ET to identify post-merger signals such as BH echoes
- Search for continuous GW signals in LVK data and upgrade of the methods in view of ET (collab: Sapienza Univ., Balearic Islands Univ.)
- Impact of coalescence signals on the search for continuous GWs in view of ET (collab: Sapienza Univ.)

- *participation in ET OSB div7, contribution to ET bluebook, contribution to LVK data analysis and pipeline development*

SGWS research lines

Synergies with EM & neutrino observatories

R. Murgia, A. Possenti, M. Burgay, M. Pilia, D. Perrodin, M. Cinus, M. Cadeddu, …

- Model-independent constraints on the expansion history of the universe with multiple multi-messenger probes, e.g. Kilonovae, GRBs in view THESEUS and HERMES, etc
  (collab: GW group @ GSSI)
- Cross-correlation between GWs from BBH and 21cm intensity mapping from neutral hydrogen to trace the underlying dark matter distribution and constrain cosmology in view of ET and SKA
  (collab: GSSI, SISSA, M. Spinelli @ Obs. Cote D'Azur, U. Dupletsa @ OEAW)
- Pulsar Timing Arrays and Fast Radio Burst Cosmology (collab: INAF-OAC)
- GW and neutrino emission from Supernova Core Collapse in view of ET
  (collab: M. Atzori-Corona @ Tor Vergata Univ.)

- *participation in ET OSB div5, contribution to ET bluebook, contribution to SKA Science Book*

Thanks for your attention

SGWS
SARDINIAN GRAVITATIONAL WAVE SCIENCE

Feel free to subscribe to the SGWS mailing list