GdR Ondes Gravitationnelles, v2

(2022-2026)

Groupement de recherche
Ondes gravitationnelles

GdR Ondes Gravitationnelles, v1

• Started in 2017 will end at the end of 2021.
A big thank you to Chiara, and also to the other actors of the GDR, for such a successful v1!

• Many things have happened

- First direct detections of GW from BBH collisions by LIGO/Virgo; now O3
- Flight of LISA Pathfinder and preparation of the LISA mission
- Birth of a new science: *GdR helped form and structure, federate and strengthen, the French community; given visibility to GW science in France*

• Furthermore
- GdR provided support to the Einstein Telescope project, and has defended the importance of GW physics at the level of the Instituts of the CNRS.
- Provided a common environment for the french scientific community with interest in GW physics: astrophysicists, theorists, experimentalists, data analysts...
- GdR meetings and assemblies allowed dozens of students and postdocs to present their work to the national community
- Budget devoted exclusively to organisation of meetings, no research financing
- Promote new collaborations and projects though *Working Groups*

• New edition, hopefully, from 2022->2026.

Structure of the GdR, v1

Overview

- >280 members
- from 70 laboratories (some outside France, former members)
- Composition ~ the end of 2021 : IN2P3 100, INSU 65, INP 55, INSIS 20, INSMI 2, INS2I 4

Governing body

Board (bureau) : 6 members

- Luc Blanchet (IAP, theory)
- Chiara Caprini (Direction, APC, cosmology)
- Eric Chassande-Mottin (APC, data analysis)
- Benoit Mours (IPHC, Virgo)
- Gilles Theureau (LPC2E, EPTA)
- Marta Volonteri (IAP, astrophysics, multi-messenger)

✓ Scientific decisions: themes, renewal, community needs...
✓ Working group supervision: themes, coordinators, programme, progress...
✓ Organisation of meetings and of the annual assembly

Scientific Council : 17 members

- *nominated members* :

Matteo Barsuglia (APC, detectors), *Sylvain Chaty* (Univ. Paris, multi-messenger astrophysics), *Joseph Martino* (APC, detectors), *Jérôme Novak* (LUTH, neutron stars), *Florent Robinet* (LAL, data analysis), *Danièle Steer* (APC, cosmology), *Filippo Vernizzi* (IPhT, modified gravity theories), *Michal Was* (LAPP, detectors)

- representing the *Programmes Nationaux*:

Philippe Brax (PNCG), *Patrick Charlot* (PNGRAM), *Susanna Vergani* (PNHE)

8 GdR working groups

• Waveforms (63 members)
coordinators : Luc Blanchet, Guillaume Faye, Eric Gourgoulhon, Alexandre Le Tiec
(2 reunions, of which 1 with "tests de la relativité")
- MBHB, stellar origin BHB, NSB et WDB
- Numerical relativity (BHB, relativistic hydrodynamics...)
- Analytical methods (PN, EoB, Phenom, effective field theories...)

• Tests of GR and of modified gravity (106 members)
(1 of which + 1 with "waveforms")
coordinators : Laura Bernard, Luc Blanchet, Filippo Vernizzi
- tests of the inspiral, waveforms in GR and alternative theo
- physics of the horizon, tests of the no-hair theorem
- tests of GW propagation and polarisations
- cosmological modified gravity theories

• Sources populations (66 members)
(2, of which 1 with "predictions et suivi des signaux multi-messagers")
coordinators : Stas Babak, Irina Dvorkin, Astrid Lamberts, Gilles Theureau
- Binaries origin and formation (MBHB, stellar origin BHB, IMBHB...)
- Stochastic foregrounds from binaries
- Complementarity ground/space: multi-wavelength GW observations

• Cosmology (102 members)
coordinators : Tania Regimbau, Danièle Steer, Vincent Vennin
(2 reunions)
- early universe signals (stochastic backgrounds)
- cosmological parameters (standard sirens)
- angular correlation, large scale structure
- Weak and strong lensing
- Cosmic- (super-) strings - Primordial BHs

• Prediction and follow-up of multi-messenger signals (85 members)

(1 reunion) coordinators : Sylvain Chaty, Olivier Godet

- Multi-wavelength follow-up of GW emitting events
- Observational prediction and interpretation of the detections
- Counterparts: NSB, MBHB, stellar origin BH-NS binaries...

• Neutron stars, supernovae and nucleosynthesis (76 members)

coordinators : Anthea Fantina, Jérôme Novak

(2 reunions, of which 1 with working group "Astrophysique nucléaire" du *GdR RESANET*)

- Internal structure and equation of state of NS
- Heavy elements synthesis
- supernovae

• Data Analysis (106 members)

coordinators : Eric Chassande-Mottin, Florent Robinet

(2 reunions, of which 1 with working group "Méthodes d'Analyse des Données" du *GdR ISIS* de l'INS

- Data quality and noise analysis - parameter estimation
- Bayesian methods; Un-modelled sources
- Non-gaussianity, non-stationarity - Foreground subtraction - De-noising, machine learning

• Detectors development (80 members)

(3 reunions) coordinators : Eleonora Capocasa, Walid Chaibi, Joseph Martino

- LIGO/Virgo and LISA
- Development of ET France from the instrumental point of view
and in light of the scientific context
- Atom interferometry: ground (MIGA, ELGAR) and space

activities in 2018-2021

5 assemblées générales :

- Paris, 18-19 octobre 2018, 98 participants

  Building the GdR community, creating contacts between theorists and experimentalists, meeting, discussing, presenting the last advancements in the field
- Lyon, 10-11 octobre 2019, 76 participants
- on line, 14-15 octobre 2020 140 participants
- on line, 30 mars -1 avril 2020, 272 participants *(occurred in the context of the IHP thematic programme)*
- Annecy, 11 -12 October 2021, 81 registrants

activities in 2018-2021

"Gravitational waves: a new messenger to explore the universe"

Six-weeks thematic programme at the Centre Emile Borel de l'Institut Henri Poincaré

1 mars - 9 april 2021

Organisation: Chiara Caprini, E. Chassande-Mottin, G. Faye, F. Vernizzi, M. Volonteri

Structure of the thematic programme

- Theoretical aspects of gravitational-wave science (March 1-12)
- Astrophysics and cosmology (March 15-26)
- Gravitational-wave detectors and data analysis (March 29-April 9)

LECTURES

- Gravitational waveforms: Alessandra Buonanno
- Testing gravitational theories: Shinji Mukoyhama
- GW detectors: David Shoemaker
- GW data analysis: Neil Cornish
- (Massive) black hole binaries: Monica Colpi
- Multimessanger astrophysics: Giancarlo Ghirlanda
- GWs and cosmology: Danièle Steer
- Hydrodynamique relativiste: Luciano Rezzolla
- Méthode d'expansion post-Newtonienne: Luc Blanchet

INTERDISCIPLINARY SEMINARS

Introduction to astrophysical observations: Susanna Vergani
Machine Learning for detectors and data analysis: Gabriele Vajente
Stochastic backgrounds: Germano Nardini

INVITED SEMINARS

Claudia De Rham; Eleonora Capocasa; Arianna Renzini; Valerie Domcke; Gabriele Vajente; Alberto Sesana; Swetha Bhagwat; Gabriele Gonzales; Katerina Chatziioannou ; Chris Messenger; Daniel Holz; Tania Hinderer; Elena Maria Rossi; Richard O'Shaughnessy; Misao Sasaki; David Kosower; Antonio Riotto; Edward Porter; Matias Zaldarriaga

GdR Ondes Gravitationnelles v2 (hopefully!)

- Application submitted to IN2P3 early september 2021; waiting on avis du conseil scientifique
- Structure marginally different:
  - Directors: Danièle Steer + Filippo Vernizzi
  - Comité de Pilotage: directeurs + responsables principaux des 8 groupes de travail

Formes d'Onde : Luc Blanchet
Population des sources : Gilles Theureau
Prédiction et suivi des signaux multi-messagers : Sylvain Chaty
Cosmologie : *Nicola Tamanini*
Etoiles a neutrons, supernovae, et synthèse des éléments lourds : Jerome Novak
Méthodes et analyse de données : Eric Chassande-Mottin
Tests de la relativité générale et théorie alternatives : *Karim Noui*
Développement des détecteurs : Joseph Martino

Couvre: Aspects organisationnels et financiers du GDR, ainsi que de la mise en œuvre de la politique scientifique proposée par le ***conseil scientifique***

- Conseil scientifique: comité de pilotage + membres externes
  (représentants des différents programmes nationaux concernés, et pour s'ouvrir à des sujets scientifiques non représentés au conseil de pilotage, p.ex atom interferometry)

mission: discuter des orientations scientifiques du GDR et de programmer un calendrier annuel des sessions du GDR afin d'atteindre ses objectifs. Se réunira plusieurs fois par an, entre autres pour organiser la réunion annuelle du GDR et pour suivre l'état des échanges au sein des Groupes de Travail.

– Working groups

Tito del Canton -> MULTI-MESSAGER
Sylvain Marsat, Viola Sordini et Antoine Petiteau -> D'ANALYSE DES DONNÉES
Marta Volonteri -> POPULATIONS DES SOURCES
Nicola Tamanini -> COSMOLOGIE
Karim Noui -> TEST RG

Your opinions, thoughts, comments?

- What worked? What didn't work?
- What could we modify / remove or add any groupes de travail?
- Multimessager aspects? Certain dispersion of efforts? physics discussed in other places (PNHE; PNCG;…). Is there space in the community for a multimessenger group focalised on the scientific aspects related to GWs?
- Semester at l'IHP? Successful? To attempt again?

- Multiple important aspects to discuss in next edition: e.g.
  - preparation of ET, instrument design, preparation of data analysis, role of french community.
  - synergies LISA – Einstein Telescope (multi-wave length physics, common experimental aspects…)
  - interpretation of future LIGO/Virgo/KAGRA O4 et O5, (multiple events at cosmological distances.)
  - LISA scientific objectives (will influence the final design of LISA, and GW astronomy from space until mid-century!),
  - Low frequency GWs (PTA europe, Nancy Radio Telescope)
  - Virgo post-O5
  - multi-messager astronomy (SVOM…)