

ET OSB

Division 1: Fundamental Physics

Coordinators:

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Fundamental physics and gravity

Some of the most important questions in fundamental physics involve **gravity**:

➤ **The nature of gravity**

- Inspiral dynamics, ringdown, how many degrees of freedom, GW propagation, coupling of dense matter with spacetime, GW memory, ...

➤ **The nature of compact objects and horizon-scale physics**

- Can be studied with inspiral tests, ringdown tests, looking for exotic compact objects

➤ **The nature of dark matter & new fields**

- Direct detection of ultralight dark matter with interferometers, boson clouds from superradiance, environmental effects

Aims of the division

- **Community building & enlargement**
- **Collecting and coordinating new research that bolsters the science case for Einstein Telescope in terms of fundamental physics**
 - Identifying new exotic phenomena that could be studied using ET
- **Identifying gaps that need to be filled**
 - Analytic and numerical waveform modeling, also for beyond-GR theories
 - Improved characterization of exotic objects
 - New ways of exploiting a network of detectors (e.g. lensing)
 - ...
- **Condensing the above into contributions to the Bluebook**

1 Introduction

2 Testing the fundamental principles of the gravitational interaction

2.1 Parametrized PN tests of the inspiral dynamics

2.2 Ringdown tests

2.3 Extra polarizations

2.3.1 Detector response to extra polarizations

2.3.2 Current and future constraints

2.3.3 Strongly lensed GW signals

2.4 Anomalous GW propagation

2.4.1 Tests of Lorentz violation and minimal length

2.5 Neutron stars and fundamental physics: Degeneracies between EoS and new physics signatures

2.6 Gravitational wave memory

2.7 Numerical simulations beyond GR

2.7.1 Binary BH mergers

2.7.2 Binary NS mergers

2.7.3 Stellar core collapse

2.8 Fundamental aspects of the two-body problem

3 Testing the nature of compact objects & horizon-scale physics

3.1 Inspiral tests

3.1.1 Model-agnostic tests of the multipolar structure

3.1.2 Model-agnostic tests of tidal effects

3.1.3 Constraining fundamental couplings of scalar interactions with boson stars

3.2 Ringdown tests: QNMs and echoes

3.3 Nonlinear ECO dynamics: Boson and Proca star mergers

4 Searches for dark-matter candidates & new fields

4.1 Direct detection of ultralight DM with interferometers

4.2 Boson clouds from superradiance

4.2.1 Continuous waves

4.2.2 Stochastic background

4.2.3 Binary systems

4.3 Environmental effects on GW signals

5 Synergies with other Divisions

Talk by
Costantino Pacilio

How we work and where we stand

- **Have been organizing telecons once a month**
 - <https://wiki.et-gw.eu/OSB/FundamentalPhysics/Meetings>
 - Typically 25-35 participants
 - Dedicated to specific topics

- **Bluebook**
 - <https://it.overleaf.com/project/60c07afe8d5f7d310fcdb3b6>
 - Multiple coordinators assigned to each (sub)section
 - All (sub)sections have text
 - Some overlap, differences in length, ...
 - Polishing in progress
 - Realistic to have a mature draft by end of May
 - *Will be looking for internal reviewers!*