LISA DATA CHALLENGE TUTORIALS

Quentin Baghi , on behalf of the LISA Data Challenge Working Group

Adding LISA to Your Astronomy Toolbox - AAS Meeting - January 6th, 2019 - Seattle, Washington

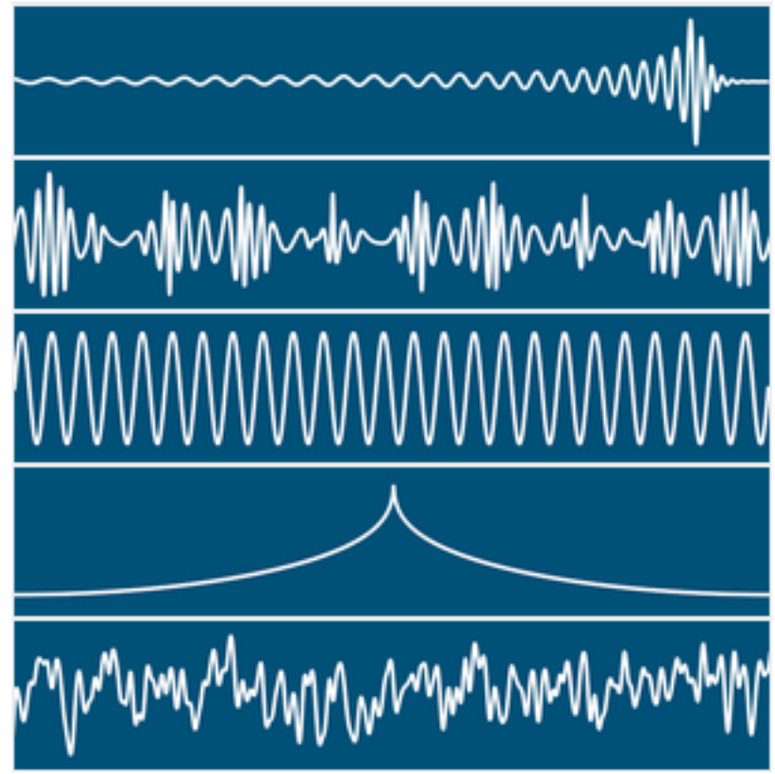
OUTLINE

1. Presentation of the LISA data challenge
2. Tutorials:
    1. compact galactic binaries waveform generation
    2. massive black hole binaries

1. PRESENTATION OF THE LISA DATA CHALLENGE

PRESENTATION OF THE LISA DATA CHALLENGE

- The LISA Data Challenge has been resurrected last July. The aims of this initiative are:
  - Project-oriented: demonstrate proof-of-concepts for LISA data analysis and capability to deliver science requirements, develop software standards and pipelines. Working group run by Stas Babak, Michele Vallisneri & John Baker.
  - Research-oriented: foster development of data analysis methods and new algorithms
  - Community-oriented: get new actors involved in the challenge of the LISA data analysis and provide tools



PRESENTATION OF THE LISA DATA CHALLENGE

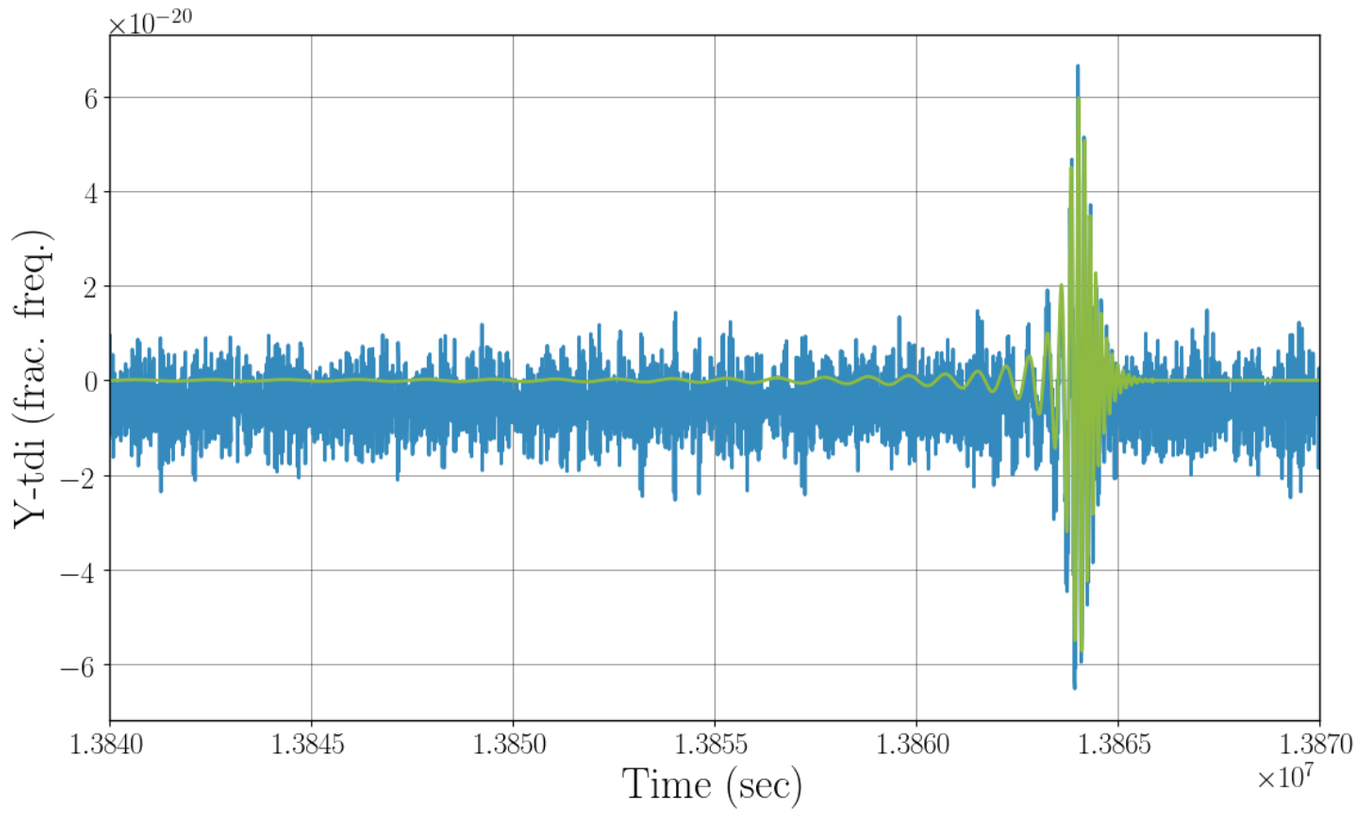
- The LISA Data Challenge is open to all, you can subscribe here https://lisa-ldc.lal.in2p3.fr/
- A new set of simulated LISA data has been released, dubbed "**Radler**"
- Its goals are:
  - To establish basic components of LISA data infrastructure
  - To provide 4 accessible single-source type sub-challenges to re-start from the basic problems
- Challenge: estimate source parameters and/or characterize their posterior distribution
- Format: hdf5 files containing TDI data in time domain in format {t , X , Y , Z }

PRESENTATION OF THE LISA DATA CHALLENGE

Overview of the sub-challenges:

- **LDC1-1**. A single GW signal from a merging massive-black-hole binary.

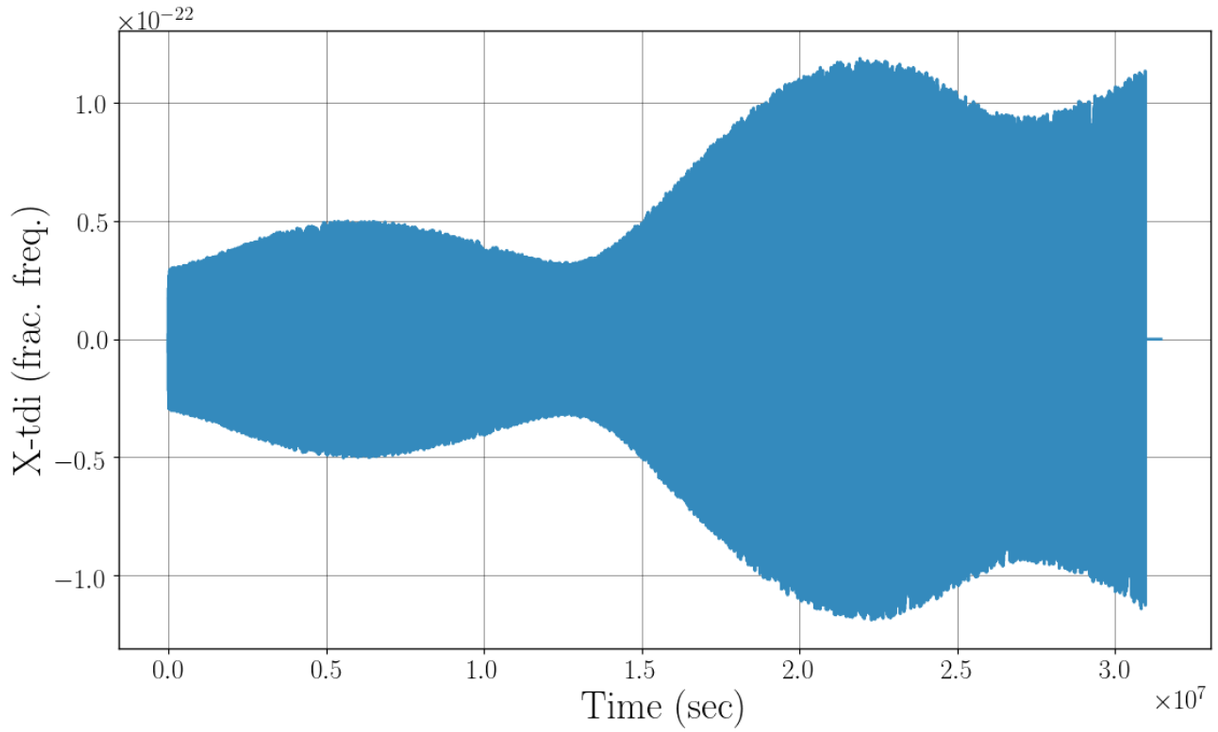
  - Represented with a frequency-domain inspiral–merger–ringdown phenomenological model (IMRPhenomD)
  - Includes black hole spins
  - Provided with and without instrumental noise



PRESENTATION OF THE LISA DATA CHALLENGE

Overview of the sub-challenges:

- **LDC1-2**. A single GW signal from an extreme-mass-ratio inspiral.



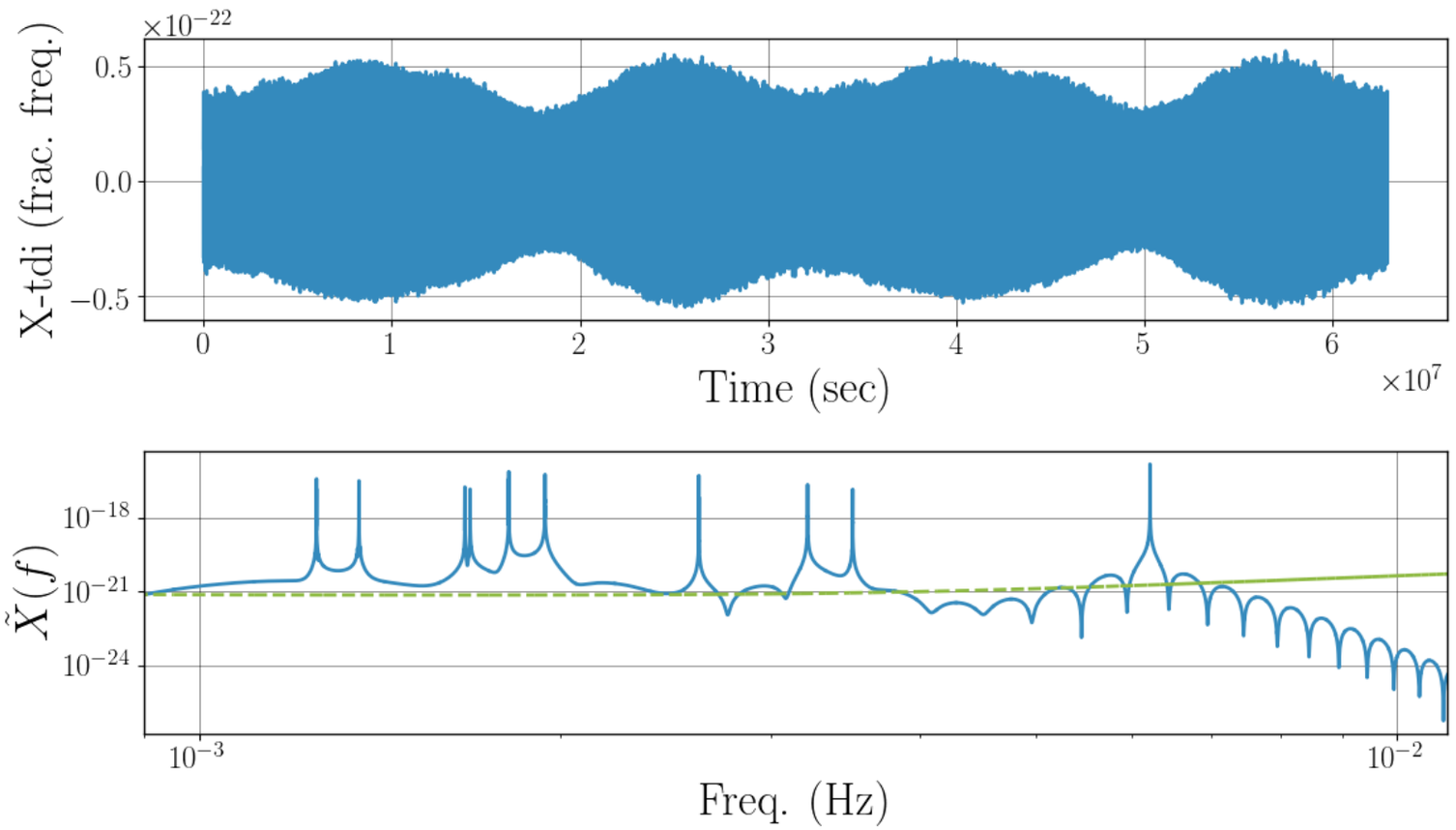
- Produced with Analytic Kludge waveforms Cf. Barack and Cutler 2004
- Will be updated in future challenges

PRESENTATION OF THE LISA DATA CHALLENGE

Overview of the sub-challenges:

- **LDC1-3.** Superimposed GW signals from several verification Galactic white-dwarf binaries.

  Cf. T. Kupfer et al. 2018

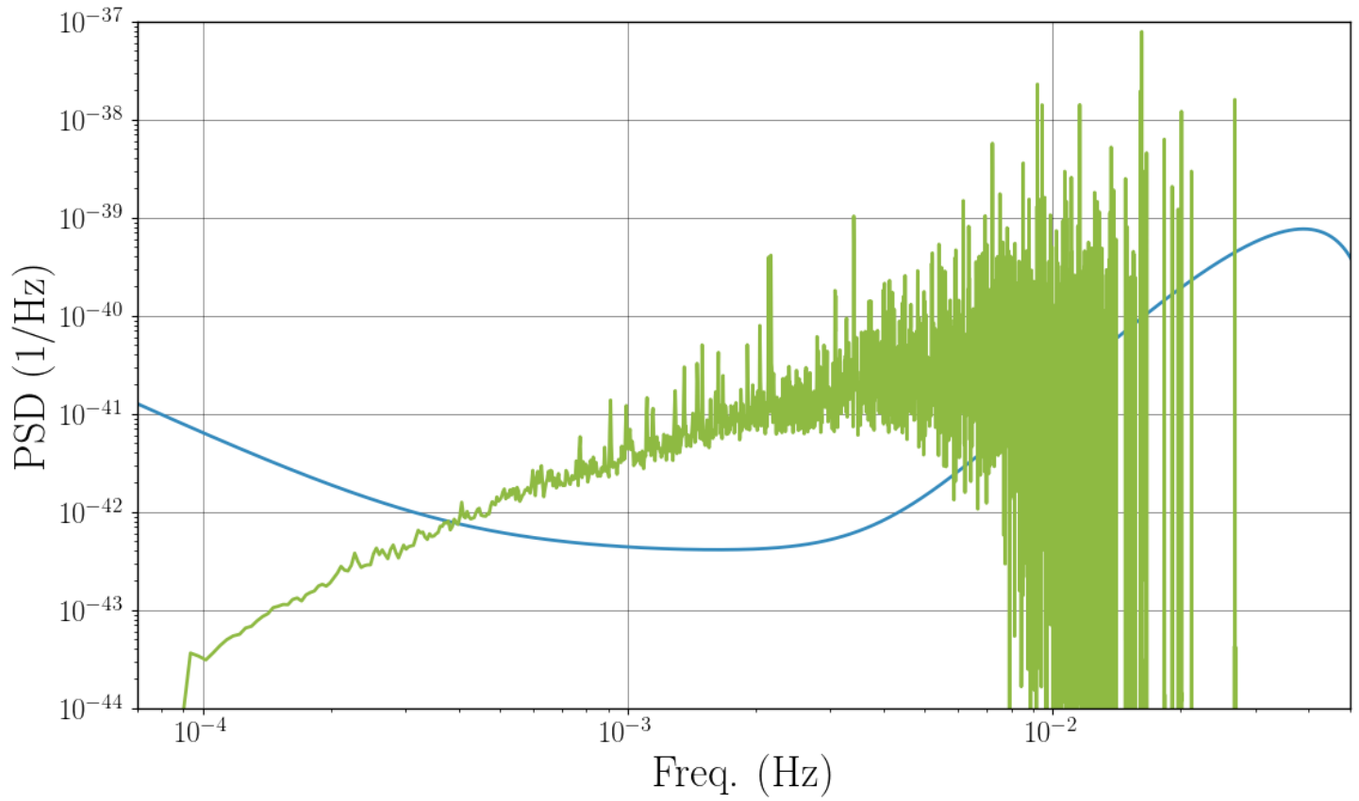


- Produced with fast response code
- A good challenge to begin with

PRESENTATION OF THE LISA DATA CHALLENGE

Overview of the sub-challenges:

- **LDC1-4.** A GW signal from a population of galactic white-dwarf binaries



  - Produced with fast response code
  - 26 million signals

FUTURE CHALLENGES

In the future challenges, some “refinement” will be introduced, including:

- Source modeling:
  - Improvement of waveform models (e.g. MBHB precession)
  - Extension to astrophysical waveform catalogues
- Instrument modeling:
  - use numerical orbits
  - more realistic noise
- Source mixing (“mild enchilada”):
  - Galaxy + MBHB + EMRI
  - Galaxy + Stochastic + SOBHBs

2. TUTORIALS

TUTORIALS

1. Use the link provided on the github “Read me” file
   https://github.com/qbaghi/lisatutos
   to access the Google Colab notebook.

2. Save the notebook on your own Google Drive (File / Save a copy in Drive)

3. Run the notebook in the cloud. The first four cells do all the work of installing the LDC software stack and downloading challenge files.

Note: you can have access to the source code and the full LDC data sets by going to the LDC website https://lisa-ldc.lal.in2p3.fr/ and create an account.