SGWB data analysis for Radler

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5th Cosmology Working Group Workshop

Helsinki - June 12, 2018

A brief introduction to...

- Resources available

A BRIEF INTRODUCTION TO...

- Resources available
- Access Radler data

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- Access Radler data
- Understand the LDC pipeline

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- Build your own data

A BRIEF INTRODUCTION TO...

- Resources available
- Access Radler data
- Understand the LDC pipeline
- Build your own data
- Perform some preliminary estimates

Resources

- Docker environments:
  - Docker for user: gitlab-registry.in2p3.fr/stas/mldc:master
  - Docker with jupyter support: gitlab-registry.in2p3.fr/elisadpc/docker:ldc_jupyter

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- LISA Data Challenge repository:
  - User and Developer branch: https://gitlab.in2p3.fr/stas/MLDC
  - How to mount/install the latter into the former: https://gitlab.in2p3.fr/stas/MLDC/blob/master/README.md

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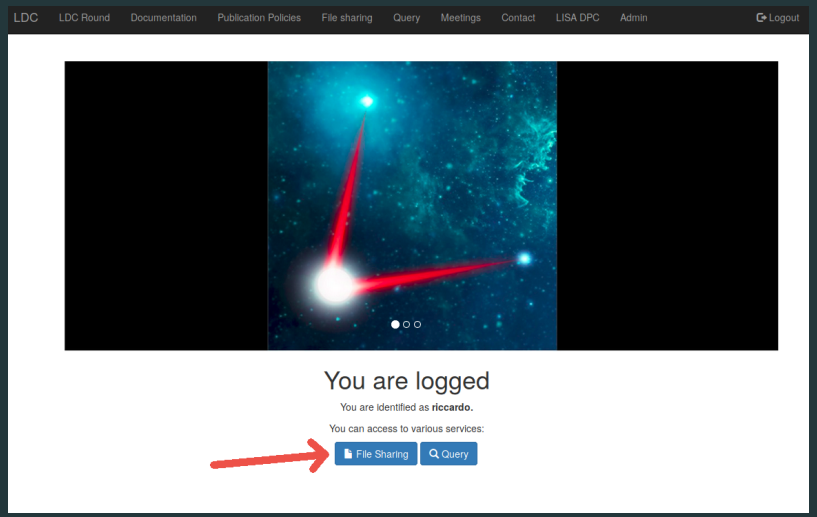
  - How to mount/install the latter into the former: https://gitlab.in2p3.fr/stas/MLDC/blob/master/README.md
- Data stored in .hdf5 files
- Lisa Data Challenge Manual: https://lisa-ldc.lal.in2p3.fr/doc

Radler Data

Reference page: https://lisa-ldc.lal.in2p3.fr/home



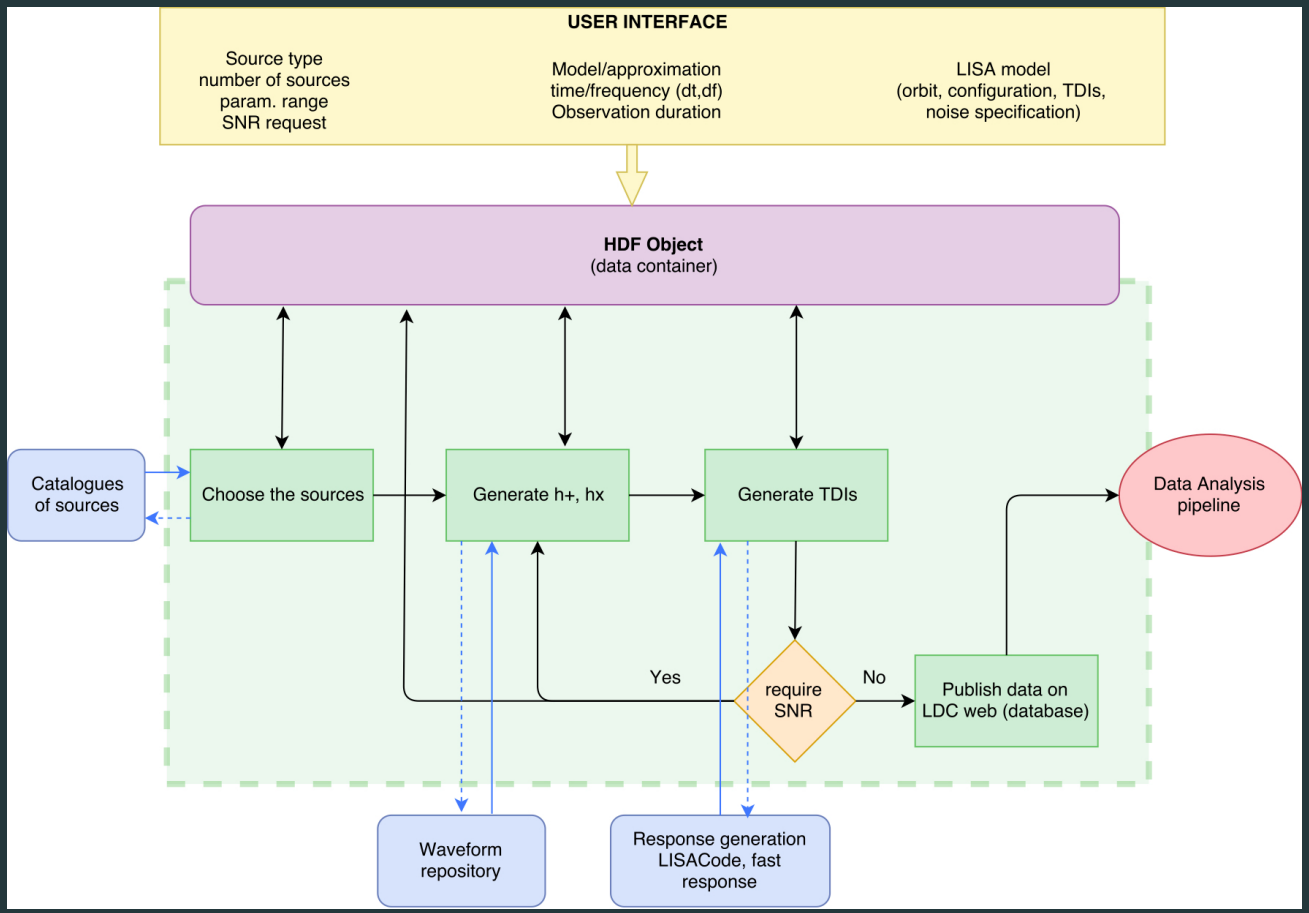
Stochastic signal:

Sim_LISA_SGWB_12345_NoNoise.hdf5
Sim_LISA_SGWB_12345_Noises.hdf5
Sim_LISA_SGWB_12345_NoiseRand.hdf5

We'll come back to these in a bit...

Radler Data

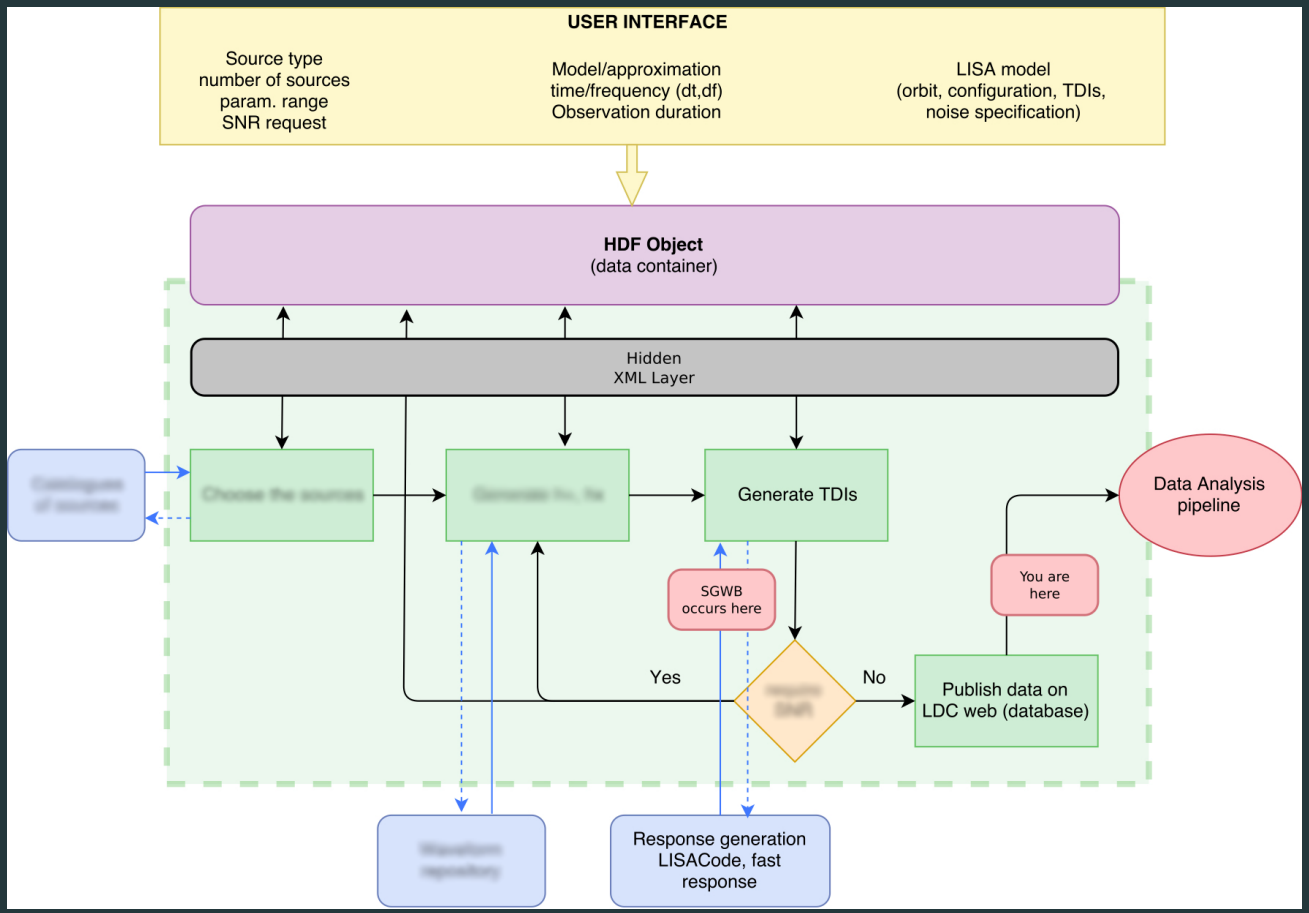
Generic case:



Mix type of sources in the same dataset with increasing complexity as example GB+MBHB, EMRI+GB, SGWB+MBHB...

Radler Data

Stochastic:



Choosing the sources is still performed, but no SNR estimate or catalogues lookup for SGWB.

Input parameter file

SGWB basic input file & Superimposing sources

```
==============================
SourceType SGWB
NumberSources 1
Approximant LISACode2SGWB_4
Sky Isotropic
FrequencyShape PowerLaw
EnergySlope 0.666667
FrequencyRef 25
EnergyAmplitude 0.5e-9:4.5e-9
==============================
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Sky Isotropic
FrequencyShape PowerLaw
EnergySlope 0.666667
FrequencyRef 25
EnergyAmplitude 0.5e-9:4.5e-9
==============================

==============================
SourceType MBHB
NumberSources 1
Catalogues "catalogues/MBHs/catalog_Q3_delay_real106.out"
CoalescenceTime 0.1-0.25
MassRatio 1.0-10.0
Spin1 0.5-0.99
Spin2 0.5-0.99
Model IMRPhenomD
RequestSNR 100.0-500.0
TimeStep 10.0
ObservationDuration 7864320.0
==============================
```

Pipeline

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- ConfigureInstrument.py --TDI="X,Y,Z" --duration=125829105.0 --timeStep=15.0 --orbits=LISACode_Orbits MySim_Param.hdf5

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  Amount of noise randomisation:

$$PSD = PSD_0 \left(1 + \frac{\mathcal{U}(-x, x)}{100}\right)$$

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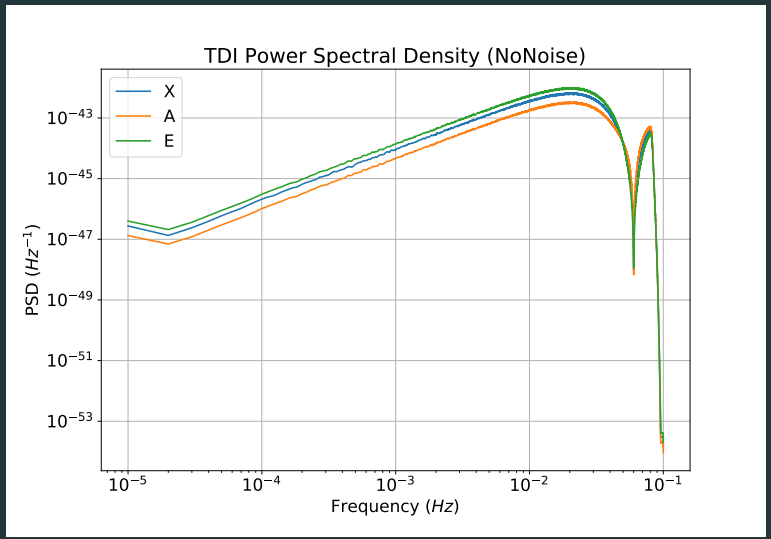
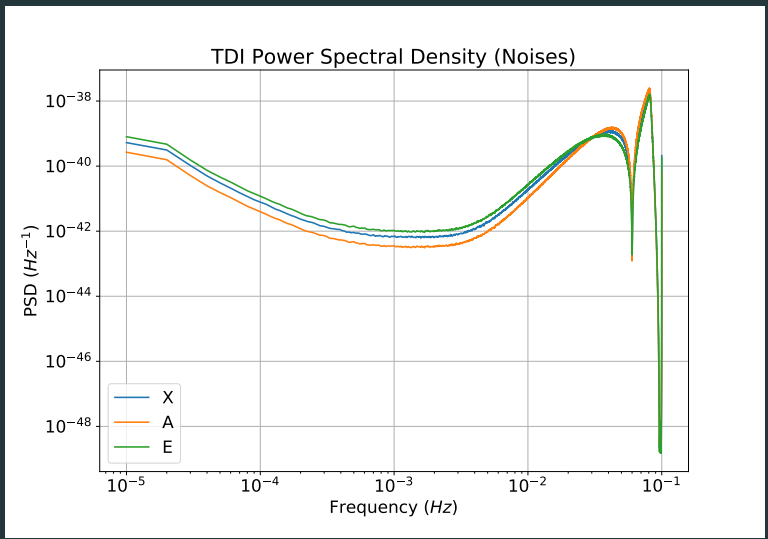
- RunSimulLC2.py --debug=False --verbose=False --path2LisaCode= --NoNoise=False --NoGW=False --seed=12345 MySim_Param.hdf5

$$T_{SIMUL} \sim 8 hours$$

Overview of Radler Data

TDIs: the line at high frequency is (partially) absorbed by the response function.





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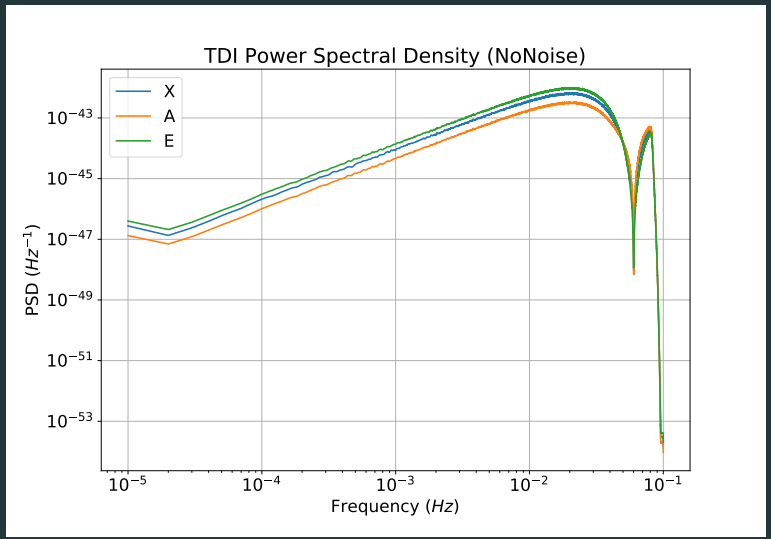

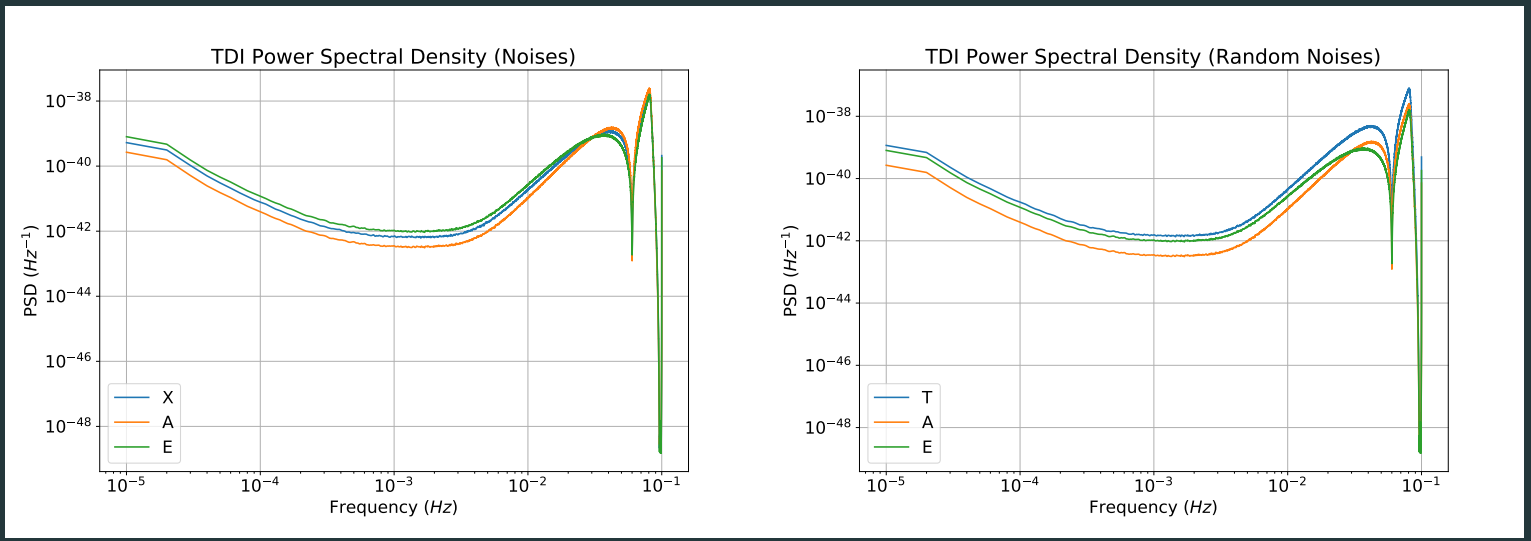

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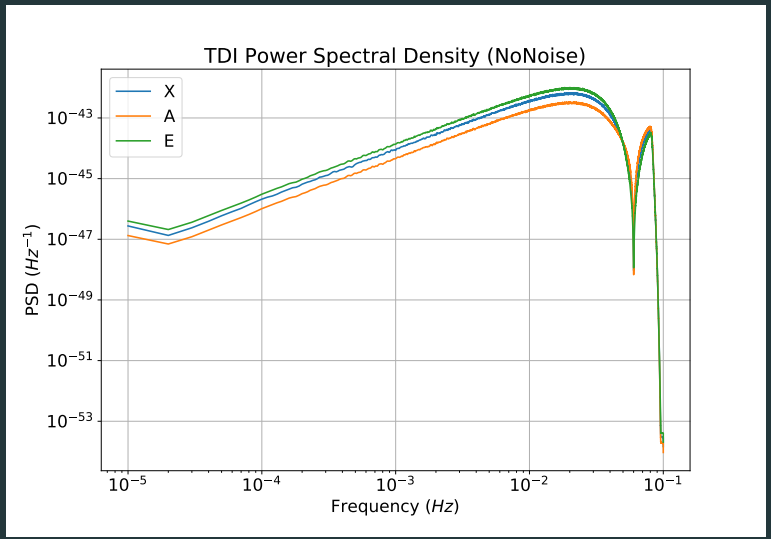
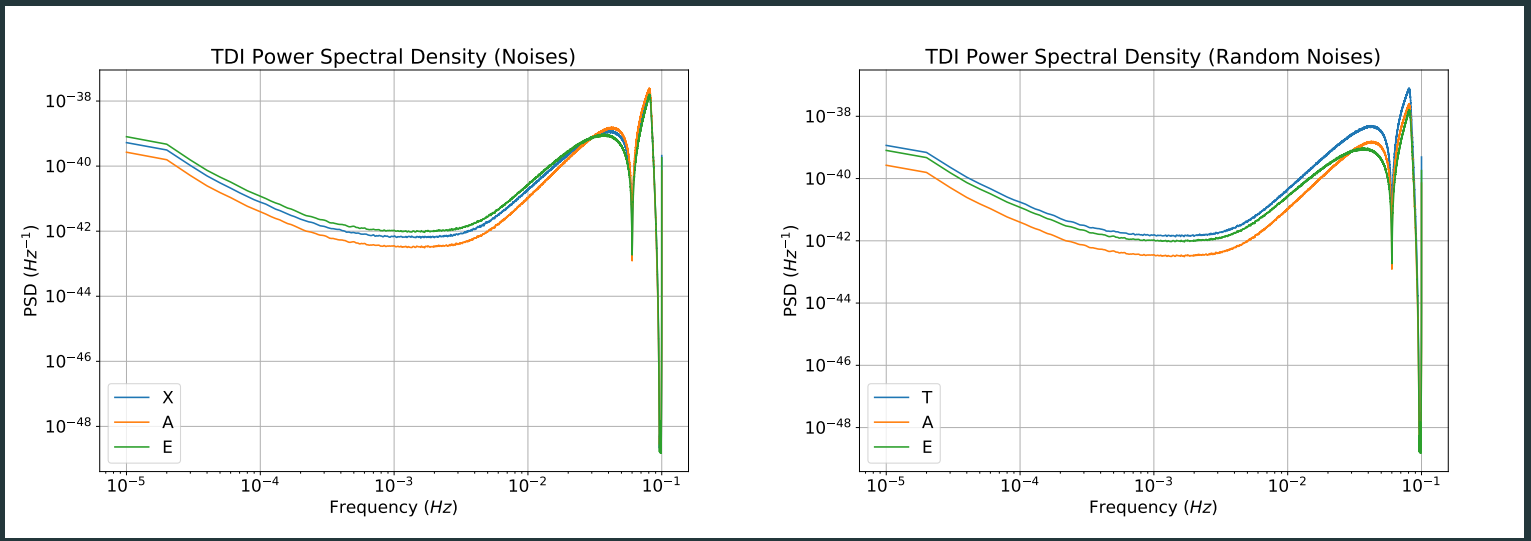
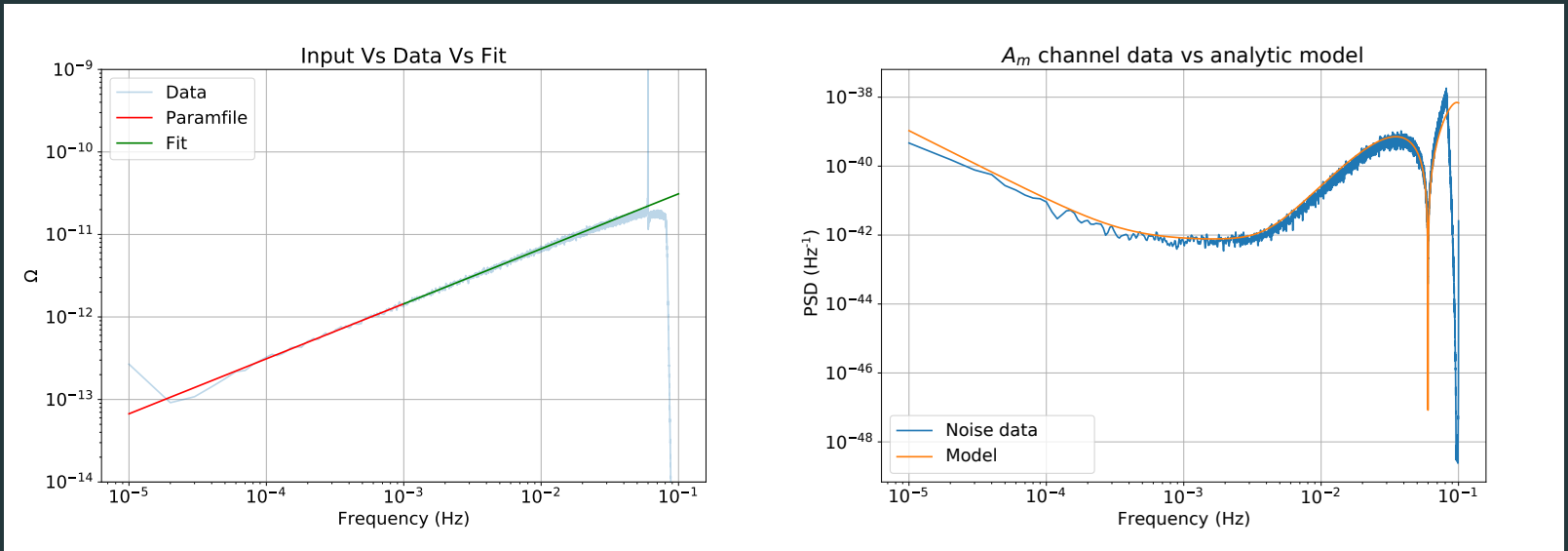


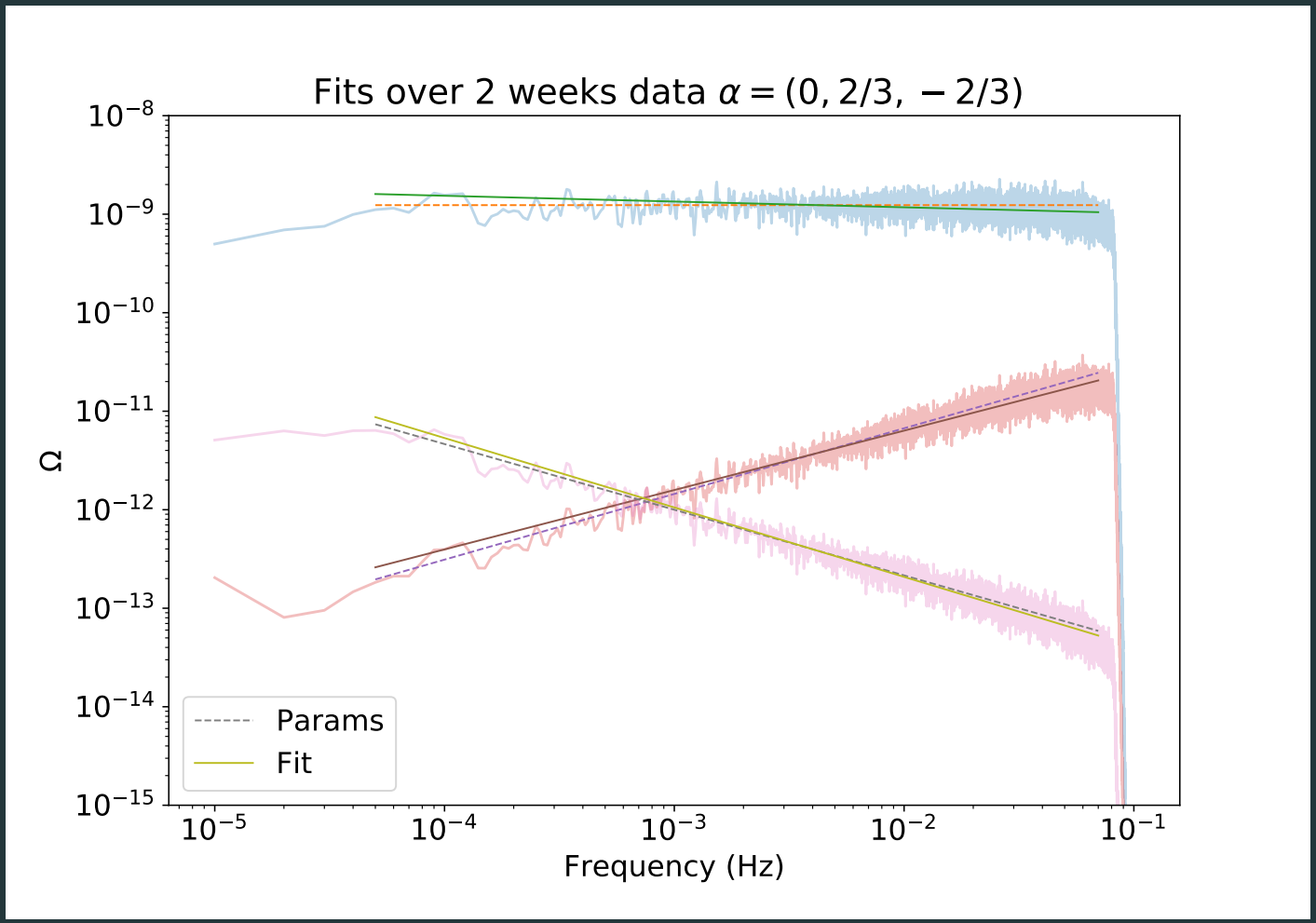


Overview of Radler data

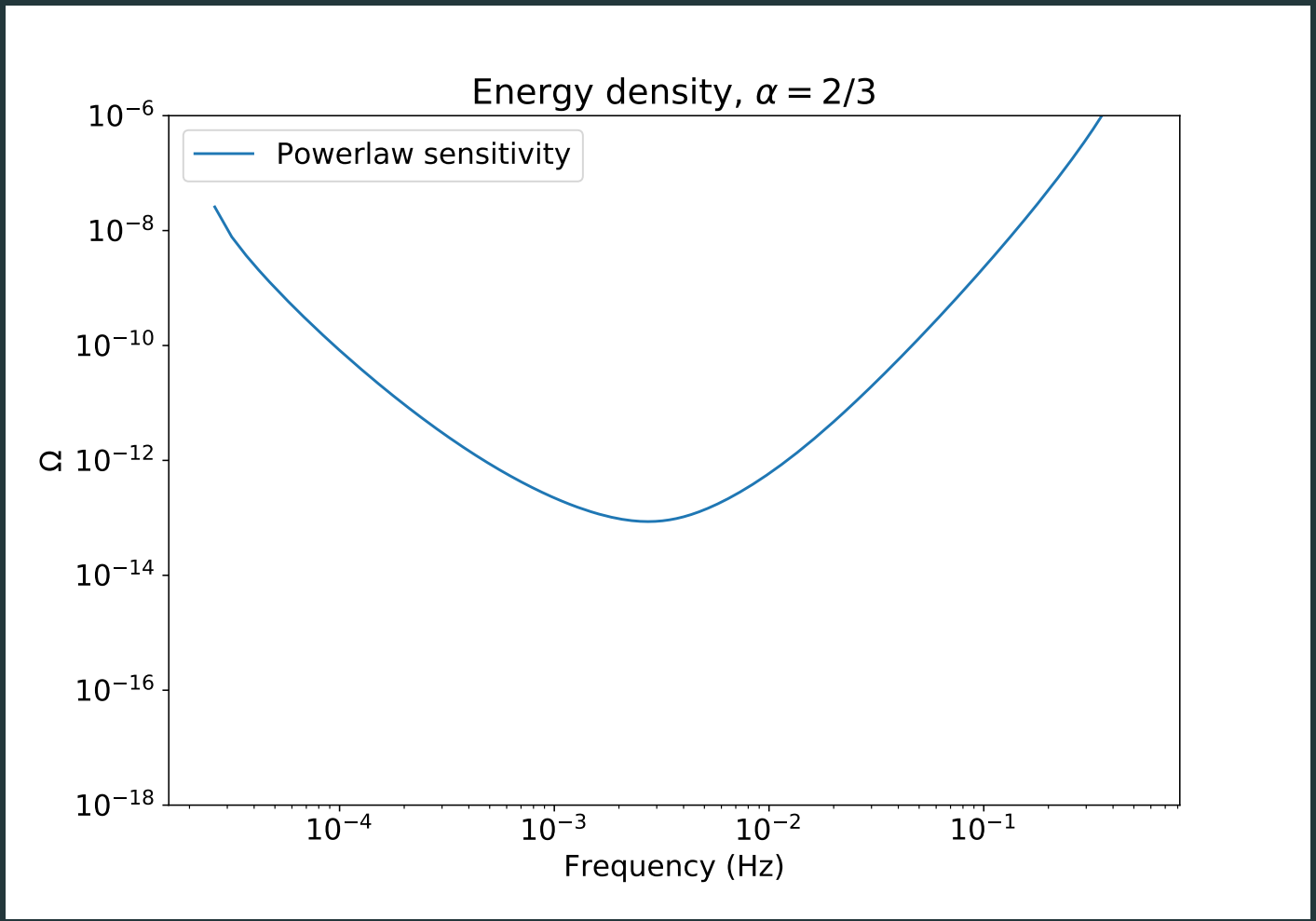
By a quick and dirty check, fits agree with the input within 1σ.



Build your own Data



An "exercise"


Energy density, $\alpha = 2/3$
Powerlaw sensitivity
10^{-6}
10^{-8}
10^{-10}
10^{-12}
10^{-14}
10^{-16}
10^{-18}
Ω
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Frequency (Hz)

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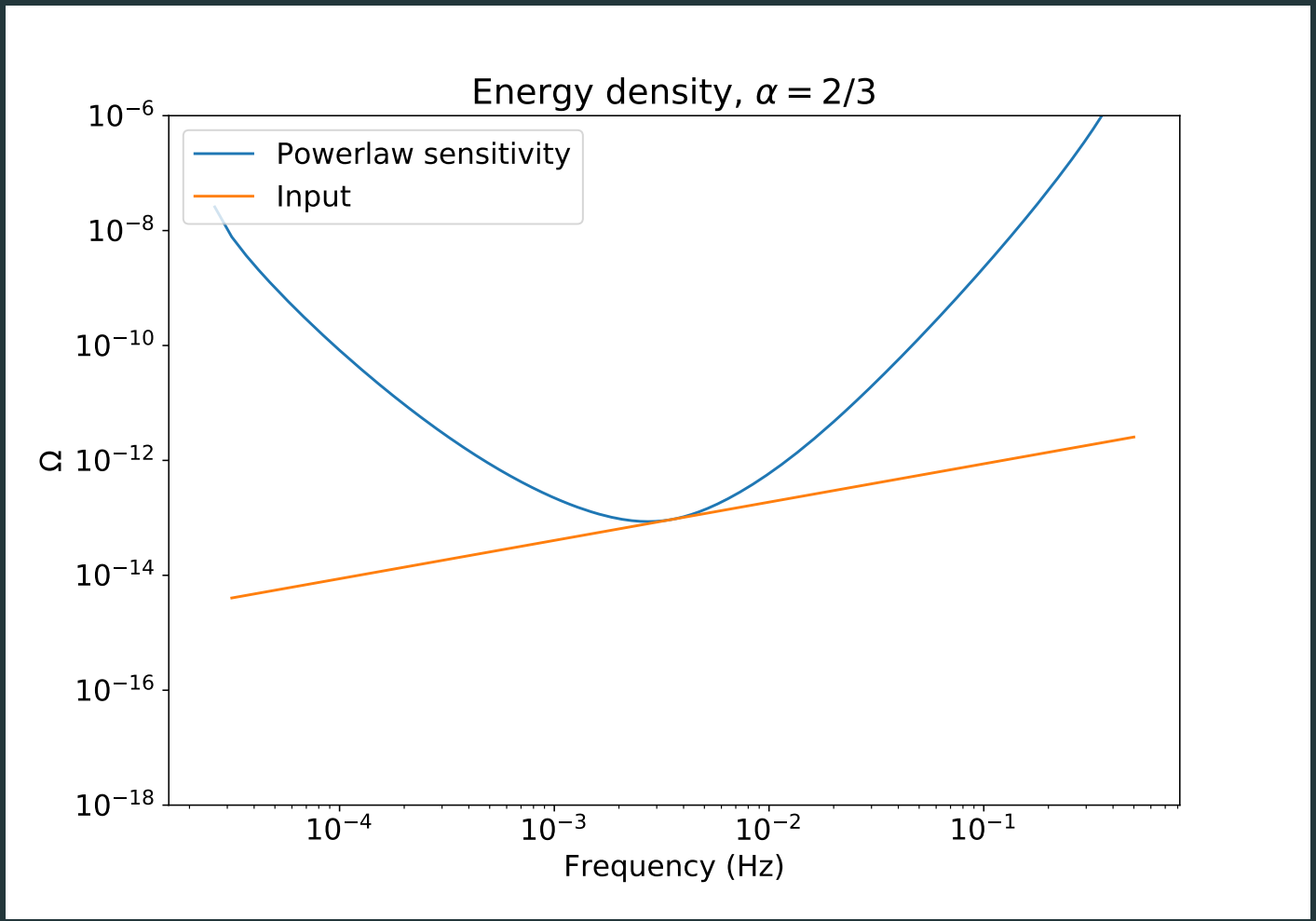
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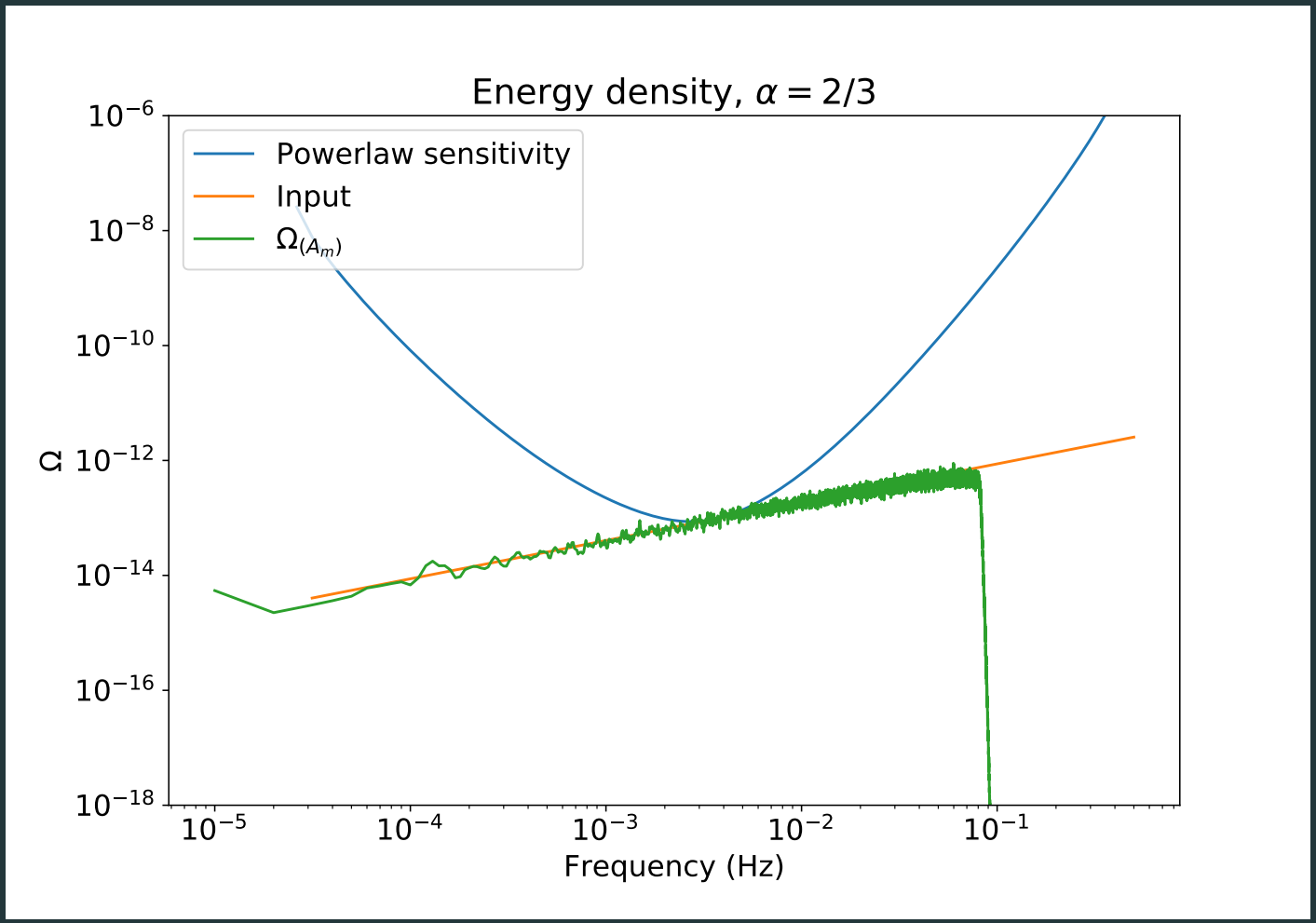
Energy density, $\alpha = 2/3$
Powerlaw sensitivity
Input
$\Omega_{(A_m)}$
Ω
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10^{-8}
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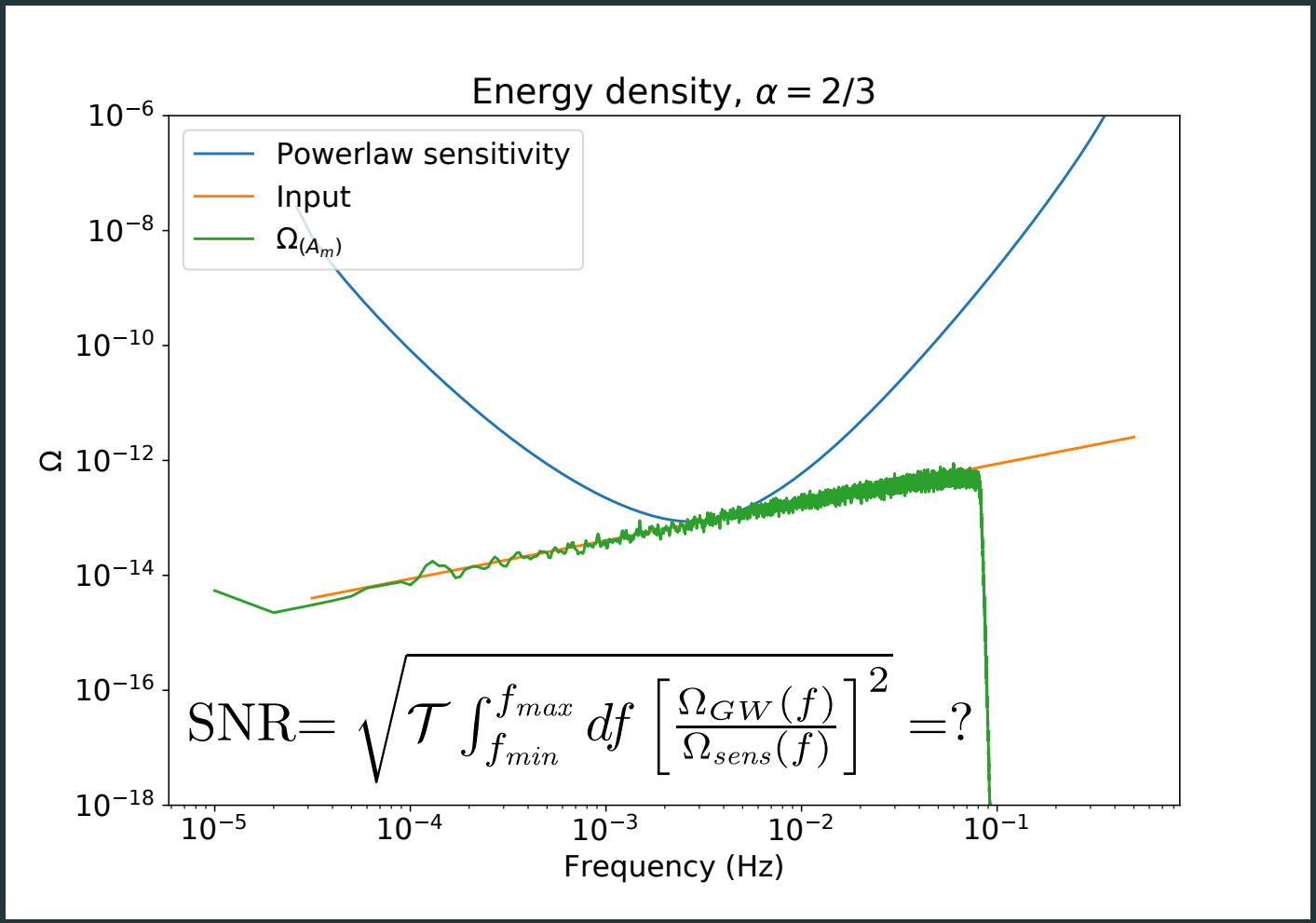
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10^{-16}
10^{-18}
10^{-5}
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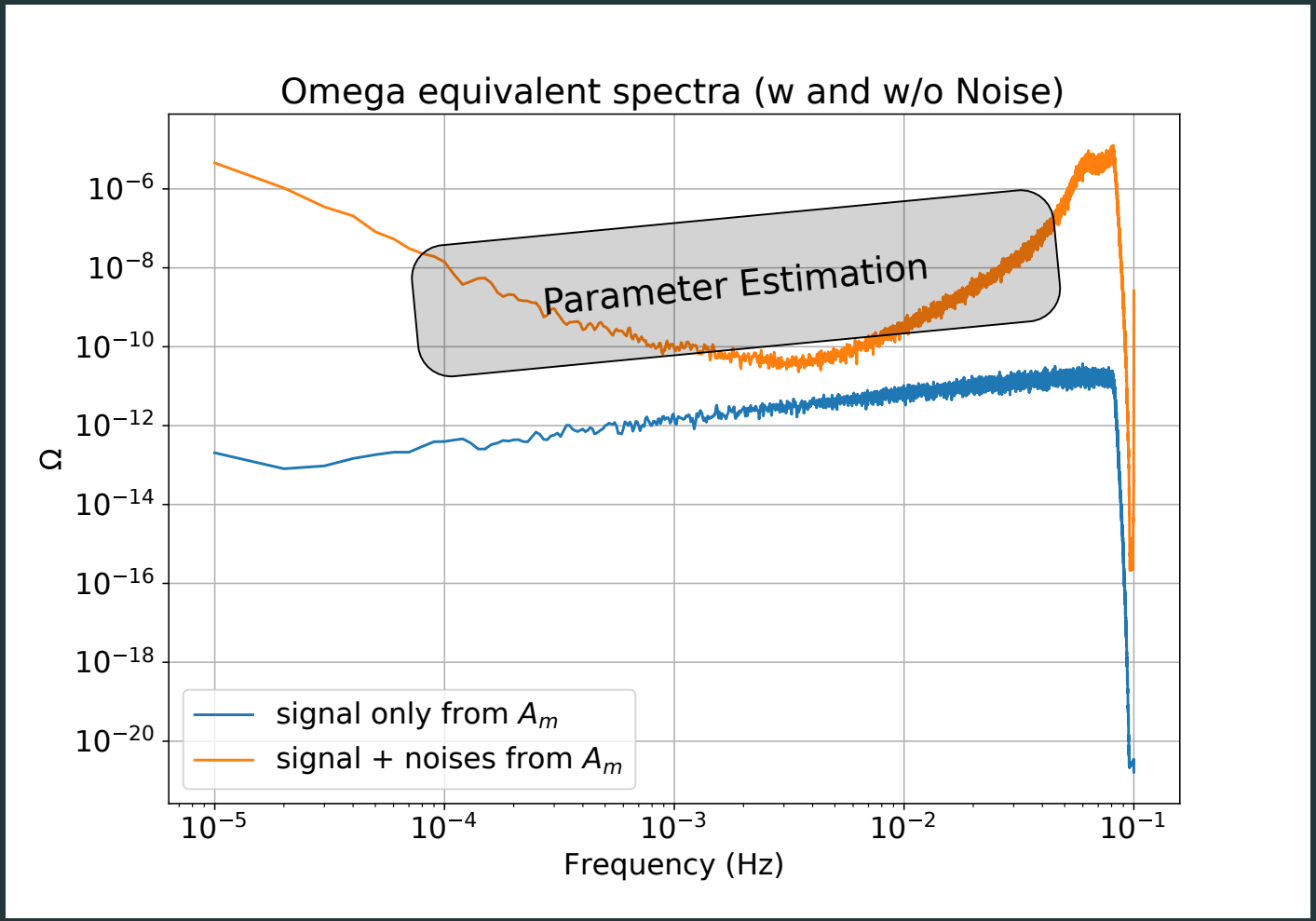
10^{-3}
10^{-2}
10^{-1}
Frequency (Hz)
$\mathrm{SNR} = \sqrt{\mathcal{T} \int_{f_{min}}^{f_{max}} df \left[\frac{\Omega_{GW}(f)}{\Omega_{sens}(f)} \right]^2} = ?$

What next?



THANK YOU!