European Pulsar Timing Array – DR2

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European Pulsar Timing Array

Effelsberg, Germany

Nancay, France

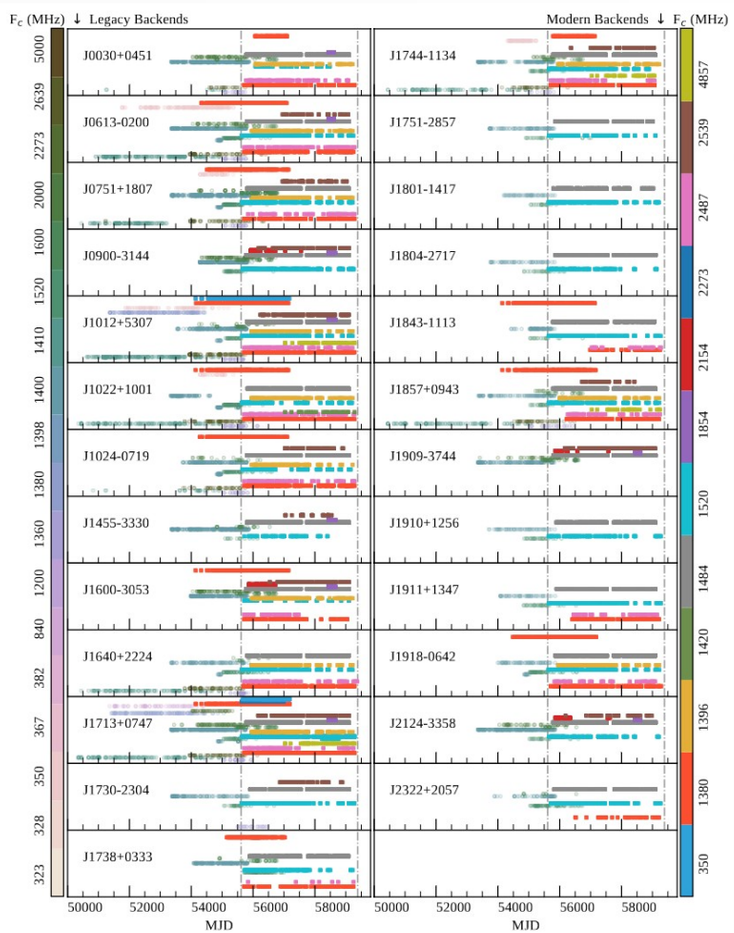
Sardinia, Italy

Lovell, UK

EPTA + LEAP

Westerbork, Netherlands

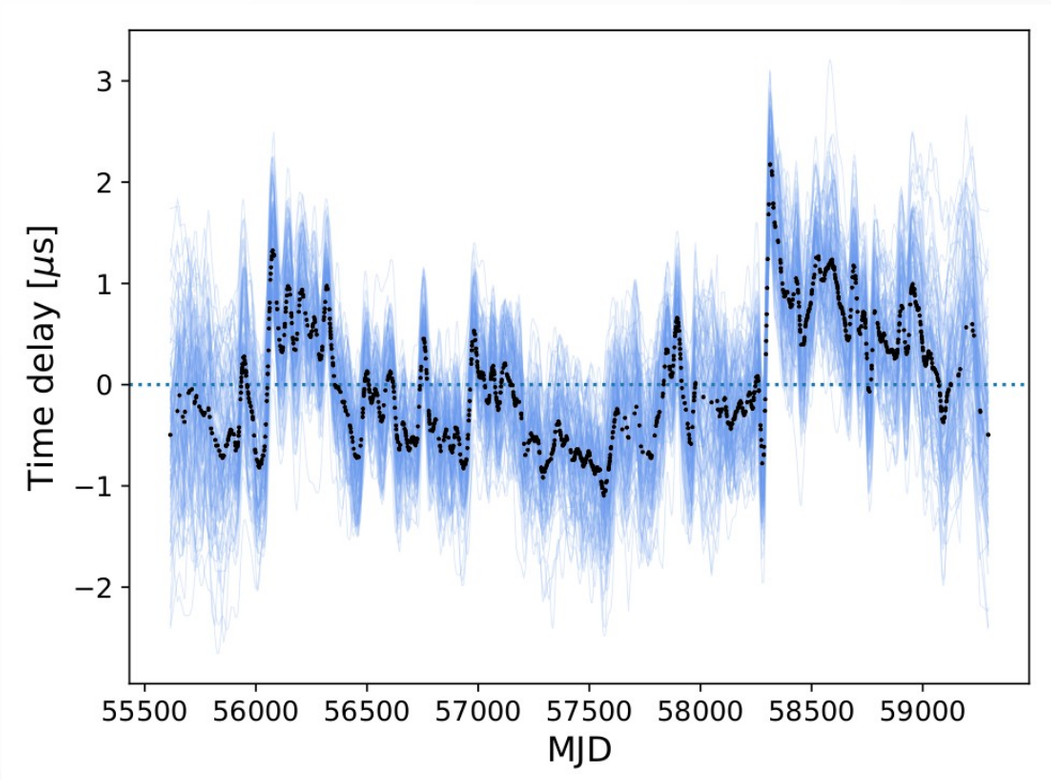
Data set



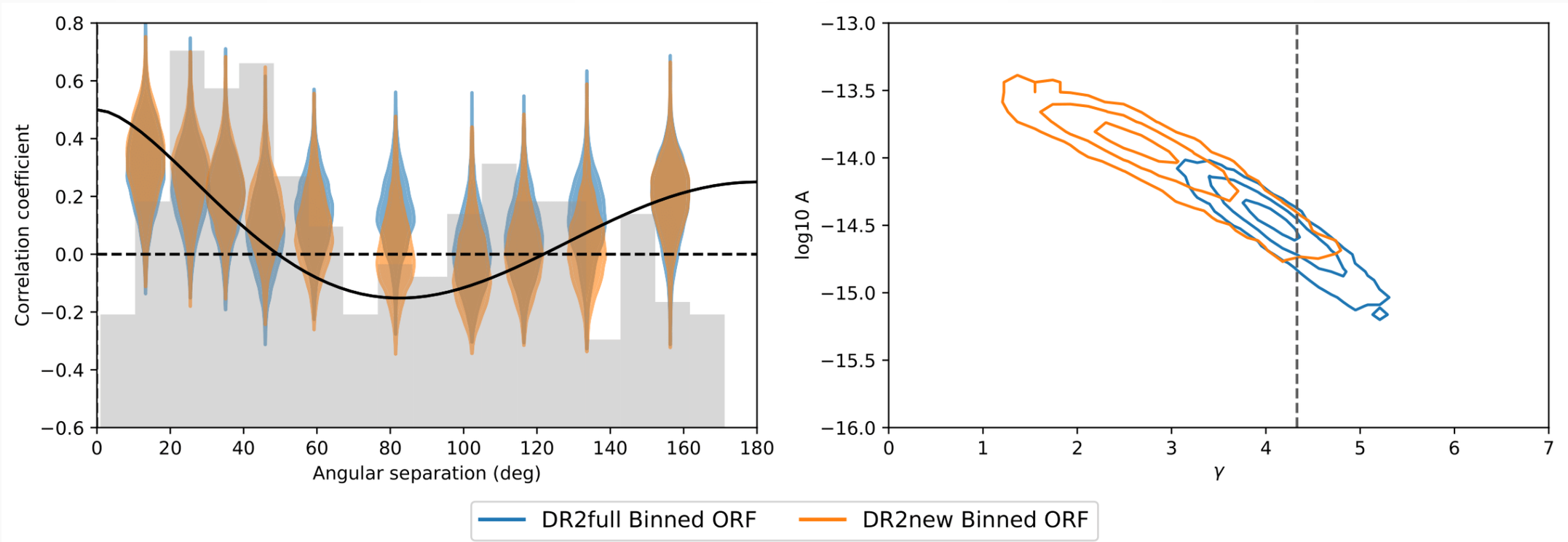
- EPTA DR2 + InPTA DR1 combination: 4 data sets, 25 millisecond pulsars
- DR2full: full EPTA only with all systems, 24.7 years
- DR2new: short EPTA only with new systems, 10.3 years
- DR2full+/DR2new+: combination of EPTA+InPTA data sets
- A&A, 2023, 678, A48

Pulsar noise analysis

- Test for red noise, dispersion measurement and scattering variation
- Optimize frequency bin choice for the power law model
- Select noise terms for the most favoured model
- A&A, 2023, 678, A49
- See also NANOGrav15, PPTA DR3, IPTA comparison

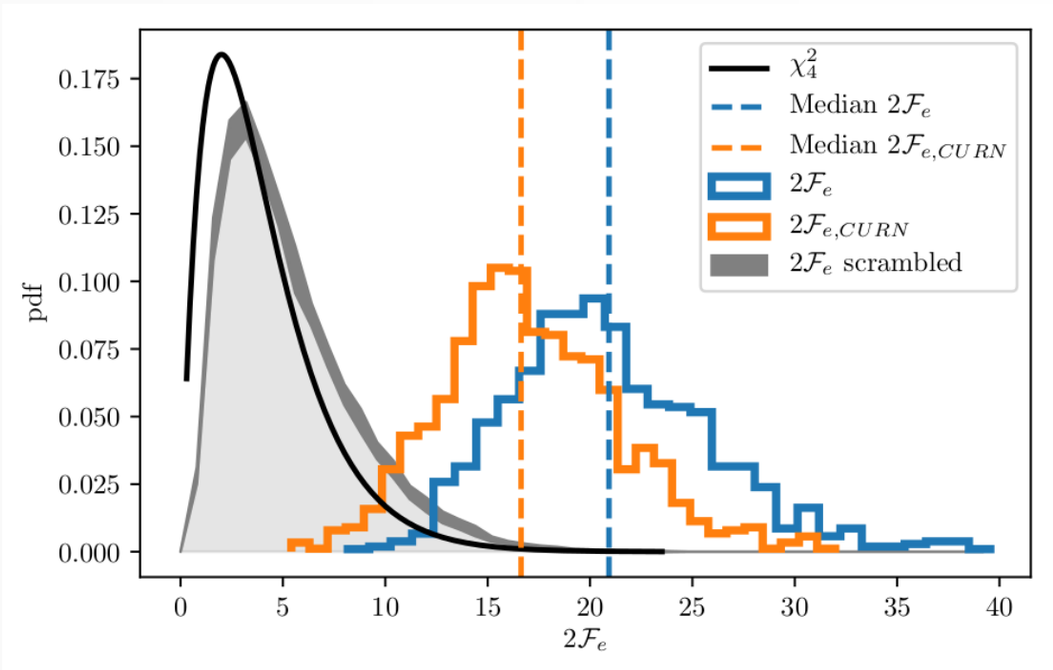


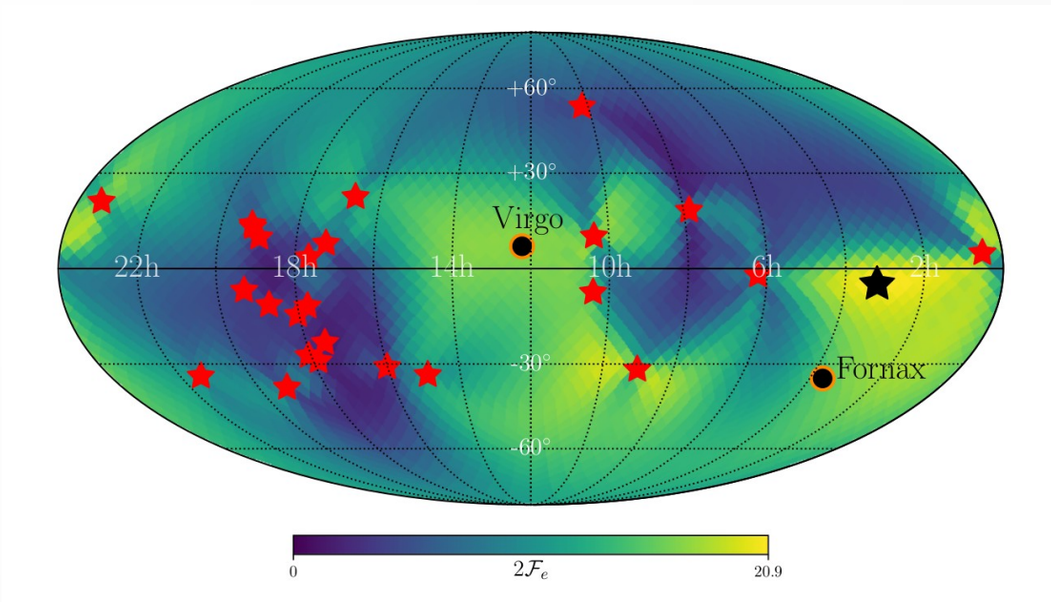
GW Background search



At gamma=13/3, A=2.5 x 10^{-15}, >3 sigma significance in DR2new
A&A, 2023, 678, A50; see also CPTA DR1, NANOGrav15, PPTA DR3

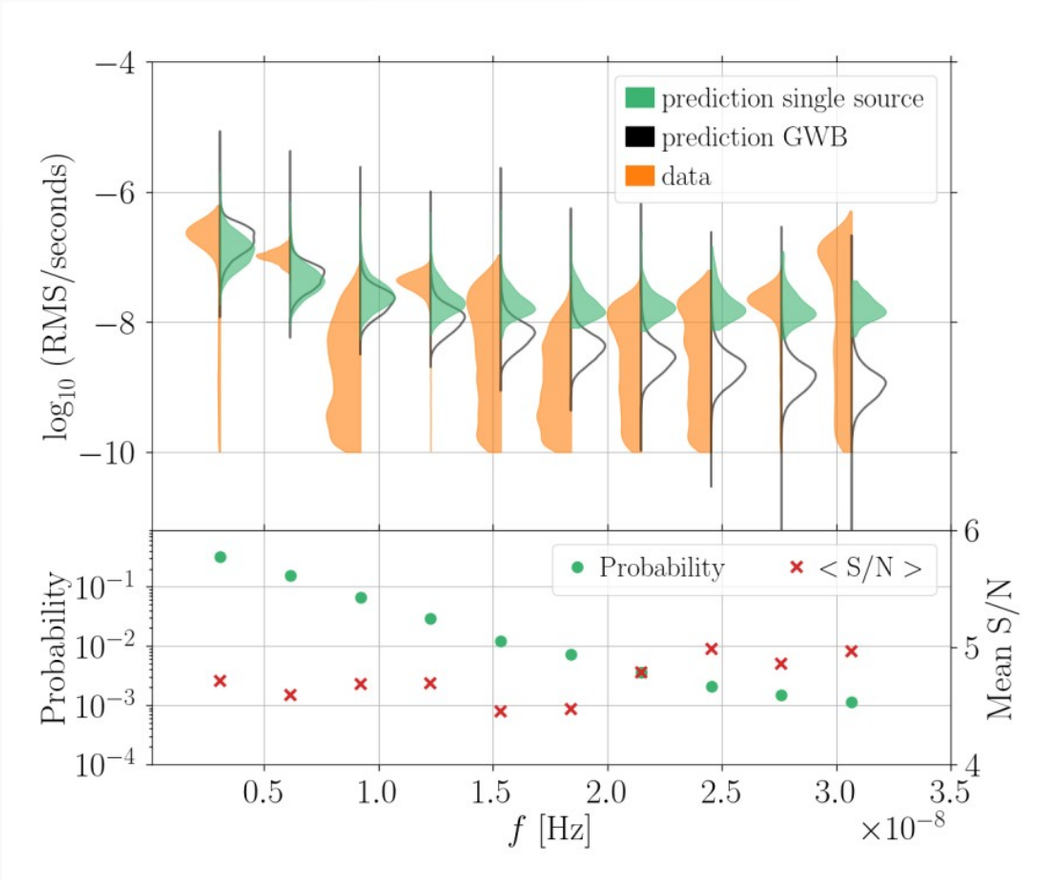
Single GW source search





Single supermassive black hole binary, >3 sigma significance in DR2new
Most likely around 4 – 5 nHz, A=10^{-14}, >10^9 solar mass, >16.6 Mpc distance
A&A, 2023, 678, A50 and arxiv:2306.16226; see also NANOGrav15

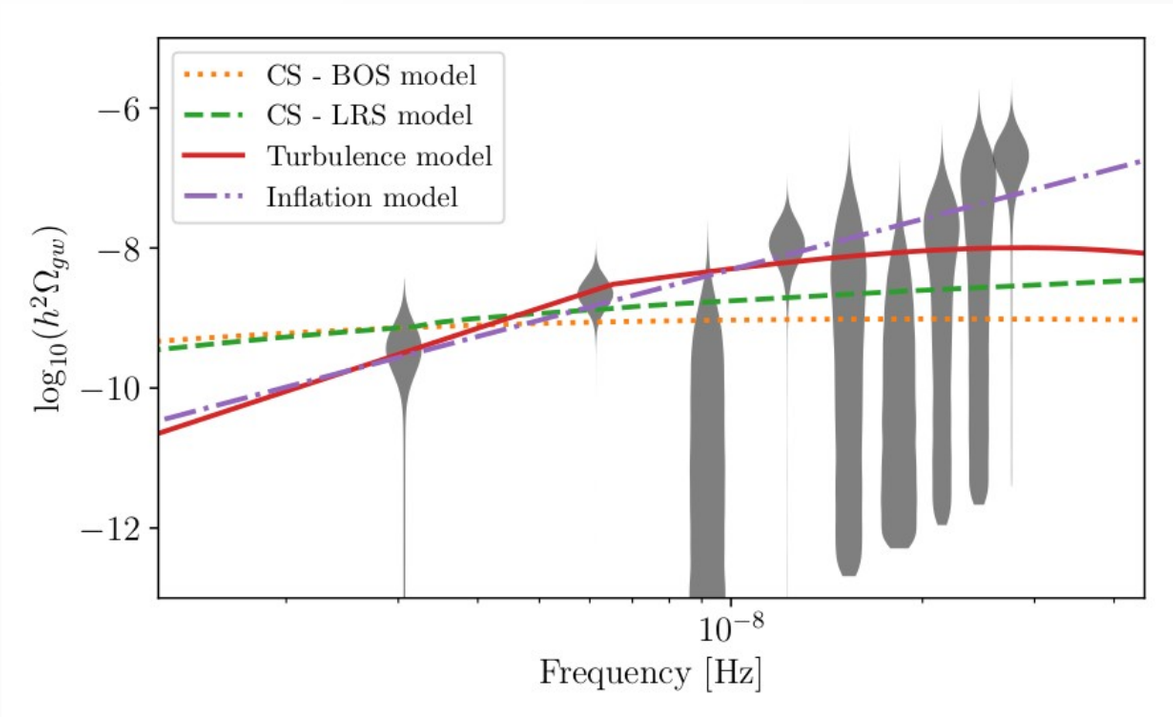
GWB – Astrophysics



- Supermassive black hole binaries are consistent as a source for the measured signal
- Large merger rate needed: very massive black holes, short delays or rapid growth
- Arxiv:2306.16227
- See also NANOGrav15

GWB – New Physics

- Primordial GWs from the inflational era
- Cosmic strings
- Turbulences at the QCD energy scale
- Curvature perturbations
- Ultra light dark matter
- Arxiv:2306.16227 and PRL, 2023, 131, 171001
- See also NANOGrav15



EPTA DR2 – Summary

- EPTA DR2: 25 pulsars with ~25 years of observations
- Combined analysis with InPTA DR1
- Series of six EPTA papers: arxiv: 2306.16214, 2306.16224 – 2306.16228
- Coordinated release with NANOGrav15, CPTA DR1 and PPTA DR3
- Detected signal of ~2.5 x 10^{-15} is consistent with a GWB with >3 sigma significance
- Detected signal could also be from a single source, possibly near the Fornax cluster
- Astrophysical supermassive black hole binaries as well as sources from new physics could be the origin
- Next steps: IPTA DR3 and extended EPTA data set