Fundamental and Gravitational Wave science with Pulsar Timing

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GW4FP, EuCAPT Workshop
Amsterdam, 11st Nov 2019

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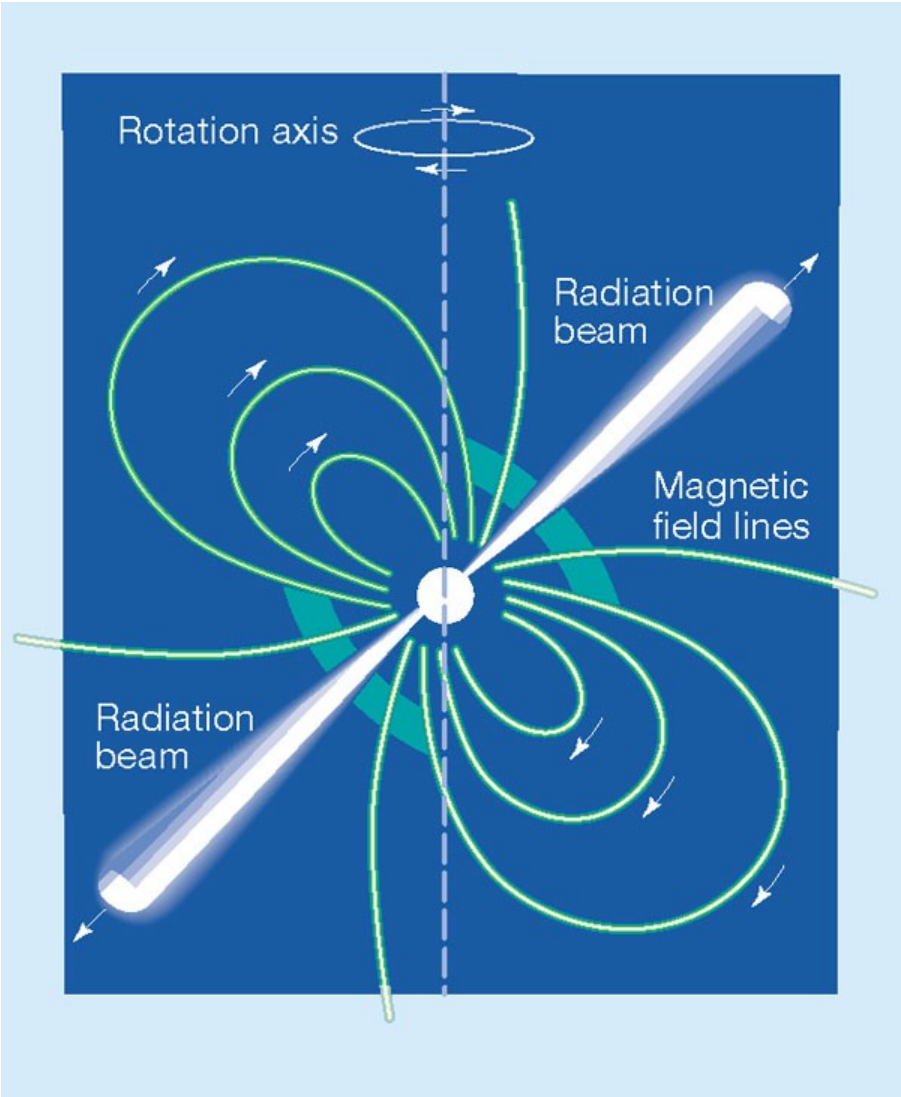
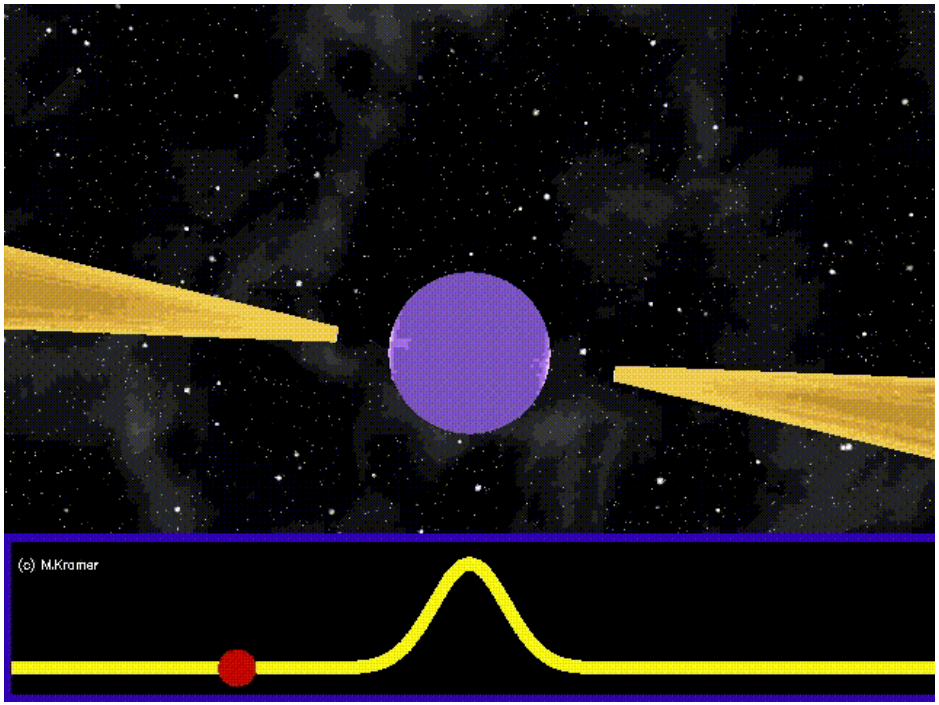
Outline

1) Introduction to Pulsar Timing
2) Fundamental Physics
3) Gravitational Waves
4) Conclusions

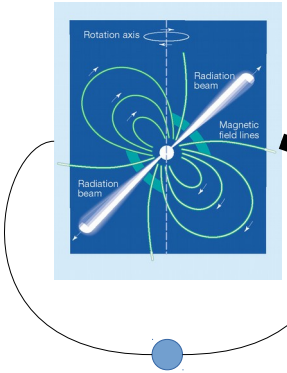
Pulsar





Credits: M. Kramer

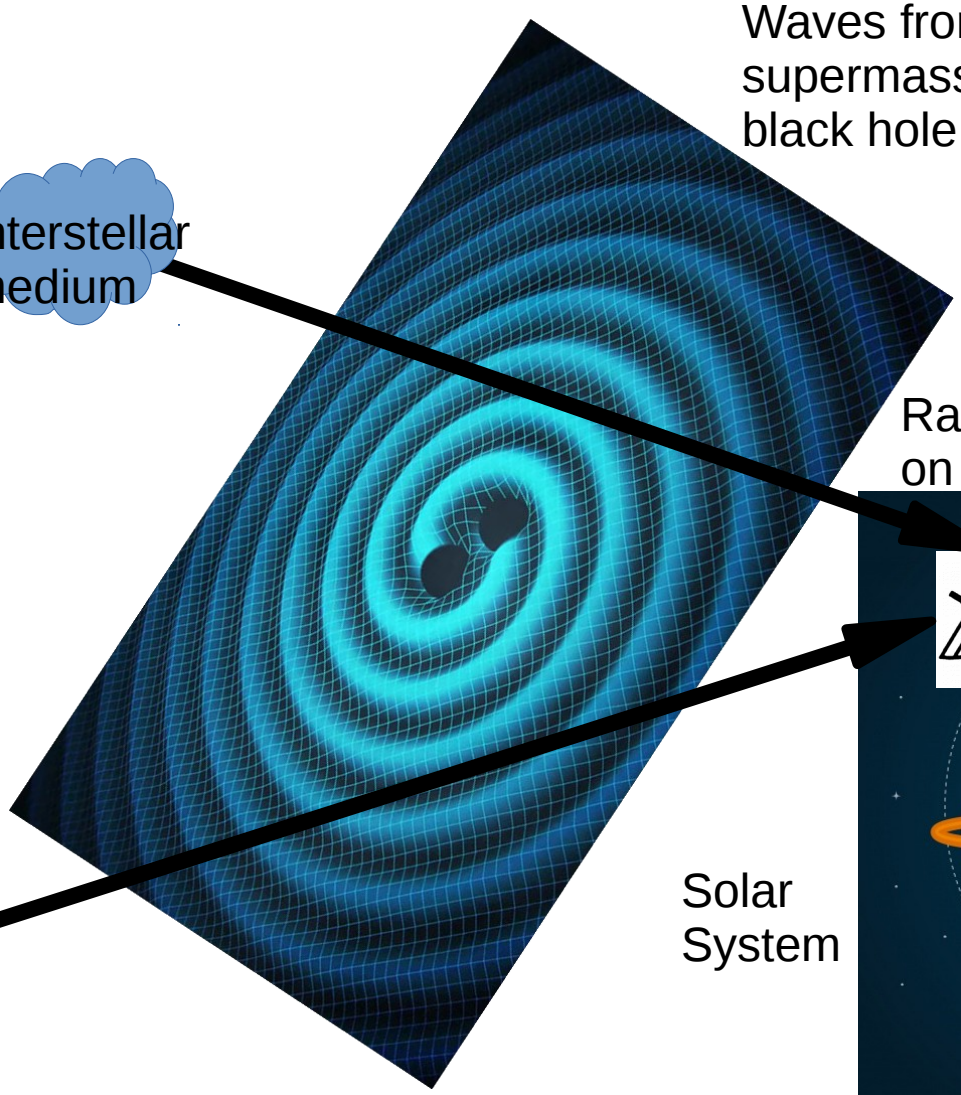
Timing



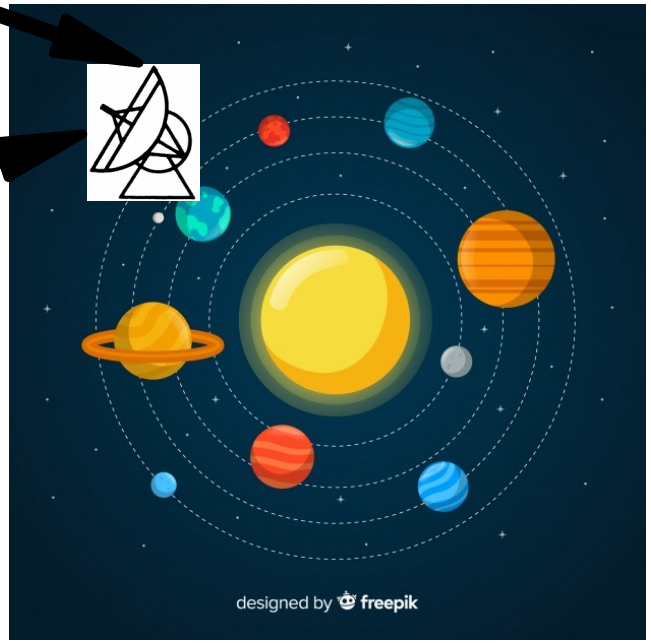
Pulsar with companion

Interstellar medium

Gravitational Waves from supermassive black hole binaries

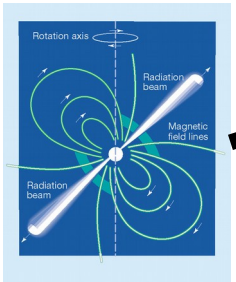


Radio telescopes on Earth

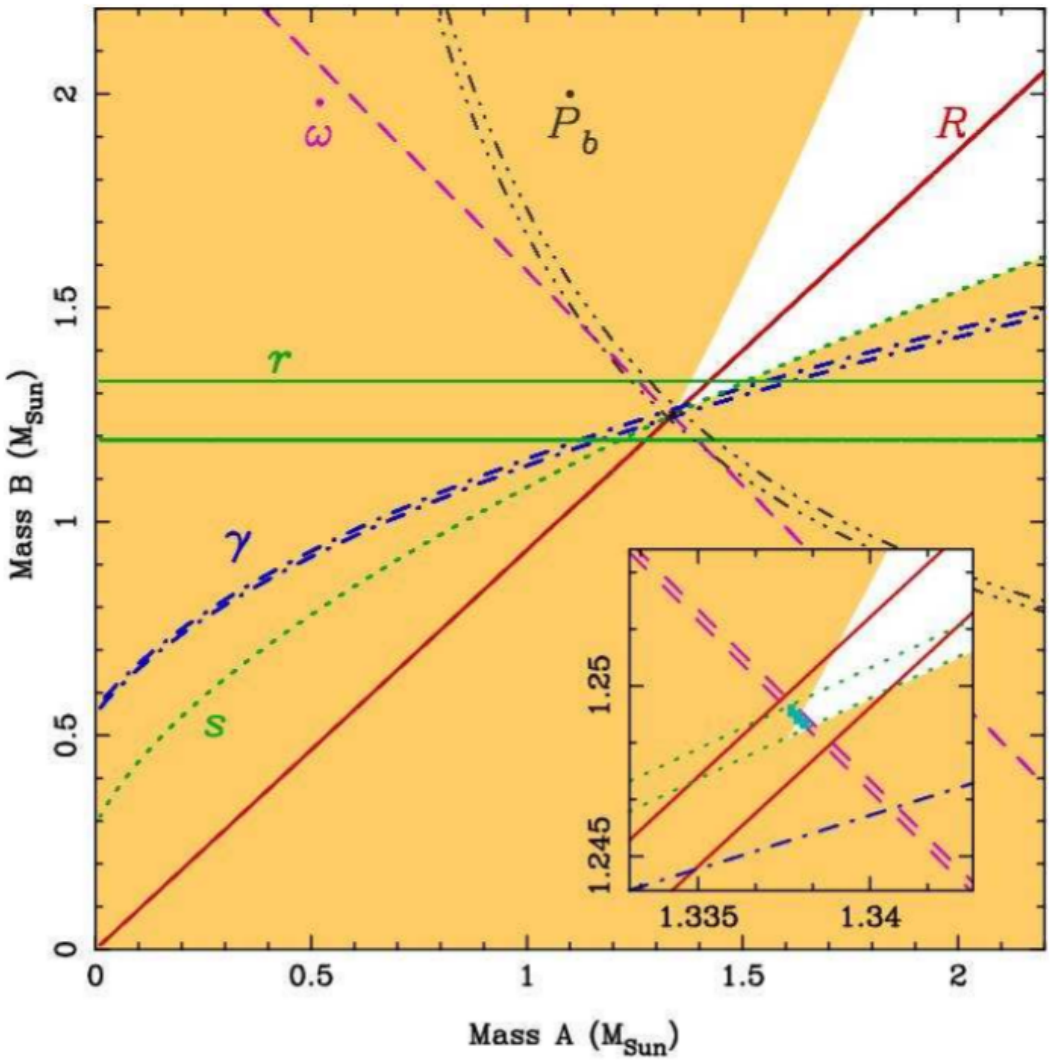


Solar System

Other pulsar

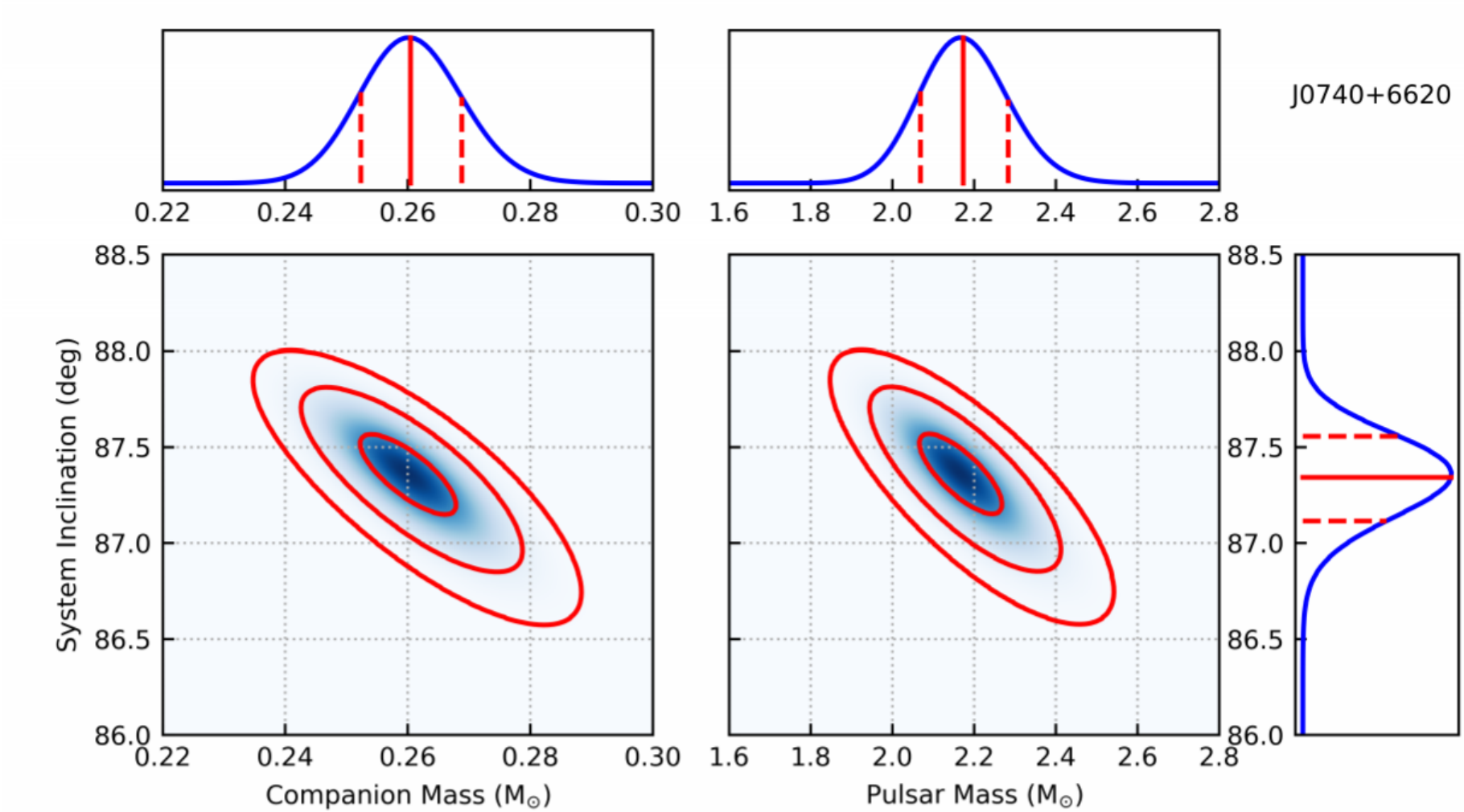


Testing GR – double pulsar



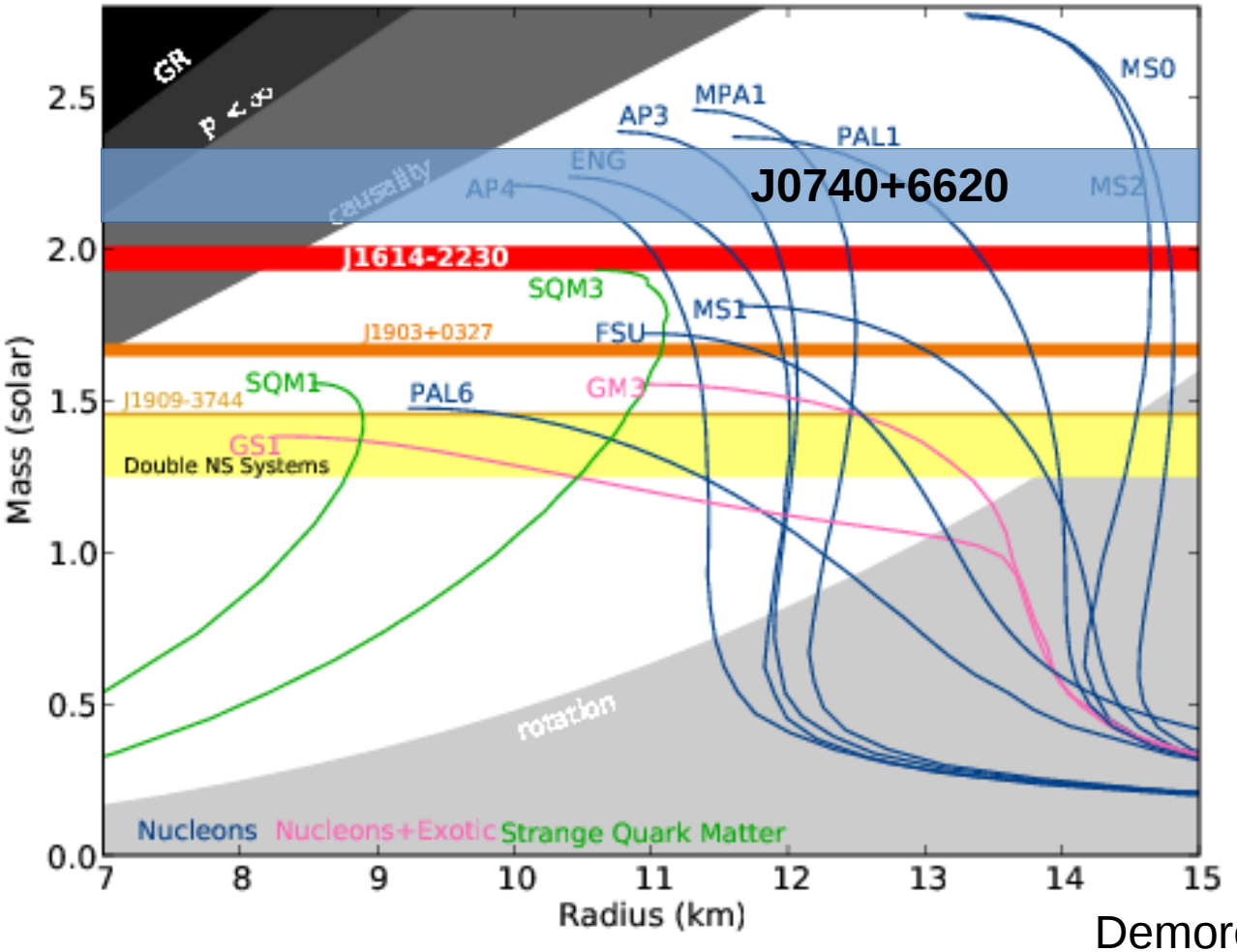
Kramer et al. 2006

Equation of state – heaviest pulsar



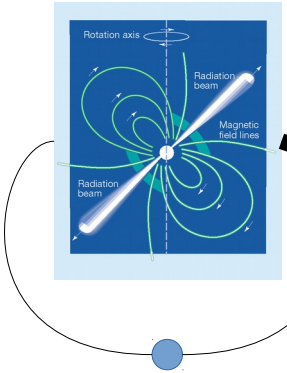
Cromartie et al. 2019

Some of the previous contenders



Demorest et al. 2010

Gravitational Waves



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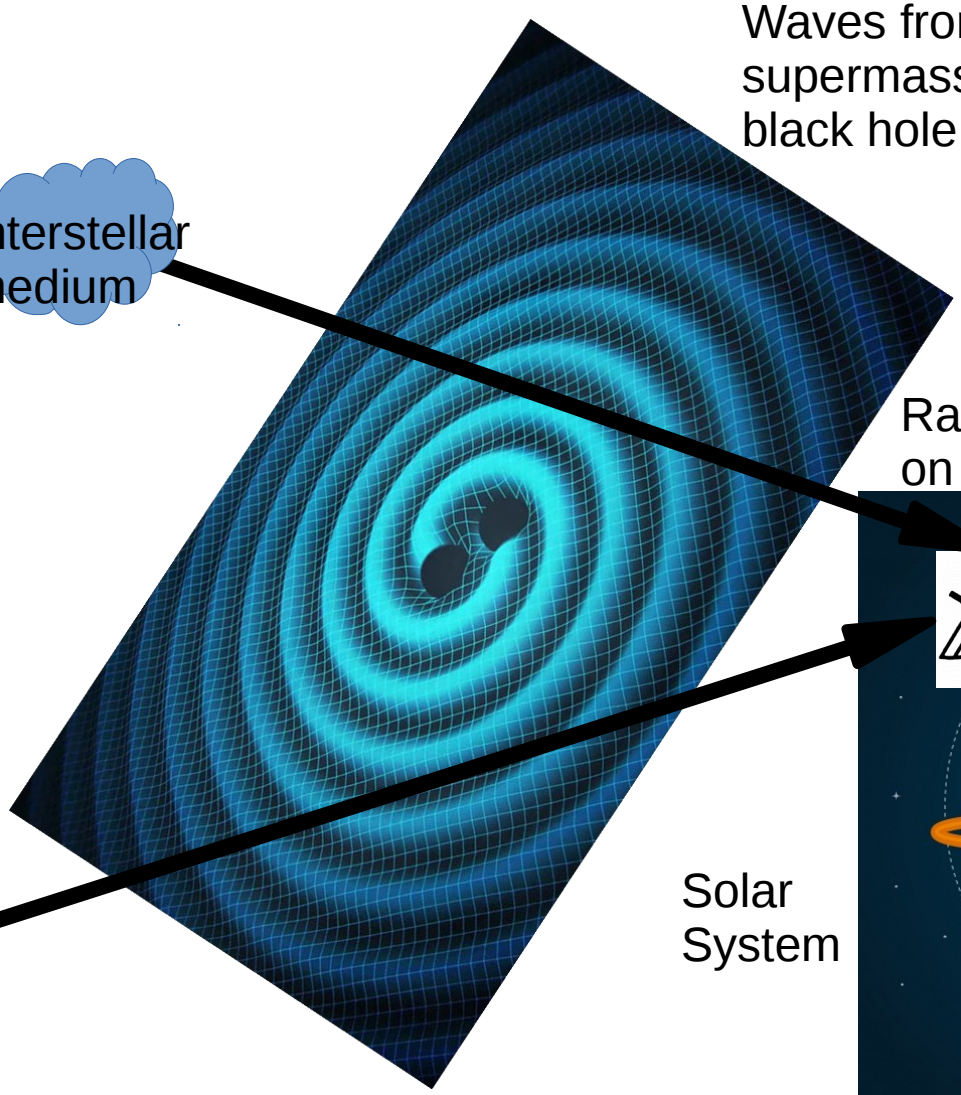

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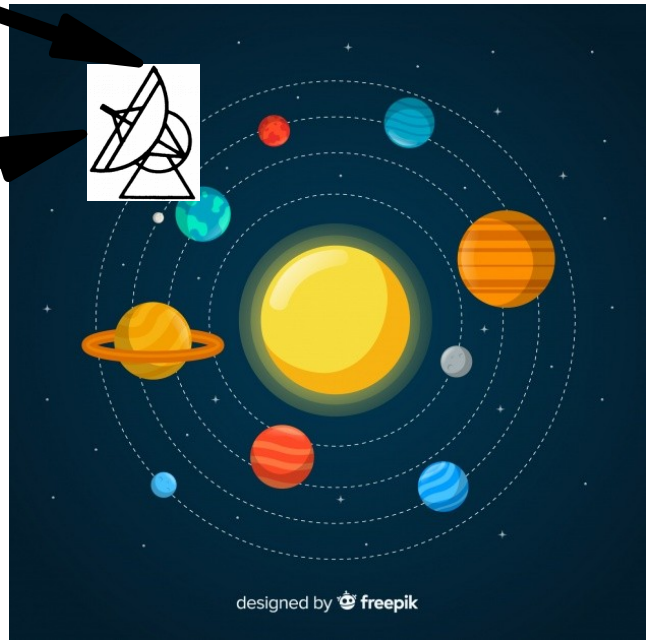
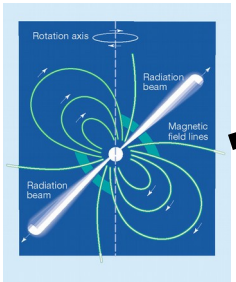
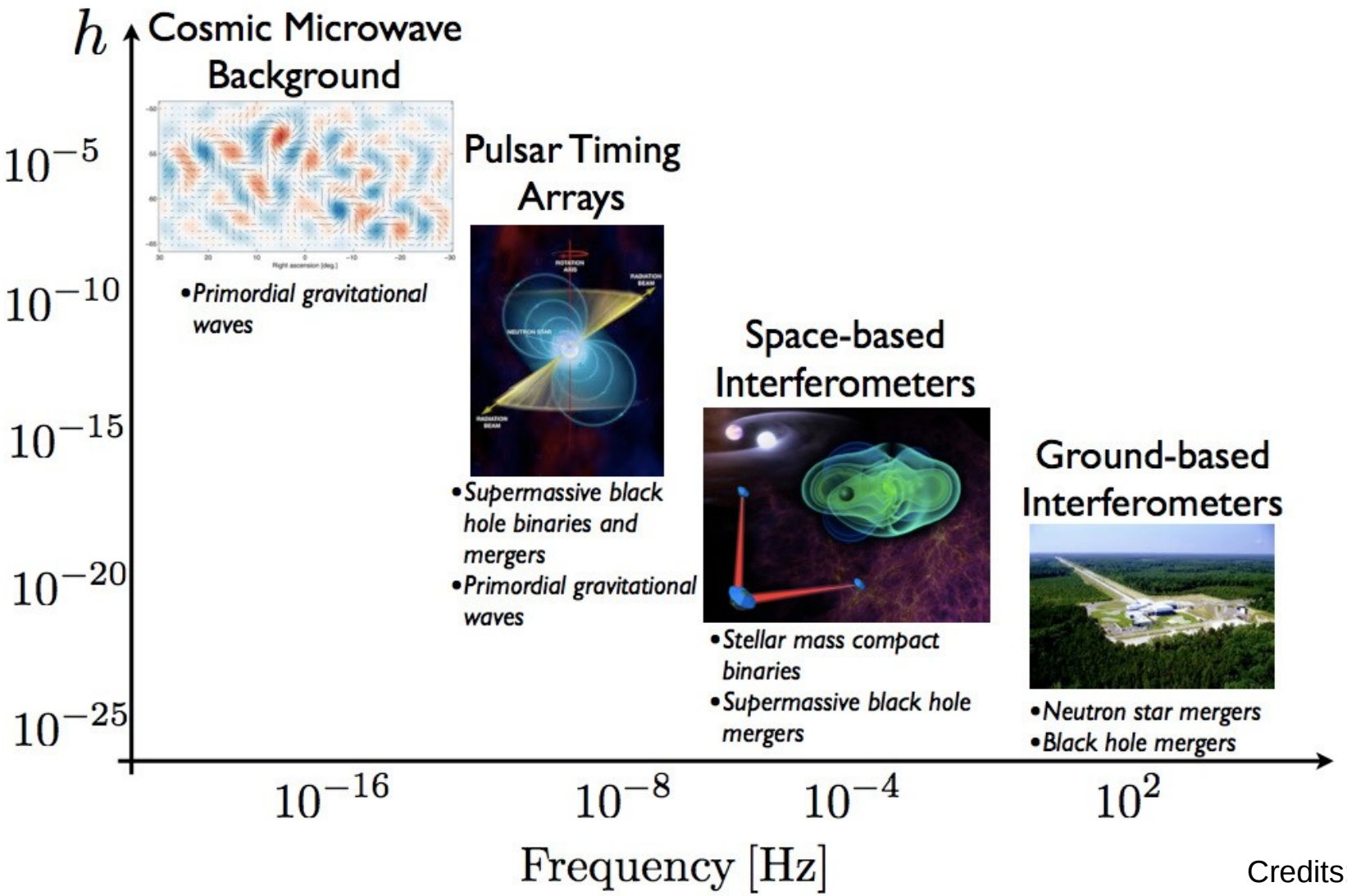


Solar System

Other pulsar

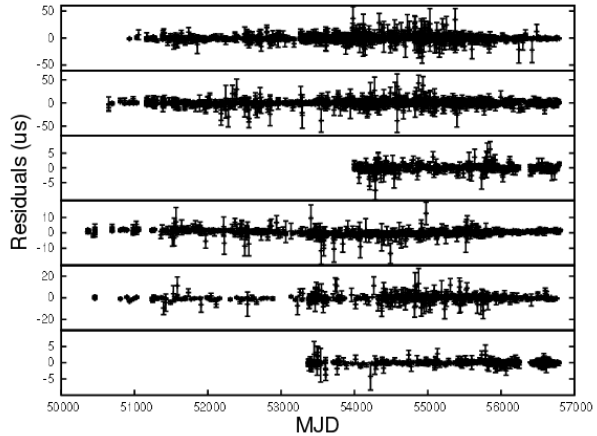


Gravitational Waves

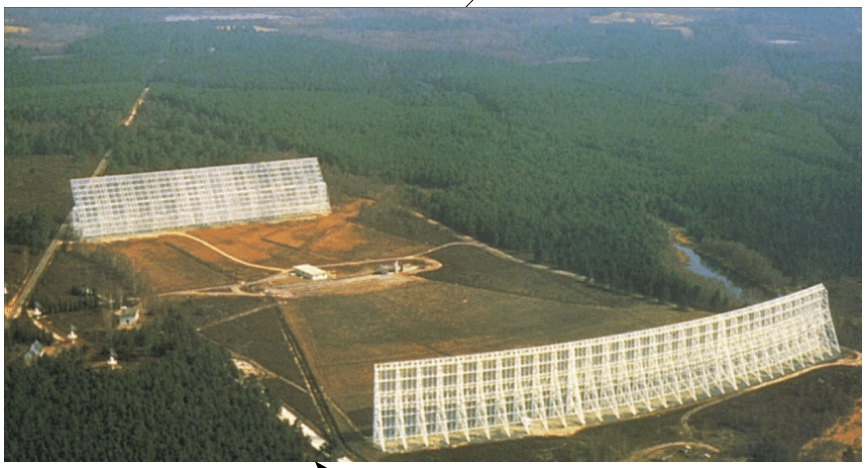


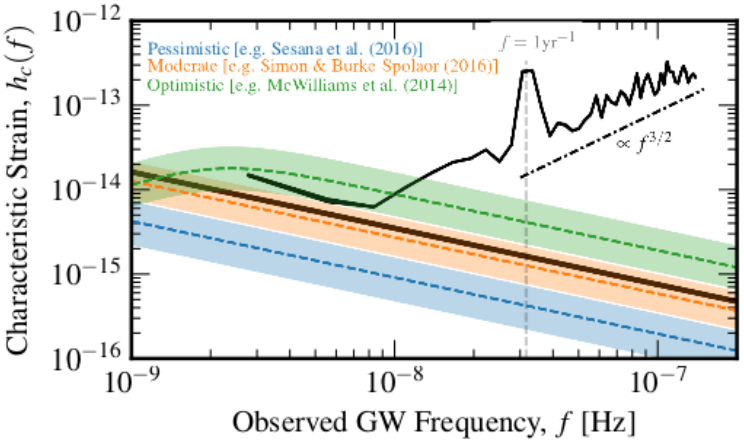
Credits: SKA

Observation/Timing



Data analysis

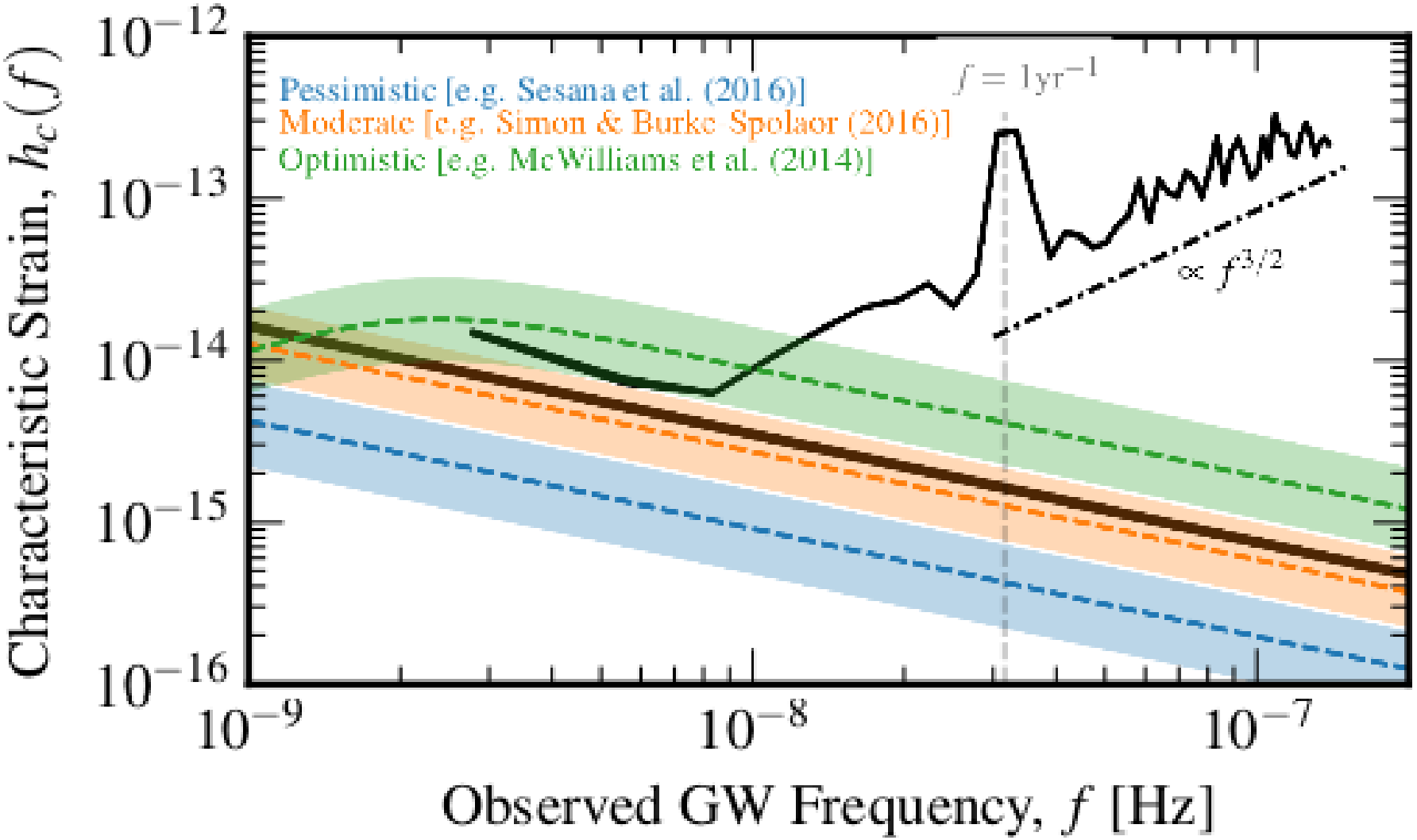




Motivation

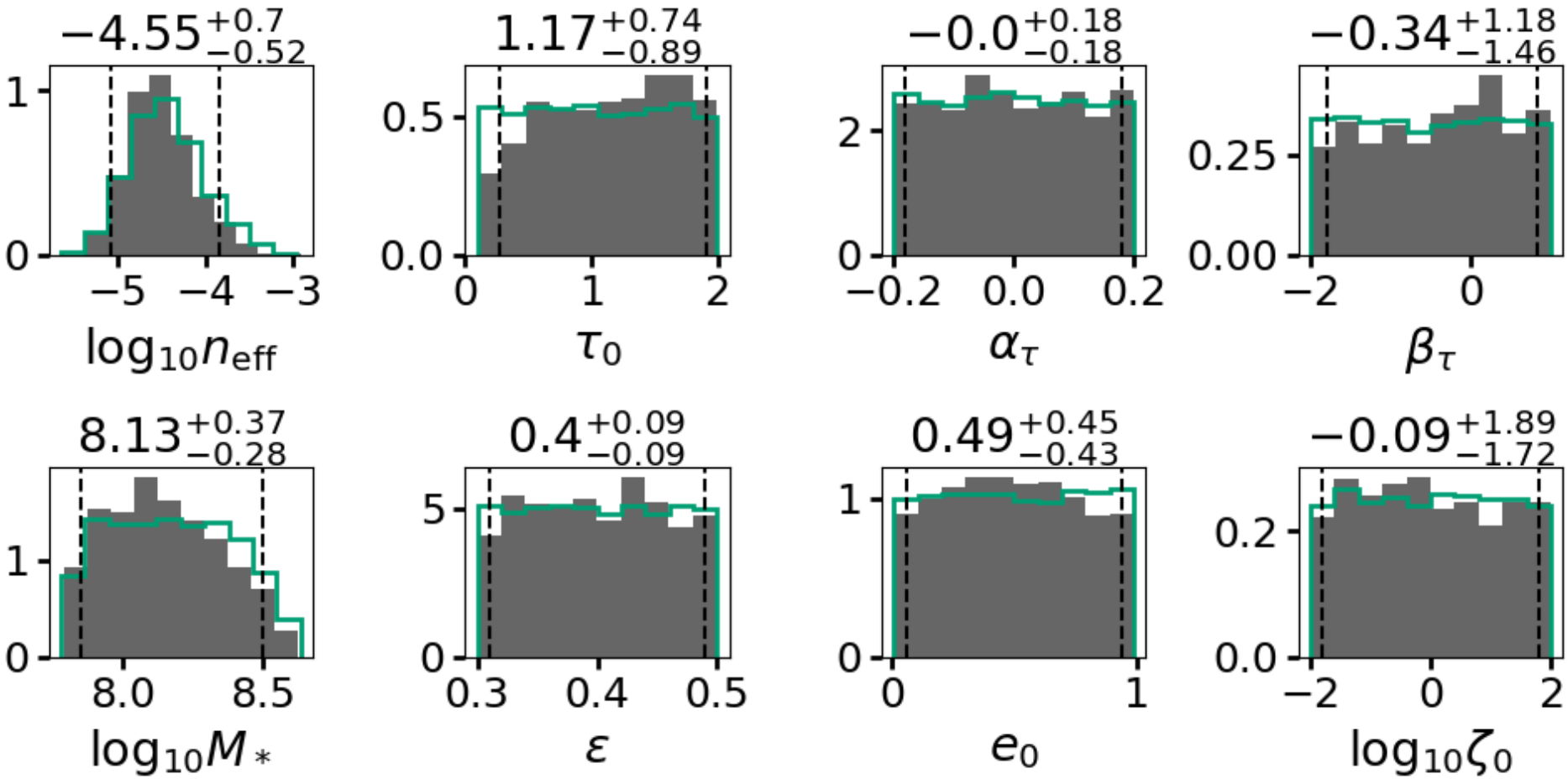
Interpretation

GWB Upper Limit



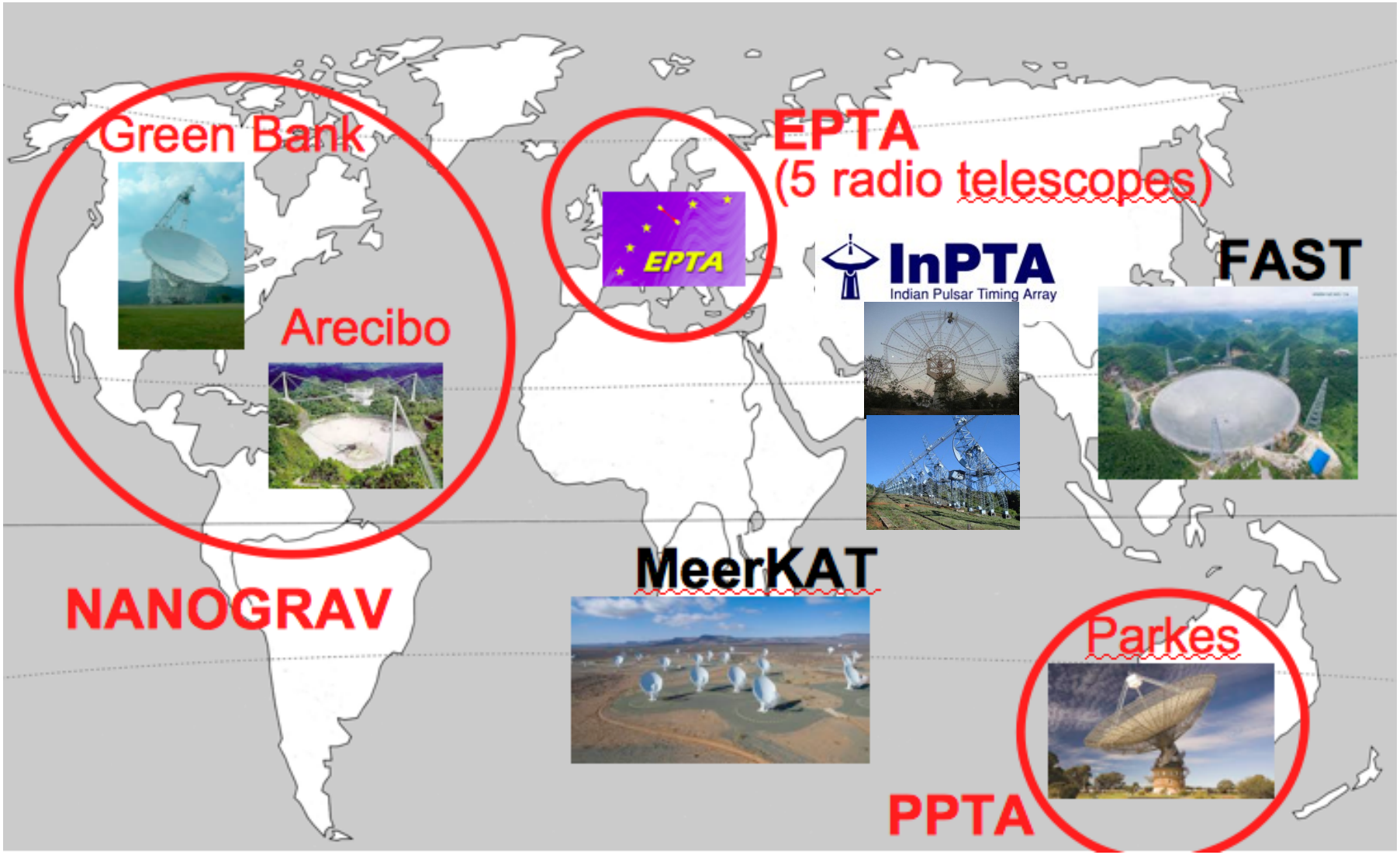
Arzoumanian et al. 2018

GWB Astrophysical Constraints

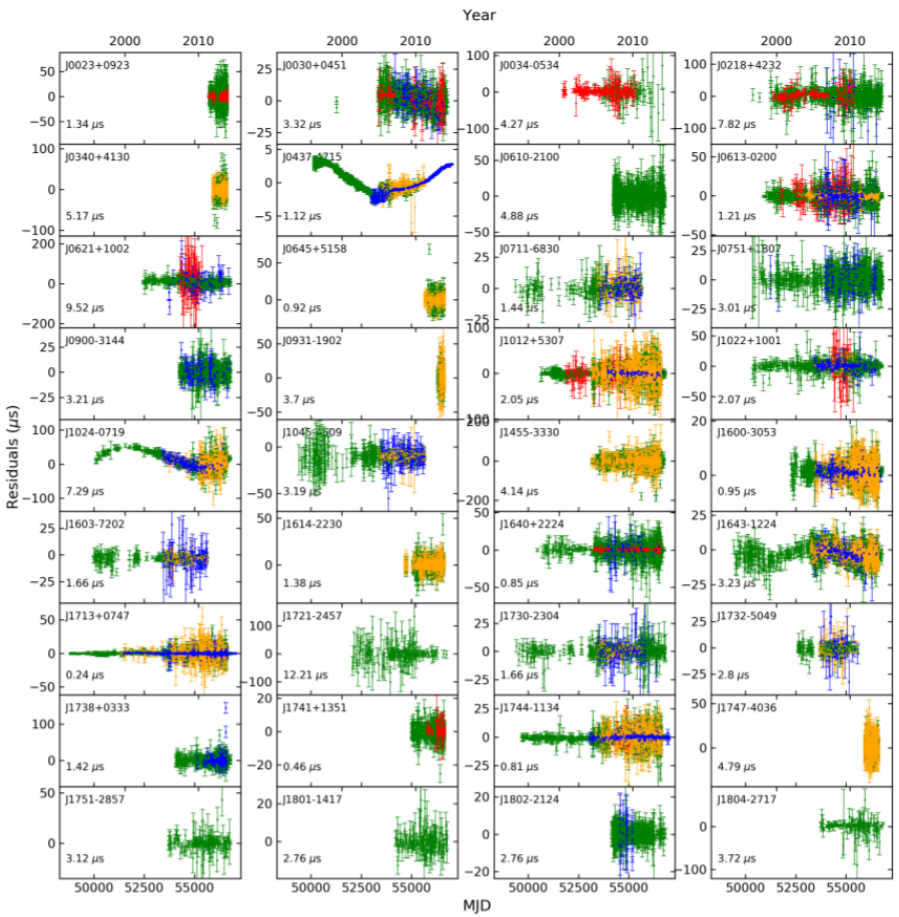


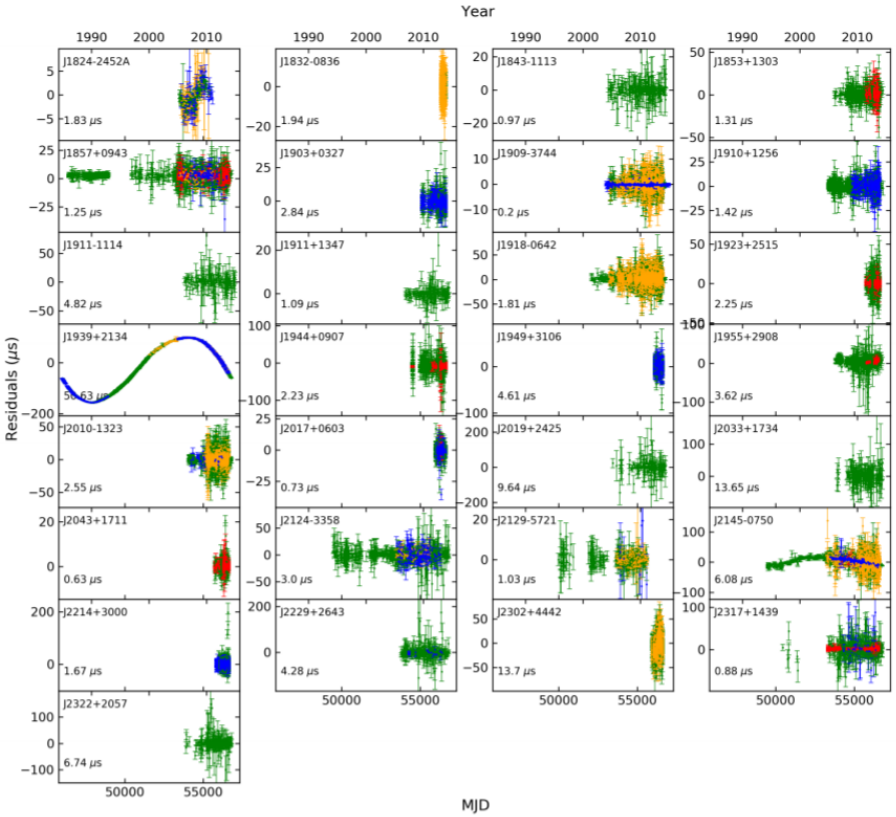
Chen, Sesana, Conselice 2019

International Pulsar Timing Array



IPTA second data release





Perera et al. 2019

Conclusions – Pulsar Timing

1) Fundamental Physics:
   – Tests of GR with pulsar + companion mass measurements
   – EOS constraints with heaviest pulsar
2) Gravitational Waves:
   – SMBHBs and galaxy merger constraints
   – constraints on exotic objects
3) Other Physics: neutron star studies, radio pulse emission, ISM, Solar System, etc.