

Model selection for spin noise in pulsar timing arrays

Boris Goncharov, Xing-Jiang Zhu, and Eric Thrane

Monash Centre for Astrophysics, School of Physics and Astronomy, Monash University, VIC 3800, Australia and OzGrav: The ARC Centre of Excellence for Gravitational-Wave Discovery, Clayton, VIC 3800, Australia

Pulsar spin noise is a dominant noise source in pulsar timing observations at low frequencies of timing residuals power spectrum. Two widely-accepted models that characterize red spin noise power spectral density are a power law and a Lorentzian power law with a turnover at low frequencies. The existence of turnover in red noise of millisecond pulsars reduces time to detection of nano-Hertz stochastic gravitational wave background. It also has interesting potential implications for neutron star physics. In this work, we do model selection studies for spin noise using Bayesian formalism.

-
- [1] G Hobbs, A Archibald, Z Arzoumanian, D Backer, M Bailes, NDR Bhat, M Burgay, S Burke-Spolaor, D Champion, I Cognard, et al. The international pulsar timing array project: using pulsars as a gravitational wave detector. *Classical and Quantum Gravity*, 27(8):084013, 2010.
 - [2] Paul D Lasky, Andrew Melatos, Vikram Ravi, and George Hobbs. Pulsar timing noise and the minimum observation time to detect gravitational waves with pulsar timing arrays. *Monthly Notices of the Royal Astronomical Society*, 449(3):3293–3300, 2015.
 - [3] L Lentati, RM Shannon, WA Coles, JPW Verbiest, R Van Haasteren, JA Ellis, RN Caballero, RN Manchester, Z Arzoumanian, S Babak, et al. From spin noise to systematics: stochastic processes in the first international pulsar timing array data release. *Monthly Notices of the Royal Astronomical Society*, 458(2):2161–2187, 2016.
 - [4] Andrew Melatos and Bennett Link. Pulsar timing noise from superfluid turbulence. *Monthly Notices of the Royal Astronomical Society*, 437(1):21–31, 2013.
 - [5] Ryan M Shannon and James M Cordes. Assessing the role of spin noise in the precision timing of millisecond pulsars. *The Astrophysical Journal*, 725(2):1607, 2010.
 - [6] SR Taylor, Michele Vallisneri, JA Ellis, CMF Mingarelli, TJW Lazio, and Rutger van Haasteren. Are we there yet? Time to detection of nanohertz gravitational waves based on pulsar-timing array limits. *The Astrophysical Journal Letters*, 819(1):L6, 2016.