Report on Round 1B Mock LISA Data Challenge

(973-Morningside-NJU)

Technical note

Xuefei Gong [1], Yu Shang [1] and Yan Wang [2]

[1]Institute of Applied Mathematics, Academy of Mathematics and Systems Science,
Chinese Academy of Sciences, 55, Zhongguancun Donglu, Beijing, 100080, China.

[2]Department of Astronomy, Nanjing University, 22, Hankou Road, Nanjing, 210093, China.

We participated in Challenges 1B.1.1a-c and 1B.1.2 in this round of MLDC. We took the TDI combinations X and Y-Z as our noise uncorrelated data channels, F-statistic based matched filtering and genetic algorithm as the basis of our approach. Our codes were written with Matlab.

For Challenges 1B.1.1a-b, we first computed the F-statistic in the frequency domain to search for the three phase parameters, namely the frequency and sky location of the sources. Since the two sources are known a priori to be monochromatic, when calculating the inner products of the data and our templates, we were only concerned with bins (w. r. t. short Fourier transforms) around the rough frequency value which can be obtained directly by taking FFT of the original data. Within these short frequency intervals, to a good accuracy the noise may be assumed to be white. We then used genetic algorithm to search for the maximum F, which has a good efficiency in the sense that for these first two challenges it converges at around 300 to 400 generations.

For the 10mHz single source, the basic searching pipeline was similar. As the rough frequency range did not show up after taking direct FFT of the data, we set the range of our genetic algorithm searching over the entire interval from 0.009Hz to 0.011Hz and then further narrowed it down step by step. This part of work was done at the last stage in haste and we did not tried the approach on the training data, even for the blind data we had to submit our result without an adequate evolution. Hopefully the three phase parameters in our 1B.1.1c result would have been better if we had a couple of days' more time.

The other four parameters were then simply recovered after we have got the phase parameters. And this also worked for Challenge 1B.1.2. We confined the range of polarization angle ψ in the interval $[\frac{\pi}{4}, \frac{3\pi}{4}]$. And as mentioned in the literature[4], apart from the gauge freedom $\psi \to \psi + \pi$, there is also an ambiguity when simultaneously changing $\psi \to \psi + \frac{\pi}{2}$ and $\varphi_0 \to \varphi_0 + \pi$, where φ_0 is the initial phase.

We included the transfer function in the construction of our templates for the Challenges 1B.1.1b-c and also those sources in 1B.1.2 which have a frequency above 2mHz.

Acknowledgements:

The work is supported by the 973 Applied Maths Project (2006CB805905) and the Morningside Center of Mathematics for financial support. The generous technical assistance offered by Matthew Benacquista, Yanbei Chen, Shane Larson, Reinhard Prix, Linqing Wen and the useful discussions with Jin Li and Xilong Fan are also gratefully acknowledged.

Reference:

[1] The Mock LISA Data Challenge Task Force, arXiv:gr-qc/0609106.

[2] L. J. Rubbo, N. J. Cornish and O. Poujade, ***Phys. Rev. D*** 69, 082003 (2004).

[3] P. Jaranowski, A. Królak, and B. F. Schutz, ***Phys. Rev. D*** 58, 063001 (1998).

[4] R. Prix and J. T. Whelan, ***Mock LISA Data Challenge 1: F-statistic Search,*** Technical note, December 3, 2006.

[5] R. Prix and J. T. Whelan, ***Class. Quantum Grav.*** **24** S565-S574 (2007).

[6] J. Crowder, N. J. Cornish and J. L. Reddinger, ***Phys. Rev. D*** 73, 063011 (2006).