General Relativity and Quantum Cosmology

On the complementarity of pulsar timing and space laser interferometry for the individual detection of supermassive black hole binaries

Alessandro D.A.M. Spallicci

(Submitted on 29 Jul 2011 (v1), last revised 18 Sep 2012 (this version, v2))

Gravitational waves coming from SMBHBs are targeted by both PTA and SLI. The possibility of a single and same SMBHB being tracked first by PTA, through inspiral, and later by SLI, up to merge and ringdown, has been previously suggested. Although, the bounding parameters are drawn by PTA, SKA, and by NGO, derived from LISA, we address sequential detection also beyond specific project constraints. We consider PTA-SKA, sensitive from 10^-9 to p x 10^-7 Hz (p=4,8), and SLI, operating from s x 10^-5 up to 1 Hz (s = 1,3). A SMBHB in the range 2 x 10^8 - 2 x 10^9 solar masses (masses normalised to (1+z), z = 0.2 - 1.5) moves from the PTA-SKA to the SLI band, in an interval ranging from 2 months to 50 years. By combining 3 SMBH-host relations with 3 accretion prescriptions, 9 astrophysical scenarios are formed. They are related to 3 levels of pulsar timing residuals (50, 5, 1 ns), generating 27 cases. For residuals of 1 ns, sequential detection probability is less than 4.7 x 10^-4 y^-2 or 3.3 x 10^-6 y^-2 (per year to merge and per year of survey), according to best and worst astrophysical scenarios, respectively: one sequential detection every 46 or 550 years for an equivalent maximal time to merge and duration of the survey. The chances are further reduced by increasing values of the s parameter (they vanish for s = 10) and of the SLI noise, and by decreasing values of the remnant spin. The spread in the predictions diminishes when improving timing precision or lowering the SLI low frequency cut-off. So while transit times and the SLI SNR may be adequate, the likelihood of sequential detection is strongly hindered by the current estimates on the number - just an handful - of observable individual inspirals by PTA-SKA, and to a lesser extent by the large separation between the pulsar timing and space interferometry bands, and by the severe requirements on pulsar timing residuals.

Comments: Large revision, 16 pages, 3 figures, 4 tables

Subjects: **General Relativity and Quantum Cosmology (gr-qc)**; Cosmology and Extragalactic Astrophysics (astro-ph.CO); High Energy Astrophysical Phenomena (astro-ph.HE)

Cite as: **arXiv:1107.5984 [gr-qc]**

(or **arXiv:1107.5984v2 [gr-qc]** for this version)

Submission history

From: Alessandro D.A.M. Spallicci di Filottrano [view email]

[v1] Fri, 29 Jul 2011 14:40:01 GMT (17kb,D)

[v2] Tue, 18 Sep 2012 09:55:24 GMT (128kb)

Which authors of this paper are endorsers?