Gravitational waves and pulsar timing: stochastic background, individual sources and parameter estimati

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Massive black holes are key ingredients of the assembly and evolution of cosmic structures. Pulsar Timing Arrays (PTAs) currently provide the only means to observe gravitational radiation from massive black hole binary systems with masses >10^7 solar masses. The whole cosmic population produces a signal consisting of two components: (i) a stochastic background resulting from the incoherent superposition of radiation from the all the sources, and (ii) a handful of individually resolvable signals that raise above the background level and are produced by sources sufficiently close and/or massive. Considering a wide range of massive black hole binary assembly scenarios, we investigate both the level and shape of the background and the statistics of resolvable sources. We predict a characteristic background amplitude in the interval h_c(f = 10^-8 Hz)~5*10^-16 - 5*10^-15, within the detection range of the complete Parkes PTA. We also quantify the capability of PTAs of measuring the parameters of individual sources, focusing on monochromatic signals produced by binaries in circular orbit. We investigate how the results depend on the number and distribution of pulsars in the array, by computing the variance-covariance matrix of the parameter measurements. For plausible Square Kilometre Array (SKA) observations (100 pulsars uniformly distributed in the sky), and assuming a coherent signal-to-noise ratio of 10, the sky position of massive black hole binaries can be located within a ~40deg error box, opening promising prospects for detecting a putative electromagnetic counterpart to the gravitational wave emission. The planned SKA, can plausibly observe these unique system although the number of detections is likely to be small. (Abridged)

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