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Probing dipole radiation with the low-frequency gravitational-wave observatories

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Atom-interferometer gravitational-wave (GW) observatory, as a new design of ground-based GW detector for the near future, is sensitive at a relatively low frequency for GW observations. Taking the proposed atom interferometer Zhaoshan Long-baseline Atom Interferometer Gravitation Antenna (ZAIGA), and its illustrative upgrade (Z+) as examples, we investigate how the atom interferometer will complement ground-based laser interferometers in testing the gravitational dipole radiation from binary neutron star (BNS) mergers. A test of such kind is important for a better understanding of the strong equivalence principle laying at the heart of Einstein's general relativity. To obtain a statistically sound result, we sample BNS systems according to their merger rate and population, from which we study the expected bounds on the parameterized dipole radiation parameter B. Extracting BNS parameters and the dipole radiation from the combination of ground-based laser interferometers and the atom-interferometer ZAIGA/Z+, we are entitled to obtain tighter bounds on B by a few times to a few orders of magnitude, compared to ground-based laser interferometers alone, ultimately reaching the levels of $|B| < 10^{-9}$ (with ZAIGA) and $|B| < 10^{-10}$ (with Z+).

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