Graviton mass bounds from space-based gravitational-wave observations of massive black hole populations

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Space-based gravitational-wave detectors, such as LISA or a similar ESA-led mission, will offer unique opportunities to test general relativity. We study the bounds that space-based detectors could place on the graviton Compton wavelength \lambda_g=h/(m_g c) by observing multiple inspiralling black hole binaries. We show that while observations of individual inspirals will yield mean bounds \lambda_g~3x10^15 km, the combined bound from observing ~50 events in a two-year mission is about ten times better: \lambda_g~3x10^16 km (m_g~4x10^-26 eV). The bound improves faster than the square root of the number of observed events, because typically a few sources provide constraints as much as three times better than the mean. This result is only mildly dependent on details of black hole formation and detector characteristics. The bound achievable in practice should be one order of magnitude better than this figure (and hence almost competitive with the static, model-dependent bounds from gravitational effects on cosmological scales), because our calculations ignore the merger/ringdown portion of the waveform. The observation that an ensemble of events can sensibly improve the bounds that individual binaries set on \lambda_g applies to any theory whose deviations from general relativity are parametrized by a set of global parameters.

Comments:	5 pages, 3 figures, 2 tables. Minor changes to address comments by the referees
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