Optimizing NN reduction in an atom interferometer network for GW detection

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Atomic Interferometry has been considered as a promising technology to build a new class of gravitational wave (GW) detectors in the frequency band [0.1,10] Hz [1]. However, as their optical counterparts, atom gradiometers have to face Newtonian Noise (NN). Such spurious signal cannot be differentiated from GW effects using a pure gradiometric configuration. Among other methods to reduce NN, passive filtering using a sensor array has been under study for several past years. Summing the differential phase obtained by gradiometer's measurements enable the NN reduction proportional to $\sqrt{N}$ (N being the number of gradiometers) and even more when benefiting from the spatial behavior of NN correlations. It results in a GW detection sensitivity improved by several orders of magnitude in comparison with a single gradiometer [2].

In our study, we further investigate the benefits of AI networks by improving their geometry and the extraction of the GW signal. We focused on Seismic Newtonian Noise in the frequency band from 10^{-1} to 10 Hz. On the one hand, we show that, with a specific detector geometry, we can optimize the number of gradiometers in the network. On the other hand, we also show that an inhomogeneous positioning of the sensors can bring further NN reduction. These studies help to determine an optimal detector network for GW detection.

Keywords: Gravitational Wave, Atomic Interferometry, Newtonian Noise

References

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