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Optimization of design parameters for Gravitational Wave detector DECIGO including fundamental noises

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The DECi-hertz Interferometer Gravitational-Wave Observatory (DECIGO) is a space gravitational wave (GW) detector. DECIGO was originally designed to be sensitive enough to observe primordial GW background (PGW). However, due to the lowered upper limit of the PGW by the Planck observation, further improvement of the target sensitivity of DECIGO is required. In the previous studies, DECIGO's parameters were optimized to maximize the signal-to-noise ratio (SNR) of the PGW to quantum noise including the effect of diffraction loss. To simulate the SNR more realistically, we optimize DECIGO's parameters considering the GWs from double white dwarfs (DWDs) and the thermal noise of test masses. We consider two cases of the cutoff frequency of GWs from DWDs. In addition, we consider two kinds of thermal noise: thermal noise in a residual gas and internal thermal noise. To investigate how the mirror geometry affects the sensitivity, we calculate it by changing the mirror mass and thickness. As a result, we obtained the optimums for the parameters that maximize the SNR that depends on the mirror radius. This result shows that a thick mirror with a large radius gives a good SNR and enables us to optimize the design of DECIGO.

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