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DRAG-FREE CONTROL FOR TRIANGLE FORMATION FLIGHT OF B-DECIGO SPACECRAFT

Abstract

B-DECIGO is a space gravitational wave telescope aimed at realizing the stage before DECIGO (Deci-hertz Interferometer Gravitational wave Observatory). Although the baseline length of B-DECIGO is 100km, which is one-tenth of the size of DECIGO, we aim to achieve observations as early as possible that cannot be made with terrestrial gravitational wave telescopes. B-DECIGO can observe gravitational waves generated from black-hole and neutron-star binary coalescences over almost the entire space. Besides, new observations not possible with the terrestrial gravitational wave telescope can be performed, such as by observing several months before the binary merger and predicting the merged time and position in advance. It also aims to unravel the mystery of galaxy formation by observing coalescences of black-hole binaries with an intermediate mass of about 1000 times the solar mass.

The formation control of a long-distance, drag-free, low-thrust, near-geostationary orbit for triangle formation by three satellites is presented, in view of future space gravitational wave observatory employing long baseline interferometry (100 km). For the purpose, a formation consisting of three drag-free satellites, orbiting at a fixed distance in a near-geostationary orbit, has been proposed. Formation fluctuations are bounded by a 40 m wide (along-track, cross-track and radial) box. This paper outlines position and attitude control problems of a long-distance three-satellite drag-free formation with time-delay system for the gravitational wave monitoring. An optimal MIMO servo controller based on LQR (Linear-Quadratic Regulator) and/or H-infinity control theory are introduced, then numerical simulations are demonstrated for a precise control performed by the multivariable controller with electrostatic actuators and micro-newton thrusters. Simulated runs through spacecraft simulation, which is dominated by a drag, show that the first-trial design meets the tight control requirements, and demonstrates the mission feasibility.