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OPTIMAL DEPLOYMENT SIMULATION FOR VARIOUS GRAVITATIONAL WAVE MISSIONS

Abstract

Space Gravitational Wave (GW) mission proposals in general use formation flying for the required interferometry implementation. The spacecraft of most of these mission proposals go to deep space and many have Earthlike orbits around the Sun. LISA (Laser Interferometer Space Antenna) has a formation of 3 spacecraft, arranged in an equilateral triangle with 2.5 Mkm arms, inclined by 60 with respect to the ecliptic and flying along Earth-like orbits trailing Earth by 20 deg. TAIJI is proposed to work on time delay interferometry for 3 Mkm armlength LISA-like orbits. ASTROD-GW (Astrodynamical Space Test of Relativity using Optical Devices optimized for GW detection) has 3 spacecraft near Lagrange points to range interferometrically with one another with armlength about 260 Mkm. DECIGO (DECi-hertz Interferometer GW Observatory) has 12 spacecraft with 0.001 Mkm armlength. There are also GW missions propose formations with high or low Earth orbits, like TianQin and AMIGO. In this paper, the deployment delta-Vs are calculated for various gravitational wave missions for comparison. After specifying the initial states of the spacecraft according to JPL DE431 solar ephemerides, we use the multi-segment compact finite-difference method for the equation of motion to calculate the optimal delta-V for deployment of the formation from LEO with fixed transfer time. Furthermore, the armlengths, armlength differences, Doppler velocities, and breathing angles are simulated to verify the measurement requirements.