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Author: Dr. An-Ming Wu
National Space Organization, Taiwan, China, amwu@nspo.narl.org.tw

Prof. Wei-Tou Ni
National Tsing Hua University, Taiwan, China, weitou@gmail.com

FORMATION DESIGN FOR VARIOUS GRAVITATIONAL WAVE MISSIONS

Abstract

Space Gravitational Wave (GW) mission proposals often use constellation or 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. ASTROD-GW, Big Bang Observer and DECIGO have spacecraft distributed in Earthlike orbits in formation. LISA has three spacecraft arranged in a nearly equilateral triangle formation with 5 million kilometer arms, inclined by 60 with respect to the ecliptic and flying along an Earth-like heliocentric orbit trailing Earth by 20. TianQin and ALIA-Descope (Taiji) are proposed to work on time delay interferometry for 3, 4, 6 Mkm arm-length LISA-like missions. ASTROD-GW has 3 spacecraft near Lagrange points to range interferometrically with one another with arm length about 260 million kilometers. The formation design is an important issue for these missions. In this paper, a 4th-order compact finite-difference method for the multi-body two-point boundary-value problem is proposed to design the transfer orbits. The deployment and maintenance of the formations regarding the travel time and propellant mass ratio are studied systematically, including fixed travel time transfer, low energy transfer, and planetary flyby transfer.