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ORBIT MAINTENANCE OF QUASI-SATELLITE TRAJECTORIES VIA MEAN RELATIVE ORBIT  
ELEMENTS**Abstract**

The Martian Moons eXploration mission is currently under development at JAXA and will be the first spacecraft mission to retrieve pristine samples from the surface of Phobos. In preparation for the sampling operations, MMX will collect observations of Phobos from stable retrograde relative trajectories also known as quasi-satellite orbits or QSOs. This paper offers a semi-analytical analysis of mid- and high-altitude QSOs in terms of relative orbit elements. Our analysis is not limited to planar orbits and takes into account the eccentricity of the moon's orbit. Furthermore, we introduce a numerical map between mean and osculating orbit elements to study the long-term evolution of MMX and derive a Lyapunov control law for orbit maintenance purposes. The nonlinear controller is based on mean relative orbit element differences and tested with respect to injection errors.