

Tentative improvement of the initial High altitude Quasi-Satellite-Orbit (QSO-H) of Martian Moons' eXploration (MMX) using onboard Light Detection and Ranging (LIDAR) data

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The spacecraft of Martian Moon's Exploration (MMX) mission led by the Japan Aerospace eXploration Agency (JAXA) will be inserted to the High-altitude Quasi-Satellite Orbit (QSO-H) around Phobos after arriving Mars region. Although MMX project will provide preliminary orbit data on the QSO-H based on Doppler observations, which will be derived by propagating the initial state vector obtained through Doppler tracking, these data may not have sufficient accuracy for onboard instruments. We conducted a study on the tentative improvement of initial orbit determination of the MMX satellite in the QSO-H orbit by directly modifying the initial orbit without using a dynamical model, while referencing onboard Light Detection and Ranging (LIDAR) data obtained simultaneously to explore the optimal orbit. When the initial orbit residual of the satellite is determined by the initial erroneous position due to Doppler observation errors (approximately 100 m), the average three-dimensional orbit residual over the Phobos orbital period is about 500 m. However, the time variation of the three components in the Phobos-fixed coordinate system can be approximated by a linear function plus a trigonometric function. By fitting parameters using simultaneously obtained LIDAR range data, it was found that averaged orbit residual can be corrected to below 20 m. Our method is simple and straightforward without estimating dynamical model. It takes only 15 or 16 minutes by a custom-made Fortran 90 program on the calculation server to process the orbit data for the Phobos orbital period and to yield practical results, which will be beneficial to the efficiency of initial data analysis for the MMX onboard instruments.

Keywords: MMX, LIDAR, QSO-H, tentative improvement