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Trojan Asteroid Mass Determination using the Radio-Science Experiment onboard the LUCY Mission

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The LUCY spacecraft was launched in 2021. The main objective of the NASA mission is to characterize several trojan asteroids. These outer solar system asteroids are located in the Lagrange points L4 and L5 of the Jupiter-Sun system.

The first flyby will be at (3548) Eurybates and its moon Queta in August 2027, followed directly by the flyby at (15094) Polymele with its moon Shaun (informal name) in September 2027. Two more flybys in the so-called Greek camp in the L4 point are at (11351) Leucus in April 2028 and at (21900) Orus in November 2028. After orbiting the Sun once more the spacecraft will reach the L5 swarm of asteroids and will flyby at the binary system of (617) Patroclus and Menoetius in March 2033.

During these flybys the mass of the target asteroids shall be determined using the Doppler tracking method. Analytic solutions for the error estimation of the mass determination have already shown that the required precision will be met. However, this analytic approach does not take into account several error sources like time limited tracking, no Doppler data +/- 2h around closest approach, uncertainties in the initial spacecraft position and velocity for a flyby, non-gravitational forces, etc. Another contributing error source is the Doppler noise imposed on the signal. Doppler data from ESAs Rosetta mission and NASAs New Horizons spacecraft as well as tracking data recorded during the first 2 1/2 years of LUCYs cruise phase could be analyzed regarding distance, solar wind turbulence, integration times etc.

A numeric orbit determination using simulated Doppler data can provide the most realistic error estimation using all perturbing forces and uncertainties. A detailed analysis of the error of the mass determination for all flybys shall be presented.