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Libration of Mercury from the BepiColombo radio science and camera experiments

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Mercury is the most enigmatic among the terrestrial planets, but the space missions MESSENGER and BepiColombo are expected to advance largely our knowledge of the structure, formation, and evolution of Mercury. In particular, insight into Mercury's deep interior will be obtained from observations of the 88-day forced libration, the obliquity, and the degree-two coefficients of the gravity field of Mercury. Of those quantities, the libration is the most difficult to measure and will hence be a limiting factor. We report here on aspects of the observational strategy to determine the libration amplitude, taking into account the space and ground segment of the experiment.

Repeated photographic measurements of selected target positions on the surface of Mercury are central to the strategy to determine the libration in the frame of the BepiColombo mission. We simulated these measurements in order to estimate the accuracy of the reconstruction of the rotational motion of the planet, as a function of the quantity of measurements made, the number of different targets considered and their locations on the surface of the planet. From this study, we determine criteria for the distribution and number of target positions to maximize the accuracy on the rotation determination, from which the libration is extracted. We take into account the errors arising from the relative positions of the spacecraft, Mercury and the Earth. The quality of the spacecraft positioning is very important since it will greatly influence our ability to position the images taken by the spacecraft on the planetary surface and hence to reconstruct the planetary rotation. We consider various error sources such as the solar thermal influence on the spacecraft bus and the Earth based tracking constraint near solar conjunctions of Mercury.