



Why Steins and Lutetia ?

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Abstract

The criteria in choosing the asteroid fly-by targets of the Rosetta mission, 2786 Steins and 21 Lutetia, are recalled and discussed.

The ratio (discoveries)/(confirmed information) is analyzed on the light of the results obtained during each fly-by.

The role of the new close observations of these small bodies in providing valuable “ground truth” for the interpretation of data on a large sample of asteroids obtained from both the Earth surface and in orbit observatories is also outlined.

1. Introduction

The Rosetta mission has been selected by ESA in 1993 and its baseline was a rendez-vous with the comet Wirtanen and, on the way toward the comet, the fly-by of two quite unknown asteroids, 3840 Mimistrobol and 2530 Shipka, selected by the ESA technical team because of their low cost in terms of ΔV . We started a wide international observational campaign to characterize these targets (Barucci & Lazzarin, 1995) and we found that Shipka was a medium size B type asteroid and Mimistrobol was a small S type object. The latter object was later replaced by another S-class asteroid, 3840 Rodari (Fulchignoni & Barucci, 1996). However, after further studies of more “weird” possible flyby candidates (Barucci et al., 1998; Fulchignoni et al., 1998), another change to the schedule was made in early 1999. The new pair of asteroids to be visited by Rosetta were two very contrasting objects: 140 Siwa (C type) the largest asteroid ever encountered and 4979 Otawara (S type) were the smallest.

From 1999 and 2002 a wide program of observations has been carried out in order to characterize these targets, and provides the Rosetta project with the information which could have been used to maximize the scientific return of each fly-by (Doressoundiram et al. 1999; Le Bras et al., 2001; Fornasier et al., 2003).

Few weeks before the scheduled launch date, due to some problem of the launcher, ESA decided to postpone the launch of at least one year to allow Ariane to fix the problem. This decision implied a global revision of the mission targets. The new target comet, P/67 Churimov-Gerasimenko, was chosen during 2003, and the new trajectory was more expensive, in terms of ΔV , than the that toward Wirtanen. So, the decision concerning the asteroid targets was postponed after the completion of the manoeuvre of interplanetary orbit insertion of the Rosetta probe, in order to check if some hydrazine would have been still available for the one or two fly-bys. We were starting another campaign of ground based observations of a group of asteroids that the Rosetta’s navigation team listed (in order of increasing ΔV cost) as possible target (Birlan, M. et al., 2003; Birlan et al., 2004; Barucci et al., 2004). The insertion manoeuvre was carried out in the nominal way, so more than 120 m/s of ΔV remained available for two asteroid fly-bys. On the basis of the results of the 2003 campaign, we proposed to the Rosetta project to include the fly-by of 2786 Steins (very small, E type) and 21 Lutetia ($D \geq 100$ km, type uncertain: C?, M?) in the mission objectives (Fulchignoni et al., 2004; Barucci et al., 2005), which guarantee the fulfilling of the scientific requests on the target nature: 1) increasing the close up characterization of the main belt population; 2) large enough (at least one) to allow the radio-science experiment to measure the mass, and consequently determine the body density; 3) interesting, new and different taxonomic types.

2. Preparing the encounters

A new trajectory toward the comet Churimov-Gerasimenko was designed by the navigation team to allow the Rosetta probe to fly-by these asteroids. The close encounters were scheduled on September 5th, 2008 and July 10th, 2010 respectively. The international observation campaign was then focused

on the characterization of the two targets, with the aim to support the schedule of the operations and of the observations with the on board instruments during the fly-by phases (for a complete review of the results of this campaign, the reader is reminded to Barucci & Fulchignoni 2009, and the references thereafter).

3. Asteroid's fly-by fringe benefits

The exploration of two more asteroids, which presented intriguing information before the fly-by, allows us to better understand the diversity of this population.

These results constitute a valuable database and allow us to check the validity and the limits of the inversion methods of the telescopic data, using those acquired by Rosetta during both fly-bys as the "ground truth". In fact, a comparison between the expected nature of Steins and Lutetia (on the basis of the ground based observations) and what the Rosetta data revealed, will give us a key to understand how the knowledge of the whole main belt asteroid population can increase.

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