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The Rosetta fly-by at (21) Lutetia – ten weeks after closest approach

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Abstract

The International Rosetta Mission is one of ESA's Cornerstone Missions on its way to rendezvous with Jupiter-family comet 67P/Churyumov-Gerasimenko in 2014, to accompany the comet into the inner solar system, and land on the comet nucleus. On cruise to the main target the spacecraft had been scheduled for close fly-bys at two main-belt asteroids. After the successful fly-by at E-type asteroid (2867) Steins in September 2008, Rosetta had its second close encounter with an asteroid, (21) Lutetia, on 10 July 2010. A first summary of the fly-by is presented.

1. Overview of Asteroid Fly-by Geometry

Rosetta had a close fly-by at asteroid (21) Lutetia on 10 July 2010, with closest approach at 15:44:53 UTC at a targeted minimum distance of 3160 km. This is the minimum distance from which Rosetta is able to track the asteroid continuously. The encounter occurred when (21) Lutetia was at a heliocentric distance, r_h = 2.72 AU, and a geocentric distance, Δ = 3.05 AU. The spacecraft passed with a relative fly-by velocity of 15 km/s. Zero phase angle was reached 18 minutes before closest approach at a distance of 16400 km from the asteroid. The fly-by strategy allowed continuous observations of the asteroid before, during and for 30 minutes after closest approach, after which the spacecraft had to slew away from the asteroid because the minimum allowed solar aspect angle was reached.

2. The Target Asteroid

(21) Lutetia is a large main-belt asteroid (estimated diameter ~95 km) discovered from Paris by H.M.S. Goldschmidt on 15 November 1852 and named in honor of the city. Its classification into a specific asteroid type on the basis of remote-sensing spectroscopic observations has turned out to be ambiguous and includes the possibilities of a C-type or an M-type asteroid, meaning that features hint to characteristics of carbonaceous chondrites, but also to metallic surface features. This contradiction makes it a very interesting object for close inspection.

Table 1: Orbital parameters of (21) Lutetia

Perihelion distance	2.036 AU
Aphelion distance	2.834 AU
Semi-major axis	2.435 AU
Eccentricity	0.164
Inclination	3.0648
Orbital period	3.80 yrs

3. (21) Lutetia Fly-by Payload Operations

Most of the scientific instruments on board Rosetta were switched on obtaining imaging and spectral observations covering wavelengths from the UV to sub-mm, as well as in-situ measurements of the asteroid and its direct environment.

Table 2: (21) Lutetia Scientific Measurements

OSIRIS	Shape, topography, reflectivity (surface regolith properties).
VIRTIS	Light curves, surface mineralogy
ALICE	UV spectral analysis of surface. Search for exosphere.
COSIMA	Detect any dust grain possibly present
MIDAS	along Rosetta's trajectory
MIRO	Study surface thermal emission, (sub)surface physical properties.
ROSINA	Determine gas emitted by Lutetia (if any) and its composition.
RPC	Interaction of asteroid and solar wind.
	Magnetometers Joint operations
RPC-MAG	Search for an asteroid magnetic field.
ROMAP	Search for an asteroid magnetic field.
RSI	Determination of asteroid mass