A PORTRAIT OF ASTEROID 2867 STEINS FROM VISIBLE AND INFRARED OBSERVATIONS WITH GROUND- AND SPACE-BASED TELESCOPES. P. L. Lamy[1], A. Barucci[2], S. Fornasier[2], O. Groussin[1], L. Jorda[1], M. Kaasalainen[3], S. Lowry[4], and I. Toth[5], [1]Laboratoire d'Astrophysique de Marseille, BP8-13376 Marseille Cedex 12, France, [2]LESIA, Observatoire de Paris, 92195 Meudon Principal Cedex, France, [3]Department of Mathematics and Statistics, University of Helsinki, P.O. Box 68, FI-00014 Finland, [4]Jet Propulsion Laboratory, 4800 Oak Grove Drive, MS 183-301, Pasadena, CA 91109, USA, [5]Konkoly Observatory, Budapest, Hungary.

Asteroid 2867 Steins is the first target of the Rosetta space mission with a flyby scheduled in September 2008. An early physical characterization, proeminently its shape and rotational state, is needed to optimize the flyby parameters and the science operations, and to maximize the scientific return.

We compiled a set of 26 visible light curves whose phase angle coverage extends from 7.5° to 41.7°. The latter phase angle, impossible to reach from Earth, was achieved by the Rosetta S/C: the asteroid was imaged with the OSIRIS-NAC camera during the cruise phase, and continuously monitored over ~24 hr on 11 March 2006, thus covering four rotational periods, at a temporal cadence of 6 min [1]. An accurate photometric calibration was obtained from the observations of a solar analog star, 16 Cyg B. The light curve in the R photometric band of the Johnson-Kron-Cousins system has a mean value $R(1,1,\alpha = 41.7°) = 14.13\pm0.03$ and an amplitude of 0.25 ± 0.04 mag [2].

We performed the simultaneous inversion of the 26 visible light curves relying on convex modeling [3]. The full three-dimensional solution for asteroid 2867 Steins is rather spherical with axial ratios a/b=1.17 and a/c=1.25 (**Fig. 1**). Inversion is basically scale-free, and absolute scaling comes from a measurement of its thermal emission with the Spitzer space telescope [4]. We used the infrared spectrograph (IRS) to obtain 14 spectra ranging from 5.2 to 38.0 µm, and sampling the rotational period of the asteroid. The observations were performed on 22 November 2005, when the asteroid was 2.13 AU from the Sun, 1.60 AU from the SST, and at a phase angle of 27.2°. They were interpreted using a standard thermal model incorporating the thermal inertia. The solution for a spherical shape leads to an effective radius $r=2.46\pm0.20$km and a thermal inertia $I=150\pm60$ MKS, for a beaming factor between 0.8 and 1.0. The solution for our 3-dimensional shape model has overall dimensions of $5.73\pm0.52 \times 4.95\pm0.45 \times 4.58\pm0.41$ km. The rotational state is characterized by a sidereal period of 6.04681 ± 0.00002 hr, and a pole direction defined by its ecliptic coordinates lambda ~250° and $\beta \sim -89°$, and therefore almost exactly perpendicular to the ecliptic plane. The viewing geometries are thus restricted to only ±20° about Steins' equator , so the shape model is not strongly constrained.

By combining ground- and space-based observations obtained at different phase angles, the phase function was constructed and characterized by a linear part having a phase coefficient $\beta = 0.025\pm0.001$ mag/deg and a mean value $R(1,1,0) = 13.10\pm0.04$. In terms of the H-G formalism, the best fit photometric values are $G = 0.35\pm0.05$ and $H = 12.84\pm0.07$, but the resulting opposition surge of 0.25 mag, although typical of E-type asteroids, is not really constrained because of the lack of data at phase angles below 7°.

The geometric albedo is constrained by visible photometry to $p(R)=0.31\pm0.05$ and $p(V)=0.27\pm0.04$ when using a linear phase function. The H-G phase law which includes an opposition effect, leads to larger values of the albedo, $p(R, H\text{-}G)=0.40\pm0.07$ and $p(V, H\text{-}G)=0.34\pm0.06$.

Altogether the photometric properties of asteroid 2867 Steins (phase function, color and albedo) indicate that it is a somewhat extreme E-type object although it is known that this quite small population exhibits at least three different surface mineralogies.

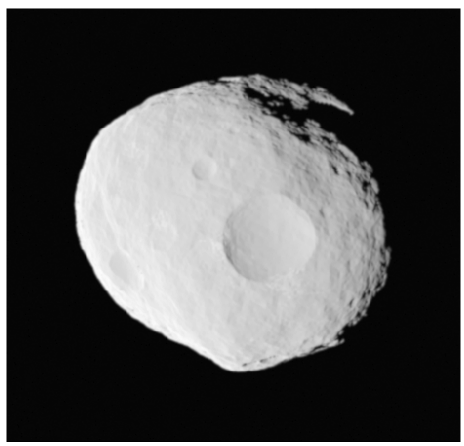

Figure 1: The shape of asteroid 2867 Steins reconstructed from the inversion of 26 light curves. A fractal texture and craters have been randomly added to the reconstructed shape.

References: [1] Küppers, M. et al., (2006) A&A 462, L13. [2] Jorda, L. et al. (2008) A&A accepted. [3,4] Lamy, P. L. et al. (2008) A&A accepted.