Thermophysical properties of 162 173 (1999 JU3) & 4015 Wilson-Harrington

Based on the experience from 25 143 Itokawa

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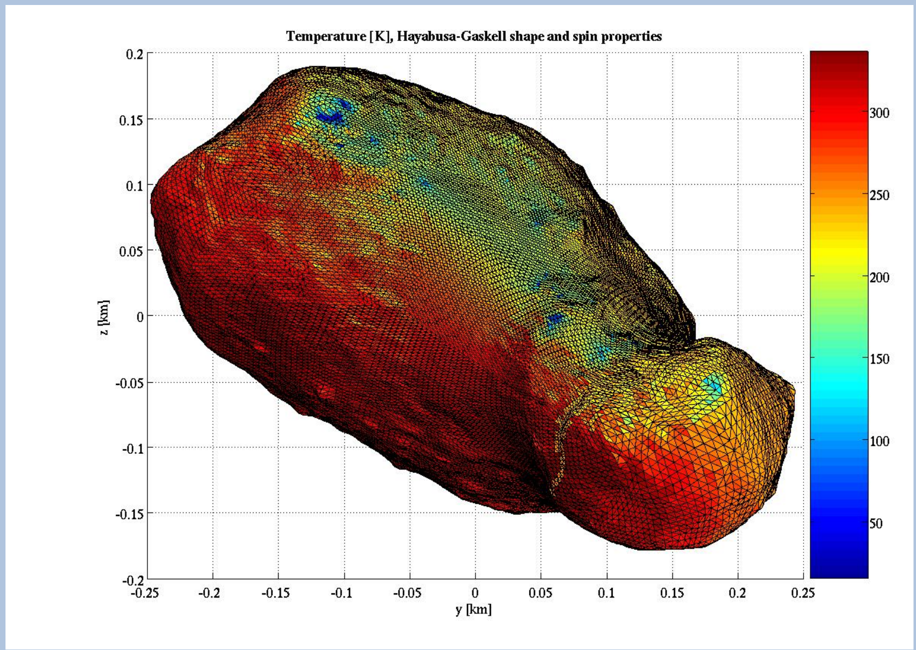


Experience from 25 143 Itokawa

Input:

- H_v mag, G-slope (Bernardi et al. 2008) from visual photometry
- Shape, spin-vector, P_{sig} (Kaasalainen et al. 2003; 2005) from lightcurve inversion technique (and radar measurements by Ostro et al. 2004; 2005)
- 30 thermal, remote, disk-integrated mid-infrared observations (ESO 3.6m, Subaru, IRTF, Akari)

Thermophysical Model (TPM) output:

(Müller et al. 2005, 2009):

- effective size = equal volume sphere:

  - 320±30 m (without Akari-data)

  - 331±25 m (with Akari-data)

→ **true value: 327.5±5.5 m (Hayabusa; Fujiwara et al. 2006)**

- geometric albedo p_V: 0.247±0.035

- thermal inertia: 1000 $\mathrm{Jm^{-2}s^{-0.5}K^{-1}}$

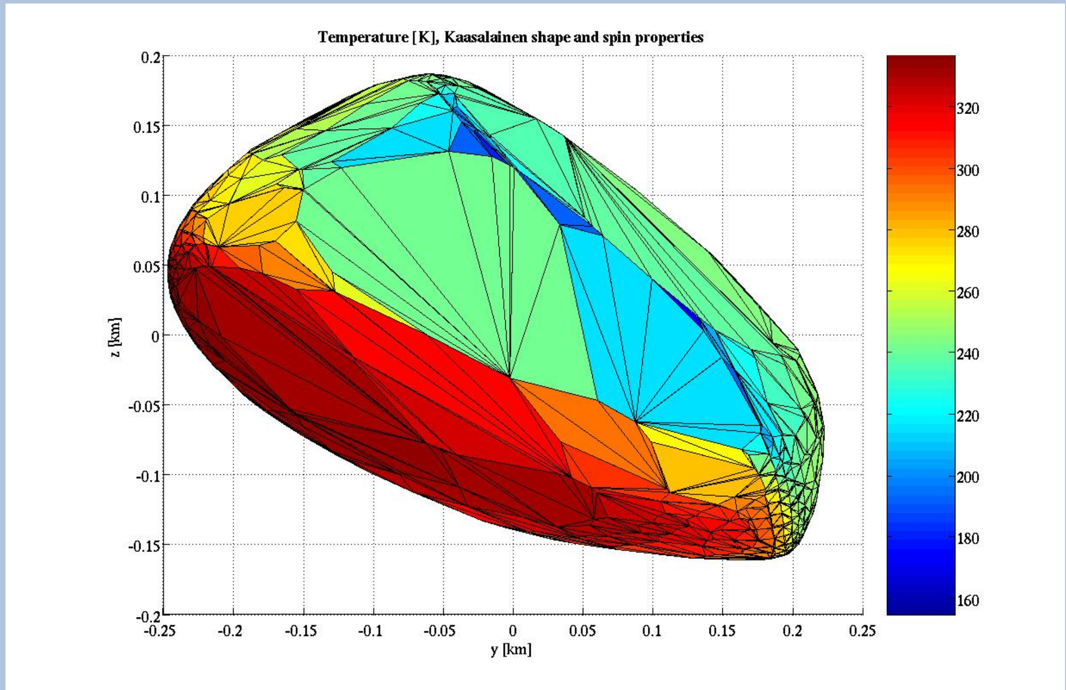
  (→ surface temperature distribution)

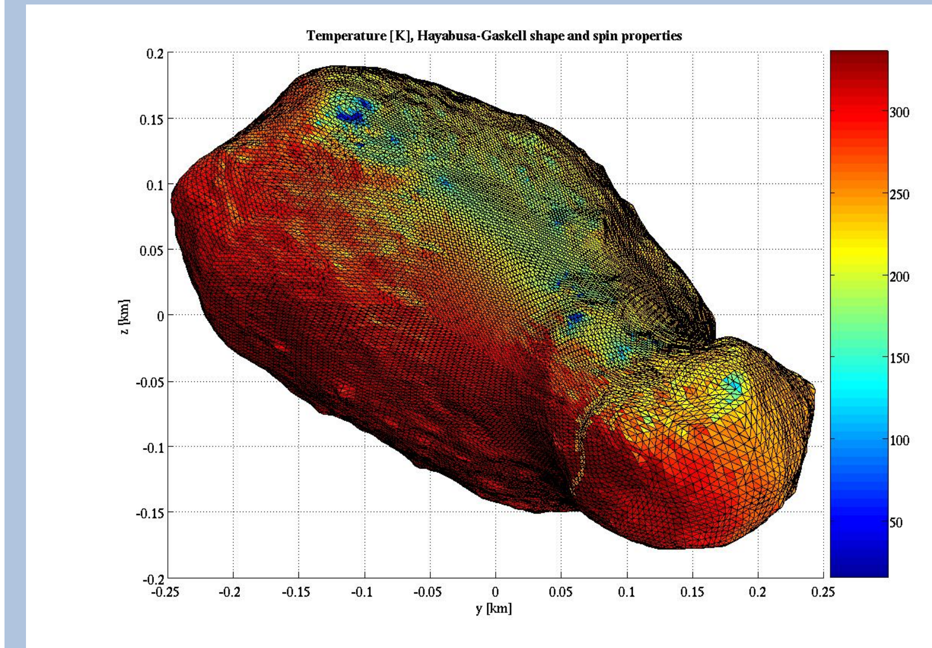
- clear confirmation of the sense of rotation

- strong indications for the absense of dusty regolith

Kaasalainen shape model

Hayabusa in-situ shape





25143 Itokawa is the "benchmark" for thermo-physical model techniques!

162 173 (1999 JU3)

Input:

- H_v mag, G-slope (Kawakami et al. 2008) from visual photometry
- $P_{sid} = 7^h 37^m 38^s$
- Shape models: sphere, ellipsoid, various shape and spin-vector solutions from lightcurve inversion techniques
- 17 thermal mid-infrared observations (Subaru, Akari)

Thermophysical Model (TPM) output (Hasegawa et al. 2008):

- effective size: 0.92 ± 0.12
- geometric albedo: $0.063^{+0.020}_{-0.015}$ (typical for C-type asteroids)
- indications for prograde sense of rotation
- thermal inertia: $>500\,\mathrm{J m^{-2} s^{-0.5} K^{-1}}$
- $\rightarrow$ predominantly covered by boulders and bare rocks, while areas with thick dust regolith are less common

But:

- thermal mid-infrared observations have only small coverage in phase angle and wavelength (Spitzer observations will help)
- shape and spin-vector solutions are not unique
- $\longrightarrow$ diameter might be somewhat smaller (0.7 km with a geometric albedo of 0.09...0.10)
- one possible spin-vector solution would also allow much smaller thermal inertias, consistent with a dusty regolith

4015 Wilson-Harrington

Input for radiometric technique:

- H_v mag, G-slope (APC 5, Lagerkvist et al. 2001) from visual photometry
- $P_{sid} = 6.1$ h (Osip et al. 2005)
- Shape models: sphere with various spin-vector orientations
- 5 thermal mid-infrared observations (Campins et al. 1995, MSX, ISOCAM)

Thermophysical Model (TPM) output (Müller et al. 2009, in prep.):

- effective size: 2.87±0.14 km
- geometric albedo p_V: 0.089±0.009
- strong indications for retrograde sense of rotation
- thermal inertia: 20...**40**...80 $\mathrm{J m^{-2} s^{-0.5} K^{-1}}$

$\rightarrow$ consistent with either a thick dust regolith on the surface or with a cometary surface

But:

- thermal mid-infrared observations have only small coverage in phase angle and wavelength (Spitzer observations will help)
- no shape and spin-vector solutions are available
- ground-based lightcurve programme is ongoing
- proposals for additional thermal data are submitted

Summary

- the radiometric techniques is very powerful for pre-encounter characterisation of small bodies
- physical and thermal properties can be derived with high accuracy
- characterisation of any target is possible (NEOs, MBAs, TNOs, cometary nuclei, ...)
- **But:**

  $\longrightarrow$ a set of high quality mid-infrared observations is required! (covering phase angles, wavelengths, rotational phases)

  $\longrightarrow$ lightcurves are required for shape and spin-vector solutions

  $\longrightarrow$ reliable visual photometry is needed for reliable H-G values