

論文紹介セミナー 15分発表

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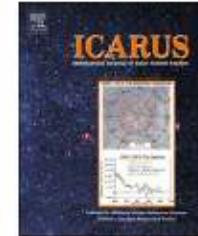
Pinilla-Alonso, N., et al. 2009, A&A, 496, 547.



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Icarus

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A giant crater on 90 Antiope?

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■ 90 Antiopeは初めて発見された同サイズのbinary小惑星 (Themis族メンバー)

→ 自転周期と連星公転周期が同期

Adaptive Optics

■ 10m Keck望遠鏡の波面補償光学 (AO) を用いた直接撮像観測で、直径91kmと86kmの天体が16.5時間周期で公転していることが判明 (Descamps et al. 2007)

■ ほぼ球形状 (わずかに潰れている楕円体)

↑ 光度曲線観測 (Descamps et al. 2007) より

Keck telescope + AO



Descamps et al. (2007)

■世界的な小口径望遠鏡ネットワーク(0.2 – 1.2 m)による可視測光観測から光度曲線を作成

⇒局所的に楕円体モデルと合わない非対称形状
掩蔽後に凸型のくぼみ

■2007年後半～2008年前半にかけて追観測
 (この期間、連星軌道がedge-on → 相互掩蔽)

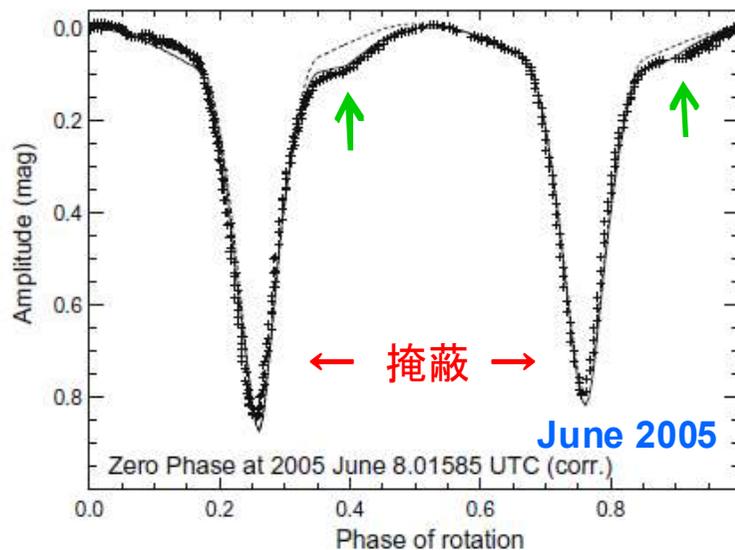
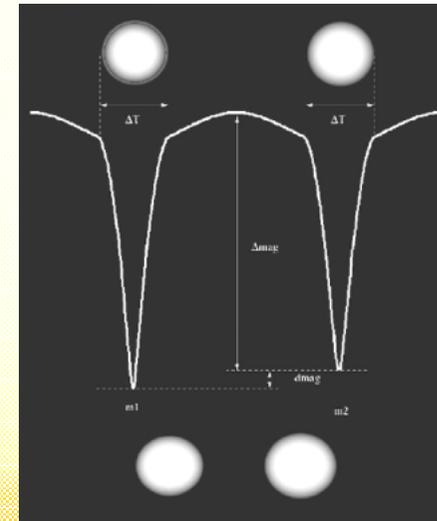
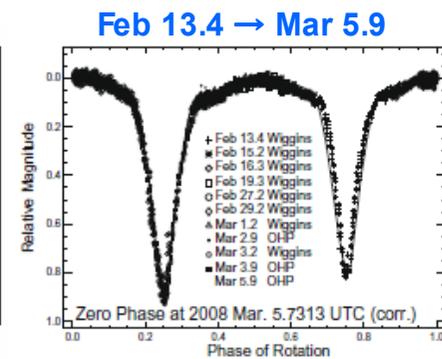
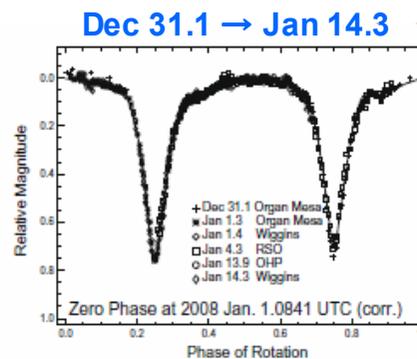
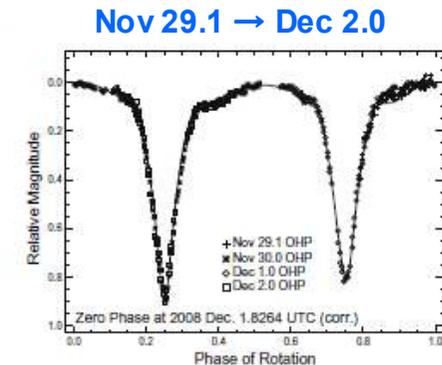
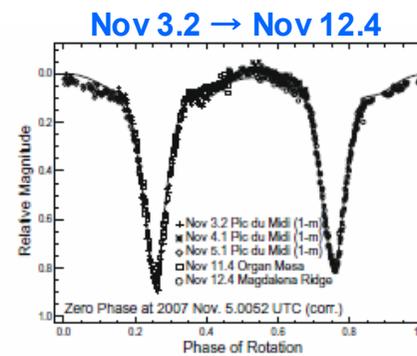


Fig. 1. Composite lightcurve of Antiope taken at SAAD on June 2005 (Descamps et al., 2007). The dashed curve results from a pure Roche solution made of two ellipsoids. Note the shallow concavities just after the eclipse egresses, centered at a rotation phase of 0.35 and 0.85. These anomalies can depart from the perfect Roche model by an amount of 0.04 mag. The solid line corresponds to the best-fit model curve obtained from addition of a large-scale feature described in Section 3.



■ 直径68kmのお椀型クレーターで光度曲線を説明できる
(dark spotのようなアルベドむらでは合わない)

■ impactorの直径は17 km、Themis族年代内で起こる確率は約50%
 2.5×10^9 yr

■ バルク密度 $1.3 \text{ g/cm}^3 \Rightarrow$ 空隙率が高いために破壊されずに済んだ?

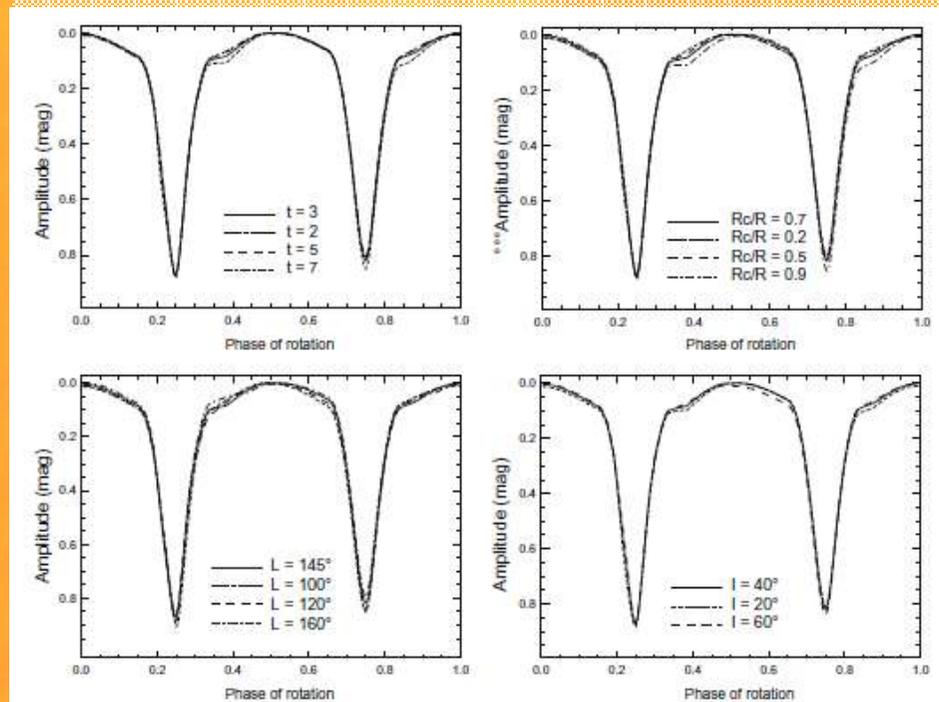


Fig. 4. Photometric effect of crater parameters. These lightcurves were generated adding a crater on the Roche ellipsoid model with different characteristics: the dimensionless depth parameter t , the ratio of the crater radius R_c to the radius of the body R , the location of the crater over the surface in longitude (L) and latitude (l). The curves in plain line correspond to the reference set of values: $t=3$, $R_c/R=0.7$, $L=145^\circ$ and $l=40^\circ$. Each panel displays variations of a single parameter while holding the others at their nominal values.

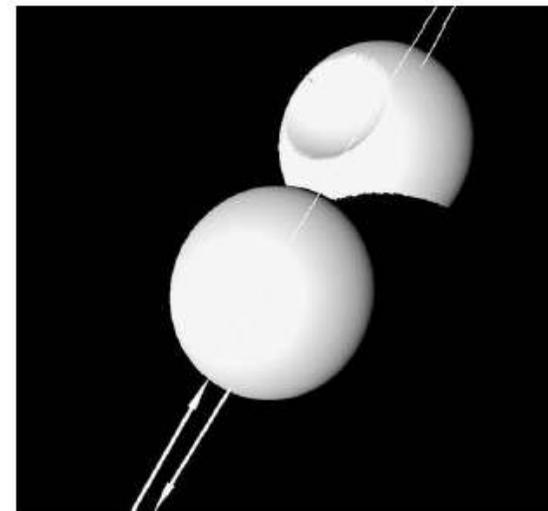


Fig. 6. Picture of the double system of 90 Antiope showing the modeled crater with a diameter of 68 km and depth of a third its diameter ($t=3$). The crater lies on the trailing side of the component at 145° in longitude and 40° in latitude. The system is rendered on November 3 2007 at 10:25 UTC just at the onset of a mutual eclipse of the secondary by the primary. The relative path of the secondary is also plotted. North is up and East is on the left. The spatial resolution on each component is $1''$. Rendering is made from Hapke law. The sub-Earth point has a longitude of 115.7° and a latitude of -1.7° . Position angle of the North pole is 58.9° . The phase angle is 15.4° .



The Shape and Surface Variation of 2 Pallas from the Hubble Space Telescope

B. E. Schmidt, *et al.*

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The Shape and Surface Variation of 2 Pallas from the Hubble Space Telescope

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■ 2 Pallas は2番目に大きな小惑星 (平均半径 272 km)

↑ Ceresも含めて

■ Pallas族は直径20kmが最大 → Pallasの破片?

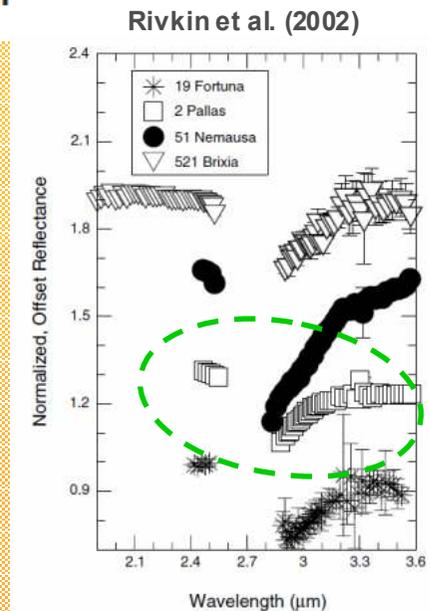
↑ 5222 Ioffe

■ 表面は含水鉱物で覆われている (Rivkin et al. 2002)

3 μm付近に吸収帯 (H₂O, OH) →

■ Hubble宇宙望遠鏡の高空間分解能力カメラにより、
形状・表面を観測

Wide Field and Planetary Camera



- 3軸楕円体モデル → 291(±9)km、278(±9)km、250(±9)km
- 質量: $1.026(\pm 0.028) \times 10^{-10} M_{\text{sun}}$ 、密度: 2400(±250)kg/m³ ↓ CeresとVestaの間
- 348°Eの南西側に大きなくぼみ → 62°E-75°Eに見える最も暗い領域

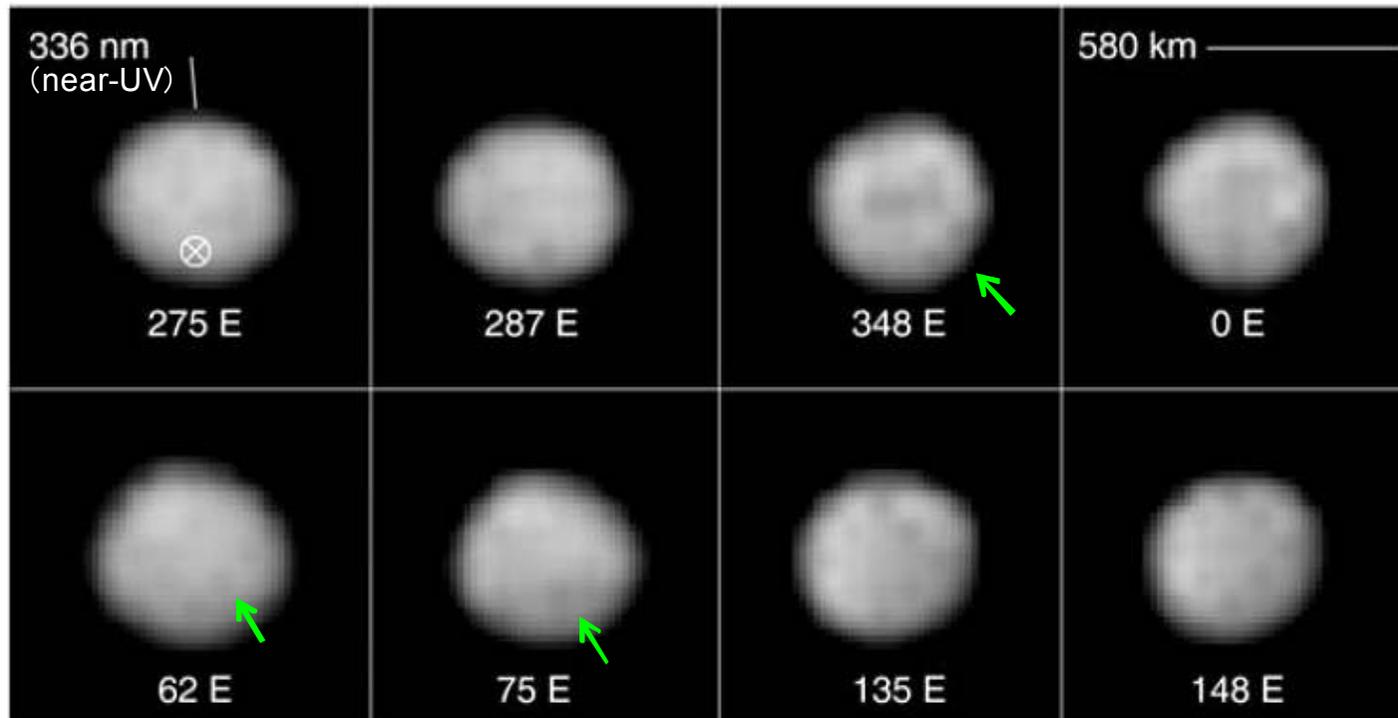


Fig. 1. Deconvolved 336-nm WFC2 images of Pallas from 8 September 2007. We observed Pallas at an angular size of 0.326 arc sec and a phase of 4.2°, resulting in a scale of ~75 km/pixel. Pallas' spin pole (pointing upward) and south pole (⊗) are marked, and the corresponding sub-Earth longitude is labeled; north is up and east is right in this panel.

- 3次元形状モデル ⇒ 100km規模の不規則形状、数個のくぼみ
- 30°S, 75°Eに直径240mのクレーター、深さ~15km(お椀型の場合)
- ejectaの体積は~ $3.5 \times 10^5 \text{ km}^3$ ⇒ Pallas族を形成？
Ioffeの体積は~5575 km^3
- クレーター中心はnear-UV アルベドが最小かつ (U-V) カラーが最大
⇒ 宇宙風化もしくは加熱によるUV吸収物質の増加が要因？



Fig. 3. Pallas's largest crater-like feature seen in the digital model (left) and from two perspectives: appearing face-on (upper right) and edge-on along the limb (lower right). The flat region indicated by the arrow rotates through multiple projections, manifests as the depression in the center of the model, and has a diameter of $240 = 25 \text{ km}$.

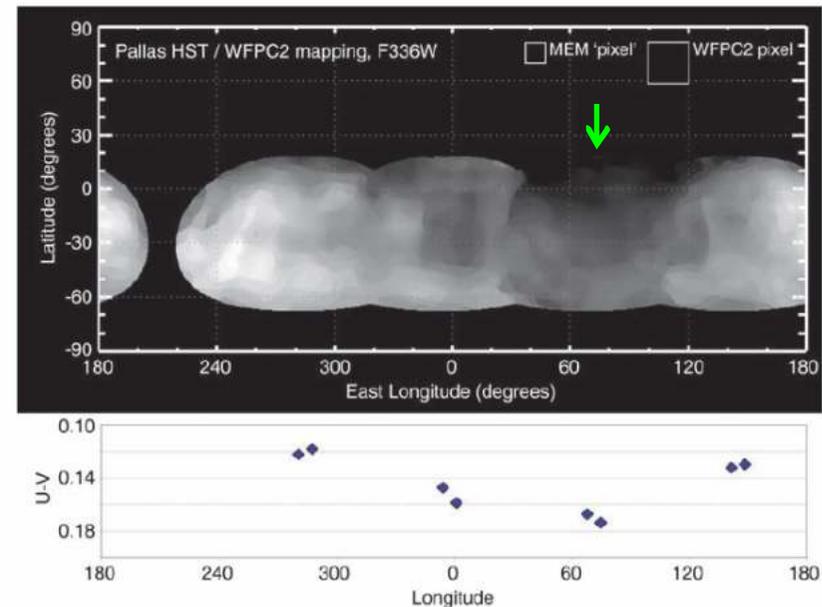


Fig. 4. Map of Pallas in the UV along with its U-V colors constructed from the deconvolved images. The map has been stretched to $\pm 20\%$ contrast to show variations more clearly. The color plot compares the disk-averaged brightness of the surface in two wavelengths, minimizing shape effects. We show the relative pixel scales of the raw and deconvolved images in the upper right. Any feature smaller than a WFCP2 pixel is beyond our resolution.



A survey of Karin cluster asteroids with the Spitzer Space Telescope

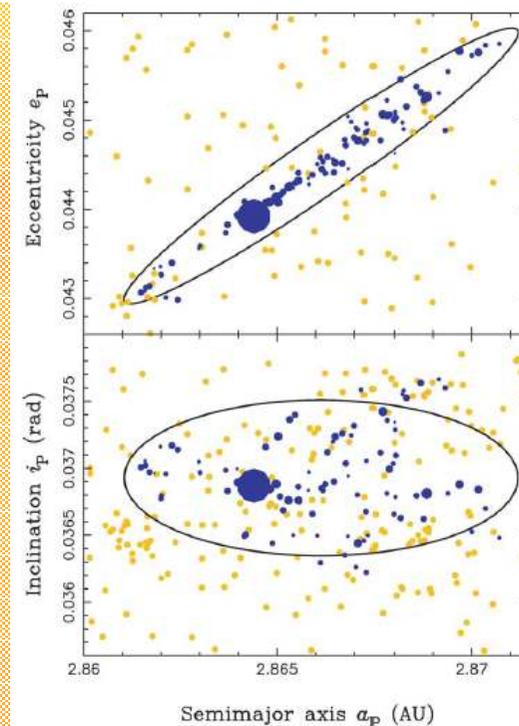
Alan W. Harris^{a,*}, Michael Mueller^{a,1}, Carey M. Lisse^b, Andrew F. Cheng^b

- Karin族は 5.8 ± 0.2 Myr前に形成された若い族
- 直径33km程度の、一枚岩の小惑星が激しい衝突破壊を起こして形成されたというモデルが提案されている (Nesvorný et al. 2006)
- Koronis族天体の中から90個がKarin族天体と同定されている (Nesvorný & Bottke 2004)
- うち17天体について、Spitzer宇宙望遠鏡を用いて近赤外および中間赤外で測光観測した

Karin族の軌道要素分布 (●はKoronis族天体) —

3.55, 4.49, 5.73, 7.82 μm (IRAC) 15.8, 22.3 μm (IRS PUI)

Nesvorný & Bottke (2004)



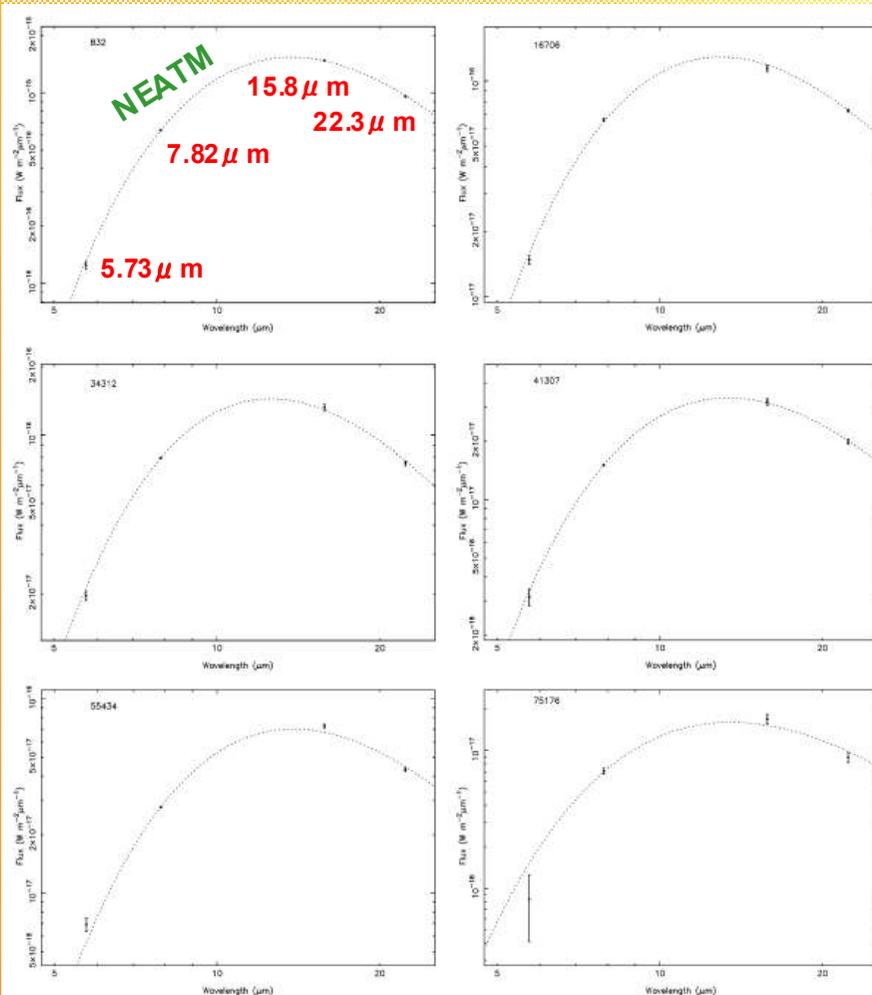
■ 5.73 – 22.3 μm のフラックス値にNEA熱モデル(NEATM)を適用

↑ 大部分が熱放射の成分

↑ そそこの熱慣性とそそこの自転速度を持つ天体向け

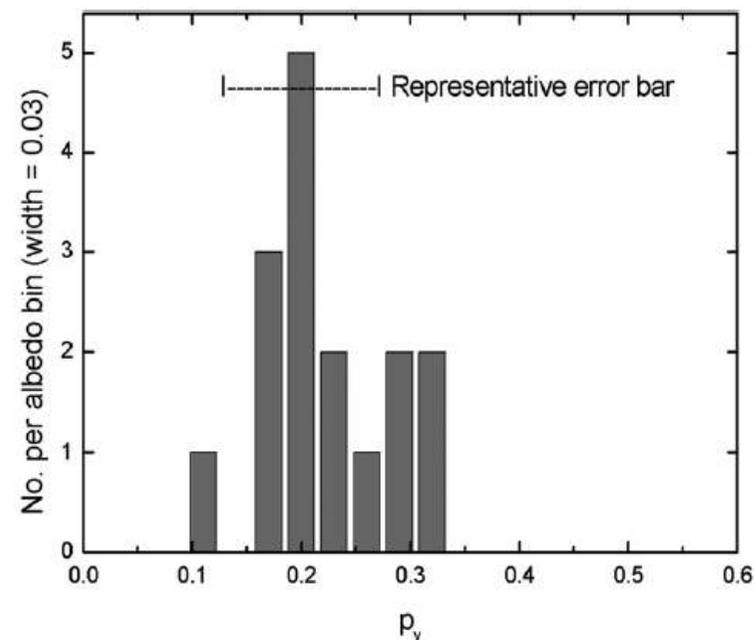
■ 直径、アルベド(p_v)、beaming parameter(η)を算出

↑ モデルの温度分布を熱慣性0の平滑な球体のものに変換するためのパラメータ



■ アルベド平均は 0.215 ± 0.015 、
Karin(0.20 ± 0.07)に酷似

⇒ family天体とKarinは物理的
にも関連性がある



■ Karin族天体のアルベド(p_v)は直径との相関がない

(NEAsは直径の増加とともにアルベドが減少する傾向が見られる)

小さい天体ほど衝突によって破壊され、風化した表面が除去される

⇒ すでに相当の宇宙風化を受けている?

■ η の増加とともにアルベドが減少

⇒ 衝突により表面粗さが増し、 η が減少

宇宙風化の急激な進行を示唆?

■ 同サイズのNEAsよりも η が1桁小さい

⇒ 熱伝導度の低いレゴリス層で覆われている?

(参考)

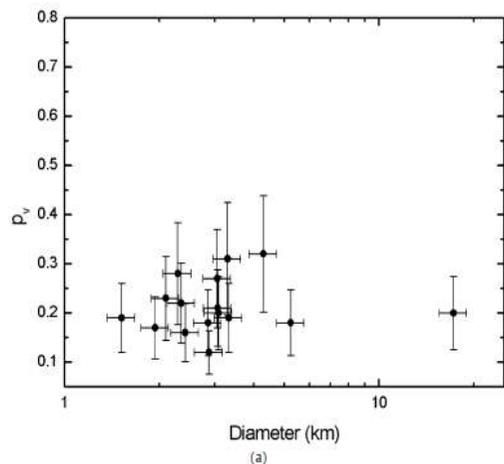
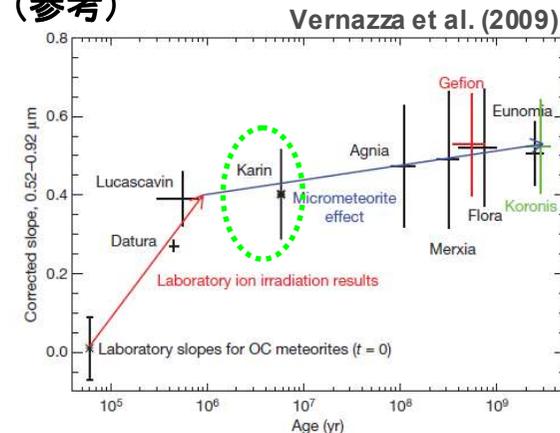


Fig. 3. Albedo versus diameter for (a) the observed Karin cluster asteroids and (b) for a set of S- and Q-type near-Earth asteroids [plot adapted from Harris (2006), with the addition of data from the compilation of Wolters et al. (2008); the horizontal line at $p_v = 0.215$ corresponds to the mean albedo of the observed Karin asteroids]. In contrast to the near-Earth asteroid albedos the Karin cluster albedos show no dependence on diameter.

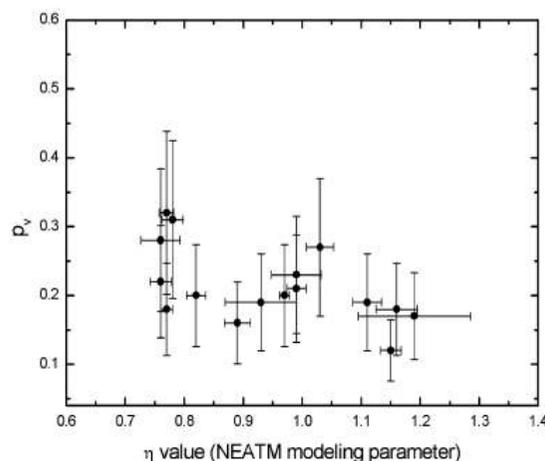


Fig. 5. The derived albedos of the observed Karin cluster asteroids versus the NEATM modeling parameter η . There is a possible trend of decreasing albedo with increasing η .

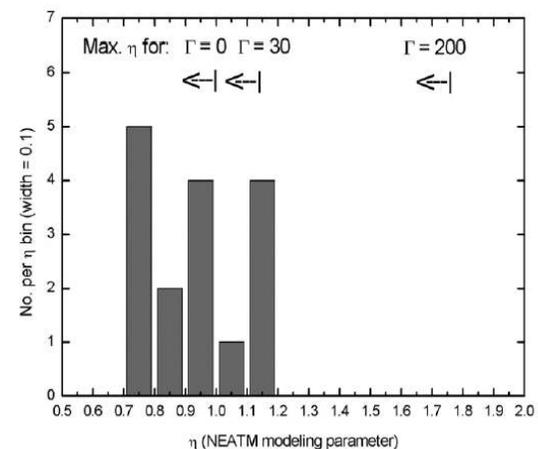


Fig. 6. Histogram of the η -value distribution of the Karin targets. Values of η consistent with thermal inertia $\Gamma = 0, 30, 200 \text{ J m}^{-2} \text{ s}^{-0.5} \text{ K}^{-1}$ for a rotation period of 20 h are indicated; these were calculated using a smooth-sphere thermophysical model and represent maximum values for a sample of objects with random spin-axis orientations and rough (cratered) surfaces. The η -value distribution falls far short of the expected maximum for $\Gamma = 200 \text{ J m}^{-2} \text{ s}^{-0.5} \text{ K}^{-1}$, suggesting the thermal inertia values of the Karin cluster asteroids are much less than those of comparably sized near-Earth asteroids.

The surface of (136108) Haumea (2003 EL₆₁), the largest carbon-depleted object in the trans-Neptunian belt

N. Pinilla-Alonso¹, R. Brunetto^{2,3}, J. Licandro⁴, R. Gil-Hutton⁵, T. L. Roush⁶, and G. Strazzulla³

- 準惑星 Haumea (2003 EL₆₁) は可視で平坦なスペクトルを示し、近赤外で水氷の吸収帯を持つ
Pinilla-Alonso et al. (2007)
- 4.2m William Herschel望遠鏡
可視低分散分光 (0.35 - 0.98 μm)
- 3.6m イタリア国立Galileo望遠鏡
近赤外低分散分光 (0.8 - 2.5 μm)
- どの面でもほぼ同じのスペクトル
⇒ 表面は一様

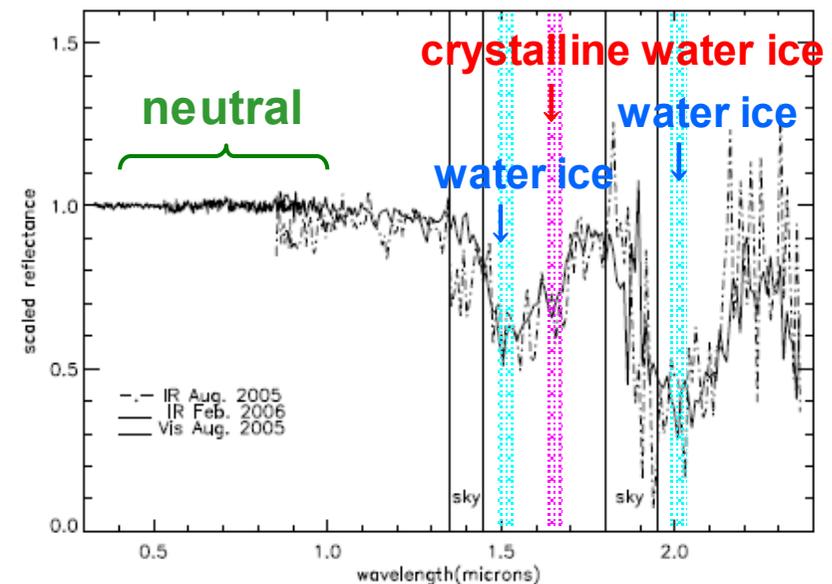
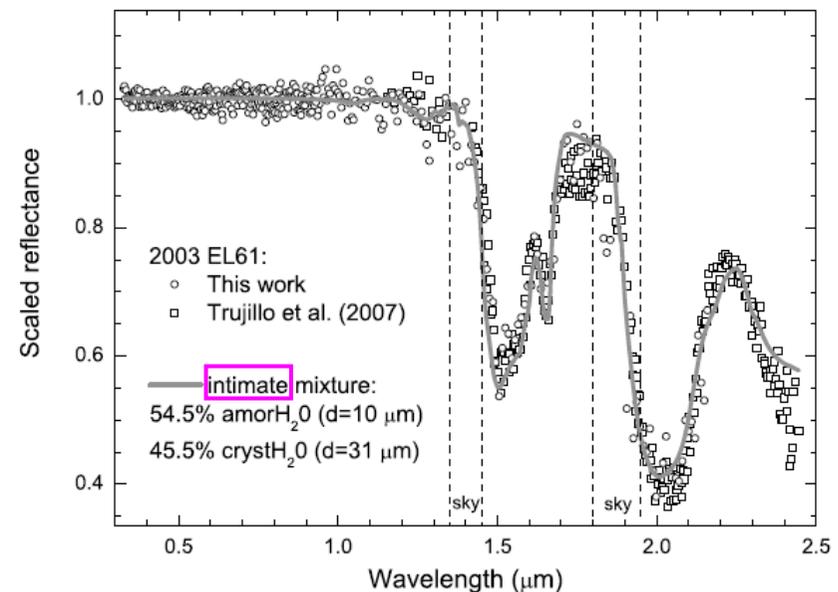
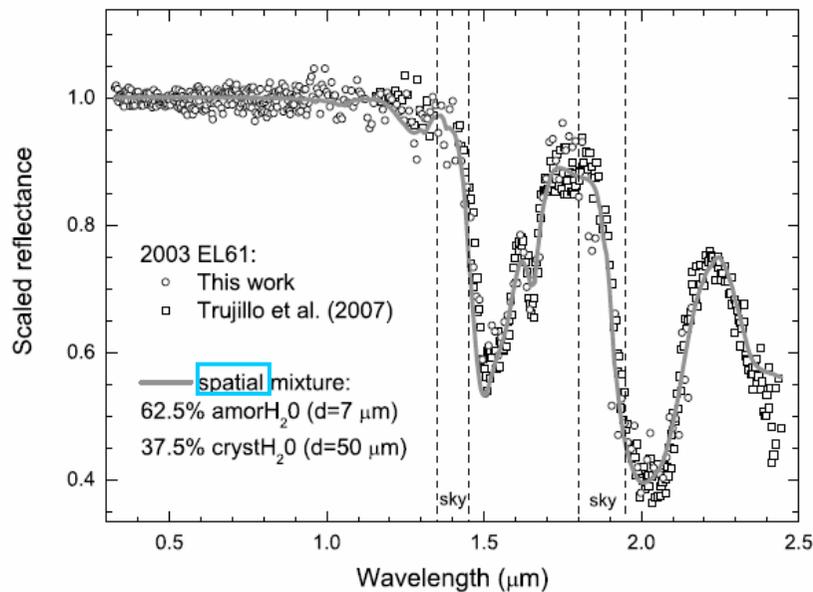
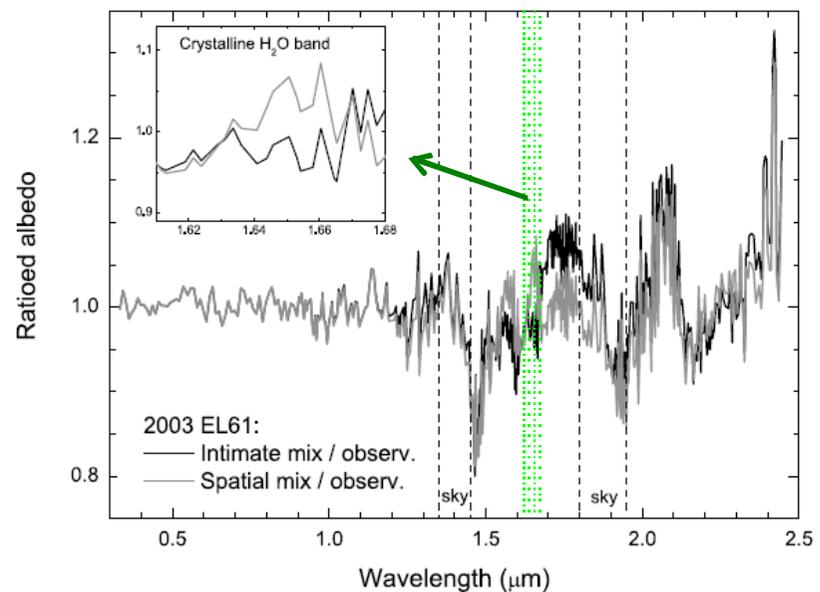


Fig. 1. VIS (2005) and NIR (2005 and 2006) spectra of 2003 EL₆₁. IR spectra match within the errors. Red slope below 1 μm in 2005 NIR spectrum can be a result of the centering of the object in the slit. Uncertainties are given by the point to point variation.



- 100%の結晶質水氷やアモルファス水氷では再現できない
 - 両者のspatialな混合では1.65 μmの吸収を再現できない
 - 両者のintimateな混合モデルなら観測スペクトルを良く再現できる
- ⇒ amorphous / crystalline の比はおよそ1:1



■ 上層crystalline 60%、amorphous 40%の混合物、下層crystalline 100%の2層構造モデルは、観測スペクトルをより良く再現

特に1.65 μm 吸収帯の深さを

■ 他の物質が混じると再現度が低下

NH_3 (<5%)、poly-HCN (<5%)、 CH_4 (<5%)、 CO_2 (<6%)、 NH_4OH (<8%)
Serpentine (<7%)、kaolinite (<4%)、orthopyroxene (<7%)、olivine (<5%)

⇒ ほぼ純粋な水氷でできている

cryovolcanism

■ resurfacingの原因は氷火山ではない

↑ NH_4OH が含まれていないから

■ 炭素はほとんど含まれていない (<5%)

