Optical Depth & Albedo of Ejecta from DEEP IMPACT

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The goal

- To extract some physical properties of the cometary nuclei from DEEP IMPACT images of 9P/Tempel 1.

Optical Depth & Albedo

$I/I_0 = e^{-\tau}$ where:

τ = optical depth

I = intensity

For simple scattering and absorption:

$\tau = N\sigma$ where:

σ = extinction cross section

N = column density

Optical Depth & Albedo

- A single particle (grain of dust or whatever) scatters light anisotropically.

- For a single particle: $I = F_{sun} \sigma\ p\ f(\theta)$, where:
  - p = geometric albedo
  - $f(\theta)$ = scattering function (θ = phase angle)
  - F_{sun} = solar flux received by the comet

Method

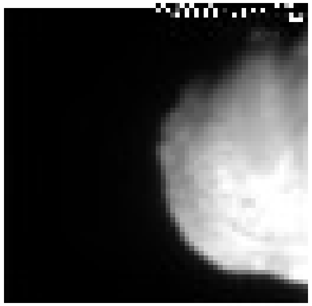
- We use the approximation that the optical depth is not large so that I(column) = N*I(particle). Then we have:

$$I = F_{sun}\, \tau\, p\ \ f(\theta)$$

The Data

- Deep Impact – MRI VIS Calibrated Images 9P/Tempel 1 Encounter Phase

  DOY 2005-185 (2005-07-04)



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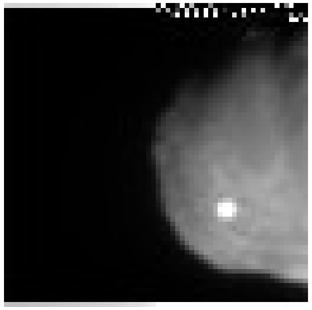

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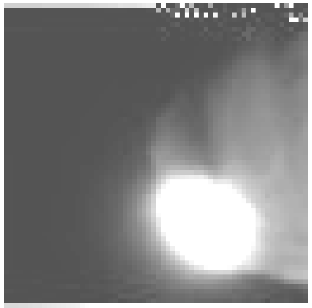

t=+1.454 s

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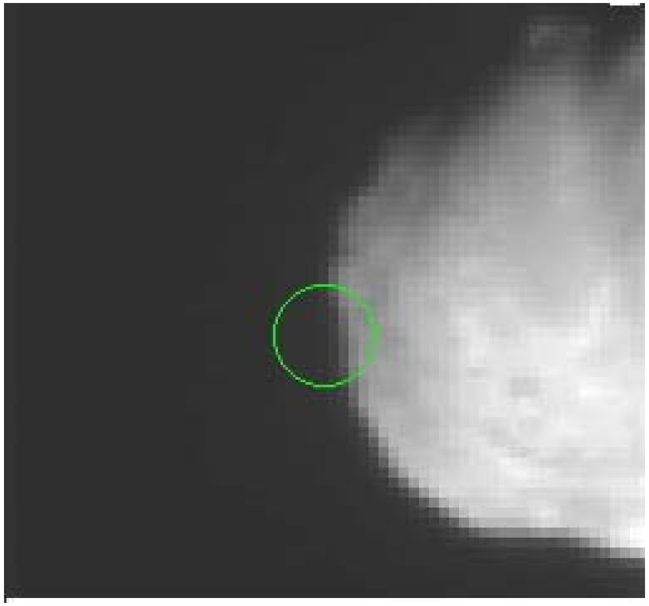
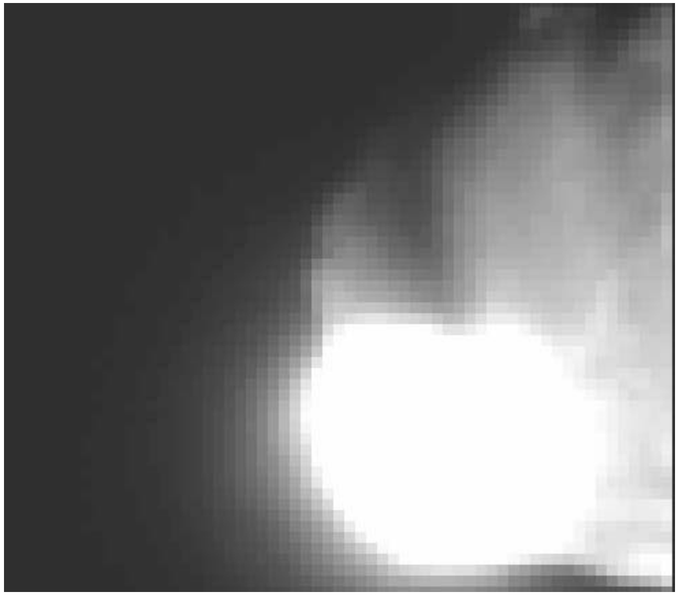
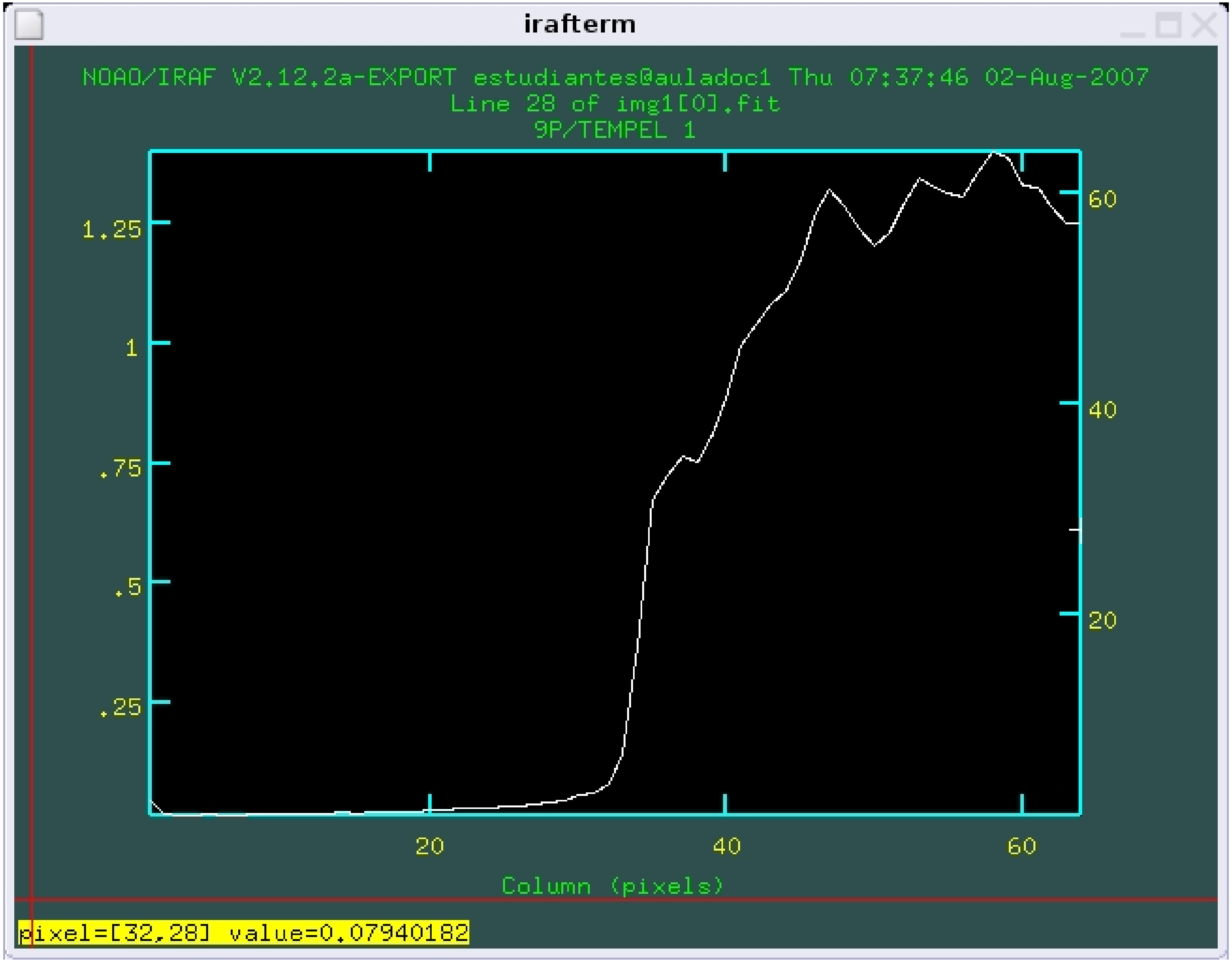
Making the measurements





We selected a feature on the sunward side of the impact site, close to the limb (better contrast).


irafterm
NOAO/IRAF V2.12.2a-EXPORT estudiantes@auladoc1 Thu 07:37:46 02-Aug-2007
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9P/TEMPEL 1
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1
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.5
.25
60
40
20
20
40
60
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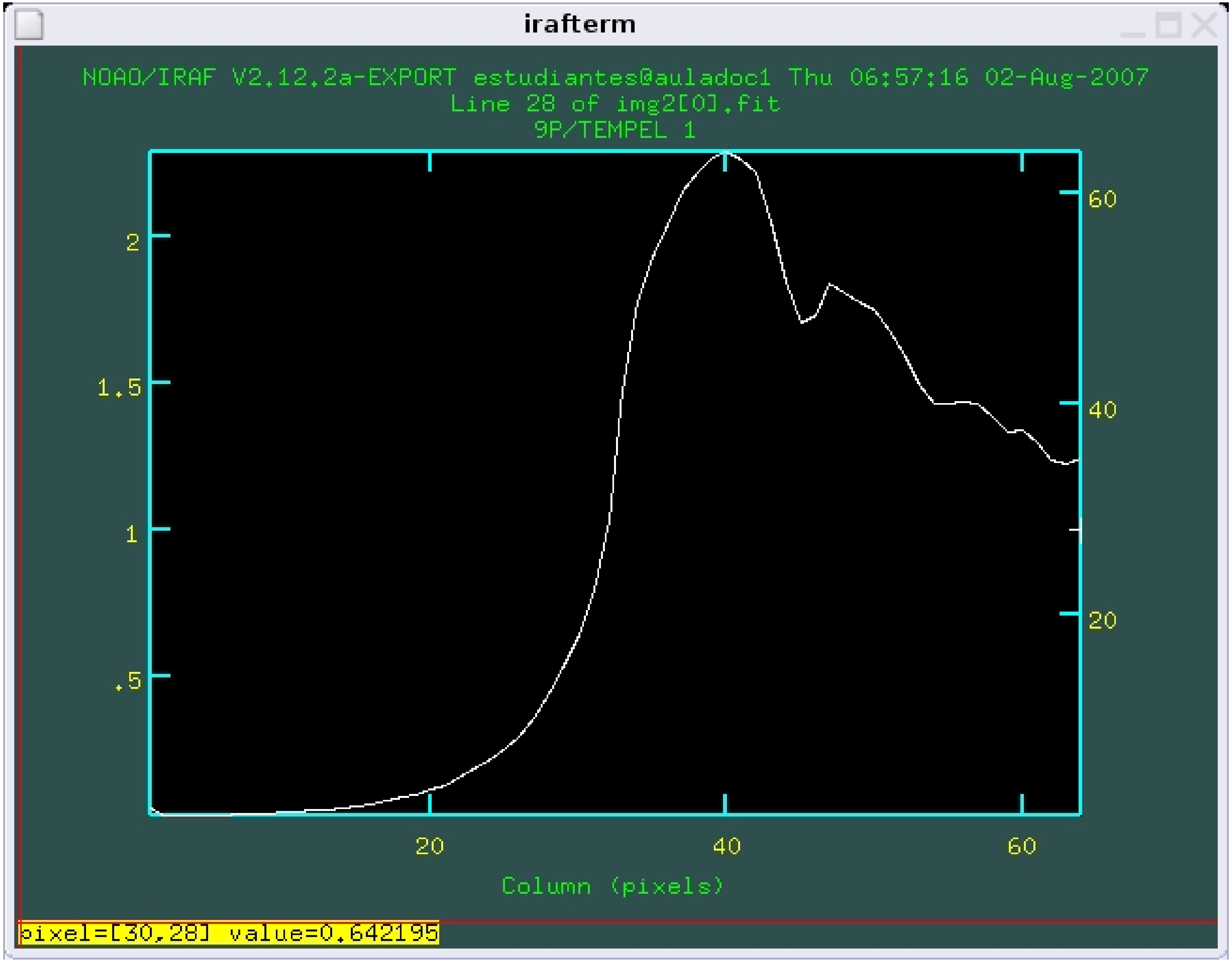
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2
1.5
1
.5
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40
20
20
40
60
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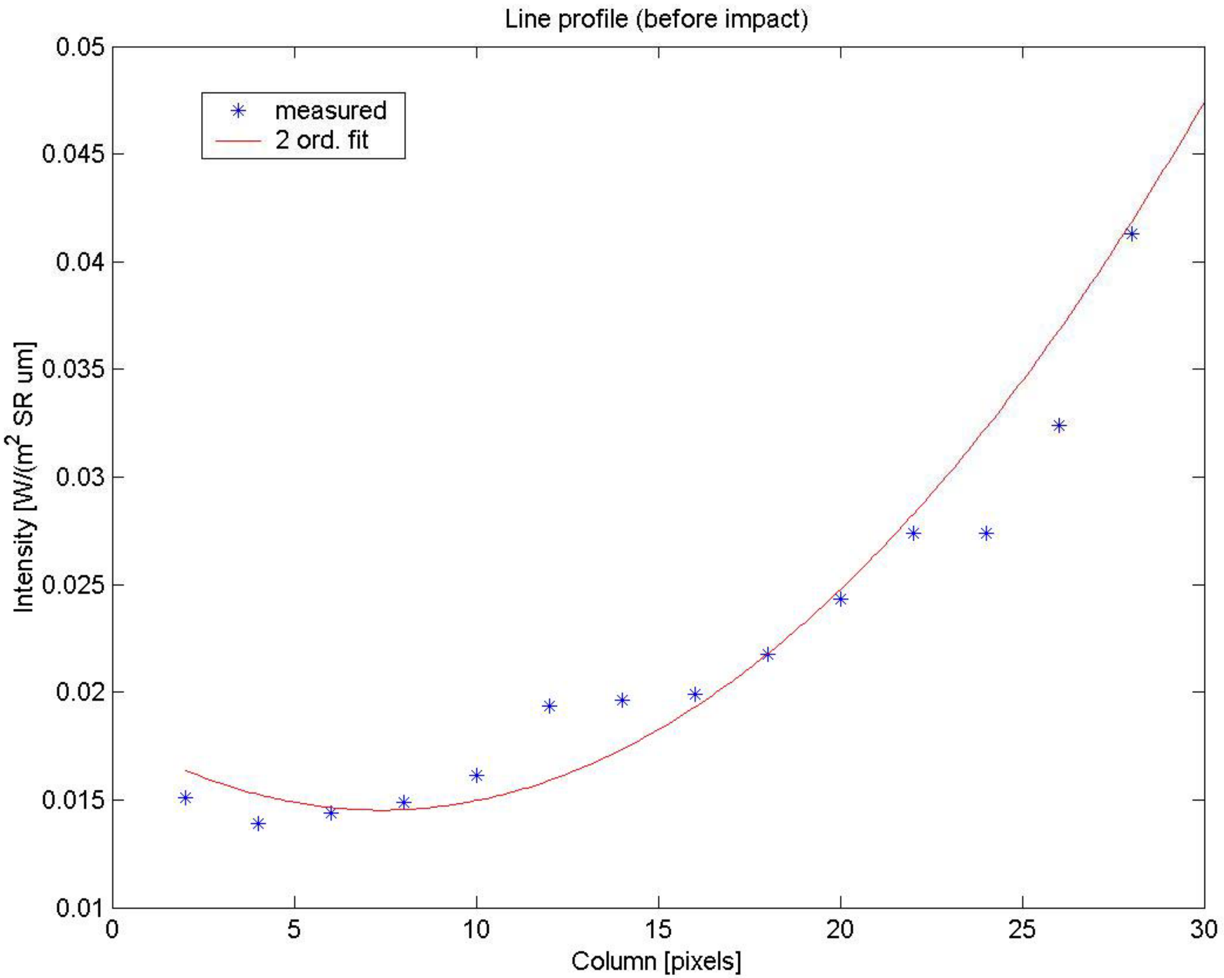
Extrapolating the coma brightness (I_0)



Very Preliminary Results

- We made a rough estimate of the optical depth and then of the albedo of the ejecta.
- Values used:
  - $\theta = 62^o$, from the label file
  - $f(\theta) = 0.0595$, from Lumme-Bowell law
  - $F_{sun} = \dfrac{L_{sun}}{4\pi r^2}$

(heliocentric distance r = 1.5 UA, from the label file)

<u>Very</u> Preliminary Results

$$\tau = \log(I / I_o) = 2.45 \longrightarrow P = \frac{I}{F_{sun}\,\tau f(\theta)} = 0.01$$

The value obtained is lower than the standar value for cometary nuclei (P = 0.04).

To be continued...

- Improve the technique by adjusting the scale and offset before register the images (to make sure that we make all measurements at the same feature on all images).
- Extending the project by analizing the variation of albedo with position around the limb and with time.

To be continued...

- This can show variations in the type of particles (ice *vs*. dust and organics) both with direction of ejection and with depth of excavation.