Deriving asteroid surface properties using light scattering simulations and laboratory measurements

MIKKO VUORI, ANTTI PENTTILÄ, HANNA PENTIKÄINEN, KARRI MUINONEN, ERIC MACLENNAN, MIKAEL GRANVIK

NORDIC BALTIC ASTRONOMY DAYS 2026


Phaethon's
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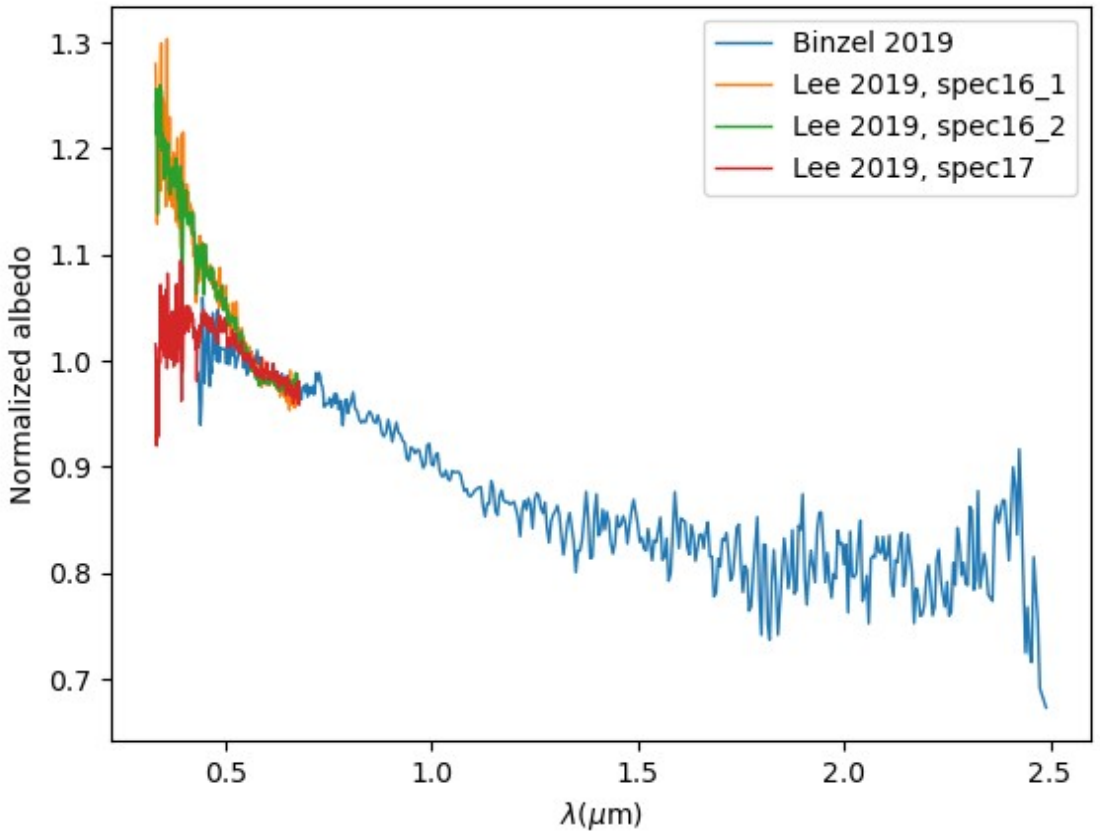
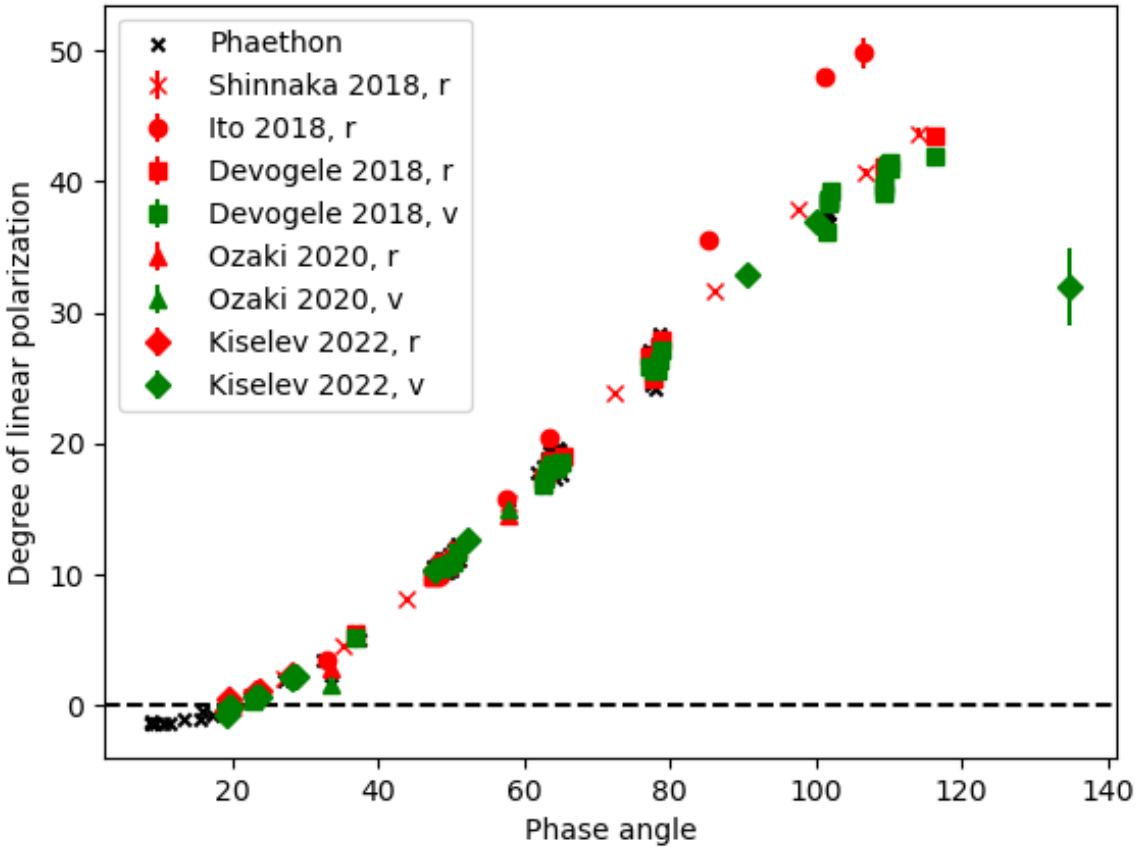
3200 Phaethon

- Near-Earth asteroid
- Active at perihelion (0.14 au from the sun)
- Probable progenitor of the Geminid meteor shower
- Regolith heterogenity between its northern and southern hemispheres

JAXA, DESTINY+ (2028)

Spectra and polarization

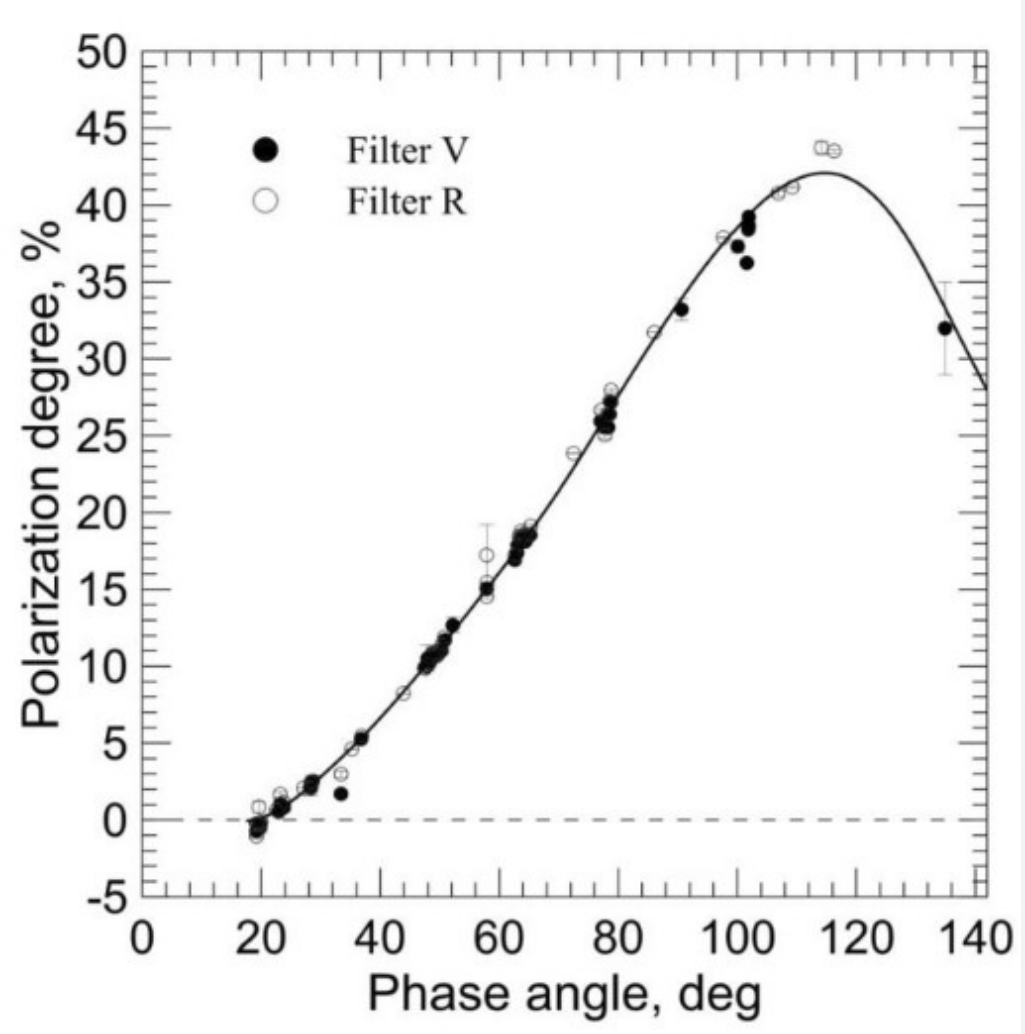




Previous analysis

- Successful polarization modeling has been done in the past
- Best results are mixes of small (1 μm) olivine and graphite

→ Based on polarization the surface has small particles

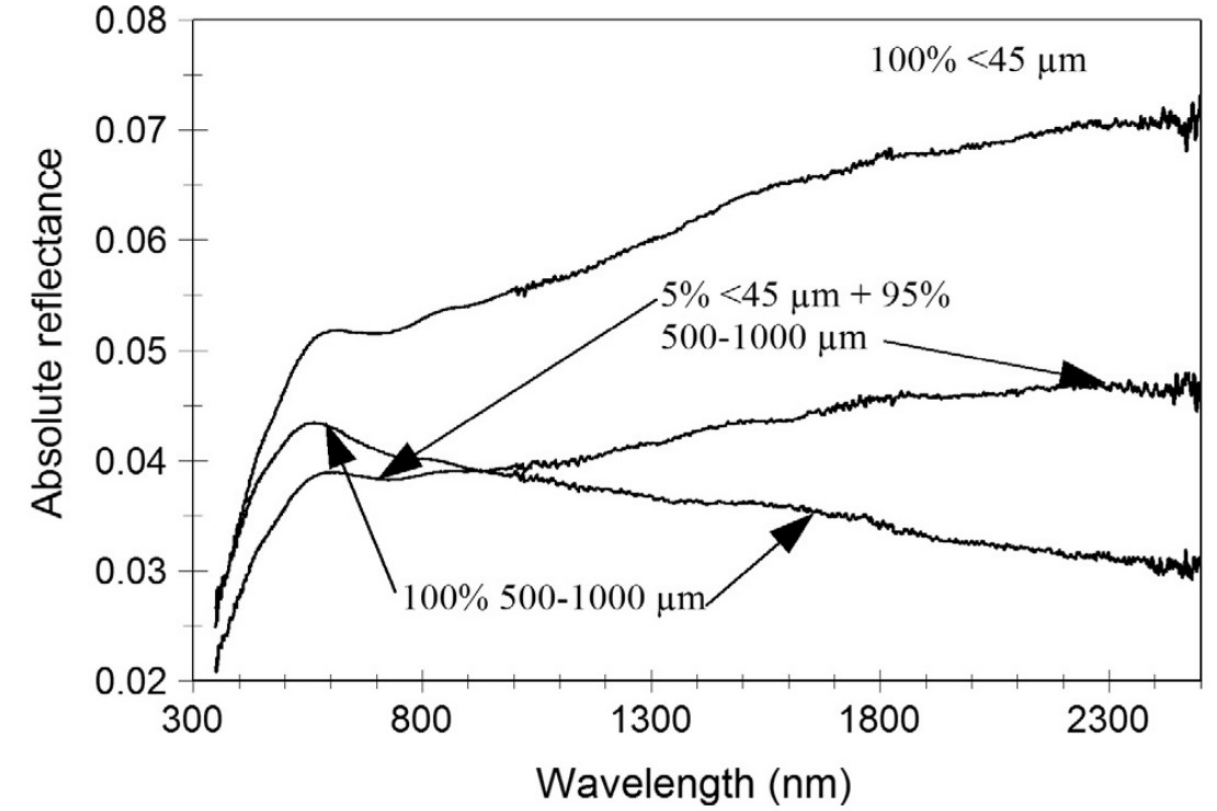


Kiselev et al. 2022

Previous analysis

- Blue spectra seems to require large particles

  → Spectra says there has to be only (quite) large particles



Binzel et al. 2015

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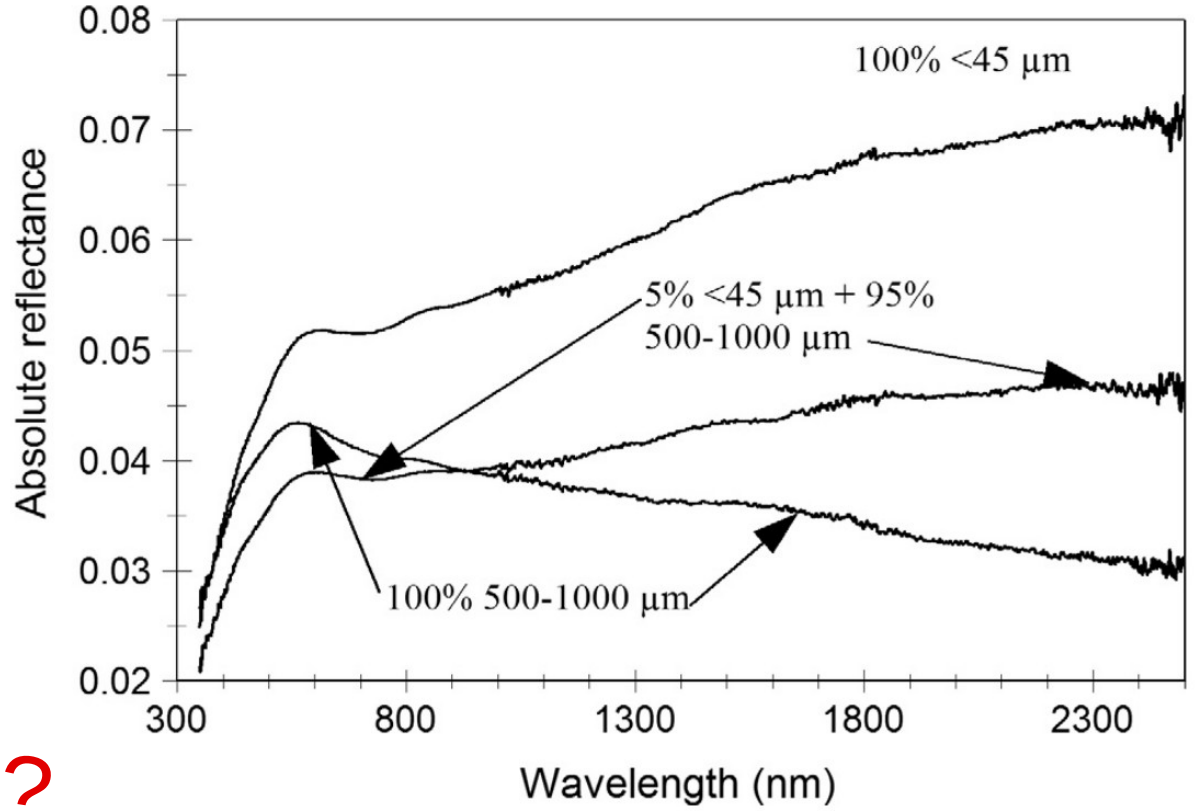
WELL WHICH ONE IS IT ?!?



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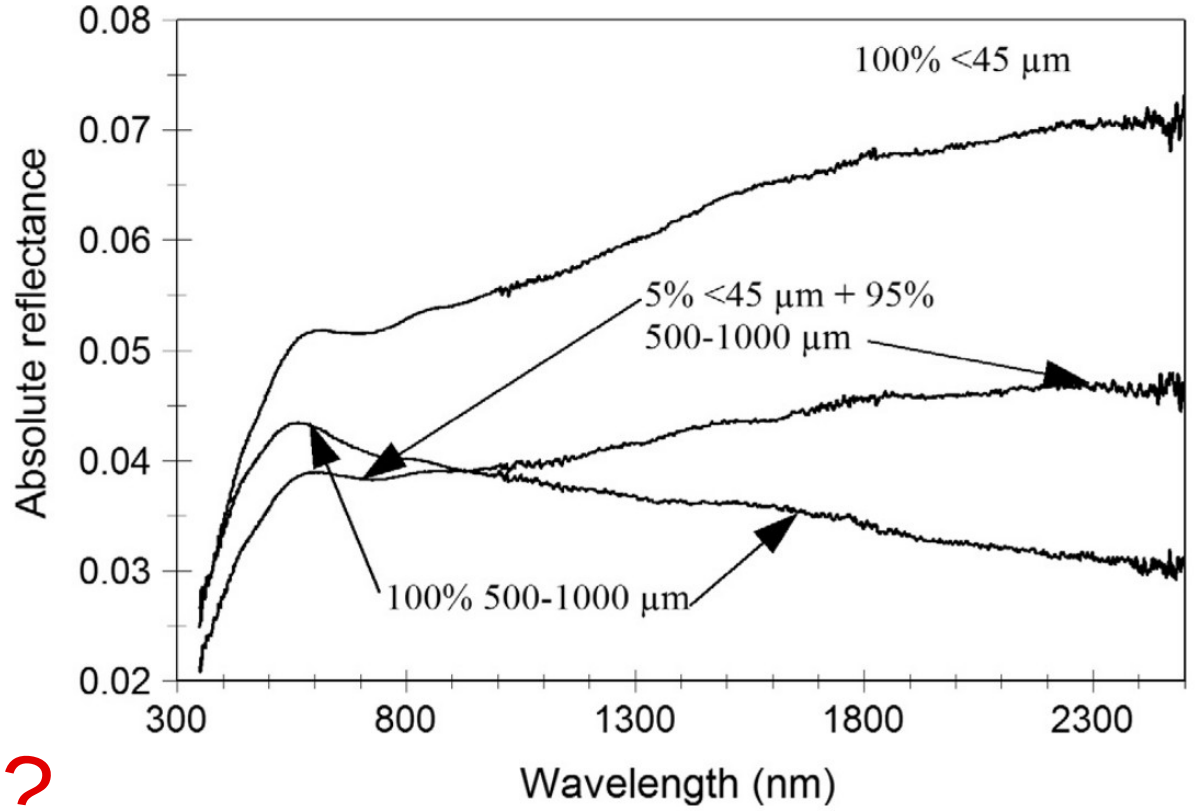
WELL WHICH ONE IS IT ?!?

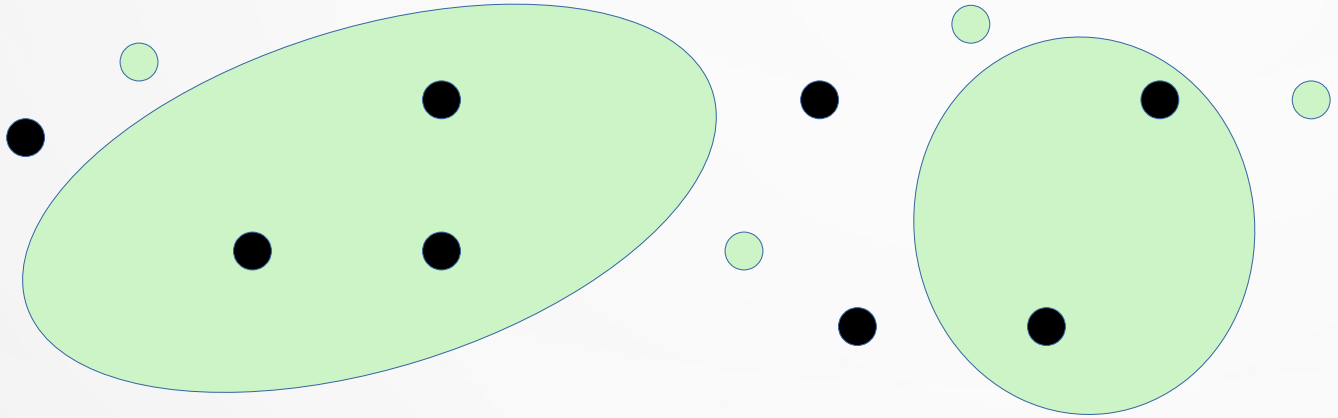
YES!



Binzel et al. 2015

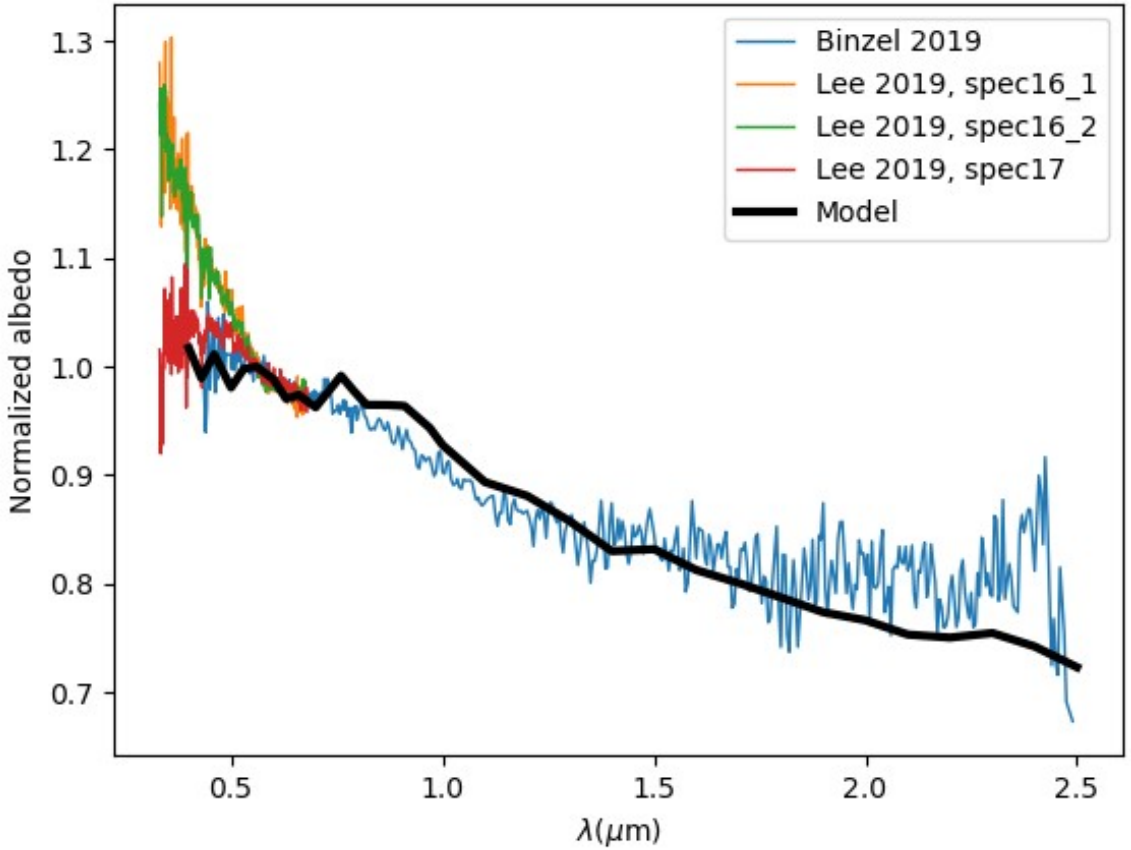
Modeling results

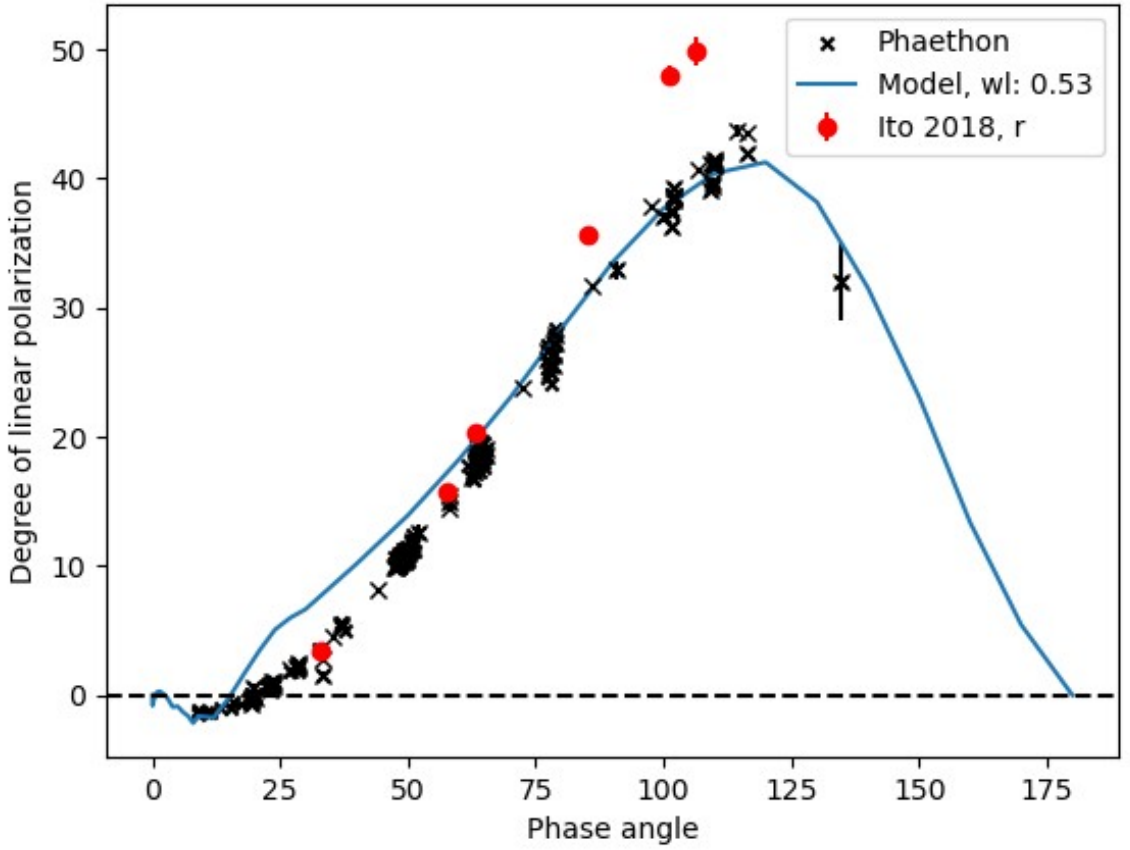
- Best fit model that fits to **both** spectra and polarization:
  - Small (**<1 µm**) dark (troilite) particles …
  - … inside large (**>100 µm**) bright (olivine) particles …
  - … mixed, with same small dark troilite, and …
  - … small (**<1 µm**) bright olivine



There seems to be a lack of particles in the 1-100 µm range

Modeling results



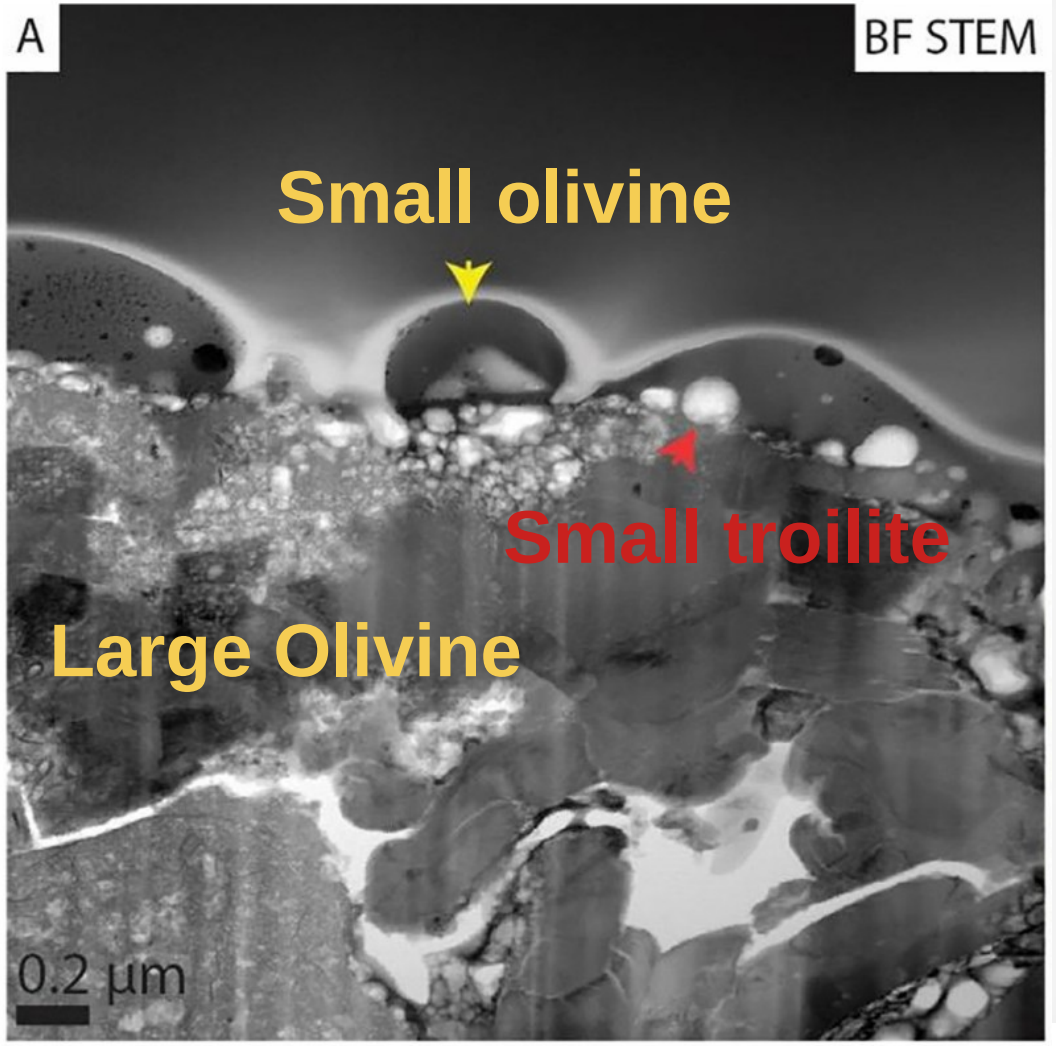


Comparison to meteorites

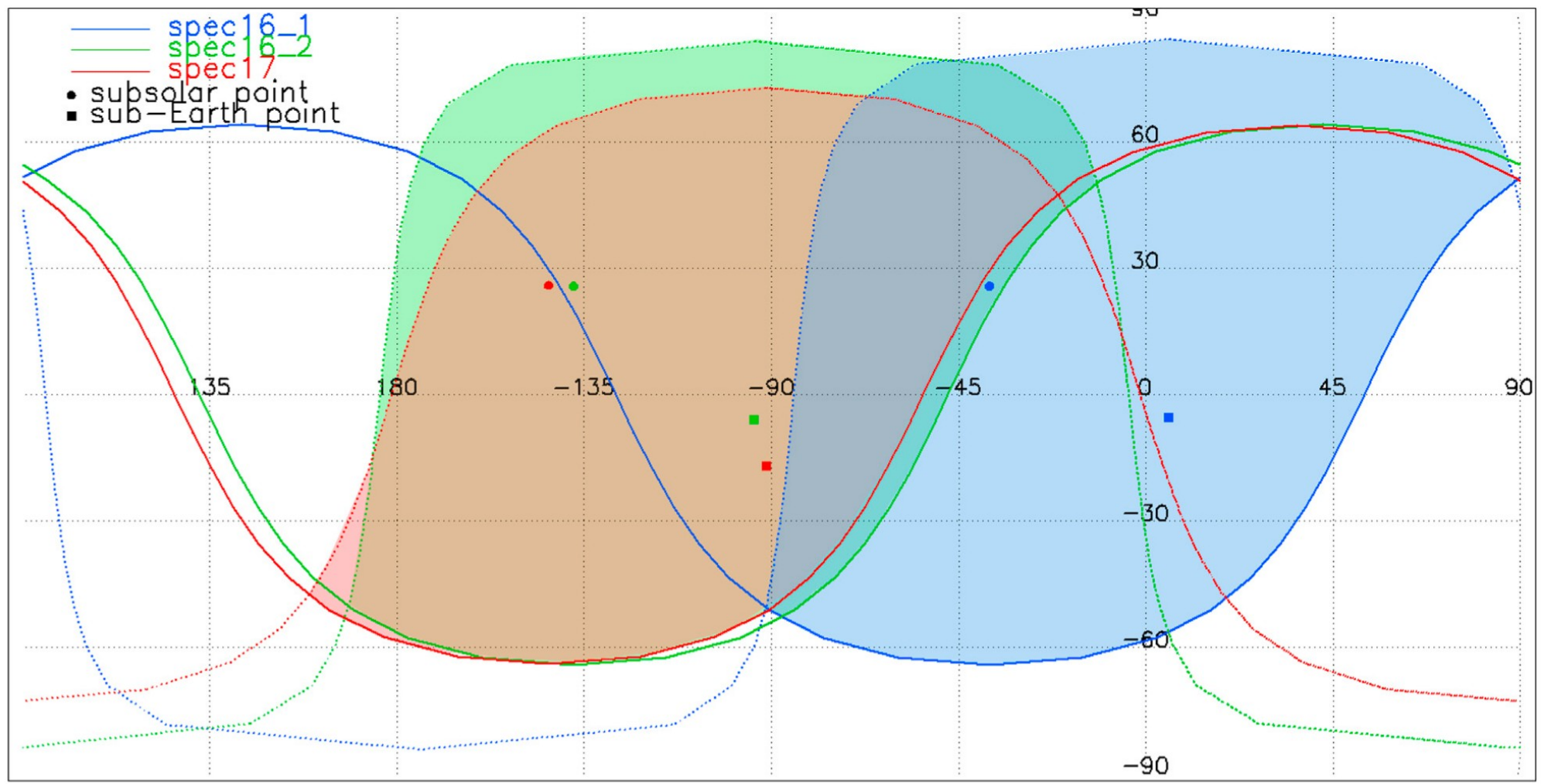
Thompson et al. 2019

- Murchison CM-meteorite has been proposed to come from Phaethon
  → The model seems to second this claim

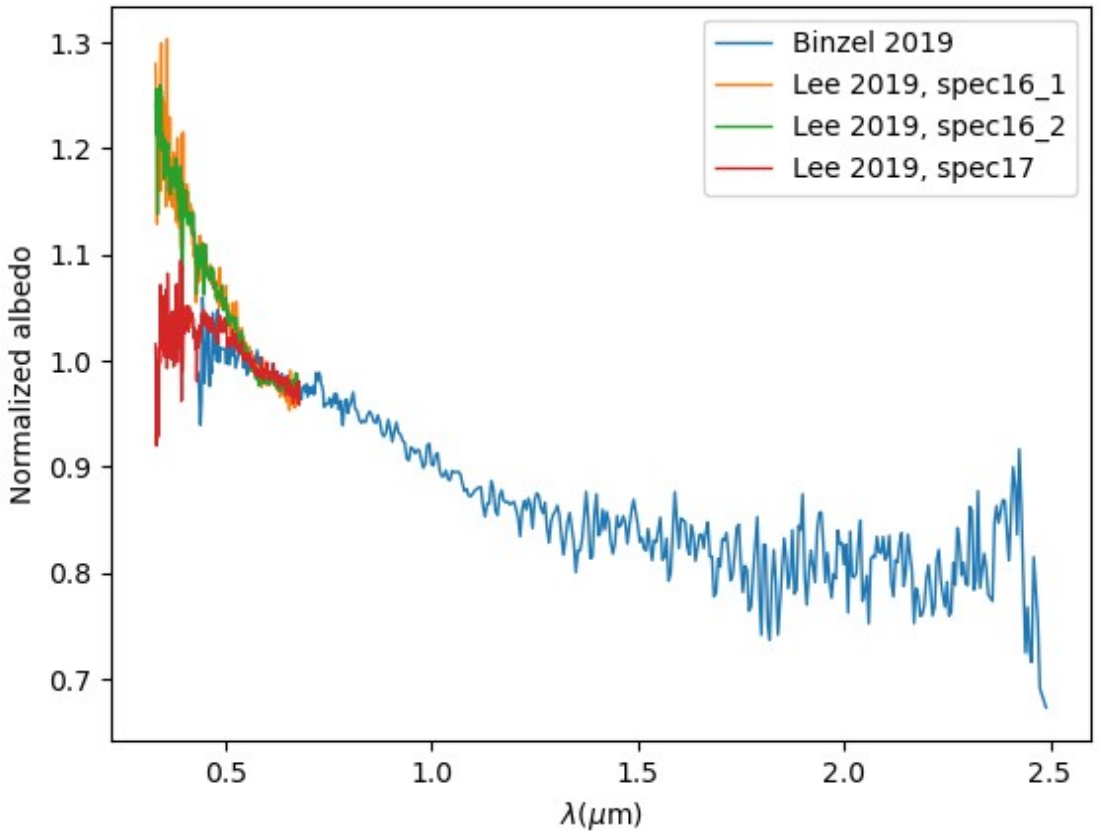
(For two of you in the audience: I am not claiming CM over CY!)

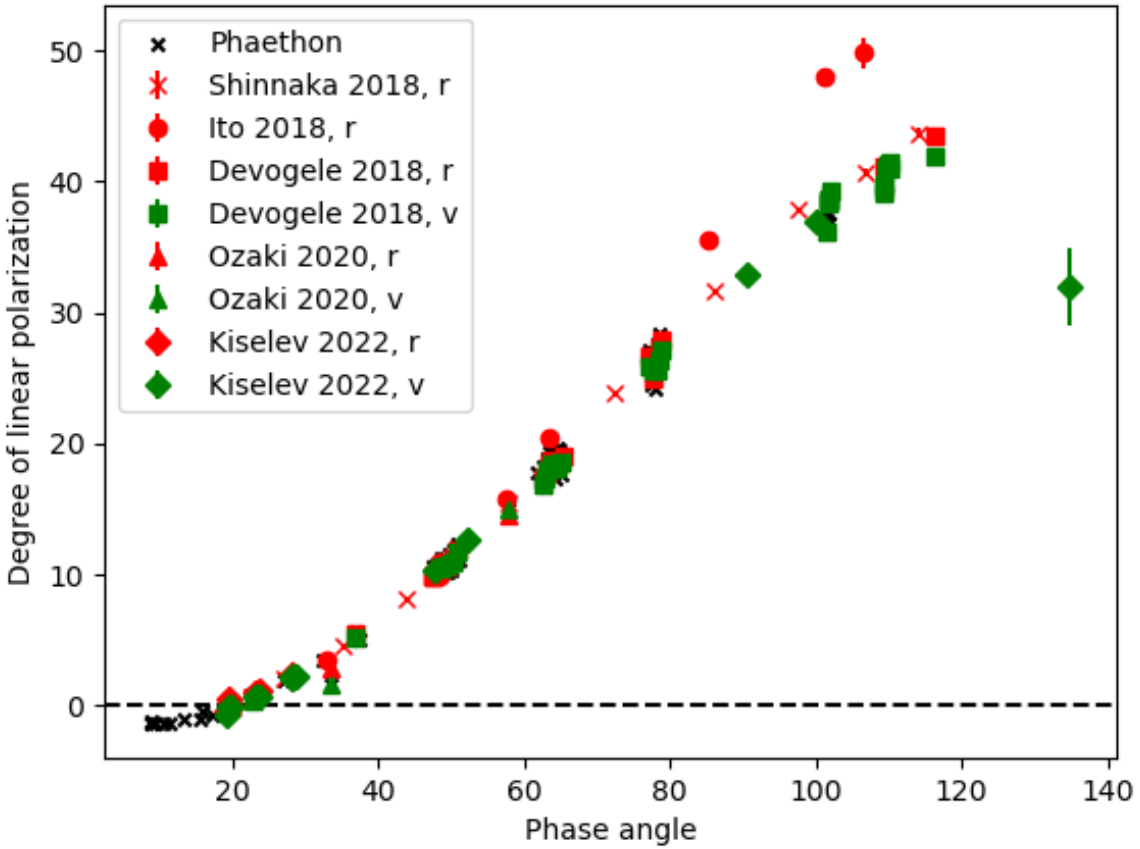


Phaethon surface (Lazzarin et al. 2019)



Spectra and polarization





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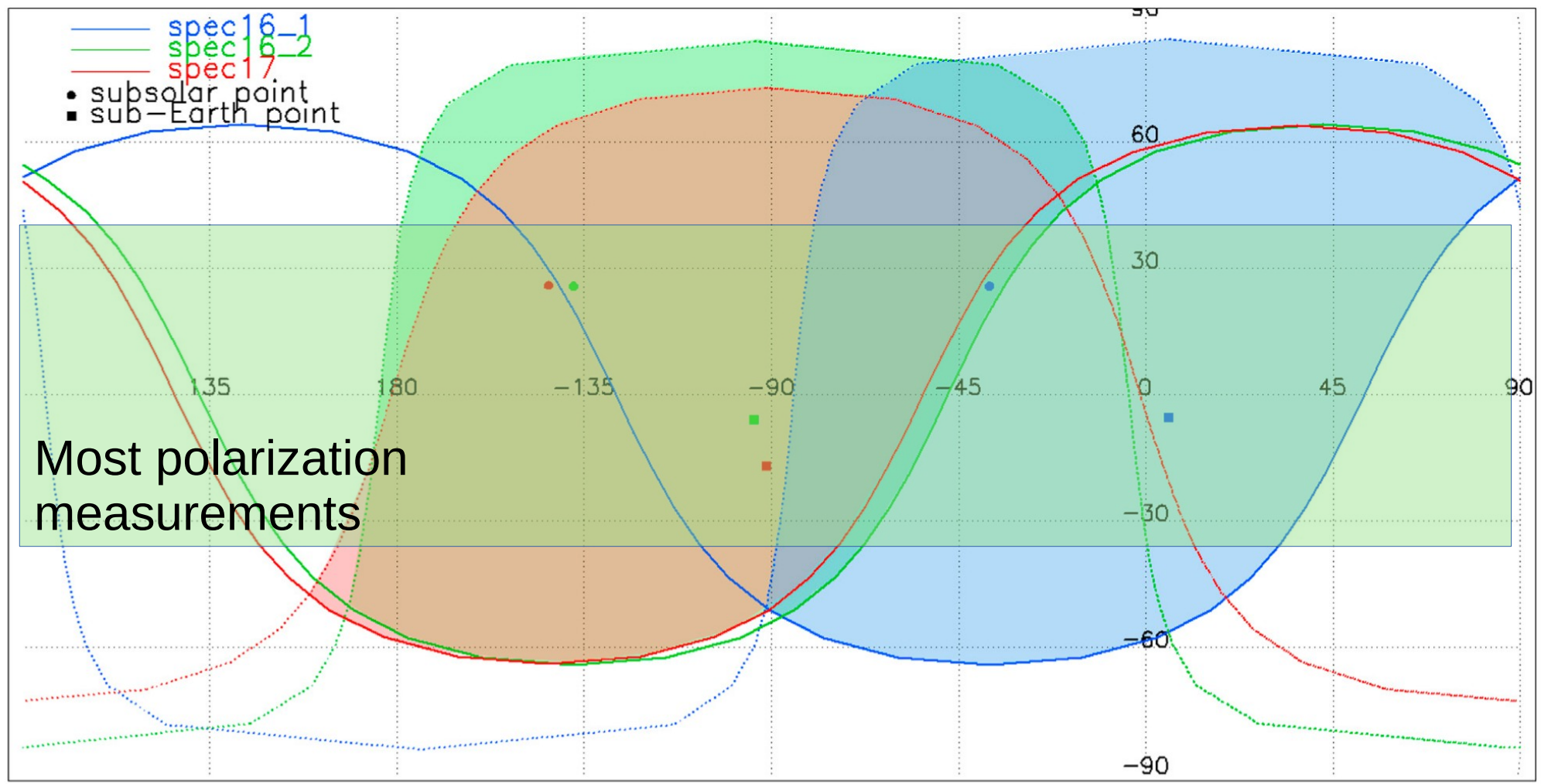

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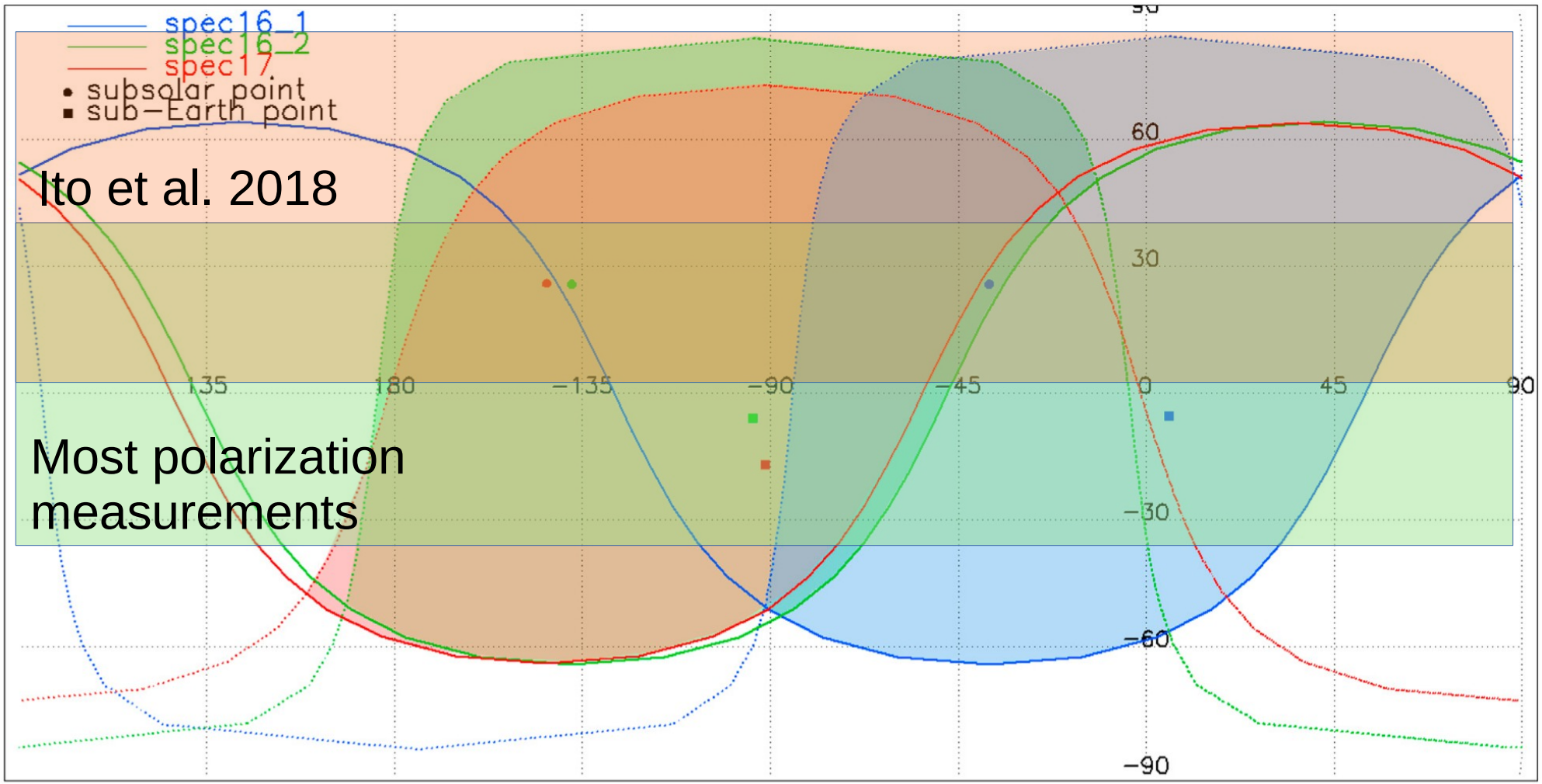

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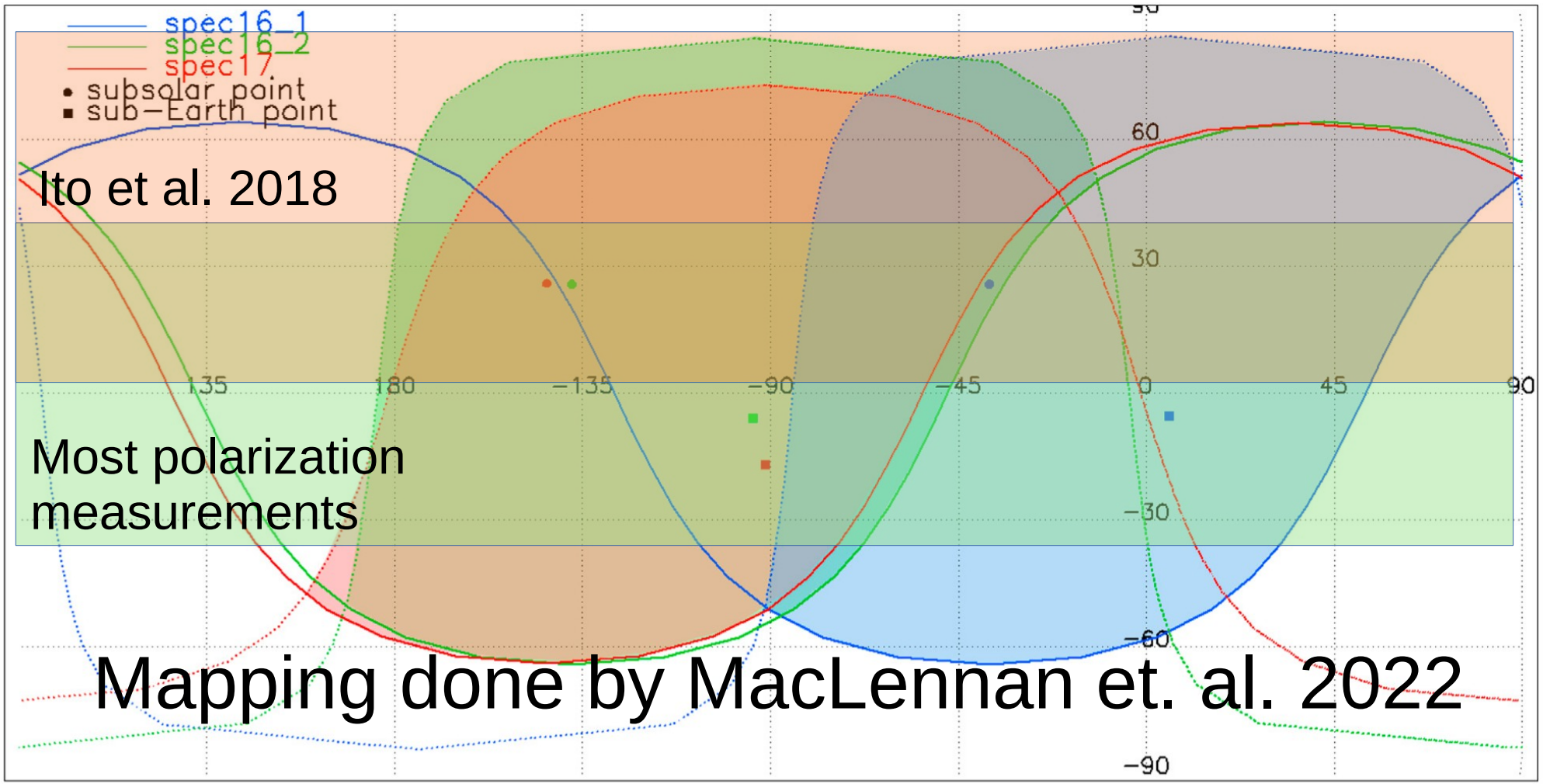

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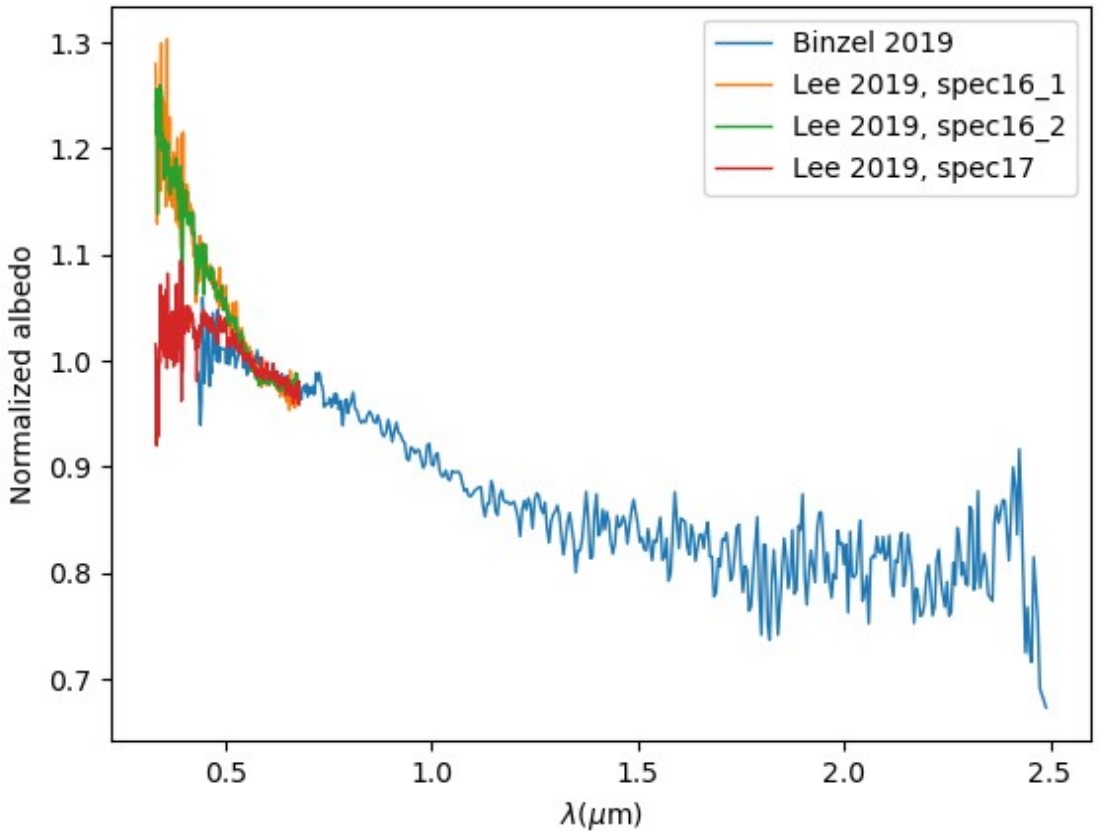

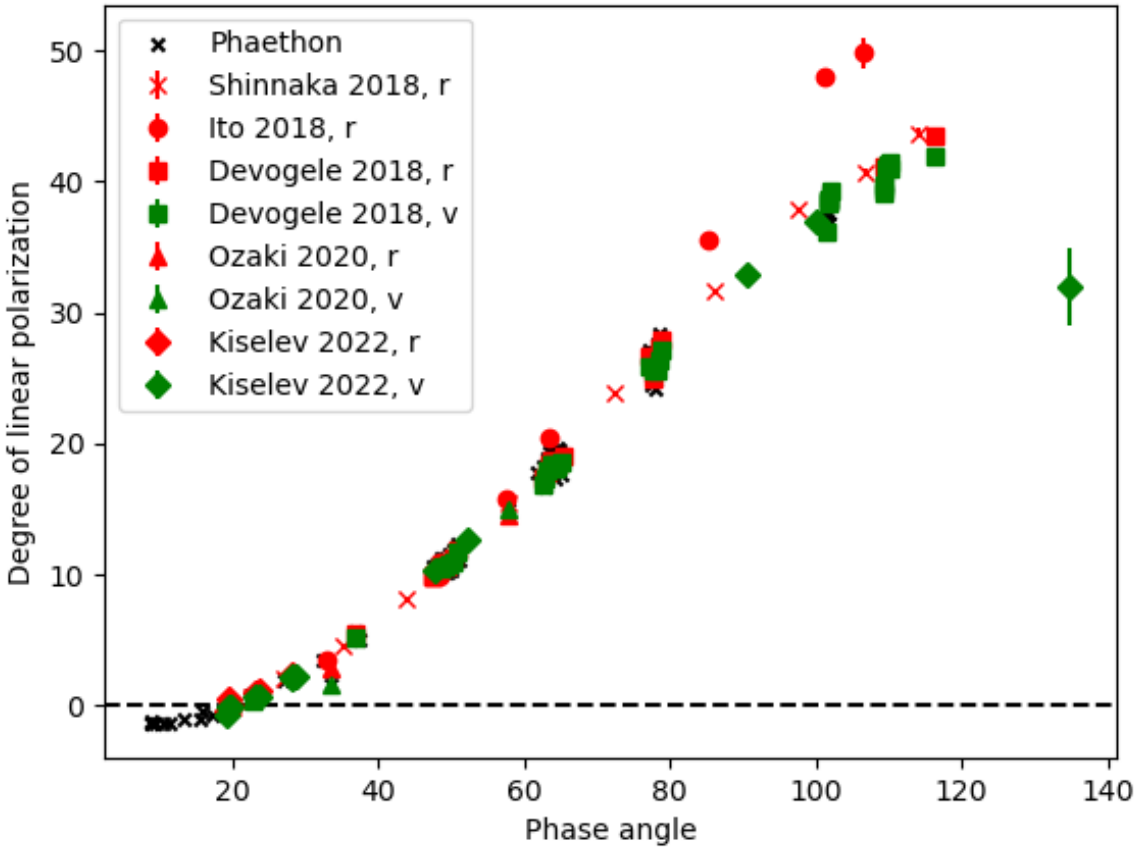

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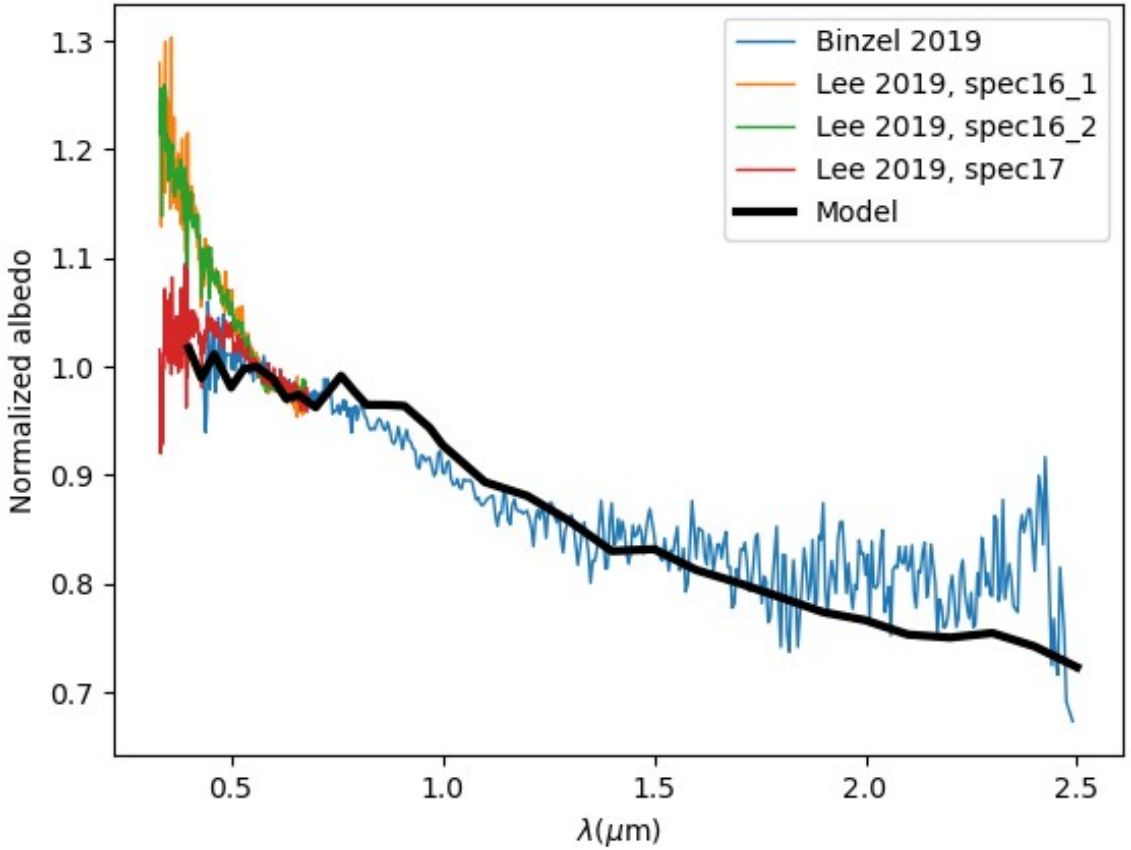

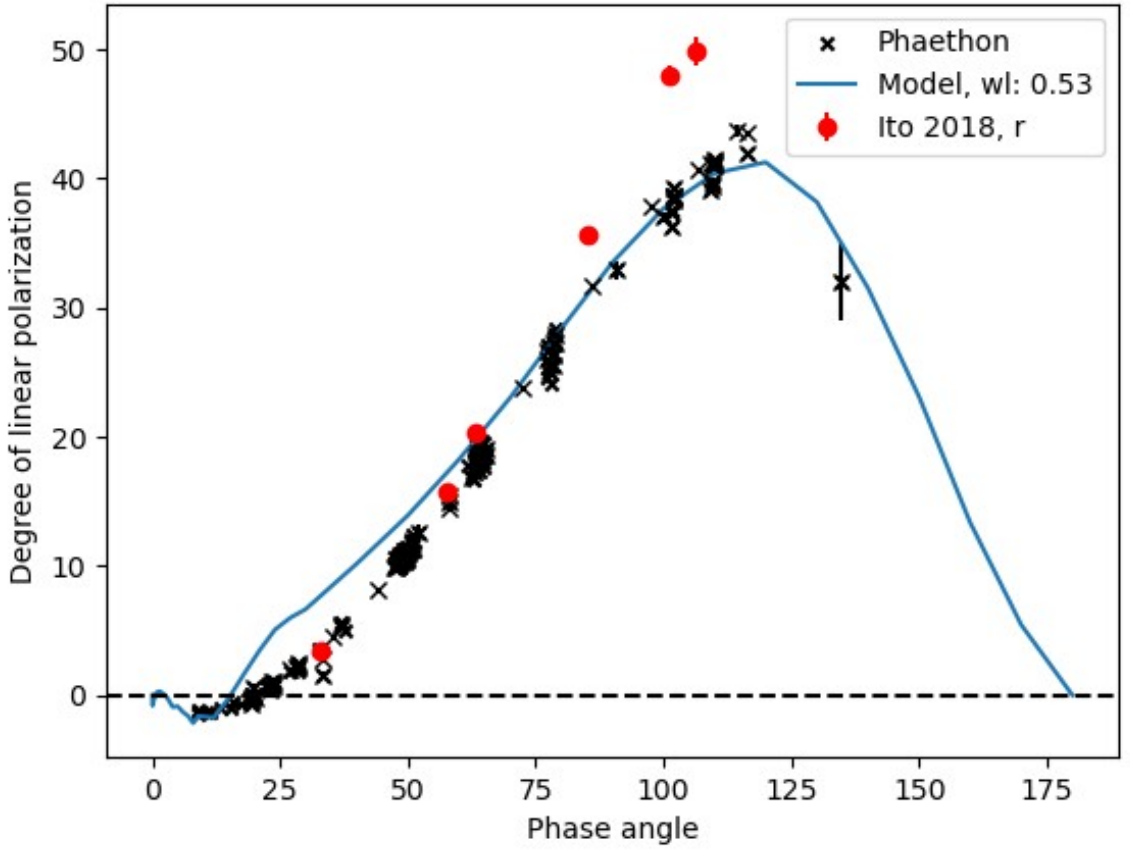

Conclusions

- Light scattering model for Phaethon allows us to:
  → Define the surface particle sizes
  → Analyze the material of the surface
  → Find the cause for the surface heterogenity

- There might be a deficit of particles in 1-100 μm

- The Murchison meteorite seems like a good match for the light scattering model