Observational evidence for a surface evolution trend of JFCs

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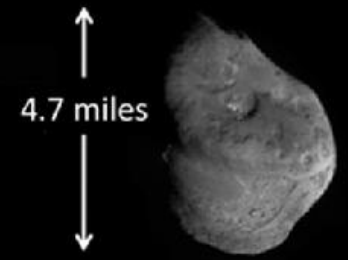
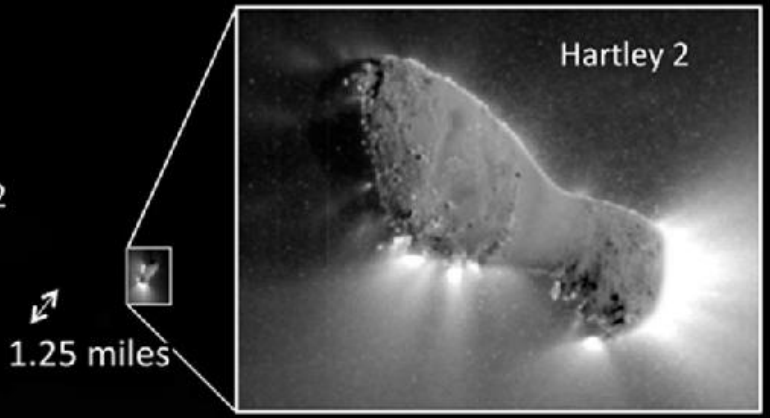


9P/Tempel 1

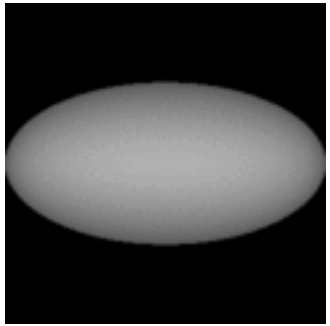
Borrelly

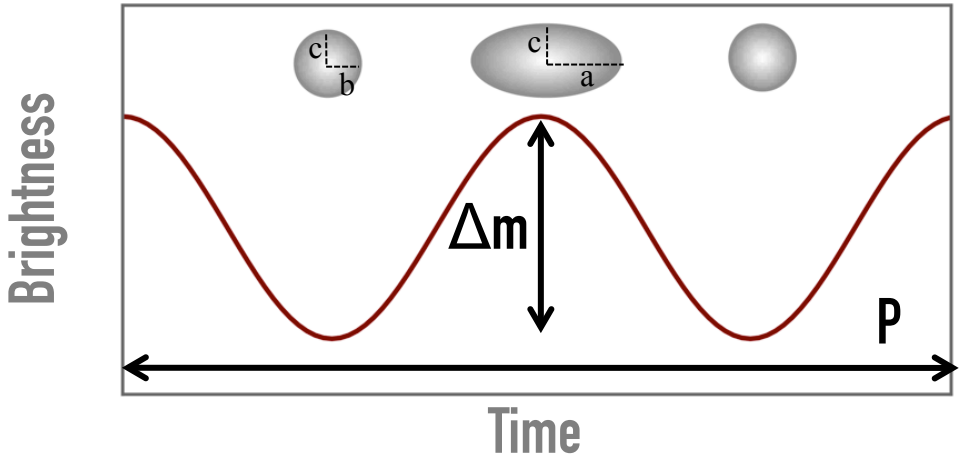
Wild 2



67P/C-G

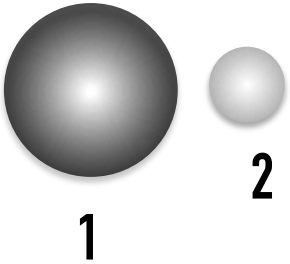
Rotational Lightcurves





Surface

Albedo

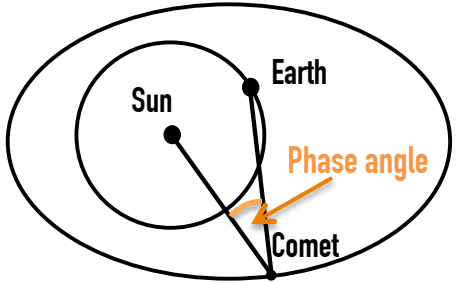


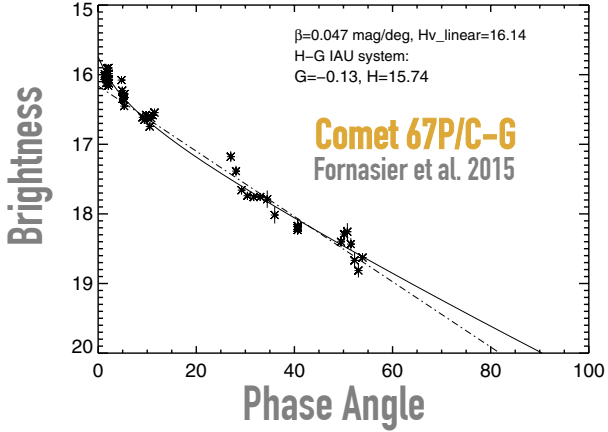
$m_1 = m_2$, $R_1 > R_2$

$A_1 < A_2$

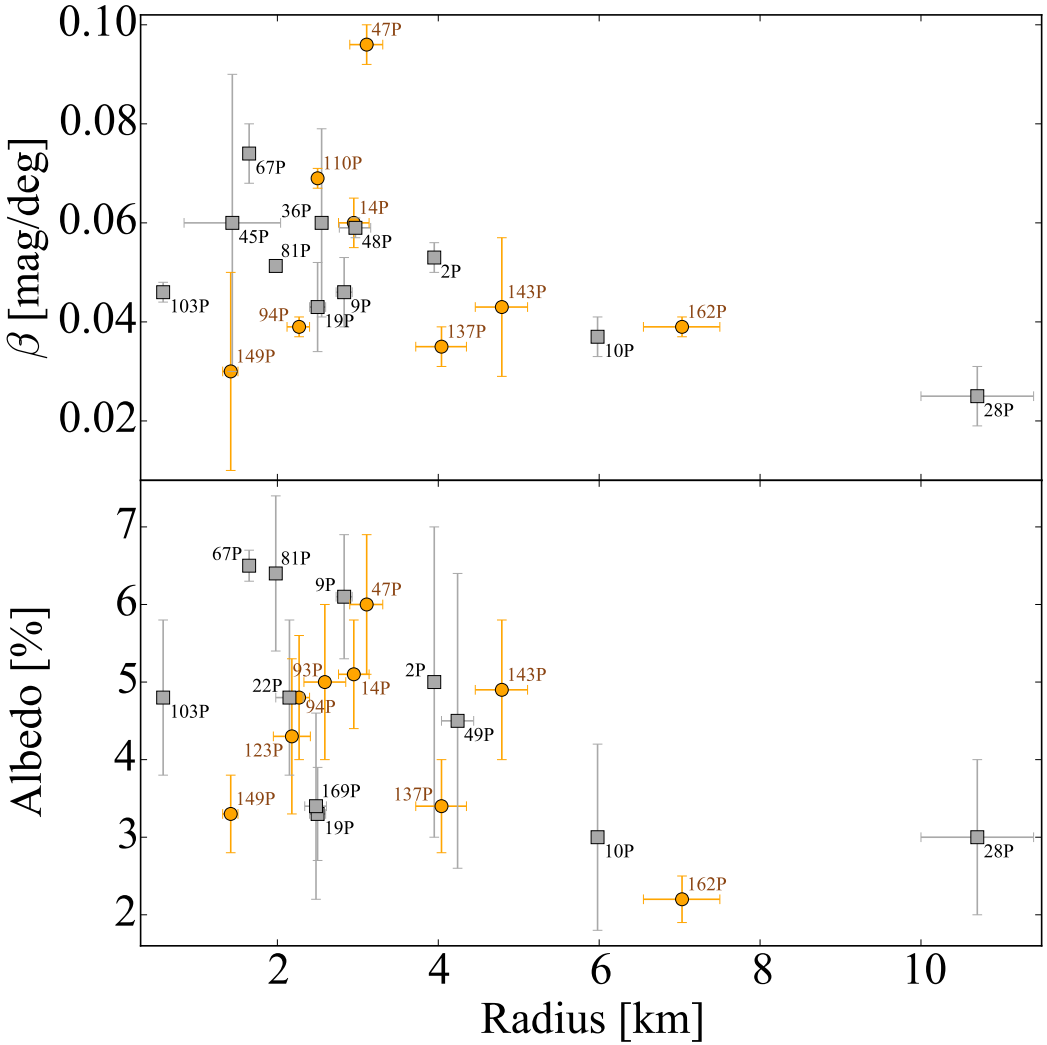
If the size is known
(e.g. thermal IR measurements)

Phase Darkening

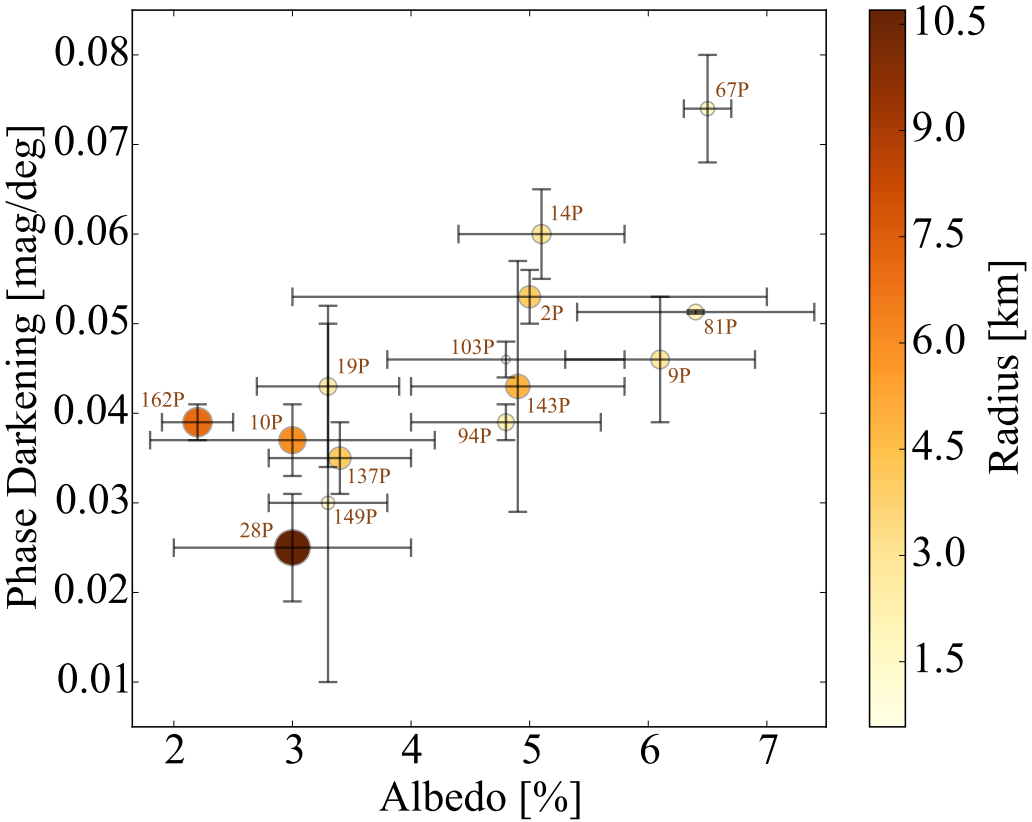




JFC Surfaces

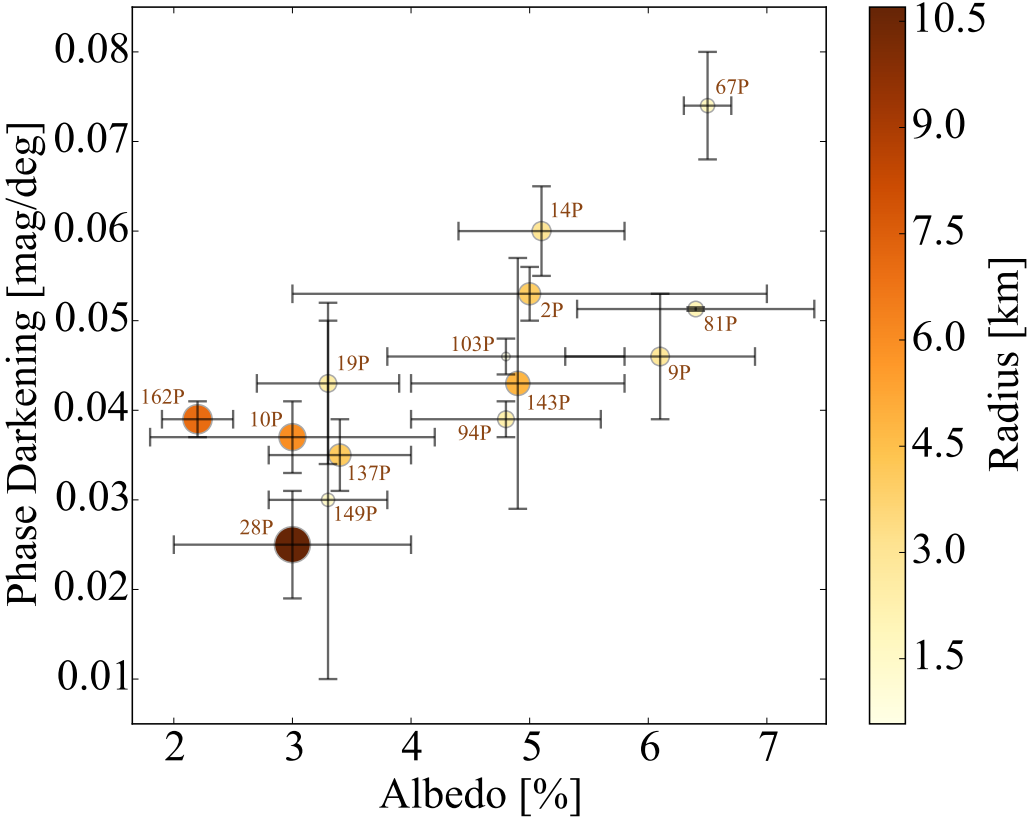


JFC Surfaces

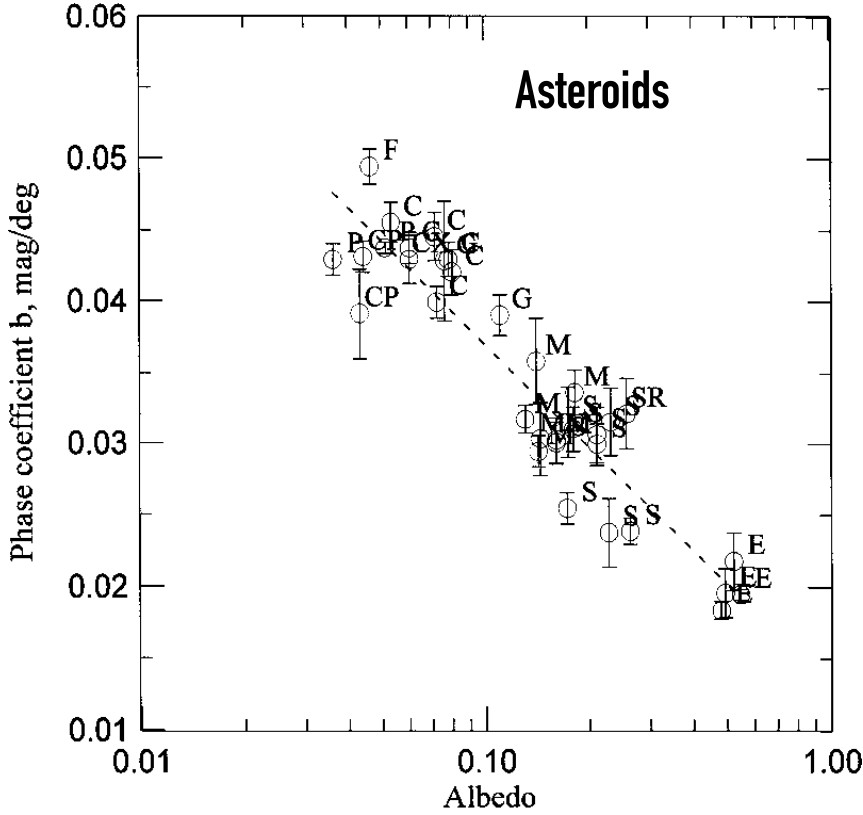


Kokotanekova et al. 2018

JFC Surfaces

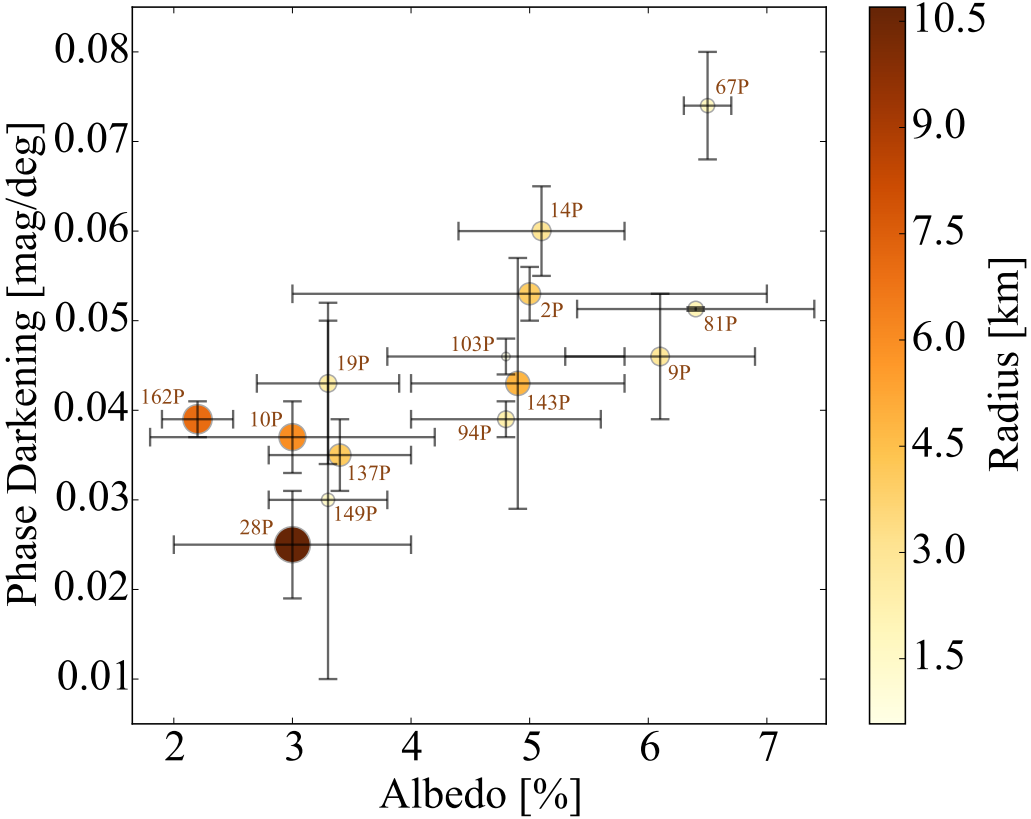


Kokotanekova et al. 2018

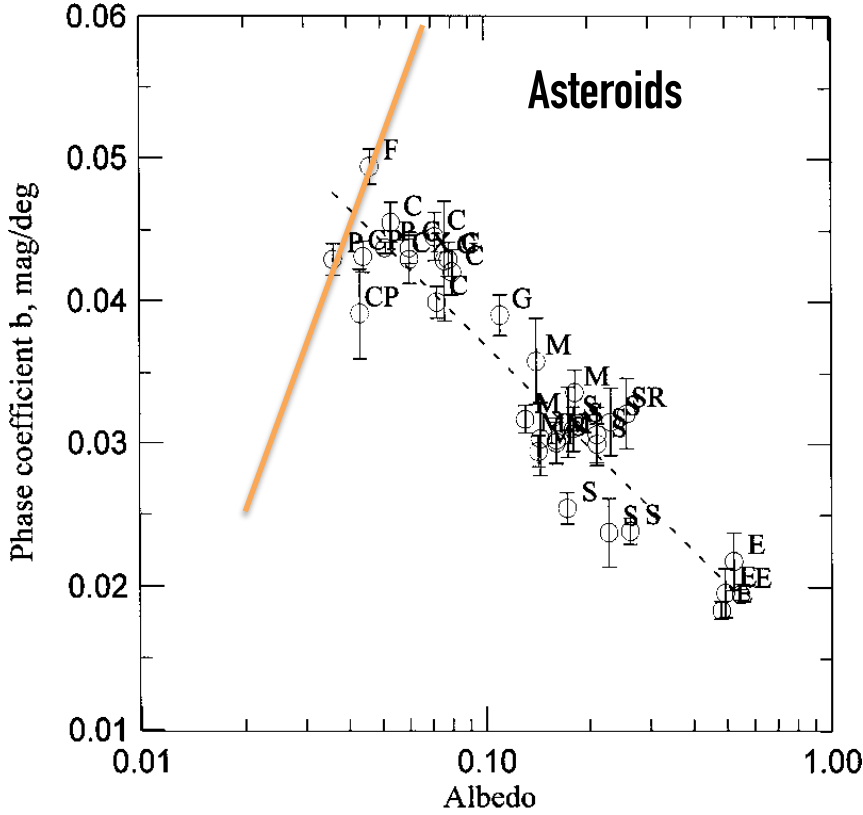


Belskaya & Shevchenko. 2000

JFC Surfaces

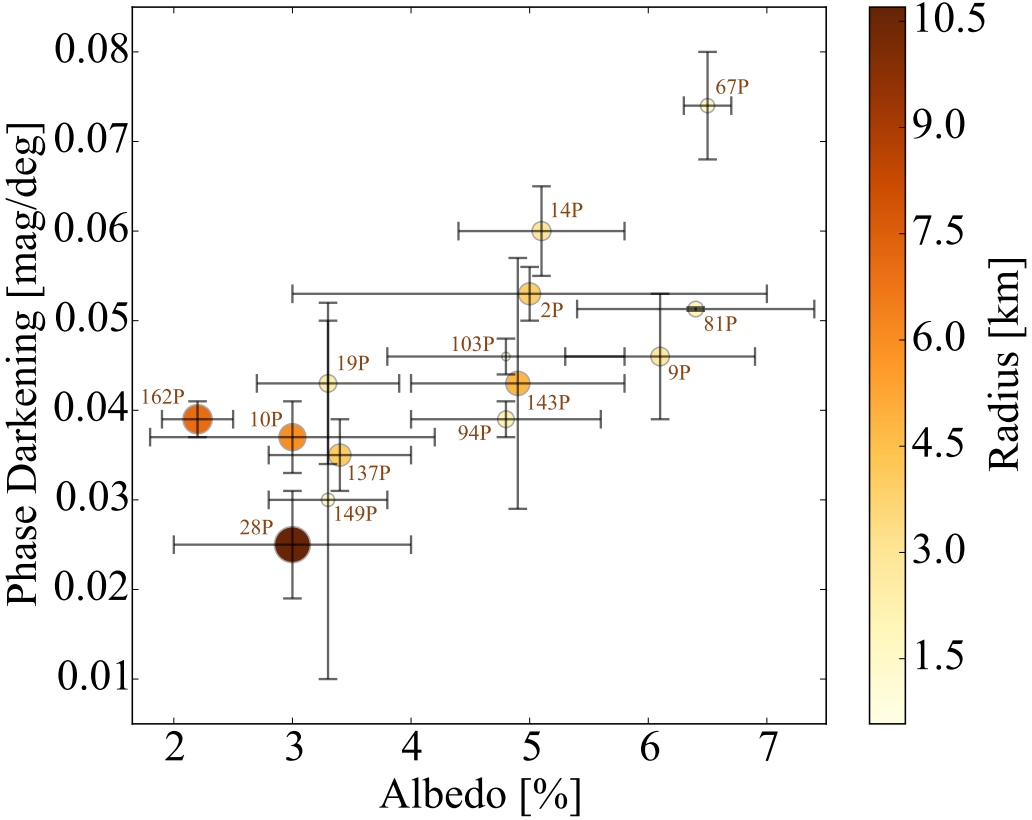


Kokotanekova et al. 2018



Belskaya & Shevchenko. 2000

Interpretation: 1. Cliff Height Distribution



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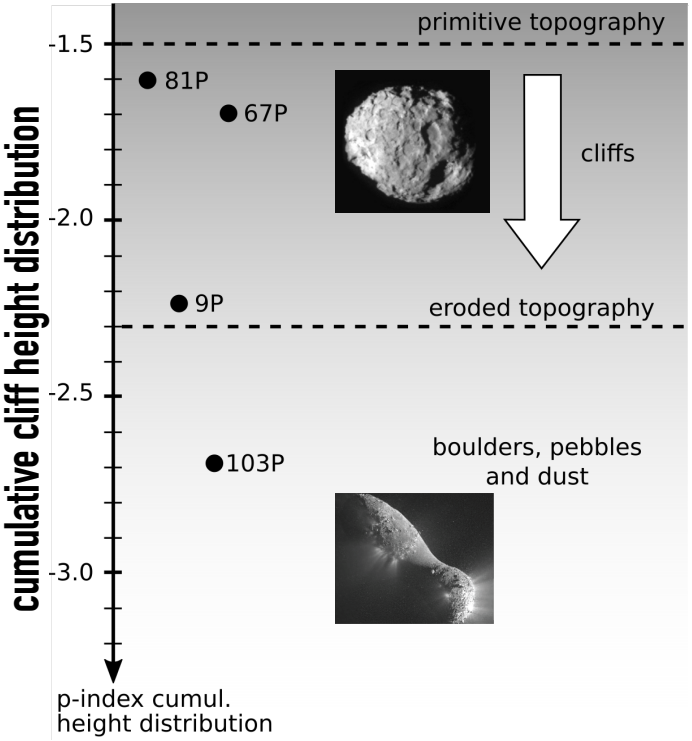
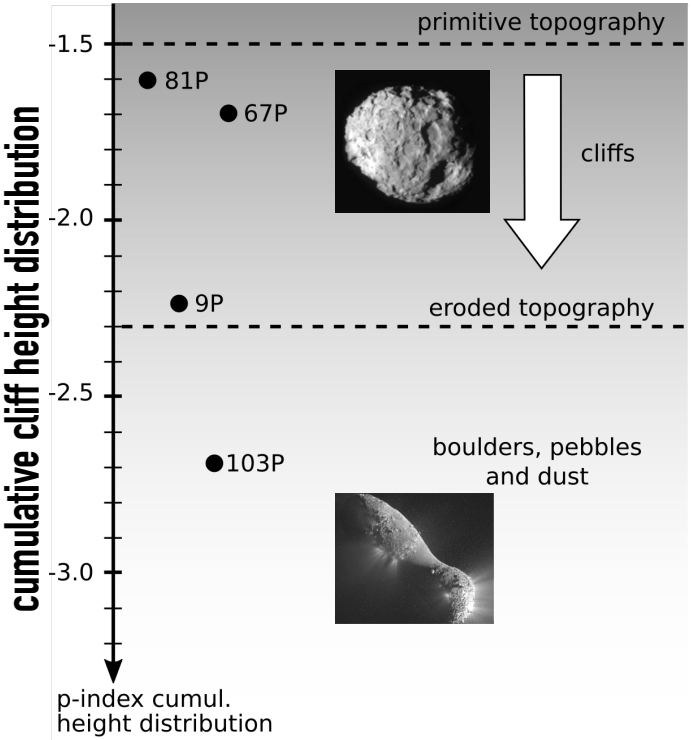


Vincent et al. 2017
Ip et al. 2016
Basilevsky & Keller 2006

3. In situ surface properties observations

Surface roughness and photometric properties are related:

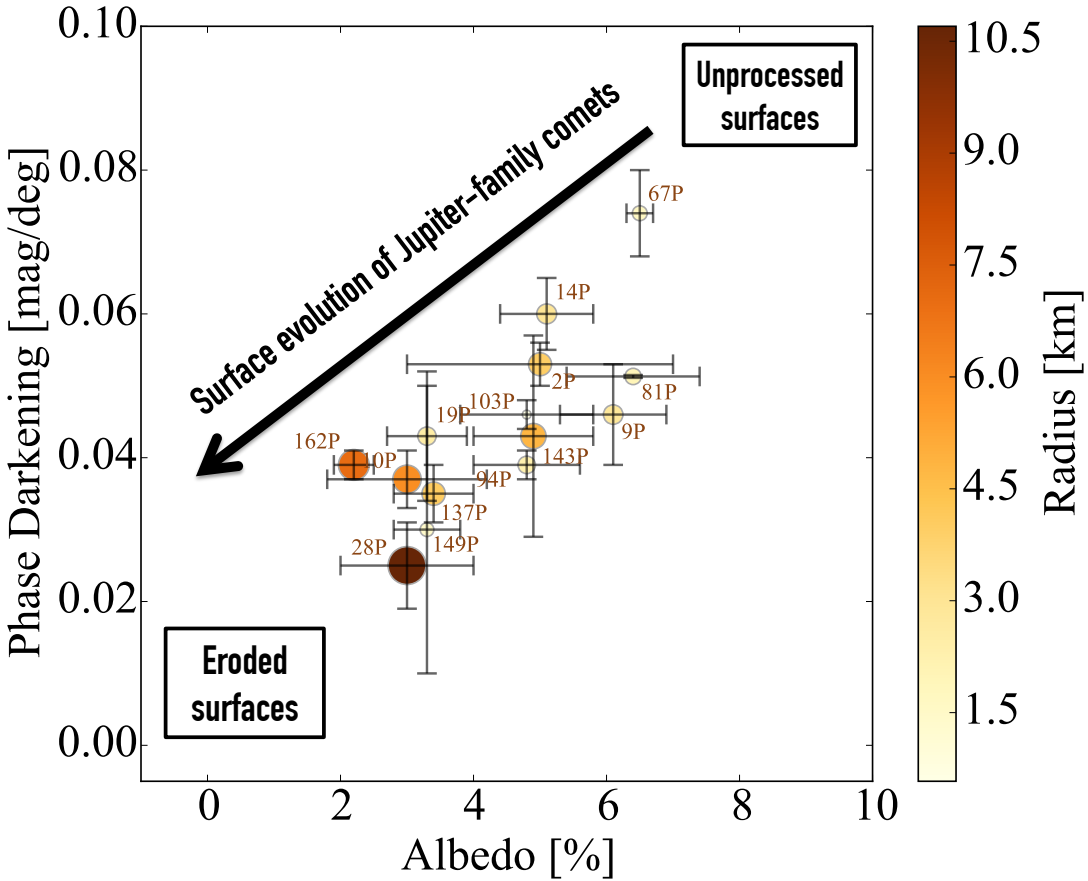
- Comparison between the comets visited by spacecraft
- Comparison between 'rough' regions – Anuket and Ash and 'smooth' regions: Hapi and Imhotep



Longobardo et al. (2017)

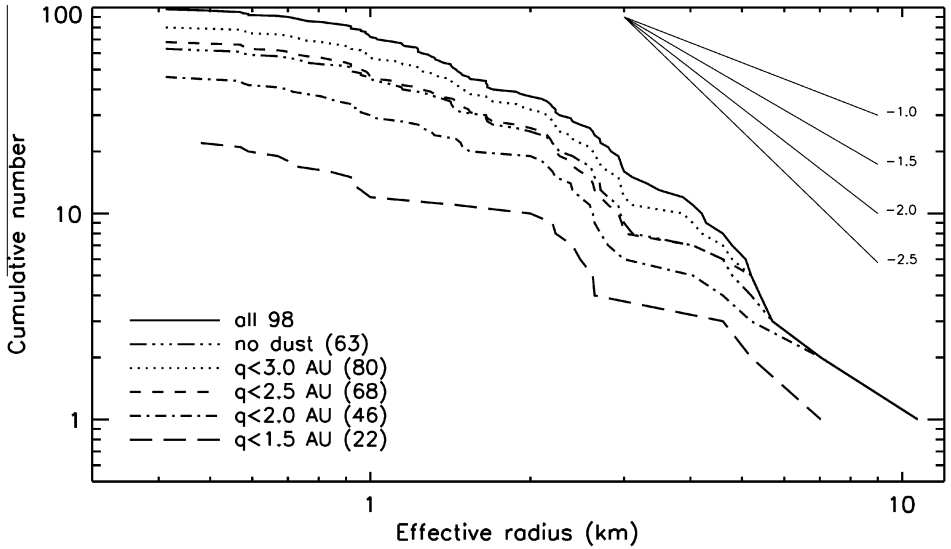
Vincent et al. 2017

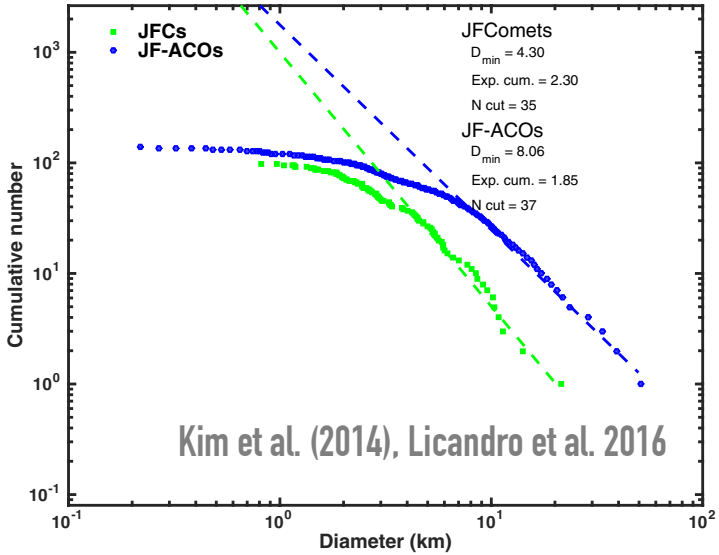
JFC Surface Evolution



Kokotanekova et al. 2018

Cumulative size distribution of JFCs





"Excess of comets with radii 3–6 km"

Fernandez et al. (2013)

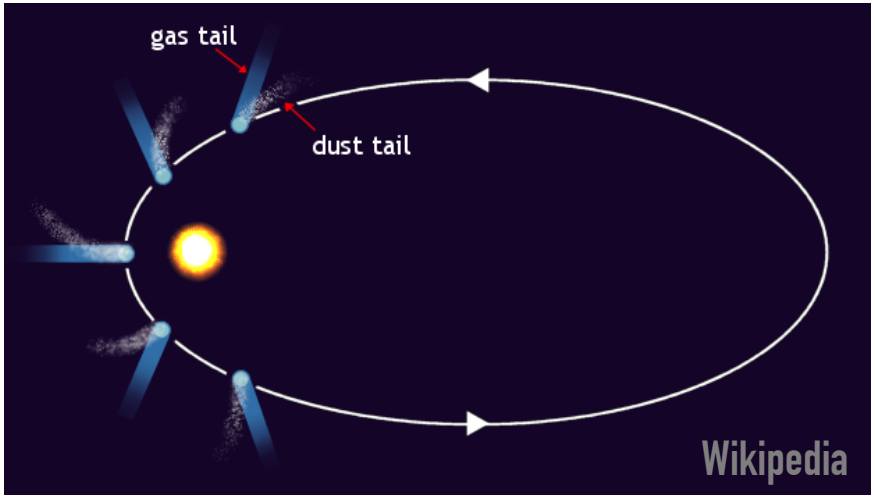
Flatter distribution for ACOs than for JFCs –> The larger nuclei preferentially survive the active phase

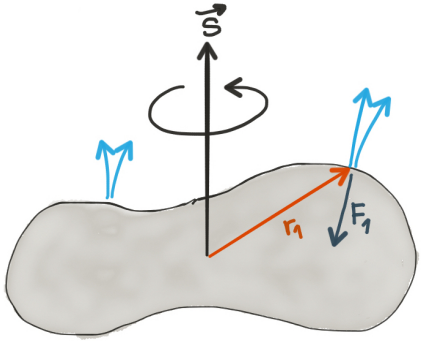
2. Dynamical simulations

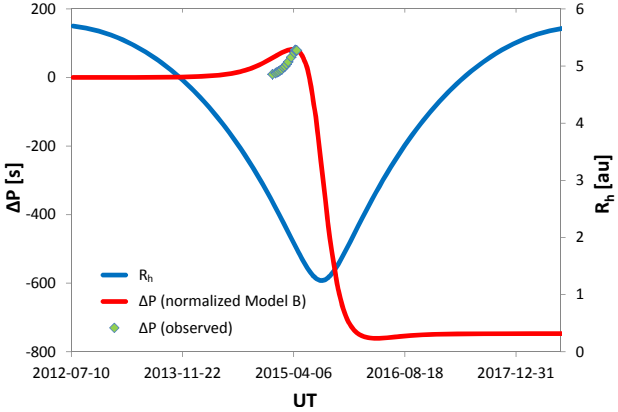
- Dynamical simulations require longer physical lifetimes for larger nuclei in order to reproduce the number or observed comets

Di Sisto et al. 2009
Nesvorny et al. 2017
Rickman et al. 2017

Spin Changes Due to Outgassing

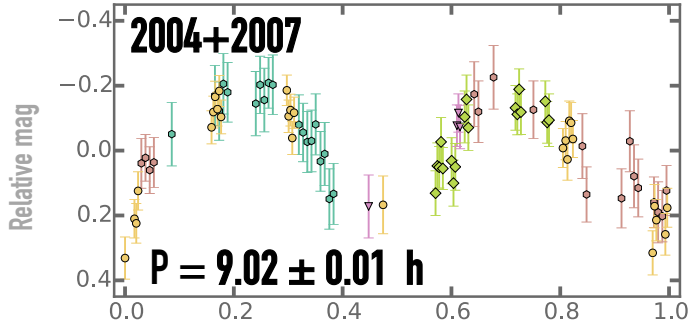






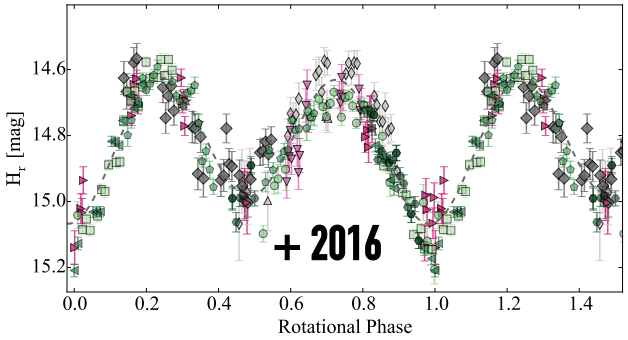
67P

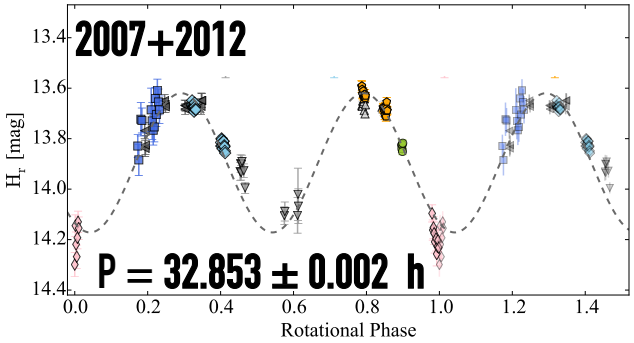
Keller et al 2015;



14P

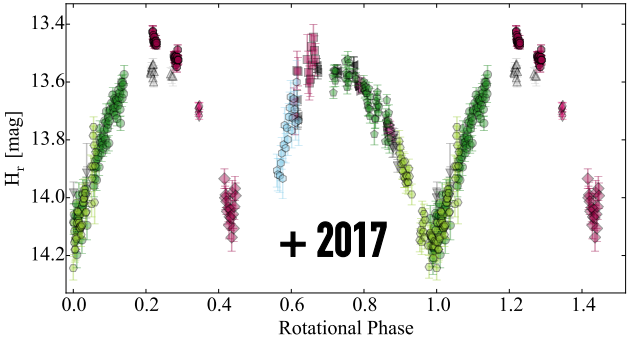
ΔP < 4.2 min

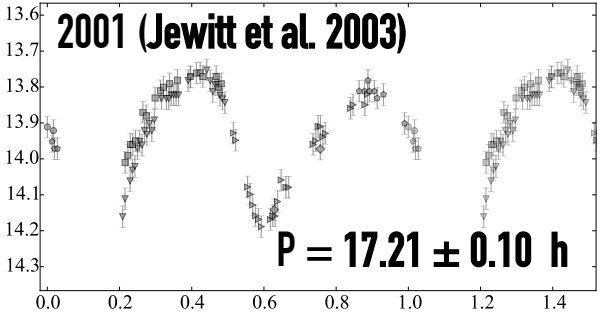




162P

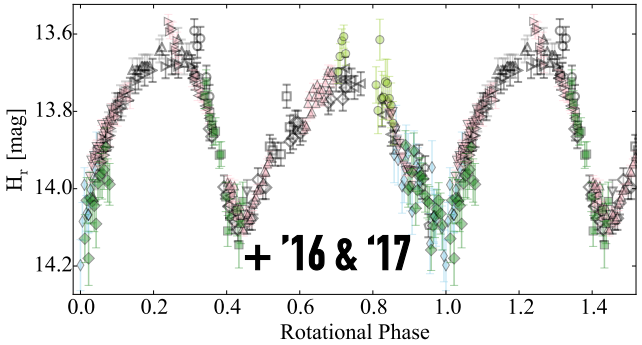
ΔP < 25 min





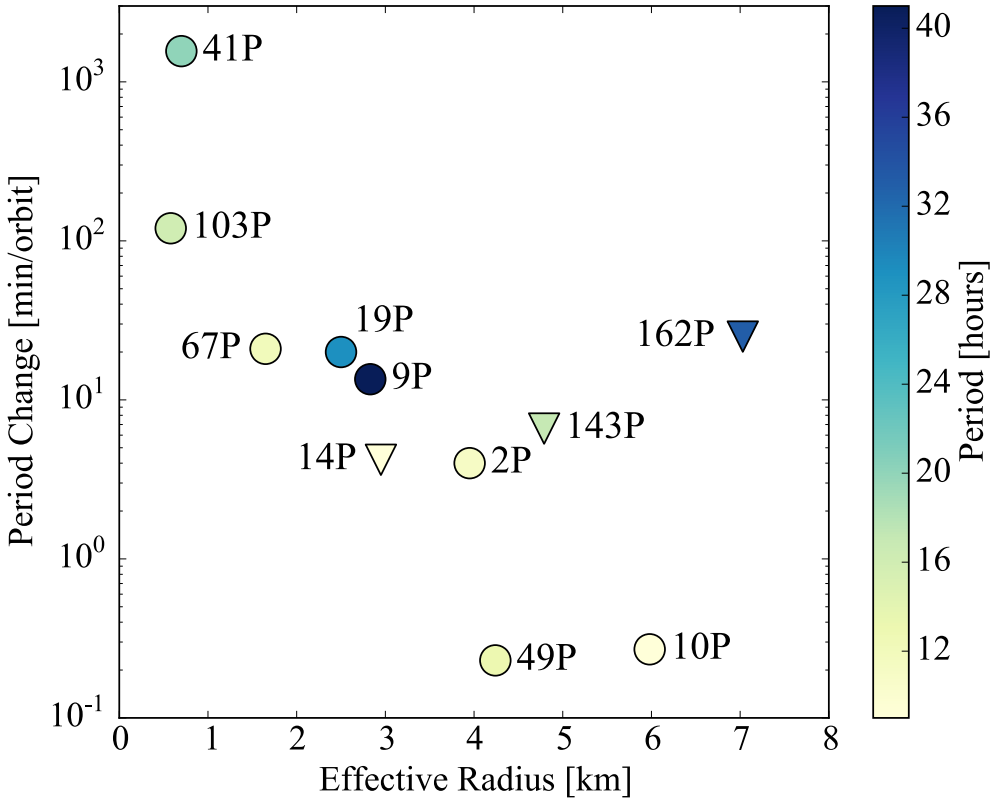
143P

ΔP < 6.6 min



Kokotanekova et al. (in prep)

Spin Changes Due to Outgassing



Mechanisms to prolong the physical lifetime of large JFCs

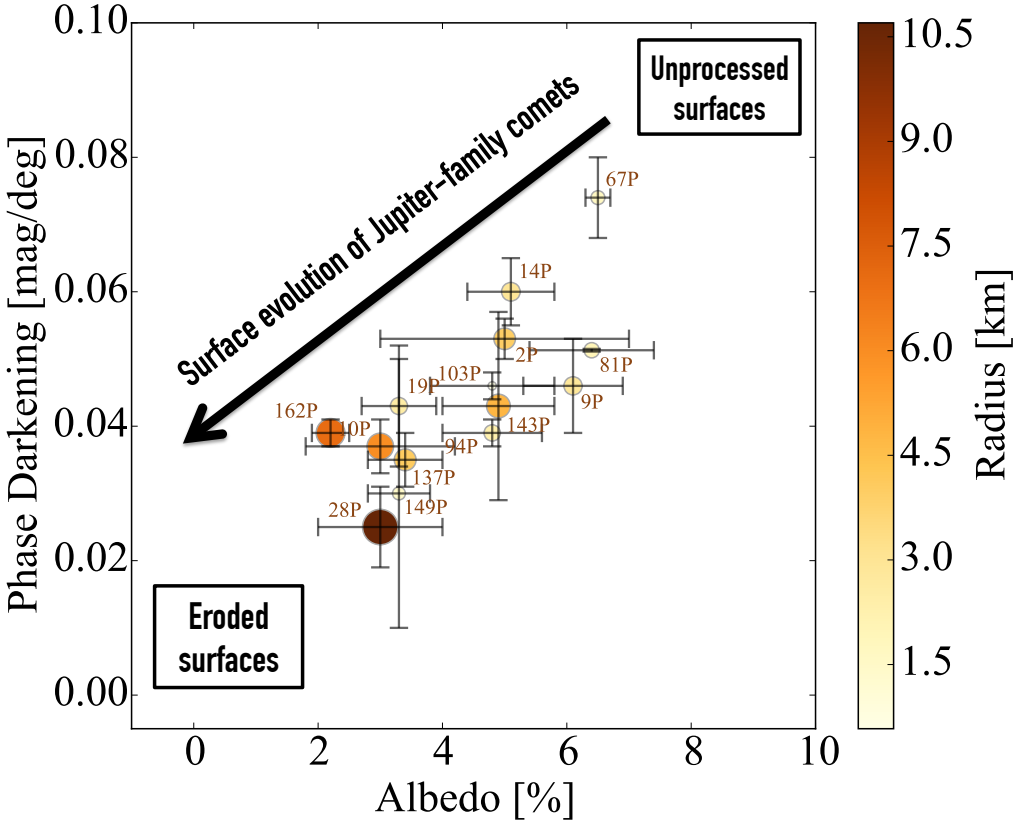
1. More difficult to spin up (larger and less active)

2. Larger nuclei have experienced larger hydrostatic compression, and therefore have larger tensile strengths which obstruct the activity (Gundlach & Blum 2016)

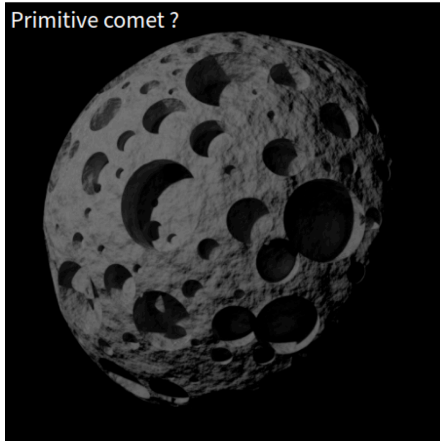
3. Larger comets have larger gravitational potential, they will retain more infalling dust and will quickly build an insulating layer (e.g. Thomas 2015)

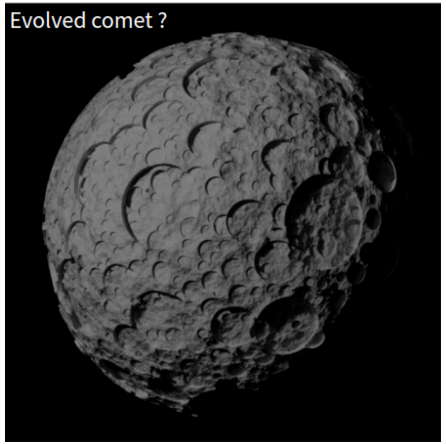
Conclusion: Larger comet nuclei have larger physical lifetimes

JFC Surfaces



Kokotanekova et al. 2018





Synthetic models from Vincent, J.-B., LPSC 2018

Summary

1. Photometric time series are a powerful tool to study the physical properties and surface characteristics of JFCs.
2. JFCs with higher albedo have steeper phase functions — a possible evolutionary trend.
3. Large nuclei do not experience significant period changes, and are less likely to undergo a break-up.
4. Large nuclei are more likely to reach the later stages of surface evolution.