

Interplanetary dust modeling: Applications to *New Horizons*

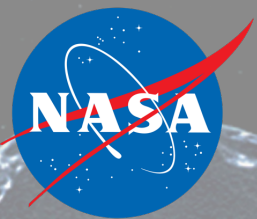
Andrew R. Poppe


NH Science Team Meeting

January 25, 2024

poppe@berkeley.edu

With thanks to M. Horányi, J. R. Szalay, C. M. Lisse, A. Doner

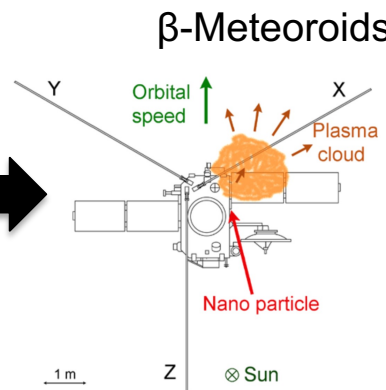
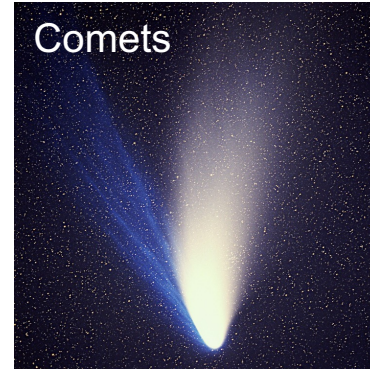
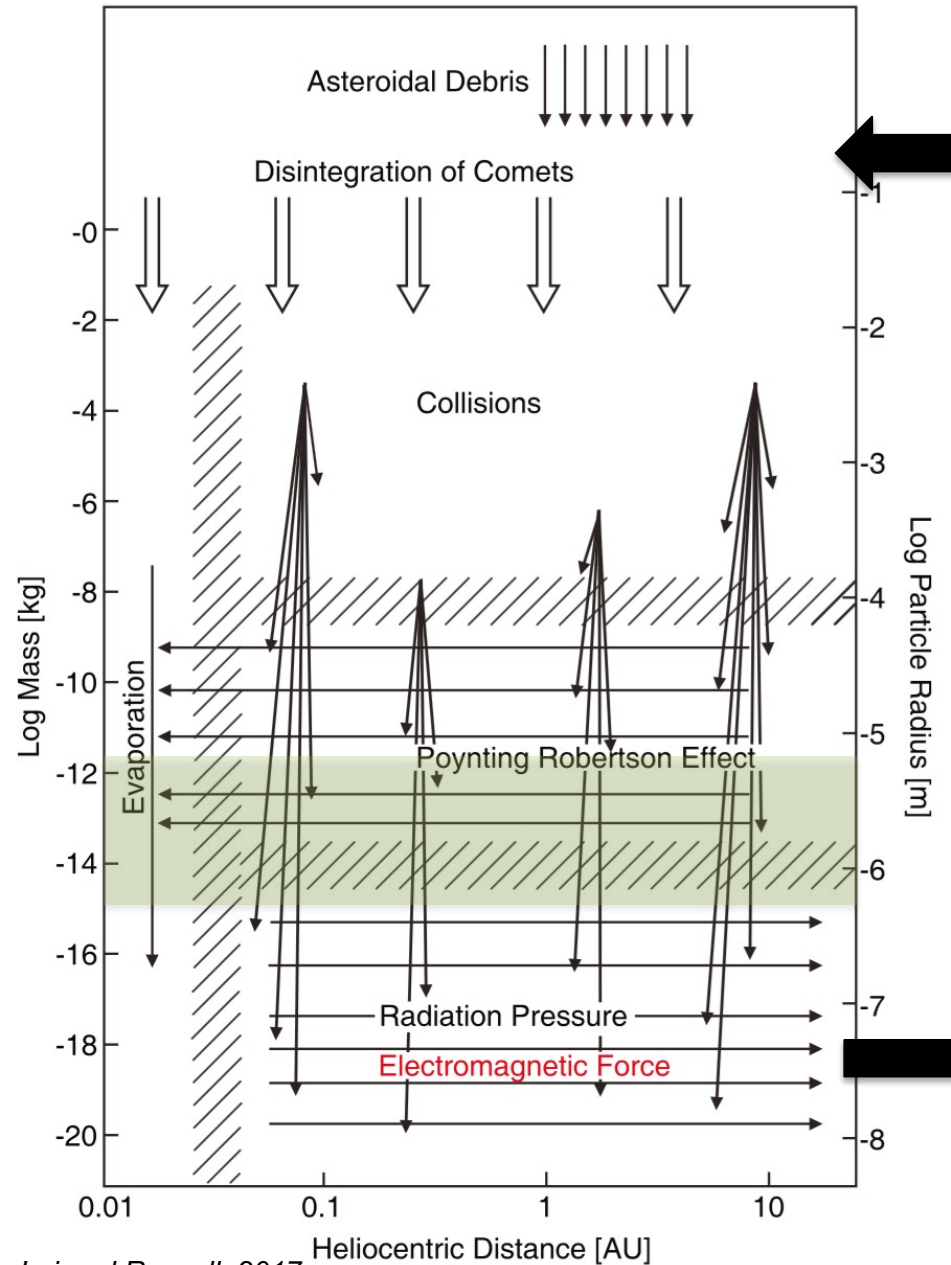




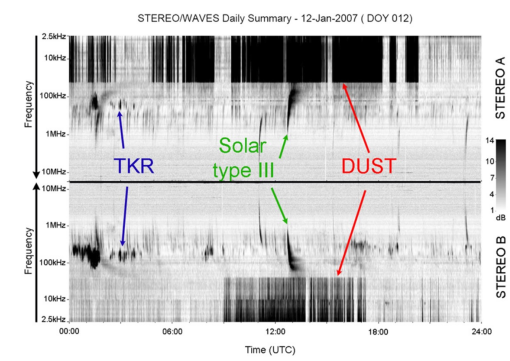
**All models are wrong, but some
models are useful.**

G. Box, British statistician (1919-2013)

The Lifecycle of Interplanetary Dust

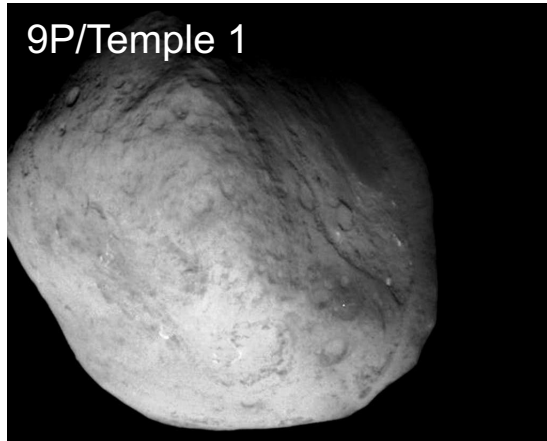


β -Meteoroids / Nanodust (?)



IDP Sources

Jupiter-family comets



Oort cloud comets



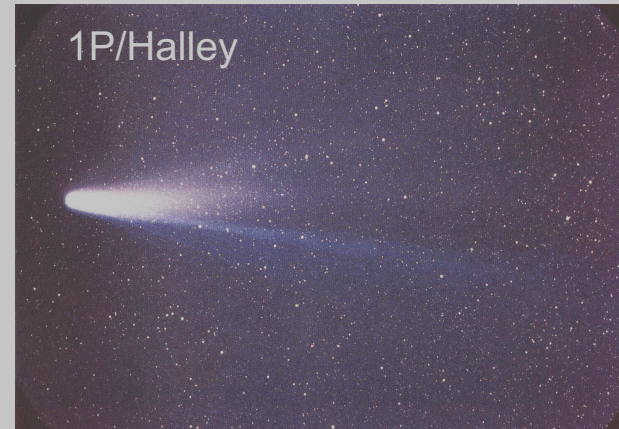
Edgeworth-Kuiper Belt



Asteroids

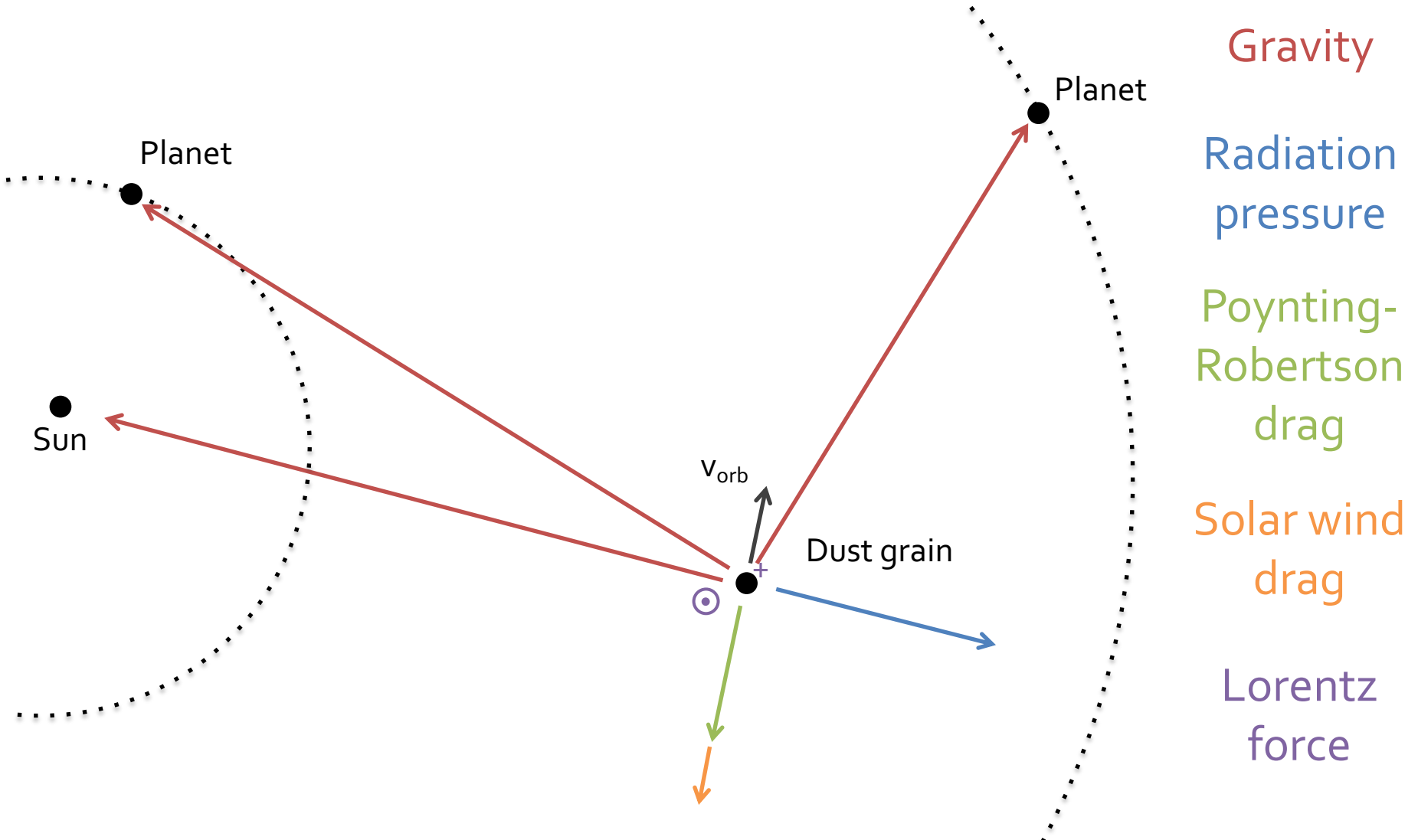


Halley-type comets



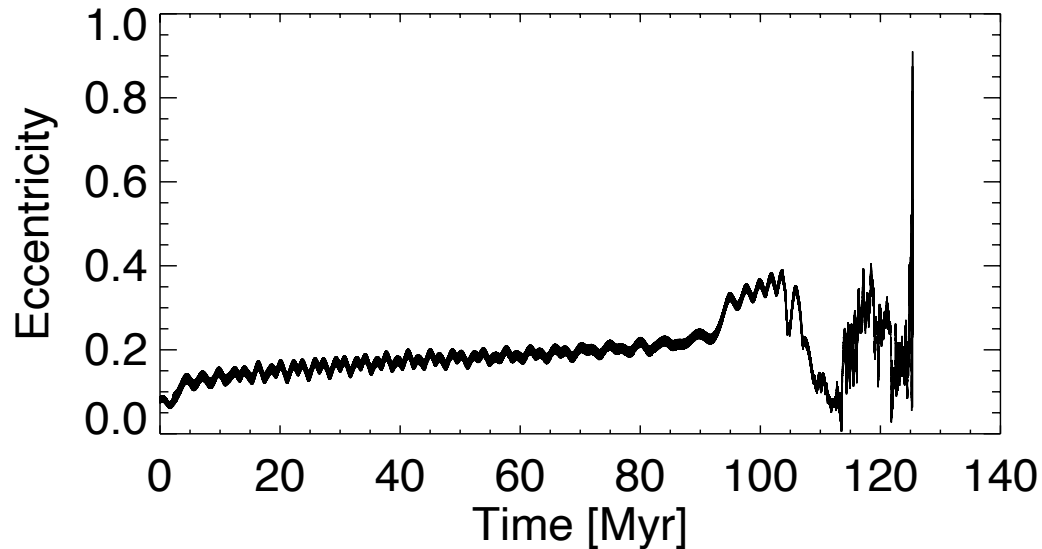
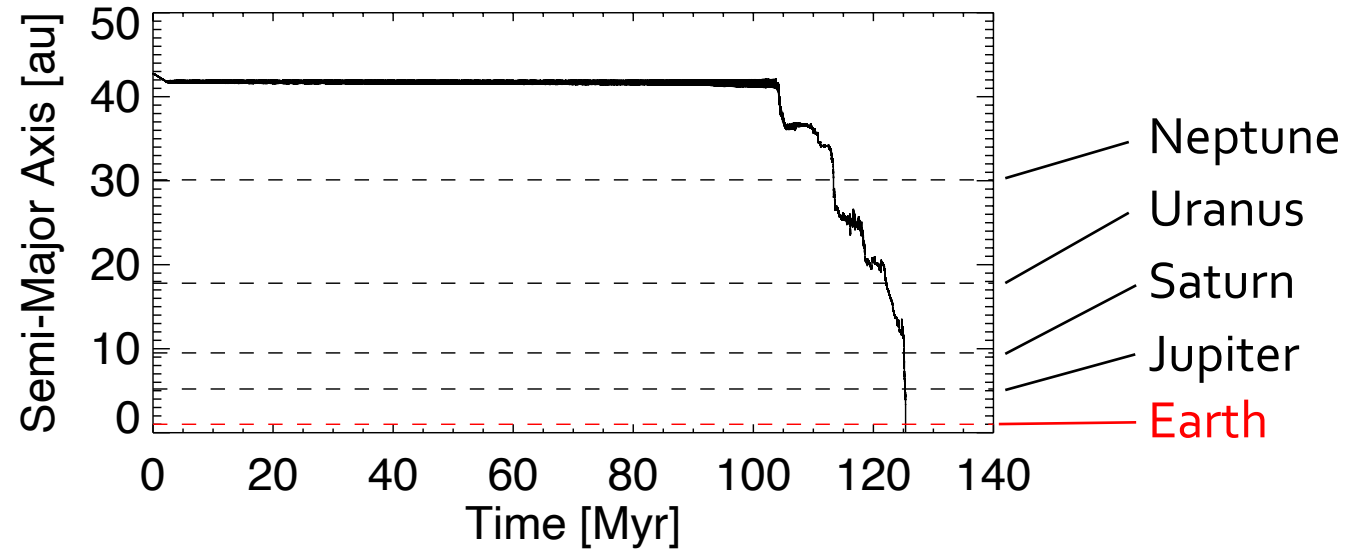
Forces on Dust Grains

$$\ddot{\mathbf{r}}_s = -\frac{GM_\odot}{r_s^3} \mathbf{r}_s - \sum_{i=1}^4 \frac{GM_i}{r_i^3} \mathbf{r}_i + \frac{1}{m} \mathbf{F}_L$$
$$+ \frac{\pi a_d^2}{mc} S Q_{pr} \left[\left(1 - (1+w) \frac{\dot{r}_s}{c} \right) \hat{\mathbf{r}}_s - (1+w) \frac{\dot{\mathbf{r}}_s}{c} \right],$$



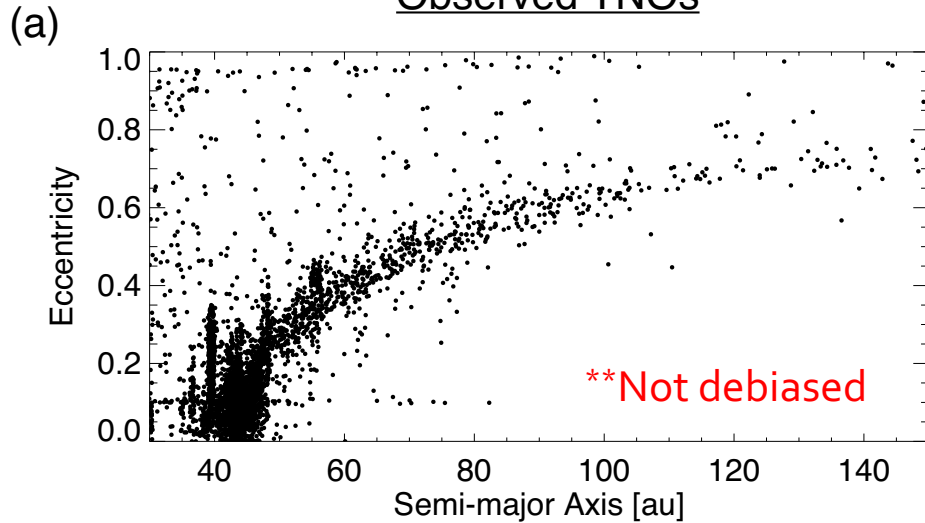
Now, integrate these forces over the lifetime of the grain

An Example Dust Grain: $10\ \mu\text{m}$ EKB Classical

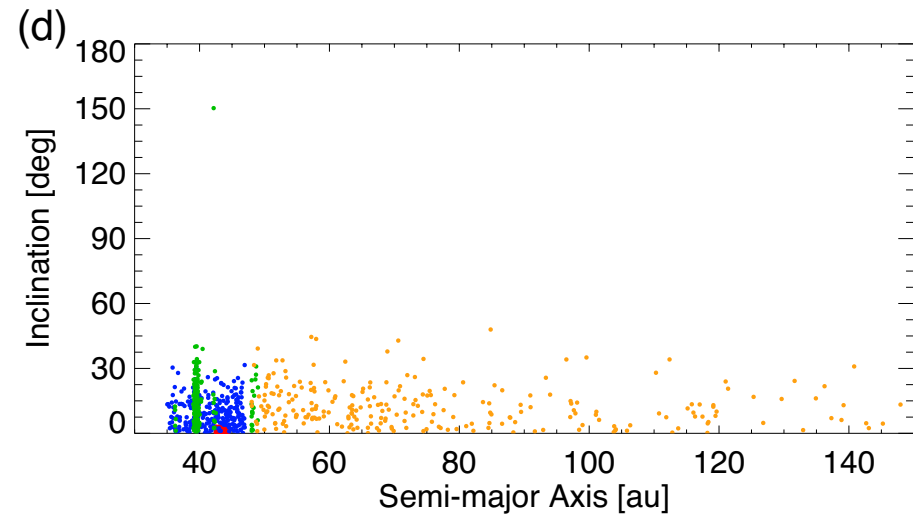
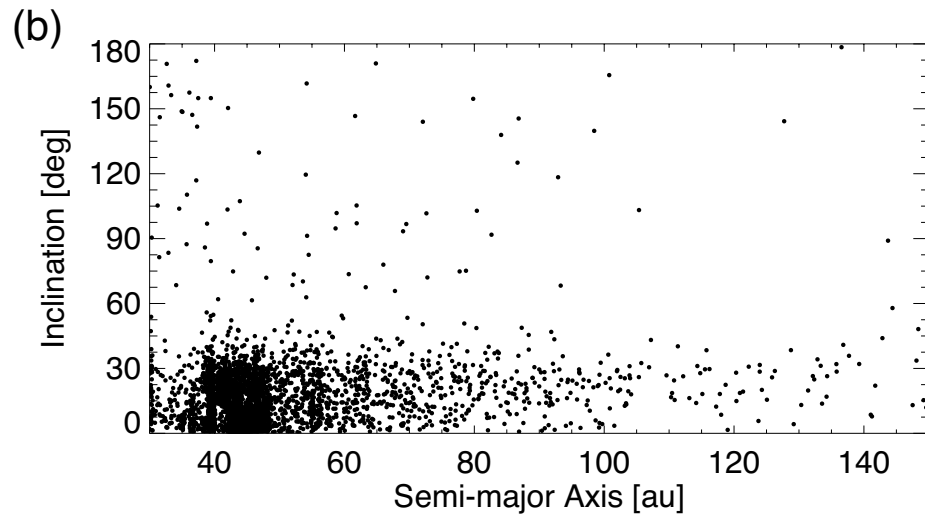
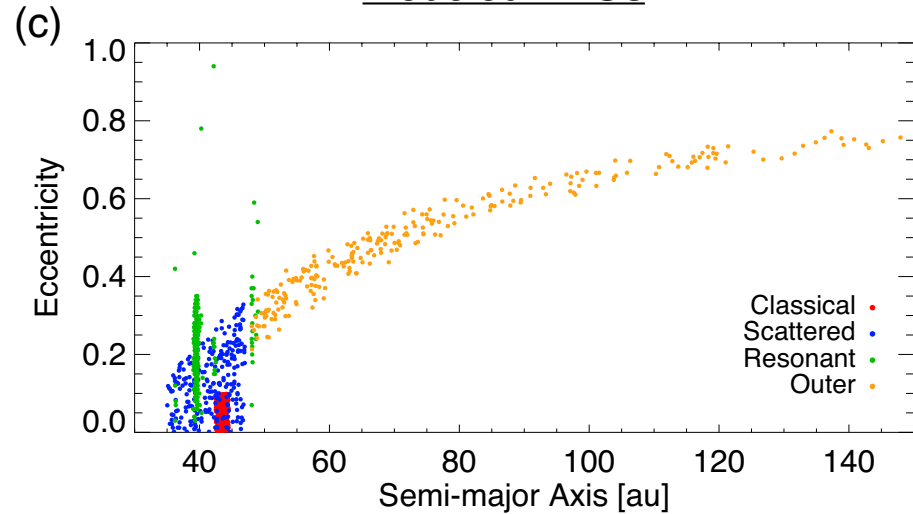


EKB Initial Conditions

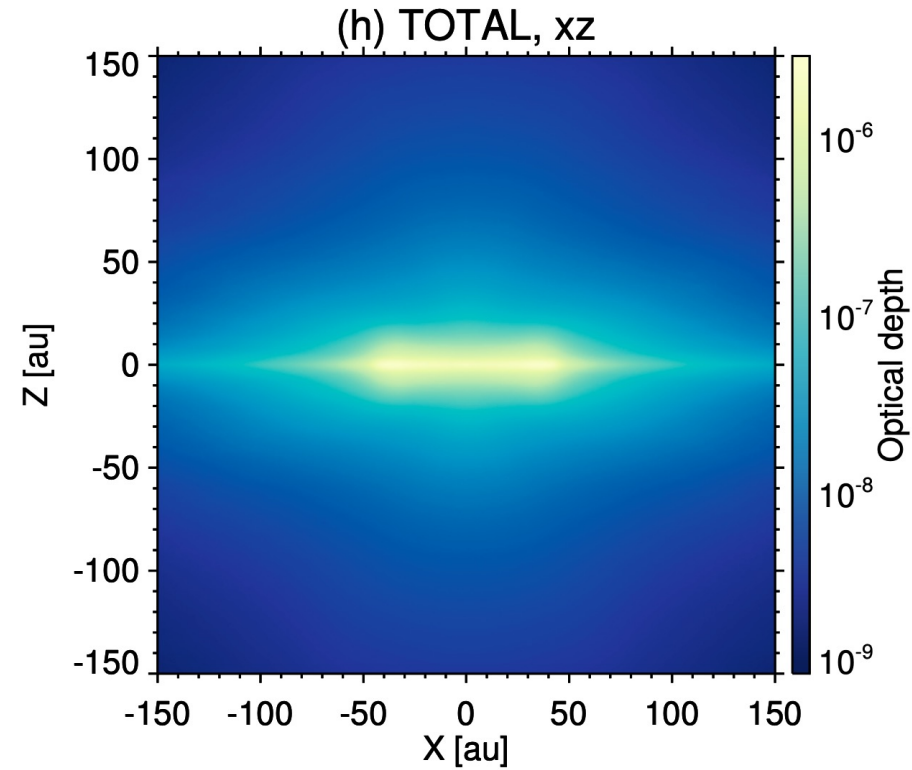
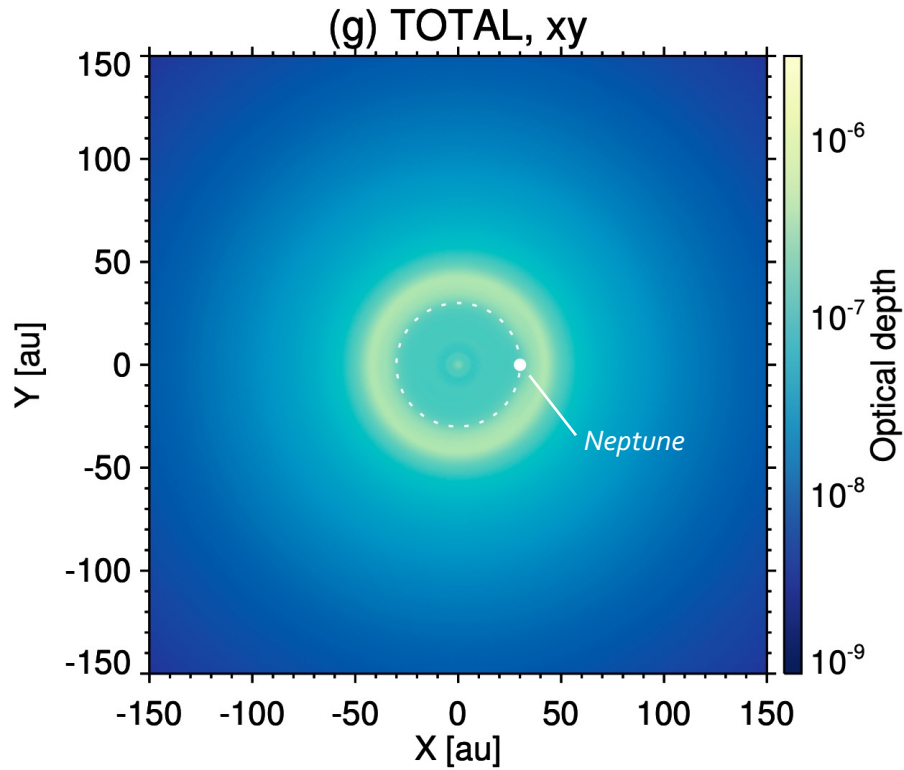
Observed TNOs



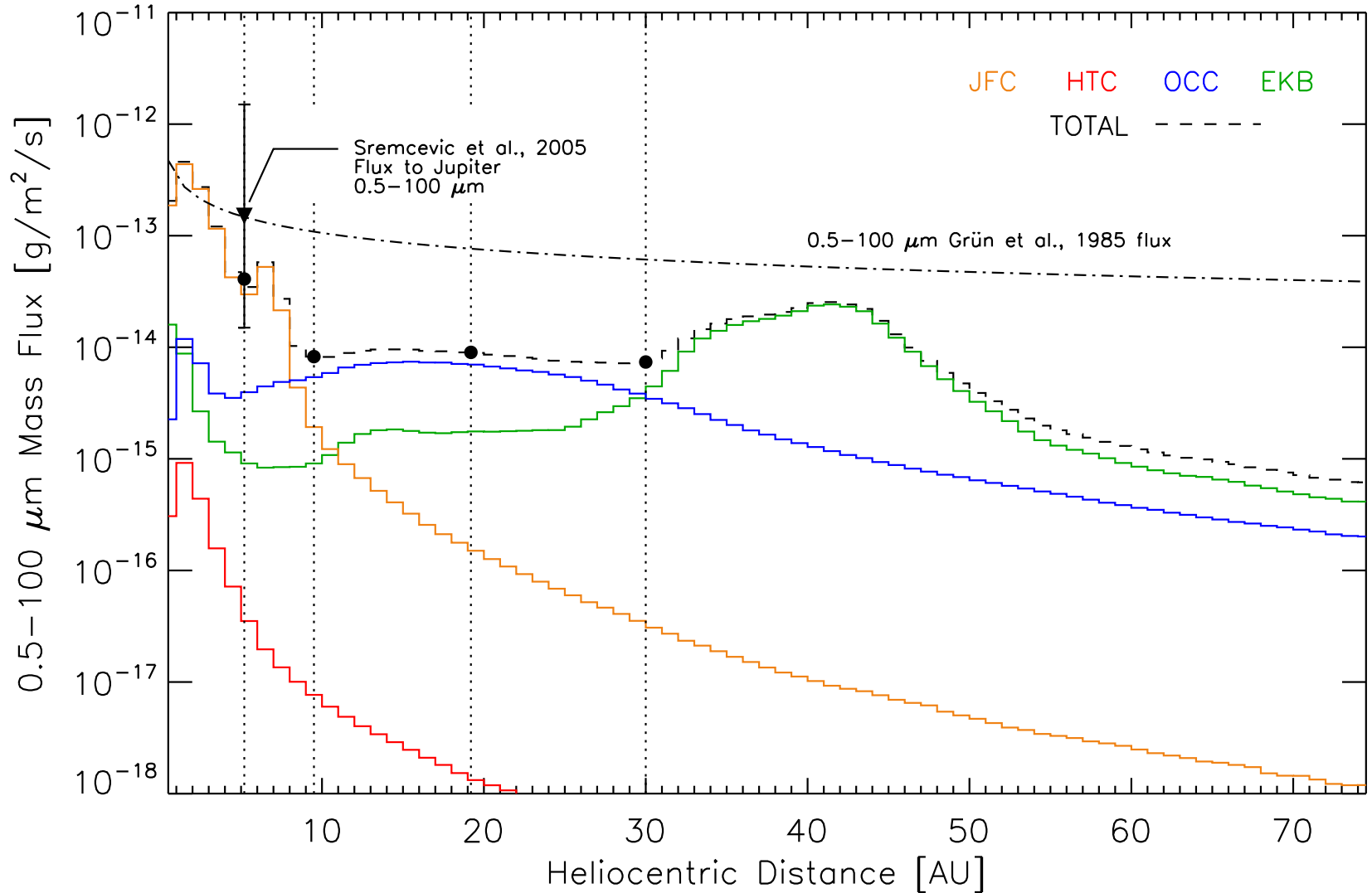
Modeled TNOs



Model Results: Optical Depths



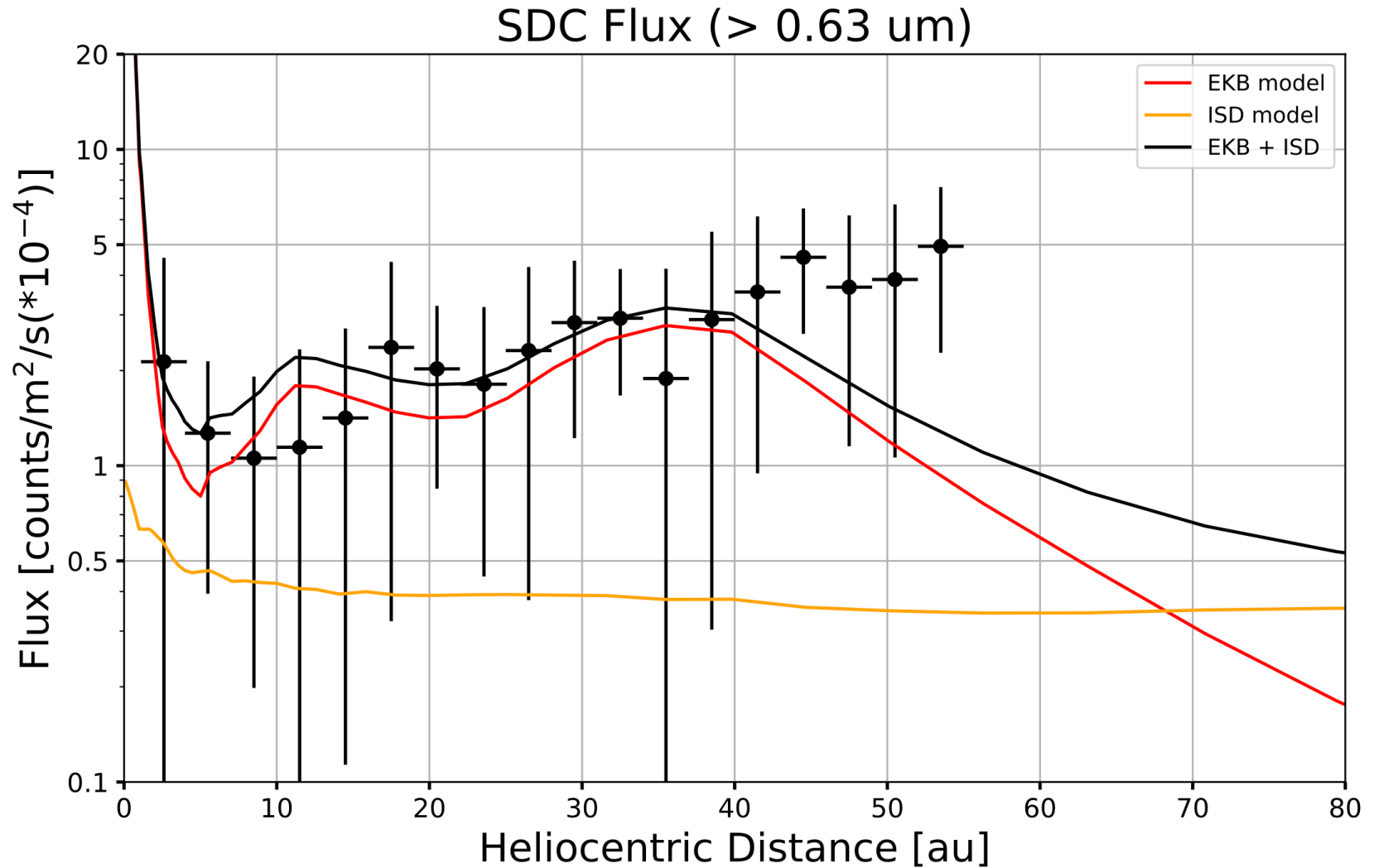
Model Results: Total Mass Flux



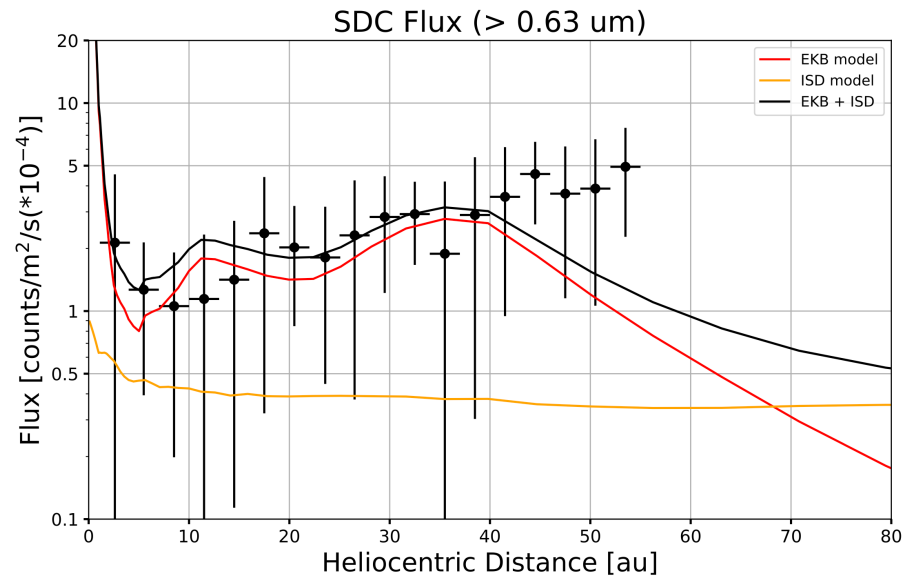


IDP Model Application to NH/SDC Measurements

Model/SDC Comparison as of ~55 au



Model/SDC Comparison as of ~55 au



Doner et al. [2024]

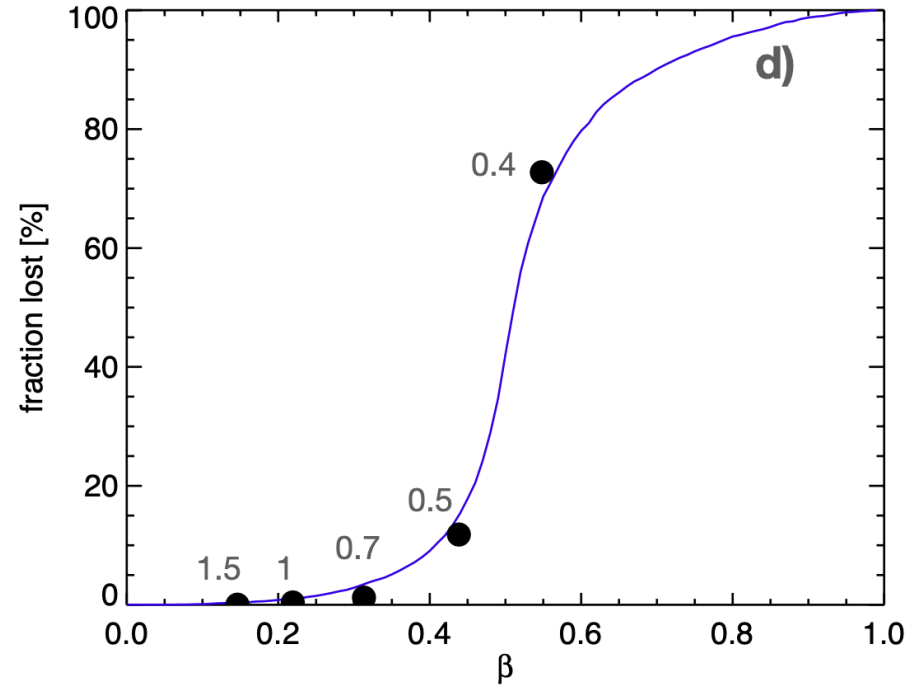
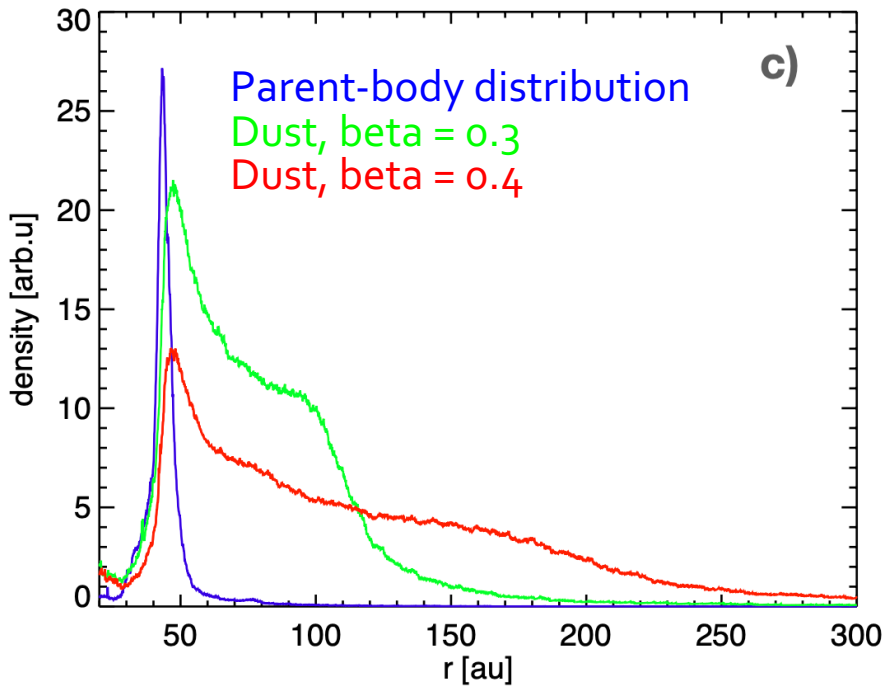
- Radiation pressure “blowing out” EKB dust
- Ice grain photo-desorption
- Presence of an additional, >55 au parent EKBO population

Radiation Pressure

$$\beta = - \frac{F_r}{F_g}$$

Radiation pressure

Solar gravitation



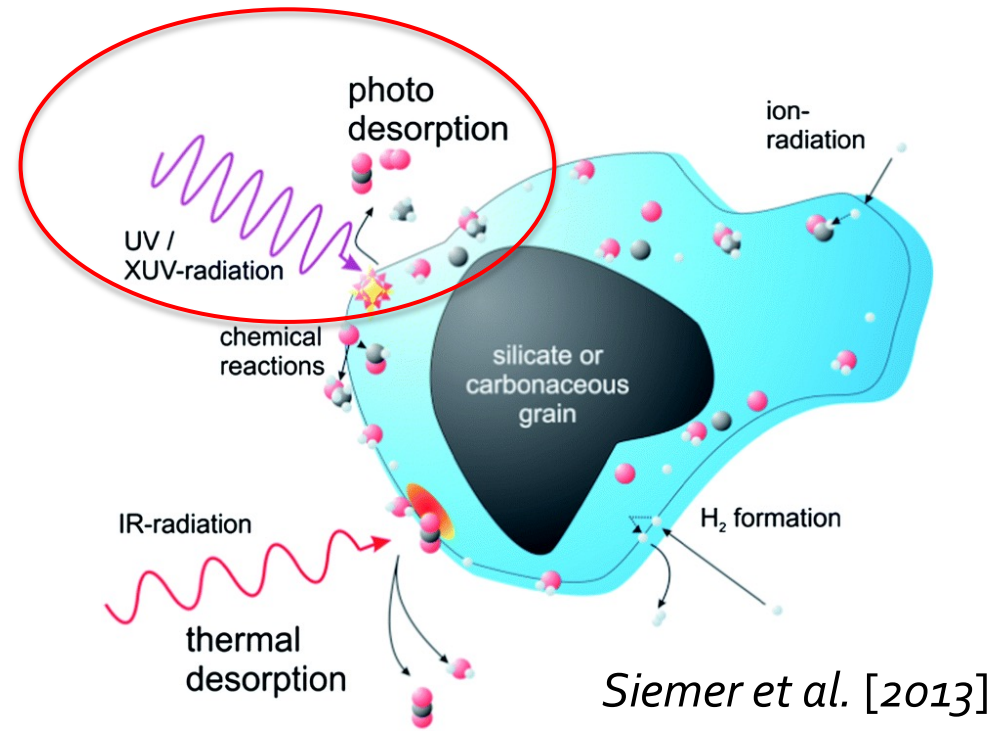
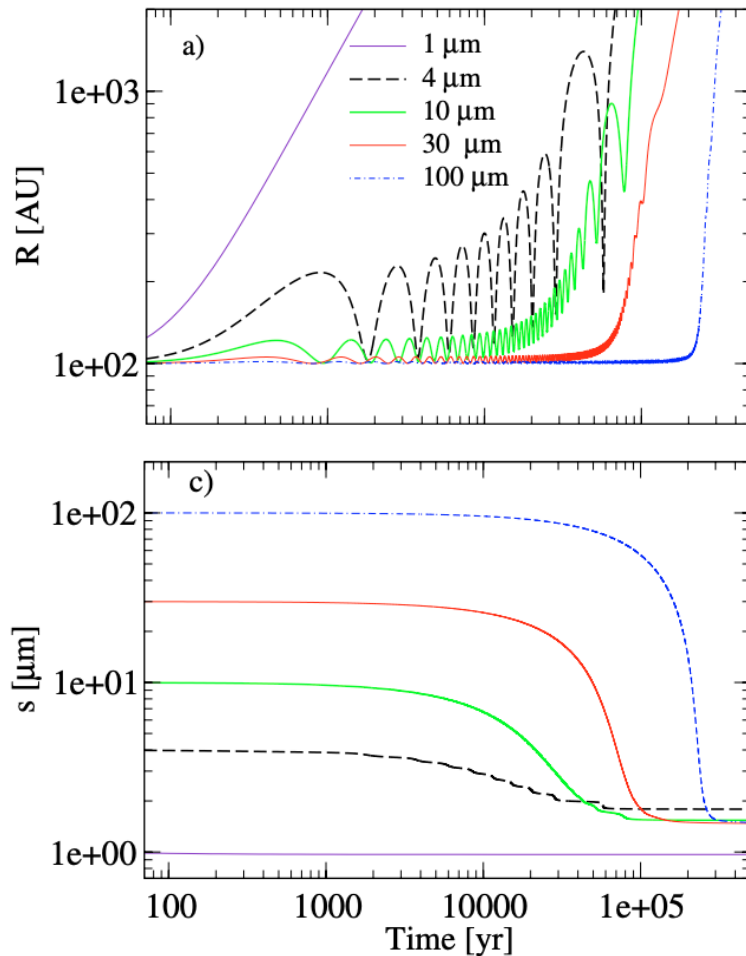
Doner et al. [2024]

Ice Grain Photodesorption

Survival of icy grains in debris discs

The role of photosputtering

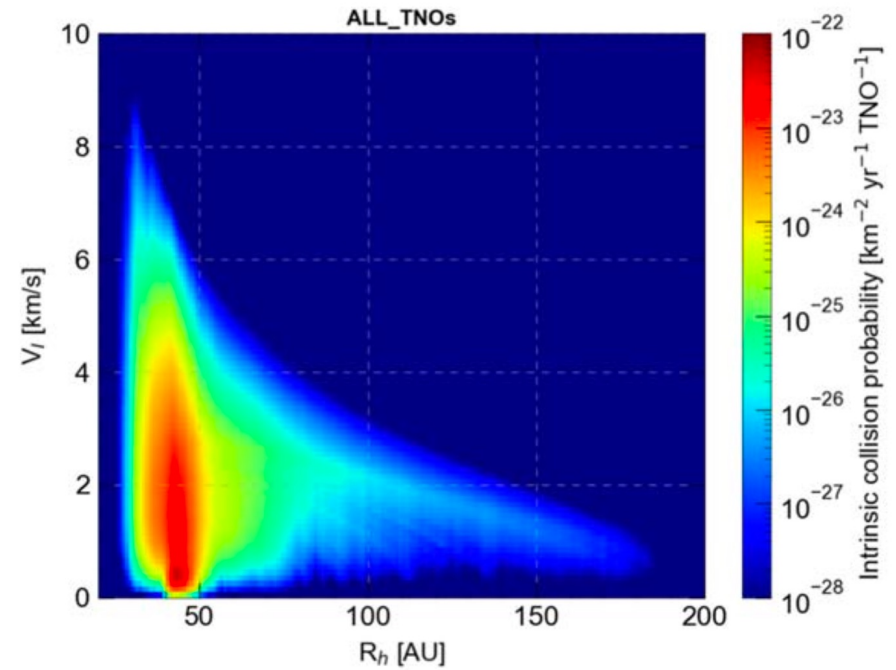
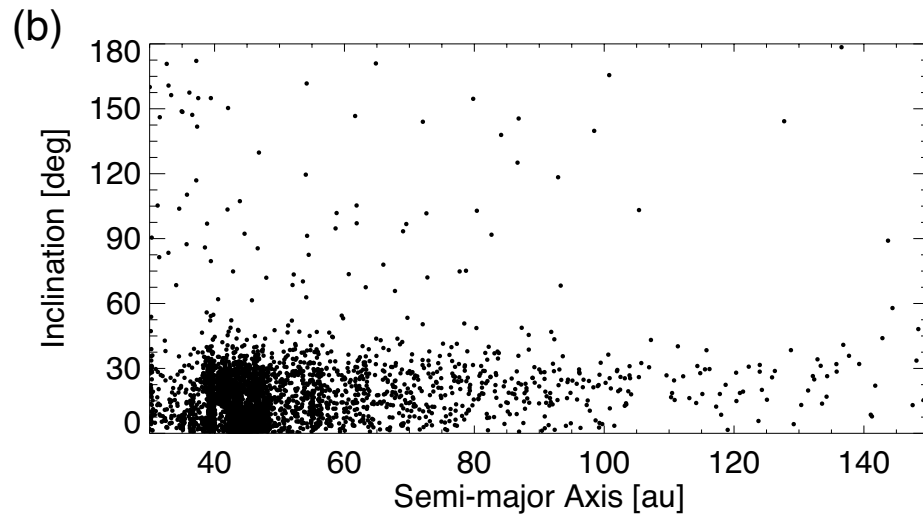
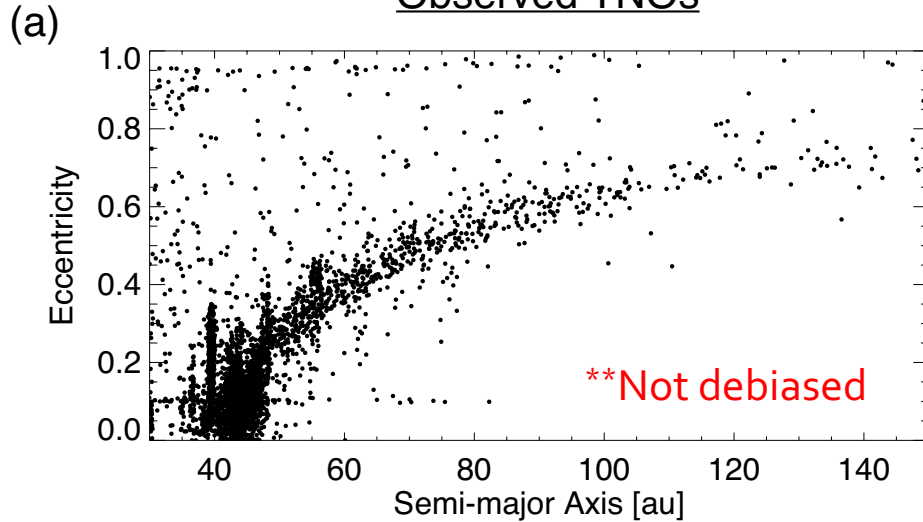
A. Grigorieva¹, Ph. Thébault^{1,2}, P. Artymowicz³, and A. Brandeker¹



Grigorieva et al. [2007]

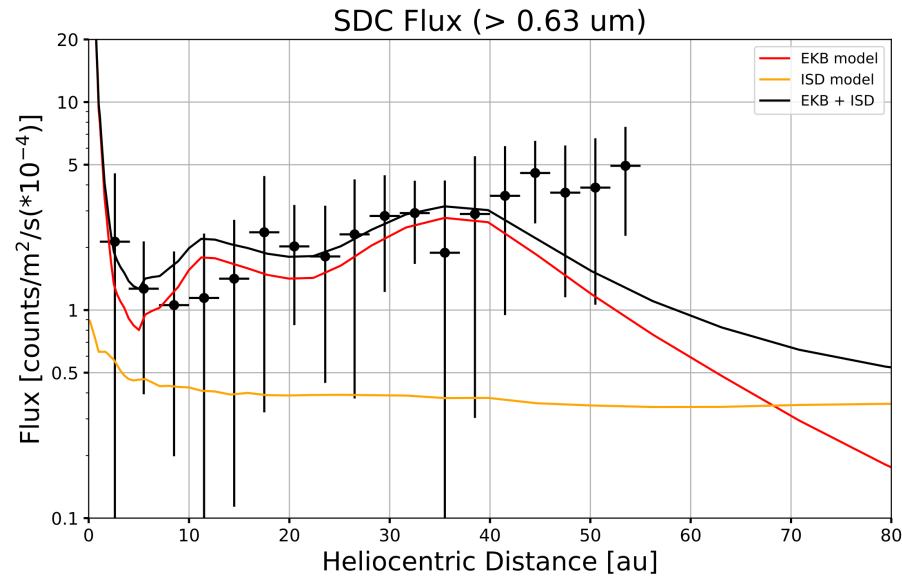
EKB Initial Conditions

Observed TNOs



Abedin et al. [2021]

Model/SDC Comparison as of ~55 au



Doner et al. [2024]

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