ANALYZING OUTCOMES OF PLANETESIMALS DURING EARLY EVOLUTION OF SOLAR SYSTEM

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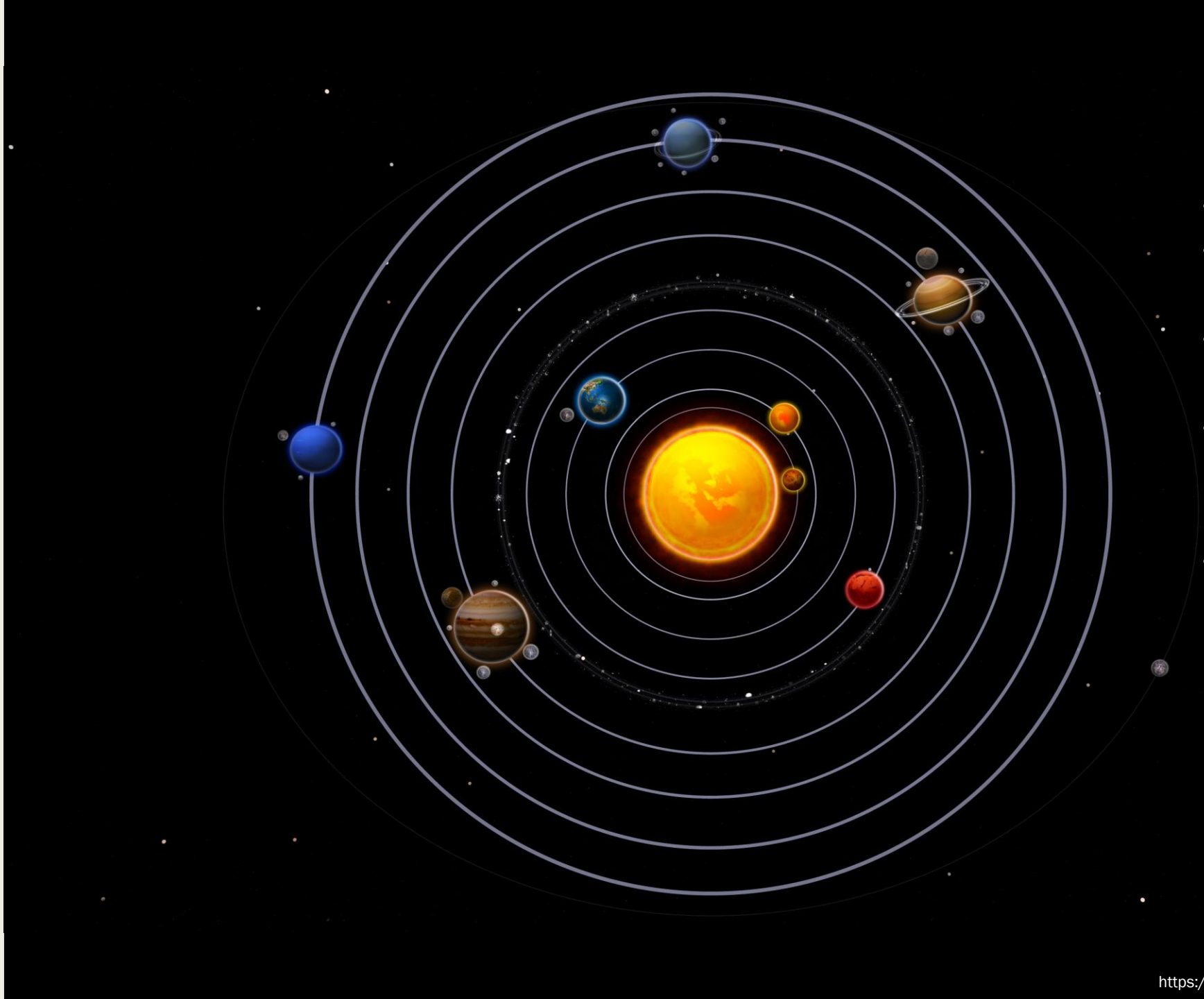
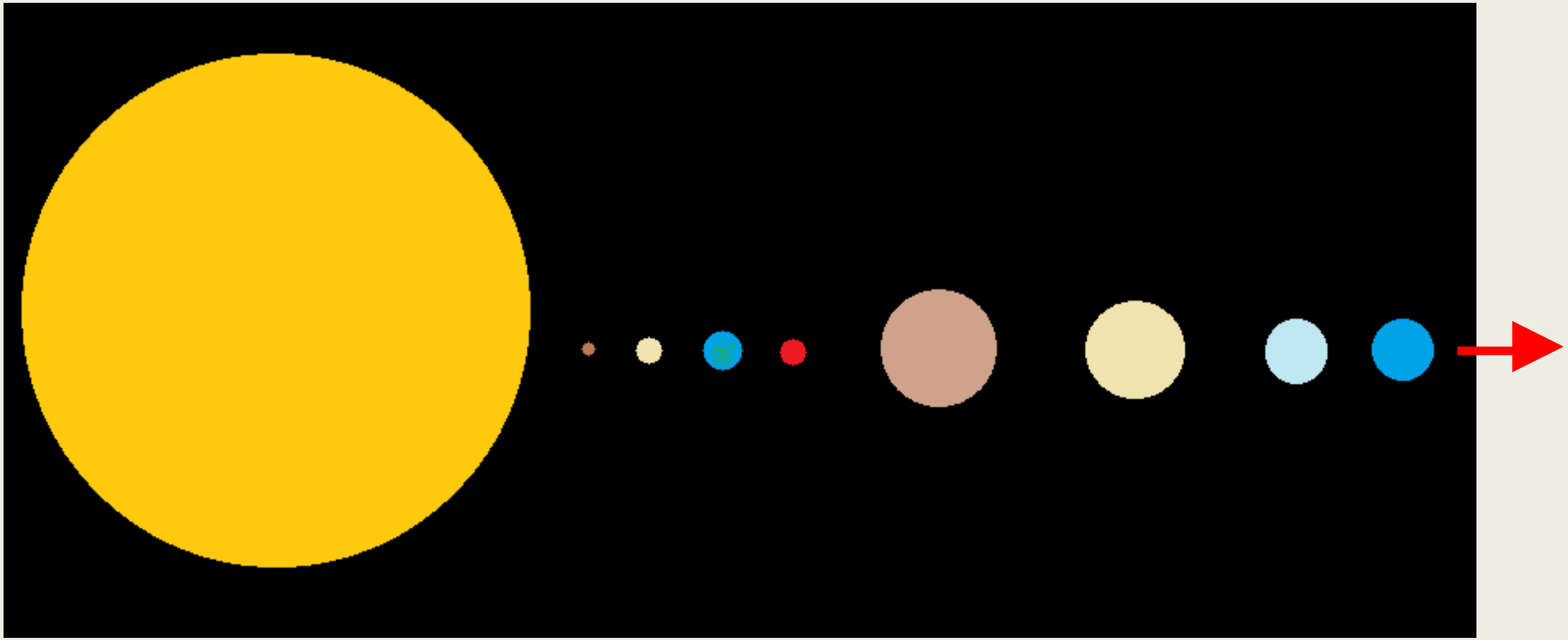


BACKGROUND

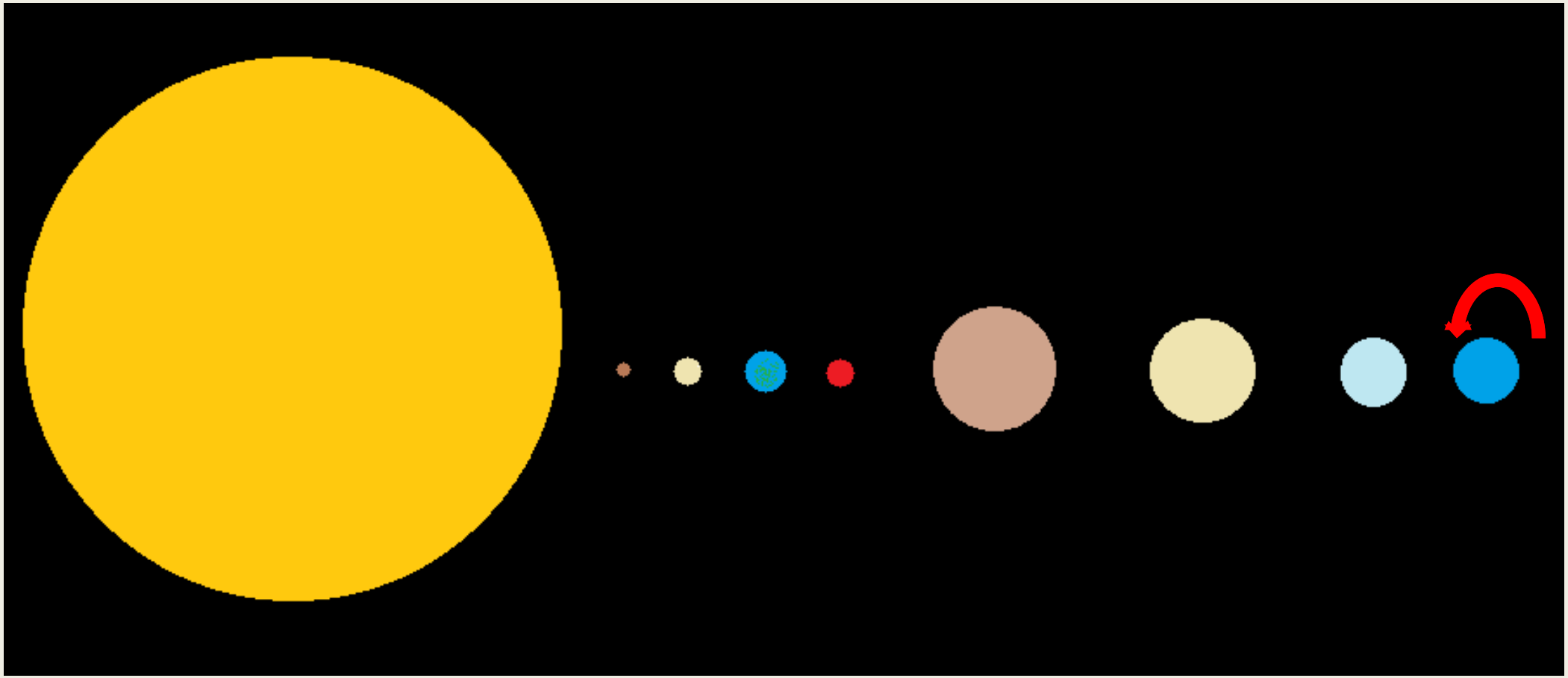
- 2005- Nice Model
- Compact planet formation
- Common: 5 planet model
- Surrounded by planetesimal disk ~30 AU
- Gravitational interactions lead to interactions with Neptune’s orbit

https://pics-about-space.com/simple-label-the-solar-system?p=1

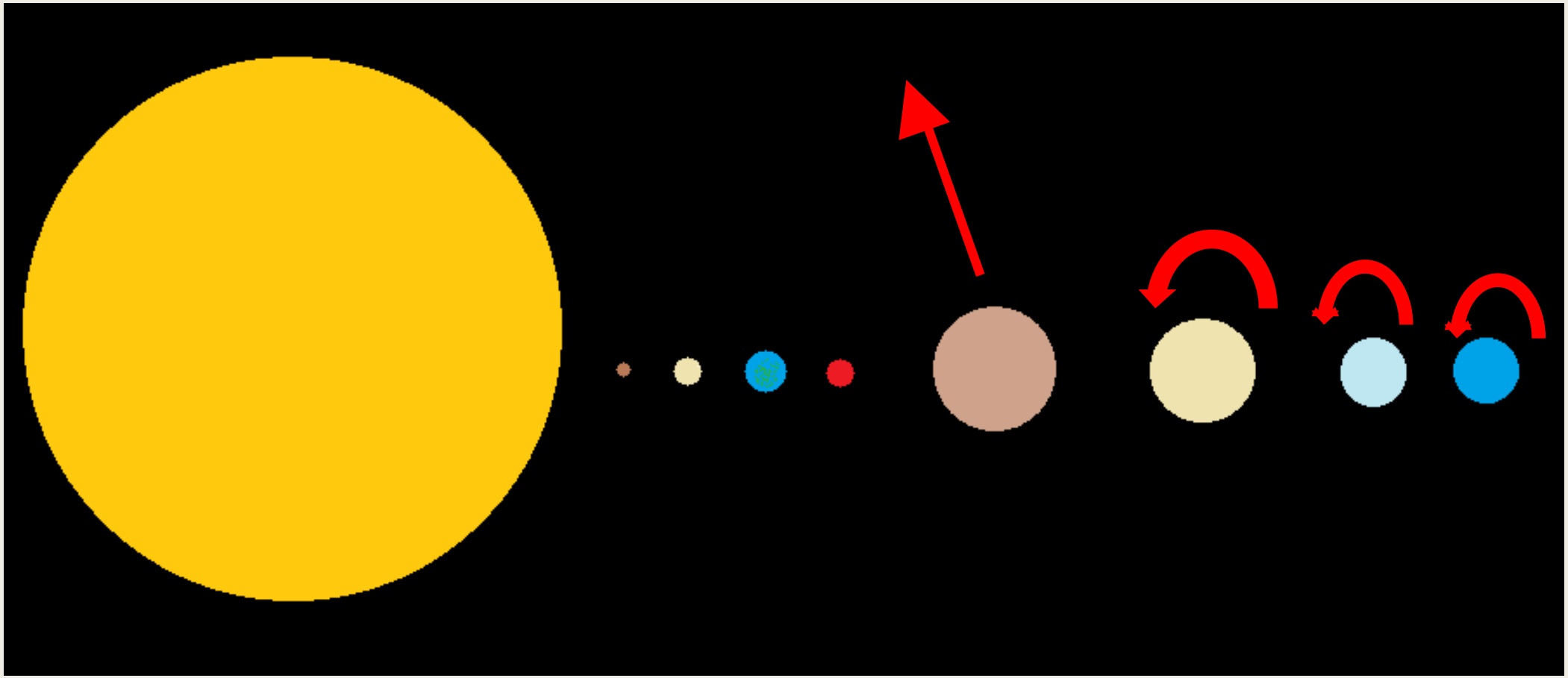
1.) SCATTER OUTWARD



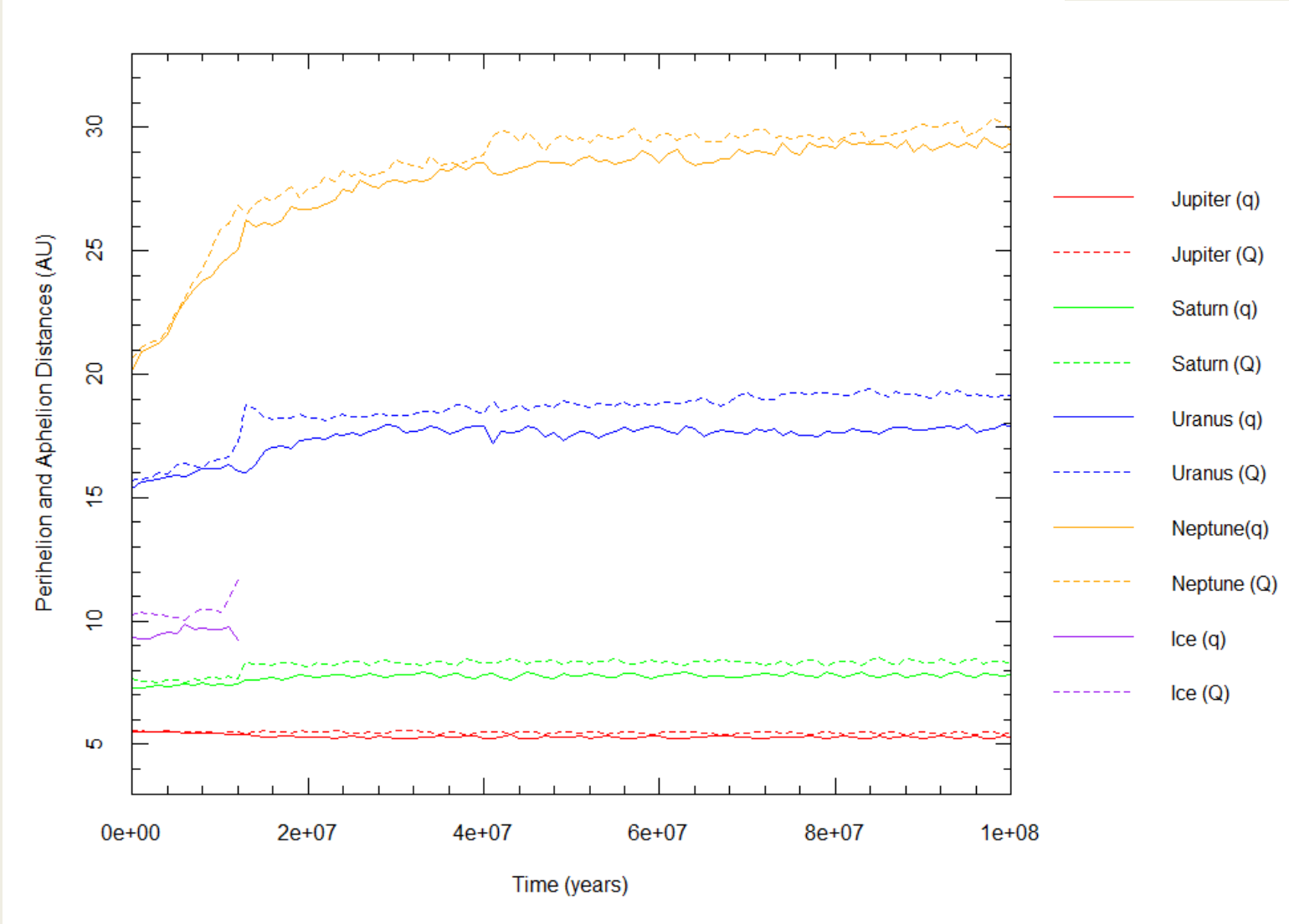
2.) SCATTER INWARD

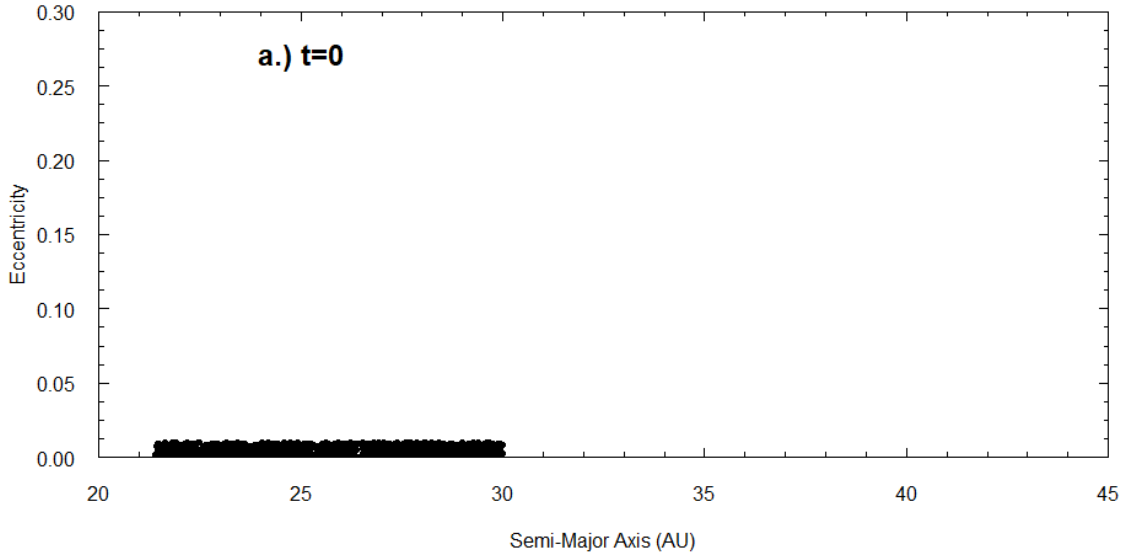


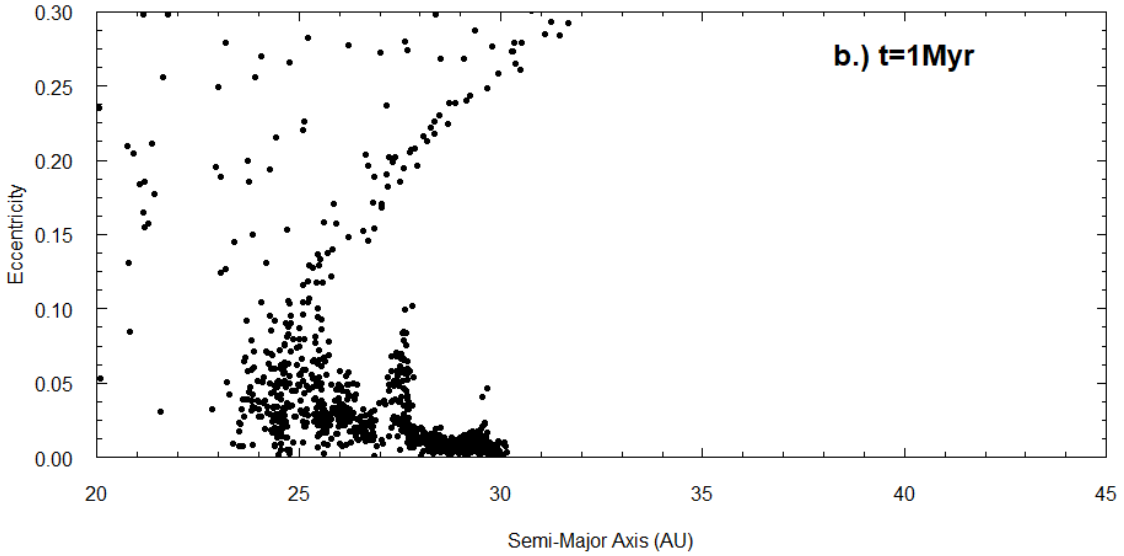
INTERACTIONS WITH JUPITER

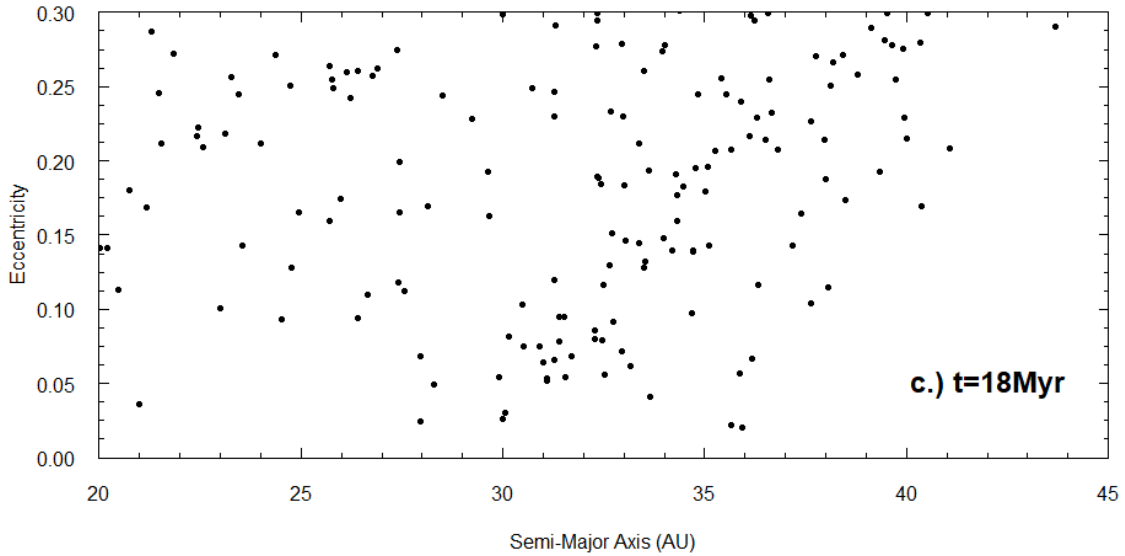


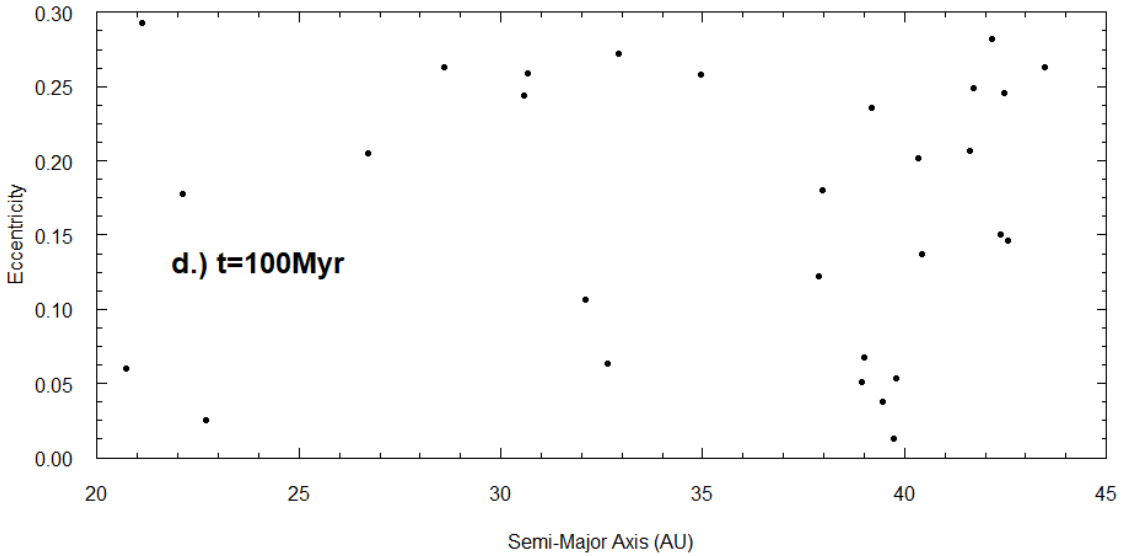
- Jupiter slowly migrating inwards
- Saturn, Uranus, Neptune and Ice slowly migrating outwards
- Ice ejected from system around 18Myr




a.) t=0
Eccentricity
Semi-Major Axis (AU)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
20
25
30
35
40
45


b.) t=1Myr
Eccentricity
Semi-Major Axis (AU)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
20
25
30
35
40
45


c.) t=18Myr
Eccentricity
Semi-Major Axis (AU)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
20
25
30
35
40
45


d.) t=100Myr
Eccentricity
Semi-Major Axis (AU)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
20
25
30
35
40
45

100 SIMULATIONS

- Each simulation contained:
  - *5 giant planets – Jupiter, Saturn and 3 Ice Giants*
  - *1000 particles*
- Sorted between “good” simulations and “bad” simulations
  - *Jupiter, Saturn and 2 of the 3 Ice Giants remained*
  - *Planets had similar semi-major axes to current values*
    - Jupiter: 4.16-6.24 AU
    - Saturn: 7.6-11.4 AU
    - Uranus, Ice and Neptune: 15.35-36.07 AU

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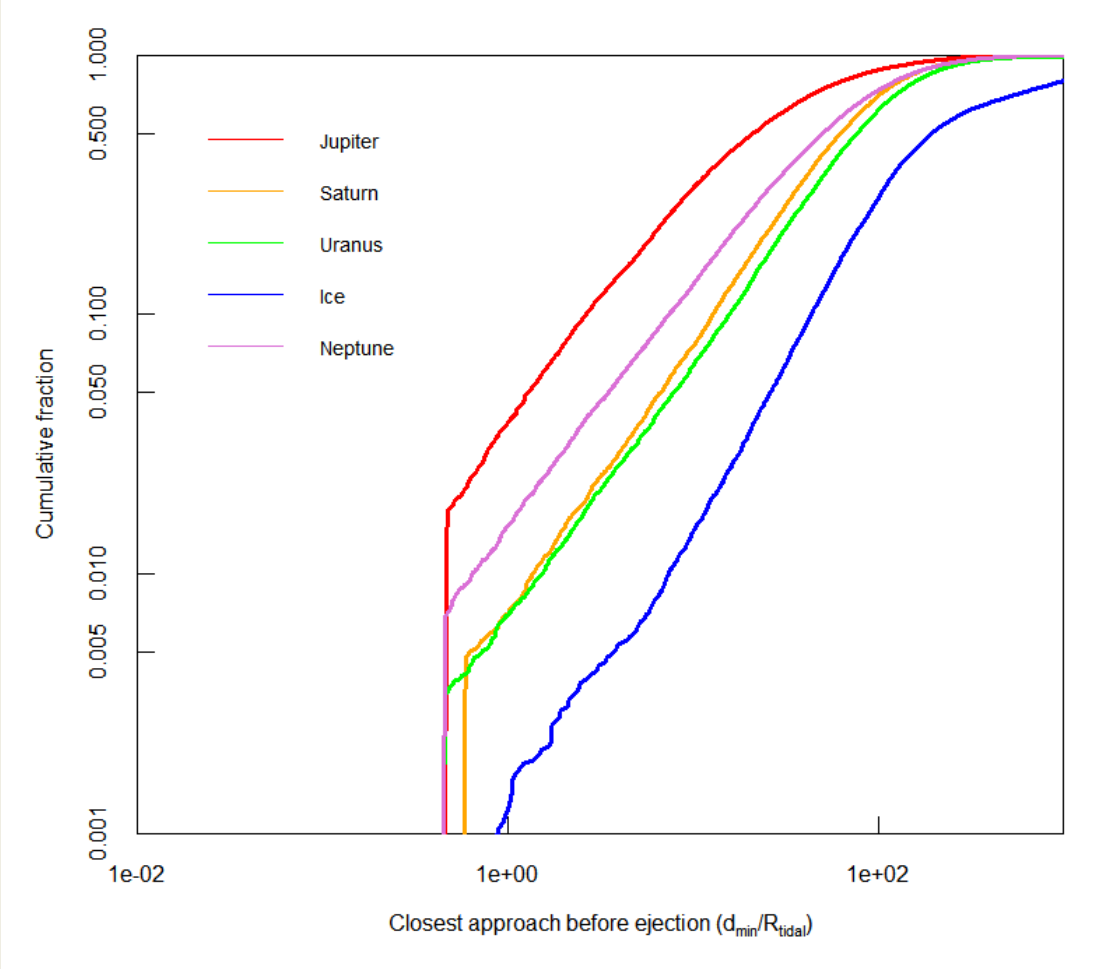
TIDAL DISRUPTIONS

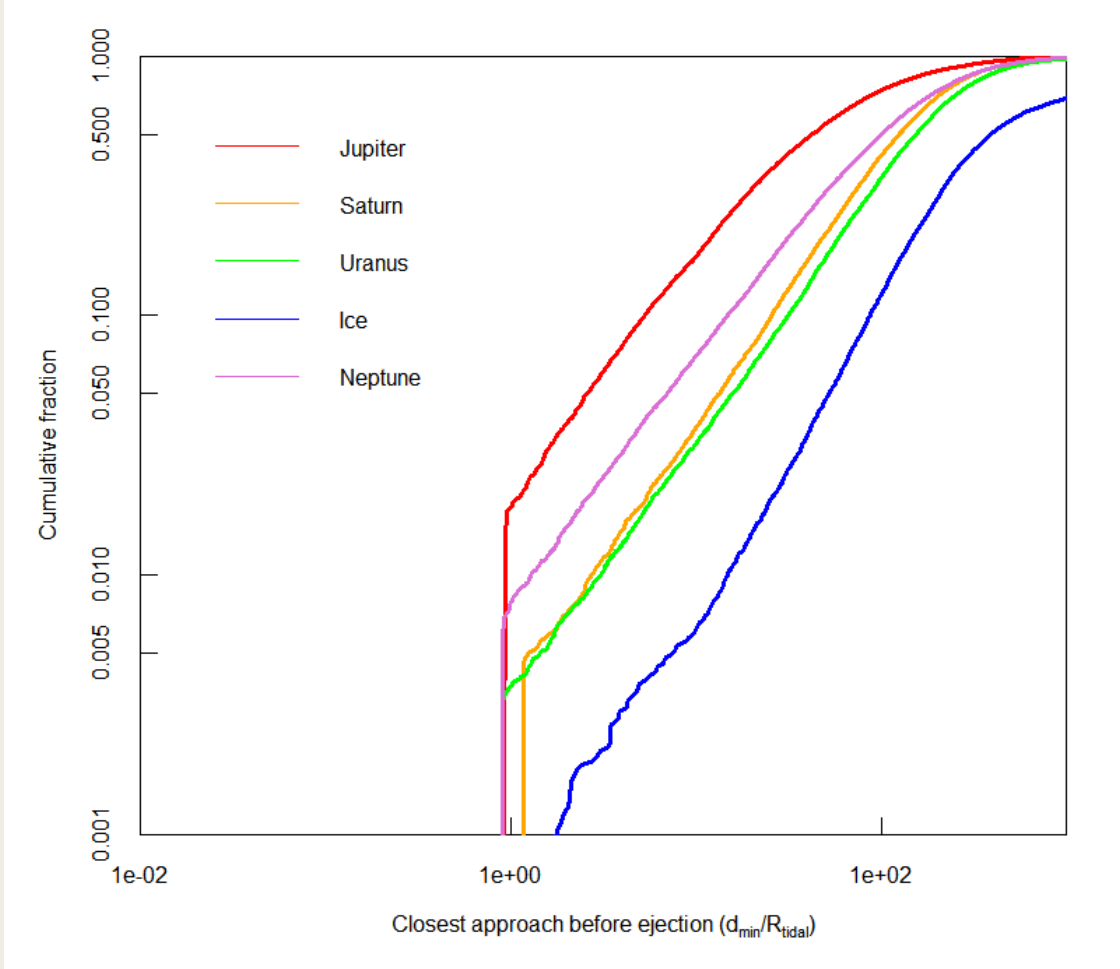
- Planetesimals can be tidally disrupted when they interact with a planet
- Each planet has a specific tidal disruption radius, R_{tidal}
  - *Depends on density of planetesimal*
- 0.5g/cm^3 and 1.0 g/cm^3

ALL PARTICLES

0.5g/cm^3

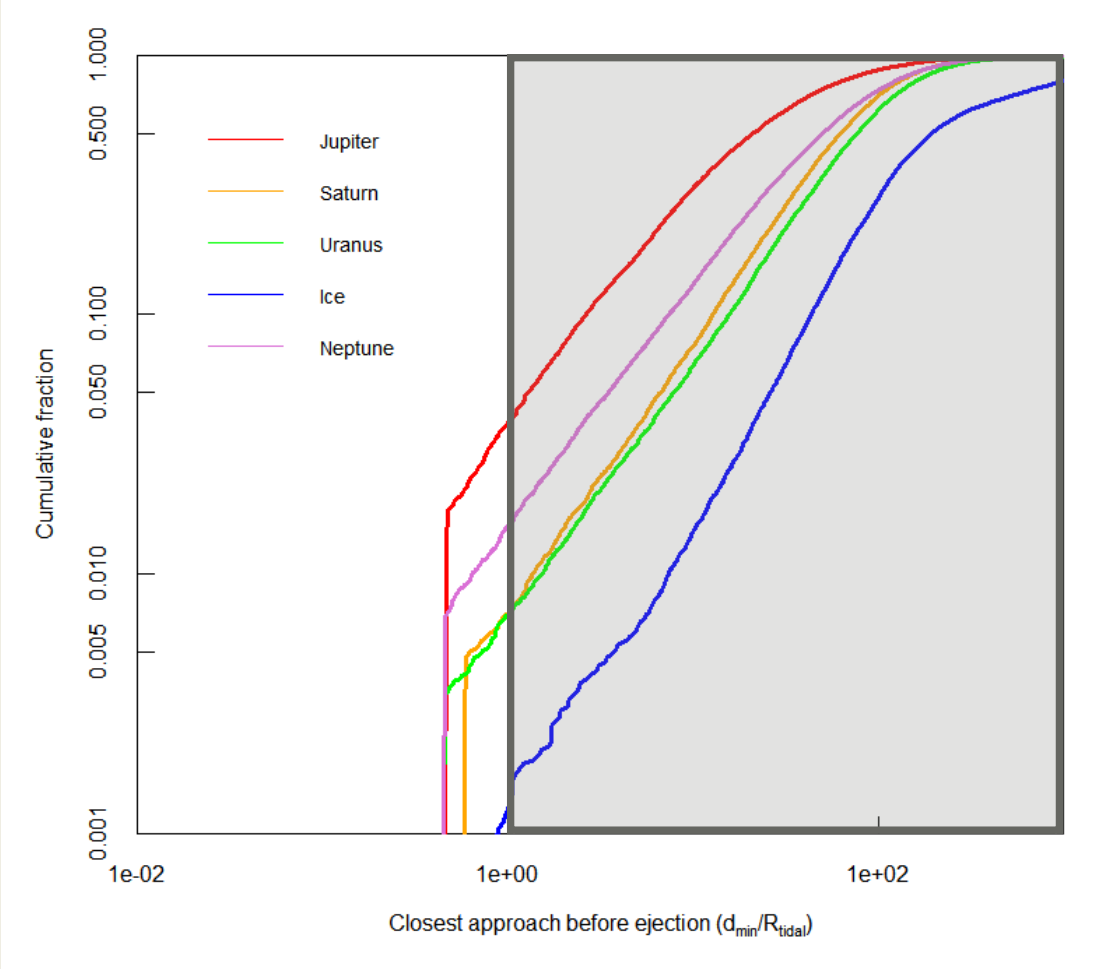


1.0g/cm^3

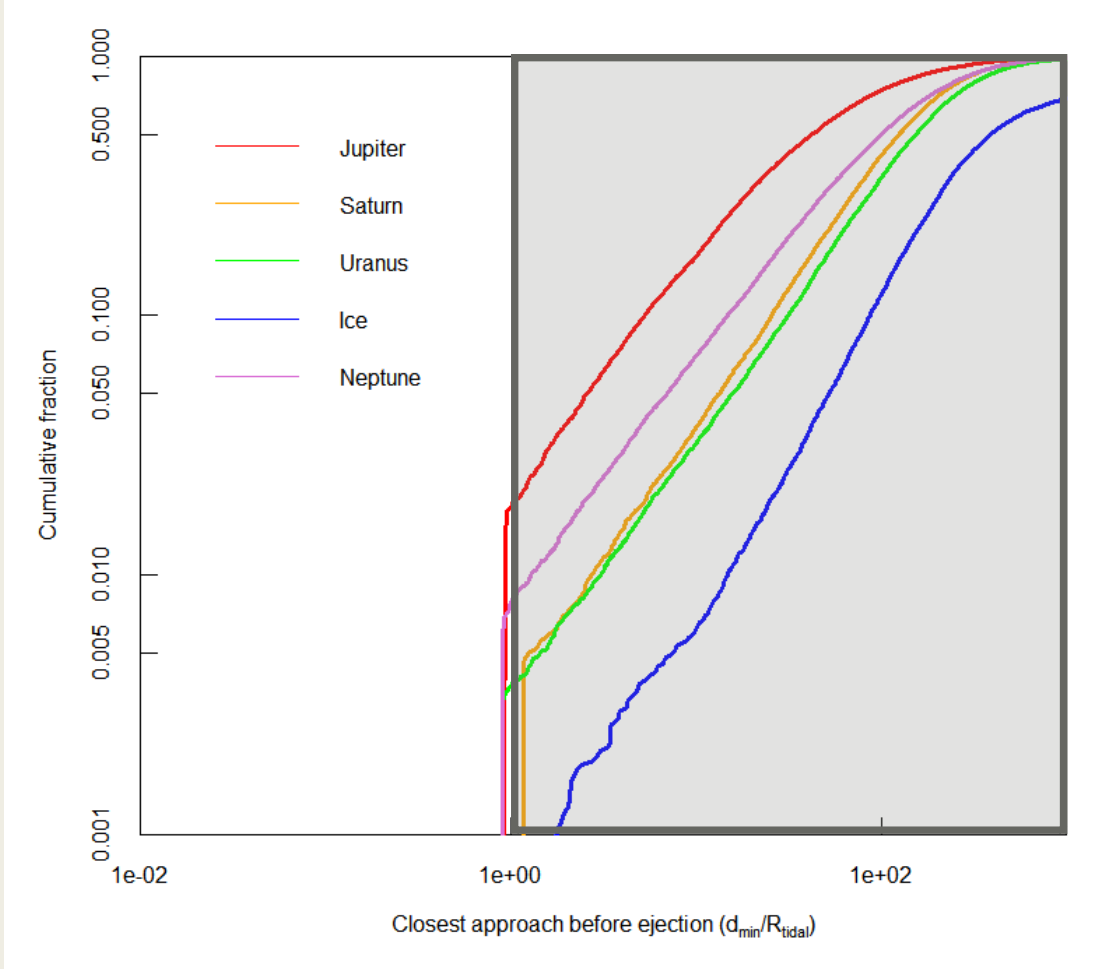


ALL PARTICLES

0.5g/cm^3



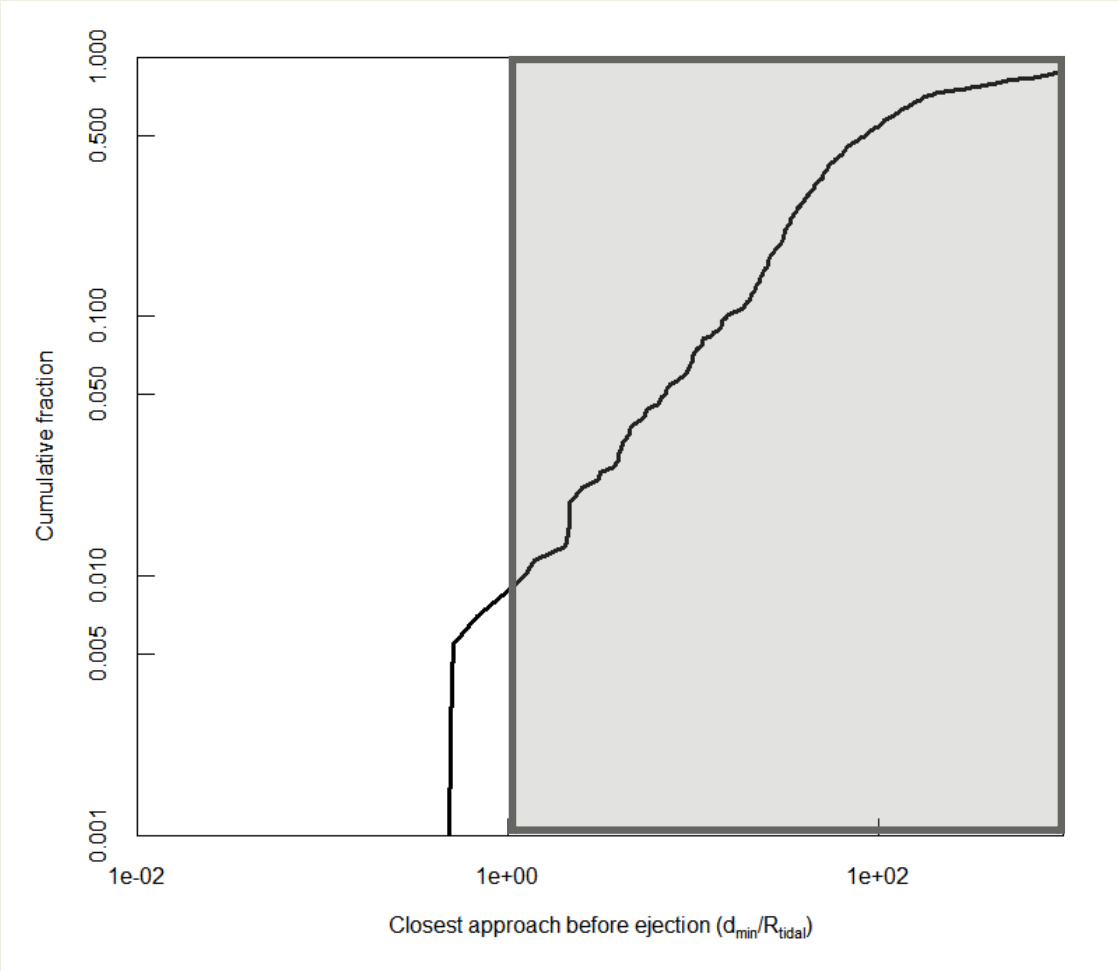
1.0g/cm^3



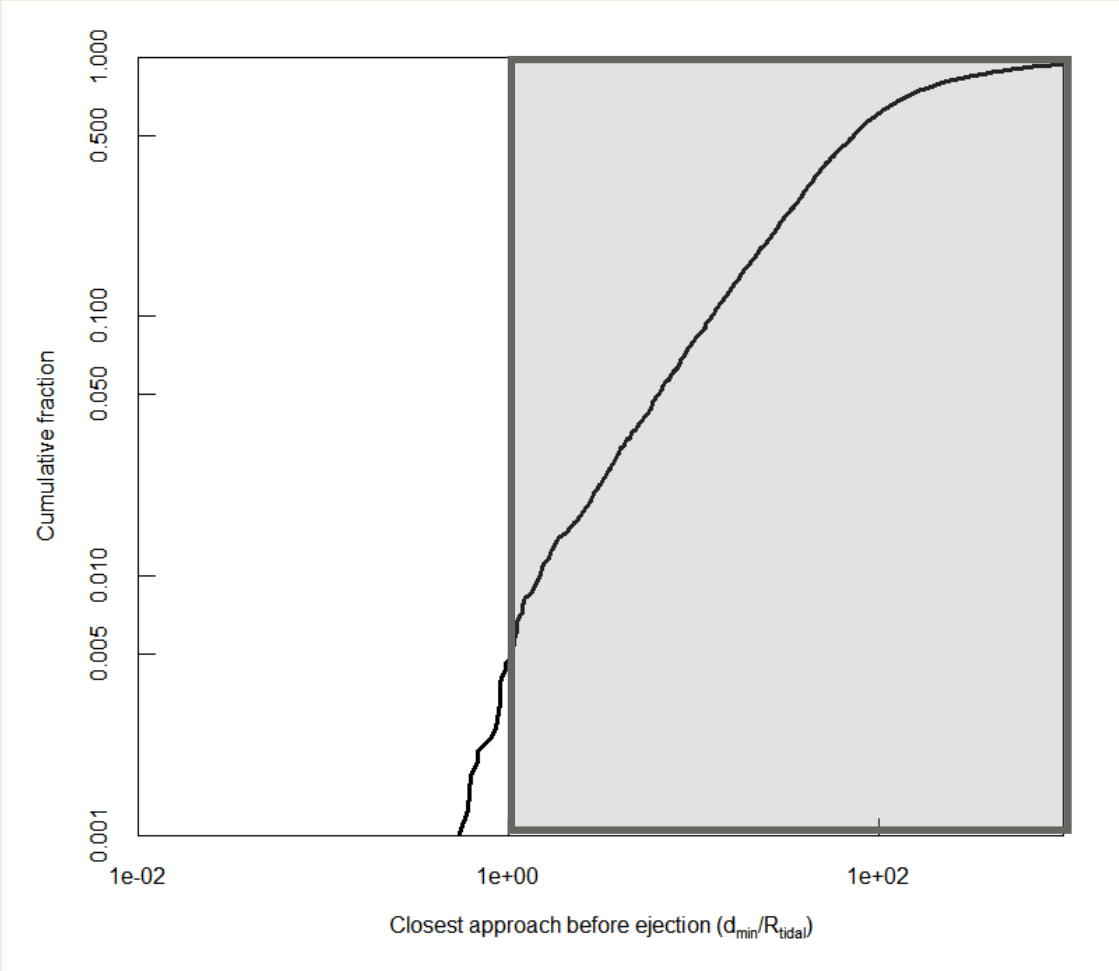
SURVIVING PARTICLES

0.5g/cm^3

KBO



Oort



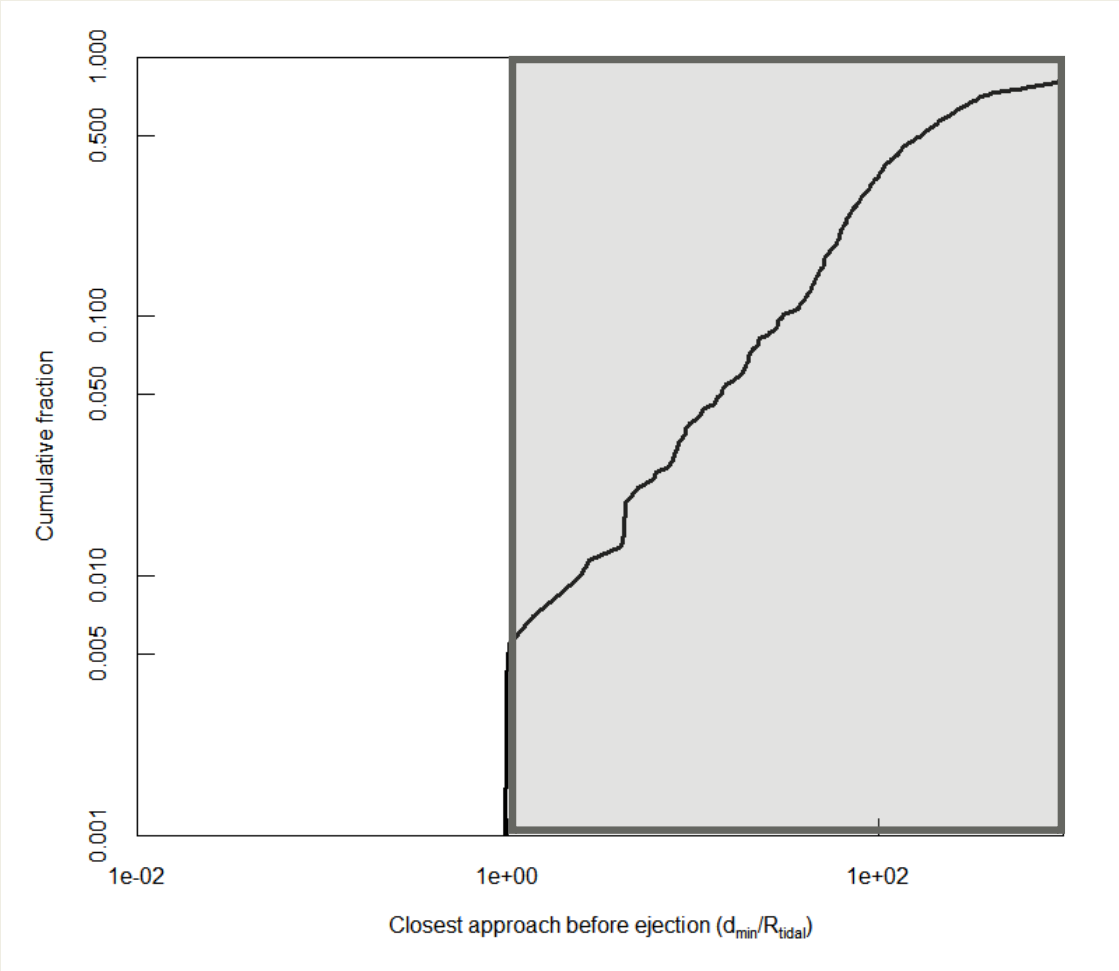
0.919%

0.468%

SURVIVING PARTICLES

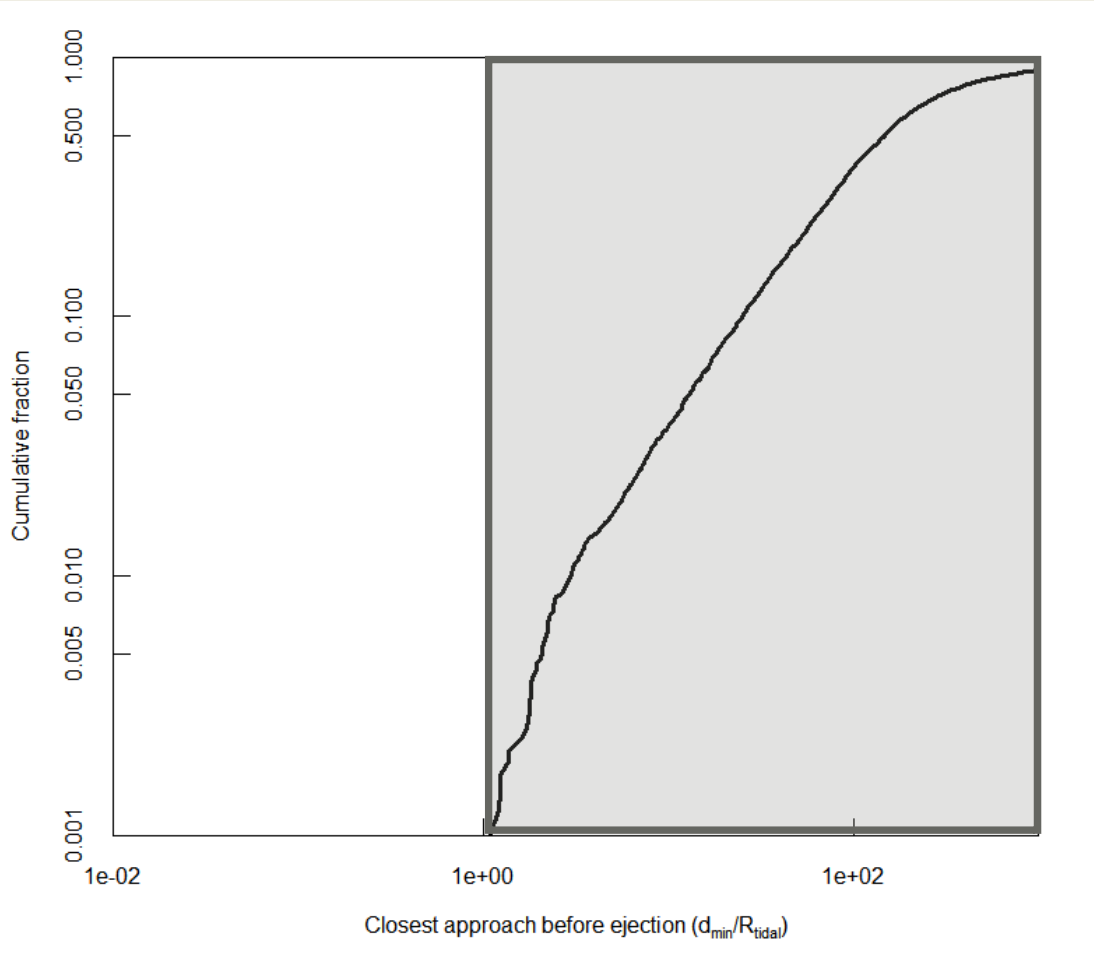
1.0g/cm^3

KBO



0.469%

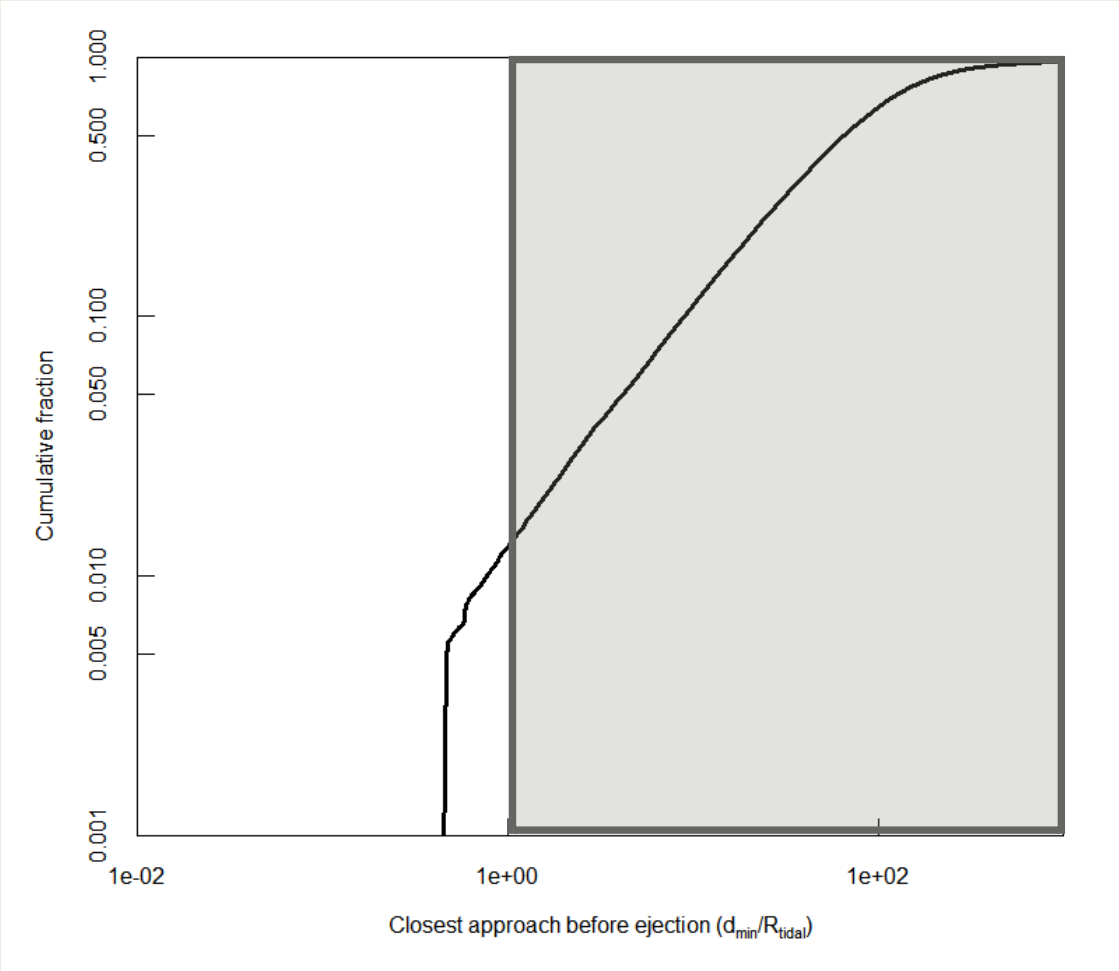
Oort



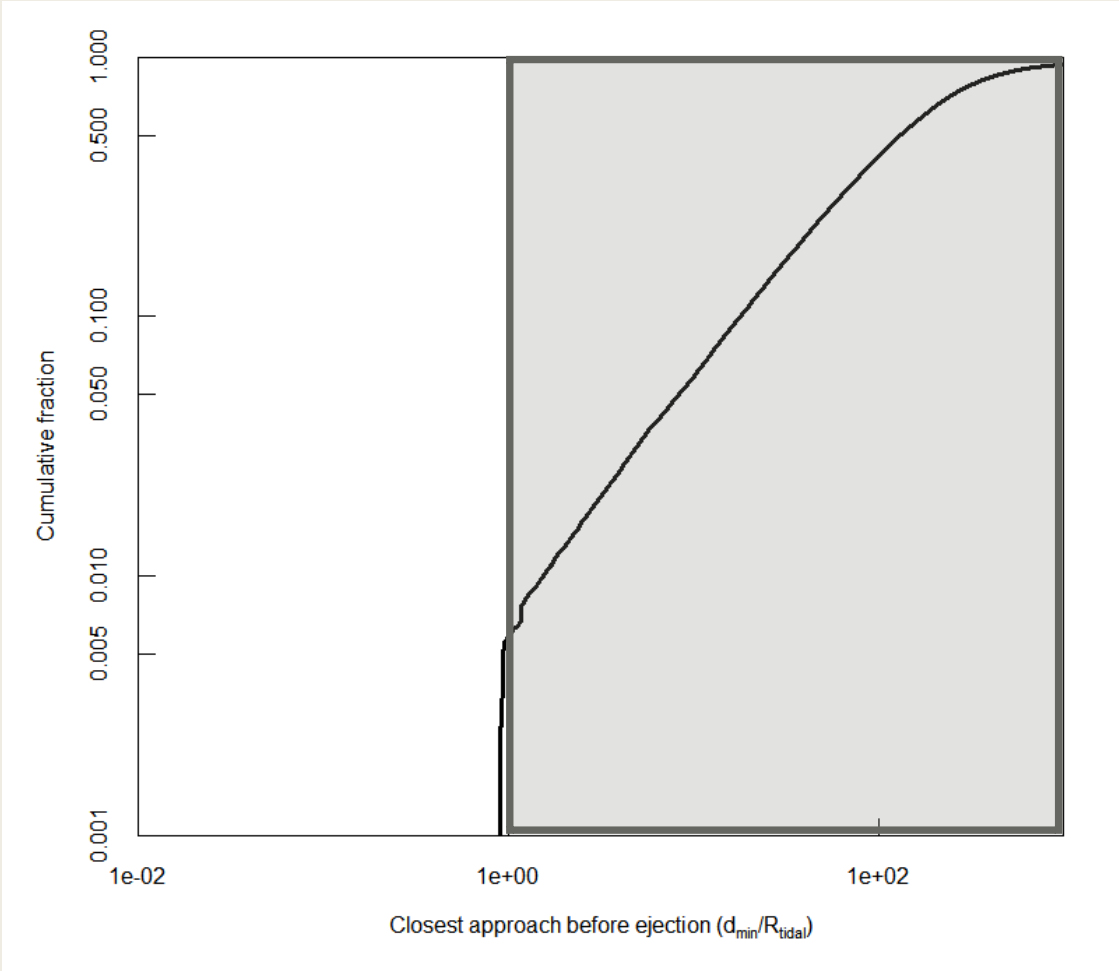
0.047%

EJECTED PARTICLES

0.5g/cm^3



1.0g/cm^3



0.586%

1.3%

CONCLUSION

- At lower densities, percentage of tidally disruptions not drastically different
  - *KBO: 0.919%*
  - *Oort: 0.488%*
  - *Ejected: 0.588%*
- At higher densities:
  - *KBO: 0.488%*
  - *Oort: 0.047%*
  - *Ejected: 1.3%*

THANK YOU

ANY QUESTIONS?

ACKNOWLEDGEMENTS

- Dr. Nathan Kaib
- Dr. Abbot and Dr. Strauss
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