Exploring Planet Formation and Early Solar System Bombardment

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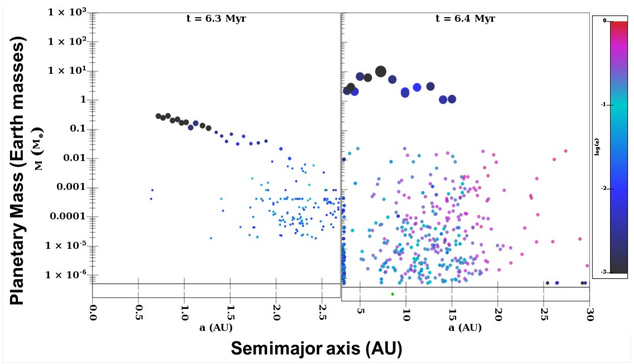
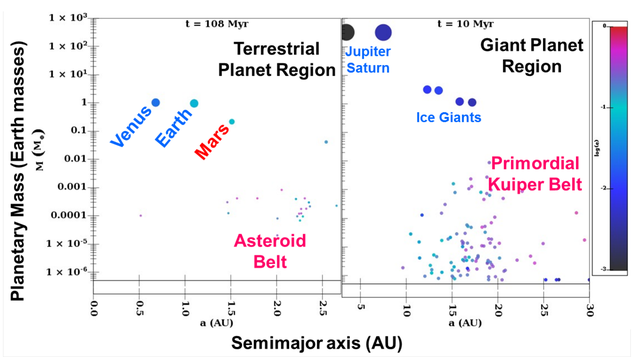
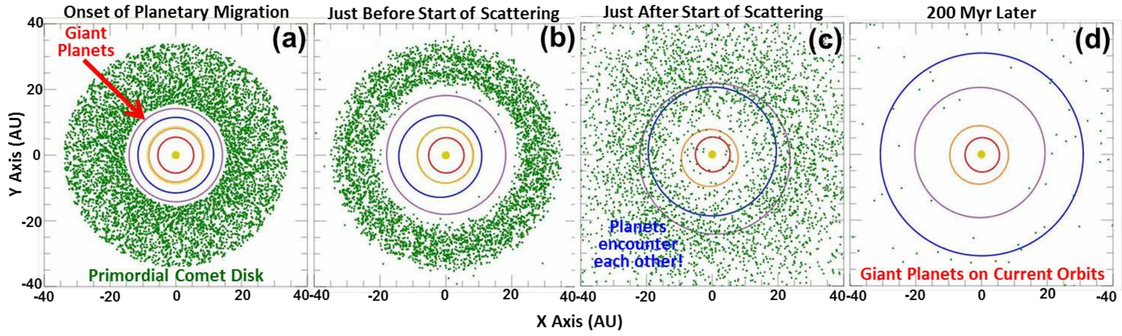
How Did Planet Formation Take Place? Did We Originally Have Multiple Neptunes?





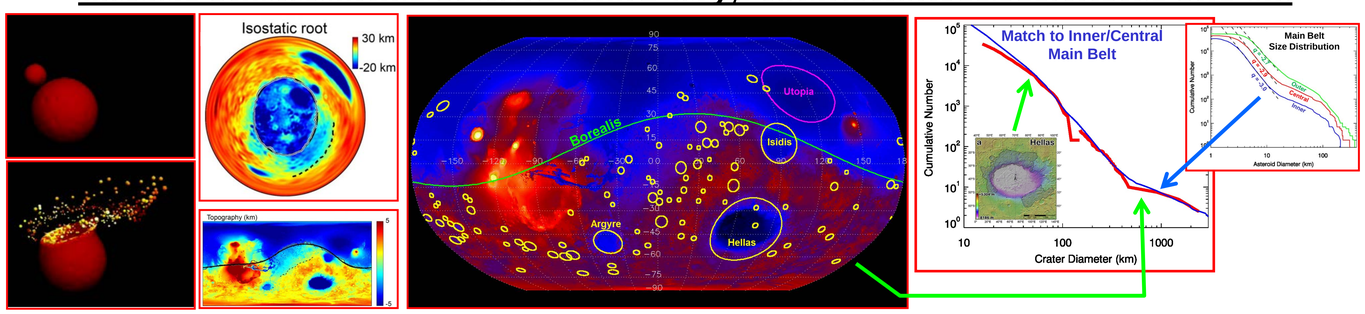
The endgame of planet formation should cause massive impacts across Solar System worlds. Their magnitude and timing is unknown, yet they define early planetary conditions

Did Giant Planets Undergo Instability and Late Migration (Nice Model)?



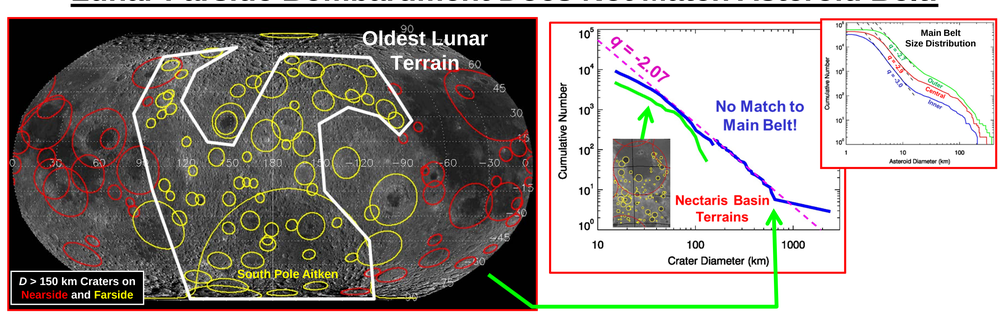
Late giant planet migration may have produced a second wave of major impacts. Did this coincide with planet formation or was there a "time gap"?

Martian Bombardment: Borealis Forms Early; Basins/Craters Are Asteroid Belt-Like



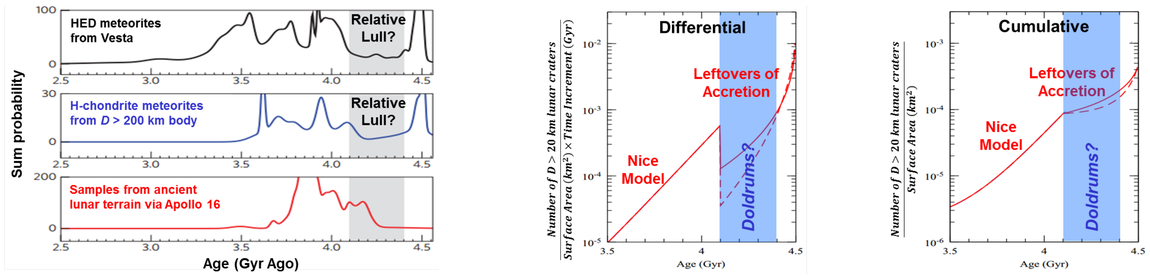
Mars is defined by Ceres-sized Borealis impact, which may be ~4.5 Ga. Later impacts match impactor sizes/flux ejected from asteroid belt by Nice Model. Impacts at 4 Ga?

Lunar Farside Bombardment Does Not Match Asteroid Belt!



Oldest lunar terrains on farside. Size distribution does not match main belt or Mars. Leftovers of accretion? When does this bombardment begin/end?

Two Waves of Impacts? When Did They Start and End? Did They Overlap?

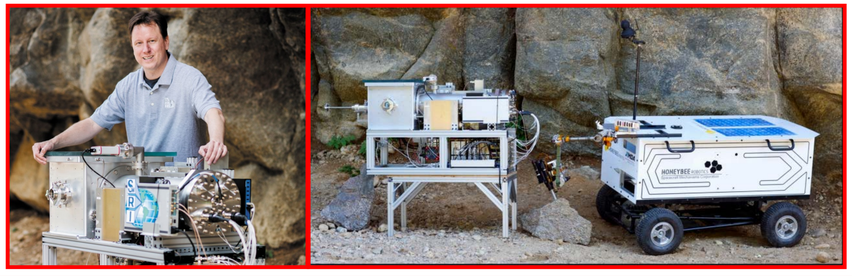


Evidence may exist for "Leftovers of Accretion" and "Late Heavy Bombardment", but things are far from settled. Some also argue for single declining bombardment.

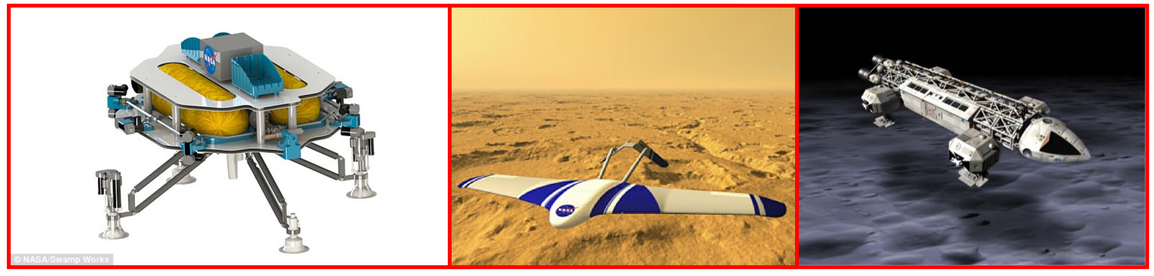
2050 Goals to Constrain Planet Formation & Bombardment

1. Find ages of oldest lunar and Martian surfaces to determine basin retention ages.
2. Find ages of oldest basins South Pole Aitken (Moon) and Borealis (Mars).
3. Find ages of basins that form near defined geologic epochs: Nectaris (Moon) and Hellas (Mars).
4. Find ages of middle-aged craters on Mars/Moon to fully understand crater chronologies for each world.

How To Do It? In Situ Dating of Terrains, Possibly Combined with Spacecraft Mobility



Scott Anderson (SwRI) with a prototype portable geochronometer.



Dating rocks across the Moon and Mars using remote/human-piloted vehicles