

How did Mercury get its Iron heart?



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Methods

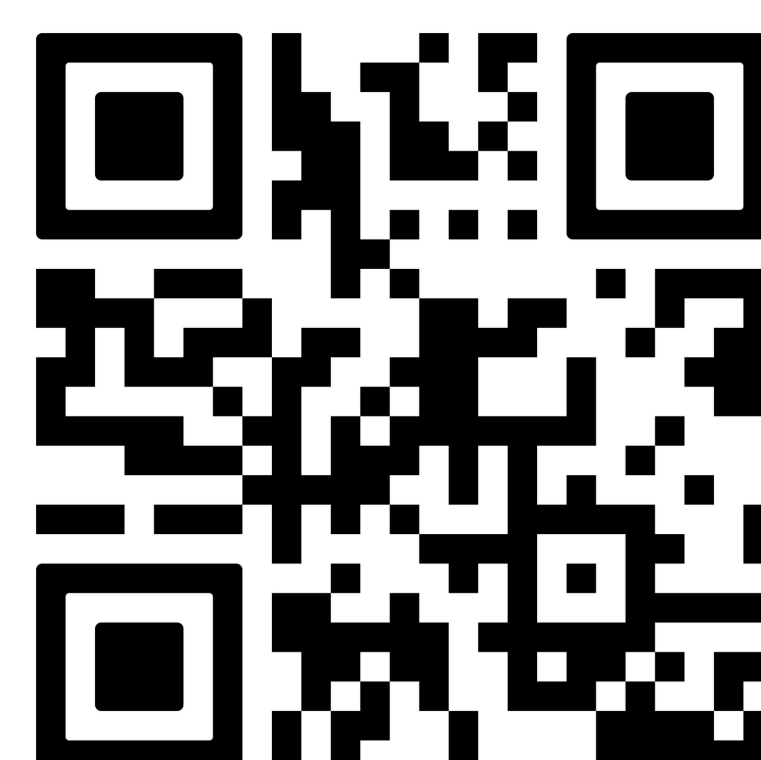
- We do N-body simulations of planet formation at planetesimal stage [7]
- We start with a bimodal mass distribution: lower mass planetesimals and higher mass planetary embryos. [1]
- Disk mass is derived based on the minimum mass solar nebula [1]
- **Different initial CMF distributions are used**
- We allow for fragmentation in our simulations to model the effects of erosive collisions and track the composition of planets [2] [3]

Results

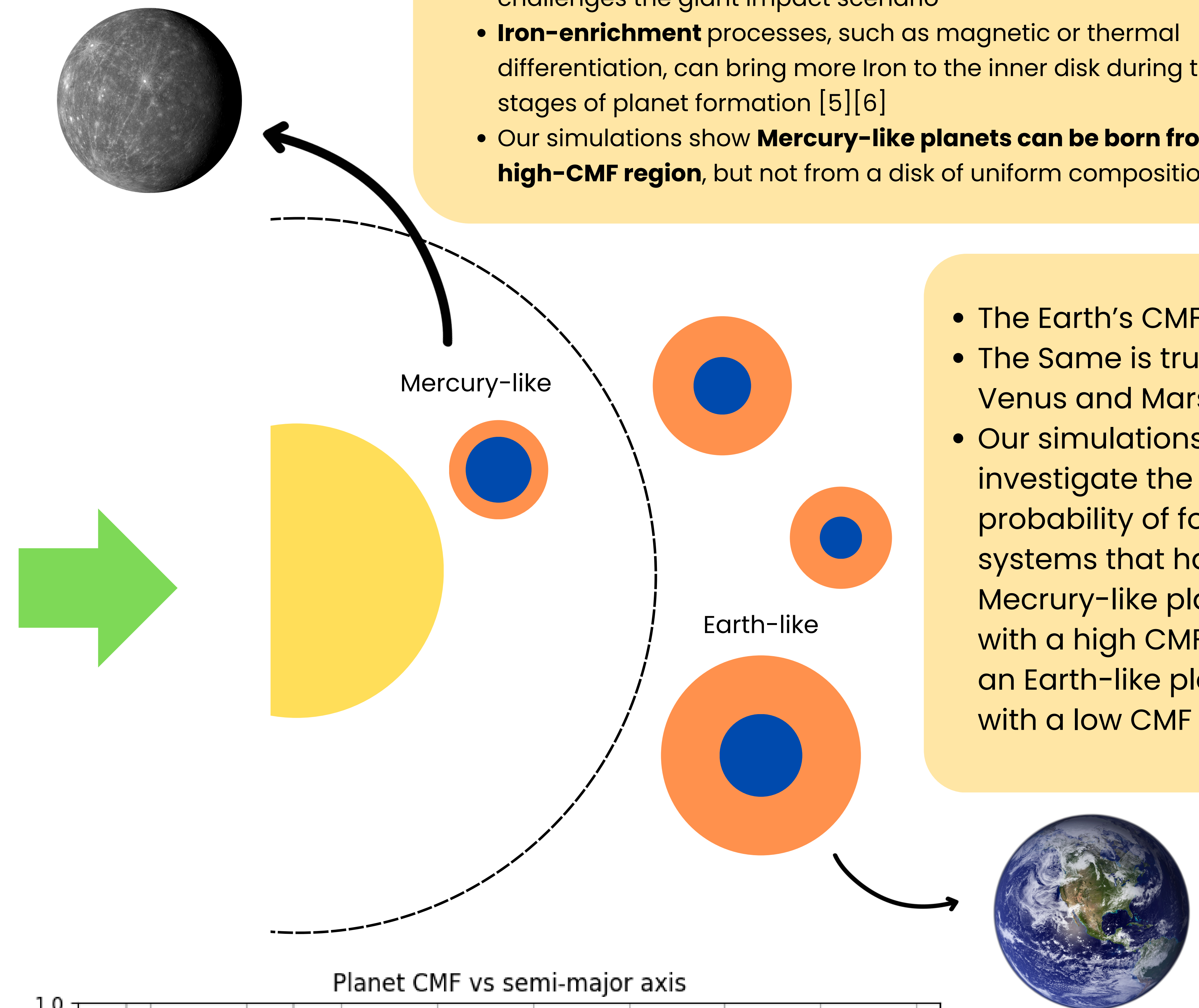
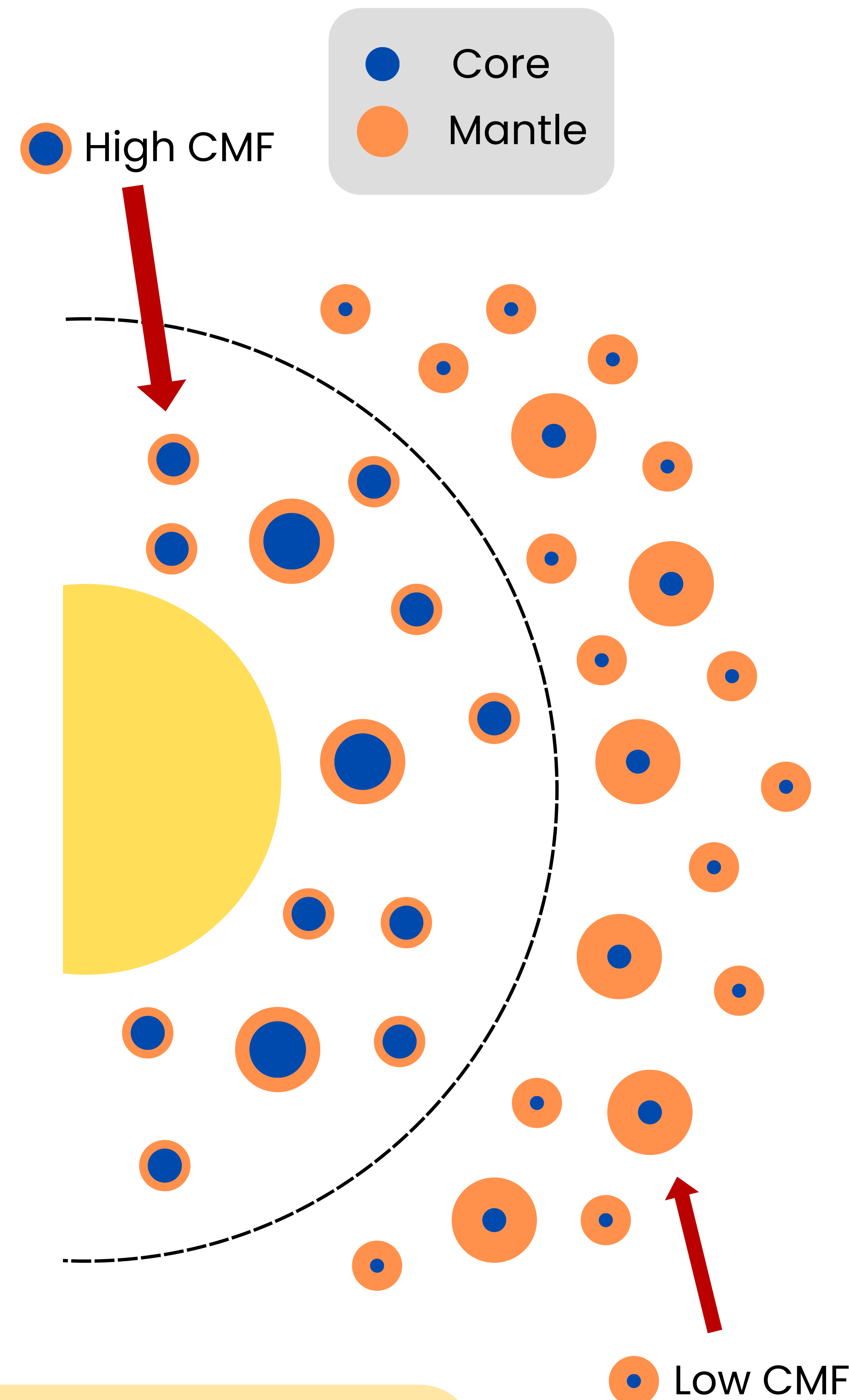
Initial CMF distribution strongly affects the final planet CMFs.

Using a step function to bring more Iron to the inner disk and exchange it with mantle material to keep disk mass constant, we can make systems with a high-CMF planet close to the star, and Earth-like planets in the outer disk.

Scan QR code for more details!

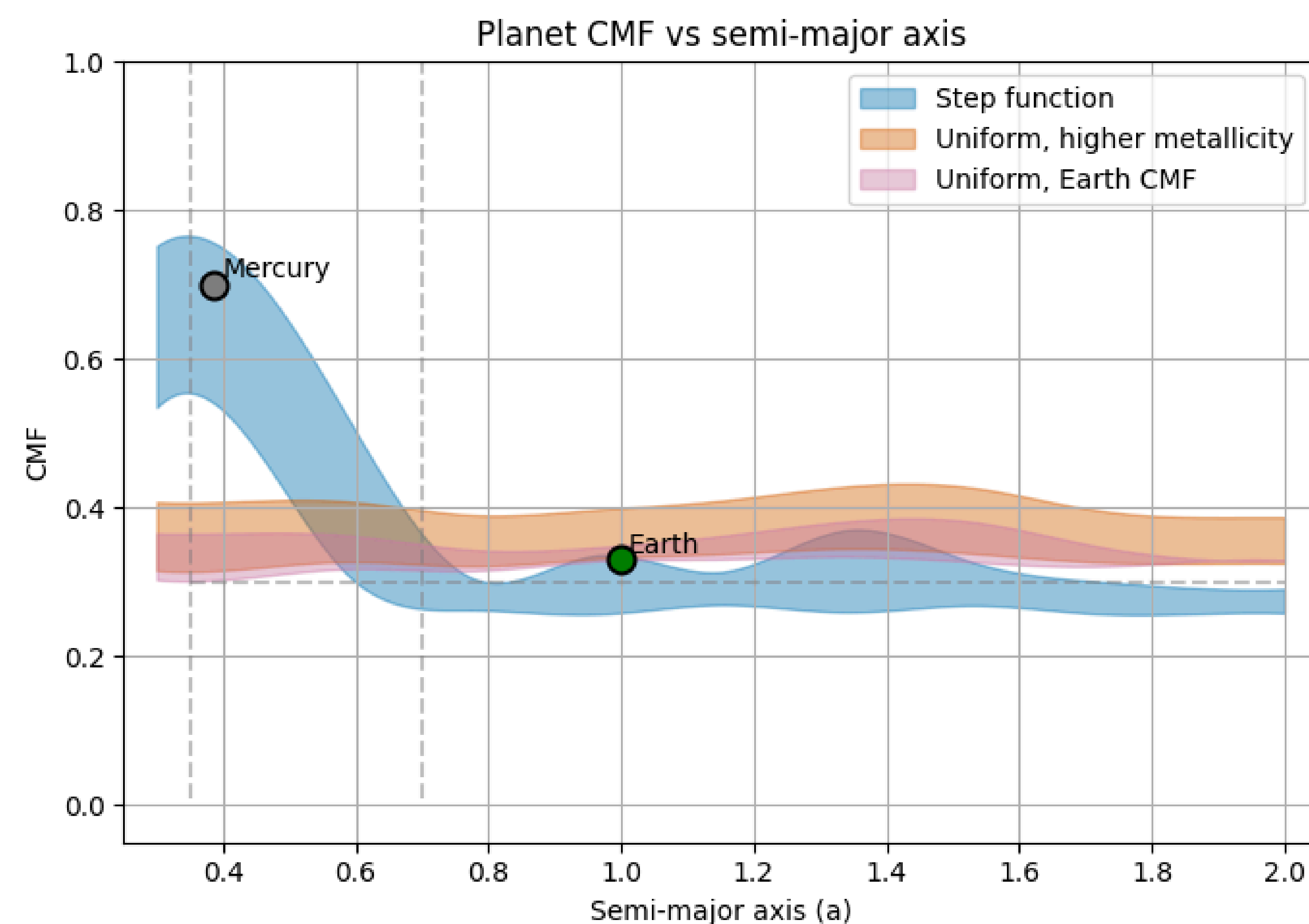


Motivation



- Mercury's core mass fraction (CMF) ~ 0.7
- **A giant impact** to strip away so much mantle to leave Mercury with its huge core has a low probability of occurrence [4]
- The presence of volatile elements on Mercury's surface also challenges the giant impact scenario
- **Iron-enrichment** processes, such as magnetic or thermal differentiation, can bring more Iron to the inner disk during the late stages of planet formation [5][6]
- Our simulations show **Mercury-like planets can be born from a high-CMF region**, but not from a disk of uniform composition

- The Earth's CMF is ~ 0.3
- The Same is true for Venus and Mars
- Our simulations investigate the probability of forming systems that have a Mercury-like planet with a high CMF and an Earth-like planet with a low CMF



References

- [1] Chambers+2013, Icarus, 224, 43
- [2] Childs & Steffen 2022, MNRAS, 511, 1848
- [3] Leinhardt & Stewart 2011, ApJ, 745, 79
- [4] Hyodo+2020, Icarus, 354, 114064
- [5] Kruss & Wurm 2018, ApJ, 869, 45
- [6] Wurm 2018, Geosci., 8, 310
- [7] Rein & Liu 2011, A&A, 537, A128