National Aeronautics and Space Administration

Building a New Planet Formation Model for Characterizing Habitable Rocky Planets

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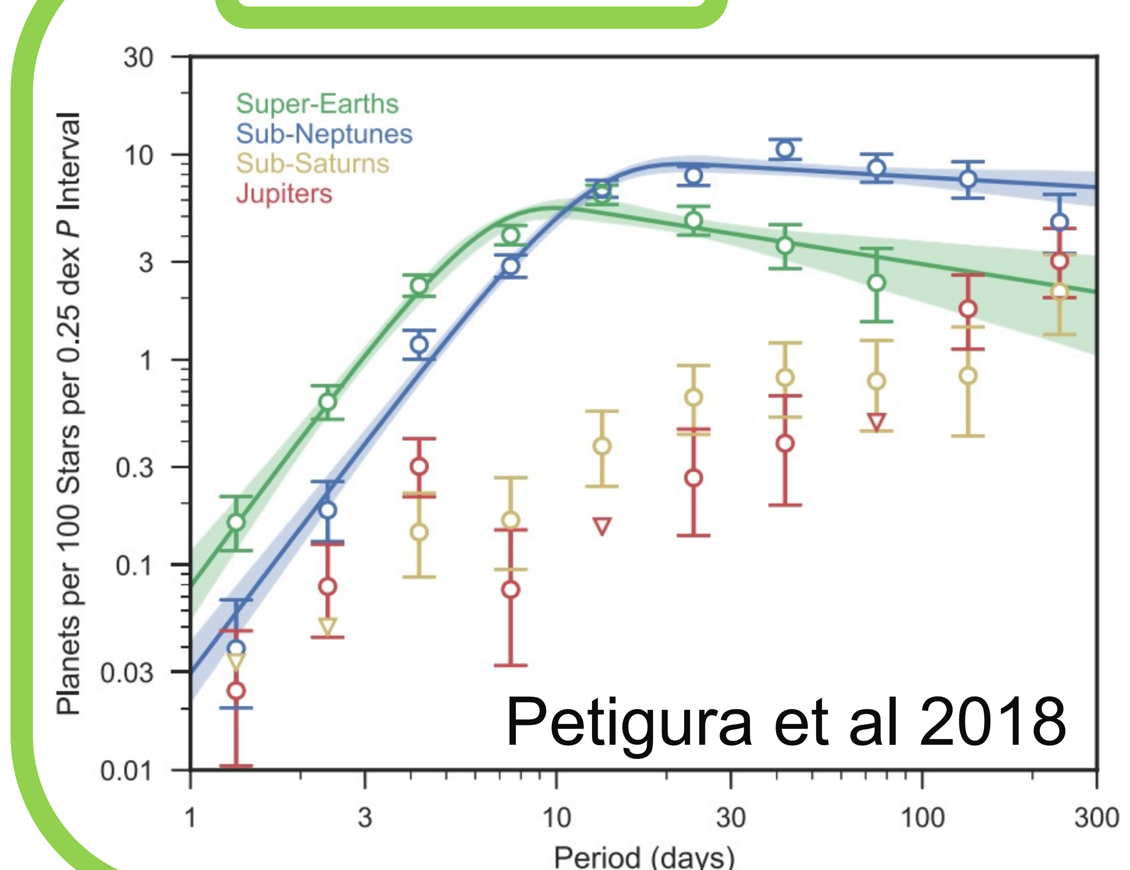
Program: FY21 SURP **Strategic Focus Area: Extra-solar planets and star and planetary formation**

Objectives

Determine the importance of stellar magnetic fields on the spatial distribution of the observed close-in super-Earth population by developing a new disk model and running *N*-body simulations

Build a strong and sustained partnership with Professor Hansen and his research group at UCLA

Background



Close-in super-Earths are dominant in the observed exoplanet population

The origin of these exoplanets is still unknown

Planetary migration should be important

Significance/Benefits to JPL and NASA

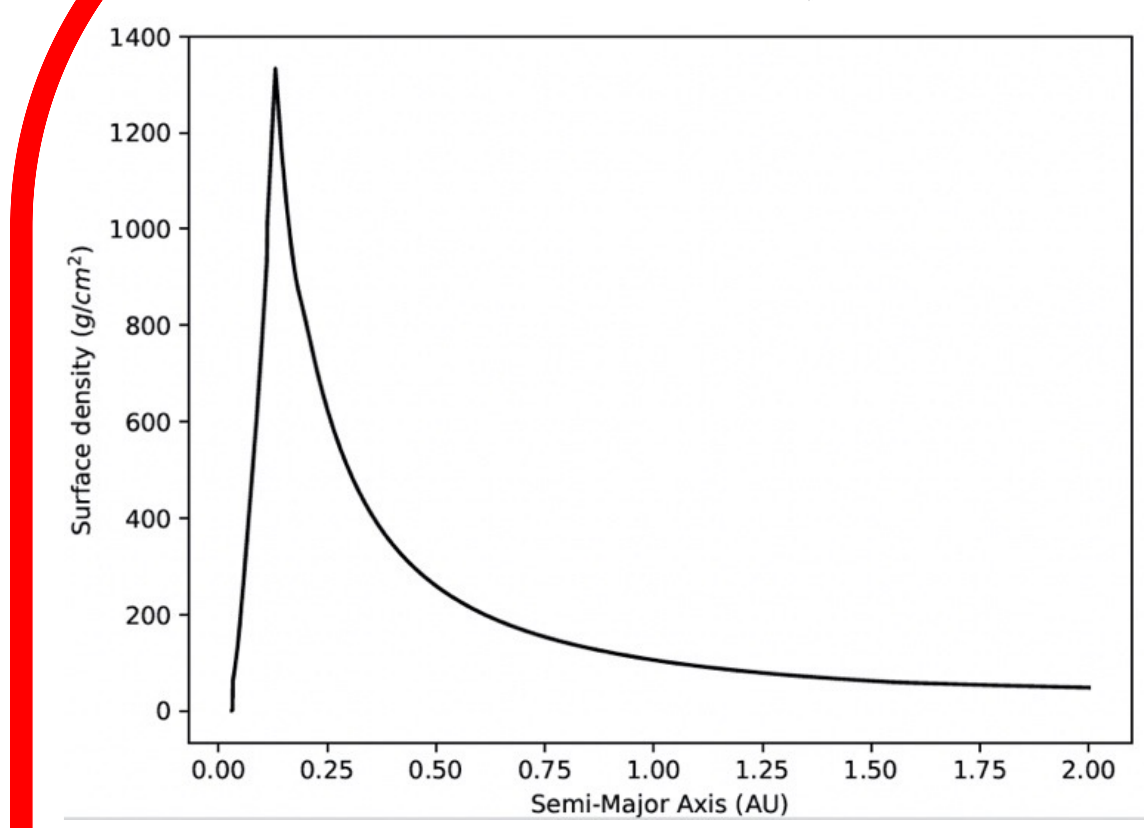
This work provided novel insights about the formation of close-in super-Earths and sub-Neptunes by tightly constraining the role of stellar magnetic fields

Our finding is useful for developing new interpretations on upcoming observations done by TESS, JWST, and Roman Space Telescope

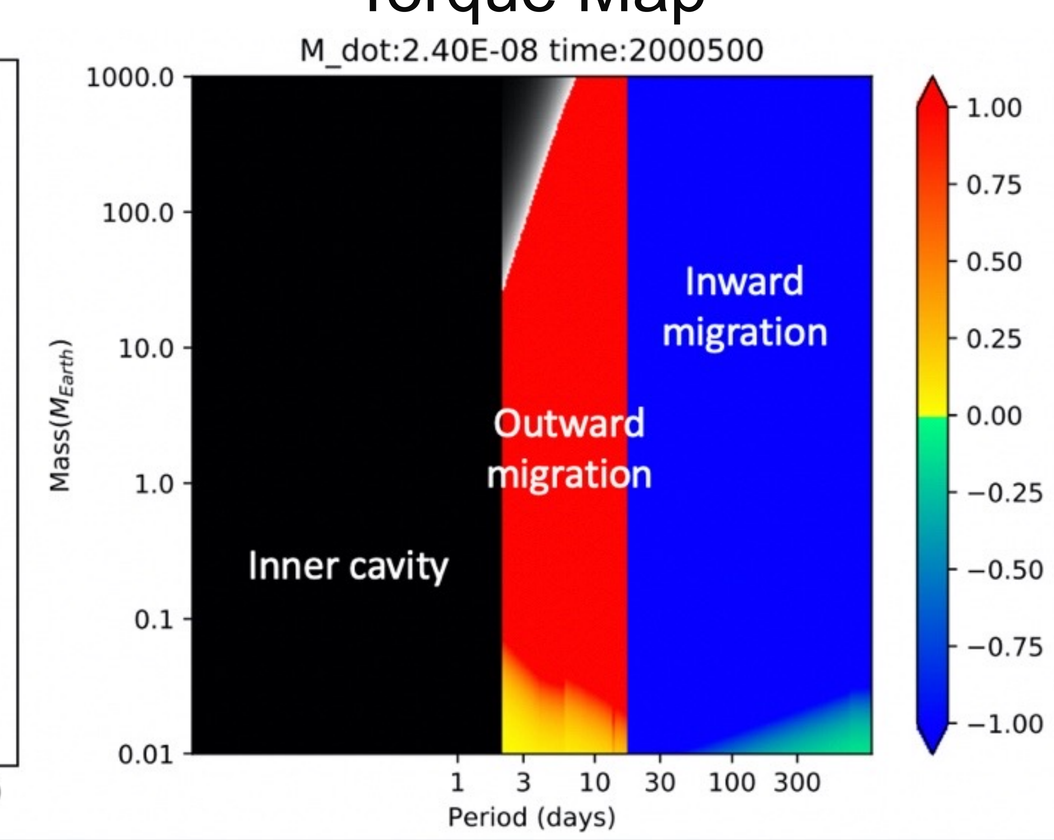
Our close interaction enabled us to submit two NASA ROSES XRP proposals (PI: Hasegawa and PI: Hansen)

Approach and Results

Gas Surface Density Profile



Torque Map

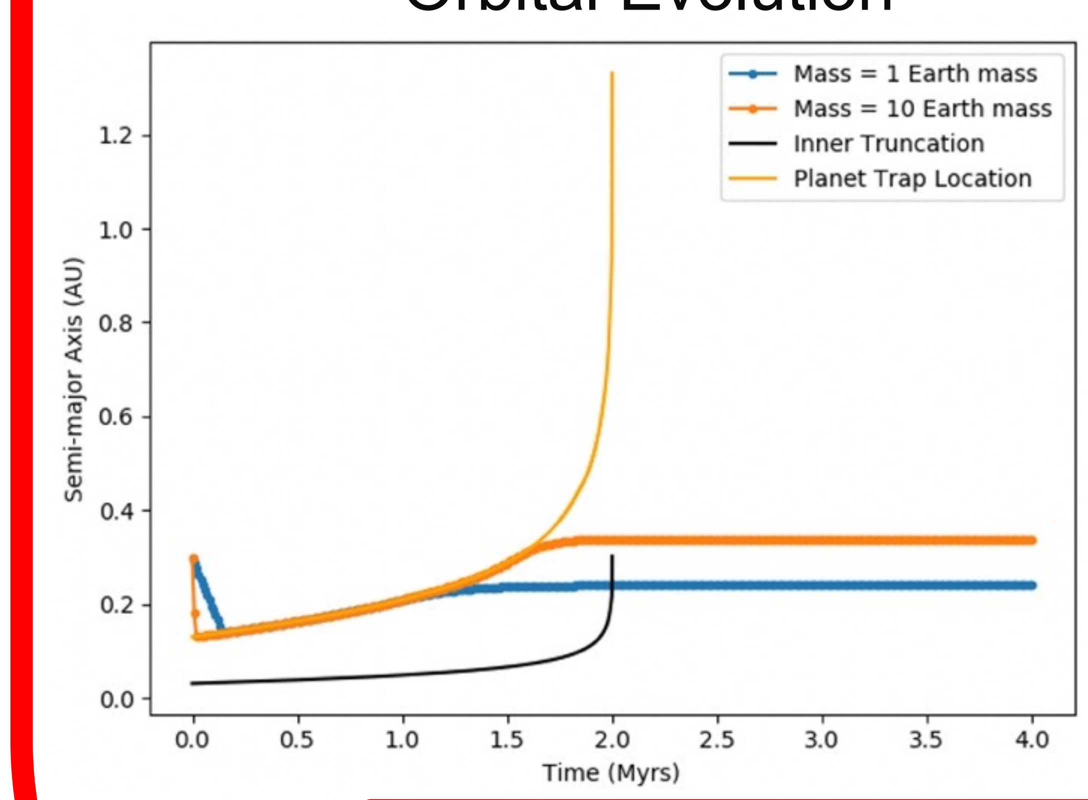


Left: the sharp rise in the surface density is caused by stellar magnetic fields

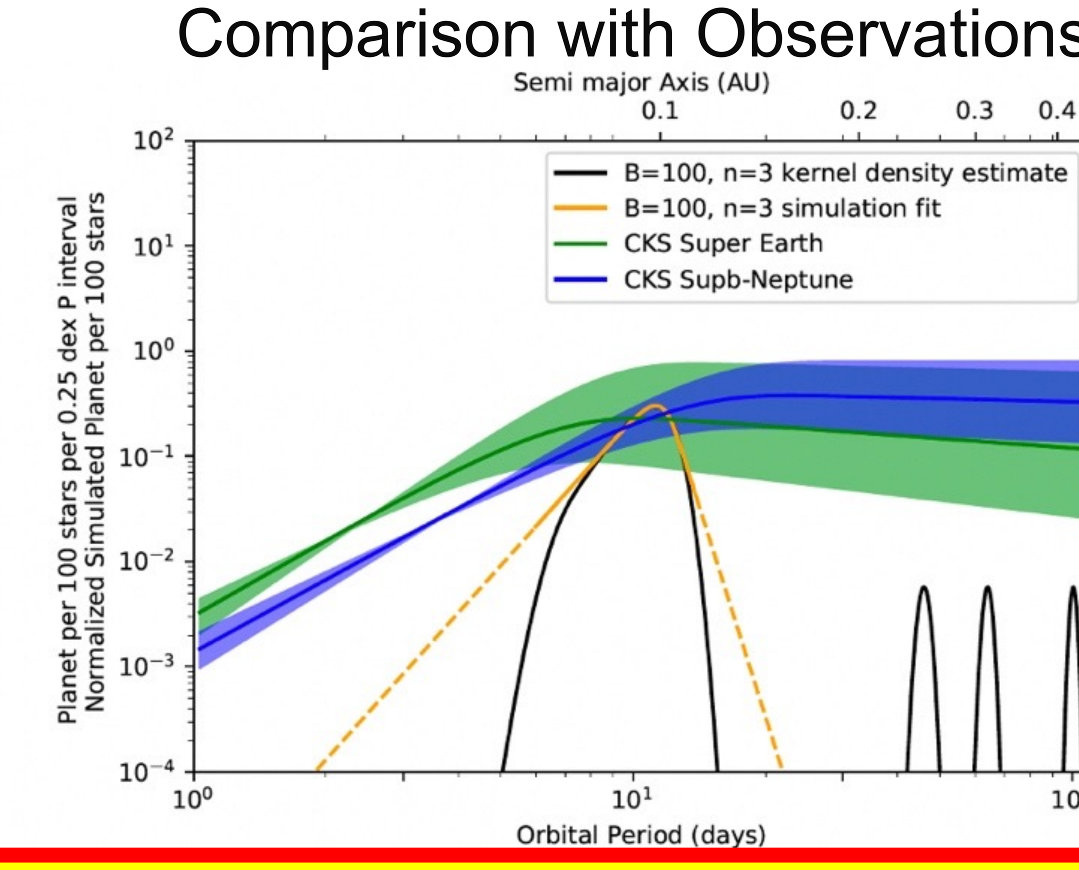
Right: the outward migration becomes possible due to the positive gradient of the surface density

Stellar magnetic fields produce a trap for (proto)planets migrating inward from the outer disk at the transition from the inward to outward migration

Orbital Evolution



Comparison with Observations



Left: Trajectories of trapped planets. The final location of planets is determined by dropping out from their host traps

Right: The occurrence rate predicted from our simulation results

The migration hypothesis can successfully reproduce the Kepler data when stellar magnetic fields are characterized by the dipole profile with the strength of about 100 G.

Publications

Yu, Hansen, Hasegawa, 2021, MNRAS, in prep

Reference: Petigura at al 2018, ApJ, 155, 89

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