Understanding Planet Formation: Initial Disk Distribution

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DISK DYNASTY

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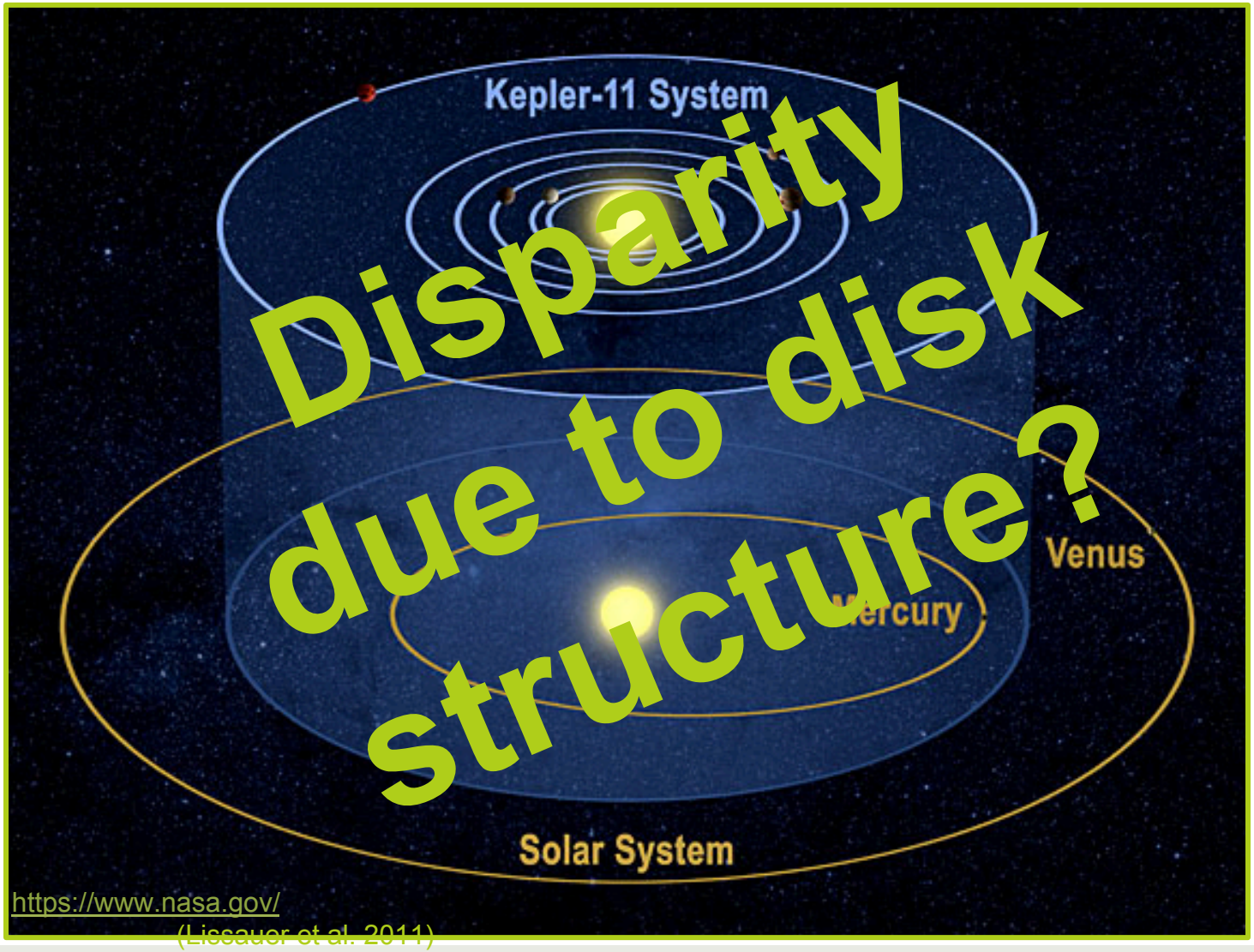
Effects of Disk Density Profile on Planet Orbital Distribution



https://www.nasa.gov/

(Lissauer et al. 2011)

What do we expect?

Steeper Density Slope

=

Increase in # of Closer Planets

How do we check?

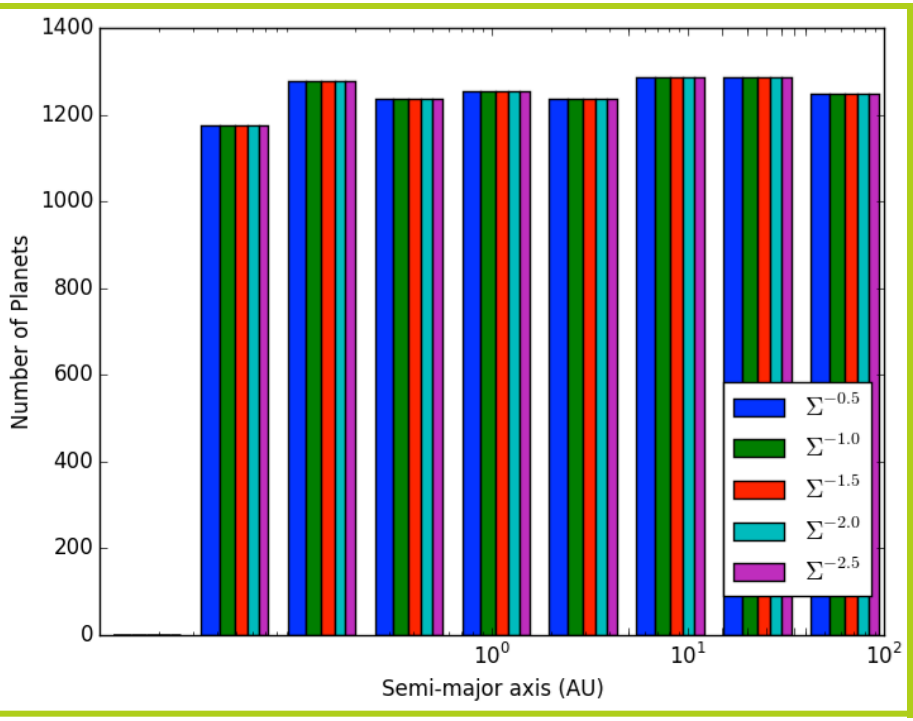
Vary Density Slope

$$\Sigma_g \propto f_g r^{p_g} \exp[-r^{2+p_g}]$$

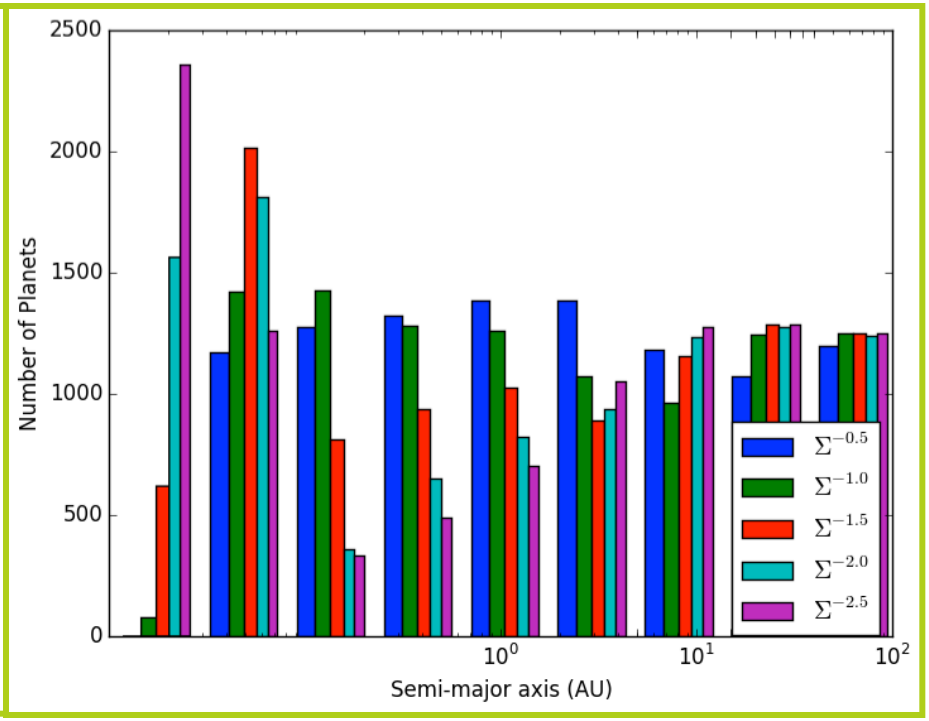
Power Law Index	Migration On	Migration Off
-0.5	1.2e-231	1.4e-232
-1.0	1.4e-178	1.4e-232
-1.5	6.6e-156	1.4e-232
-2.0	1.1e-171	1.4e-232
-2.5	7.0e-182	1.4e-232

Simulations show…

DENSITY SLOPE ITERATION WITH **NO** MIGRATION

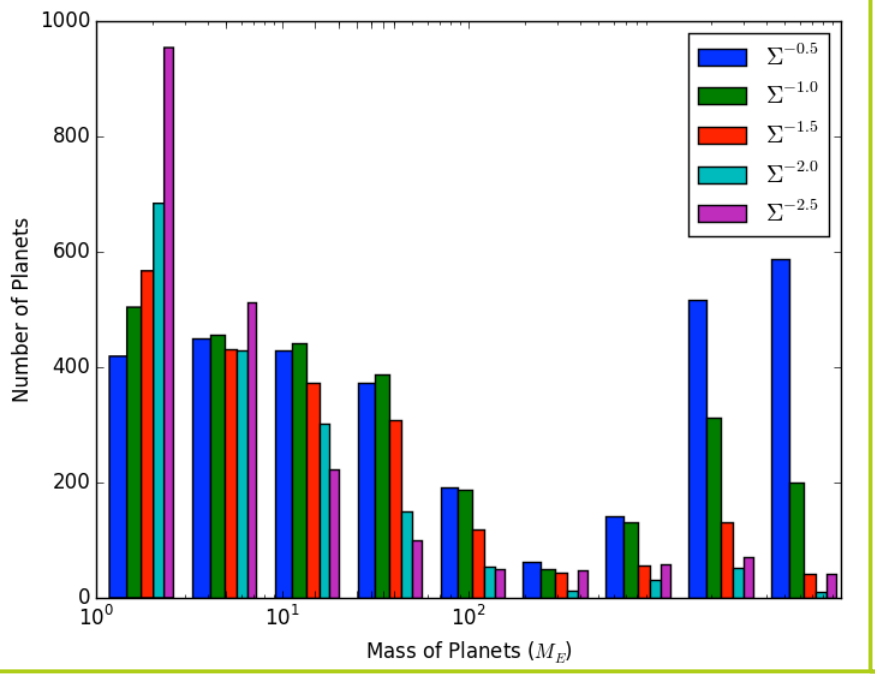


DENSITY SLOPE ITERATION WITH LIMITED MIGRATION



Simulations show…

DENSITY SLOPE ITERATION WITH **NO** MIGRATION



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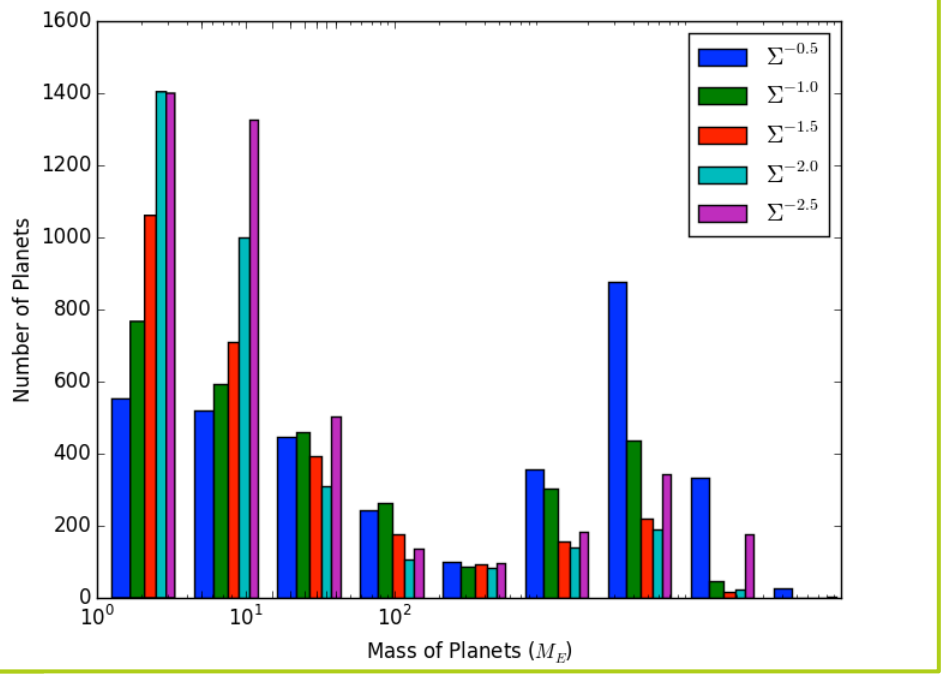
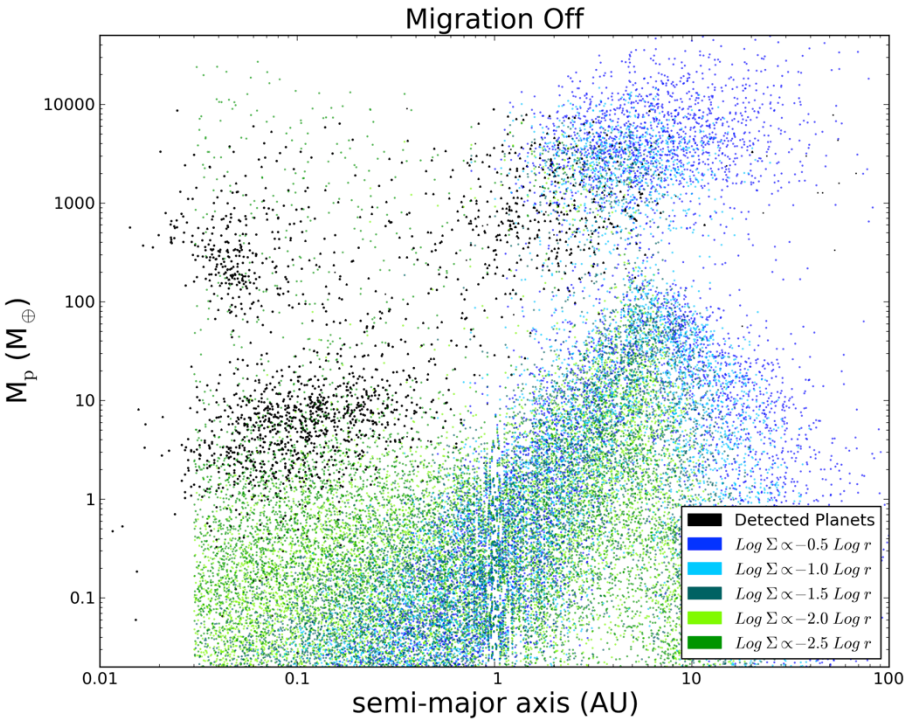
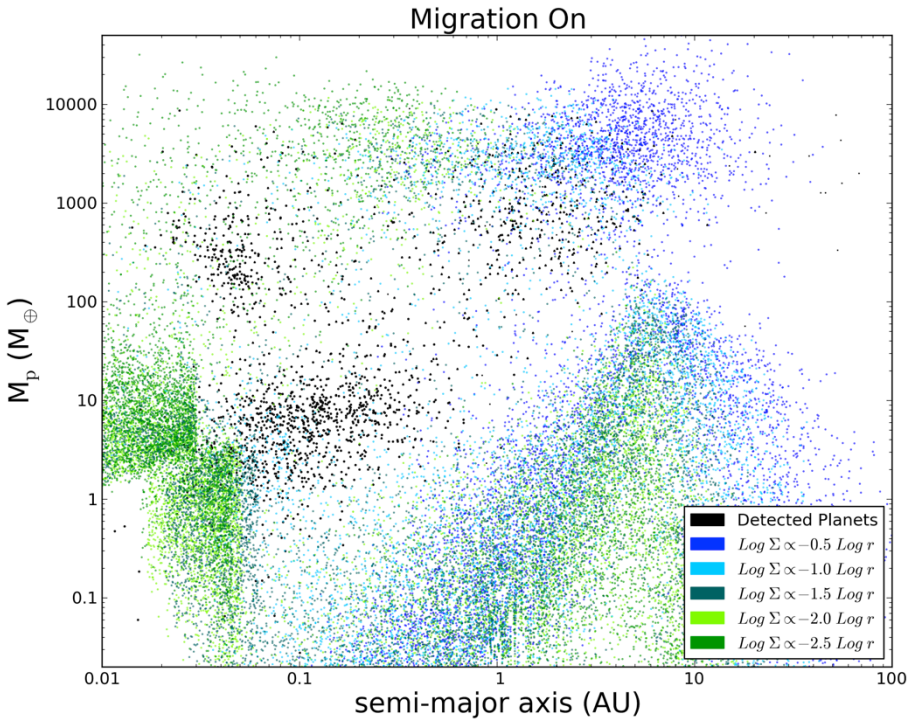


Comparing with Observations…

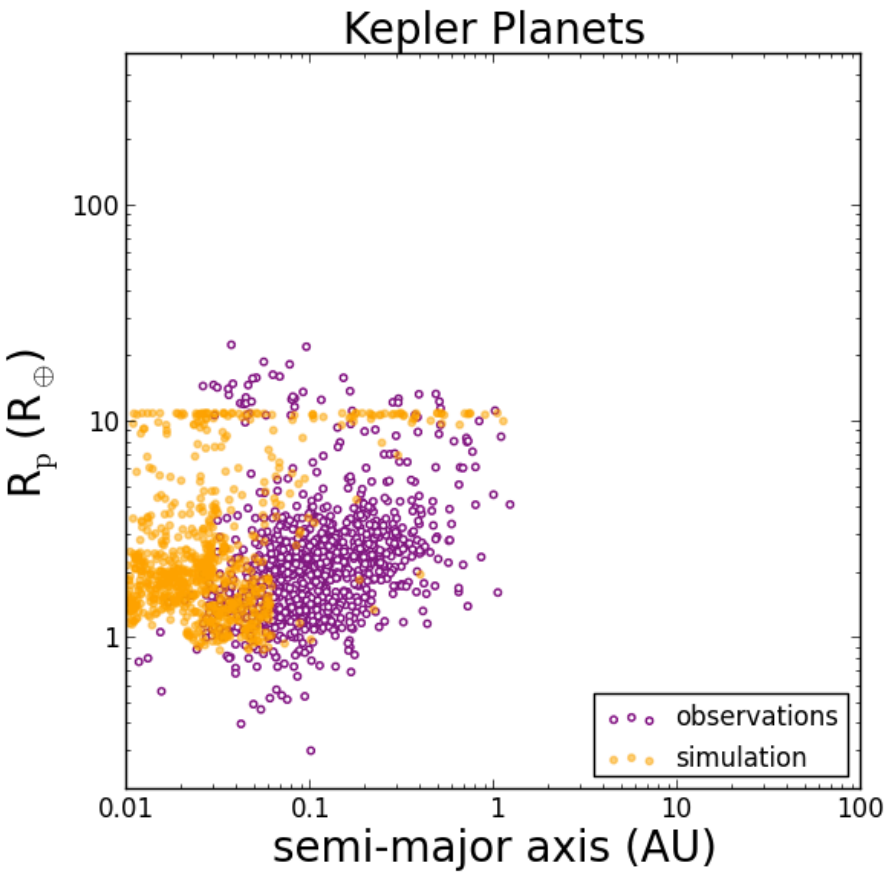
DENSITY SLOPE ITERATION WITH **NO** MIGRATION

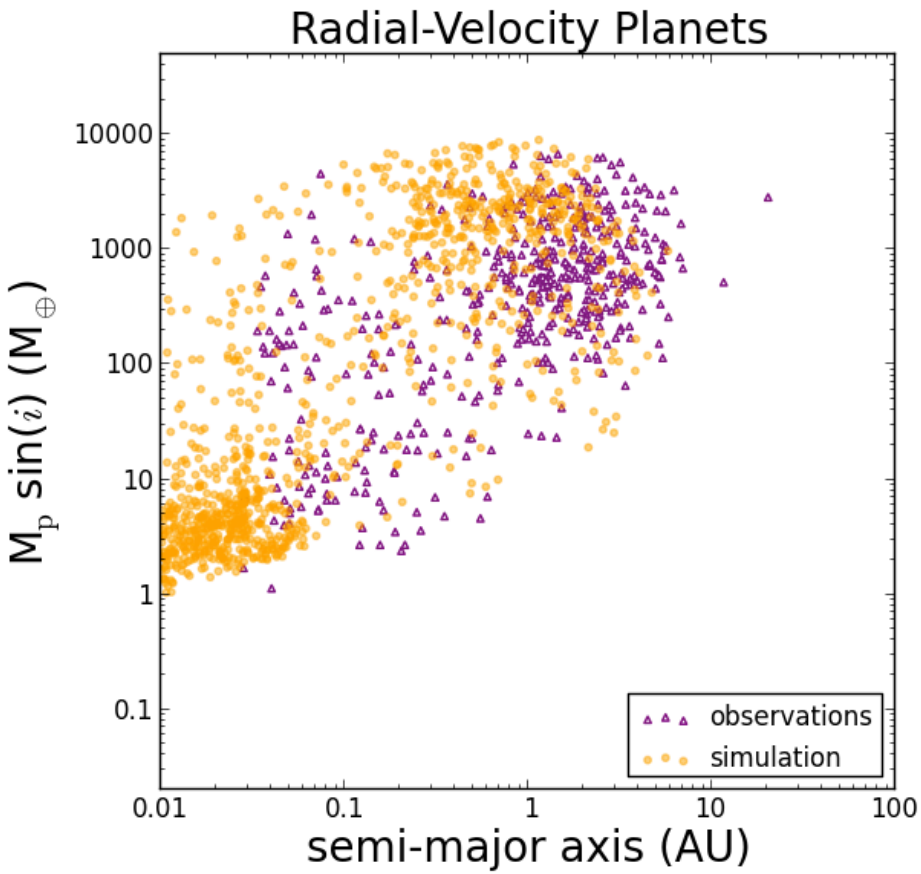


DENSITY SLOPE ITERATION WITH LIMITED MIGRATION



Method-Specific Comparisons:





surface density = C $r^{-1.5}$; limited migration on

What do we expect?

Larger Scaling Factor (Total Disk Mass)

=

More large, close-in planets

How do we check?

Vary Normalization Constant

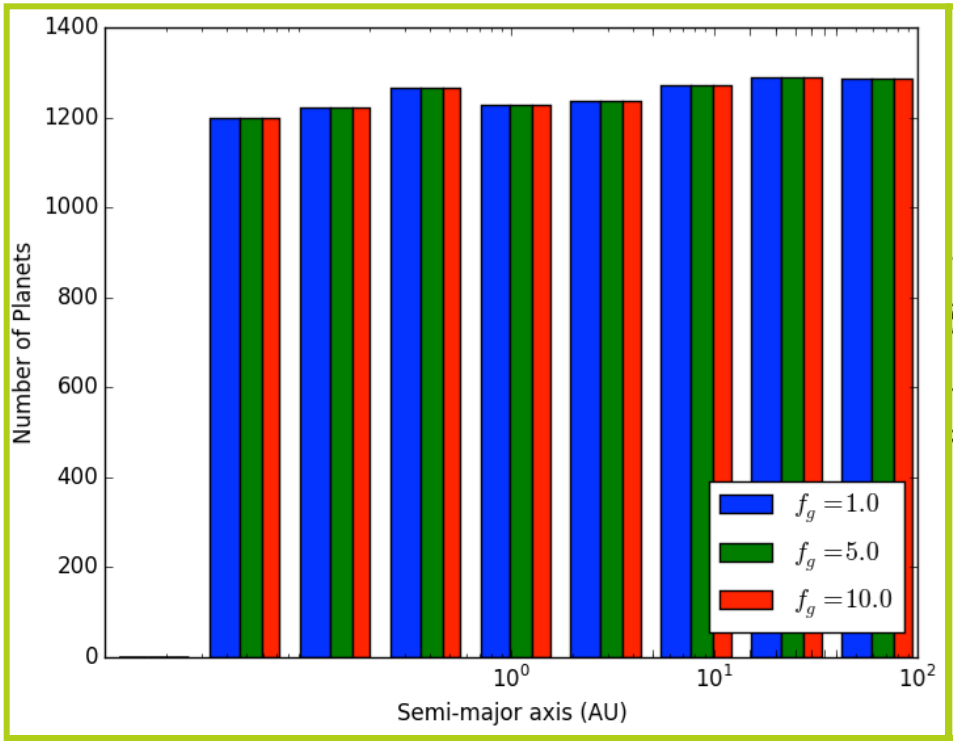
$$\Sigma_g \propto f_g r^{p_g} \exp[-r^{2+p_g}]$$

Scaling Factor f_g	Migration On	Migration Off
1.0	3.4e-158	9.7e-236
5.0	1.8e-306	9.7e-236
10.0	0.0	9.7e-236

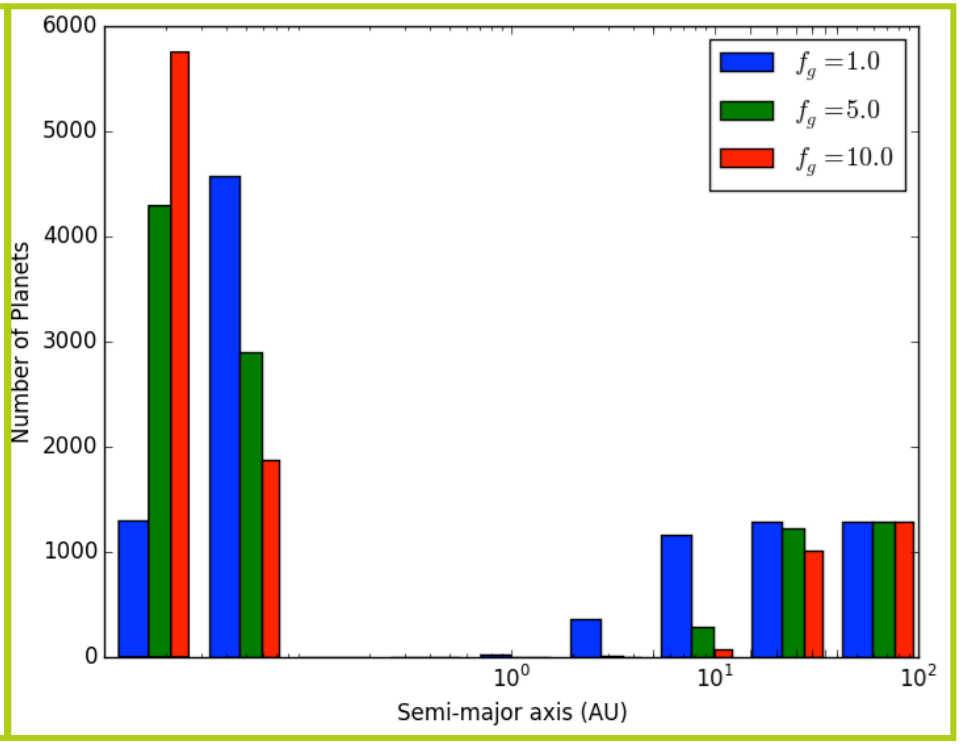
$* p_g = 1.5$

Simulations show…

DISK MASS ITERATION WITH **NO** MIGRATION

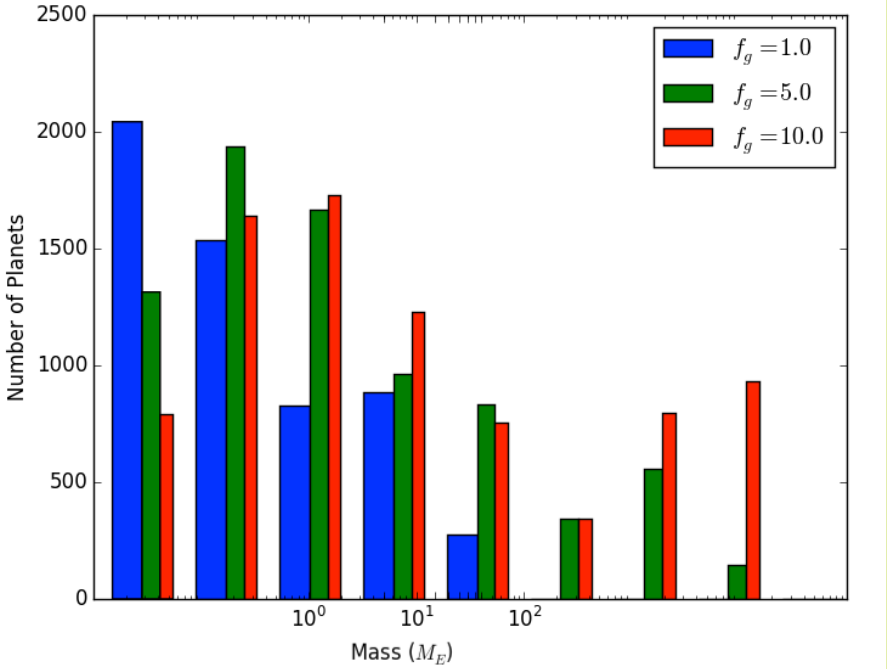


DISK MASS ITERATION WITH (FULL) MIGRATION



Simulations show…

DISK MASS ITERATION WITH **NO** MIGRATION



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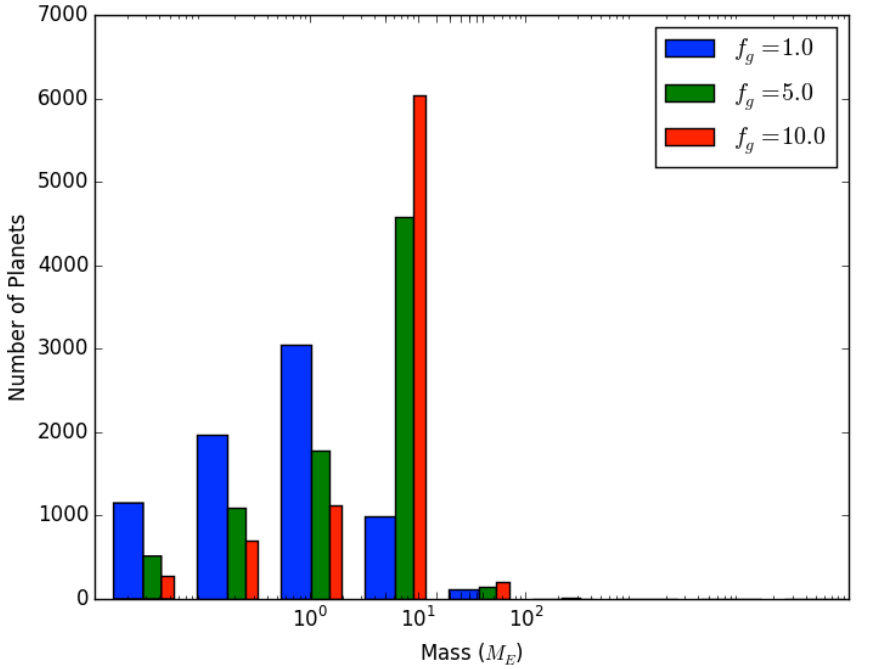
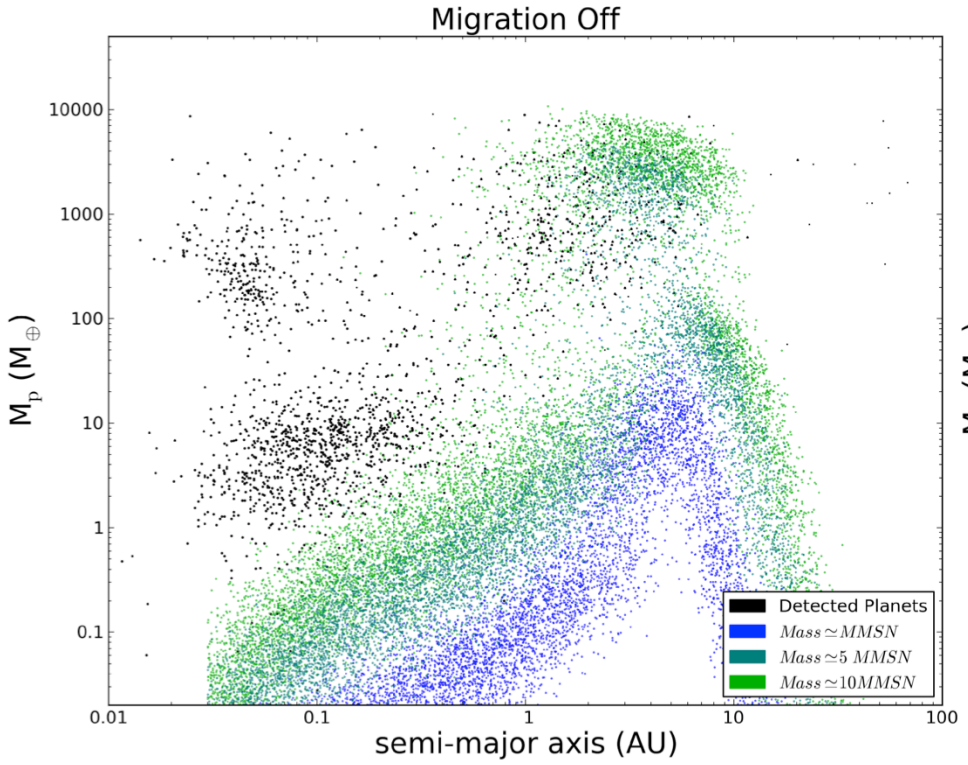


Comparing with observations…

DISK MASS ITERATION WITH **NO** MIGRATION



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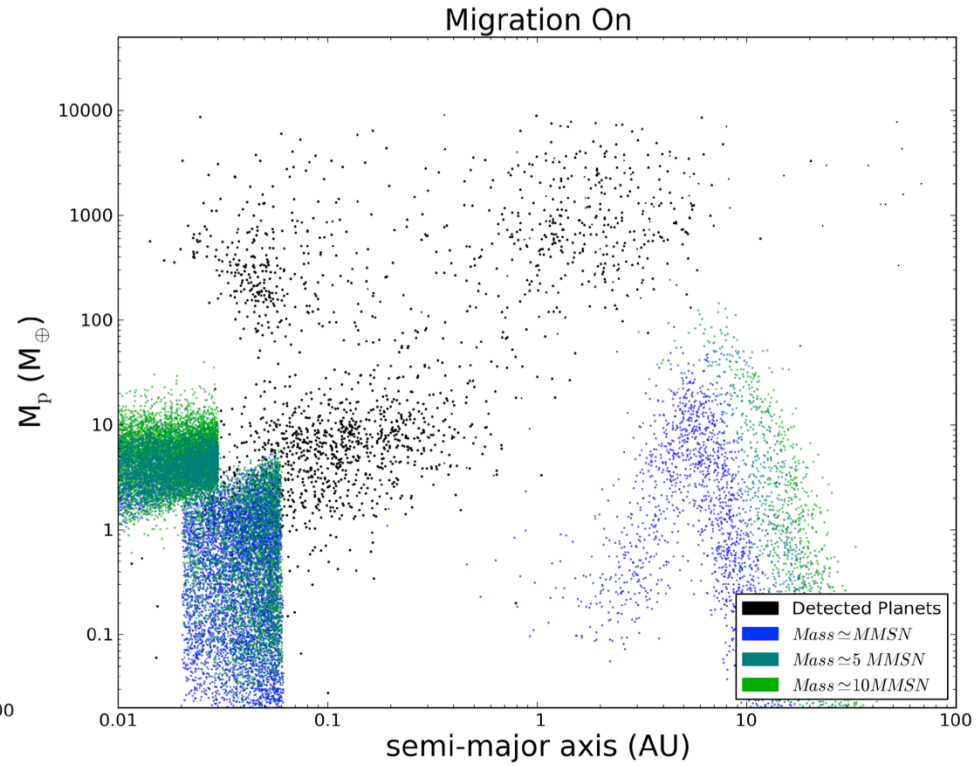

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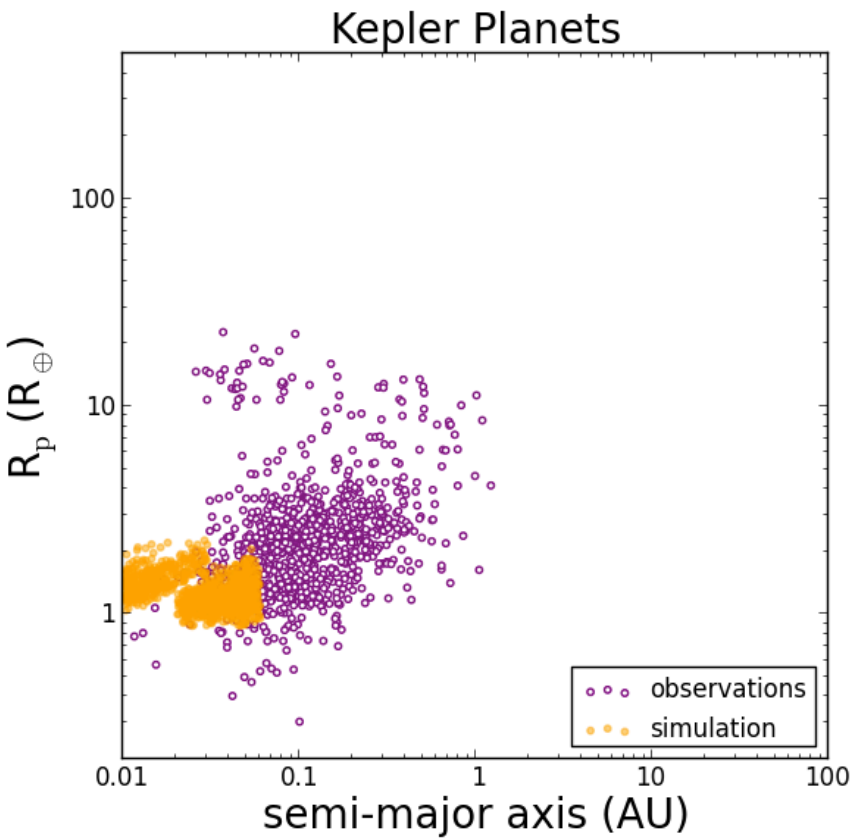

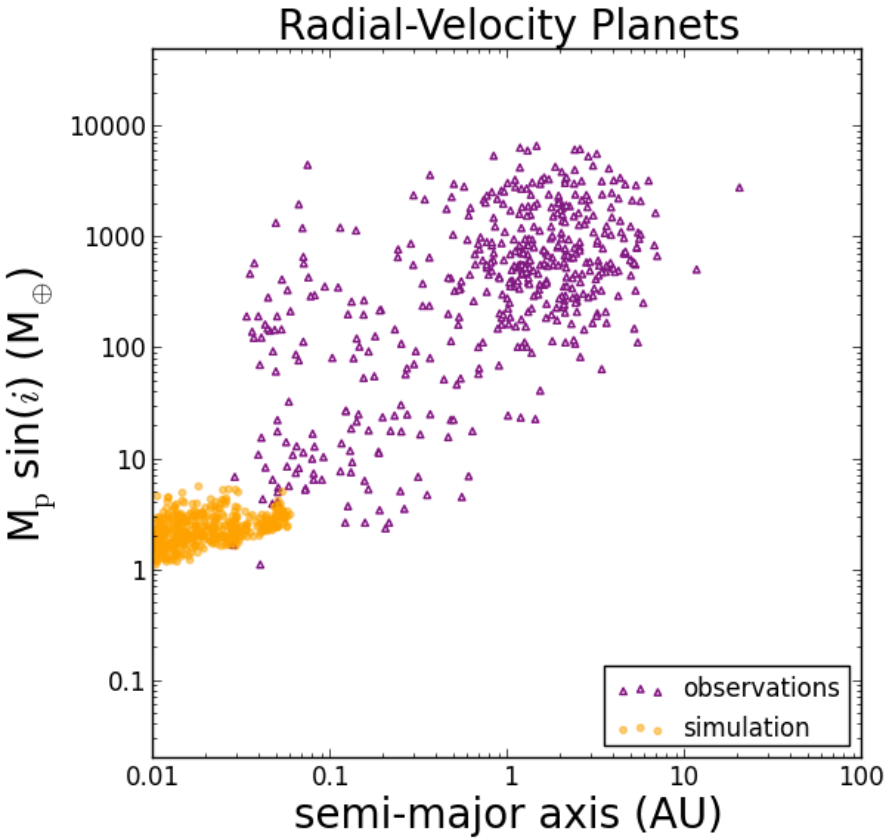

MMSN disk; migration on full

Conclusions

Interesting way to see how the different physical processes interact with each other . . .

Some trends:

- Steeper disk slope -> more close-in planets
- Steeper disk slope -> more small planets
- Higher disk mass, no migration -> fewer small planets
- Higher disk mass, with migration -> lack of Jupiters

None of these match observations very well, especially super-Earth population . . . so lots of work for all of us to do!!

Acknowledgements

Worked based on GlobalPFE, a population synthesis code by Christoph Mordasini

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