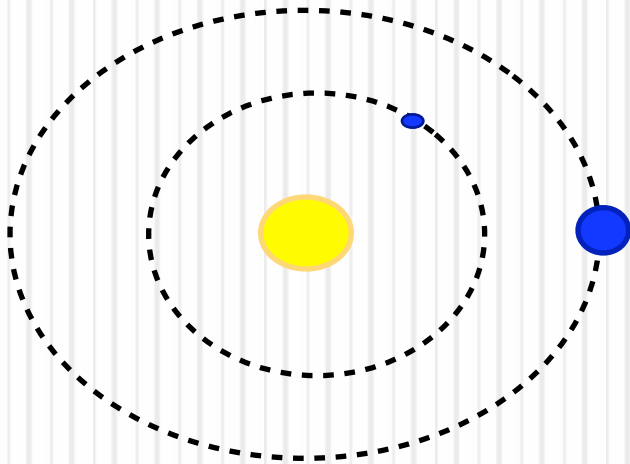


# Tracking the Planets: Ours and Theirs

Renu Malhotra



A little about me....



## PTYS/LPL FACULTY

**Renu Malhotra**

Professor and Chair-Theoretical Astrophysics Program

Orbital dynamics, Theoretical astrophysics

Ph.D., 1988, Cornell University

Kuiper #515

520-626-5899

[renu@lpl.arizona.edu](mailto:renu@lpl.arizona.edu)

Years with LPL: 2000 to present

**RESEARCH INTERESTS**

Prof. Malhotra's research spans orbital dynamics in the solar system and in exo-solar planetary systems. Current topics of research are: the orbital migration history of the giant planets, chaos and stability in the Kuiper belt, dynamics of near-Earth and main belt asteroids, the meteoritic bombardment history of the terrestrial planets, and architectures of exosolar planetary systems.

[More about Dr. Malhotra](#)[CV for Dr. Malhotra \(PDF\)](#)**CURRENT GRANTS**

- Multiple Planet-Debris Disk Interactions: Probing Planetary System Evolution: NESSF
- Dynamical structure and evolution of the young solar system: NSF

**CURRENT STUDENTS**

- Youngmin JeongAhn (PTYS)
- Sarah Morrison (PTYS)

**FORMER STUDENTS**

- David Minton, 2009 (PTYS)
- Amaya Moro-Martin, 2004 (Astronomy)
- Matthew Tiscareno, 2004 (PTYS)
- Kathryn Volk, 2013 (PTYS)

**FORMER POSTDOC(S)**

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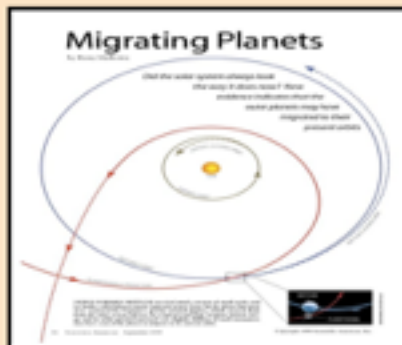
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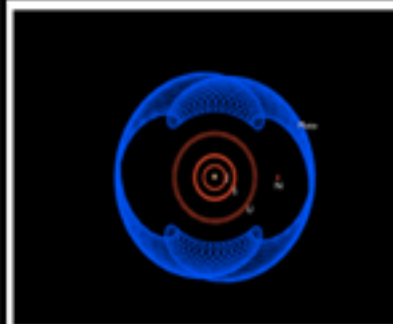
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A little about me

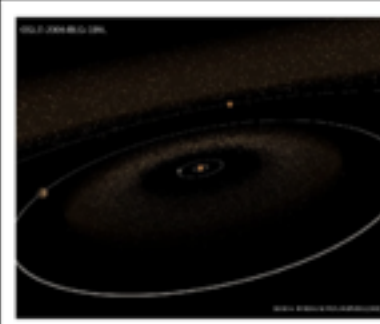
Prof. Malhotra's research spans orbital dynamics in the solar system and in extra-solar planetary systems.



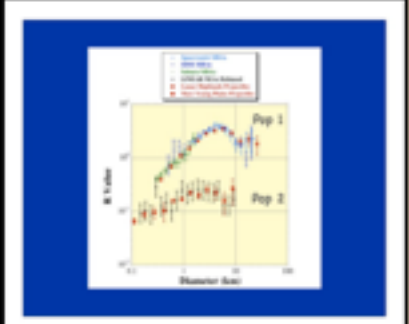
Planet migration



Orbital resonances & chaos



Exo-planetary systems



Late Heavy Bombardment





New Delhi  
1961-1968

Hyderabad  
1968-1978

New Delhi  
1978-1983

# St. Ann's School, Secunderabad, India



**St. Ann's School, Secunderabad, India**



**Indian Institute of Technology, Delhi**





**St. Ann's School, Secunderabad, India**



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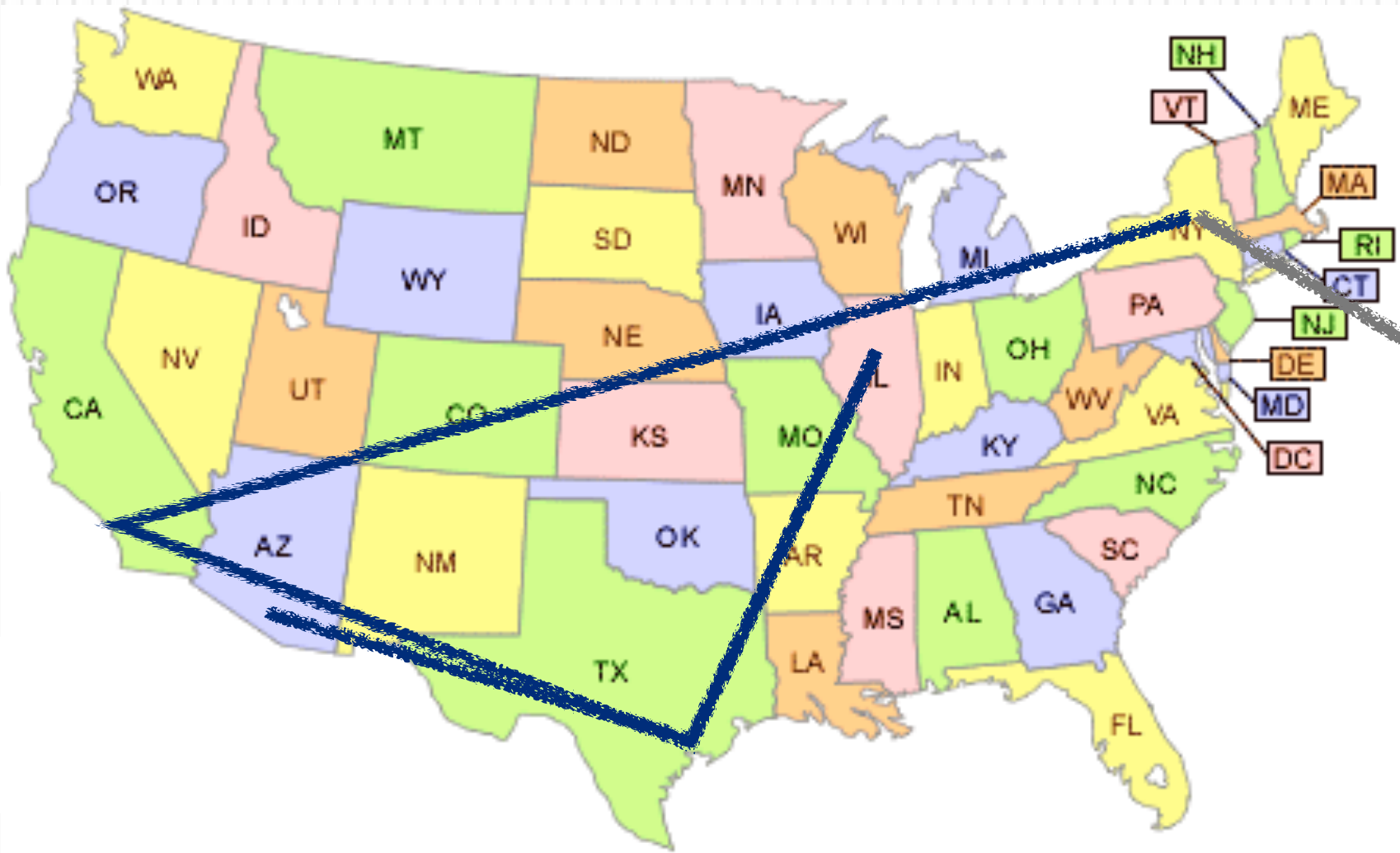




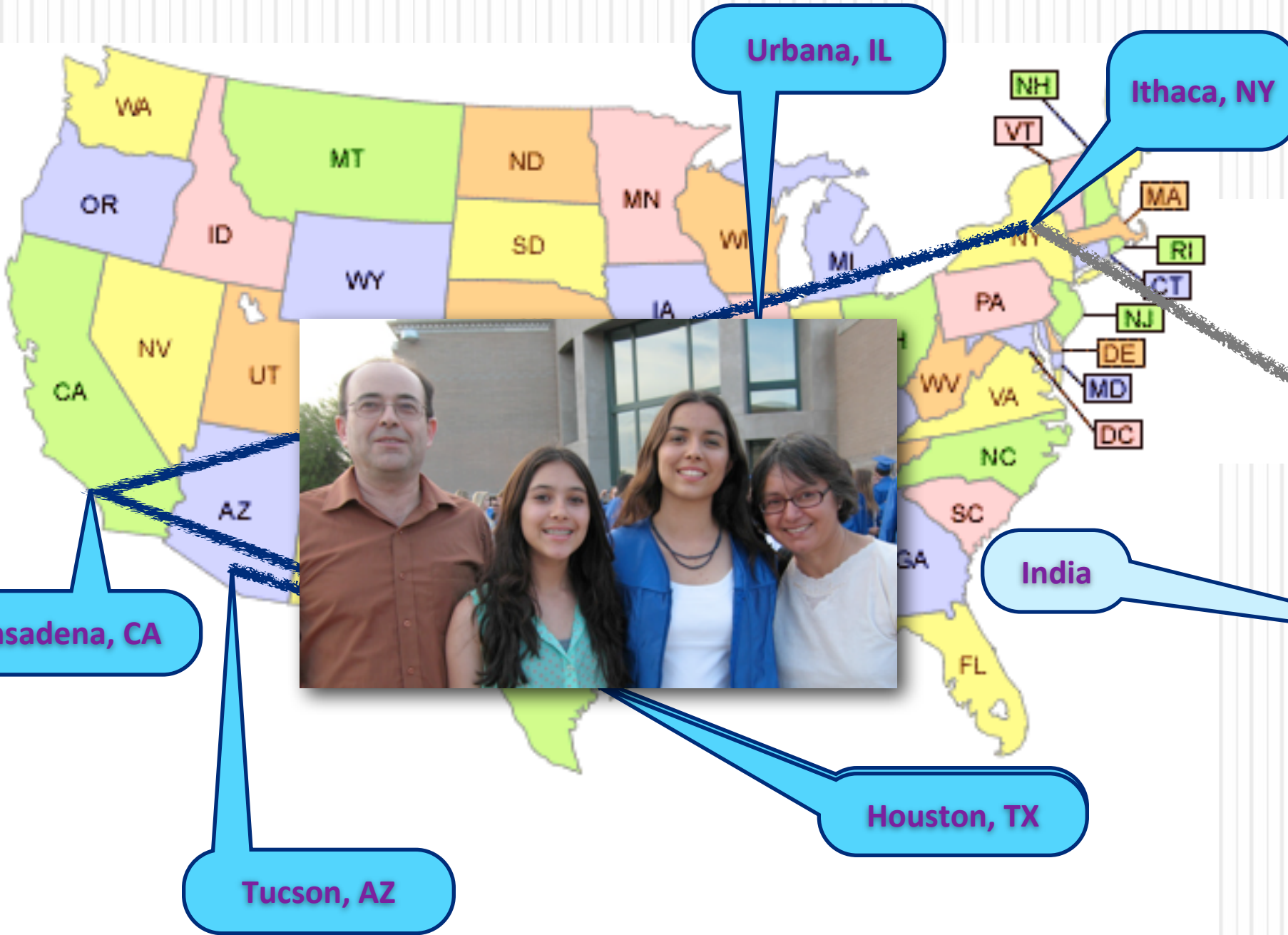
# World map



Ithaca, NY  
Cornell Univ  
1983-1989







Urbana, IL

Ithaca, NY

Pasadena, CA

Tucson, AZ

Houston, TX

India

## factors that got me here

- curiosity
- ignoring distractions
- perseverance
- perfectionism
- caring parents
- teachers & mentors
- spouse
- USA ... country & society

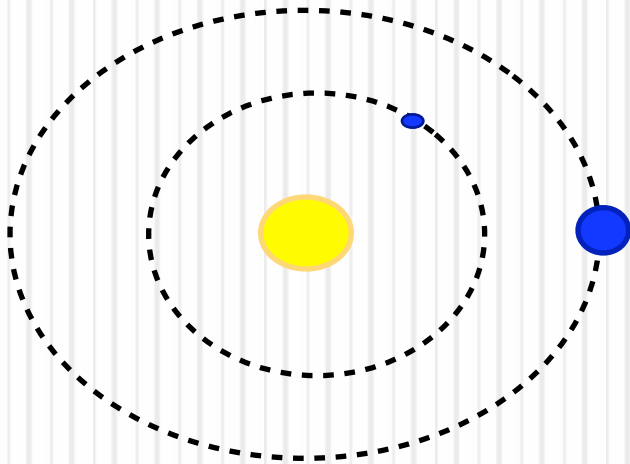
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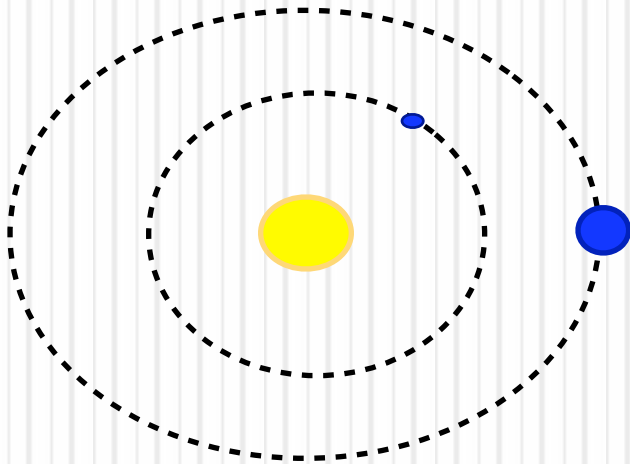


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- how planetary orbits are arranged
  - how planet masses are arranged



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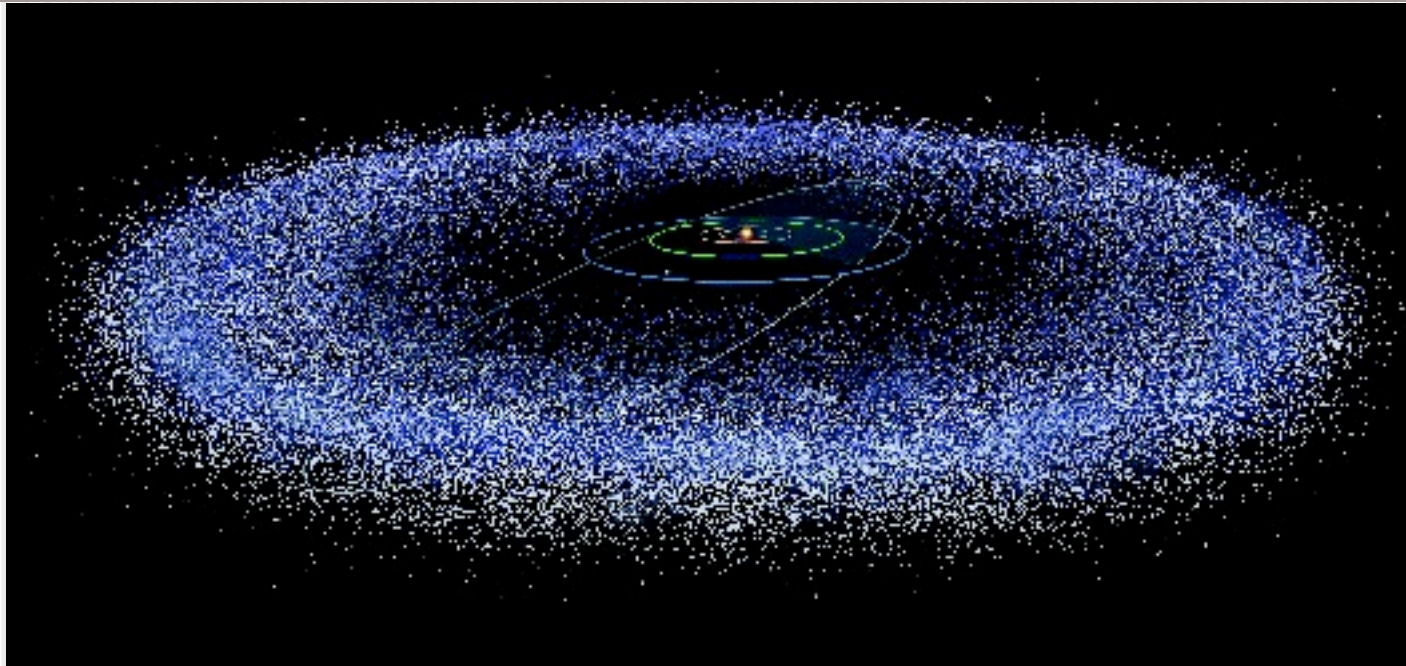
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mathematics  
+  
physics  
+  
astronomy

## In our solar system

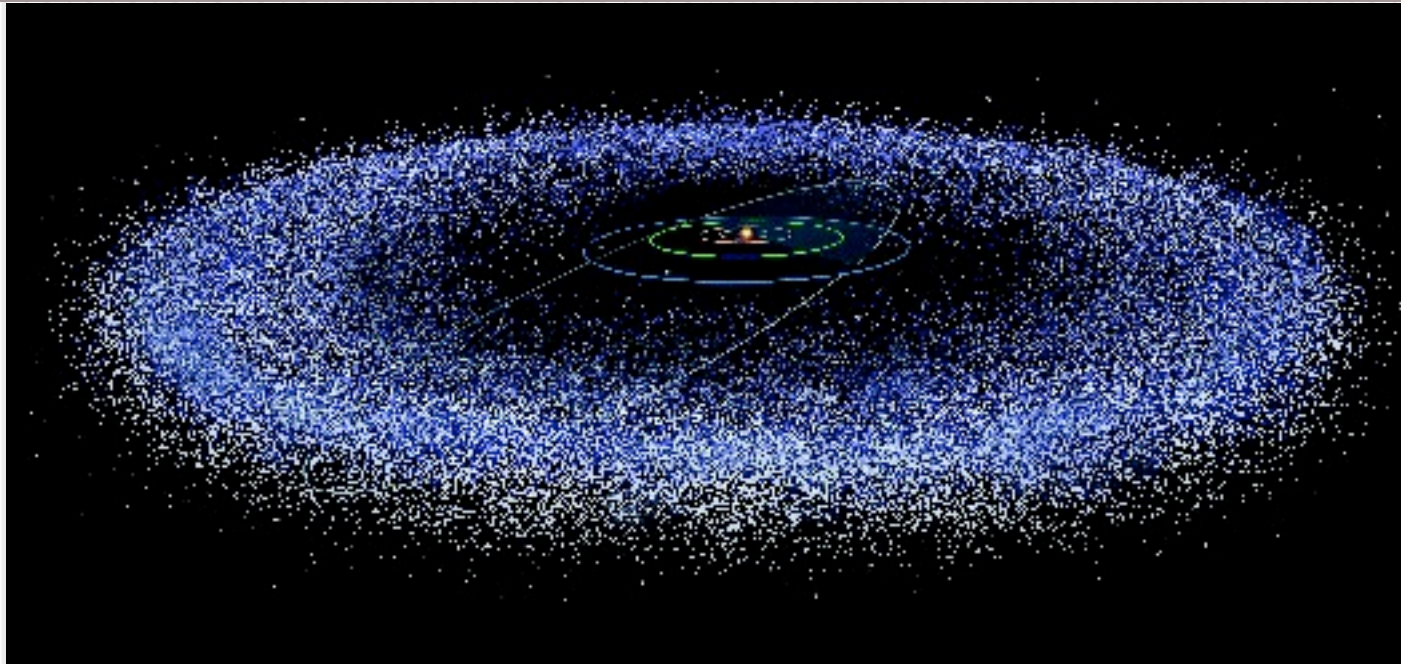
- small rocky planets in the "inner" region
- large gassy planets in the "outer" region
- a little "debris" (asteroids, comets, dwarf planets)



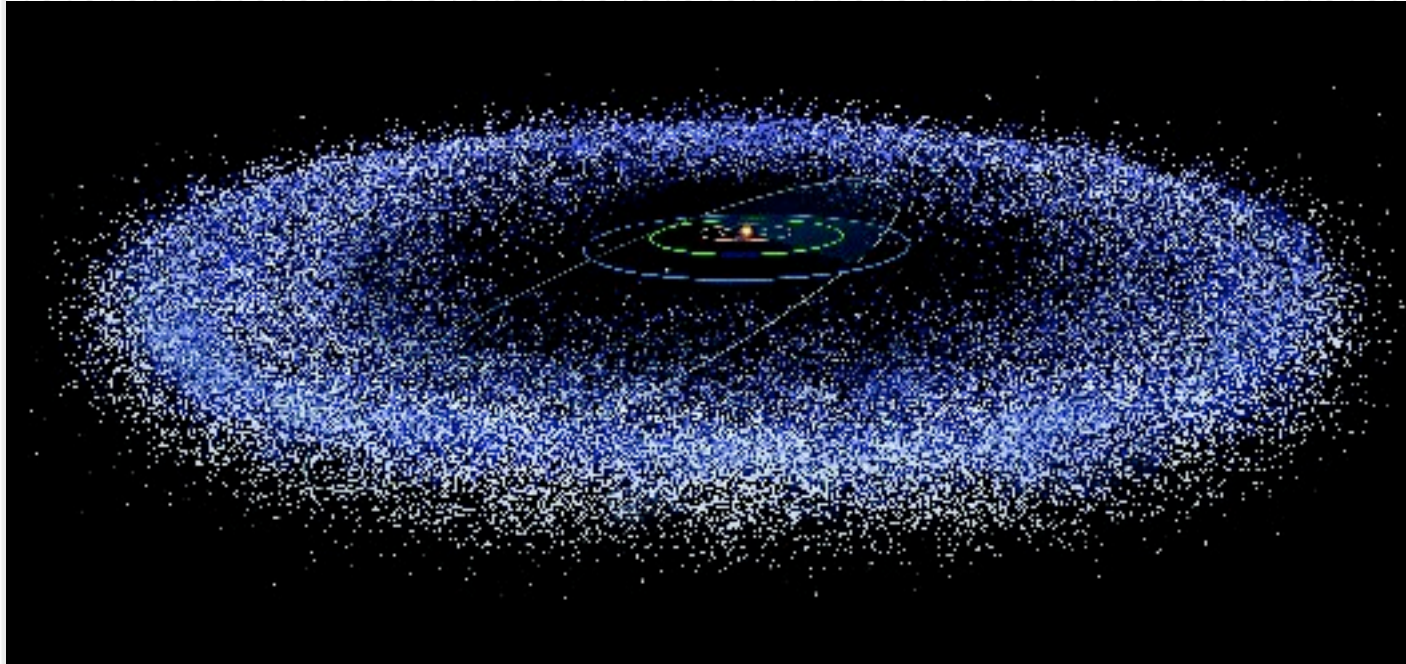
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well-spaced



- How did this arrangement come about?
- How stable is it?
- Is it common for all sun-like stars in our Galaxy?
  - or is it rare?



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The young solar system was a chaotic place!  
planets were crowded together, with lots of debris!  
lots of collisions, even escapes!  
gradually...reduced the chaos  
...and consolidated the number of planets  
... the surviving planets spread out into well-spaced orbits  
"Planet Migration"

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The solar system planets' orbits  
are stable for a few billion years!

But they do change slowly.

Even Earth's orbit!

Cause of climate cycles, ice ages, warm ages...

Asteroids, comets ... not as stable as the planets!

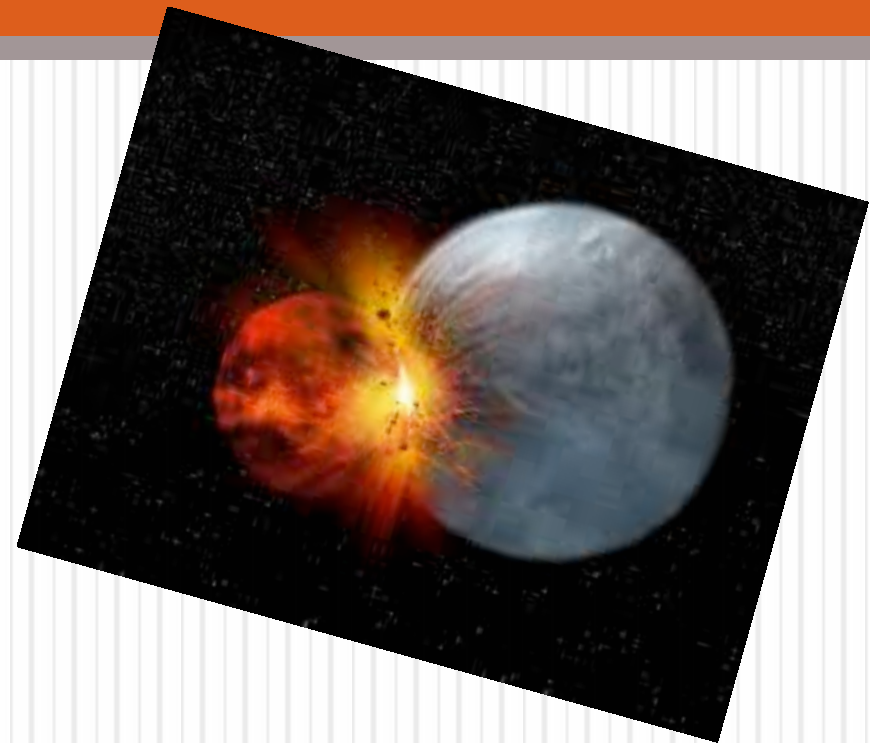
- Earth's orbit stability depends upon our planetary architecture
  - also Earth's rotation stability
  - also meteoritic bombardment rate



If  
Venus/Jupiter/Saturn  
were slightly different...?

!!!

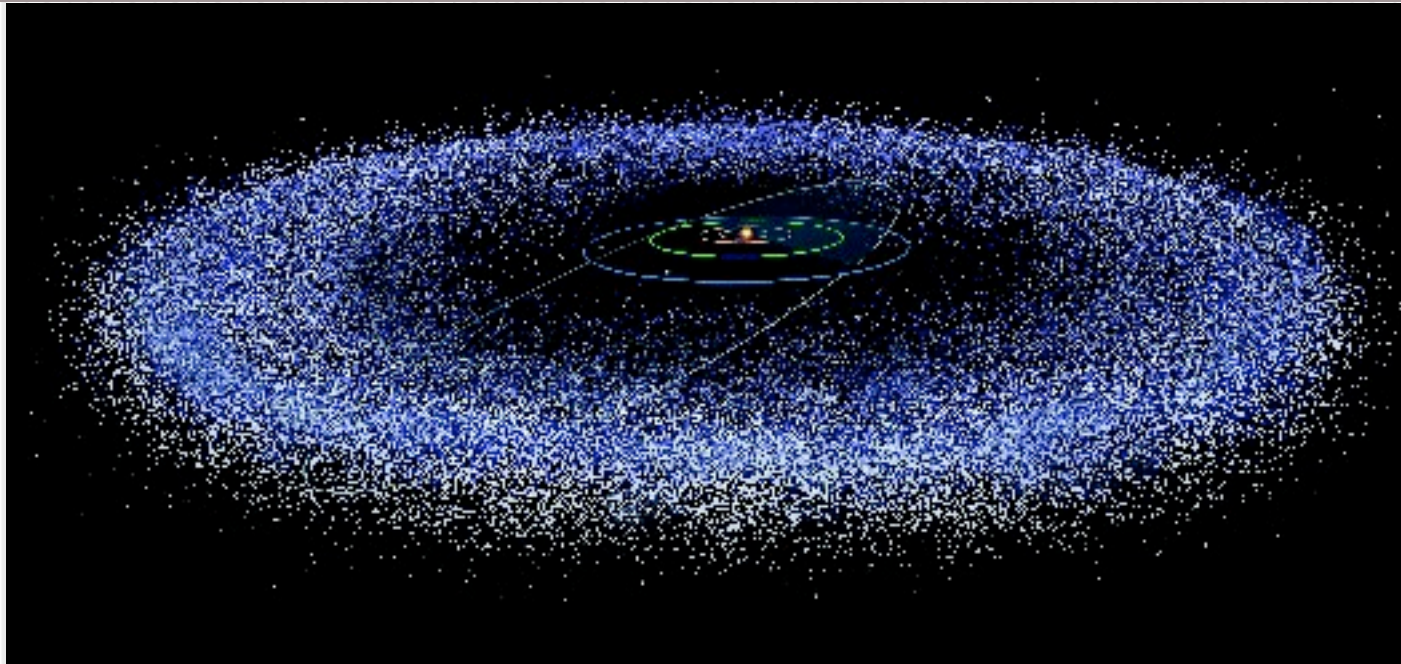
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New discoveries of planetary systems of other sun-like stars are finding a large variety of planetary arrangements! Astronomers are in the initial stages of taking a census of planetary systems in our Galaxy... so we must wait for the answer...

- Would different arrangements still be "ok" for life on Earth?
- Would different arrangements allow Earth-like planets elsewhere in the Universe?



# The Kepler Orrery II

t[BJD] = 2454965

D. Fabrycky 2012

