

Why is it so difficult to detect planets around other stars? Brightness Difference

- A Sun-like star is about a billion times brighter than the sunlight reflected from its planets (planets lost in glare)
- Like being in San Francisco and trying to see a pinhead 15 meters from a grapefruit in Washington, D. C.

Planet Detection

- **Direct:** Pictures or spectra of the planets themselves
- **Indirect:** Measurements of stellar properties revealing the effects of orbiting planets
- Current census: 2108 planets known orbiting stars beyond the Sun http://exoplanet.eu



Direct Detection

- Search among nearby, fainter stars in infrared light where contrast between star and planet is less
- Use special techniques to eliminate light from brighter objects and enable direct planet detection













Revisiting the Nebular Theory for Formation of Planetary Systems

- Nebular theory predicts that massive Jupiter-like planets should not form inside the frost line (at << 5 AU)
- Discovery of "hot Jupiters" has forced reexamination of nebular theory
- "Planetary migration" or gravitational encounters may explain "hot Jupiters"

Planetary Migration



- A young planet's motion can create waves in a planetforming disk
- Models show that matter in these waves can tug on a planet, causing its orbit to migrate inward

Gravitational Encounters

- Close gravitational encounters between two massive planets can eject one planet while flinging the other into a **highly elliptical** orbit
- Multiple close encounters with smaller planetesimals can also cause inward migration









Transit Light Curves					
	Kepler 4b	Kepler 5b	Kepler 6b	Kepler 7b	Kepler 8b
1.000 Flux 0.995 0.990	4 0 4 Phase (hours)	Phase (hours)	Phase (hours)	Phase (hours)	Phase (hours)
Orbital Period (days)	3.2 days	3.5 days	3.2 days	4.9 days	3.5 days
Size (R _g)	4.31	18.8	15.0	16.9	18.3























Census for Milky Way Galaxy

- ≈ 1 billion rocky planets that are approximately the size of the Earth and are orbiting familiar-looking yellow-sunshine stars in the orbital "habitable zone" where water could be liquid at the surface.
- Many places to explore for life elsewhere!

