Introductory Astronomy

Week 3: Solar System(s)

Clip 11: We May Not Be Alone

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Planets Elsewhere?

- Protoplanetary Disks and universality suggest many stars have planets
- First discovery in 1988. Now 853 around 672 stars
- Finding planets is tough: dim, small, near bright star. 32 planets in 28 systems detected by imaging

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Who Orbits Whom?

- Planet and Star orbit common center of mass

$$M_p R_p = M_s R_s$$

$$R = R_s + R_p = R_s(1 + M_s/M_p)$$

$$R_s = (M_p/M)R$$

$$R_s = (M_♃/M_\odot) \cdot 7.79 \times 10^{12}\,\mathrm{m} = 7.44 \times 10^{9}\,\mathrm{m}$$

- One detection by Astrometry

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How Fast?

$$\frac{GM_sM_p}{R^2} = \frac{M_sv_s^2}{R_s} \quad v_s^2 = \frac{GM_pR_s}{R^2} = \frac{GM}{R}\left(\frac{M_p}{M}\right)^2$$

$$v_s = \sqrt{\frac{GM}{R}}\left(\frac{M_p}{M}\right) = v_{♃}(M_{♃}/M_\odot) = 12.5\,\mathrm{m/s}$$

- 498 planet in 386 systems detected by radial velocity measurements

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Transiting Planets

- If planet eclipses star can observe light curve
- Shape of curve helps find size, mass, even properties of atmosphere of planet
- 290 planets in 235 systems detected via transit
- Kepler has 2321 candidate planets in 1290 systems

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Other Methods

- Gravitational lensing of starlight by planet. 16 planets in 15 systems
- Transit Timing Variation uses discrepancies in transit times of eclipsing planet to predict others in same system

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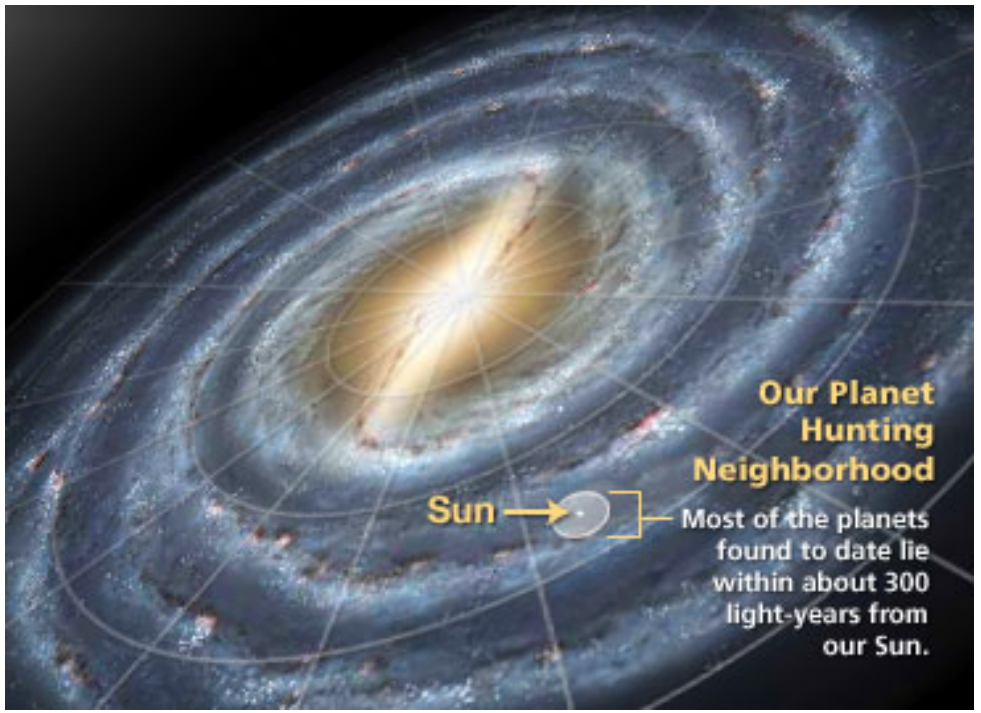
What Have We Found?

- 1-40% of (Sunlike) stars have planets. Planets are ubiquitous!
- Our methods are most sensitive to hot Jupiters so these are mostly what we find
- Migration is common as are strongly interacting orbits



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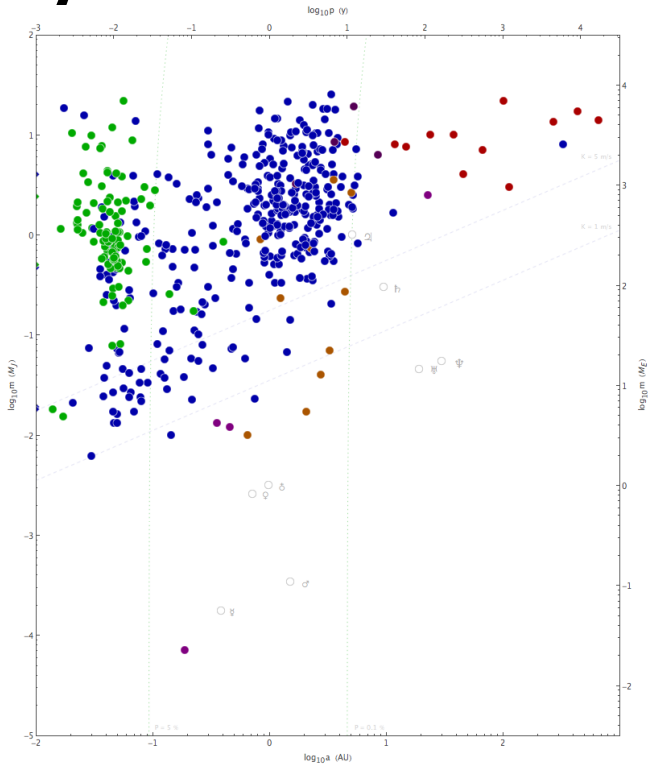
What Are They Like?

- Taking selection bias into account, super Earths outnumber Jupiters
- Some SuperJupiters
- Kepler-16b orbits two stars



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Summary

- Lots to learn in our own neighborhood
- Much of it being learned still
- Physics starting to pay off
- Exoplanets likely to revolutionize our understanding – Stay Tuned!

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Credits

- Astronomy Animations: University of Nebraska-Lincoln Astronomy Education Group http://astro.unl.edu/
- Exoplanet Data: The Extrasolar Planets Encyclopedia, Jean Schneider, CNRS/LUTH - Paris Observatory http://exoplanet.eu/

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