Wednesday, Nov. 19

Syllabus, class notes, and homeworks are at:
www.as.utexas.edu → courses → AST 301, Lacy

Reading for this week: chapter 16

We'll go back to the old help session time and place this week: Wednesday at 5:00 in GRG 424

Topics for this week

What evidence do we have that planets exist orbiting around other stars?

Describe and compare briefly the compositions and orbits of the terrestrial and Jovian planets, asteroids, and comets.

Describe the nebular theory of the formation of the solar system.

How does the nebular theory explain the differences in composition among the planets?

Detection of Extrasolar Planets

How could we find planets orbiting around other stars?

See them in visible light pictures

See them in infrared pictures

Measure the spectra of star+planet

Observe them blocking the star's light

Observe the effects of their gravities on the star

- causing the position of the star to change
- causing the velocity of the star to change

PlanetQuest: Exoplanet Exploration - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://planetquest.jpl.nasa.gov/

planetquest

Jet Propulsion Laboratory
California Institute of Technology

+ NASA Home Page
+ NASA en Español

JPL HOME | EARTH | SOLAR SYSTEM | STARS & GALAXIES | SCIENCE & TECHNOLOGY

PLANETQUEST
Exoplanet Exploration

- HOME
- OVERVIEW
- SCIENCE
- TECHNOLOGY
- EXOPLANET MISSIONS
- NEW WORLDS ATLAS
- MULTIMEDIA
- RESOURCES
- PLANET HUNTERS
- FOR PROFESSIONALS

SEARCH

POD Podcasts
RSS News Feed
TWITTER Twitter

Exoplanet: *n.* a planet that orbits a star outside the solar system.

CURRENT PLANET COUNT: **326**

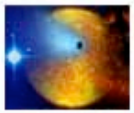
stars with planets: 278
Earthlike planets: 0

get this on your desktop ▸

1 2 3

Explore the
NEW WORLDS ATLAS
A visual guide to exoplanets ▸

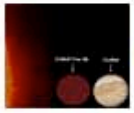
MORE STORIES



Fantastic journey
Slideshow of exoplanet milestones.
11.13.08

Doubling up
Cosmic neighbor has two asteroid belts.
10.27.08

Eyes on the prize:
NASA tests planet-imaging optics.
10.16.08



Space oddity
New exoplanet defies categorization.
10.06.08

Send your name into space with Kepler ▸
News archive ▸

MULTIMEDIA

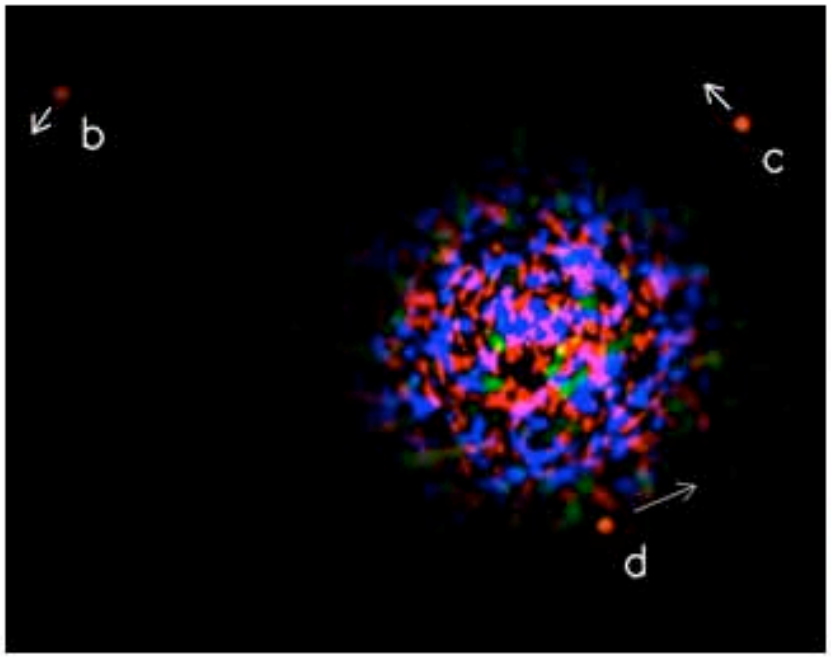


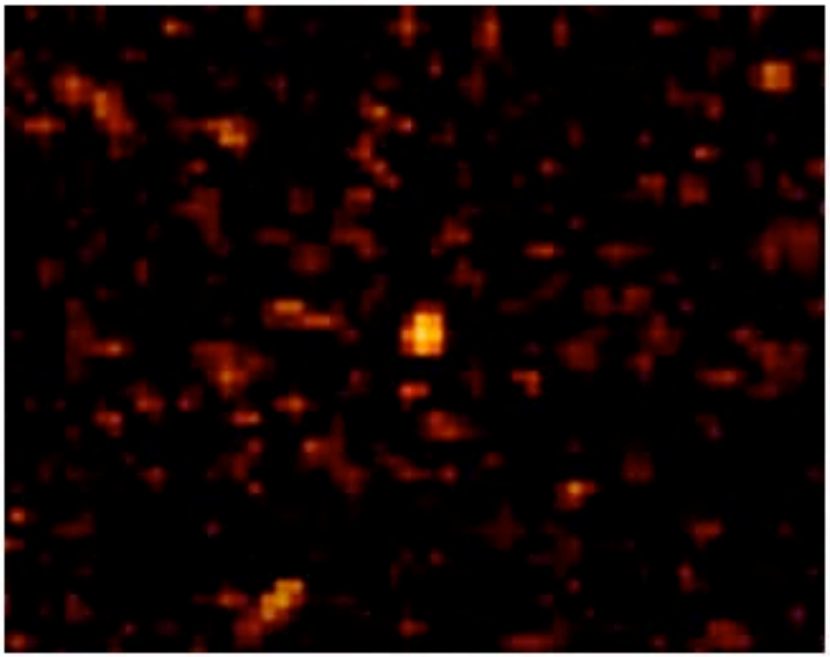

FEATURED PLANET

Size: 21.5 Jupiters

First optical exoplanet pictures released

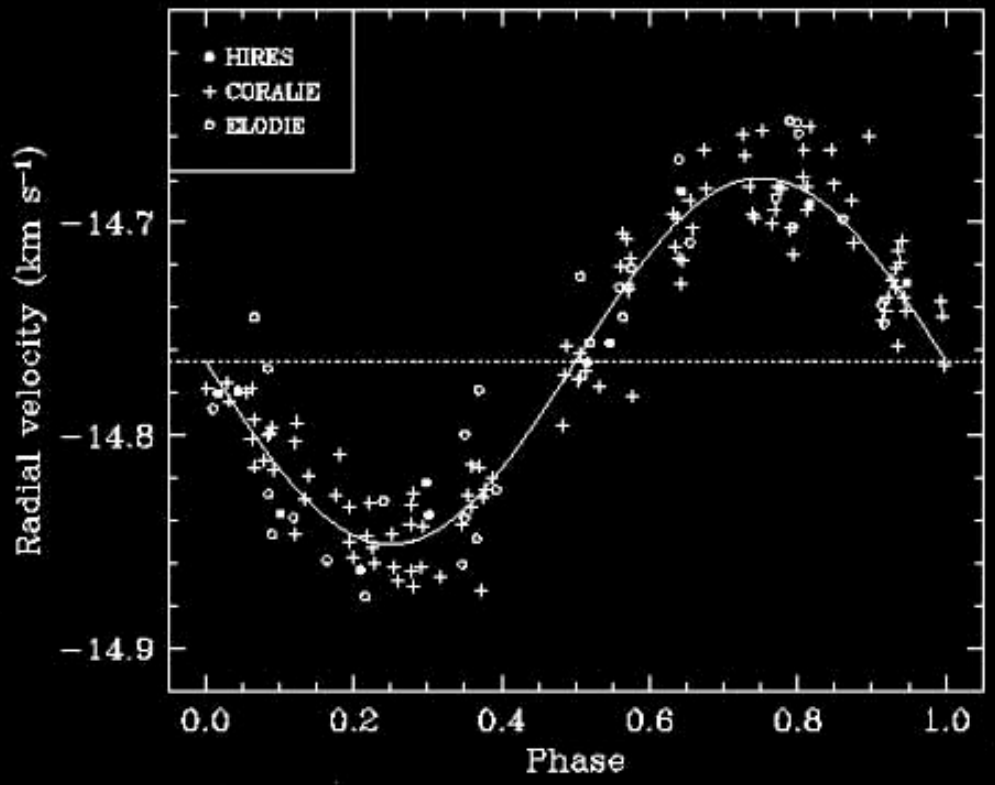
November 13, 2008





(PLANETQUEST) -- It's been a banner day for planet hunters, as two separate projects have announced the first-ever confirmed photos of planets orbiting stars other than our own. Researchers using the Hubble Space Telescope have unveiled a picture of a young planet orbiting the star, and scientists using the Gemini and Keck Earth-based telescopes have confirmed pictures of three exoplanets orbiting one star.

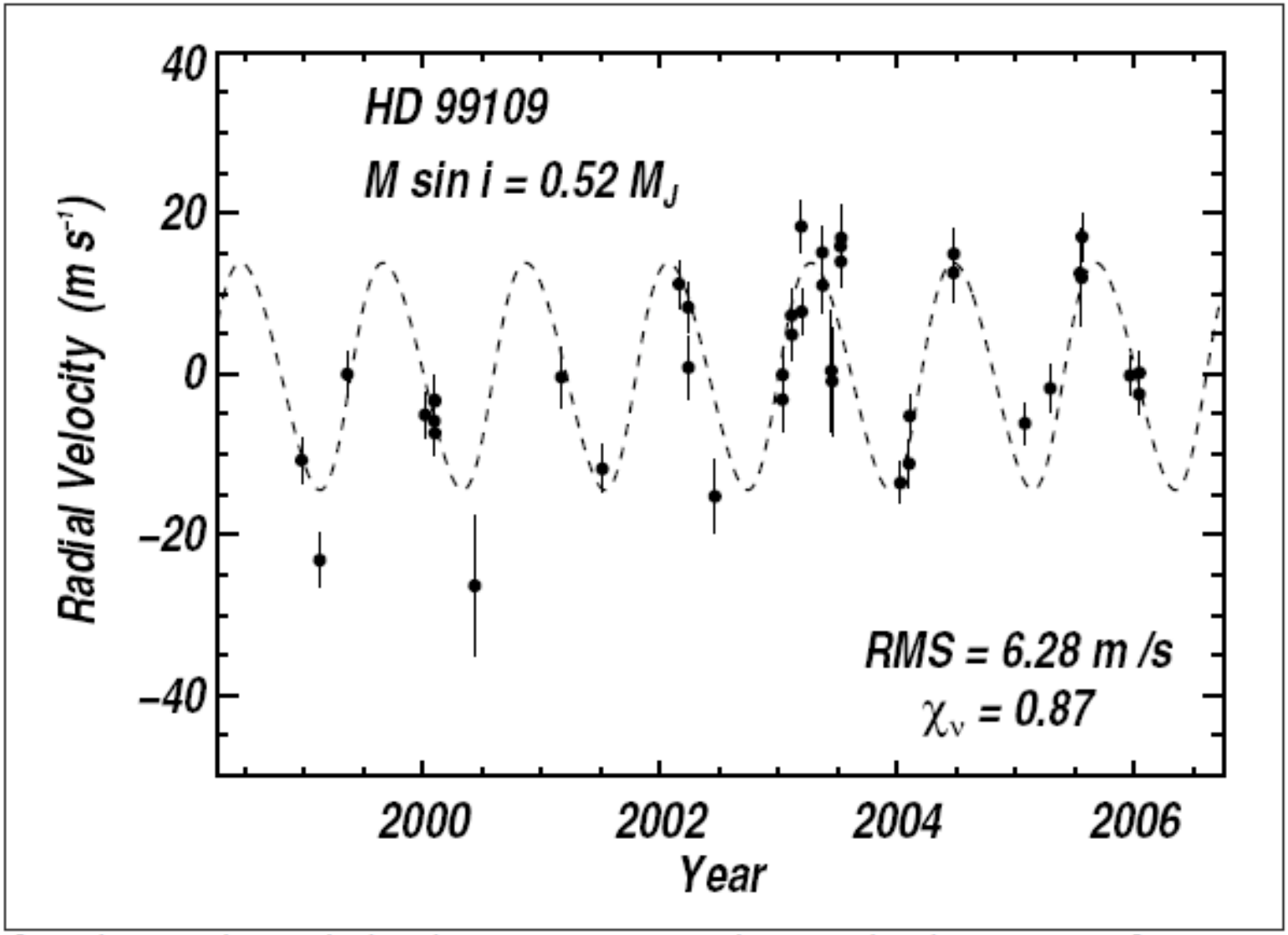
There are many professional websites that deal with extrasolar planets. One of the most comprehensive is the Extrasolar Planets Encyclopedia, which is what Extrasolar Visions uses for its chief reference.



The velocity curve of HD 209458 showing the wobble caused by its planet

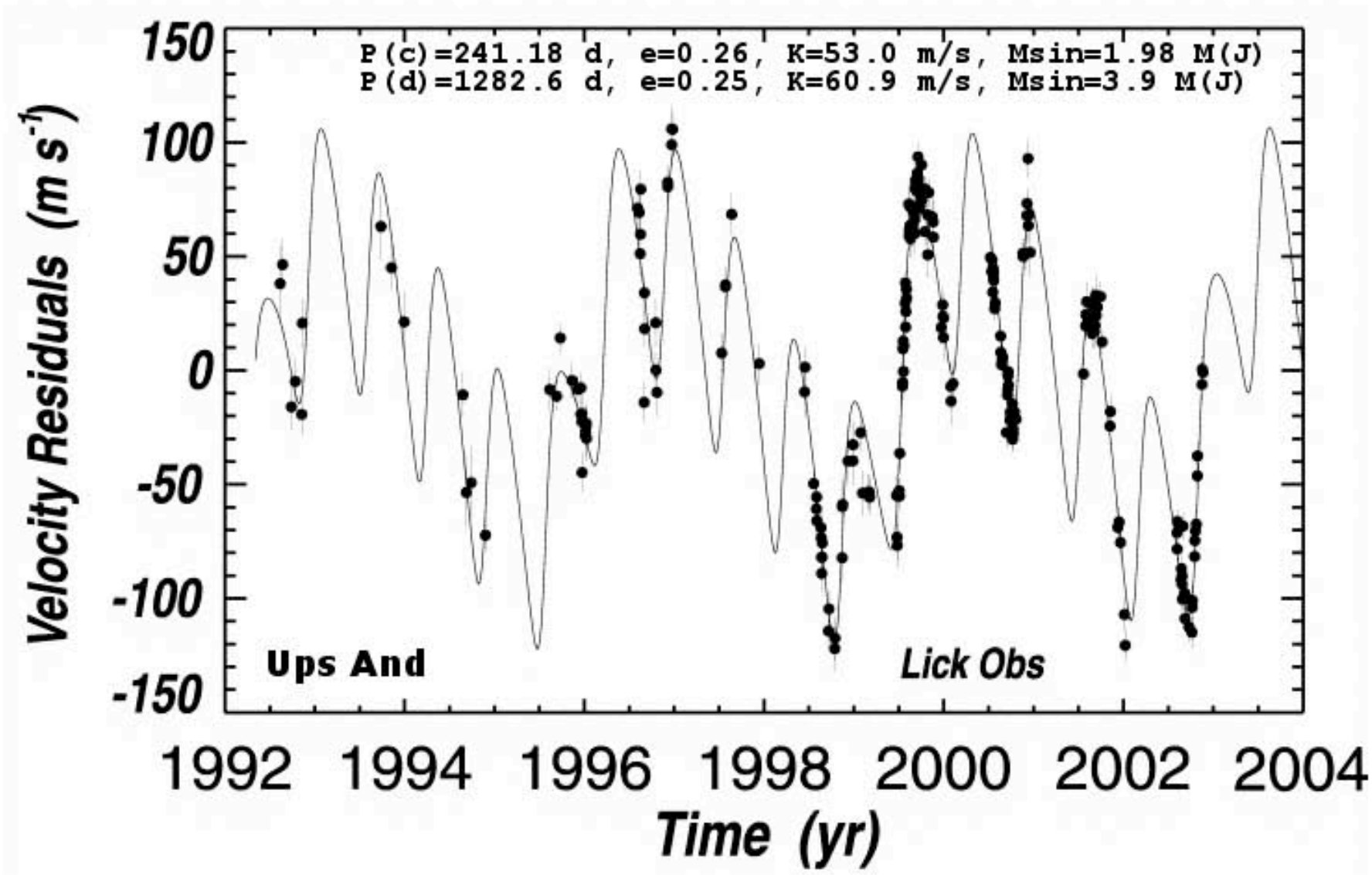
Most extrasolar planets have been discovered via the radial velocity method, which infers a planet's orbital period, orbital distance, and approximate mass from the wobble of its parent star. So, in most cases, we have these three pieces of data from which to determine a planet's properties. In most cases, as well, good data is available for the parent star itself, information such as spectral class, mass, radius, and surface temperature. If such stellar data is available, then the planet's temperature can be approximated. Armed with a planet's mass and temperature, we can go a long way in our speculations.

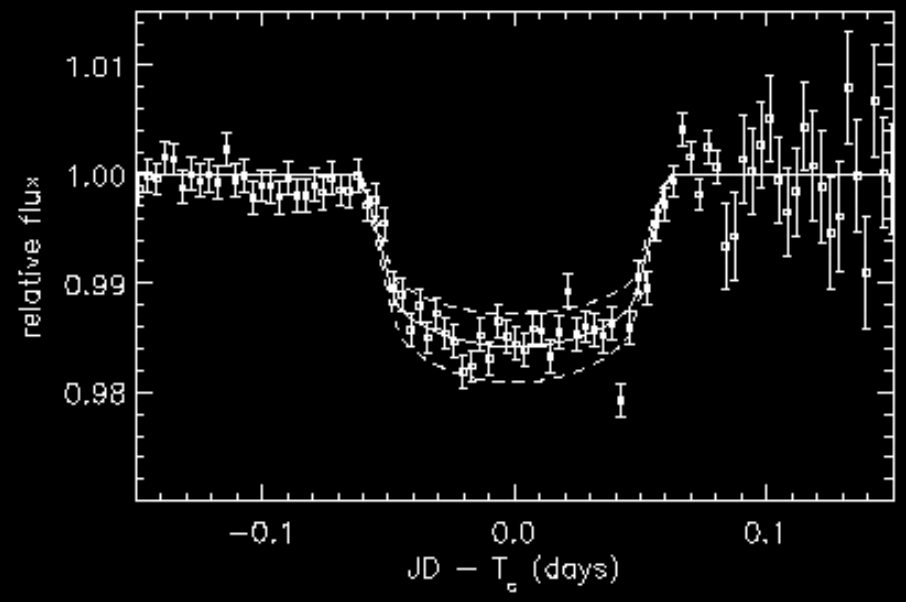
A Planet Around HD 99109



Best-fit orbit to the radial velocities measured at Keck Observatory for HD 99109, with P = 1.2yr, e ~ 0, and M sin i = $0.5M_{Jup}$.

Examples of Radial Velocity Data



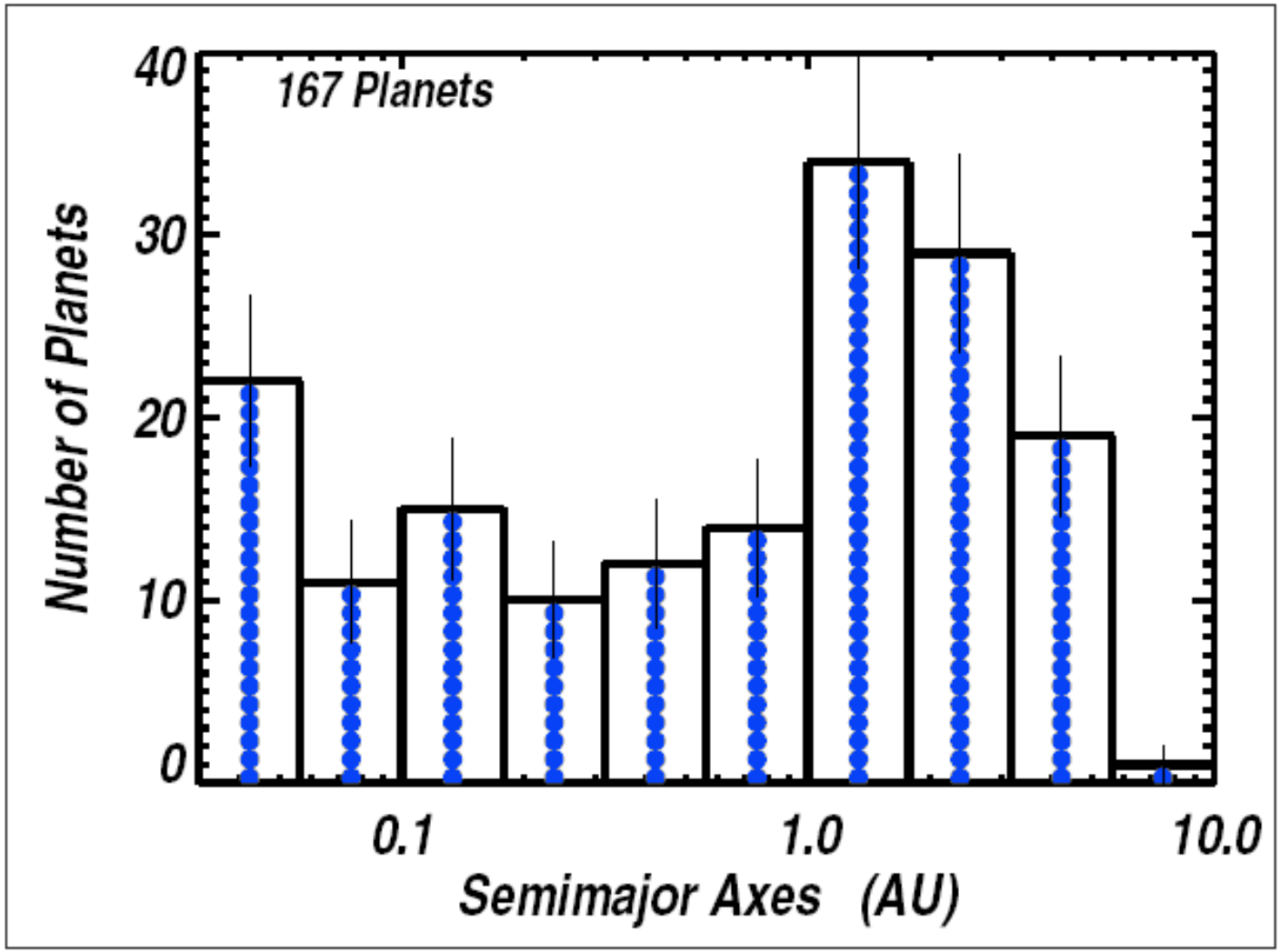


The light curve of HD 209458 dims during the transit of its planet

Some planets have been discovered by the transit method, which detects the dimming of a star as a planet passes in front of it. Transits give us a planet's radius, orbital period, and orbital inclination (which must be near 90º for the transit to be possible). Transits also allow astronomers to probe a planet's atmospheric density by detecting the rate of dimming just as the planet begins to cross the disk of its star, as well as the planet's chemistry by detecting how the starlight is absorbed as it passes through the planet's atmosphere.

If a planet is detected both by transit and by radial velocity, its total density can be determined because both the planet's radius and mass are known. The planet of HD 209458 has been detected using both these methods and much of what we know about Hot Jupiters is based on the properties of this particular world.

Orbital Distance Distribution



Orbital distance distribution of the 167 known nearby exoplanets with 0.03 < a < 10 in logarithmic distance bins. Planets with a > 3AU have periods comparable to or longer than the length of most Doppler surveys, so the distribution is incomplete beyond that distance. This distribution represents results from many surveys, and so is drawn from an inhomogeneous sample.

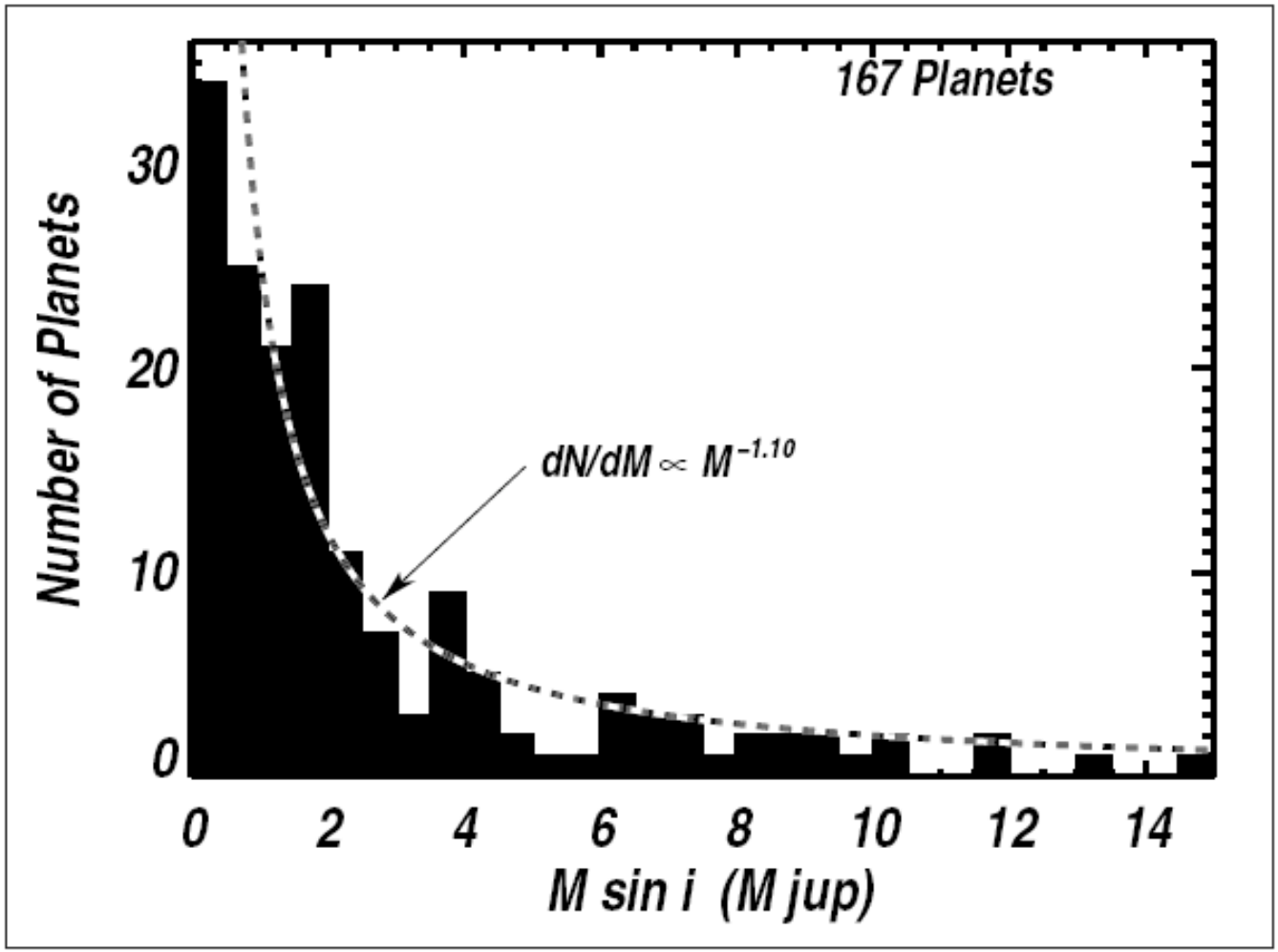
Orbits of exoplanets

Most of the planets we have found around other stars are in orbit smaller than Jupiter's orbit.

Why is this?

Is our solar system unusual, with 3 big planets beyond Jupiter?

Minimum Mass Distribution



Minimum mass distribution of the 167 known nearby exoplanets with M sin i < 15 M_{Jup}. The mass distribution shows a dramatic decrease in the number of planets at high masses, a decrease that is roughly characterized by a power law, $dN/dM \sim M^{-1.16}$. Lower mass planets have smaller Doppler amplitudes, so the relevent selection effects enhance this effect. This distribution represents results from many surveys, and so is drawn from an inhomogeneous sample.

Masses of planets

Most of the planets we have found around other stars have masses comparable to Jupiter's or even larger.

We haven't found any exoplanets with masses as small as the Earth's.

Why is this?

Is our solar system unusual with 4 terrestrial planets?

A puzzle

We have evidence for planets even more massive than Jupiter in orbit around other stars, orbiting closer to their stars than Mercury is to the Sun.

I claimed that the Jovian planet first formed icy cores, and once the cores were massive enough they pulled in gas.

But ices could not have formed that close to a star, so the cores should not have been massive enough to pull in hydrogen and helium.

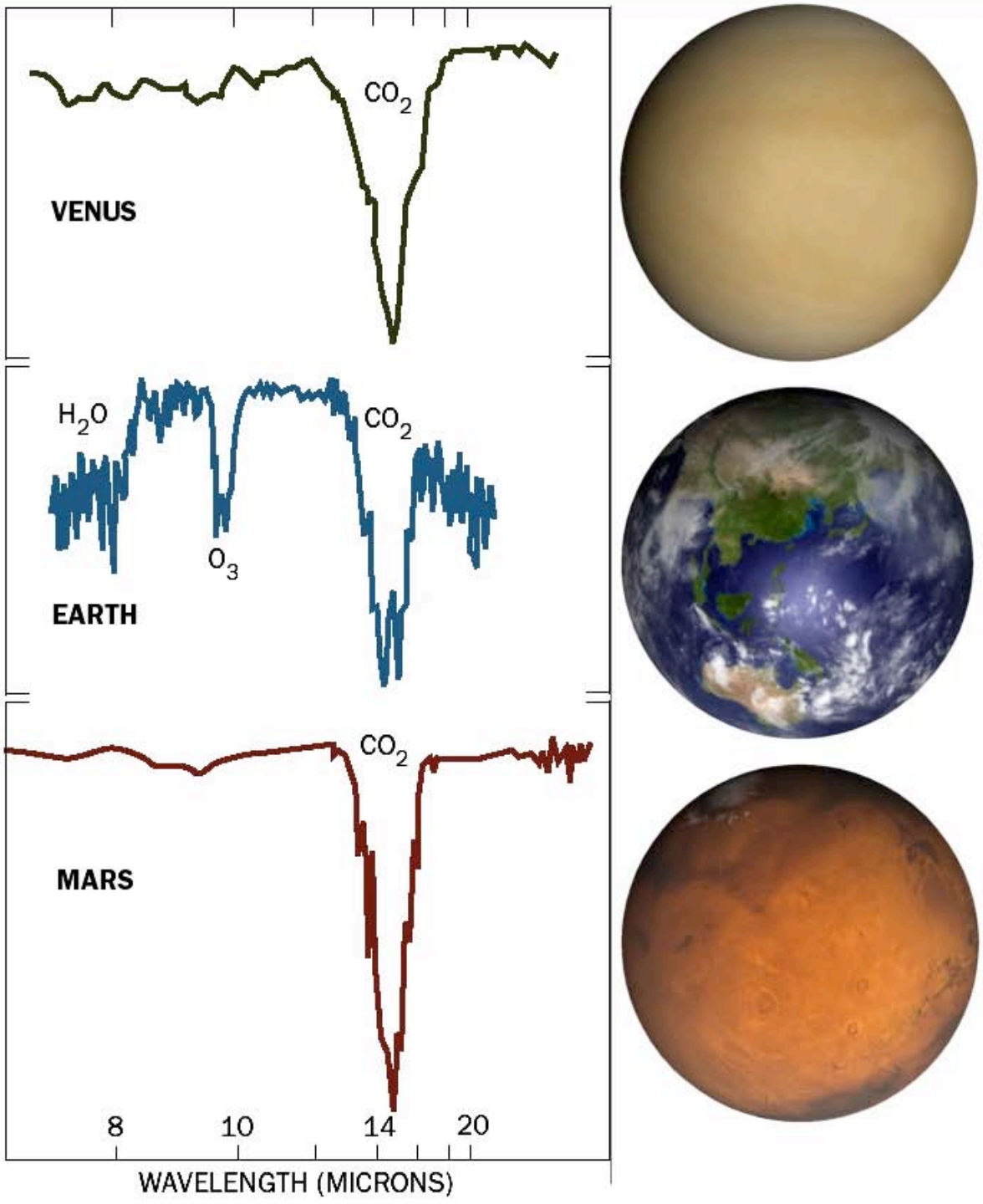
How can such massive planets be so close to stars?

Life on other planets?

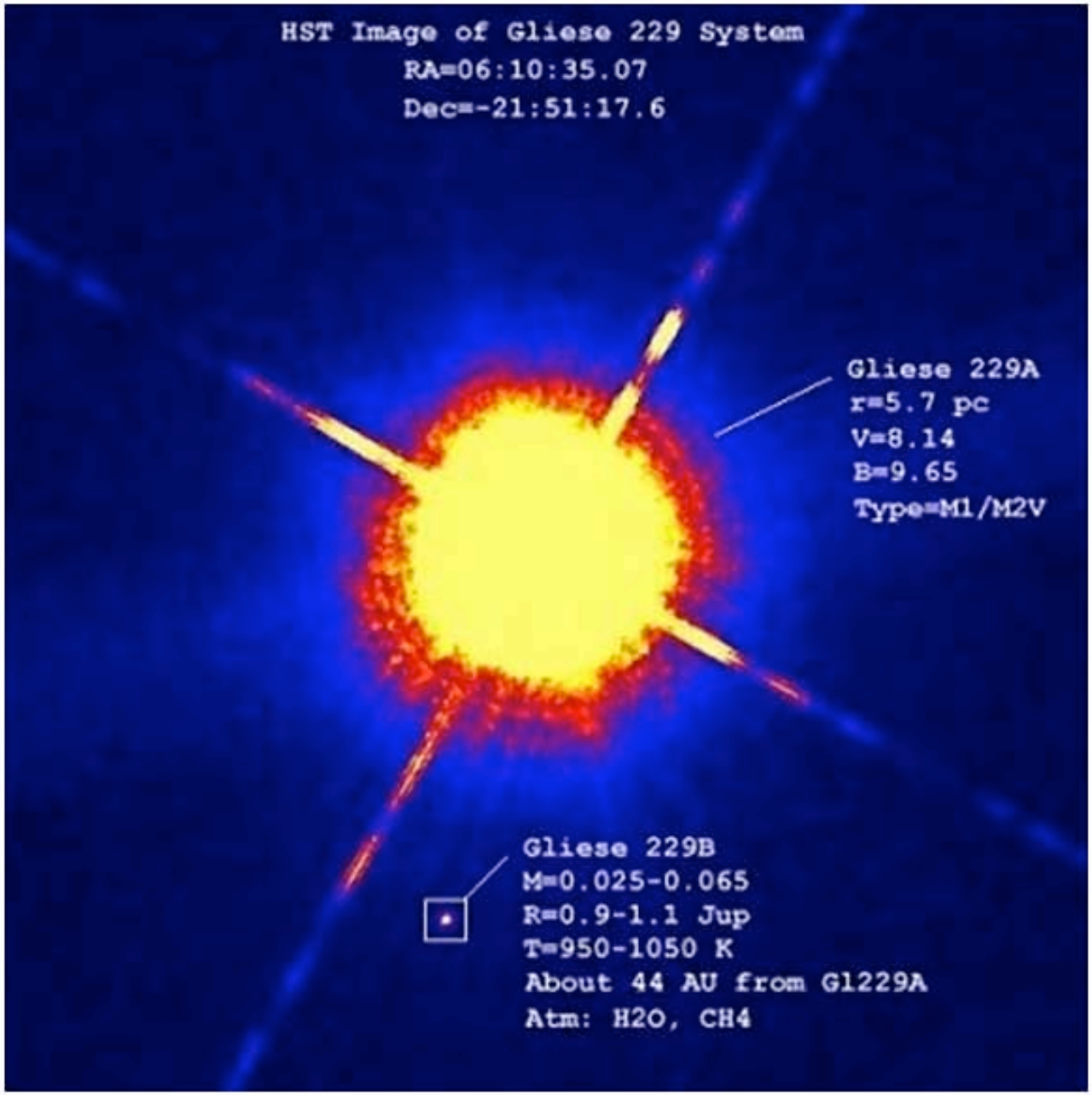
It will probably be a long time before we are able to take pictures of exoplanets good enough to see oceans or continents. Right now it is very difficult to see the planets at all.

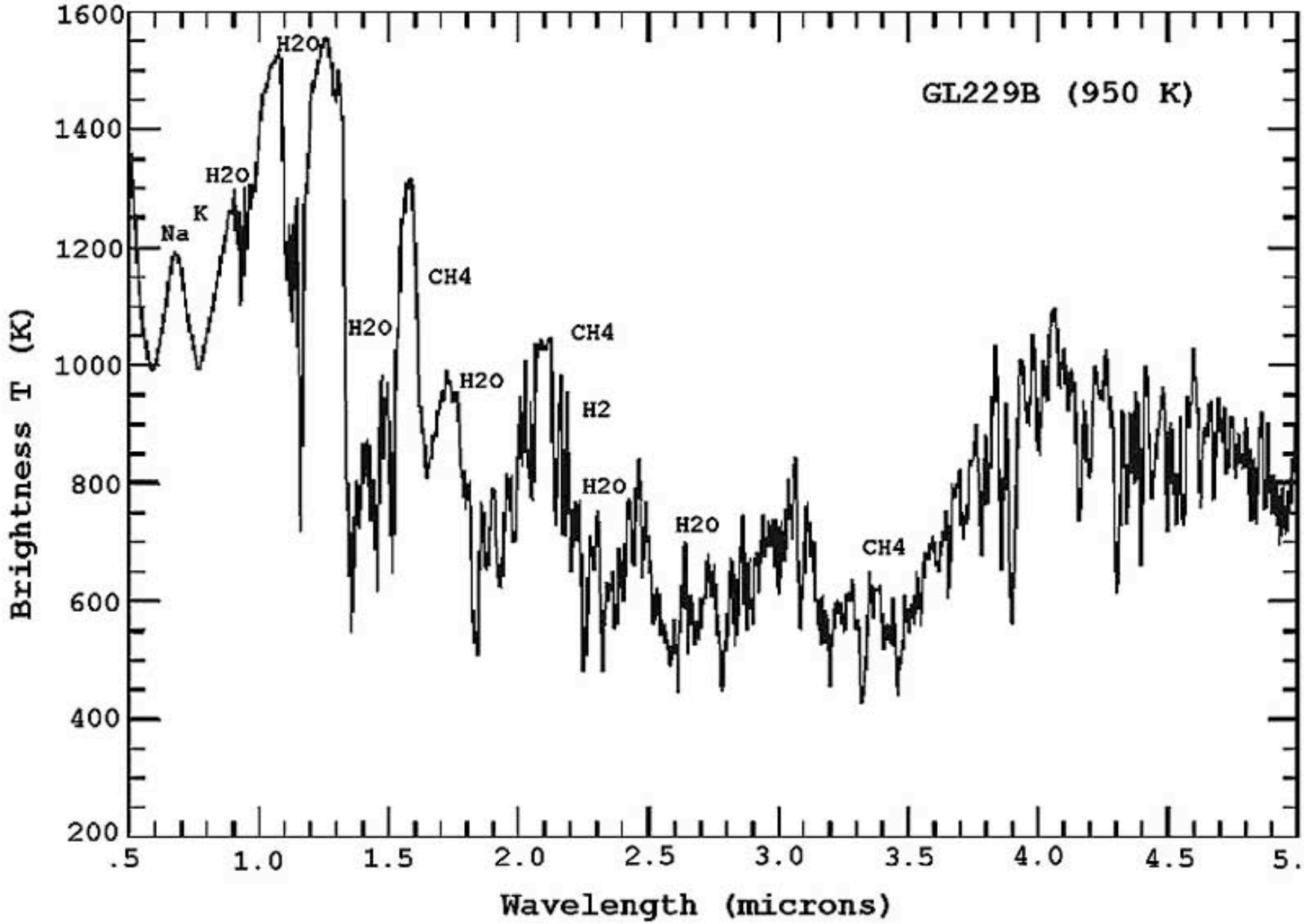
Can we possibly hope to find evidence for life on exoplanets?

We can't do it yet for terrestrial planets that might possibly harbor life, but it should be easier to measure planets' spectra that to take pictures of them.


CO_2
VENUS
H_2O
CO_2
O_3
EARTH
CO_2
MARS
8
10
14
20
WAVELENGTH (MICRONS)

Classification of Exoplanets from Spectra




GL229B (950 K)
Brightness T (K)
Wavelength (microns)
1600
1400
1200
1000
800
600
400
200
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.
H2O
H2O
Na
K
H2O
CH4
H2O
H2O
CH4
H2
H2O
H2O
CH4