

Extra-solar planets and Extraterrestrial life

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**Christians in Science Conference,
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Life Elsewhere ?

- Science assumes no special act of creation
- Since life evolved here it could happen elsewhere
- “It would indeed be rash to assume that nowhere else in the Universe has Nature repeated the strange experiment which she has performed on the Earth” (A. Eddington, 1933)



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Implications?

- How to form life. Chemistry → Biology ?
- Why is there a Universe to have life in ?
- **Must be God?**



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Implications?

- Same reaction: evolution - ‘missing link’ now not tenable, current debate on ‘intelligent design’, anthropic principle – universe ‘designed’ for us
- All are God of the gaps.....
- As science grows, the gaps shrink, God gets smaller – science as threat!





Life on Earth

- Earth formed 4.5 Gyr
- First rocks from 3.8 Gyr
- Fossil bacteria: 3.5 Gyr.
- Multi-cellular: 500 Myr
- Hominids 5 Myr
- Civilization 5 Kyr
- Suggests simple life is easy to form if right conditions



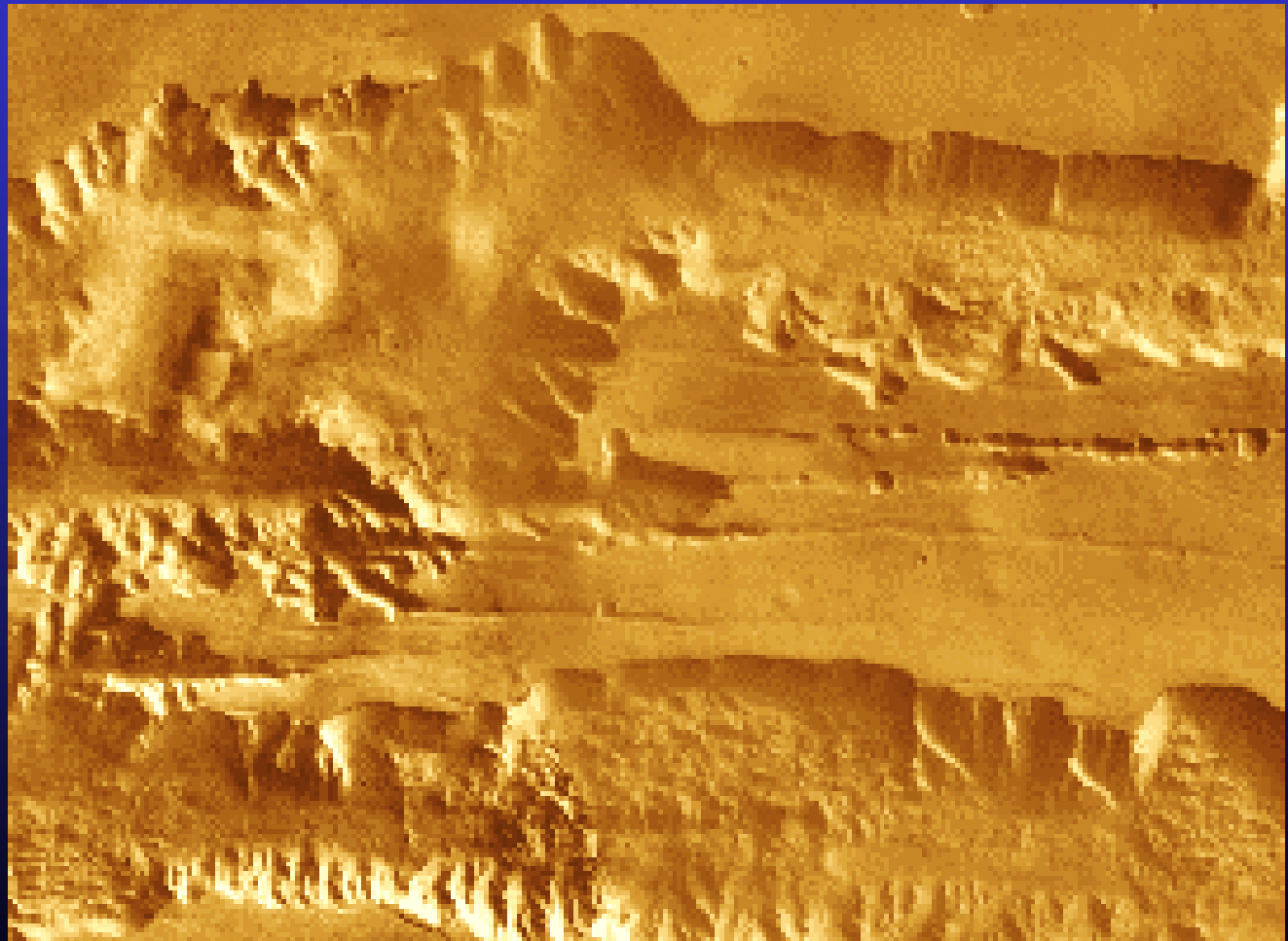
Conditions for life?

- Extrapolate from one known point (Earth!)
- Liquid water
- Energy: light, chemical
- Biochemistry fixed by physics. Not infinite number of chemical pathways → energy



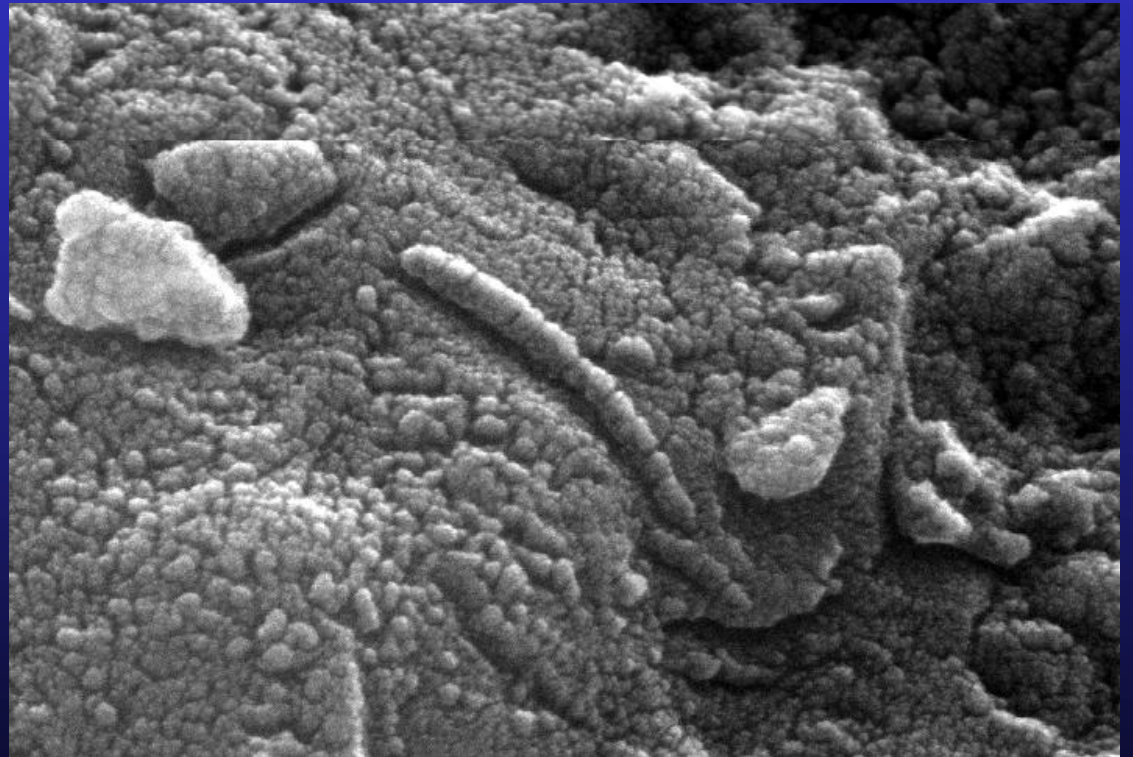
Life on Mars?

- Liquid water in past...
- So maybe simple life in past if not now ?



Life on Mars?

- Martian meteorite?
- Mars gets hit by asteroid, rocks escape, eventually hit Earth
- Find in Antarctica (rock on snow!)
- MAYBE fossil bacteria: but some ambiguity



Intelligent life?

- Discovery of bacteria would show that life is widespread
- But intelligent, self aware, communicative life is what we **REALLY** want!
- Not in our solar system



Drake equation

Number of civilizations =

number of stars \times

fraction of stars with planets \times

number of Earth-like planets per star \times

fraction on which life arises \times

fraction that develop intelligent life \times

fraction that develop civilization

Number of stars?

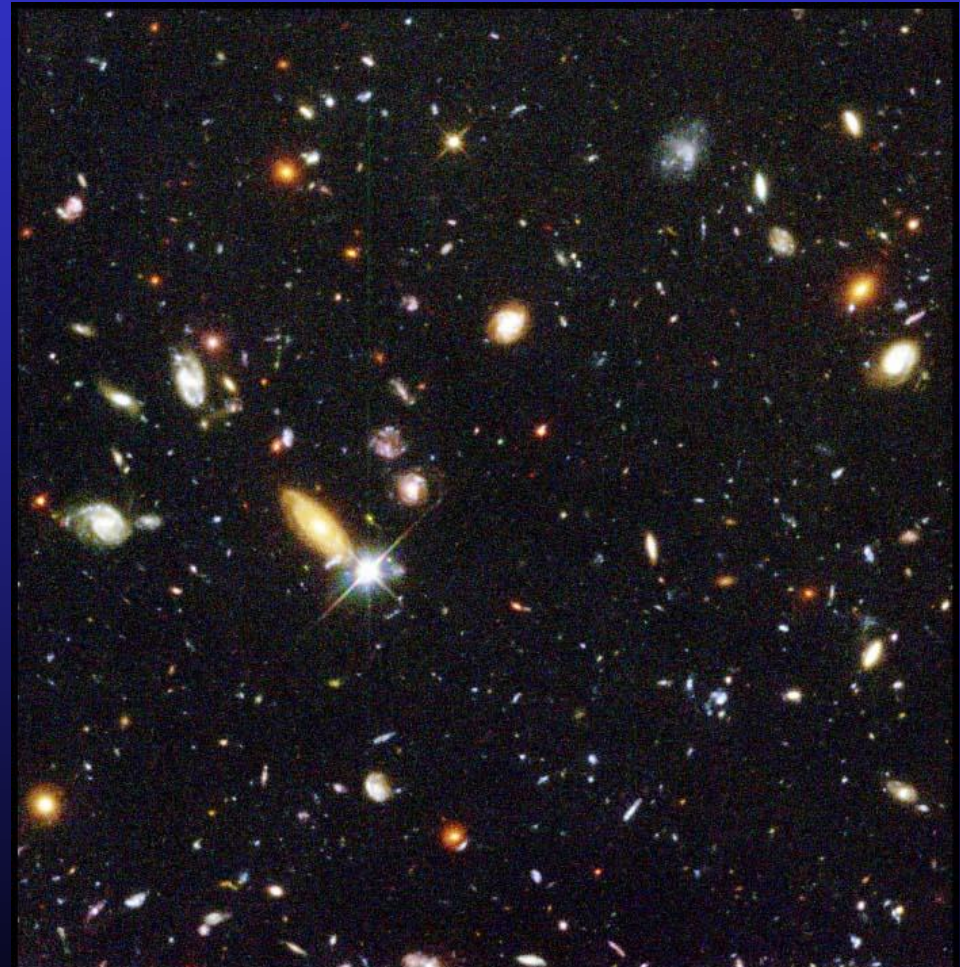
- 100 000 000 000 in our galaxy
- Spiral disc is 100 000 light years across



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Number of stars?

- See galaxies everywhere
- 100 000 000 000 galaxies in observable universe
- 100 000 000 000 stars per galaxy....
- 10^{22} stars (same as grains of sand)
- **Heaven as crystal sphere 10 miles above Earth or this ?**



Hubble Deep Field

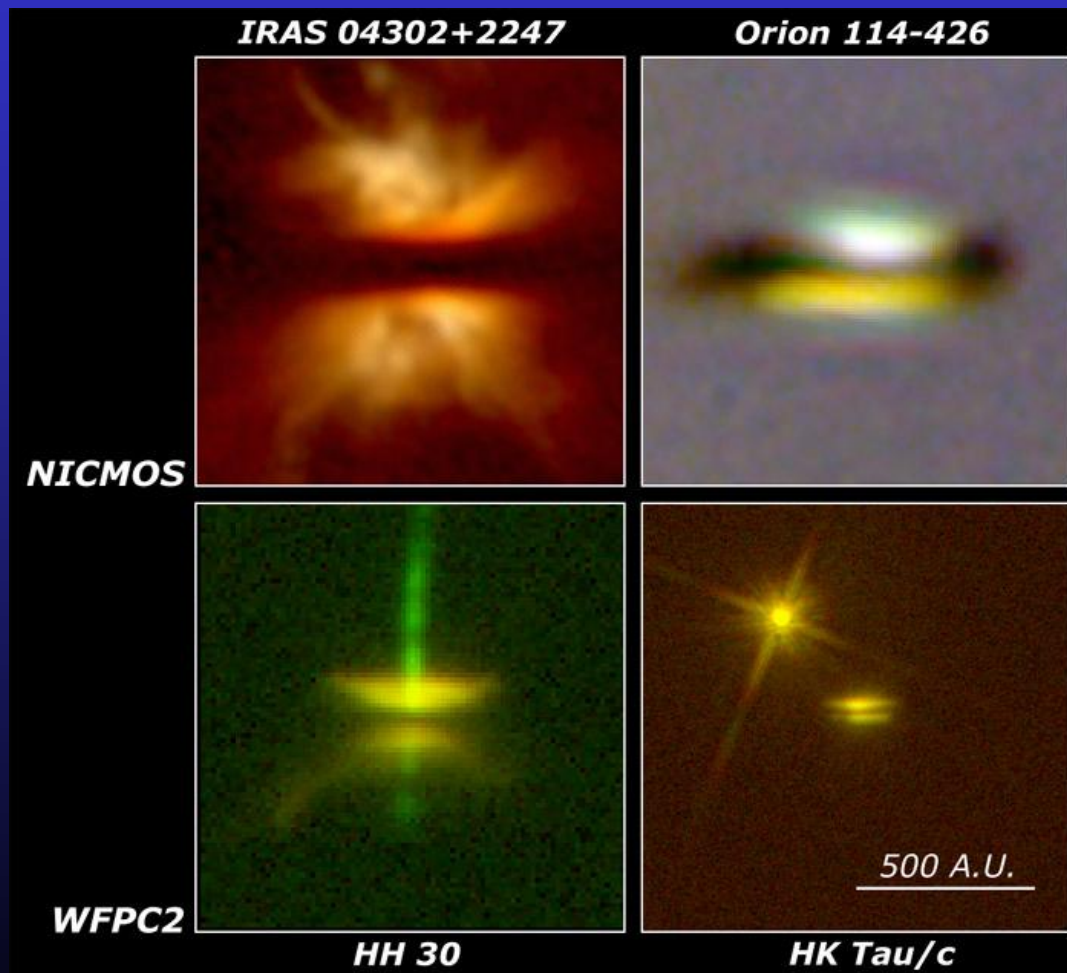
HST · WFPC2

PRC96-01a · ST ScI OPO · January 15, 1996 · R. Williams (ST ScI), NASA

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Fraction of stars with planets?

- Widespread planets means possibility of widespread life.
- Might expect that its easy to form planets as many isolated young stars have discs
- ~ 0.1 (no binaries)



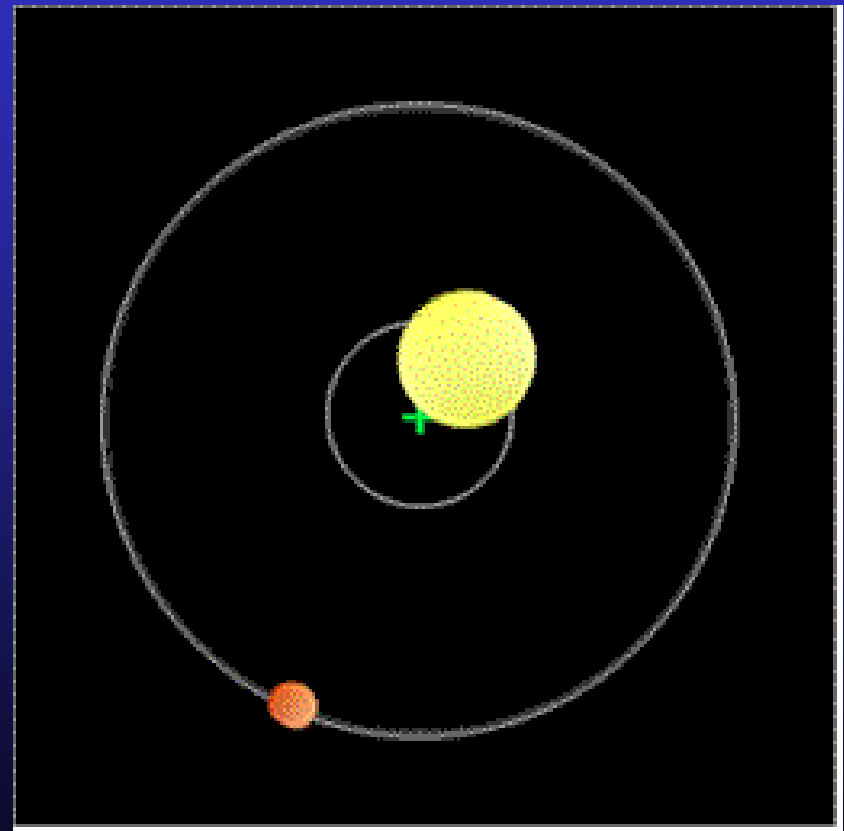
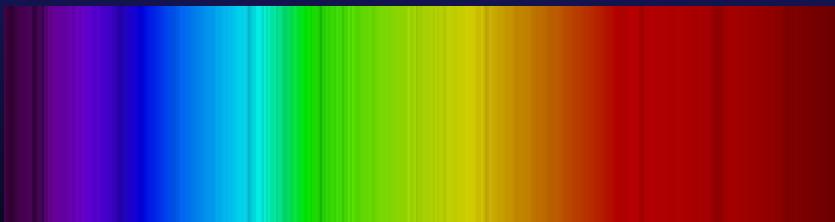
How to detect planets?

- Too faint for direct imaging – Earth from Voyager 1 on edge of solar system!



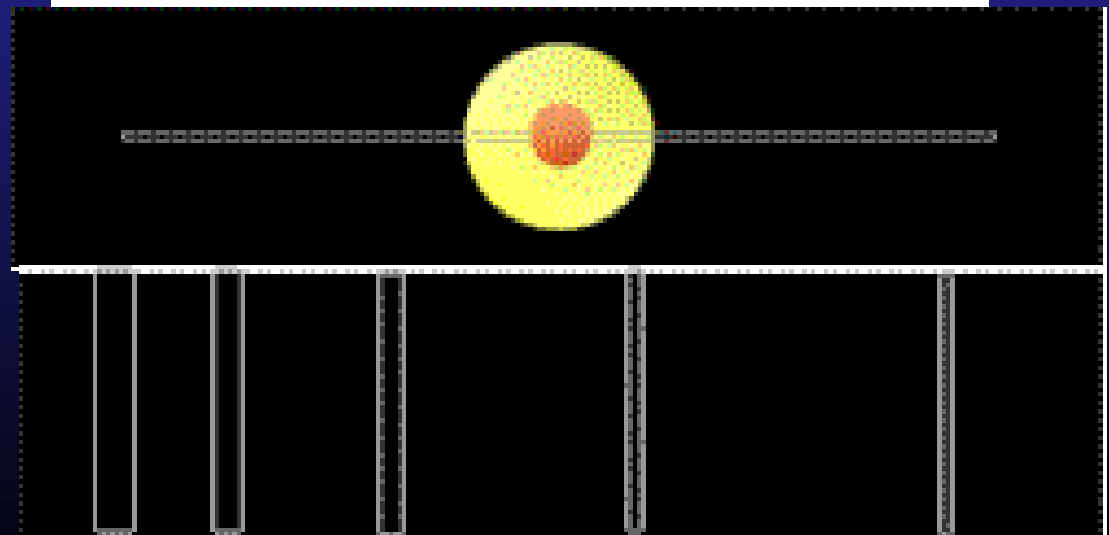
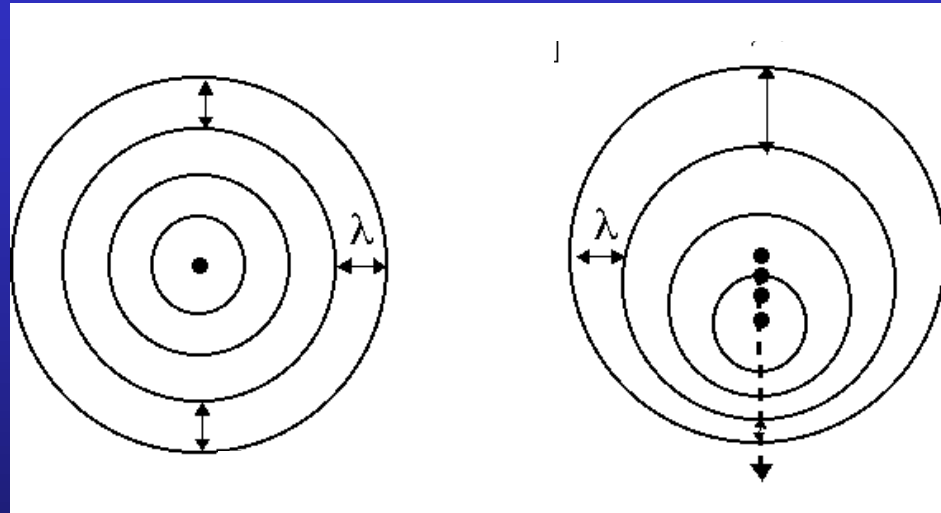
Extrasolar planets

- Star will wobble!
- Edge on – star moves forward and back
- Star has characteristic lines in spectrum – identifiable wavelength



Doppler shift

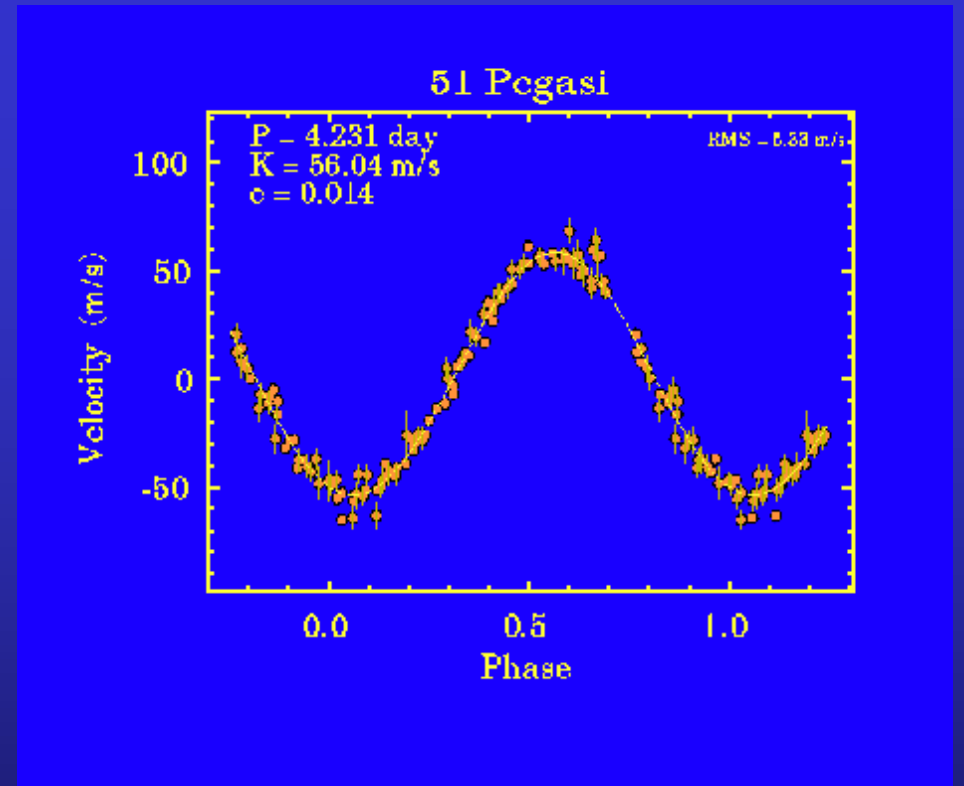
- Period and velocity give distance and gravity strength
- Find mass and distance of planet



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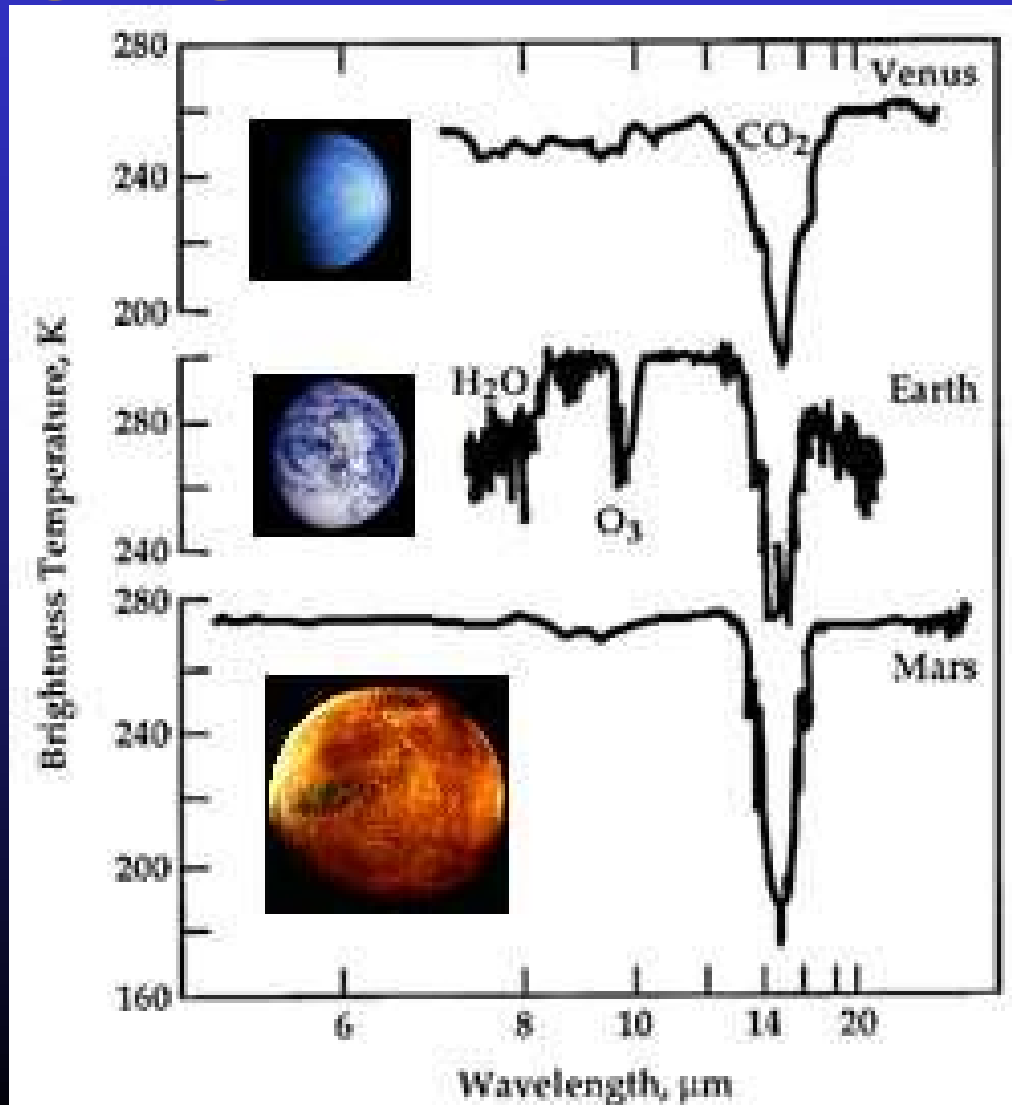
51 Peg

- First extrasolar planet
- Very different from Earth
- Now over 100 – all high mass, close in...
- Because of technique!!
- Other ways to detect Earth mass planets



Detecting signs of life?

- How about life?
- Atmosphere with water and out of chemical equilibrium?
- Not yet done but it is possible



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The future ???

- Earth mass planets in 5-10 years
- Spectra of their atmospheres in 20-30 years
- Search of solar system for bacterial life (Mars, Europa, Titan) 20-30 years
- Likely to know in the next 20-30 years whether or not life is widespread locally.

If found....

- No special 'act of God' for life on Earth
- Extending Copernican revolution of view of Universe (Earth – Sun – Galaxy – Universe)
- Widespread death as well as life (needed for evolution)

If intelligent life found....

- We are not special (Bible is history of un-special people being chosen by God)
- But life is special to God – he created it in all its forms
- ‘The church at any rate says that man’s will is free, and that evil is the price we pay for knowledge, particularly the kind of knowledge we call self-consciousness’ (D.L Sayers 1938)
- Concept of sin, God, purpose ?
- Pride hit if technologically more advanced (as needed for contact and communication). colonialism

Supremacy of Christ

- All of creation redeemed by Jesus on the cross (Rom 8)
- The creation waits in eager expectation for the sons of God to be revealed. For the creation was subject to frustration, not by its own choice but by the will of the one who subjected it, in hope that the creation itself will be liberated from its bondage to decay and bought into the glorious freedom of the children of God (Rom 8)

If not found....

- Not disproven – just not found locally
- Fermi's paradox – it took ~4 Gyr for Earth to develop a civilization. Most stars are older, so longer established civilization, technologically advanced, colonisation of galaxy. So why aren't they here.
- So we could be alone. But don't bank on it.
- Disputable theological position – word of God 'everything needed for life and godliness' NOT answering every intellectual speculation

Conclusions!

- However big our concept of God is, its not big enough