

Search for Habitable Planets Around Low-Mass Stars Using the InfraRed Doppler Instrument

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IRD team

IRD: Special Instrument

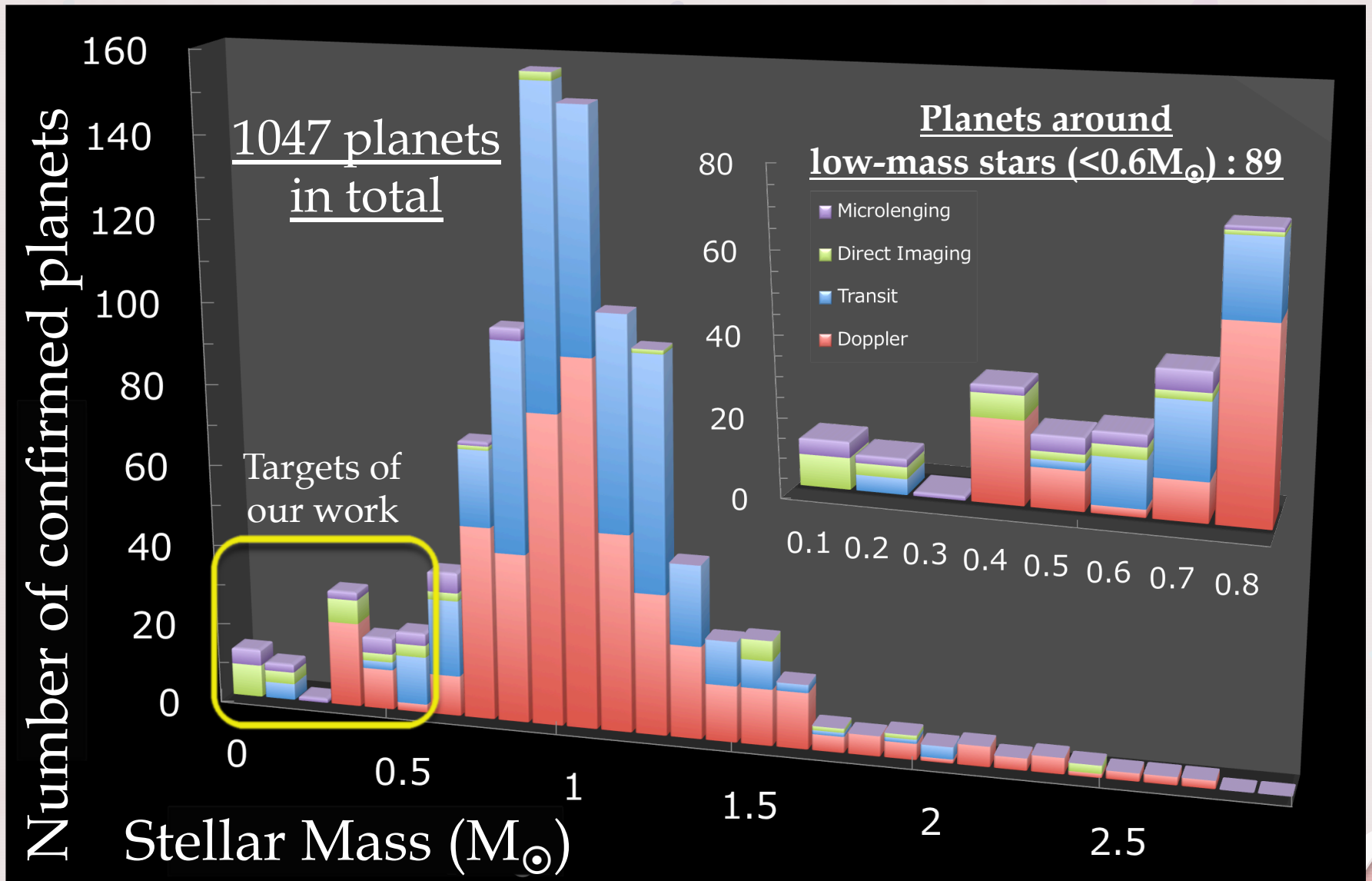
Infrared Doppler Instrument for the Subaru Telescope (IRD)

**Aim for Earth-mass planets
around low-mass stars**

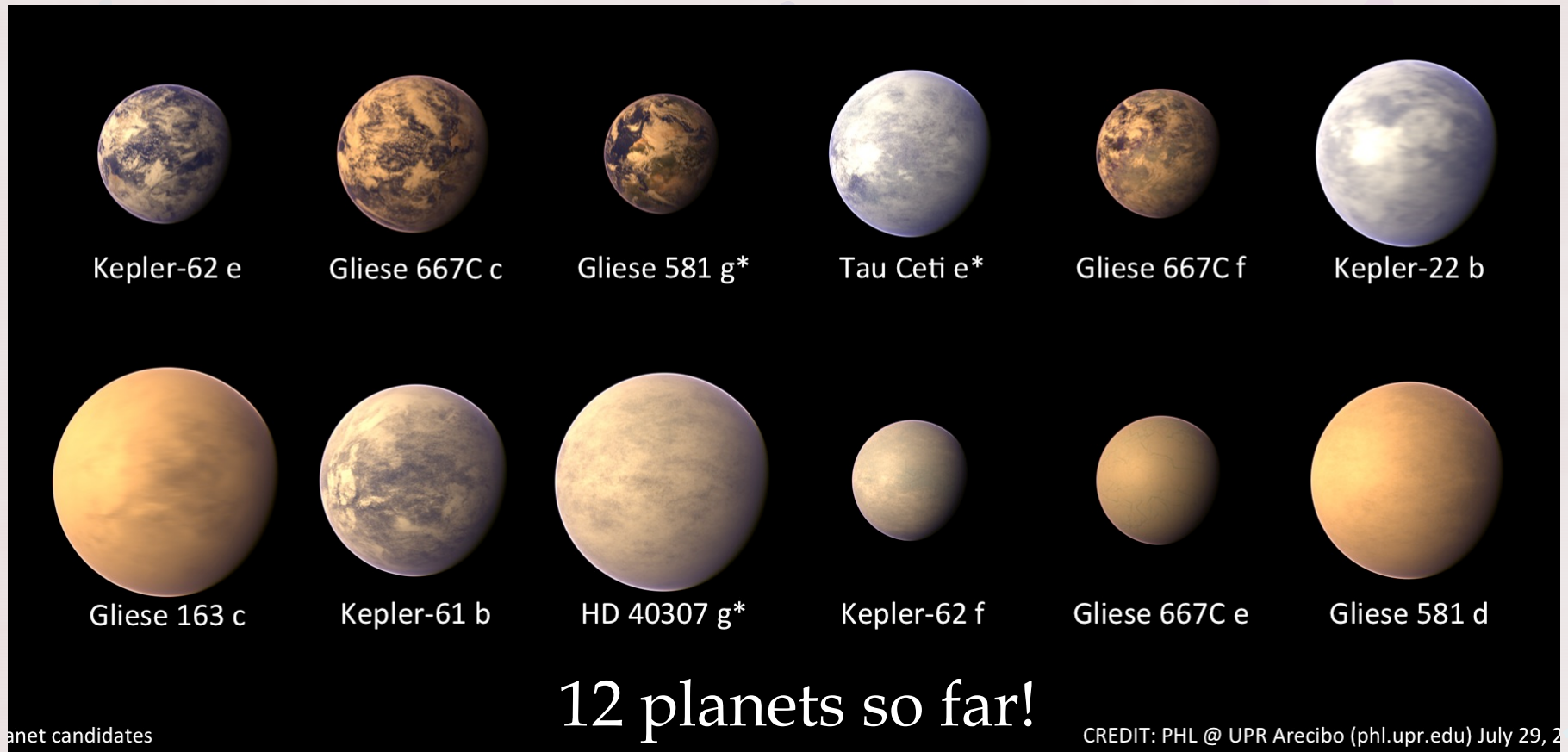
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Mass distribution of Planet Host Stars



Potentially habitable planets



- Mass : $\sim 1-3 M_{\text{earth}}$
- Size : $\sim 0.8-2 R_{\text{earth}}$
- Semi-major axis: 0.7-1.9AU
- (density : 5 m s^{-1} ?)

Kepler-22 System

Solar System

Habitable Zone



Kepler-22b



Mercury



Venus



Earth



Mars

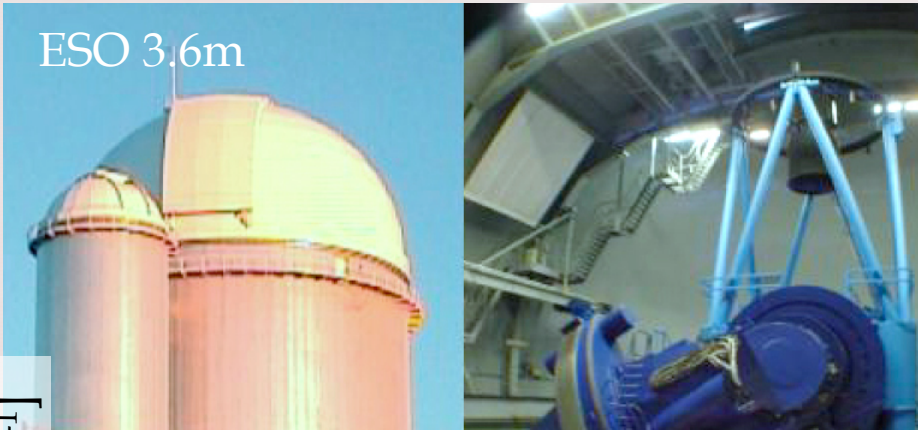
NASA

Planets and orbits to scale

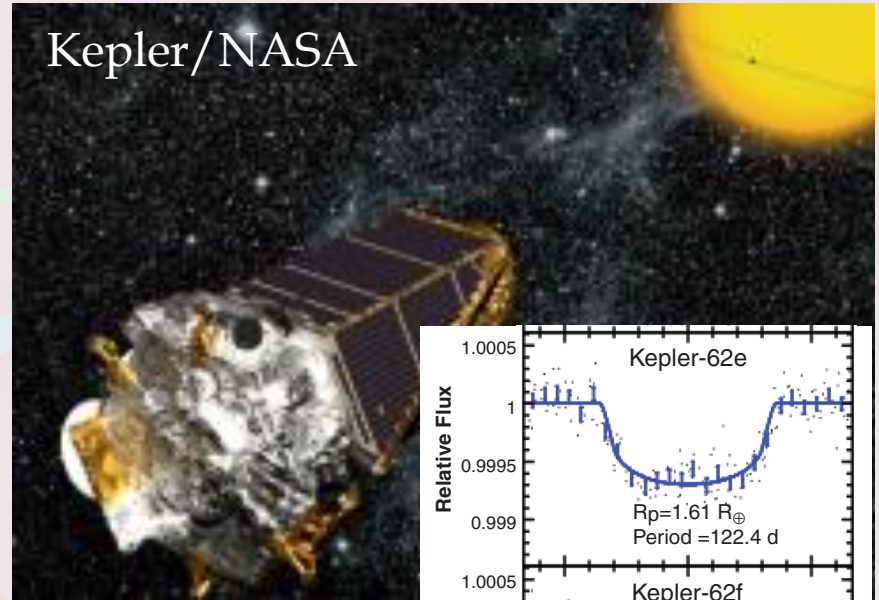
Search for Habitable planets

- Doppler survey
 - Ground telescopes
- Transit survey
 - Kepler satellite

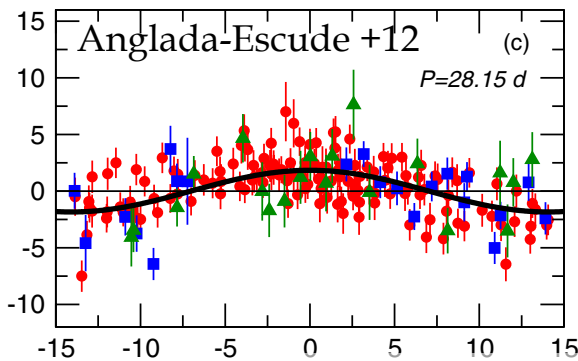
ESO 3.6m



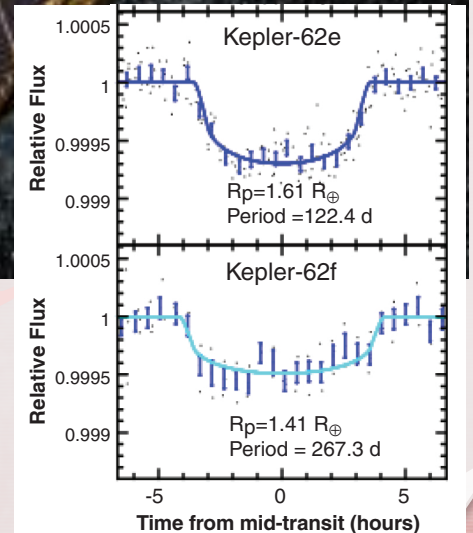
Kepler/NASA



Radial velocity [m s^{-1}]

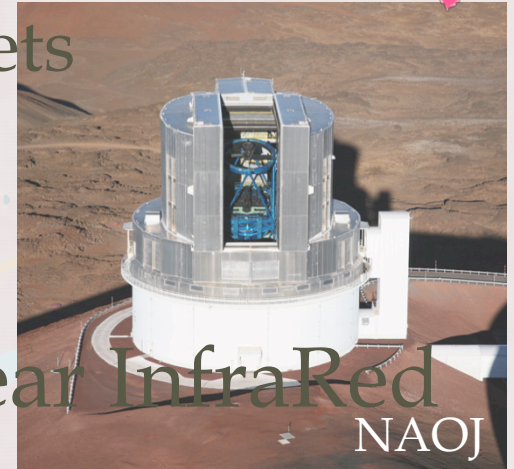


Orbital Phase



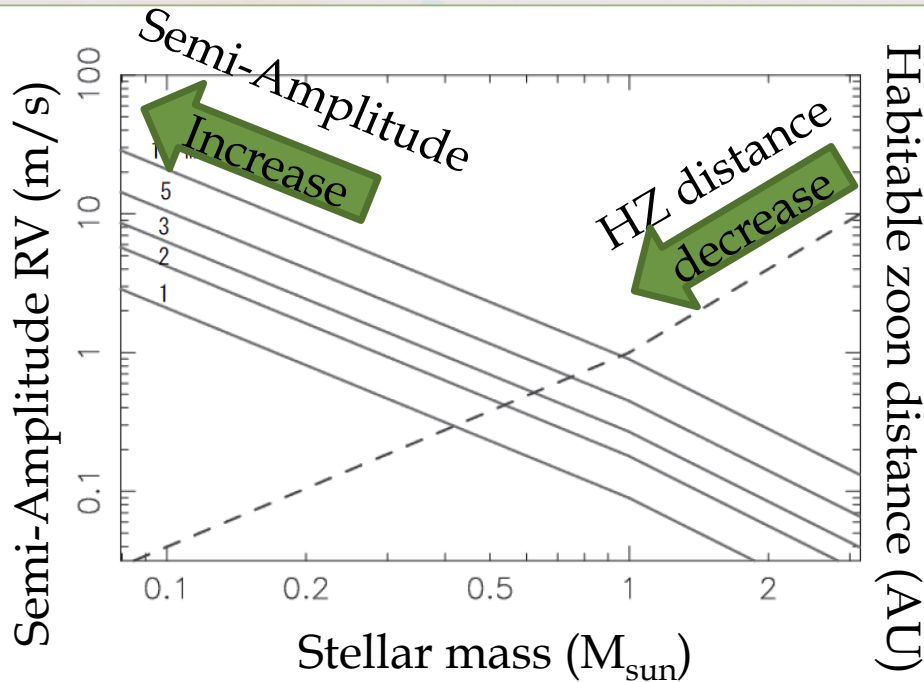
The InfraRed Doppler Survey

- Search for planets around low-mass stars
 - Detect earth-mass planets in habitable zone
 - Show statistical properties of planets
- An Radial Velocity Survey in Near InfraRed
 - New instrument : IRD/Subaru 8.2m
 - Firstlight of IRD : 2014 => Start survey in 2015
 - Expected High RV precision: ~ 1 m/s

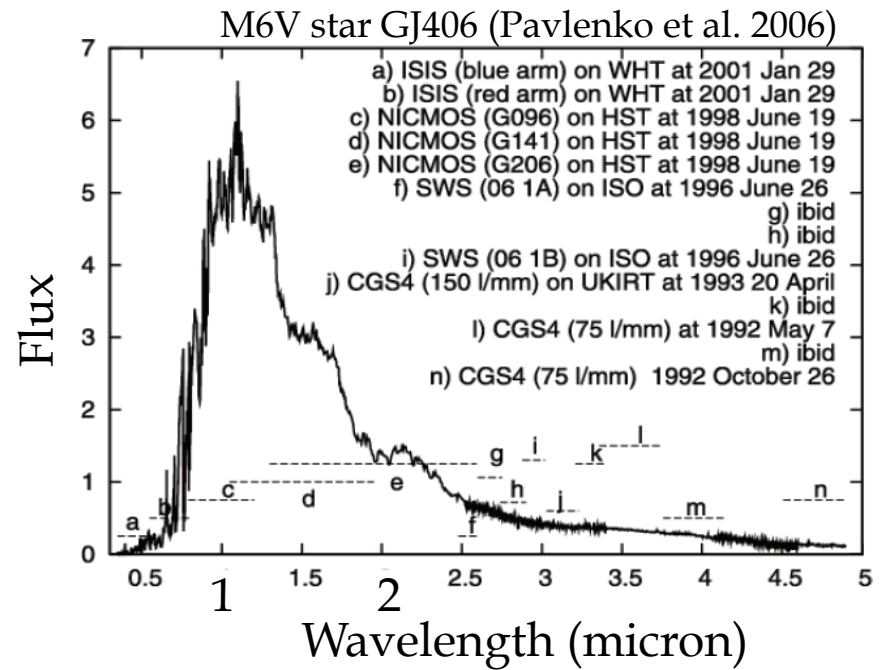


Target : planets @ low-mass stars

Habitable Zone & RV Amplitude



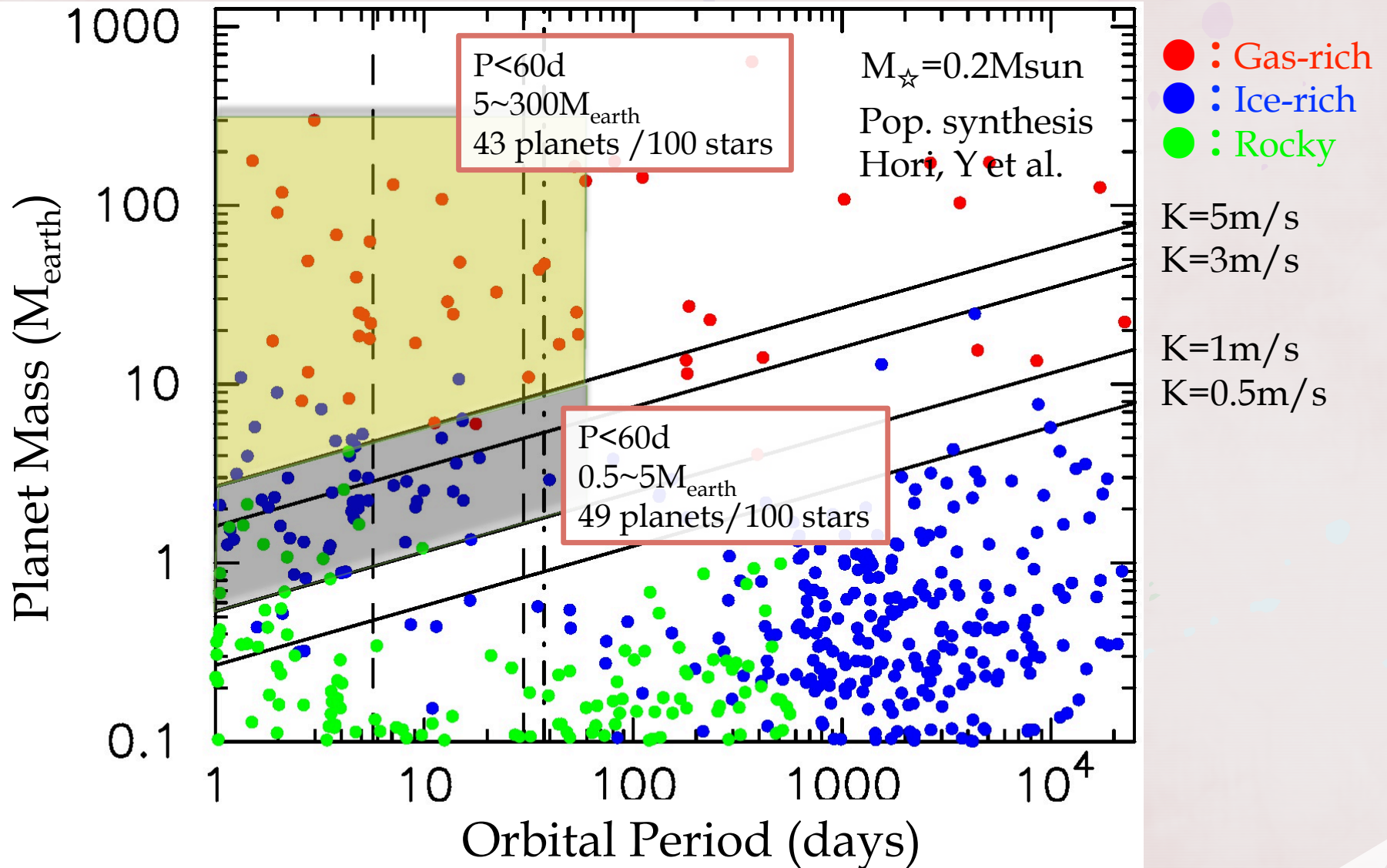
Flux of stellar light



- Habitable zone $< \sim 0.3$ AU
- Amplitude of RV = 1-2m/s

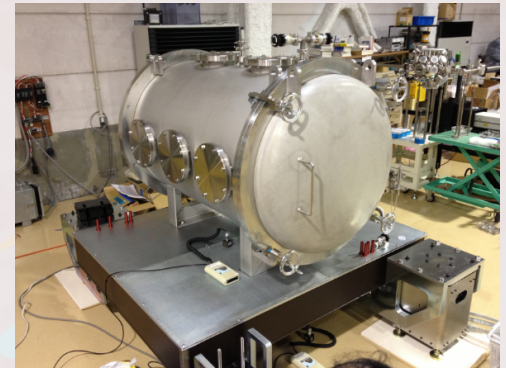
- Flux peak in Near Infrared
- High-efficiency observation

Simulation: Planets @ low-mass stars



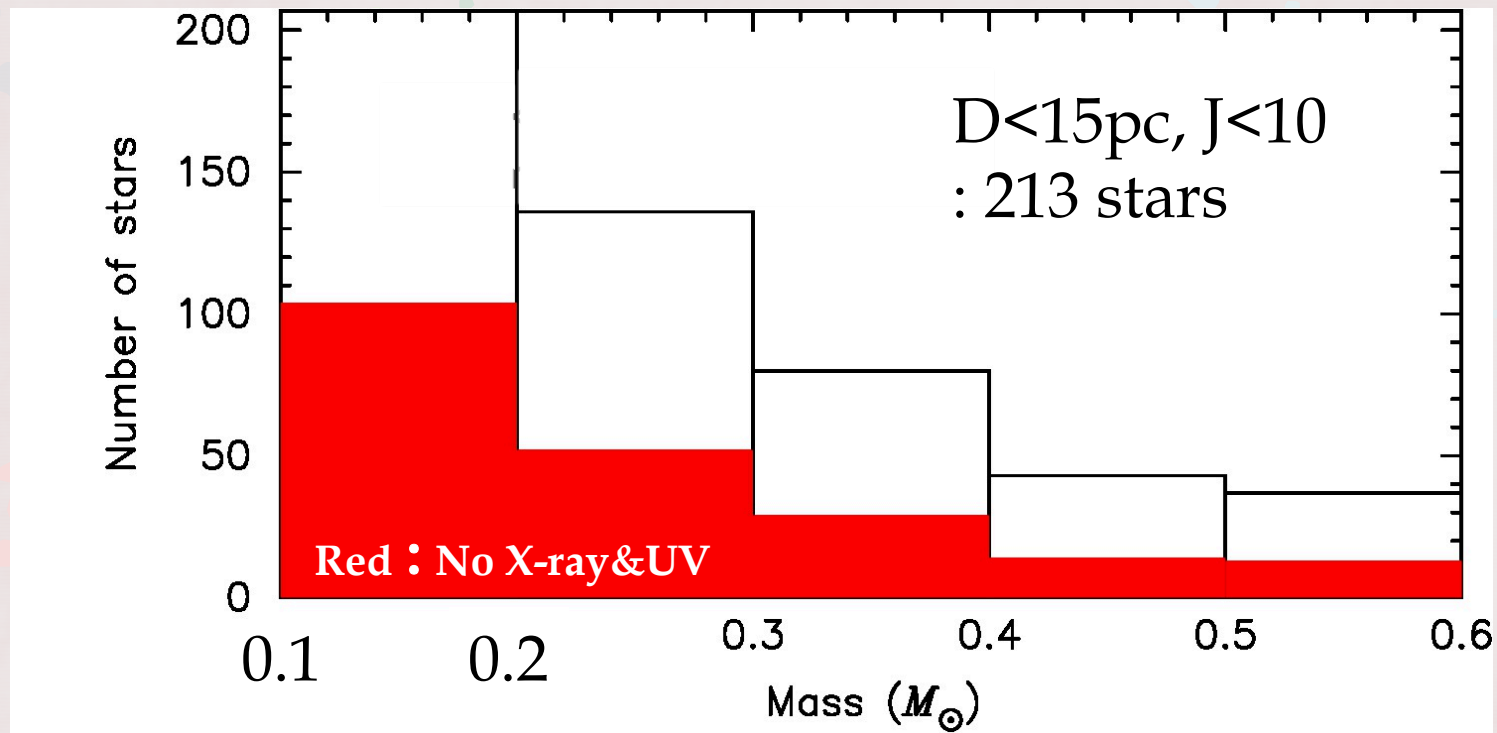
Spec summary of IRD

- Wavelength: 0.97-1.75 μm
 - Important region: 0.97-1.1, 1.4-1.8 μm for M stars
- Spectral resolution: 70,000 (3pixel sampling)
- Pixel scale: 0.09 arcsec/pixel
- Fiber-fed: star + reference + sky + comb
- Dispersive optics: Echelle & VPH-Grating
- Detector: Hawaii 4096x4096
- Detector temperature: 60K, Optics temperature: 200K
- Cooler: Pulse-tube cooler
- Tip-Tilt: Rlimit=18 & 0.27arcsec slit usable
- Expected RV precision: 1 m/s w/laser frequency comb



Sample of our survey

- Nearby stable dwarf stars : 200-500 stars
 - An All-sky catalog of Bright M Dwarfs (Lepine+2011)
 - A Spectroscopic Catalog of the Brightest ($J < 9$) M Dwarfs in the Northern Sky (Lepine+2012)



Strategy for the IRD Survey

- Quicklook observation
- Monitoring observation
 - More massive planets in habitable zone
- Intensive observation
 - Toward rocky (Earth-mass) planets
- Follow-up observation by Transit
 - At Japanese facilities (See N. Narita's talk)

Summary



- IRD/Subaru 8.2m
 - Infra-Red Doppler instrument with frequency comb
 - First light in 2014
- Search for planets around low-mass stars
 - Detection of habitable planets
 - Statistical properties of more massive planets
- Simulations for the IRD survey
 - Strategy: Quicklook => Intensive and Uniform obs.
 - Detectability for 3 year observations
 - Quicklook : To find planet candidate
 - Uniform : planets more massive than $20 M_{\text{earth}}$ @ ~ 100 d
 - Intensive : We can reach to habitable rocky planets