Masashi Omiya NAOJ / ABC (omiya.masashi@nao.ac.jp) & IRD team

Precise Radial Velocity Survey with IRD: Searching for Earth-like planets orbiting M dwarfs

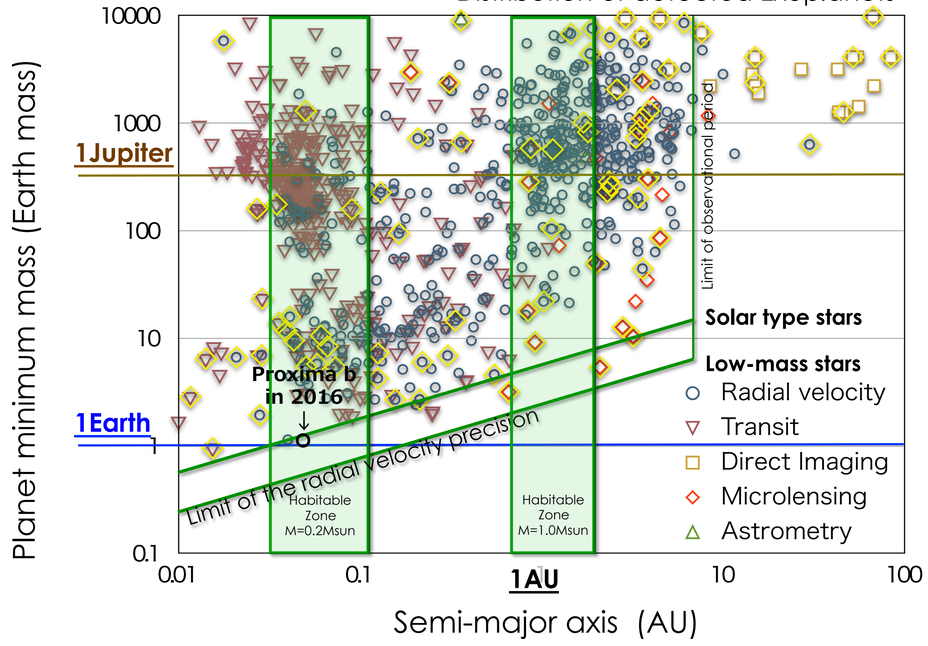
P20

Abstract

We are planning to perform a new planet search for Earth-like planets around late-M dwarf stars using **the InfraRed Doppler instrument for the Subaru telescope (IRD)**. The planet search project aims detecting Earth-mass planets in the habitable zone (HZ) and understanding configurations of planetary systems including Earth-mass planets around low-mass stars by the infrared Doppler method. Although a planetary companion with Earth-mass around Proxima Centauri in the HZ has been reported by using a most advanced optical spectrograph, HARPS, **a very strategic survey with IRD** is necessary for detecting significant number of Earth-like planets and achieving our scientific goals. In this poster, we describe a scientific background, a strategy, and simulation results of the Subaru/IRD planet search.

Introduction

Toward Earth-mass planets in HZ



☆ Optical planet searches around solar type stars
There are a few reports of the earth-radius planets by Kepler
However, it is difficult to detect earth-mass planets around nearby stars

☆ Optical planet searches around low-mass stars
There are some candidates of the planets.
However, it is difficult to search for Earth-mass planets around many stars because of small stellar flux in optical.

☆ Infrared planet search around lower-mass stars (Mass < 0.3 M_{Sun}):
Larger signal ➔ Detectable for $1M_{Earth}$ planets
➔ Can Detect planetary systems including Earth-, Naptune-, Jupiter- mass planets
Stellar flux peak is in near infrared region.
Closer Habitable Zone (HZ) (<0.3AU).

A Strategy to detect Earth-mass planets

Difficult to detect Earth-mass planets around solar-type stars

- Search for exoplanets using IRD/Subaru
- IRD + Subaru ➔ Can target on faint low-mass stars
- High precision ➔ Easier to detect Earth-mass planets
- Target stars ➔ Can select more than 100 stars

Our targets: Late-M type dwarfs（M4V-M9V、0.1-0.3 M_{Sun}）

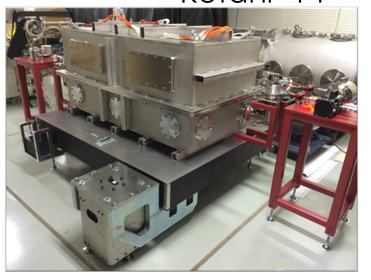
Large signal (K = 0.5~2 m/s) ➔ Easier to detect Earth-like planets
Short orbital period (P < 40 d) ➔ Easier to detect Earth-like planets
Flux peak is in infrared ➔ Effective in infrared observation
Many stars in solar neighborhood ➔ Many bright sample

InfraRed Doppler (IRD) instrument

Telescope: **Subaru telescope**（8.2m）
Wavelength： 0.97-1.75um （Y, J, H –band）
Resolution： 70,000 （3pixels-sampling）
Calibrator： **laser-frequency comb**

Kotani+14

Goal: 1m/s radial velocity precision for non-active low mass stars



Start obs. with IRD in 2017 spring
IRD/Subaru planet search in 2018

Main Science Goals of Subaru/IRD planet search
1.Discovery of Many Earth-mass planets (in the habitable zone)
2.Statistical understanding planetary systems around low-mass stars

Subaru/IRD planet search for Earth-mass planets around low-mass stars

1. Secreening observatons of low-mass stars using small telescopes

To select slowly rotating stars for samples of the planet search
Small rotational velocity: <4 km/s (RV error ~ 1m/s)
Small stellar jitter: ~1 m/s
Optical medium resolution observations
R~1500, 5500~8000Å (including Hα)
At five observatories and telescopes:
Okayama(1.88m), NHAO,(2.0m)
KPNO(3.5m), Calar Alto(2.2m),
APO(3.5m)

2. Target : ~100 late-M dwarf stars

Inactive M4V-M9V type stars
with measurements of parallax
without X/UV emission
without Hα emission
with masses of 0.1-0.3 M_{Sun}

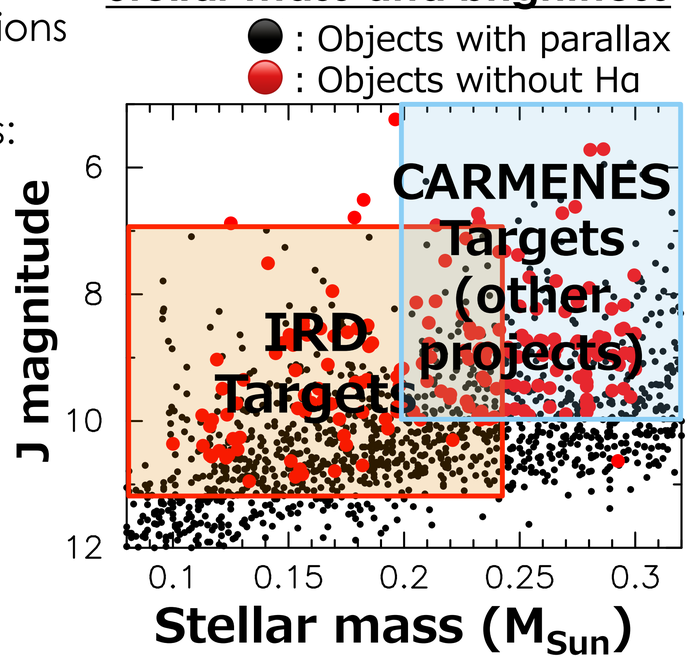
They are IRD-unique targets!

Too faint for other Doppler projects using 3m-class telescopes
Tess would detect many planets around late-M stars with J>12 (too faint)

3. Strategic observation using the Subaru 8.2m telescope and IRD

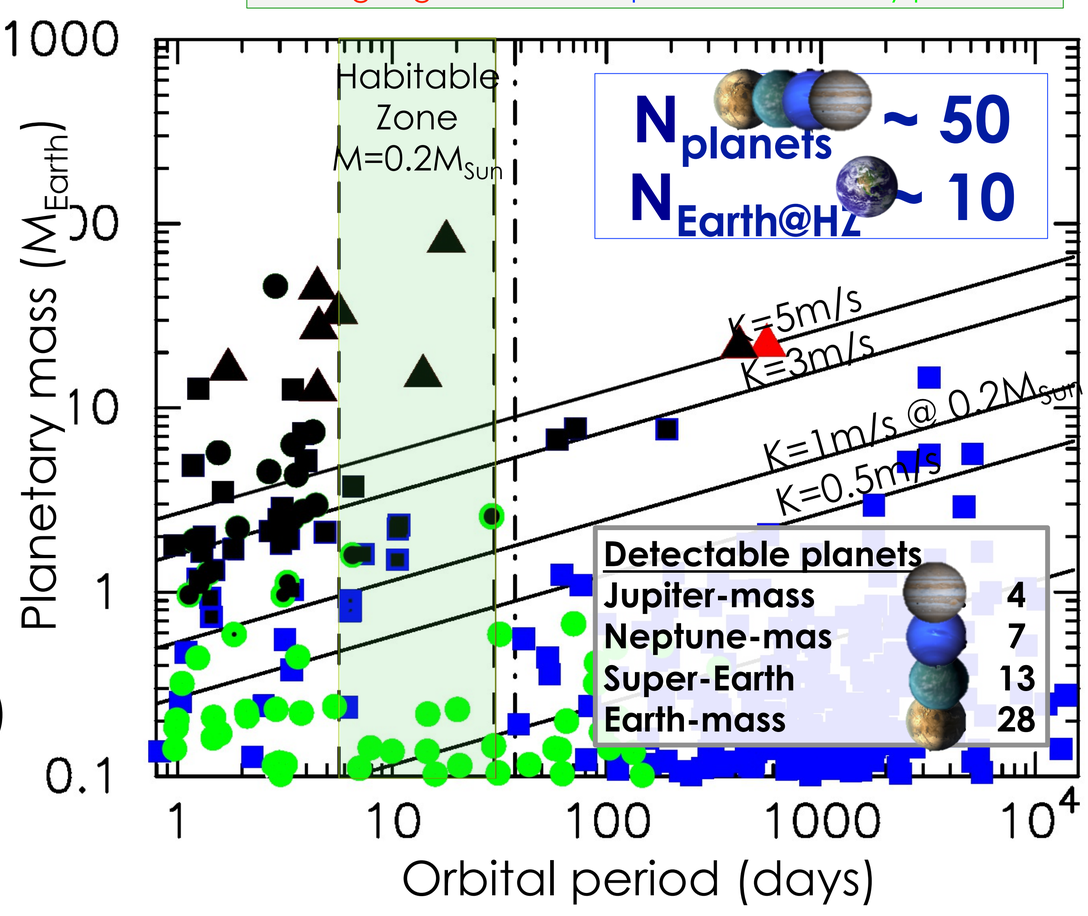
half night-allocated mode: ex. ~70 half nights/yr 8(-6h/1night)
Period of the survey : 5 yr (Success rates of 70%)
Number of observations : Nobs~ 50 or 80 / star

Stellar mass and brightness



Observational simulation of detectable planets (black, Size indicates detection probability.)

Theoretical Simulation (Pop. synthesis by Hori, Y et al.)
▲ : gas giants ■ : ice planets ● : Rocky planets



Summary

In *Subaru/IRD planet search* with the specific strategies for 5 yrs, we aim to detect Earth-mass planets orbiting low-mass late-M dwarfs in their habitable zone. We would like to start a unique planet search in 2018.

Subaru/IRD detects many Earth-mass exoplanets in the habitable zone!