Hunting many Proxima b analogs using infrared radial velocity spectrometer and laser frequency comb on the Subaru telescope. M. Tamura[1,2] and IRD team, [1]UTokyo (Department of Astronomy, Hongo 7-3-1, Bunkyo-ku, Tokyo 113-0033, motohide.tamura@nao.ac.jp), [2]Astrobiology Center (Osawa 2-2-1, Tokyo 181-8588)

Introduction: With the discoveries of more than 3500 exoplanets including the nearest habitable planet, Proxima b, more and more interest is concentrated on hunting nearby habitable low-mass planets around low-mas stars. In fact, our knowledge of the exoplanets around M stars, which are the main components in our Galaxy, is still limited.

The rdial velocity (RV) searches have been one of the most successful methods to hunt exoplanets including its first discovery around the Sun-like star 51 Peg and the recent discovery of a habitable planet around the nearest M star, Proxima. Ceratinly, the RV searches for low-mass planetrs are suitable for M stars rather than G stars with a limited accuracy of a few m/s. However, such M stars have very low-temperatures and thus are faint at optical (but they are in fact bright at infrared). For example, Proxima is 11 mag at 0.6 micron and 5 mag at 1.2 micron. Threfore precission RV searches at infrared wavelengths such as 1-2 microns are exteremly important for M star planet hunting.

IRD is a near-infrared high dispersion spectrometer developed for the Subaru 8.2-meter Telescope. It aims at achieving measurement precision of 1 m/s in RV at near-infrared wavelengths of 0.97-1.75 microns and thus will be a very powerful instrument for exoplanet searches around M stars or red dwarfs.

Our main astronomical targets using IRD are late-M dwarfs, which are too faint to observe at optical wavelengths even with 4-m class telescopes. Their lower luminosities bring the potentially habitable zone (where water is liquid on the planet surface) closer to the star, making planets in shorter period orbits more interesting for the search of life outside our solay system.

With the RV precision of 1 m/s, we can expect to detect Earths (~1 Earth-mass) and Super-Earths (>1 - ~10 Earth masses) in the habitable zone around low-mass stars. Recent Kepler mission discovered many low-mass exoplanets including ~20 Eath-sized ones in the habitable zone but their distances are too large to allow follow-up observations with the current and near-future instruments.

Instrument Perfomance and Status: The spectrometer covers the wavelength range from 0.97 to 1.75 microns with a 70,000 spectral resolution and 3-pixel sampling. The instrument shown in Figure 1 has a fore-optics part for star-light and laser frequency comb injection into fibers, and a backend spectrometer optics, and a detector unit comprised of 2 2048x2048-element IR arrays. Our laser comb covers almost the whole wavelengths at once. In contrast to the general purpose high dispersion spectrometer, IRD is optimized for stable and accurate monitoring of periodical wavelength shift of absorption lines of M stars and aiming for Earth-like planets orbiting around them. The RV precission achieved in the laboratory is less than 1 m/s. Telescope first light is planned in early 2017.

Figure 1: Overview of the IRD instrument..

Planet Survey: We paln to conduct a large scale survey on the Subaru 8.2m telescope for the habitable planets around late-M stars using IRD. Our survey focuses on late-M dwarfs, because early M dwarfs can be accessed with optical RV instruments. Furthermore, large aperture of the Subaru telescope can be a unique advantage for targeting faint late M dwarfs. We selected late M dwarfs with small rotational velocity and low stellar activity based on our precursor observations with smaller telescopes.

Our survey simulation, assuming that a total of 170 nights are available for 5 years, suggests that ~40 Earth-mass planets including some of them in their habitable zone will be expected, as well as many Super-Earths and Neptunes.

References:

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