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Optical SETI observations with the NAYUTA telescope

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Abstract

Japanese first Optical SETI (OSETI) observations were performed on 34 nights from 2005 November to 2007 August with the 2m NAYUTA telescope at NHAO. We have searched for laser emission lines in the optical spectra of 8 exoplanetary systems based on the method of Reines and Marcy (2002). The candidate emission lines were not seen in the differential spectra.

Key words: SETI – OSETI – Spectroscopy – Solar type star – Exoplanetary system – Habitable zone : Indivisual(51 Peg, 47 UMa, 55 Cnc, ρ CrB, Pollux, HD 49674, τ Boo, Gl 581)

Optical SETI (OSETI) project was suggested by Schwartz and Townes (1961). Some OSETI observations have been performed (e.g. Beskin et al. 1997, Howard et al. 2004). Reines and Marcy (2002) searched for laser emission in the Keck 1/ HIRES spectra of 577 nearby F, G, K, and M main-sequence stars. They estimated the detection limit of power of laser. The one of the most powerful laser on the Earth is the LFEX laser at Institute of Laser Engineering Osaka University which will be completed in 2008. This can produce 10^{16} W laser. We also calculated the detection limit of power for the case of the NAYUTA / MALLS system based on the logic of Reines and Marcy (2002) . The result is 10^{16} W when we use parameters which shown in Table 1.

We carried out OSETI observations using the MALLS (Medium And Low-dispersion Longslit Spectrograph) installed on the Nasmyth platform of the 2m NAYUTA telescope (the largest telescope in Japan) at NHAO. Technical details of the MALLS are given in Ozaki and Tokimasa (2005).

The peak wavelength of the quantum efficiency of the MALLS is about 5000 Å. Therefor, 5320.7 Å is decided for central wavelength to our observations. This is a half wavelength of the strongest laser (R2 →Y3) of YAG which is powerful and efficient one. We can search for other (1/2) wavelengths (5260.2 Å; R2 → Y1, 5307.6 Å; R1 → Y1, 5323.0 Å; R1 → Y2, 5369.0 Å; R1 → Y3, 5390.0 Å; R1 → Y4 and 5560.5 Å; R2 → Y6) of YAG lasers in wavelength width (450 Å) of the MALLS.

We selected our target stars whose planets can remain in the habitable zones at least the 1000Myr. Jones et al. (2005, 2006) have performed such examinations for Earth-mass planets of exoplanetary systems. We chose 7 bright solar type stars from their lists. And we add the M dwarf Gl 581 which has a 5 M_Earth planet in the habitable zone (Udry et al. 2007).

The observational journals are summarized in Table 2. These are the first OSETI observations in Japan. In 11 of total 34 nights, we invited visitors (ordinary citizens) of our observatory to operate under the "NHAO at site program (Sakamoto et al. 2005)".

The reduction of spectral data was performed using the IRAF[1] software package in a standard manner. The signal, if any, will appear as a variation of intensity at laser wavelength. We searched such variation by subtracting a spectrum as one time from another. Figure 1 and 2 show one of the observed and differential spectra, respectively. Observations are still being continued, up to the time of this report, no candidate signals above 6 σ level in our differential spectra.

[1] IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

Table 1. Used parameters for estimate of detection limit of power of laser.

Parameter	Value
the aperture size of the laser transmitter	10 m (the largest telescope on the Earth)
the central wavelength of the laser	5320.7 Å (1/2 wavelength of the YAG R2 → Y3)
the pulse duration of the laser	1 nano sec.
the spectral energy distribution of solar type star	4000 Å
the luminosity of the solar type star	3.8×10^{26} W
the wavelength resolution of the MALLS	0.6 Å
the exposure time	600 sec.
the S/N ratio	1000
the threshold signal above noise level	6 σ

Table 2. Observational log.

Obs. date	Star	Remarks (1)	Obs. date	Star	Remarks (1)
2005/11/04	51 Peg	@	2006/08/08	ρ CrB	
2005/11/12	51 Peg	@	2006/08/15	51 Peg	
2005/12/02	47 UMa	@	2006/08/25	51 Peg	
2006/01/23	55 Cnc, ρ CrB		2006/08/29	51 Peg	
2006/01/26	55 Cnc		2006/09/01	51 Peg	
2006/01/27	55 Cnc	@	2006/09/08	51 Peg	@
2006/02/11	55 Cnc	@	2006/10/03	51 Peg	
2006/03/24	55 Cnc	@	2006/10/13	51 Peg	@
2006/03/31	55 Cnc	@	2007/02/03	HD49674, Pollux	@
2006/04/25	Pollux		2007/03/07	τ Boo	
2006/05/25	ρ CrB		2007/03/13	τ Boo	
2006/07/26	51 Peg		2007/04/26	Gl 581	
2006/07/27	51 Peg		2007/04/27	Gl 581	
2006/07/30	ρ CrB		2007/05/31	Gl 581	
2006/08/03	51 Peg		2007/06/01	Gl 581	
2006/08/06	51 Peg		2007/07/26	Gl 581, 51 Peg	
2006/08/07	51 Peg		2007/08/15	Gl 581, 51 Peg	@

(1) @: ordinary citizens were invited to observations under the "NHAO at site program (Sakamoto et al. 2005)"

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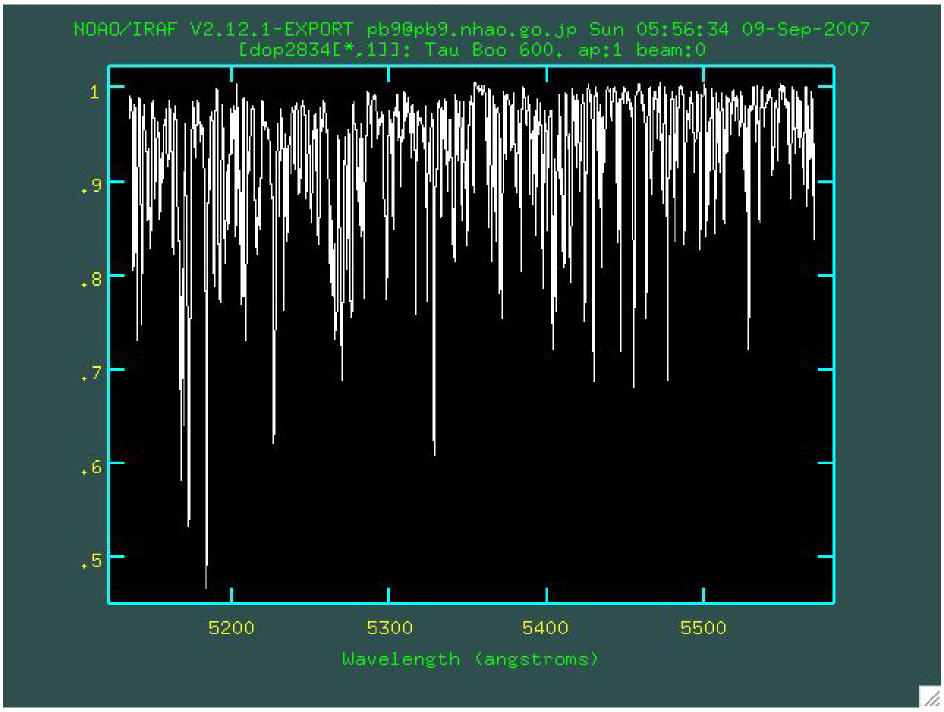

Fig. 1. One of the observational spectra of the NAYUTA/MALLS system.

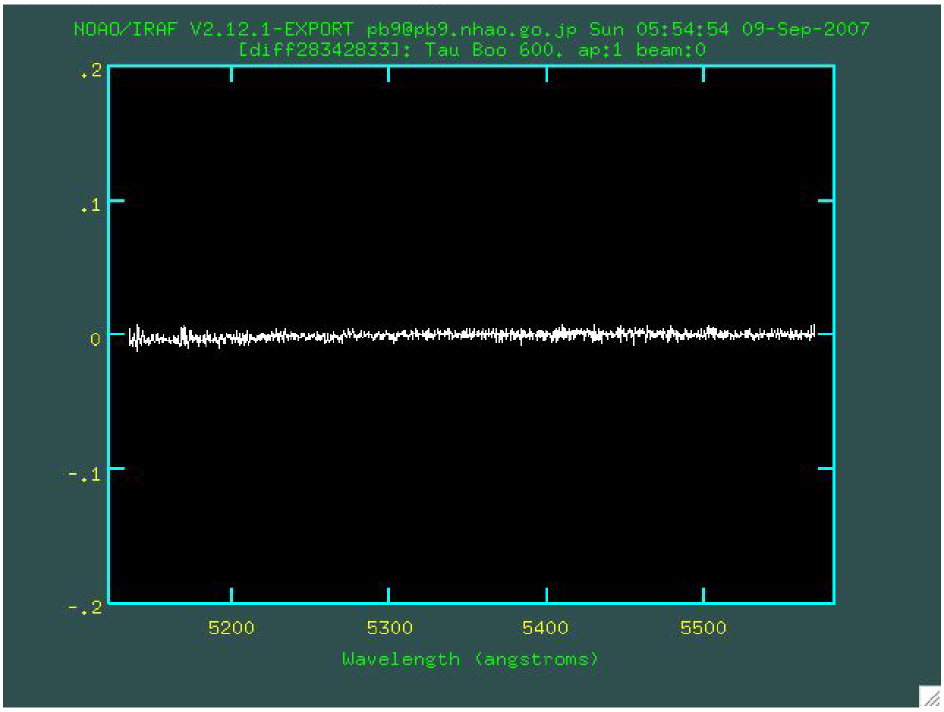

Fig. 2. One of the differential spectra.