

4th EAPS-Net workshop  
2009.10.7-9 in Jouzankei, Hokkaido

# Current status of Korean-Japanese Planet Search Program

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- Observation results
- Current results of Korean-Japanese program
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# Korean-Japanese Planet Search Program

- High dispersion spectroscopic observation
  - Precise RV monitoring
  - Stellar abundance analysis
  - Diagnostic of chromospheric activity

@Bohyunsan Optical Astronomy Observatory; BOAO (Korea)  
@Okayama Astrophysical Observatory; OAO (Japan)
- Precise RV measurements
  - Use Iodine-absorption Cell
  - Spectral modeling & least-square fit (Sato et al. 2002)
- Num. of target stars : 188 lateG-earlyK giant stars
  - The targets were divided between BOAO and OAO.

# Korean-Japanese Planet Search Program

## Our sample stars

- Number : 188 stars

- $6.2 < V_{\text{mag}} < 6.5$

- $0.6 < B - V < 1.0$

(late G - early K)

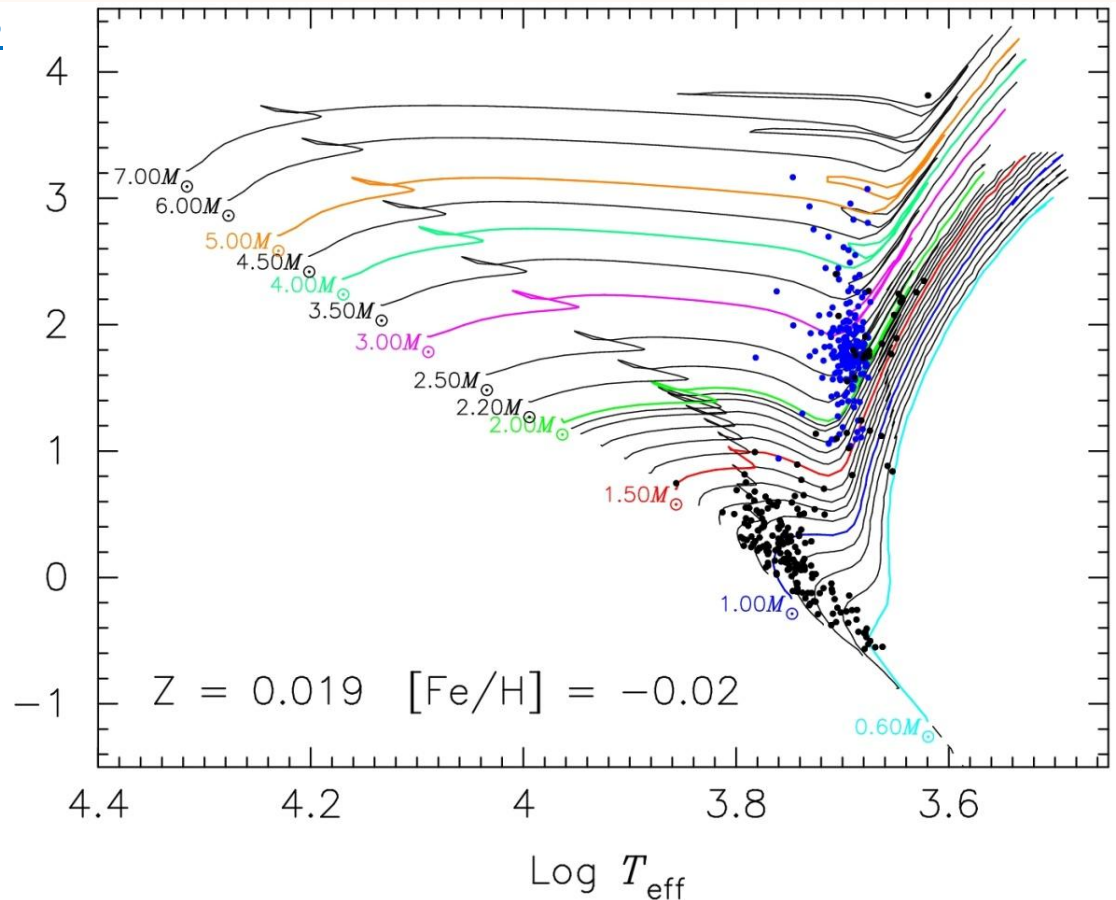
- $-3 < M_V < 2$

( $1.5 M_{\odot} < M < 5 M_{\odot}$ )

- $\delta > -25^{\circ}$

- not binary

We selected 188 stars from *Hipparcos* catalog following above criteria.



BOAO&OAO targets on HR diagram with evolutionary track (Girardi et al.2000,  $Z=0.019$ )

# Korean-Japanese Planet Search Program Observation @ BOAO & OAO



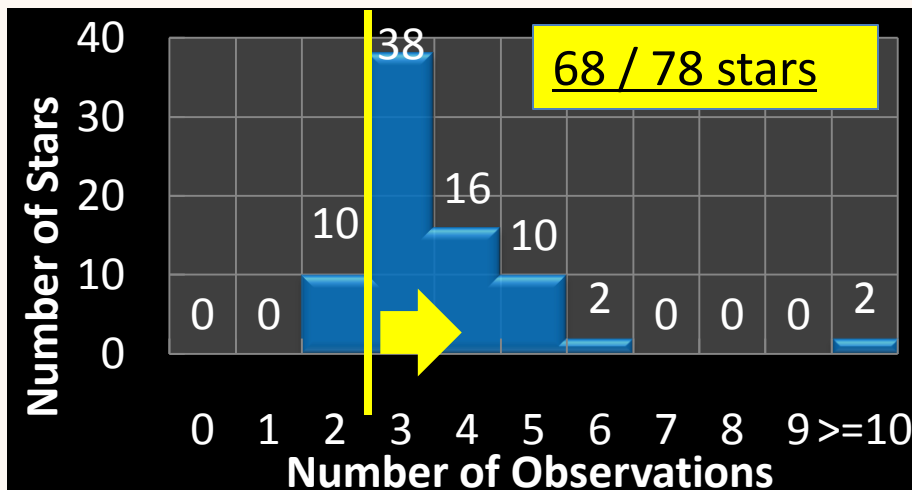
- BOES: BOhyunsan Echelle Spectrograph
    - Resolution:  $R=\lambda/\Delta\lambda\sim 50000$
    - Wavelength : 3500~10500Å
  - I<sub>2</sub>-Cell observation (RV)
    - SN : ~150/pix @ ~6.5 mag for 20 min. exposure
    - Doppler precision : ~15m s<sup>-1</sup>
    - Num. of monitoring stars : 78
  - Observation without I<sub>2</sub>-Cell
- HIDES: High Dispersion Echelle Spectrograph
    - Resolution:  $R=\lambda/\Delta\lambda\sim 65000$
    - Wavelength: 3750~7500Å
  - I<sub>2</sub>-Cell observation (RV)
    - SN : ~150/pix @ ~6.3 mag for 20 min. exposure
    - Doppler precision: ~6m s<sup>-1</sup>
    - Num. of monitoring stars : 110
  - Observation without I<sub>2</sub>-Cell

# Korean-Japanese Planet Search Program

## Observation status @ BOAO & OAO

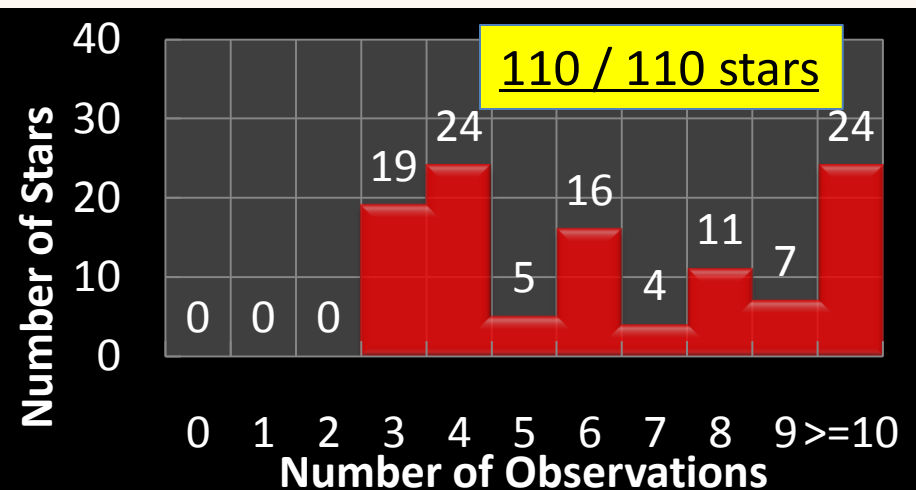
### BOAO

- Allocated nights: 56 nights
  - 2005.2-2009.6
- Success rate: about 24%
  - 18% (in the previous 1 year)
- Status of I<sub>2</sub>-Cell observations
  - see figure below
  - follow up 7 OAO targets (1~9times)



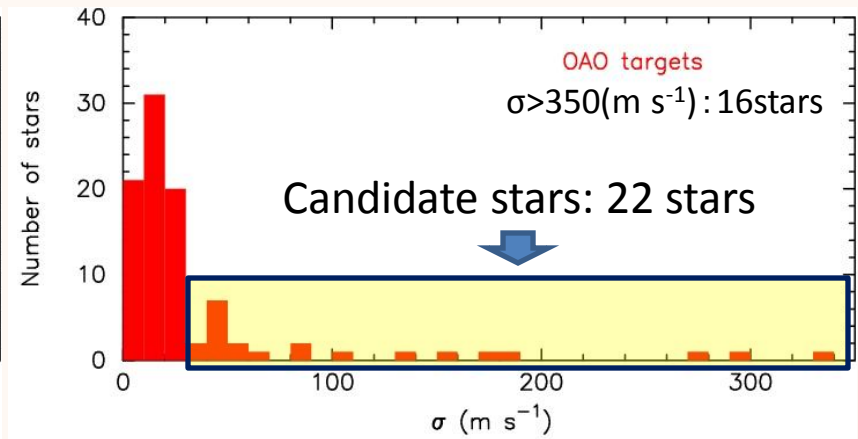
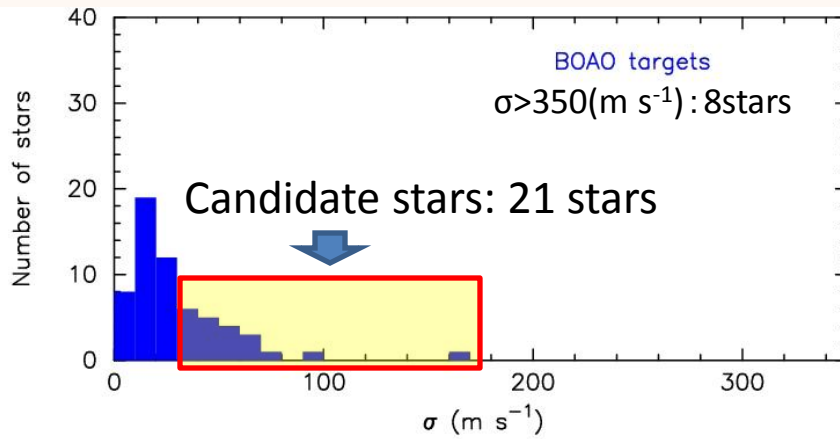
### OAO

- Allocated nights: 78 nights
  - 2005.1-2009.6
- Success rate: about 43%
  - 28% (in the previous 1 year)
- Status of I<sub>2</sub>-Cell observations
  - see figure below
  - follow up 5 BOAO targets (7~23times)



# Distributions of RV RMS scatters $\sigma$

$\sigma$ : rms scatter of RV

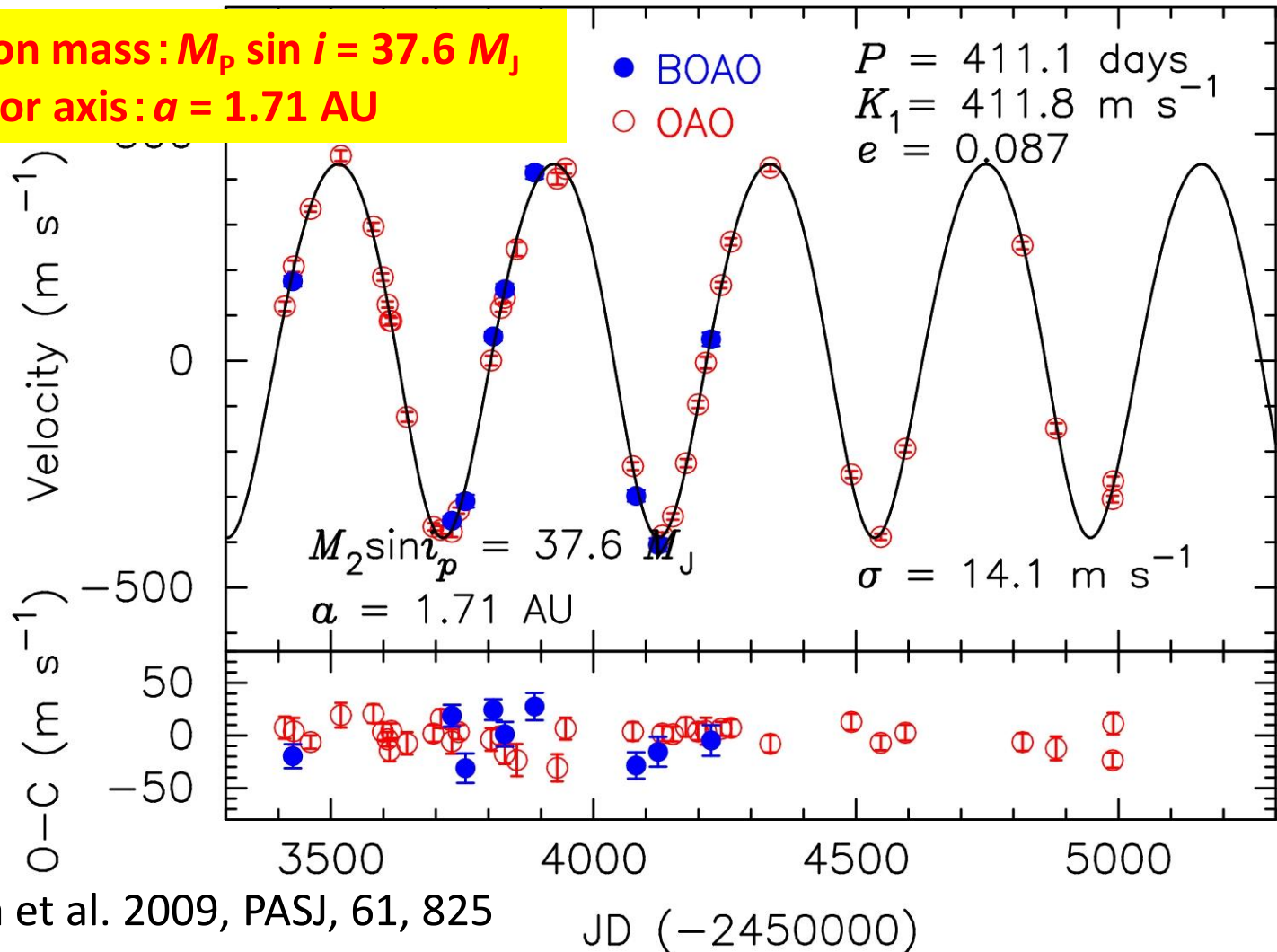


	BOAO (68stars)	OAO (110stars)
Periodic Variation	total	8 stars
<u>Planetary candidate</u>	2stars	5stars
Brown dwarf candidate	0stars	1stars

# Discovery of a brown dwarf

## HD 119445 b

Companion mass:  $M_p \sin i = 37.6 M_J$   
Semi-major axis:  $a = 1.71$  AU

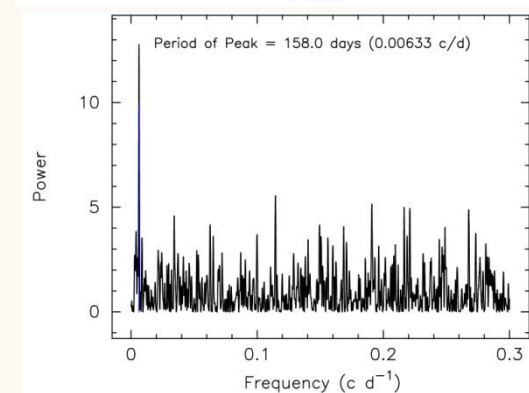
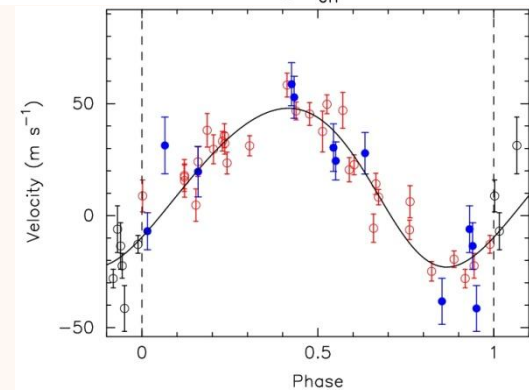
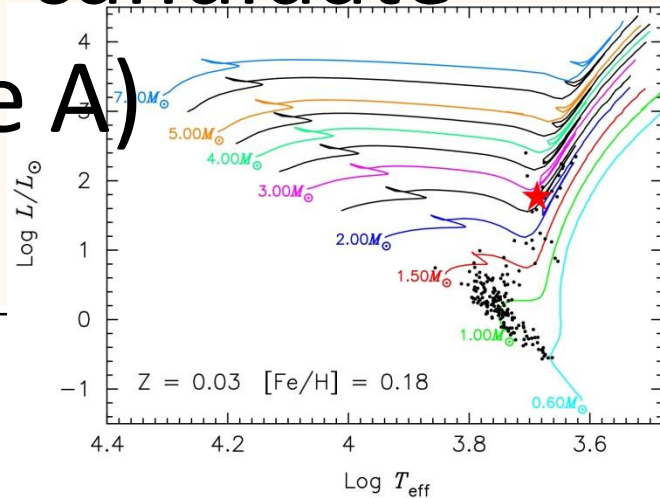
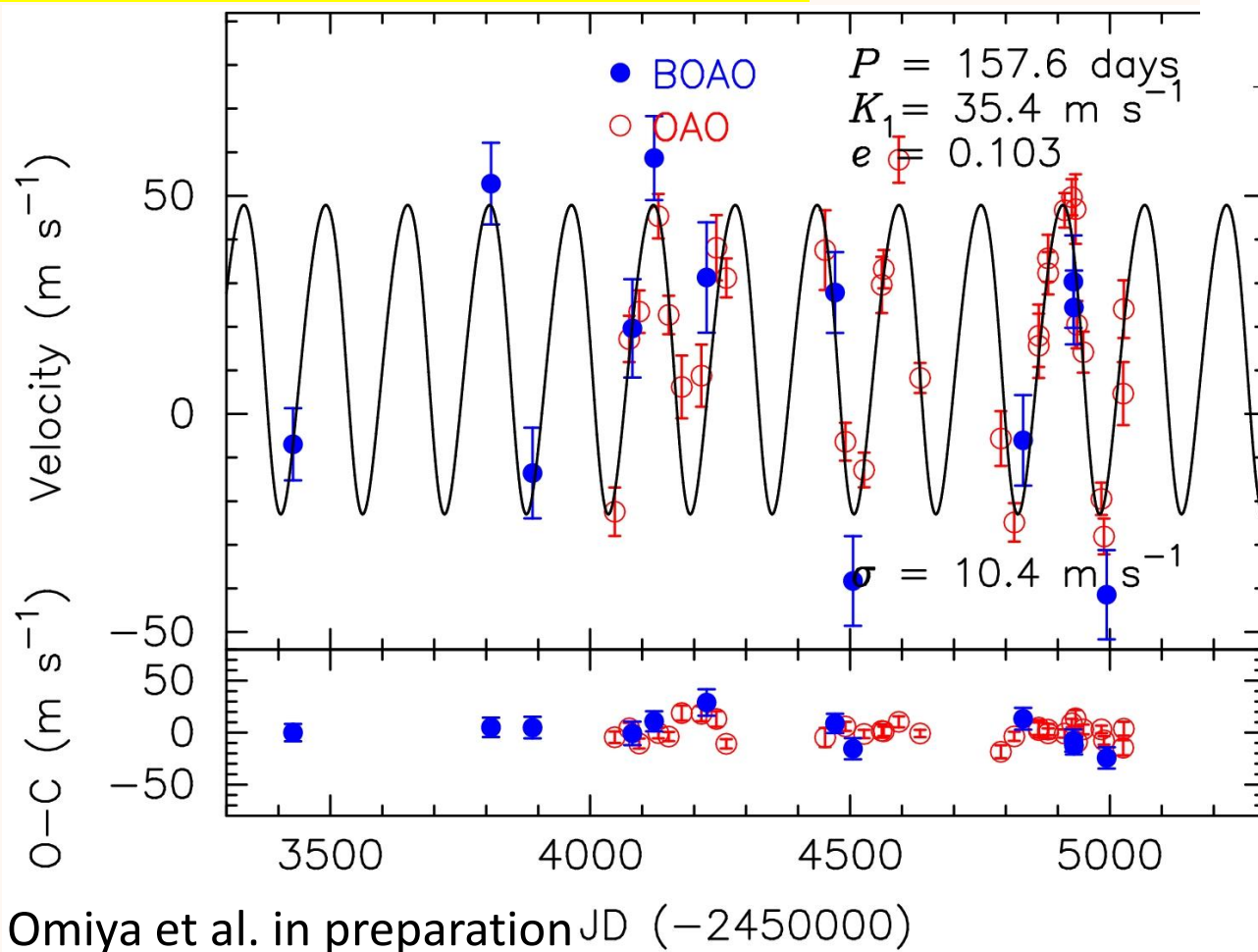


Omiya et al. 2009, PASJ, 61, 825



# Detection of a planetary candidate (Planet candidate A)

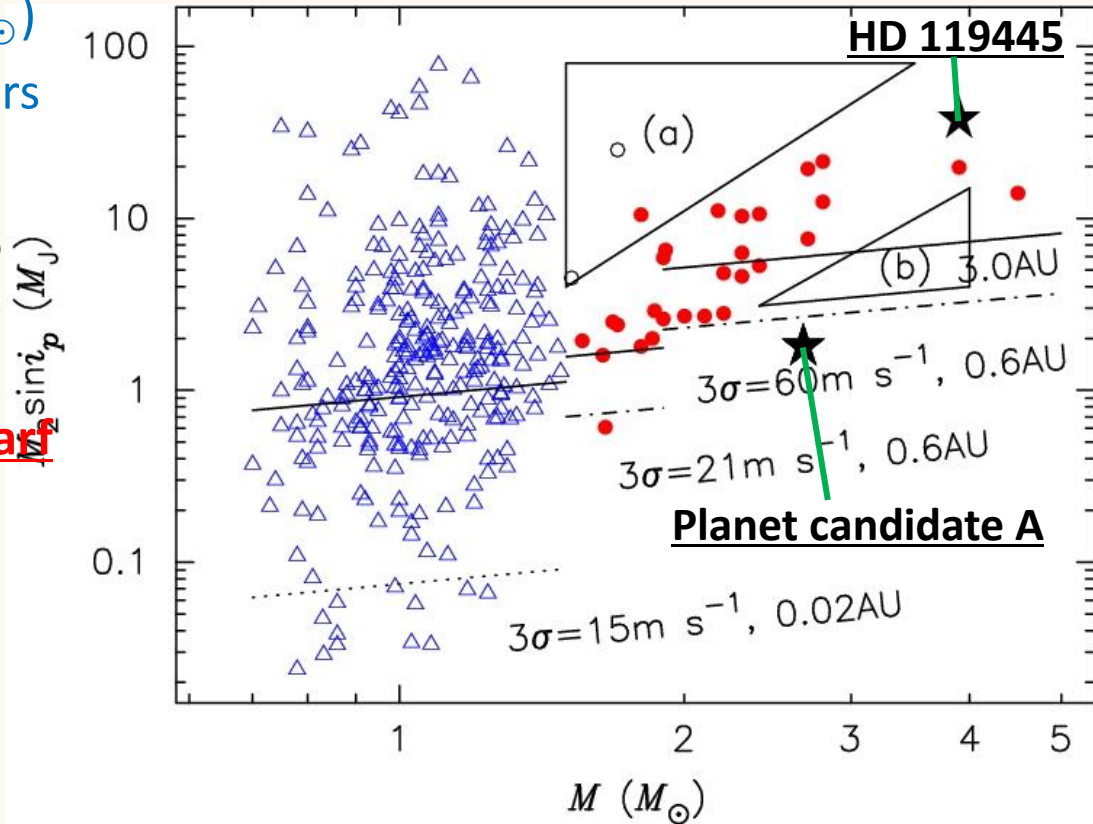
Companion mass:  $M_p \sin i = 1.8 M_J$   
Semi-major axis:  $a = 0.79 \text{ AU}$



# Properties of the systems

## Mass relation between stars and planets

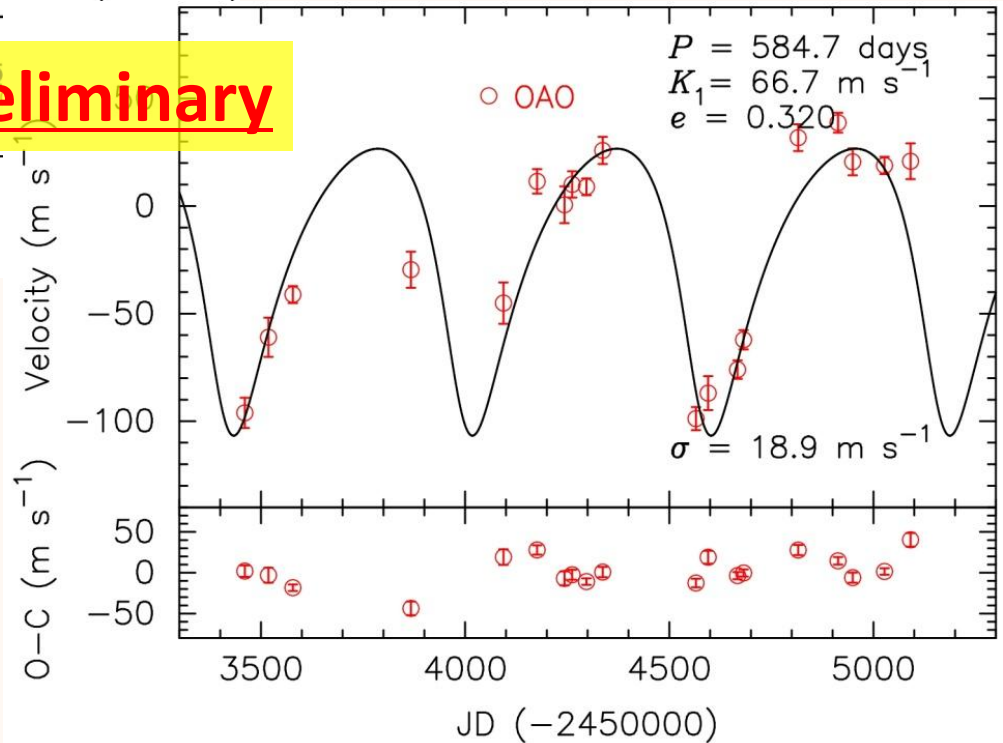
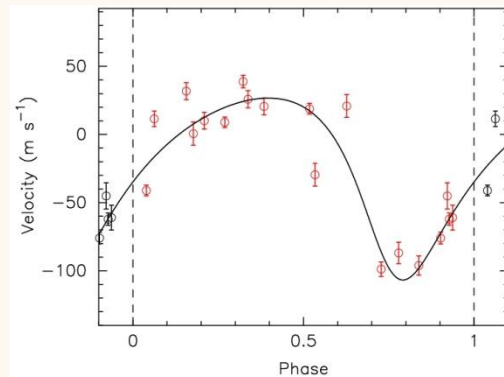
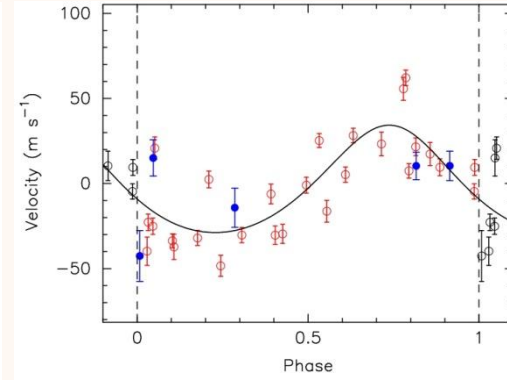
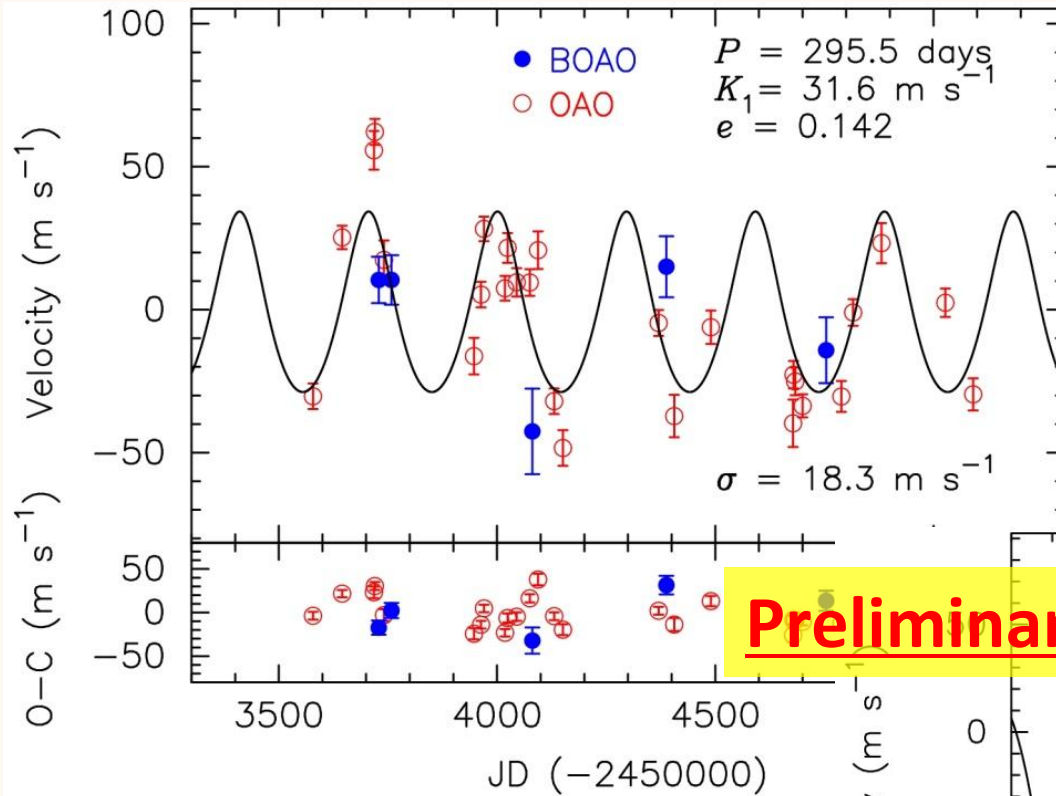
- Massive primary stars ( $> 2.6M_{\odot}$ )
  - Planets around massive stars are only a few.
- Among companions of  $>1.9M_{\odot}$  primary stars
  - HD119445b:  
**Most massive brown dwarf**
  - Planet candidate A:  
**Lowest-mass planet**



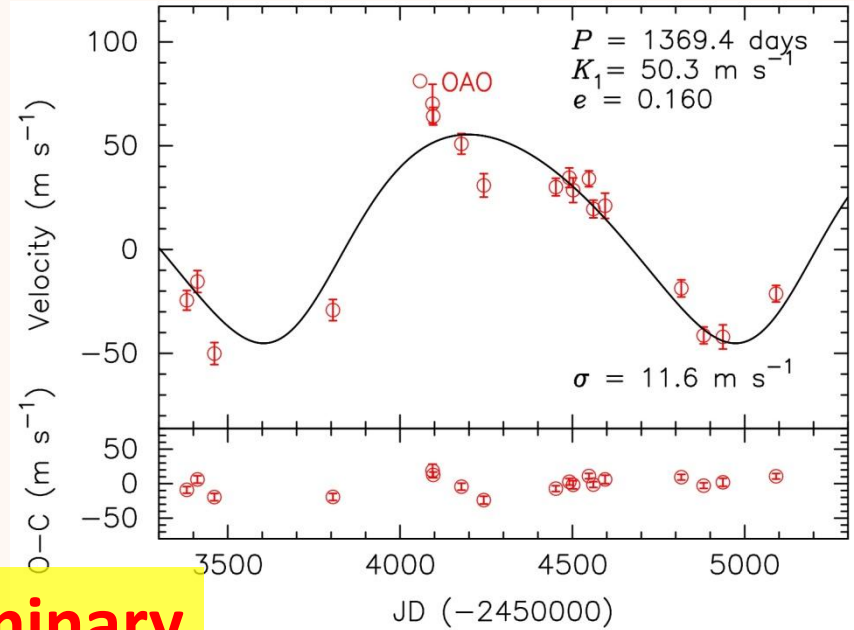
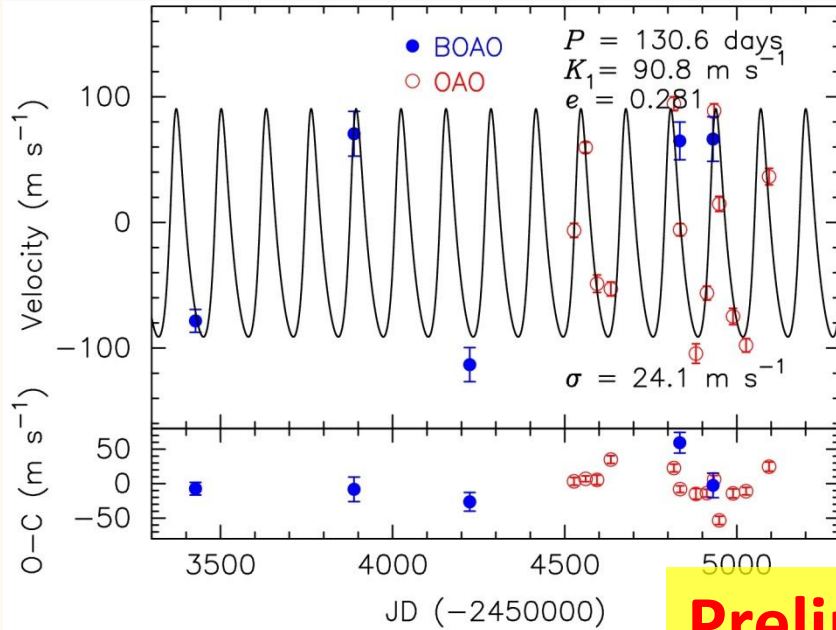
- ★ HD119445b or Planet candidate A
- Massive ( $>1.5M_{\odot}$ ) dwarf ( $a < 3 \text{ AU}$ )
- Massive ( $>1.5M_{\odot}$ ) giants ( $a < 3 \text{ AU}$ )
- △ Solar-mass stars ( $0.7 \sim 1.5M_{\odot}$ ) ( $a < 3 \text{ AU}$ )

**More massive substellar companions tend to exist around more massive stars.** (Lovis & Mayor 2007; Hekker et al. 2008)

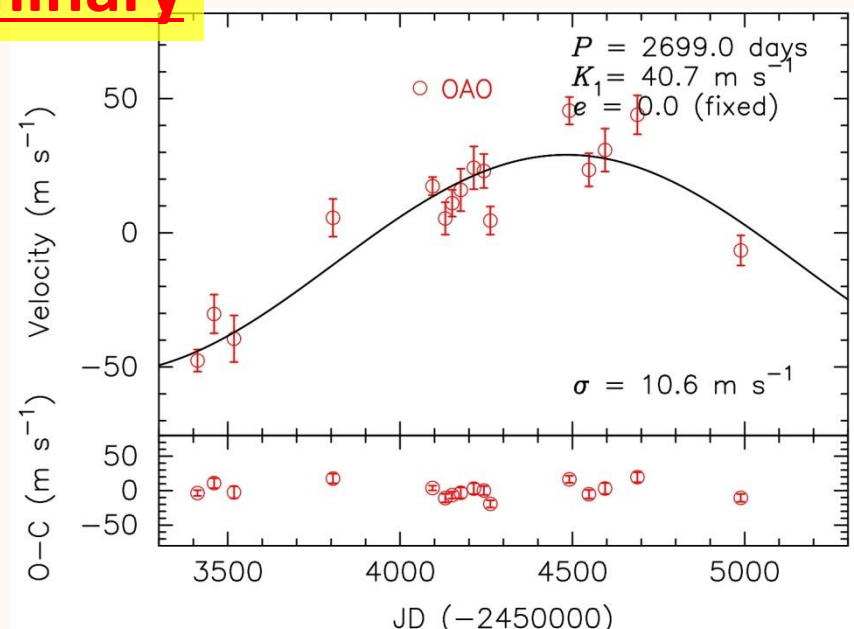
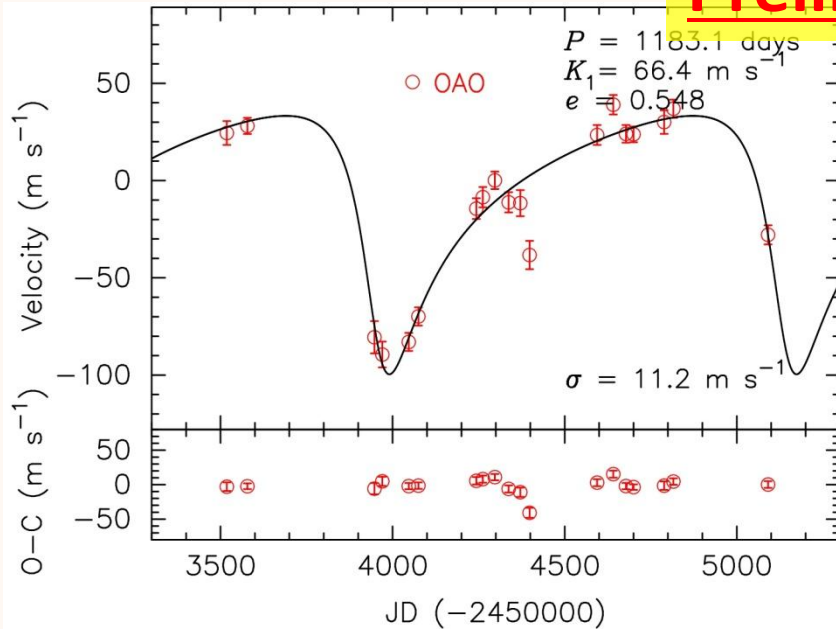
# Stars with periodic RV variation I



# Stars with periodic RV variation II



**Preliminary**

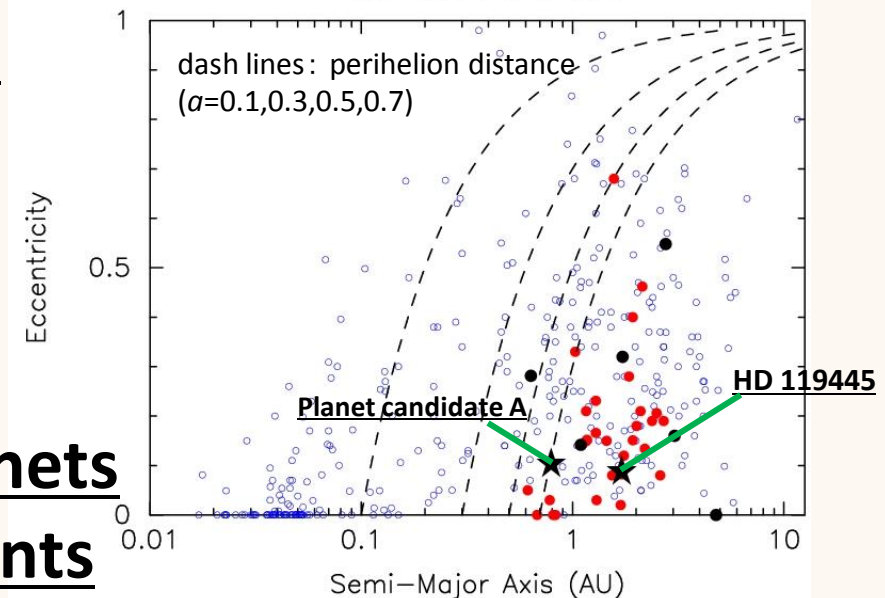
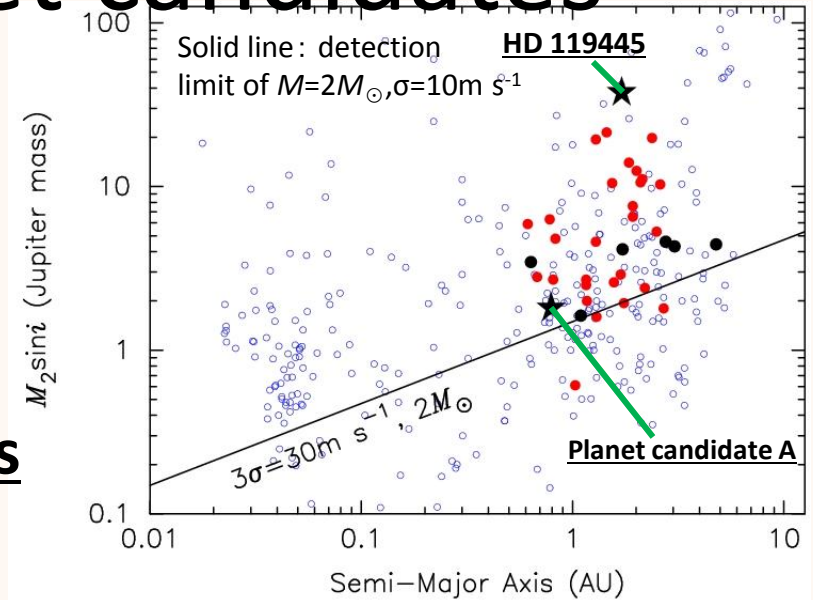


# Properties of planet candidates

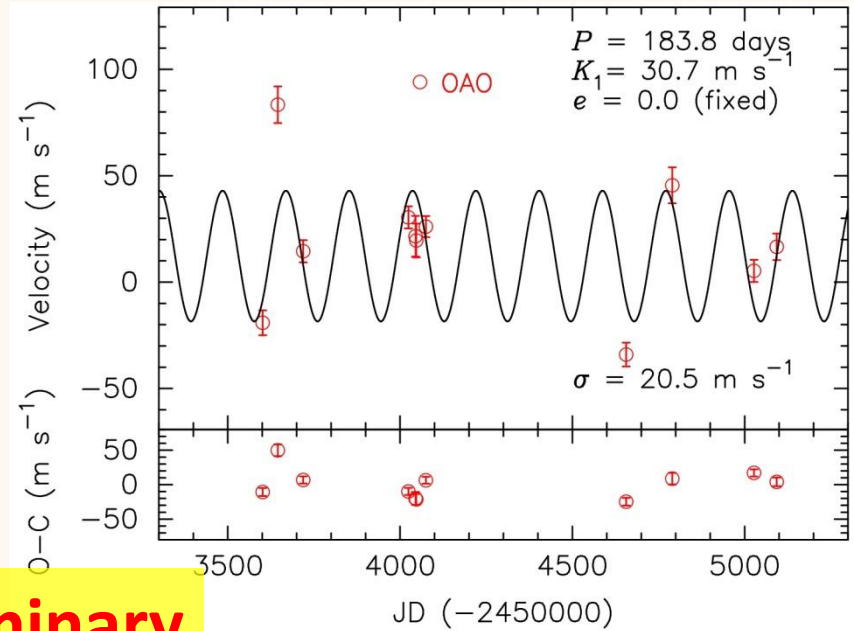
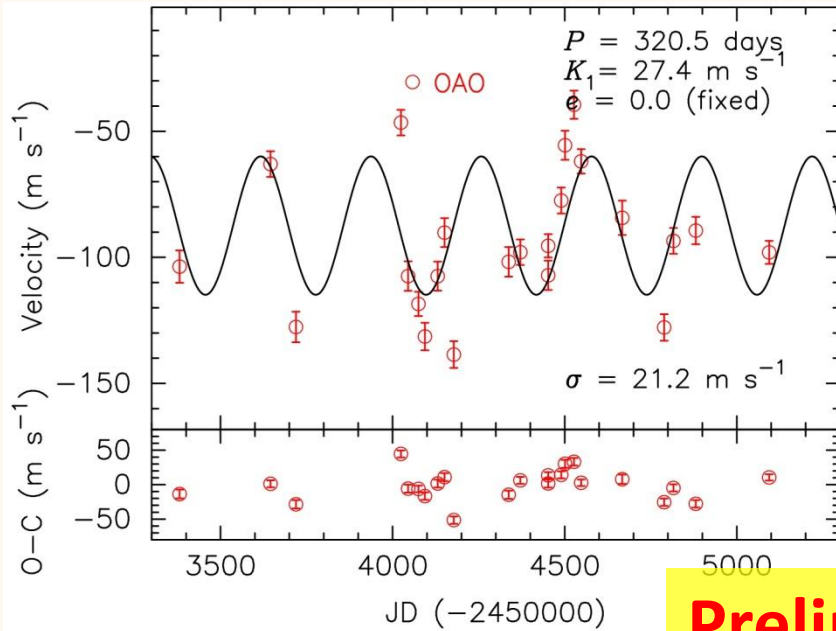
- Plot planet candidates
  - Assuming the star's mass of  $2M_{\odot}$
- Parameter ranges of planet candidates
  - Period  $P$ : **130-2700days**
  - Amplitude  $K$ : **19-100m s<sup>-1</sup>**
  - Eccentricity  $e$ : **0(fixed)-0.55**
  - Semi-Major Axis  $a$ : **0.6-5AU**
  - Mass  $M_p \sin i$ : **1.6-5M<sub>Jupiter</sub>**
    - Mass of a B.D is  $37M_{Jupiter}$

**Not so difference from the planets around intermediate-mass giants**

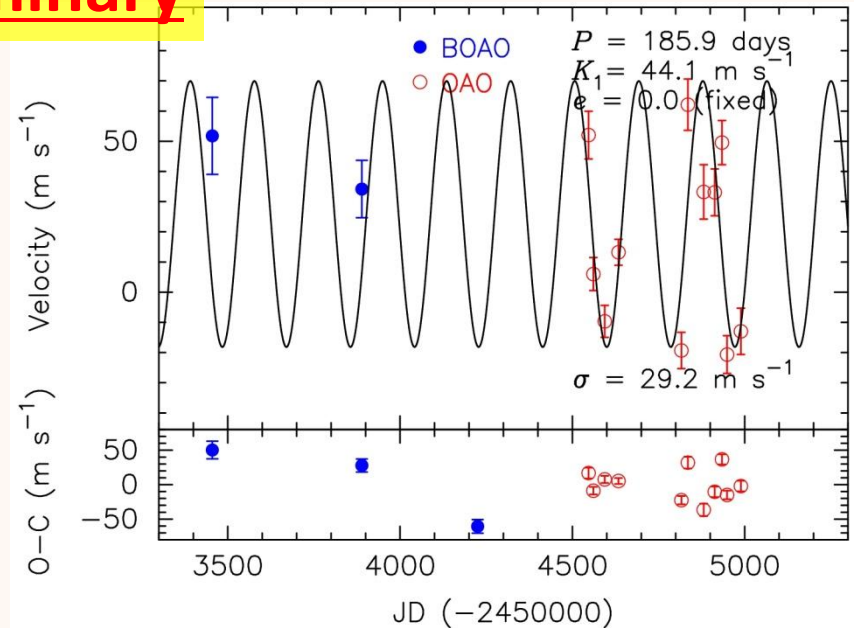
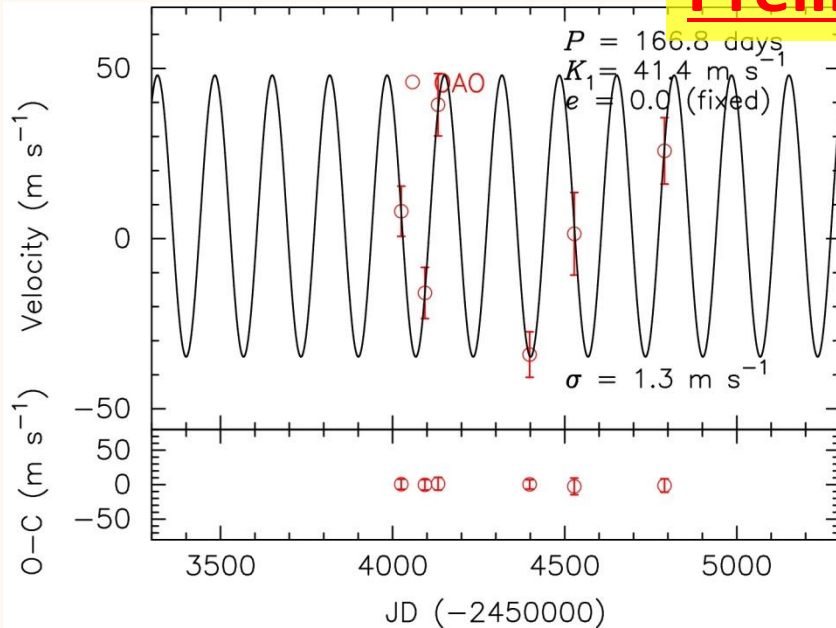
- ★ HD119445b or Planet Candidate A
- Candidate stars from our survey
- Massive(>1.5M<sub>⊙</sub>)giants
- Other



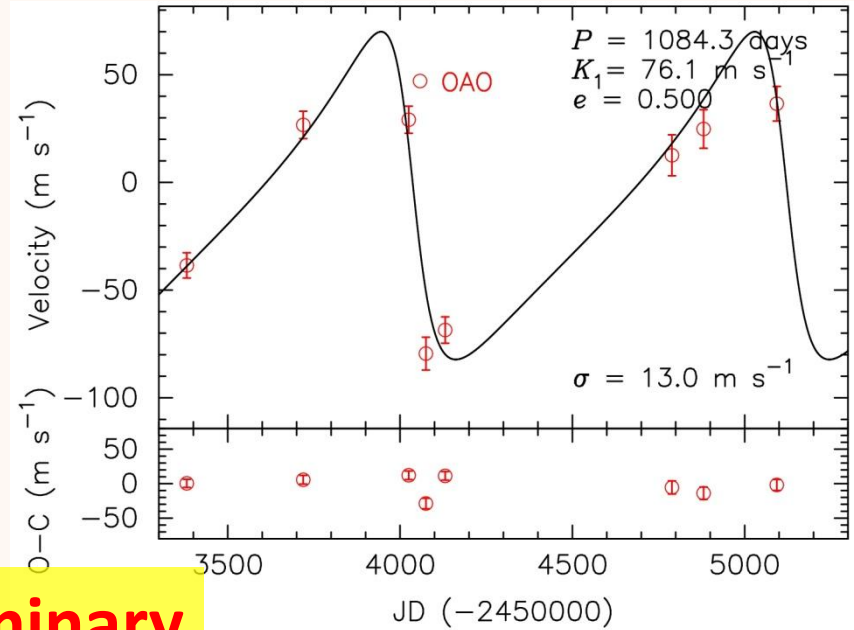
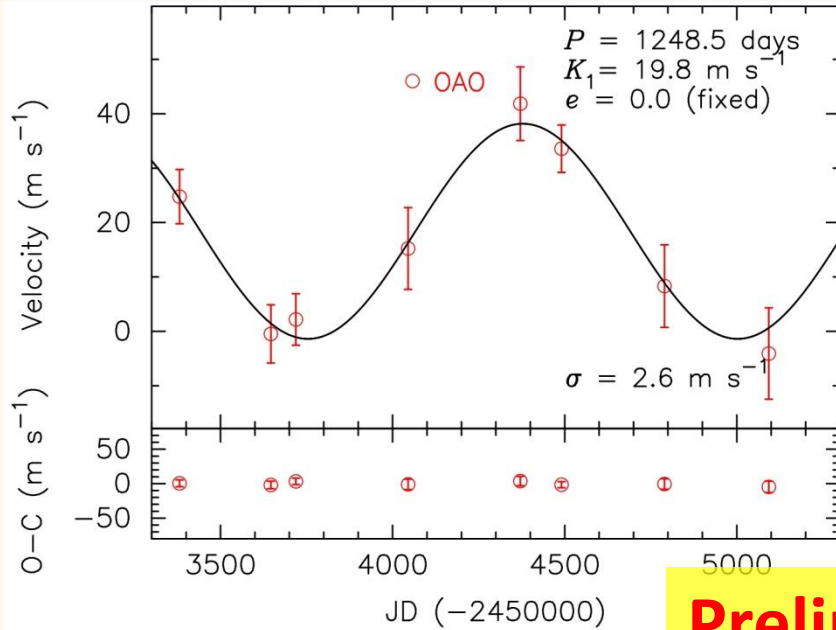
# ??? 160-320 d period planets 1 ???



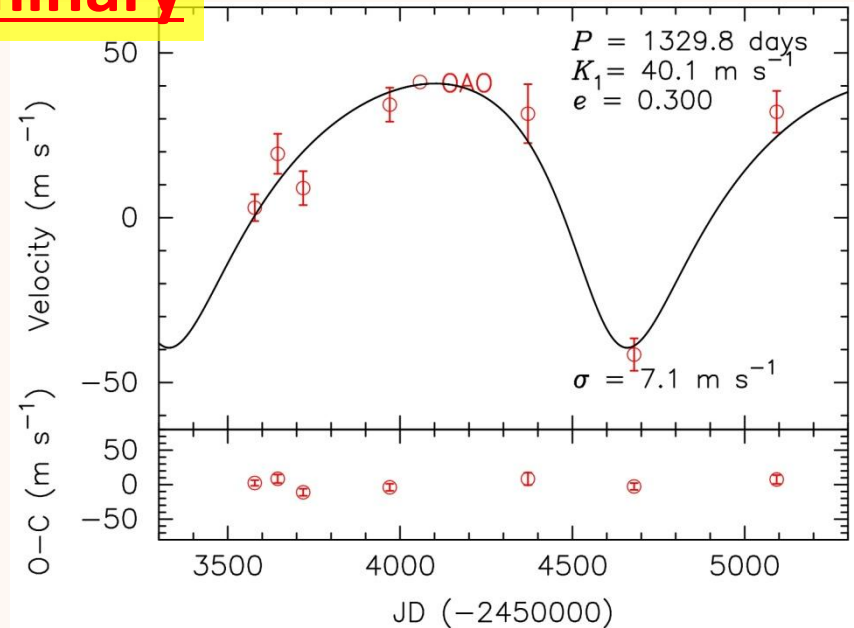
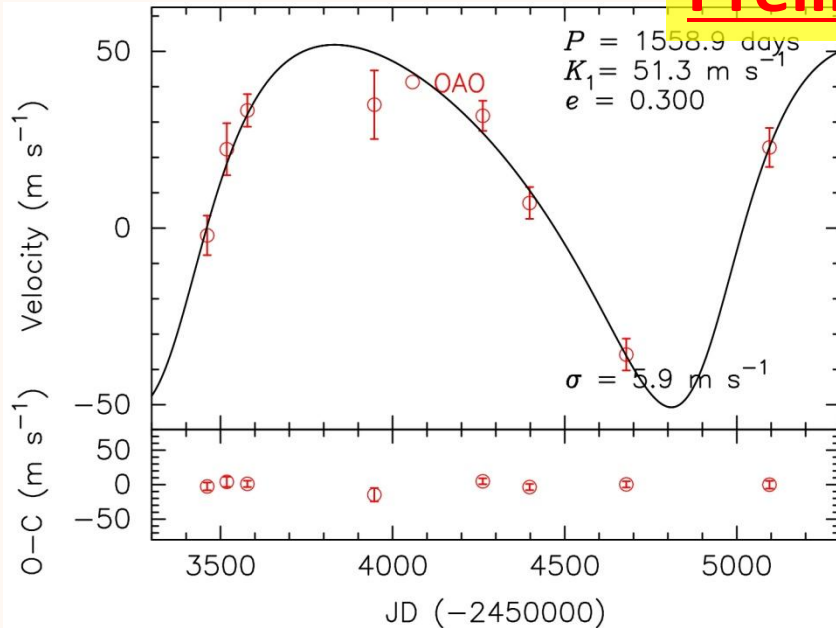
**Preliminary**



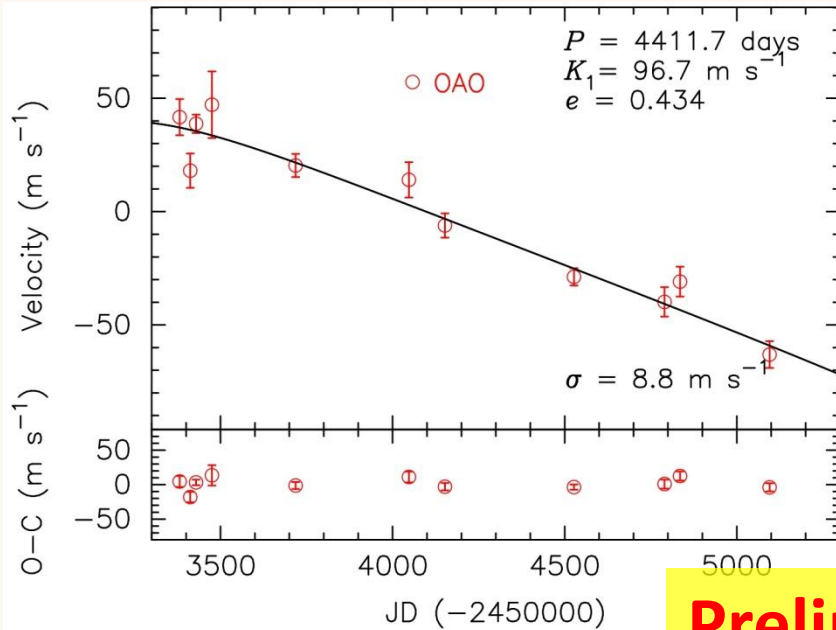
# ??? 1000-1600 d period planets 2 ???



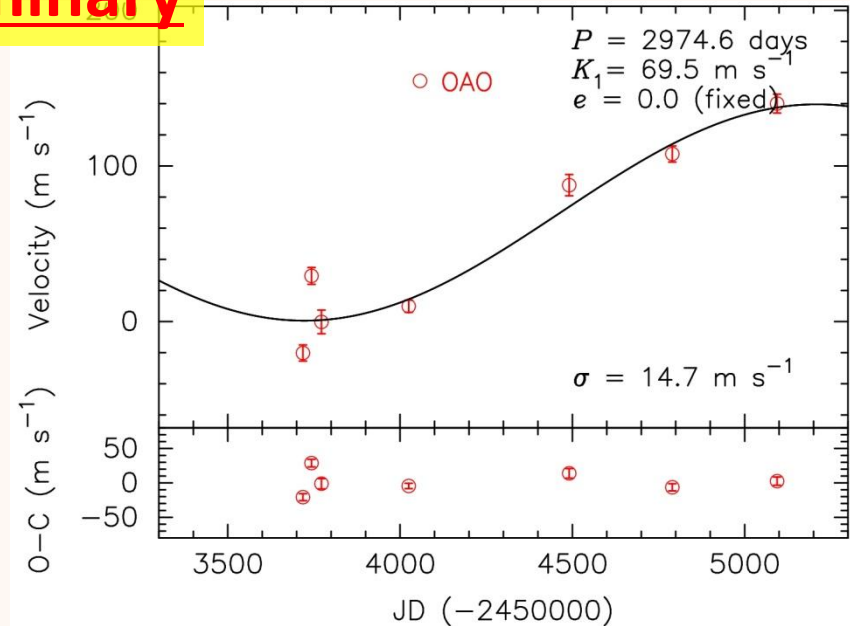
**Preliminary**



# ??? long period planets 3 ???



**Preliminary**





# Summary and Future plan

- We have carried out a Korean-Japanese Planet search program @ BOAO(Korea) and OAO(Japan).
- Korea-Japanese program for 4.5 years
  - Candidate stars ( $\sigma=30-350\text{m s}^{-1}$ ): 43stars
  - Stars with periodic RV variation: 8stars
    - Planet candidate 7, Brown dwarf candidate 1
    - Discoveries of a brown dwarf and a planet
- Next 1.5 years
  - 1, Follow-up candidate stars at both observatories
  - 2, Search for planets with long period (Period<1200days)
  - 3, Determine the parameters of target stars.