中国科学院国家天文台

NATIONAL ASTRONOMICAL OBSERVATORIES ,CHINESE ACADEMY OF SCIENCES

# Lithium abundance in K/G giants

**Yujuan LIU 劉玉娟**
National Astronomical Observatories,
Chinese Academy of Sciences

Collaborate with: Bun'ei Sato, Kefeng Tan…

2015.2.10 @ Taipei

# MOTIVATION I:

Investigation of the Li abundance as a function of metallicity, effective temperature and stellar mass in a large sample of giant is helpful to understand the chemical evolution history of the Galaxy, as well as in the study of the mixing process in stellar interiors.

# MOTIVATION II:

- **1% Li-rich G/K giants** from literatures

Standard stellar evolutionary models predict Li dilution by a factor of about 30 -60 for 1-5 solar-metallicity stars. Therefore, RGB stars are expected to show lithium abundance with 1.3-1.7 dex.

- **Find Li-rich giants**, to provide essential material for testing hypotheses about Li-enrichment.

# MOTIVATION III:

Dwarfs:

Lithium in stars with and without planet had conflicting conclusions:

- Lithium dilute more in stars with planet (Israelian et al. 2004, Chen et al. 2006)
- There is no different between PHS and non-PHS

Giants:??

- **Have not been explored for such big sample of giants**

# MOTIVATION IV:

Chemical composition is different in the thin and thick-disk stars, particularly for alpha and oxygen.

Dwarfs:

Ramirez 2012 investigate for dwarfs and sub-giants, and observe a differences.

Giants:??

With a catalog supplement of Luck 2007, can be used to explore the difference properties

# SAMPLE SELECTION

**321** targets from Okayama Planet search program, stellar parameters are taken from Takeda et al. (2008)

+

**57** targets from Xinglong Planet search program, stellar parameters are taken from Liu et al. (2010)

=

378 targets

# SPECTRA

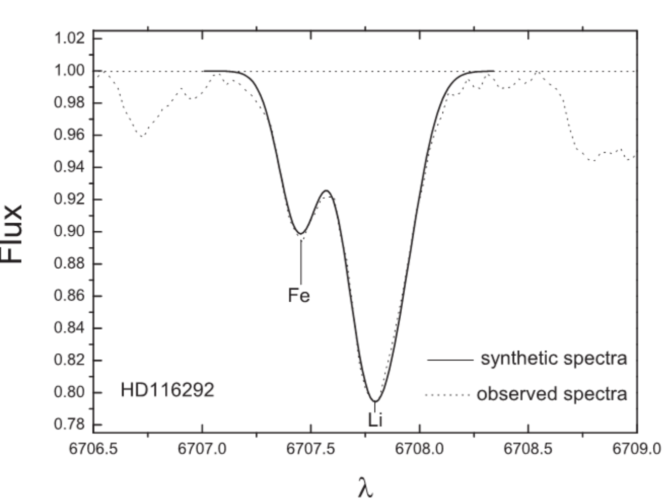
**Wavelength coverage**: 400-754 nm

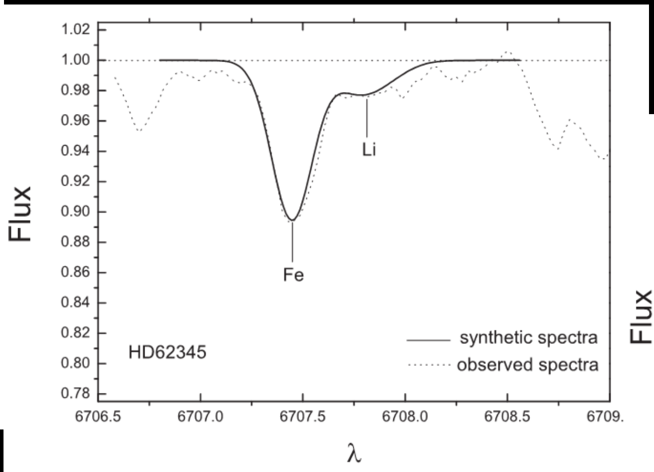
**R-67000**, **S/N>200**

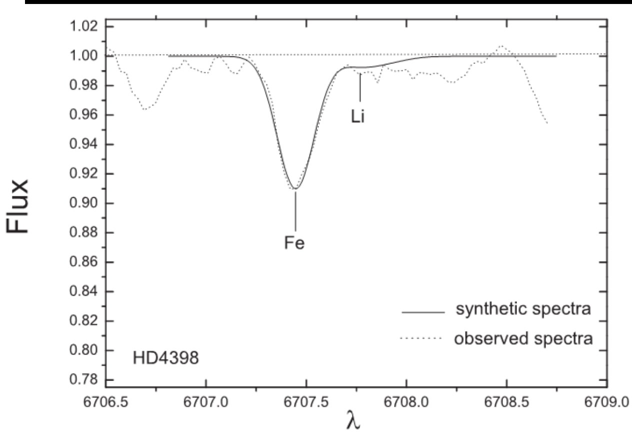
**$I_2$ superposed spectra**, the stellar spectral lines located in the region of 500-630nm were heavily blended with the absorption feature of $I_2$. The uncertainty of EW cause by $I_2$ around 670nm is estimated be 2mÅ.

# DATA REDUCTION

**Spectral synthesis** with the IDL/Fortran SIU package developed by Reetz (1998)

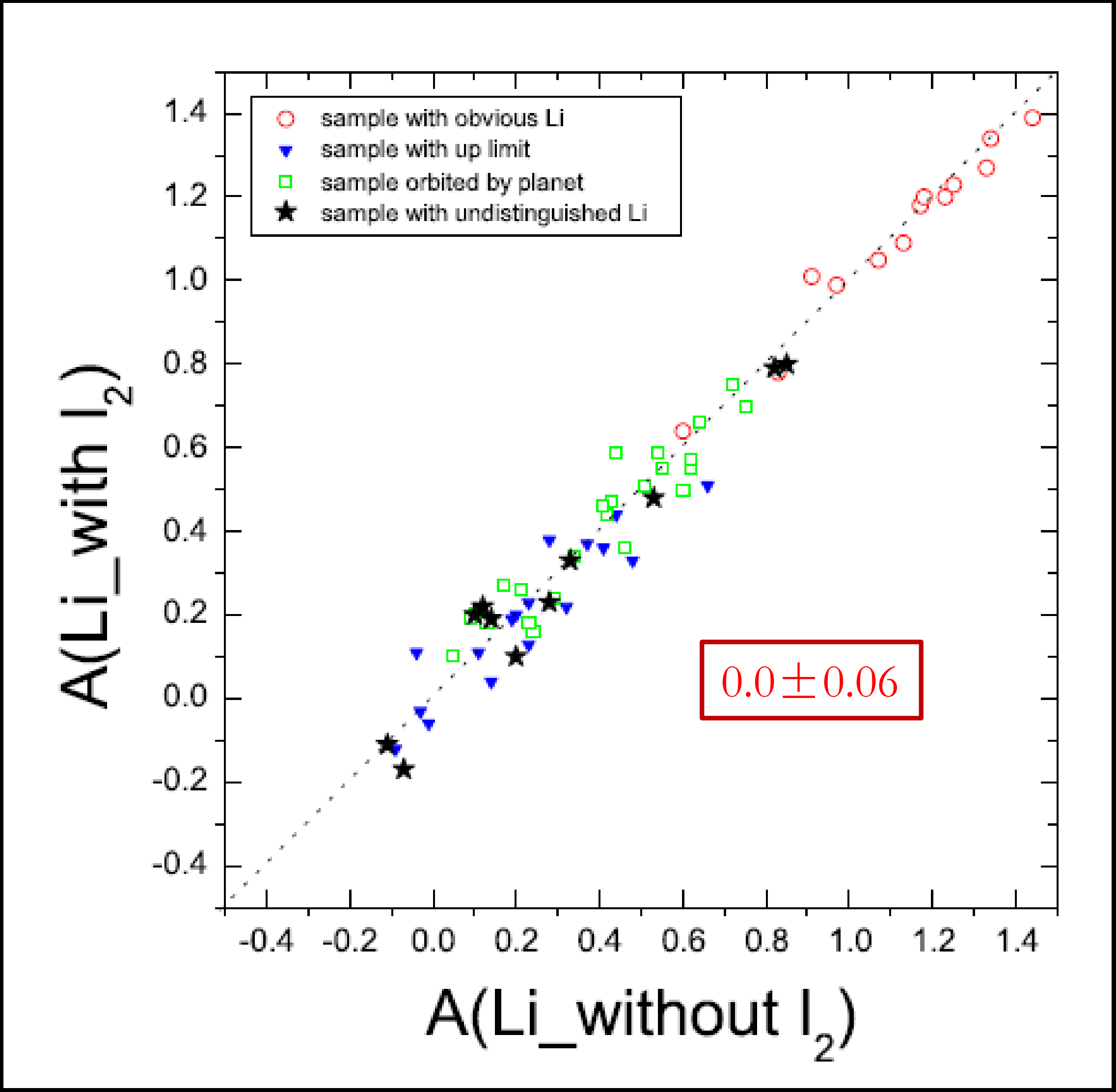



Best fits obtained between observed and synthetic spectra for three typical stars.

# LITHIUM ABUNDANCE FROM SPECTRA WITH $I_2$ AND WITHOUT $I_2$



# ERROR ANALYSIS

Systematic errors introduced by the atmospheric parameters

100k in Teff,

0.1 dex in logg, → 0.1 dex

0.2 in microtubul ence

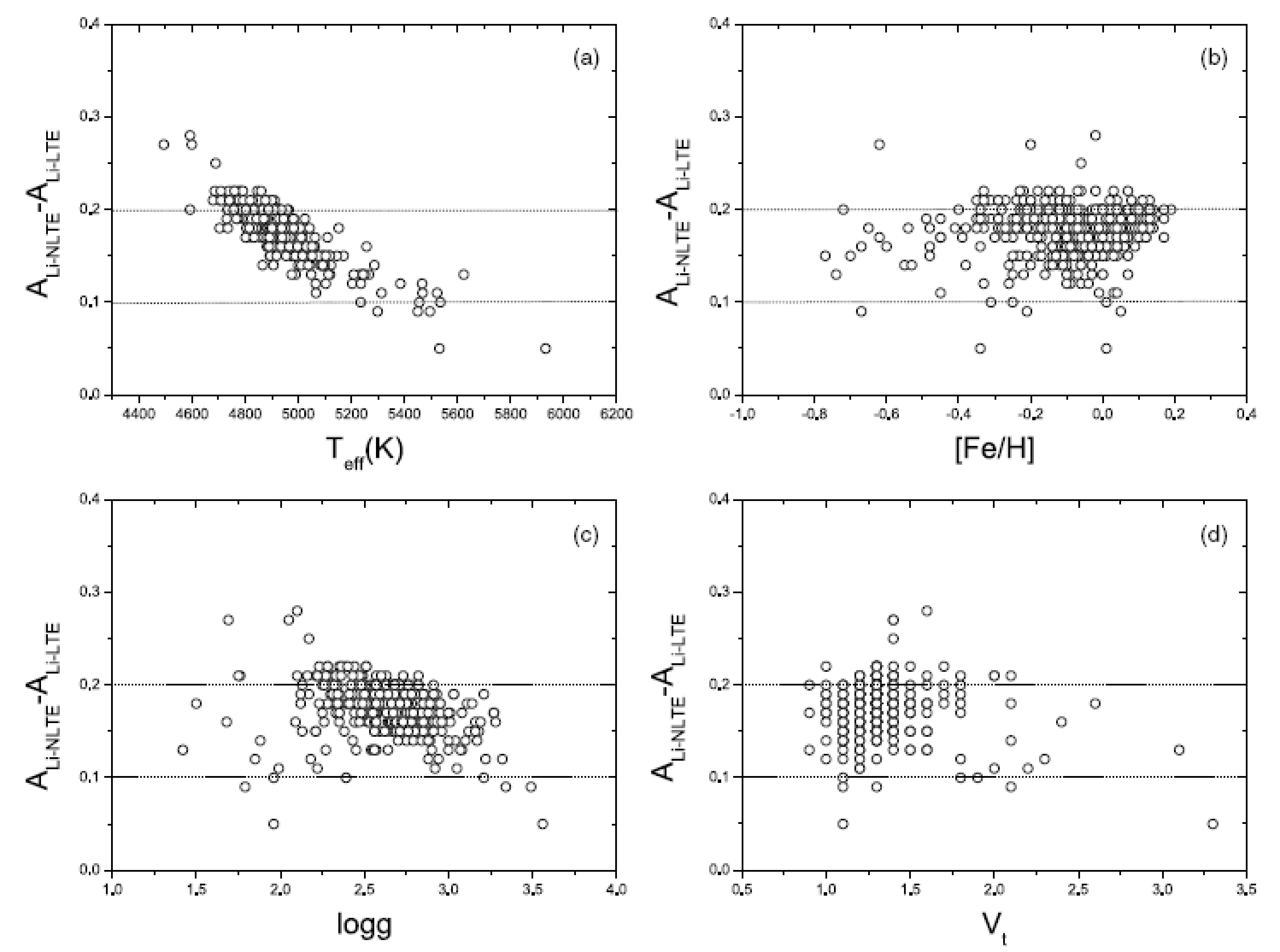
Uncertainty in the stellar continuum → 0.1 dex

↓

The overall uncertainty in A(Li) is less than 0.14 dex

# NLTE CORRECTION

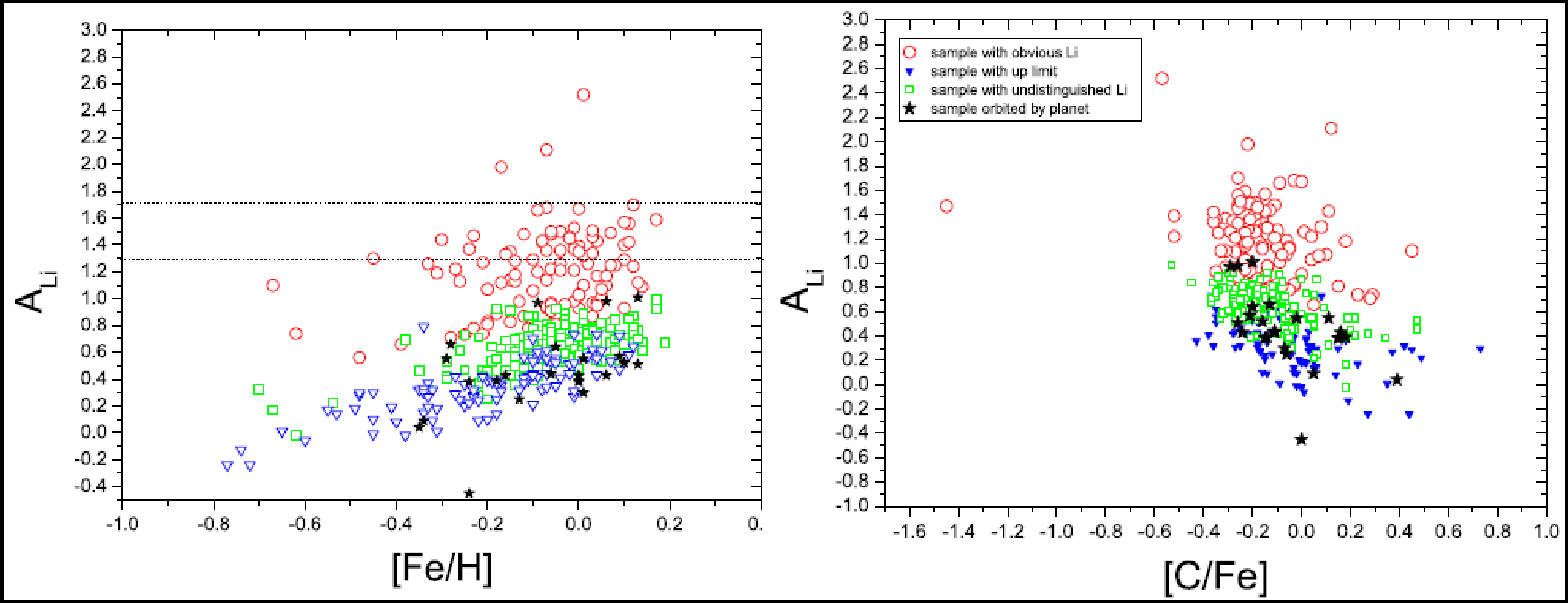
Based on interpolation code of Lind et al. 2009




NLTE correction is very sensitive to the temperature

0.05–0.28 dex, average of 0.18 dex for most sample

# LI-RICH AND LI-NORMAL STARS




Far more depleted than theoretical predicted

3 Li-rich stars

36 Li-normal stars

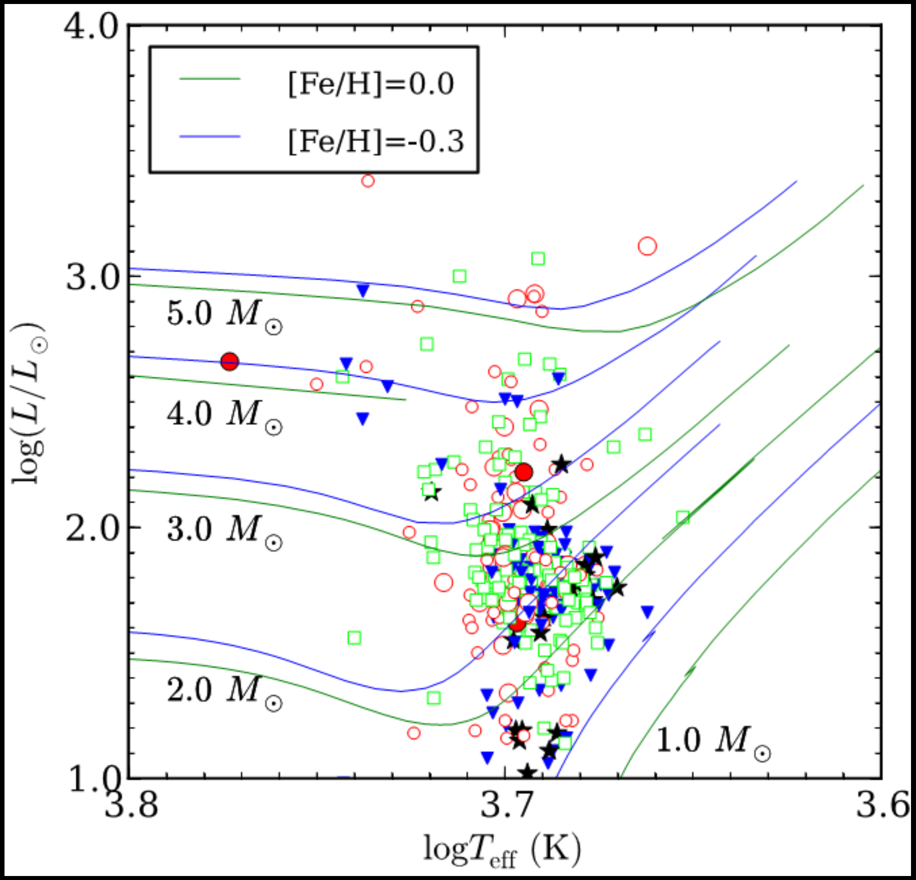
339 Li-depleted stars: may have already existed at the main sequence phase

8/23 compared with 273/355 have detected Li value, suggest Li is easy to deplete in PHS.

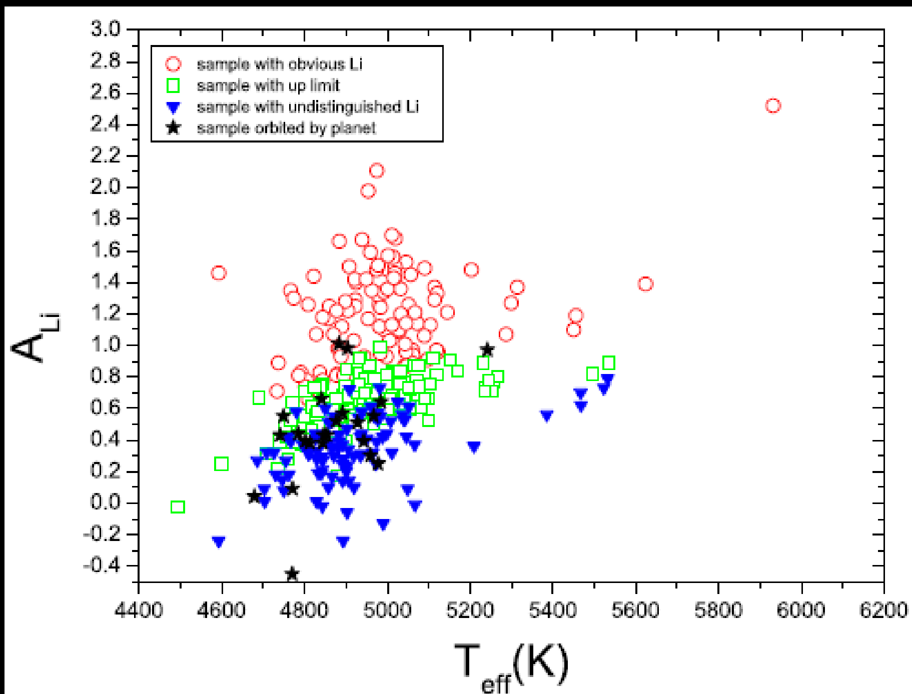
# LI-RICH AND LI-NORMAL STARS

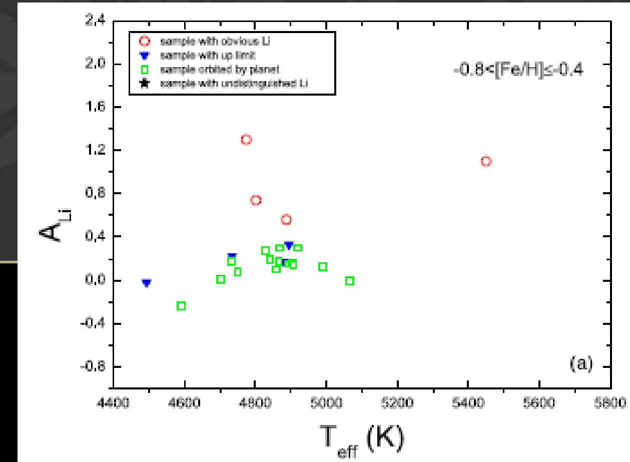
HD65228 just began to develop a Convective envelope.

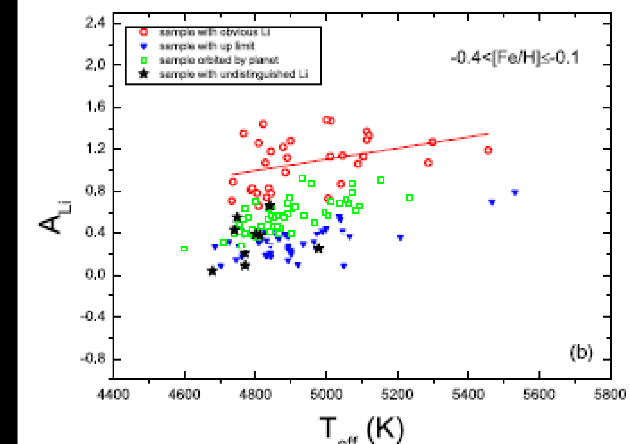
For the other two li-rich giants, the most reasonable explanation is that they have undergone a Li-production period.

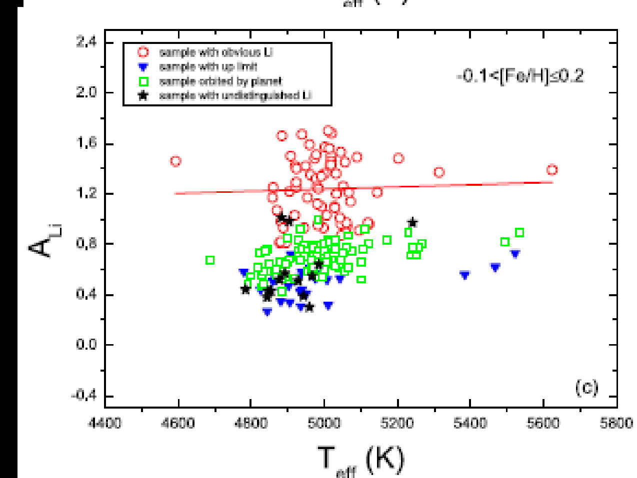


# A(LI) VS. EFFECTIVE TEMPERATURE



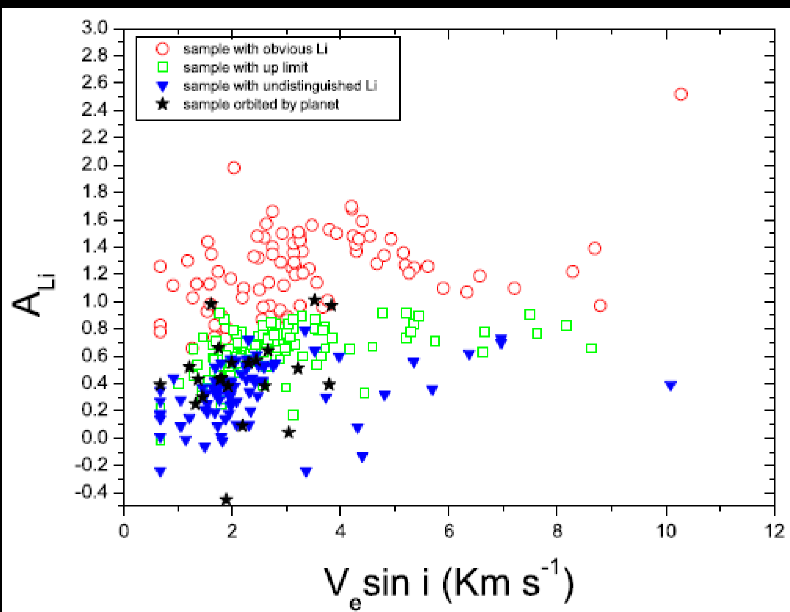



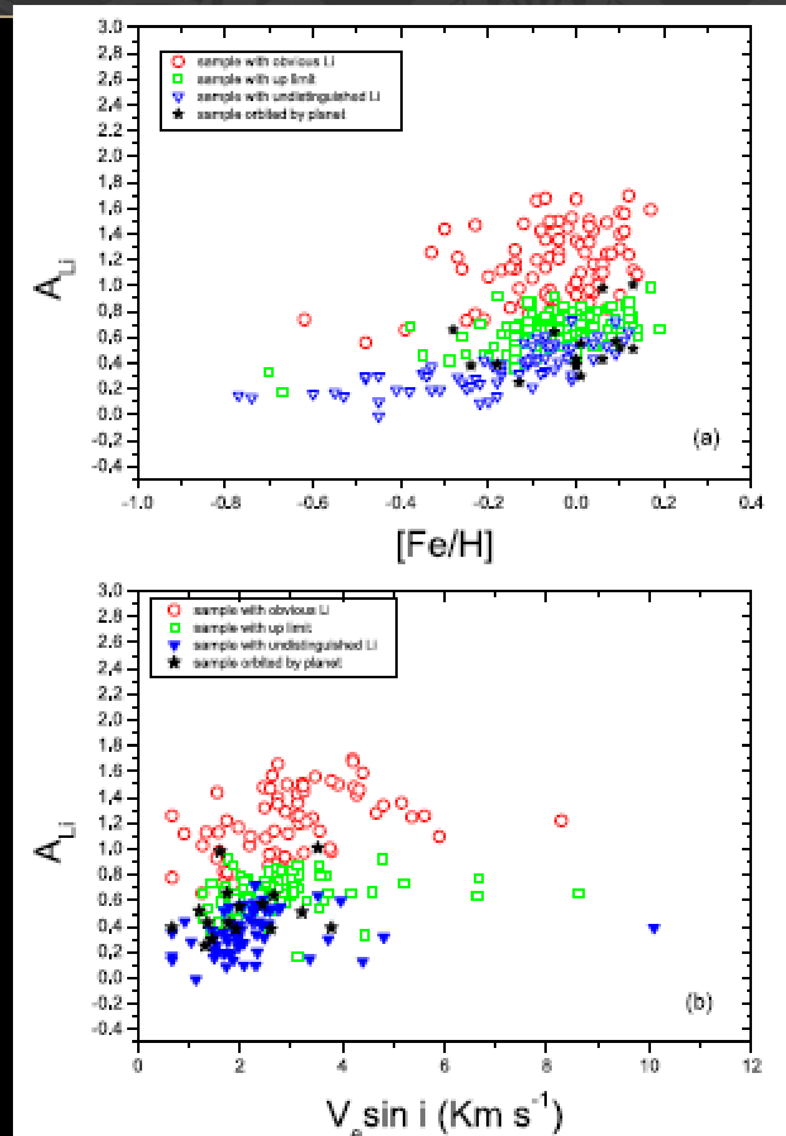




- Detecting limit increase with increasing Teff
- 4800-5100K: there is no clear relationship
- >5100K: Ali increase with increasing Teff

# A(LI) VS. ROTATIONAL VELOCITY



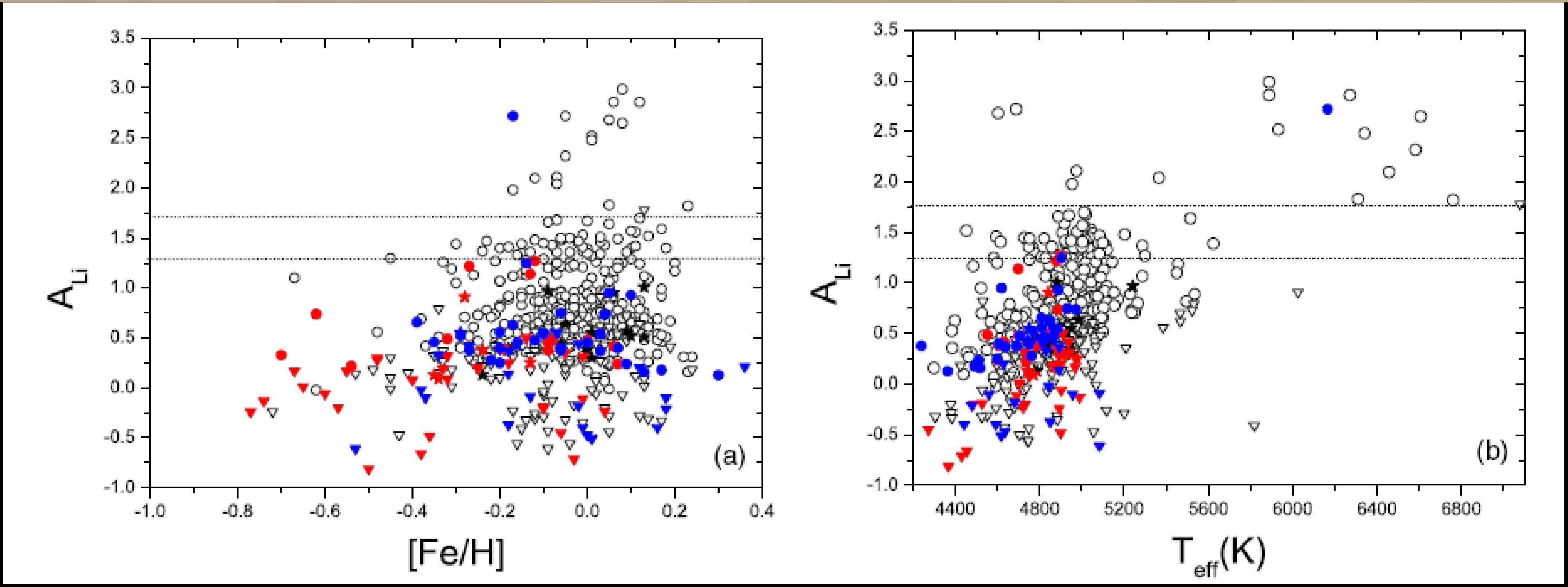




<10km/s: no trend

All PHS < 4.0 km/s

# THIN/THICK DISK DIFFERENCE

+ 187stars from Luck & Heiter 2007= 565 red giants




Lithium abundances are lower in thick-disk stars than those in thin disk stars. **Li is more depleted in thick-disk**, since they are more older.

**No notable difference between SWPs in thin- and thick-disk.**

# CONCLUSIONS

**The Li deplete far excess** compared with theoretical prediction, suggesting Li deficiency may have already existed at the main sequence stage. Less than 1% of giant are Li-rich.

**For SWP, Li is easy to deplete**. All SWP have a slow rotational velocity due to lower rotational velocity showing a suitable pattern to detect planet by radial velocity method.

For **stars within 4800-5100K, there is no clear relationship of Li and $T_{eff}$.**

Lithium abundances are lower in thick-disk stars than those in thin disk stars. **Li is more depleted in thick-disk**, since they are more older. **No notable difference between SWPs in thin- and thick-disk.**