LOW-METALLICITY PULSATING STARS IN THE LAMOST DR1

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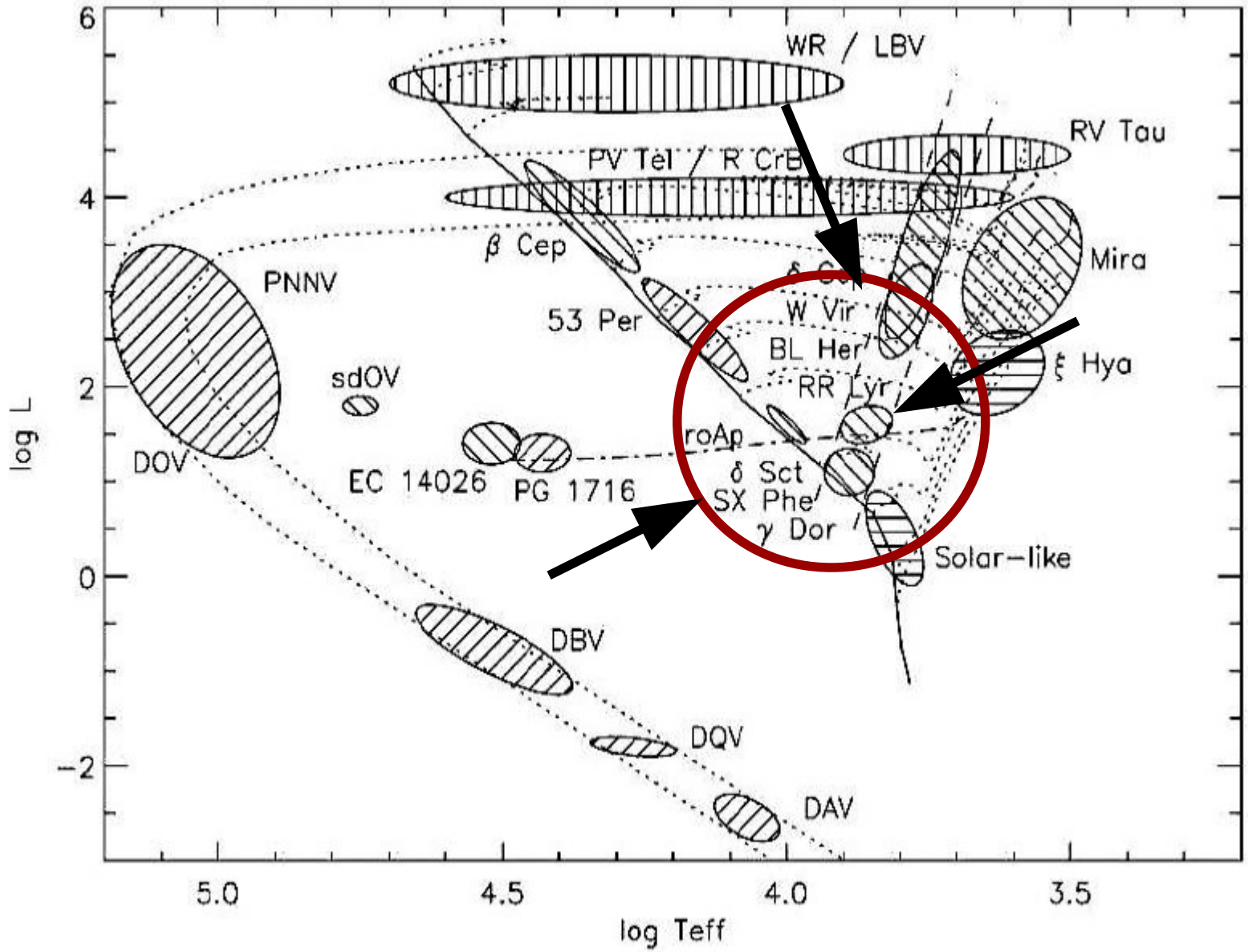
Aim

Finding new low-metallicity pulsating stars in the LAMOST DR1 and uncovering their pulsation and atmospheric parameters.

WHY ?

They protect detailed information about the place where they were born. Alow us to understand evolution of the Galaxy, formation of stars

Low-metallicity pulsating stars

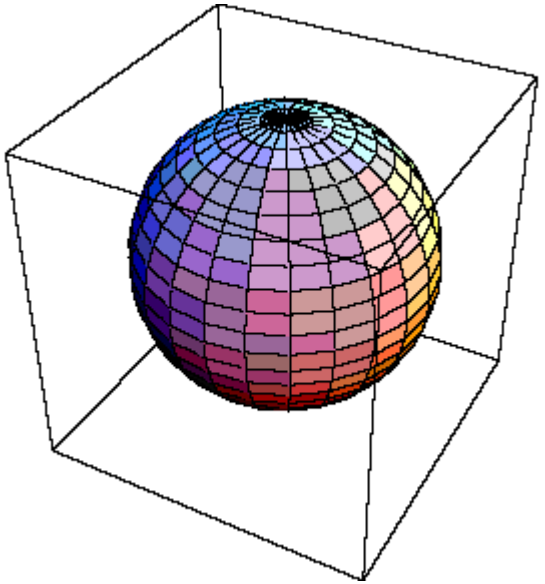


(taken from Jeffery (2008))

Low-metallicity pulsating stars

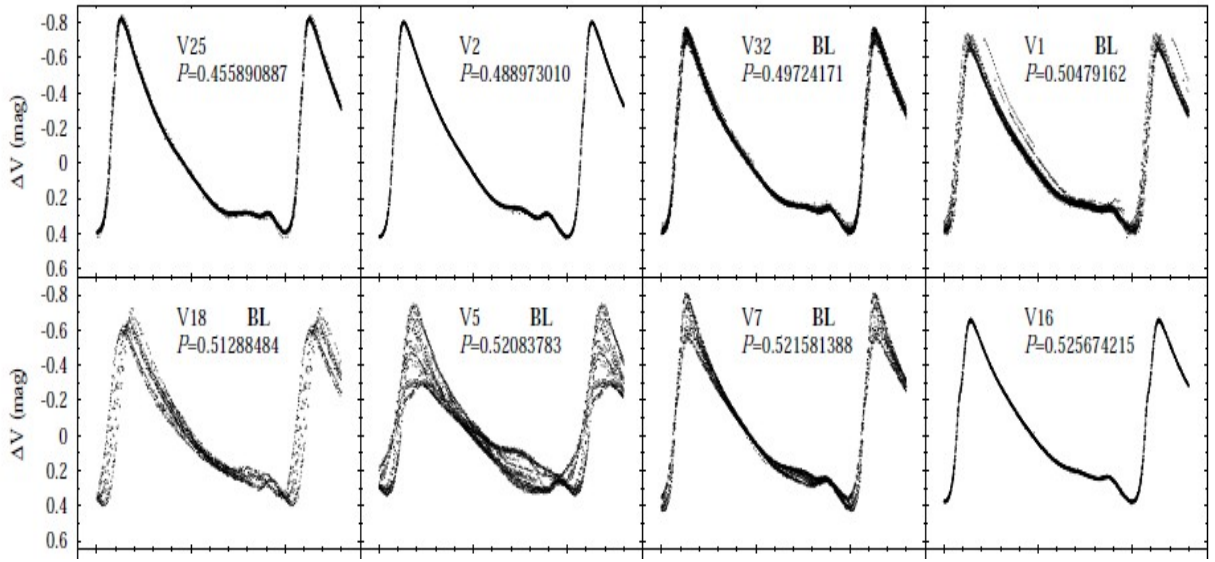
RR Lyare stars:

- Classical radial pulsator, Pulsation period = ~0.5 days
- Exication mechanism, HeII, HeIII ionization zone
- Mass => ~0.6 – 0.8 M_{sun}
- Horizontal bracnh stars
- T_{eff} => 6100 – 7400 K

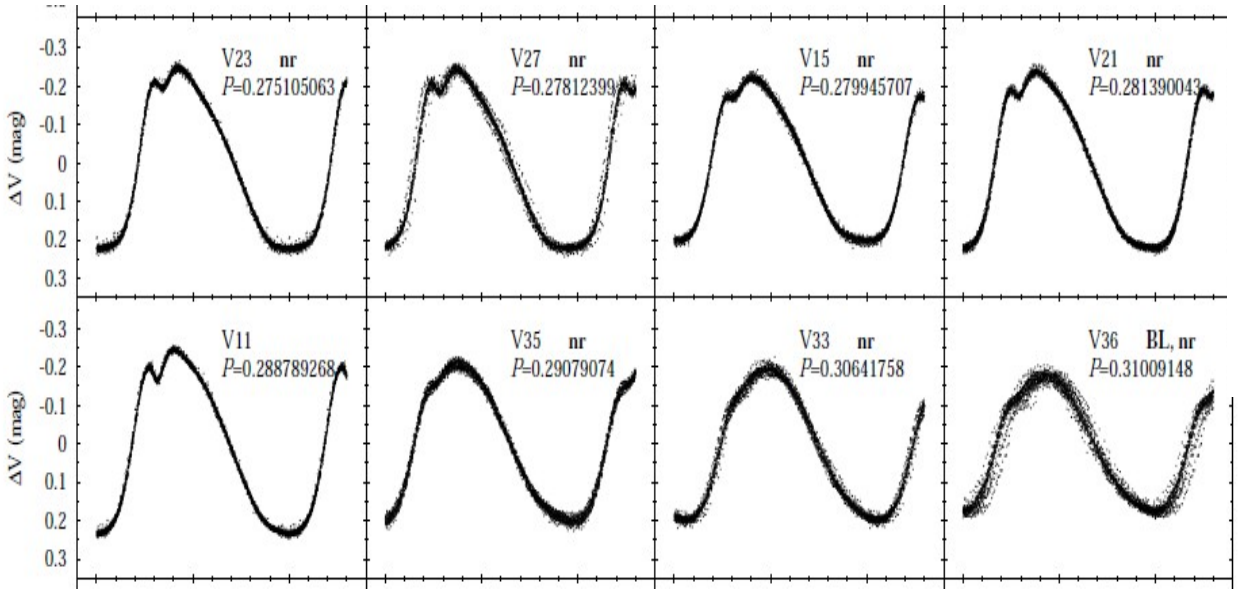


(Taken from http://www.physics.usyd.edu.au/~bedding/animations/visual.html)

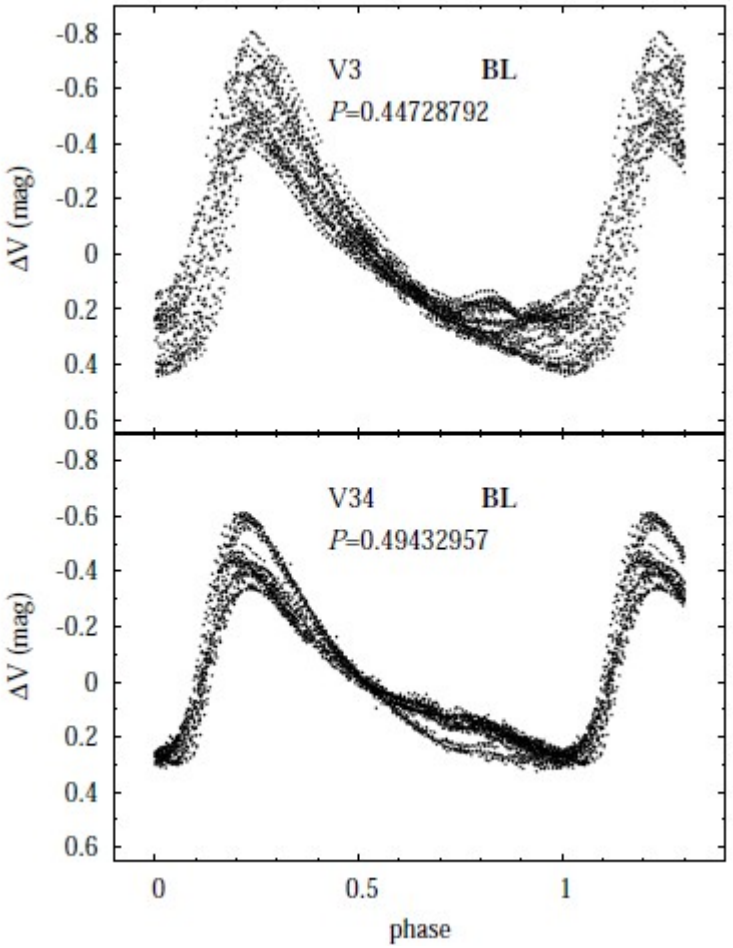
RRab



RRc



RRd

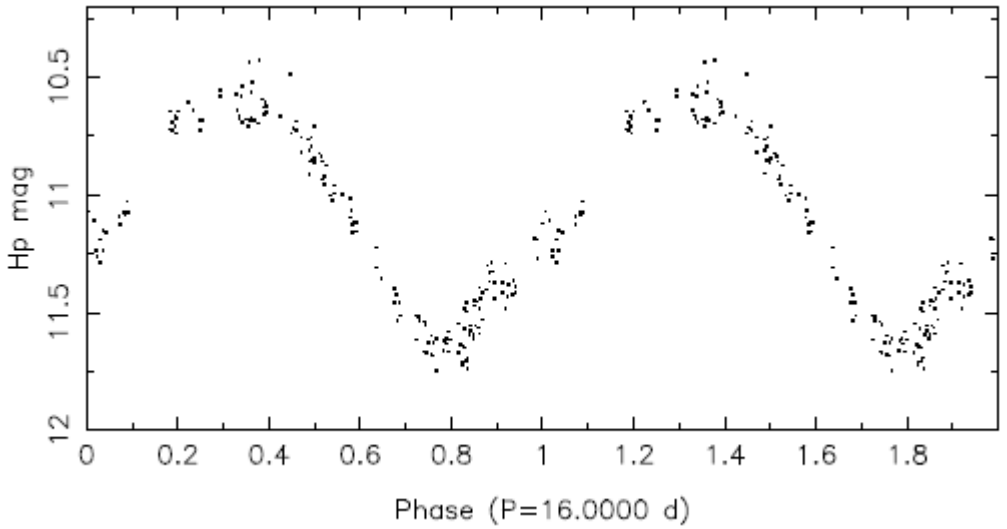


(Smolec et al., 2017, MNRAS, 467, 2349)

Low-metallicity pulsating stars

Type II Cepheids

- partial ionization zone of He ii – Heiii and of Hi – Hii
- Period 1 – 5 d ==> BL Herculis
- Period 10 – 20 d ==> W Virginis
- Period > 20 d ==> RV Tauri

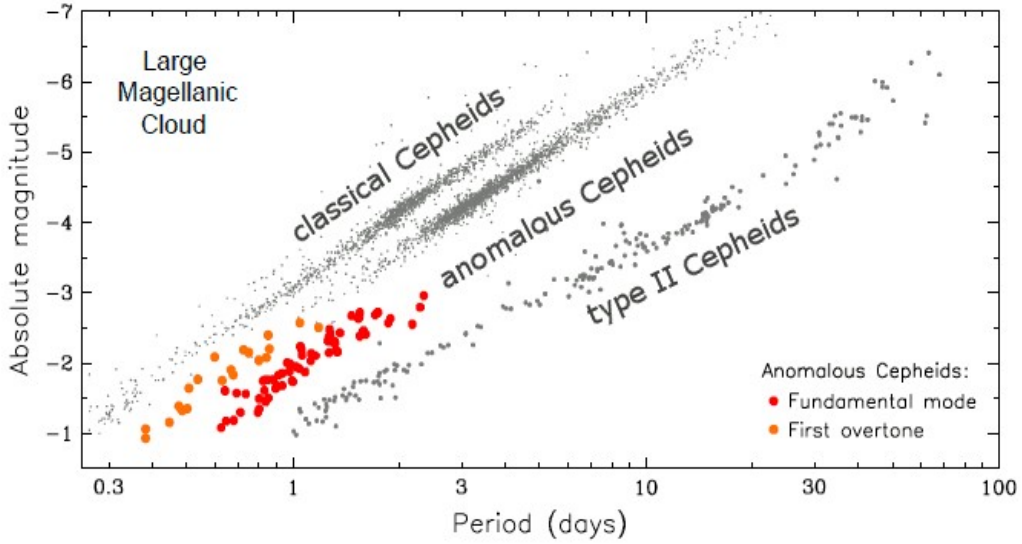


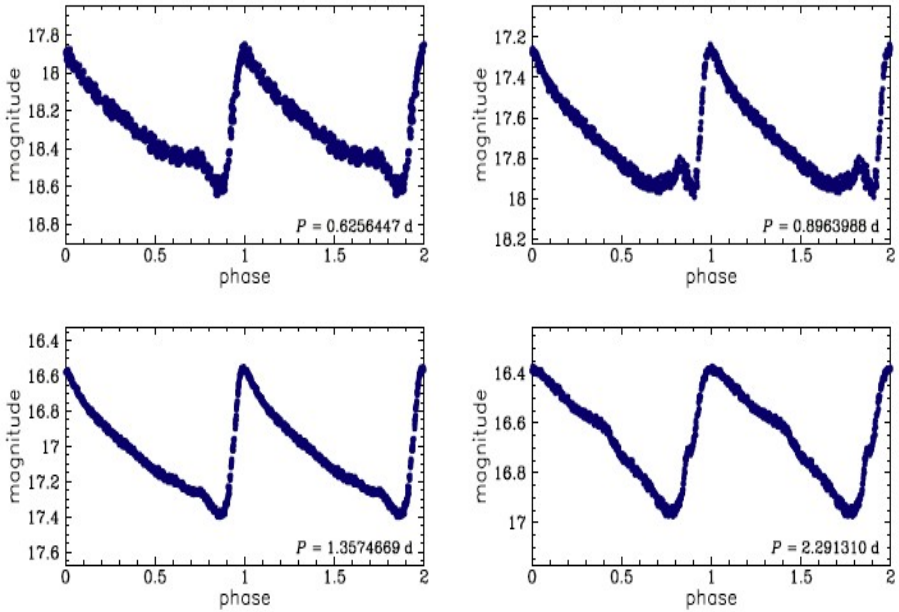
Taken from Aerts C., Christensen-Dalsgaard J., Kurtz D. W., 2010, Astroseismology, Springer, Berlin

Low-metallicity pulsating stars

Anomalous Cepheids:

- 1 – 2 M_{sun}
- spread between classical and type II Cepheids in the period-luminosity diagram



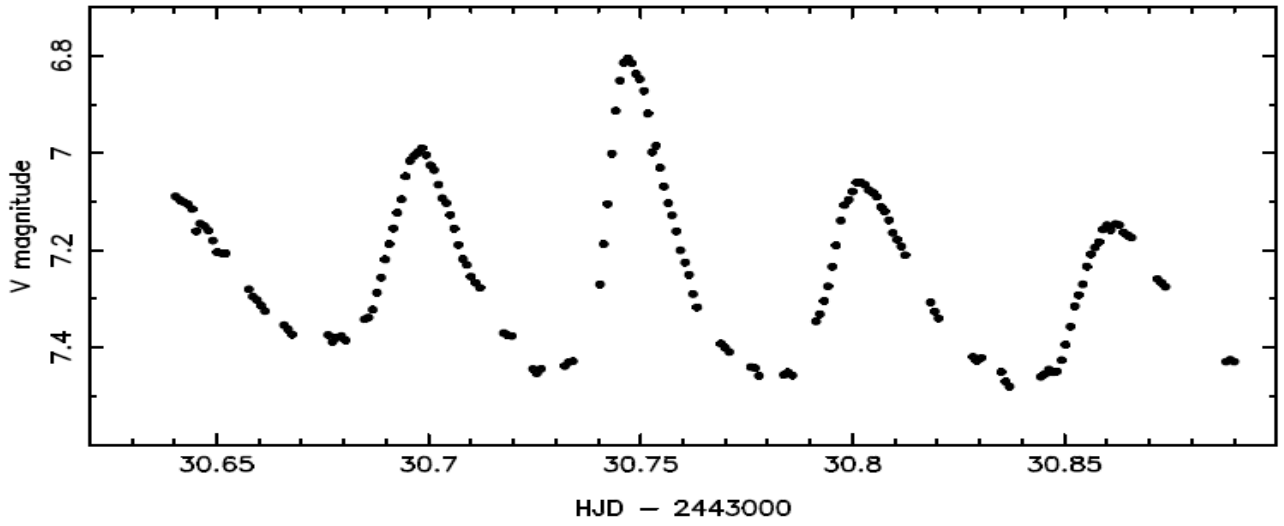


(http://ogle.astrouw.edu.pl/atlas/anomalous_Cepheids.html)

Low-metallicity pulsating stars

SX Phoenix stars:

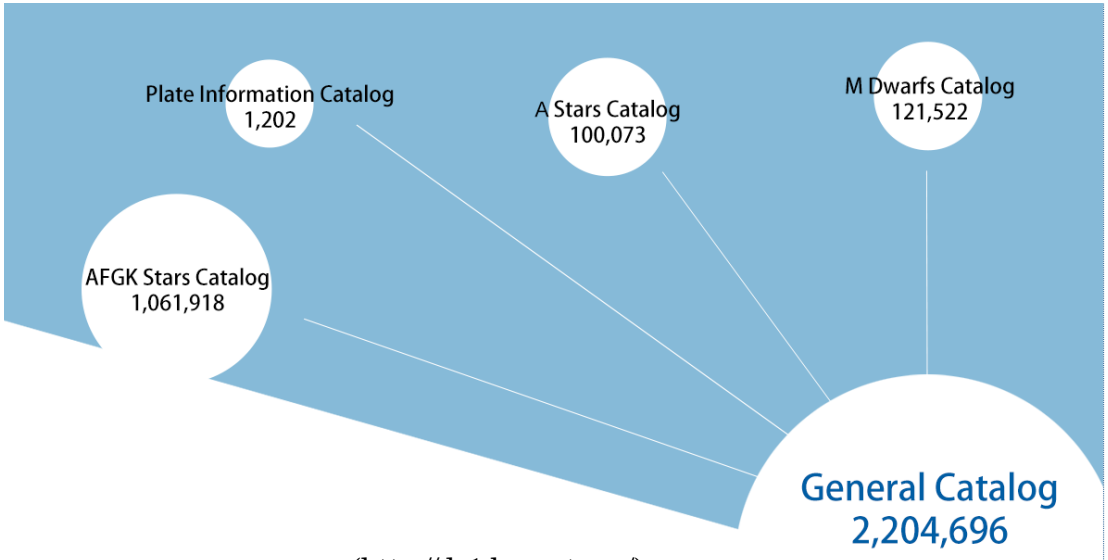
- Similar to high amplitude δ Scuti star, Low-metallicity
- Mass => 0.9 – 1.5 Msun
- Sx Phe stars are believed to be blue stragglers.
- Amplitude > 0.1 mag, Amplitude >~0.02 – 0.03 mag



Taken from Aerts C., Christensen-Dalsgaard J., Kurtz D. W., 2010, Astroseismology, Springer, Berlin

Target Selection

- DR1 AFGK Stars Catalog, R=1800, SNg > 6, λ = 370 – 900 nm
- $T_{\rm eff}$ ==> 6500 – 8600 K
- log g ==> 3.8 – 4.5
- Fe/H ==> -2.4 – -0.5 dex



(http://dr1.lamost.org/)

Target Selection

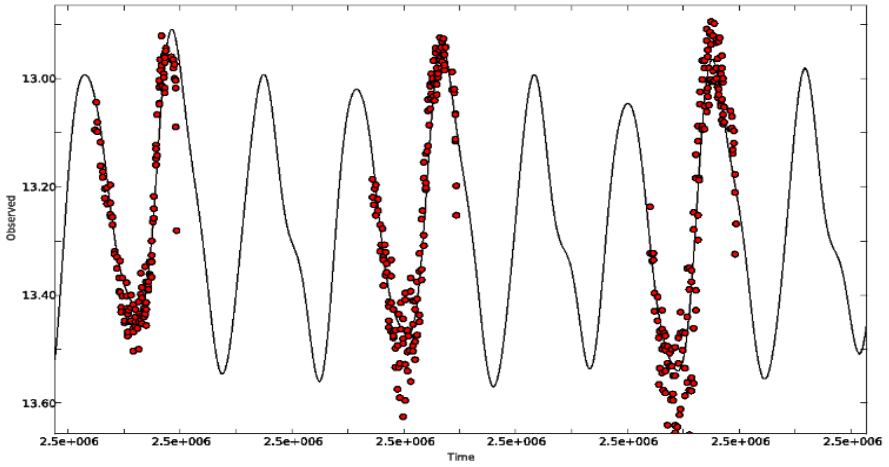
- SuperWASP Data, extra-solar planet detection programme
- Two robotic observatories, eight wide-angle cameras
- 10 objects showing light variation were found.
- Data were taken from 2004 to 2008.
- Few of them have good quality data.

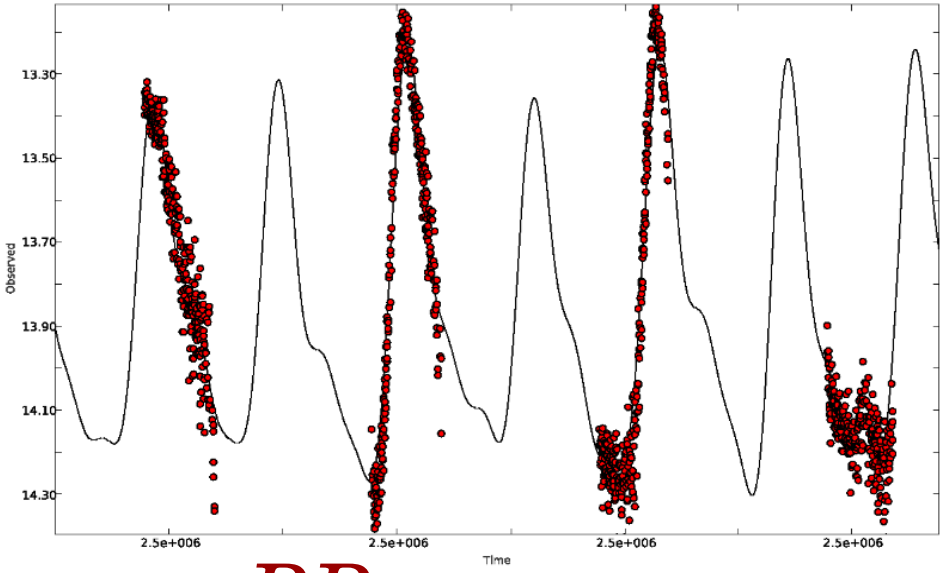
Name	SP	T_{eff} (K)	log g	[Fe/H] (dex)	SNRg	Points in WASP LC
AT Tri	F0	6689	4.397	-1.271	20	8722
SDSS J231359.63+232425.9	A2V	7580	4.274	-1.18	45	8104
SDSSJ093736.90+244038.7	F0	6510	4.247	-0.994	28	1298
AG Com	A2V	7580	4.247	-0.994	120	7996
V421 Her	F0	6680	4.136	-0.86	65	43107
TYC 3497-1816-1	F0	6800	4.152	-0.699	24	16304
HD 241952	A3	6540	4.254	-0.639	7	3369
HD 277660	A3V	7535	4.135	-0.599	195	1740
HD 248784	F5	6550	4.498	-0.59	16	3759
BD+291479	F0	7170	4.167	-0.636	30	1352

Frequency Analysis

- Performed by using PERIOD04 (Lenz & Breger, 2004)

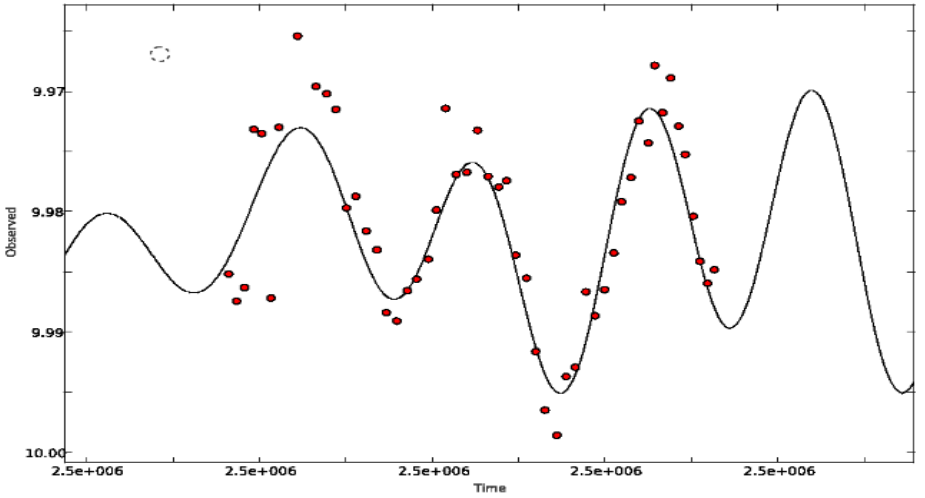
RRab ==>





<== RRc

Candidate SX Phe ==>

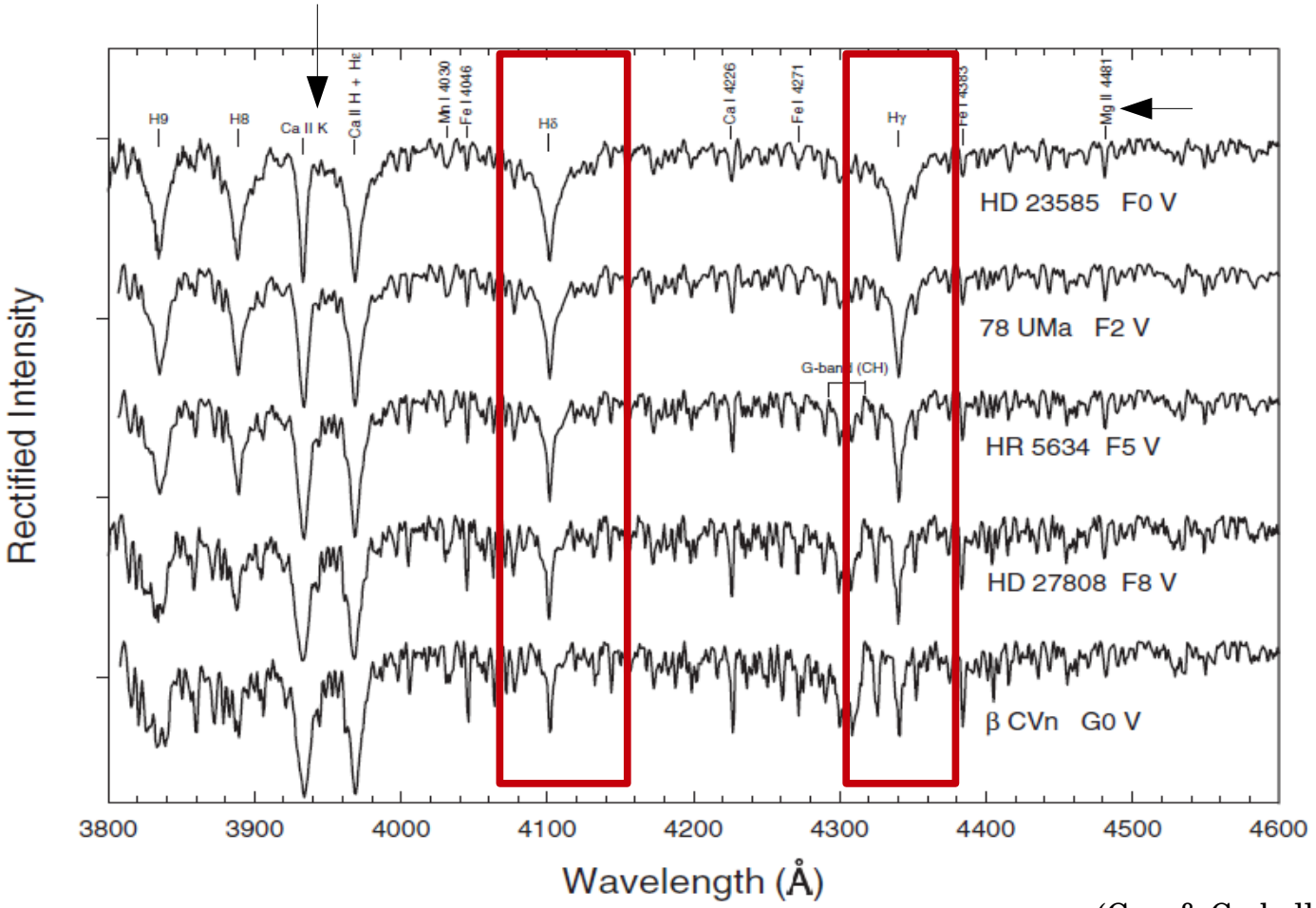


Frequency Analysis

Name	Period (d) ± 10^{-5}	Amplitude (mmag)	S/N	Classification
AT Tri	0.6526	255.2 ± 4.3	24	RRab Lyrae
SDSS J231359.63+232425.9	0.3451	204.8 ± 2.6	16	RRc Lyrae
SDSSJ093736.90+244038.7	0.3690	227.8 ± 16.8	4	RRab Lyrae
AG Com	0.3224	255.8 ± 1.4	52	RRc Lyrae
V421 Her	0.5567	374.8 ± 2.5	64	RRab Lyrae
TYC 3497-1816-1	0.1424	14.7 ± 3.7	17	Candidate SX Phe
HD 241952	0.0989	3.9 ± 0.2	14	Candidate SX Phe
HD 277660	0.0804	3.9 ± 0.6	6	Candidate SX Phe
HD 248784	0.4097	35.6 ± 2.4	5	Candidate RR Lyrae
BD+291479	0.9074	2.9 ± 0.3	5	Candidate RR Lyrae

Spectral Classification

- LAMOST spectra were compared with well-known standard stars (Gray et al. 2003).



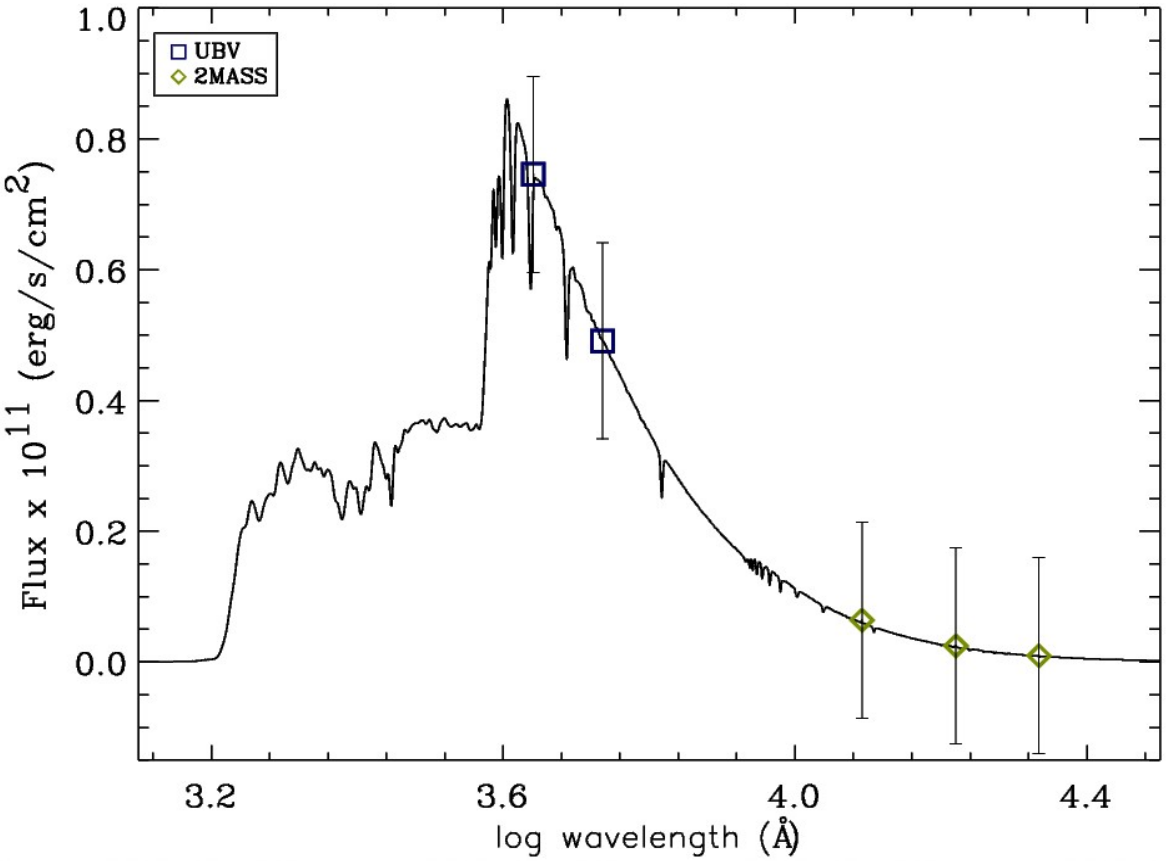
(Gray& Corbally, 2009)

Spectral Classification

Name	SP LAMOST	SP_New
AT Tri	**F0**	**F2mA0 III**
SDSS J231359.63+232425.9	**A2V**	**A9mA0 III-IV**
SDSSJ093736.90+244038.7	**F0**	**F6mA5 III-IV**
AG Com	**A2V**	**A9mA1 III**
V421 Her	**F0**	**F5mA5 III-IV**
TYC 3497-1816-1	**F0**	**F3mA9 III**
HD 241952	**A3**	**F4 III***
HD 277660	**A3V**	**A9mA3 V**
HD 248784	**F5**	**----------**
BD+291479	**F0**	**F2mA7 V**

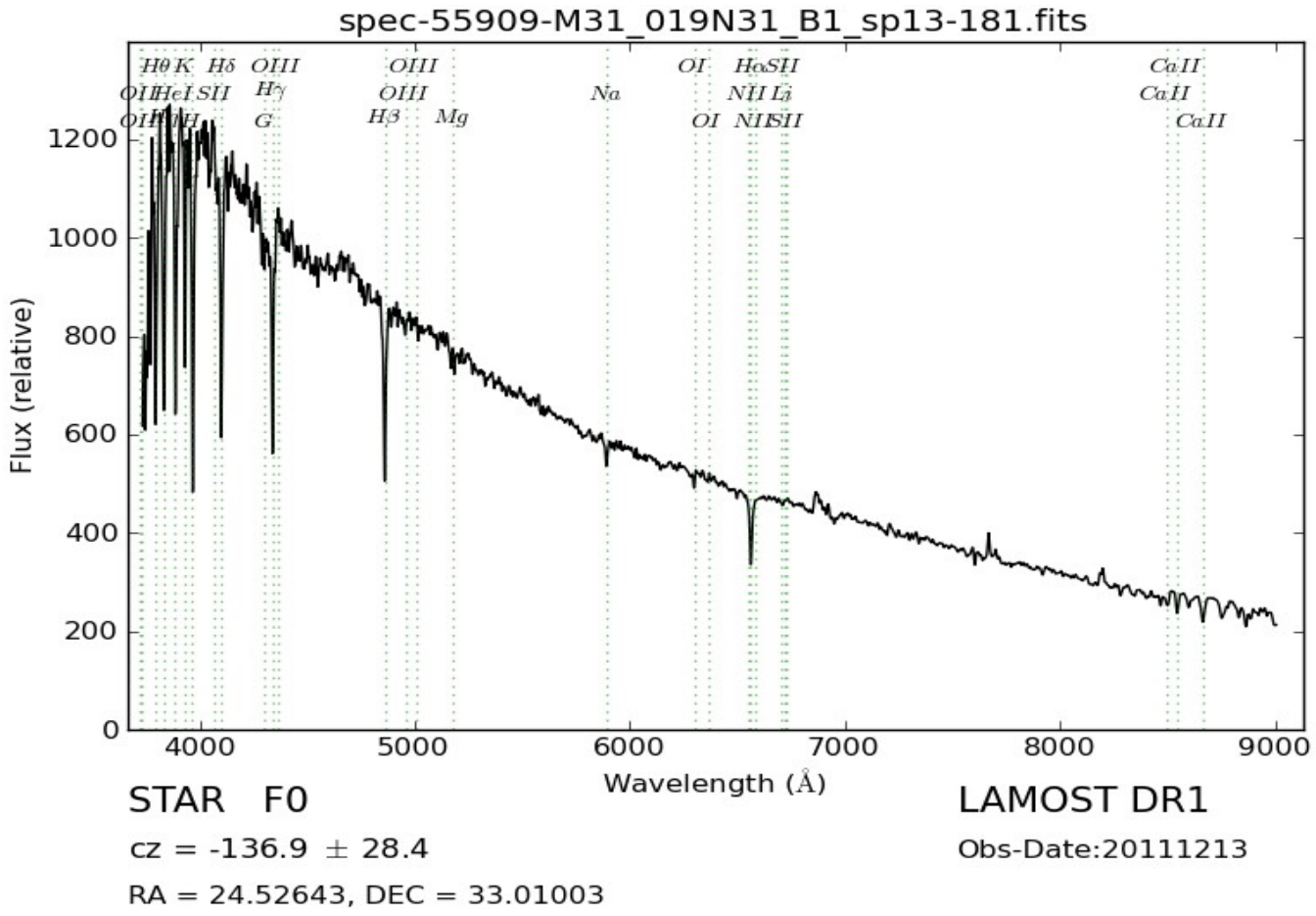
Determination of T_{eff}

- Used Spectral Energy Distribution (SED)
- ATLAS9 code (Kurucz 1992, 1993)
- E(B-V) values determined from interstellar excation map (Amôres & Lépine, 2005)



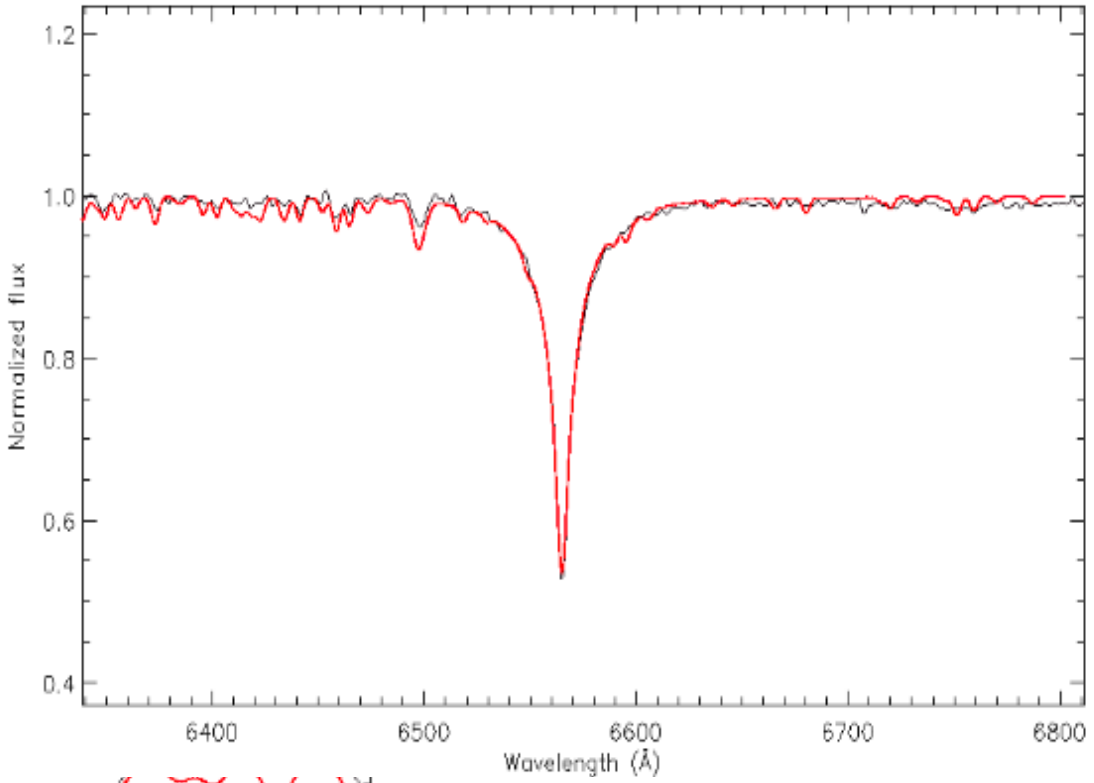
Determination of T_{eff}

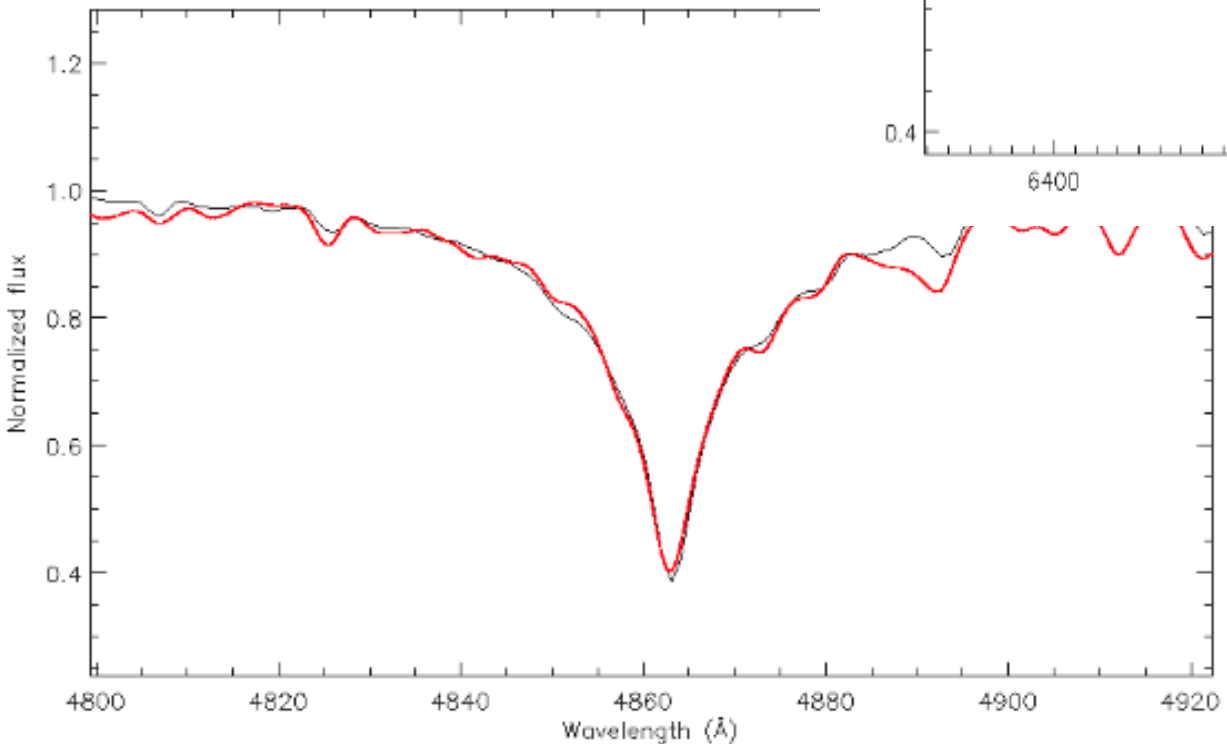
- H_α, H_β lines were used to detemine T_{eff} values
- ATLAS9 atmosphere models, [Fe/H] = -1, VALD line list, SYNTH3
- vsin*i* values were derived by fitting the Mg, Fe lines at 510 nm



Determination of T_{eff}

H_α ==>



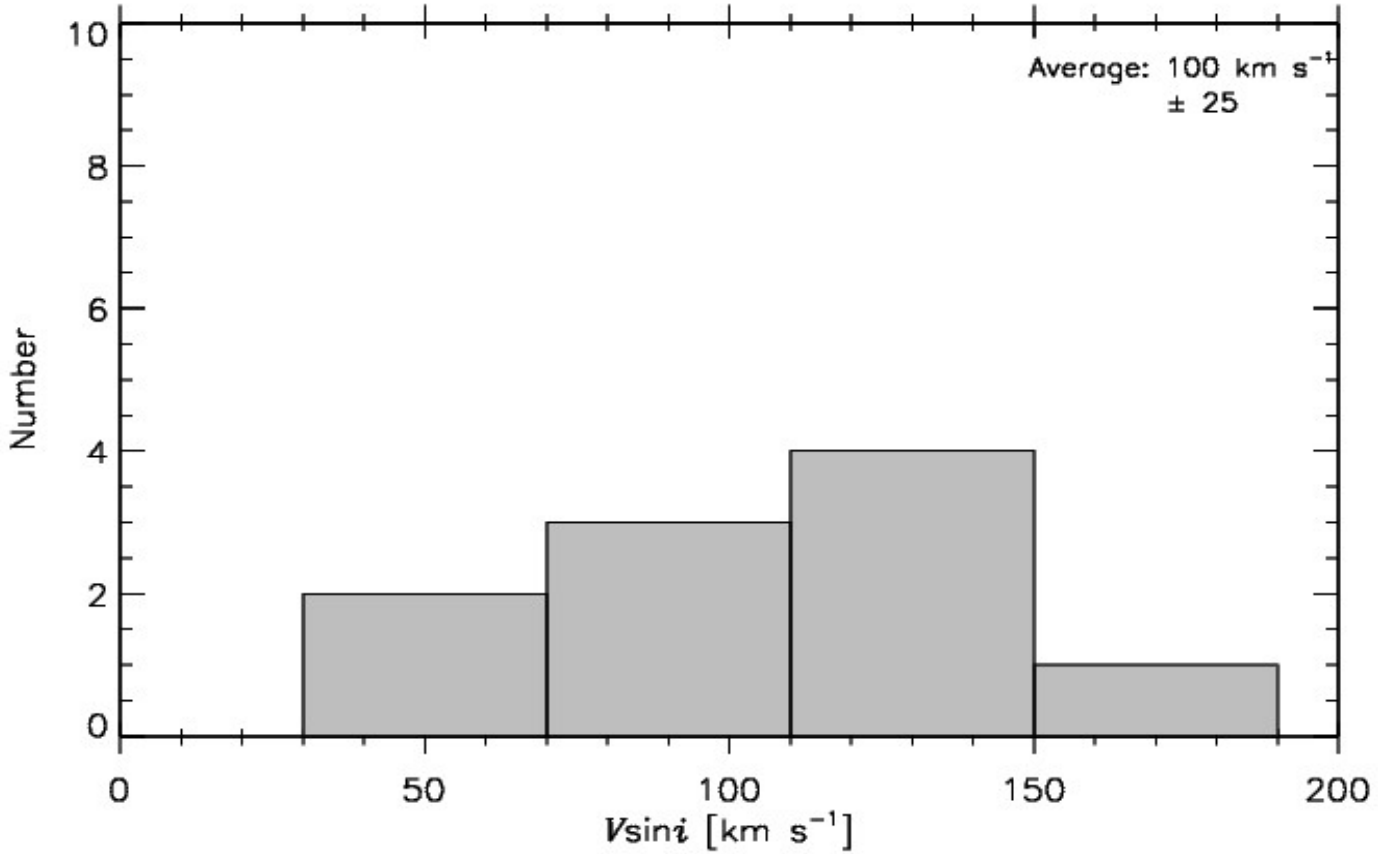


<== H_β

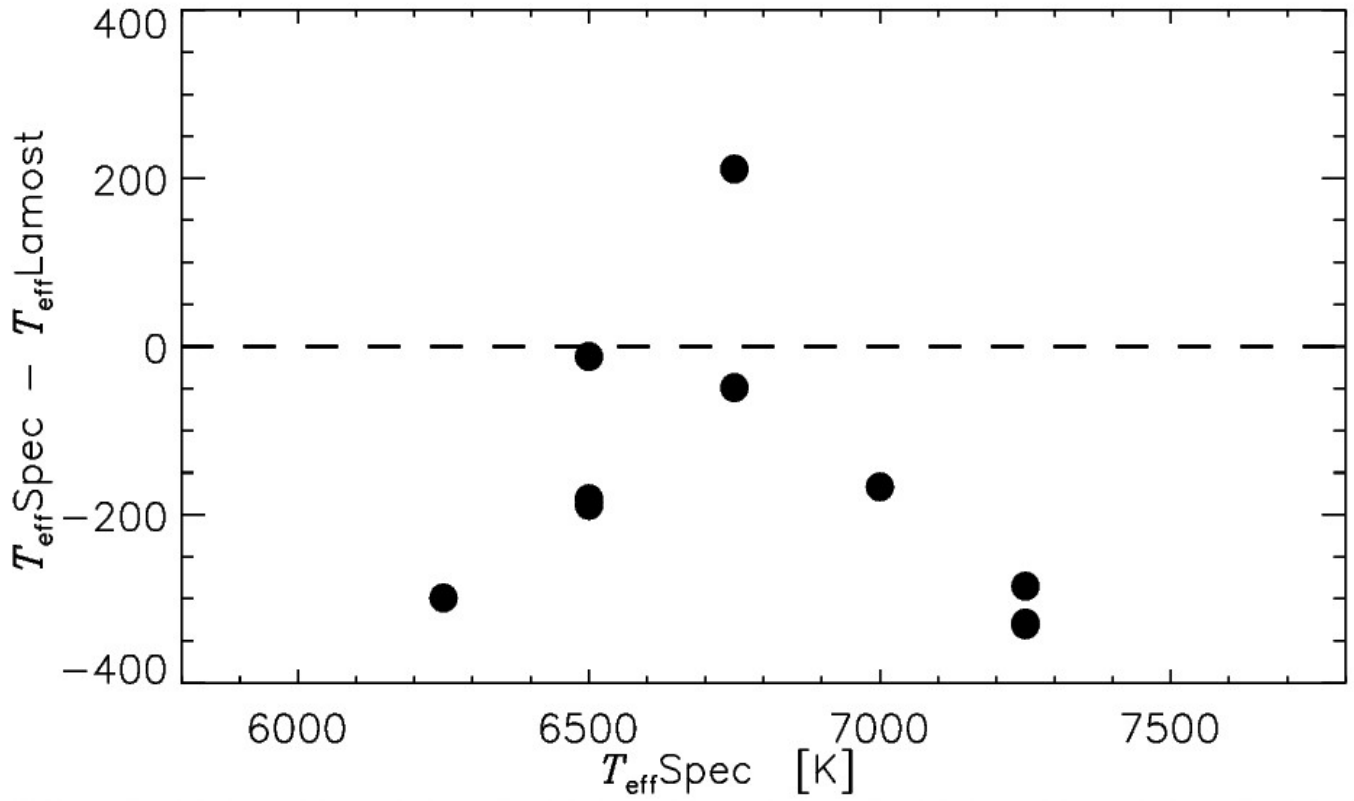
T_{eff} Results

Name	T_{eff} SED (K) ± 250	T_{eff} Hlines (K) ± 250
AT Tri	7100	6500
SDSS J231359.63+232425.9	*****	7250
SDSSJ093736.90+244038.7	6960	6500
AG Com	6270	7250
V421 Her	6780	6500
TYC 3497-1816-1	6150	6750
HD 241952	6500	6750
HD 277660	7720	7250
HD 248784	*****	6250
BD+291479	7200	7000

Results

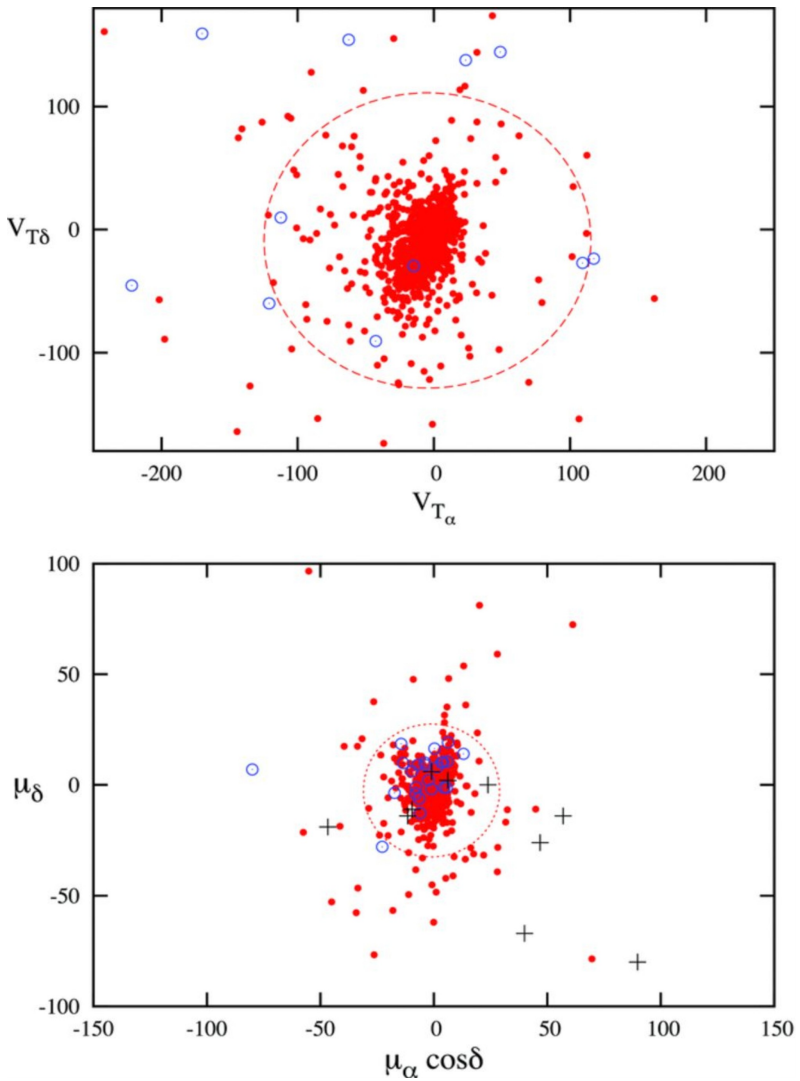

Average: 100 km s^{-1}
± 25
Number
$V\sin i$ [km s^{-1}]
0
2
4
6
8
10
0
50
100
150
200

T_{eff} Results



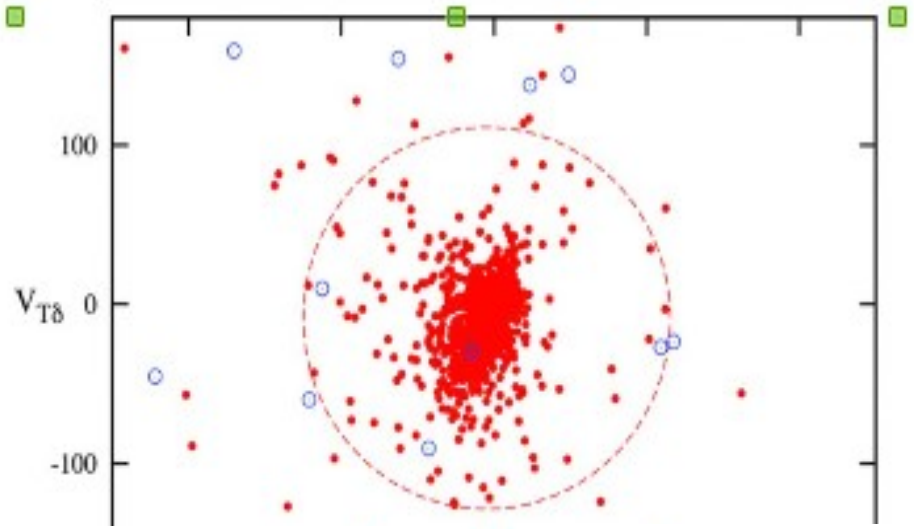
Proper Motion

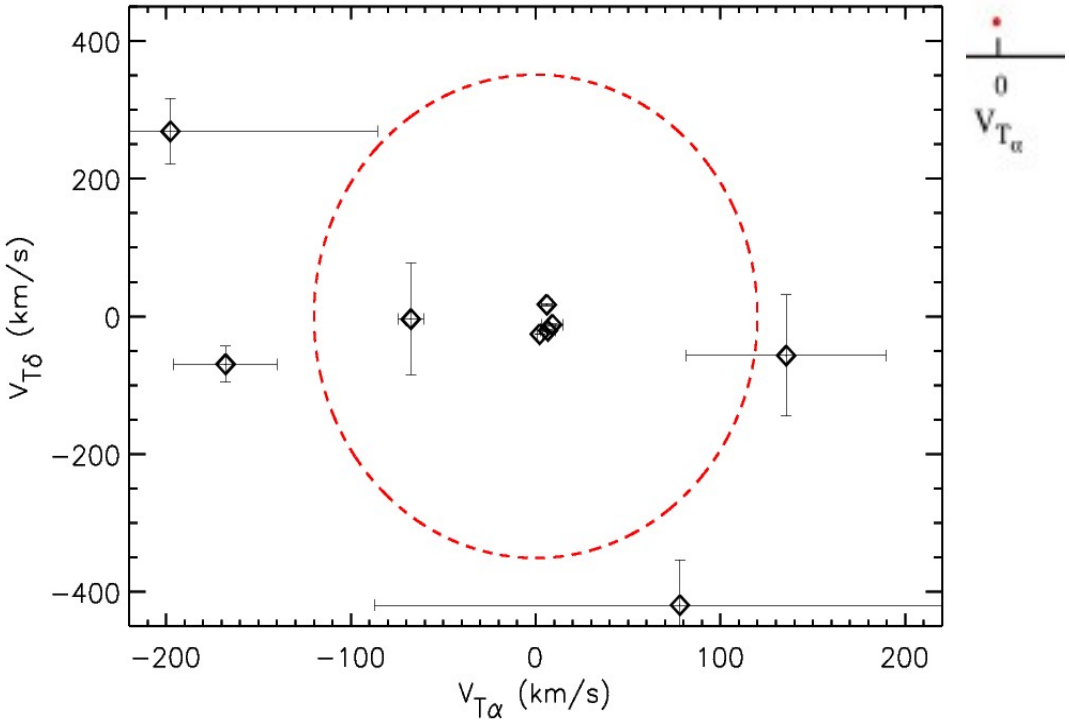
- Proper motion in RA an DEC taken from Zacharas et al. (2010)

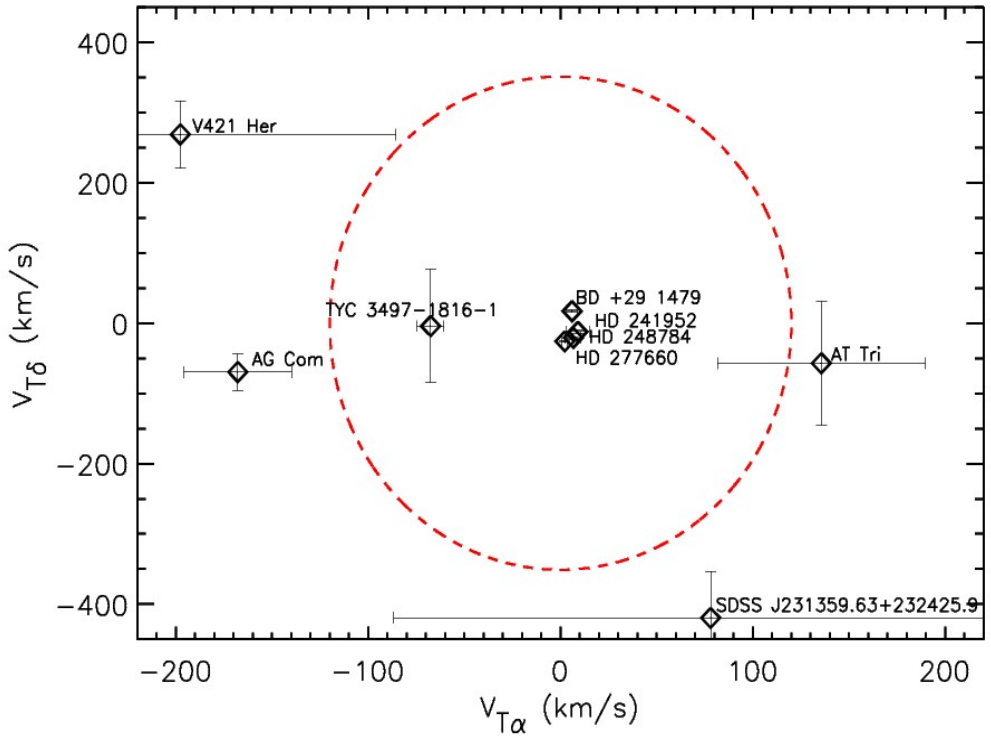


From: A search for SX Phe stars among Kepler δ Scuti stars, Balona & Nemec, 2012

Proper Motion







Results

- 10 stars' pulsation types were classified.
- Spectral type $_{\text{Lamost}}$ > Spectral type $_{\text{this study}}$
- T_{eff} values were determined from SED and H lines analysis
- T_{eff} Lamost > T_{eff} this study
- Four confirmed RR Lyr stars have higher proper motion
- log g values, “lower accuracy”

Thank You