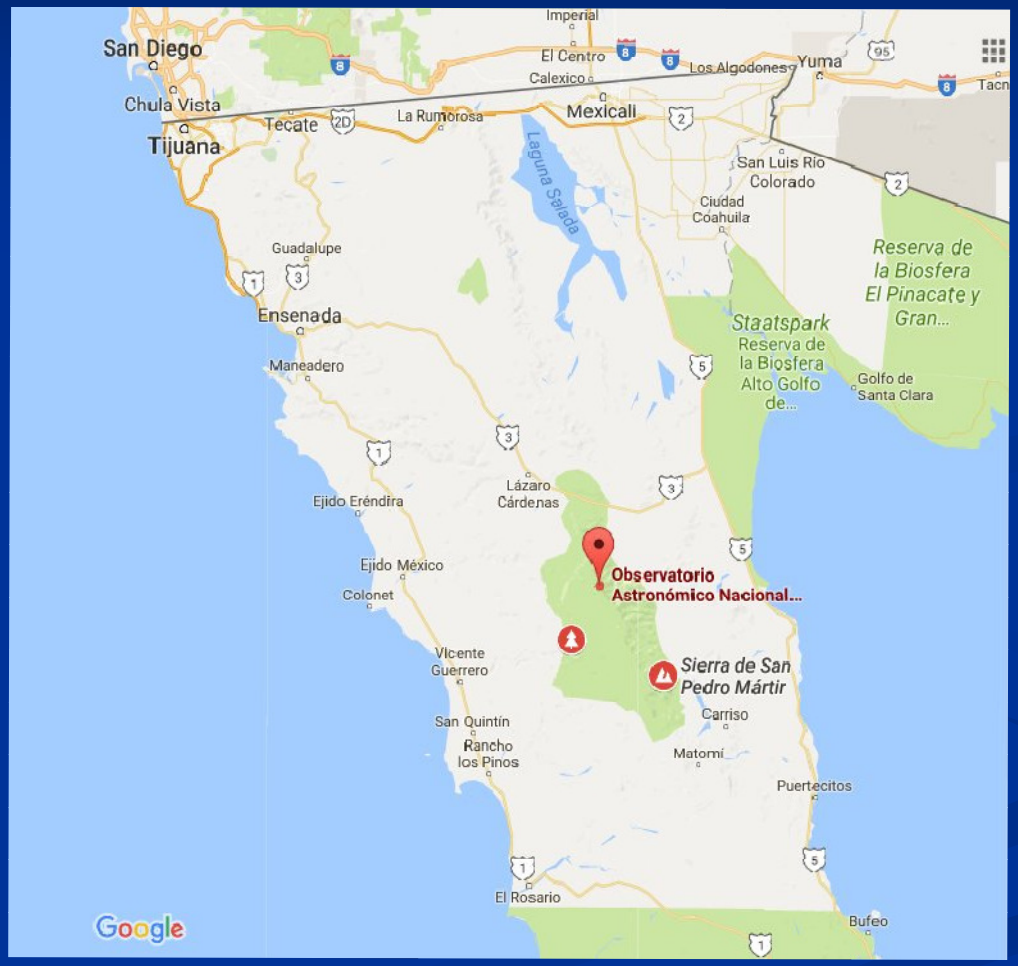
OAN-SPM Spectroscopic observations of a number of stars in the KEPLER field: comparison with LAMOST database

Dr. Lester Fox Machado

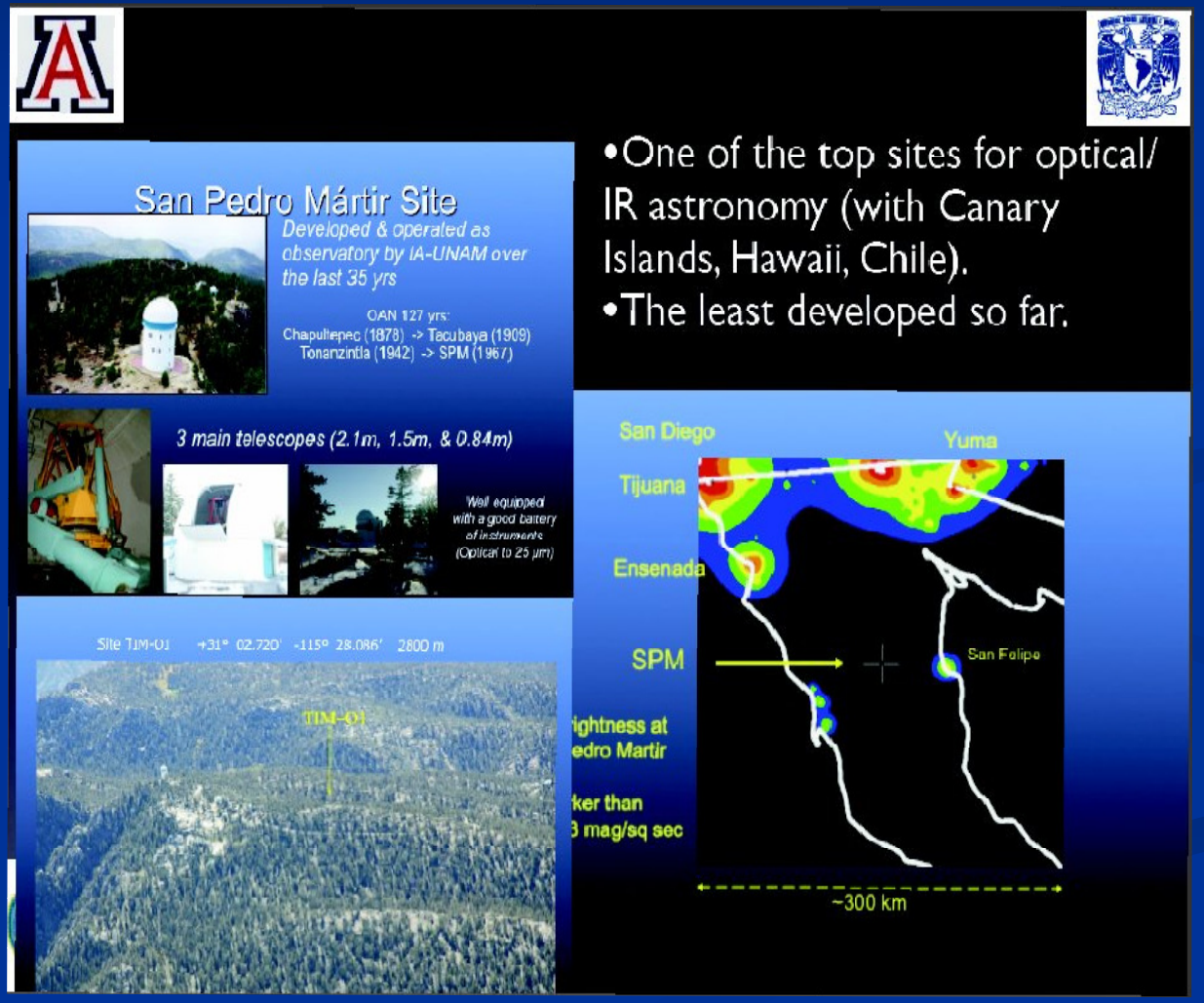
Instituto de Astronomía – UNAM

2nd LAMOST - KEPLER WORKSHOP

San Pedro Martir observatory



San Pedro Martir observatory



Outline

Searching for pulsating Mdwarfs in Kepler database:

- Sample selection: Identification of Mdwarfs
- Spectroscopic observations
- Comparison with LAMOST

Searching for pulsating M Dwarfs in Kepler database

ACTA ASTRONOMICA
Vol. **61** (2011) pp. 325–343

Mt. Suhora Survey – Searching for Pulsating M Dwarfs in Kepler Public Dataset*

A.S. Baran[1], L. Fox-Machado[2], J. Lykke[3], M. Nielsen[3] and J.H. Telting[3]

[1] Mt. Suhora Observatory of the Pedagogical University, ul. Podchorążych 2, 30-084 Kraków, Poland
email: andy@astro.as.up.krakow.pl
[2] Instituto de Astronomía – Universidad Nacional Autónoma de México, Ap. P. 877, Ensenada, BC 22860, Mexico
email: lfox@astrosen.unam.mx
[3] Nordic Optical Telescope, 38700 Santa Cruz de La Palma, Spain
email: jht@not.iac.es

Received December 9, 2011

ABSTRACT

We present our analysis of Kepler short cadence public data to search for stellar pulsations in M dwarfs. Theoretical calculations predict that these stars may suffer from a fundamental radial mode driven by the nuclear ε mechanism. First results published thus far show no significant signal around the expected frequency of 36 c/d down to 1 ppt (parts per thousand). In this paper we include new results obtained from a sample of 86 stars, although a real number of M dwarfs after spectral classification turned out to be small. Unluckily, we have not detected any significant signal typically down to 1–10 ppm (parts per million) in M dwarfs and since the sample of these stars consists of 6 objects only, we cannot make any strong conclusion if the ε mechanism drives perturbation in radius to propagate to a detectable amplitude at the surface. As a by-product of our work we provide a spectral classification of 86 Kepler objects, along with their variability and thus far unknown artifacts residing in Kepler photometry.

Key words: *Stars: oscillations (including pulsations) – Stars: low-mass – Asteroseismology*

Theoretical predictions of radial pulstions in M Dwarfs:
The observational detection of oscillations for the 0.4 and 0.5M models excited by a flux-blocking mechanism is more likely, as the amplitude of the modes have enough time to develop due to the shorter time-scale for the growth of the instability. Periods in the range 23 – 40 min are most likely to be detected (Rodríguez, MacDonald & Moya 2012)

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY LETTERS

Mon. Not. R. Astron. Soc. 419, L44–L48 (2012) doi:10.1111/j.1745-3933.2011.01174.x

Pulsations in M dwarf stars

C. Rodríguez-López,[1⋆] J. MacDonald[2⋆] and A. Moya[3⋆]

[1]*Departamento de Física Estelar, Instituto de Astrofísica de Andalucía (IAA-CSIC), 18008 Granada, Spain*
[2]*Department of Physics and Astronomy, University of Delaware, Newark, DE 19716, USA*
[3]*Departamento de Astrofísica, Centro de Astrobiología (CAB, INTA-CSIC), ESAC Campus, PO Box 78, 28691 Villanueva de la Cañada, Madrid, Spain*

Accepted 2011 October 11. Received 2011 September 29; in original form 2011 August 4

ABSTRACT

We present the results of the first theoretical non-radial, non-adiabatic pulsational study of M dwarf stellar models with masses in the range 0.1–0.5 $M_\odot$. We find the fundamental radial mode to be unstable due to an ϵ mechanism, caused by deuterium (D) burning for the young 0.1 and 0.2 $M_\odot$ models, by non-equilibrium He^3 burning for the 0.2 and 0.25 $M_\odot$ models of 10^4 Myr and by a flux-blocking mechanism for the partially convective 0.4 and 0.5 $M_\odot$ models once they reach the age of 500 Myr. The periods of the overstable modes excited by the D burning are in the range 4.2–5.2 h for the 0.1 $M_\odot$ models and is of the order of 8.4 h for the 0.2 $M_\odot$ models. The periods of the modes excited by He^3 burning and flux blocking are in the range 23–40 min. The more massive and oldest models are more promising for the observational detection of pulsations as their ratio of instability e-folding time to age is more favourable.

Key words: stars: low-mass – stars: oscillations.

Sample selection from Kepler Input Catalog (KIC)

- MAST Archive
- Short cadence data: Nyquist freq= 734 c/d
- Long cadence data are not useful as Nyquist freq. = 48 c/d close to 36 c/d espected period.
- Teff < 5000 K
- R < 1 R$\odot$
- Log g > 4.2
- 1 < (R - J) < 4
- 86 objects, Q0, Q1, Q2, Q3

KIC	$T_{\rm eff}$	log$g$	R [mag]	$R-J$	Radius
01026895	3977	4.528	9.160	2.277	0.666
01160867	3753	4.566	9.504	2.463	0.590
01162220	4089	4.515	11.183	2.004	0.706
02159700	3686	4.605	9.785	2.545	0.545
02450412	3587	4.648	10.653	2.679	0.498
02846051	4012	4.465	10.191	2.154	0.746
03101129	4285	4.417	11.542	1.837	0.871
03128488	4475	4.615	11.625	1.536	0.688
03222519	3736	4.578	11.909	2.601	0.576
03430868	4729	4.584	8.053	1.369	0.760
03630240	4968	4.513	11.609	1.343	0.878
03735269	4220	4.527	10.939	1.875	0.722
03735699	3953	4.531	10.386	2.188	0.659
03836105	4059	4.542	10.329	2.096	0.670
03936736	3782	4.539	11.652	2.432	0.621
04040928	4233	4.580	11.336	1.779	0.668
04056079	4574	4.451	9.977	1.472	0.888
04060593	3874	4.291	9.276	2.325	0.953
04243486	3882	4.555	11.130	2.256	0.623
04276716	4621	4.619	11.723	1.441	0.708
04346953	4231	4.555	11.578	1.822	0.694
04373485	3905	4.444	11.717	2.375	0.749
04376841	3775	4.524	11.407	2.549	0.635
04385594	3822	4.500	11.393	2.563	0.669
04671547	4059	4.653	11.373	2.145	0.569
04736074	4826	4.615	9.554	1.366	0.746
04738764	4471	4.650	9.767	1.581	0.656
04930560	4078	4.370	10.909	1.928	0.886
04935950	4201	4.375	11.035	1.778	0.908
05351659	3687	4.399	11.842	2.752	0.758
05390438	4536	4.418	10.508	1.522	0.924
05436582	4097	4.589	11.200	1.941	0.629
05629080	4925	4.527	10.329	1.294	0.855
05701829	4623	4.634	9.015	1.503	0.694
05707338	4748	4.499	10.101	1.409	0.859
05716526	4250	4.454	9.297	1.797	0.816
05784204	3732	4.585	8.618	2.628	0.568
06368045	3978	4.441	11.363	2.111	0.768
06470598	4746	4.693	11.692	1.414	0.662
06531550	4769	4.466	10.882	1.449	0.901

KIC	$T_{\rm eff}$	log$g$	R [mag]	$R-J$	Radius
06627606	4481	4.389	9.103	1.616	0.955
06871713	4803	4.605	11.756	1.439	0.752
07023973	4324	4.361	11.713	1.723	0.958
07034097	3764	4.437	11.392	2.662	0.729
07049465	4033	4.505	11.264	1.985	0.705
07176070	3955	4.418	10.245	2.130	0.792
07499271	4231	4.477	11.708	1.744	0.783
07505113	3697	4.489	10.513	3.448	0.657
07694241	4485	4.665	11.041	1.599	0.645
07748051	3748	4.548	11.523	2.565	0.607
07799575	3965	4.416	8.174	2.327	0.798
07936309	4421	4.413	11.001	1.591	0.909
08042251	3931	4.422	11.287	2.089	0.782
08211551	4690	4.587	8.456	1.455	0.751
08352528	3917	4.500	8.648	2.317	0.687
08386623	4684	4.596	11.601	1.457	0.740
08429280	4616	4.385	9.595	1.481	0.983
08547390	4643	4.609	8.316	1.530	0.721
08561221	4997	4.653	9.843	1.315	0.737
08677933	4620	4.652	8.157	1.133	0.678
08737920	4415	4.584	10.952	1.594	0.705
08831759	3501	4.662	8.508	2.661	0.479
09344010	4843	4.594	11.711	1.376	0.769
09455756	3953	4.399	13.491	2.052	0.816
09527740	3758	4.544	11.837	2.587	0.612
09532030	4408	4.594	8.400	1.779	0.693
09896545	3701	4.485	10.530	3.508	0.662
10001154	4336	4.599	8.741	1.783	0.672
10026749	3947	4.489	11.223	2.557	0.705
10063343	3976	4.433	13.230	2.343	0.777
10163983	3504	4.659	11.222	2.815	0.481
10230145	4882	4.427	10.785	1.299	0.969
10259462	4358	4.580	11.651	1.594	0.696
10490561	4944	4.431	11.626	1.370	0.975
10785374	4109	4.574	11.153	1.768	0.648
10801273	3981	4.356	10.540	1.995	0.882
11099165	3856	4.510	8.954	2.530	0.664
11393580	3845	4.453	11.614	2.502	0.726
11446143	4303	4.473	11.822	1.849	0.805
11514682	4861	4.527	15.871	2.066	0.845
11560447	4969	4.476	10.804	1.353	0.922
11717716	4160	4.485	11.761	1.836	0.757
12010862	3667	4.571	11.493	2.783	0.571
12024065	3737	4.530	11.256	2.648	0.623
12102573	4251	4.507	11.841	1.977	0.752
12155015	3825	4.521	8.665	2.488	0.648
12644769	4051	4.479	11.734	1.920	0.739

Spectroscopy at OAN-SPM, BC, Mexico

- Low resolution spectra at San Pedro Martir observatory
- 2.12m Telescope + Boller & Chivens
- 4400 A to 7500 A
- Resolution= 8 A

(R ~ 750 at central wavelength)

- Dispersion: 1.8 A/pixel

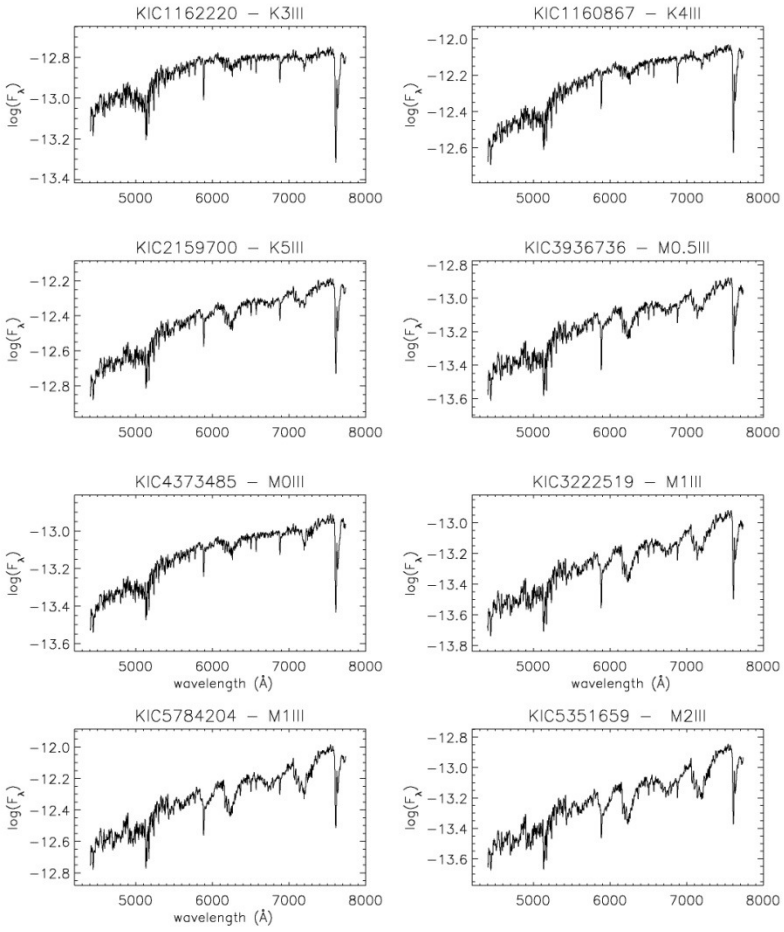
Spectroscopy at NOT, La Palma, Canary Island, Spain

- Low resolution spectra at Nordic Optical Telescope
- 2.5m Telescope + ALFOSC spectrograph
- 4800 A to 9000 A
- Resolution= 7.5 A

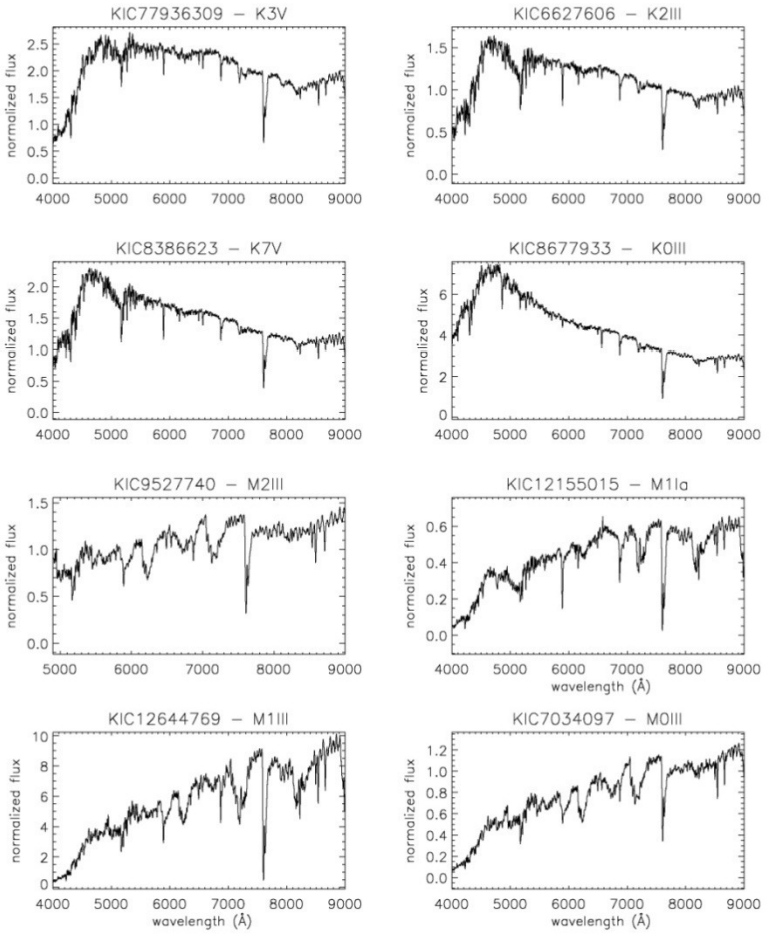
(R ~ 850 at central wavelength)

- Dispersion: 3.0 A/pixel

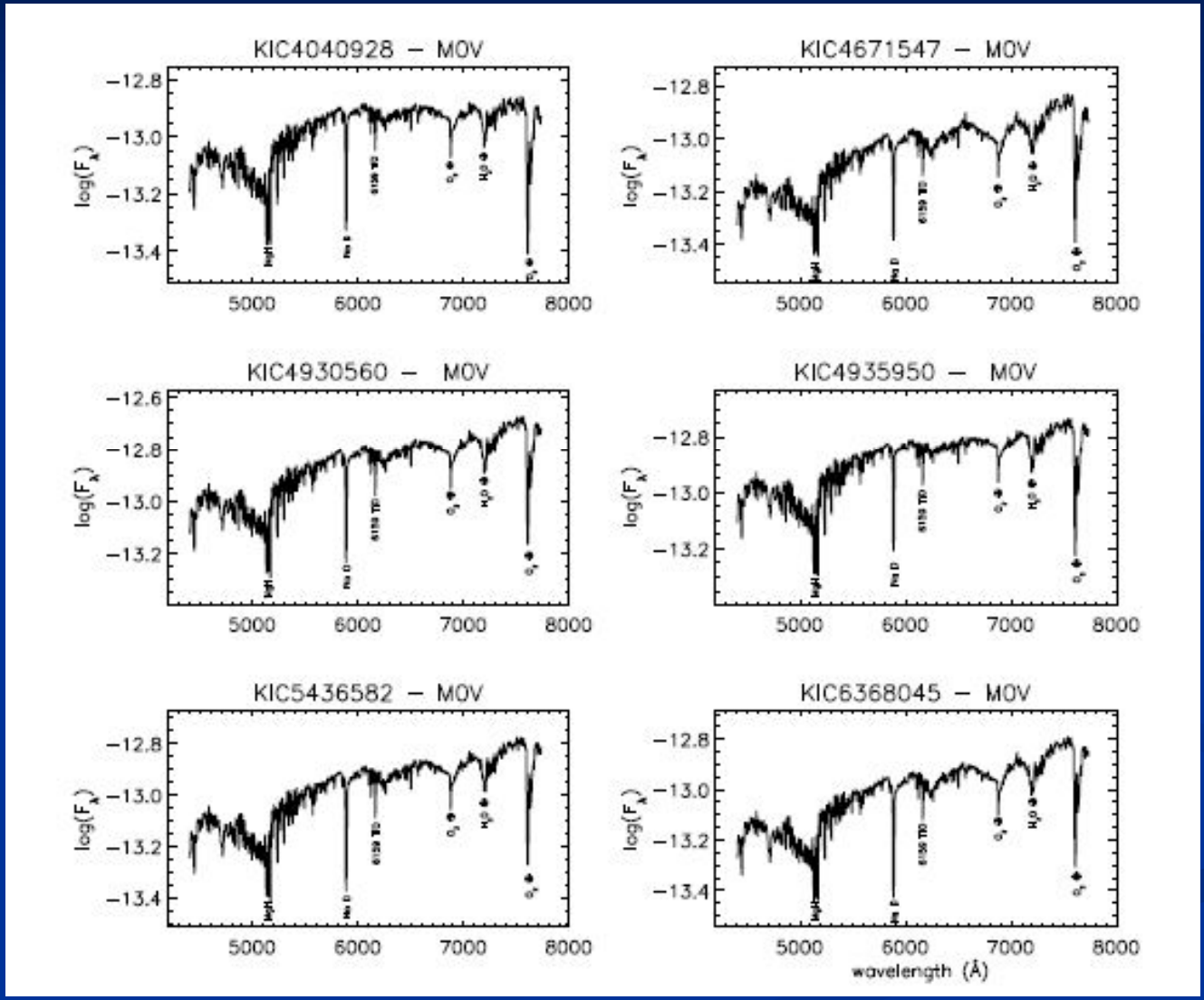
SPM - 2.12m+B&Ch, MEXICO



NOT – ALFOSC, LA PALMA



M Dwarfs in the sample



KIC	$T_{\rm eff}$	log$g$	R [mag]	$R-J$	Radius	SpT	site
01026895	3977	4.528	9.160	2.277	0.666	K4III	SPM
01160867	3753	4.566	9.504	2.463	0.590	K4III	SPM
01162220	4089	4.515	11.183	2.004	0.706	K3III	SPM
02159700	3686	4.605	9.785	2.545	0.545	M0.5III	SPM
02450412	3587	4.648	10.653	2.679	0.498	K5III	SPM
02846051	4012	4.465	10.191	2.154	0.746	K4III	SPM
03101129	4285	4.417	11.542	1.837	0.871	K7V	SPM
03128488	4475	4.615	11.625	1.536	0.688	K5V	SPM
03222519	3736	4.578	11.909	2.601	0.576	M1Ia	SPM
03430868	4729	4.584	8.053	1.369	0.760	K0IV	SPM
03630240	4968	4.513	11.609	1.343	0.878	K0III	SPM
03735269	4220	4.527	10.939	1.875	0.722	K1.5III	SPM
03735699	3953	4.531	10.386	2.188	0.659	K2II	SPM
03836105	4059	4.542	10.329	2.096	0.670	K4III	SPM
03936736	3782	4.539	11.652	2.432	0.621	M0.5III	SPM
04040928	4233	4.580	11.336	1.779	0.668	M0V	SPM
04056079	4574	4.451	9.977	1.472	0.888	K0III	SPM
04060593	3874	4.291	9.276	2.325	0.953	M0.5III	SPM
04243486	3882	4.555	11.130	2.256	0.623	K5III	SPM
04276716	4621	4.619	11.723	1.441	0.708	K3V	SPM
04346953	4231	4.555	11.578	1.822	0.694	K2III	SPM
04373485	3905	4.444	11.717	2.375	0.749	M0III	SPM
04376841	3775	4.524	11.407	2.549	0.635	M0.5III	SPM
04385594	3822	4.500	11.393	2.563	0.669	M0III	SPM
04671547	4059	4.653	11.373	2.145	0.569	M0V	SPM
04736074	4826	4.615	9.554	1.366	0.746	K3V	SPM
04738764	4471	4.650	9.767	1.581	0.656	K2III	SPM
04930560	4078	4.370	10.909	1.928	0.886	M0V	SPM
04935950	4201	4.375	11.035	1.778	0.908	M0V	SPM
05351659	3687	4.399	11.842	2.752	0.758	M2III	SPM
05390438	4536	4.418	10.508	1.522	0.924	K2III	SPM
05436582	4097	4.589	11.200	1.941	0.629	M0V	SPM
05629080	4925	4.527	10.329	1.294	0.855	K0III	SPM
05701829	4623	4.634	9.015	1.503	0.694	K0III	SPM
05707338	4748	4.499	10.101	1.409	0.859		
05716526	4250	4.454	9.297	1.797	0.816	K4III	SPM
05784204	3732	4.585	8.618	2.628	0.568	M0II	SPM
06368045	3978	4.441	11.363	2.111	0.768	M0V	SPM
06470598	4746	4.693	11.692	1.414	0.662	K5V	SPM
06531550	4769	4.466	10.882	1.449	0.901	K1III	NOT

KIC	$T_{\rm eff}$	log$g$	R [mag]	$R-J$	Radius	SpT	site
06627606	4481	4.389	9.103	1.616	0.955	K2III	NOT
06871713	4803	4.605	11.756	1.439	0.752	K0III	NOT
07023973	4324	4.361	11.713	1.723	0.958	M1III	NOT
07034097	3764	4.437	11.392	2.662	0.729	M0.5III	NOT
07049465	4033	4.505	11.264	1.985	0.705	K7V	NOT
07176070	3955	4.418	10.245	2.130	0.792	K5III	NOT
07499271	4231	4.477	11.708	1.744	0.783	K4V	NOT
07505113	3697	4.489	10.513	3.448	0.657	M4IIIa	NOT
07694241	4485	4.665	11.041	1.599	0.645	K4V	NOT
07748051	3748	4.548	11.523	2.565	0.607	M2III	NOT
07799575	3965	4.416	8.174	2.327	0.798	M0III	NOT
07936309	4421	4.413	11.001	1.591	0.909	K3V	NOT
08042251	3931	4.422	11.287	2.089	0.782	K7V	NOT
08211551	4690	4.587	8.456	1.455	0.751	K0.5IIIb	NOT
08352528	3917	4.500	8.648	2.317	0.687	M0.5III	NOT
08386623	4684	4.596	11.601	1.457	0.740	K7V	NOT
08429280	4616	4.385	9.595	1.481	0.983	K7V	NOT
08547390	4643	4.609	8.316	1.530	0.721	K3V	NOT
08561221	4997	4.653	9.843	1.315	0.737	K0III	NOT
08677933	4620	4.652	8.157	1.133	0.678	K0III	NOT
08737920	4415	4.584	10.952	1.594	0.705	K0IIIb	NOT
08831759	3501	4.662	8.508	2.661	0.479	M2III	NOT
09344010	4843	4.594	11.711	1.376	0.769	K0IIIb	NOT
09455756	3953	4.399	13.491	2.052	0.816	K1V	NOT
09527740	3758	4.544	11.837	2.587	0.612	M2III	NOT
09532030	4408	4.594	8.400	1.779	0.693	K2III	NOT
09896545	3701	4.485	10.530	3.508	0.662	M4III	NOT
10001154	4336	4.599	8.741	1.783	0.672	K2III	NOT
10026749	3947	4.489	11.223	2.557	0.705	K5III	NOT
10063343	3976	4.433	13.230	2.343	0.777	K7V	NOT
10163983	3504	4.659	11.222	2.815	0.481	M2III	NOT
10230145	4882	4.427	10.785	1.299	0.969	K3V	NOT
10259462	4358	4.580	11.651	1.594	0.696	K4V	NOT
10490561	4944	4.431	11.626	1.370	0.975	K0IV	NOT
10785374	4109	4.574	11.153	1.768	0.648	K7V	NOT
10801273	3981	4.356	10.540	1.995	0.882	K7V	NOT
11099165	3856	4.510	8.954	2.530	0.664	M0.5III	NOT
11393580	3845	4.453	11.614	2.502	0.726	M0.5III	NOT
11446143	4303	4.473	11.822	1.849	0.805	K4V	NOT
11514682	4861	4.527	15.871	2.066	0.845	K7V	NOT
11560447	4969	4.476	10.804	1.353	0.922	K1IV	NOT
11717716	4160	4.485	11.761	1.836	0.757	K7V	NOT
12010862	3667	4.571	11.493	2.783	0.571	M2III	NOT
12024065	3737	4.530	11.256	2.648	0.623	M2III	NOT
12102573	4251	4.507	11.841	1.977	0.752	K4V	NOT
12155015	3825	4.521	8.665	2.488	0.648	M1Ia	NOT
12644769	4051	4.479	11.734	1.920	0.739	M1III	NOT

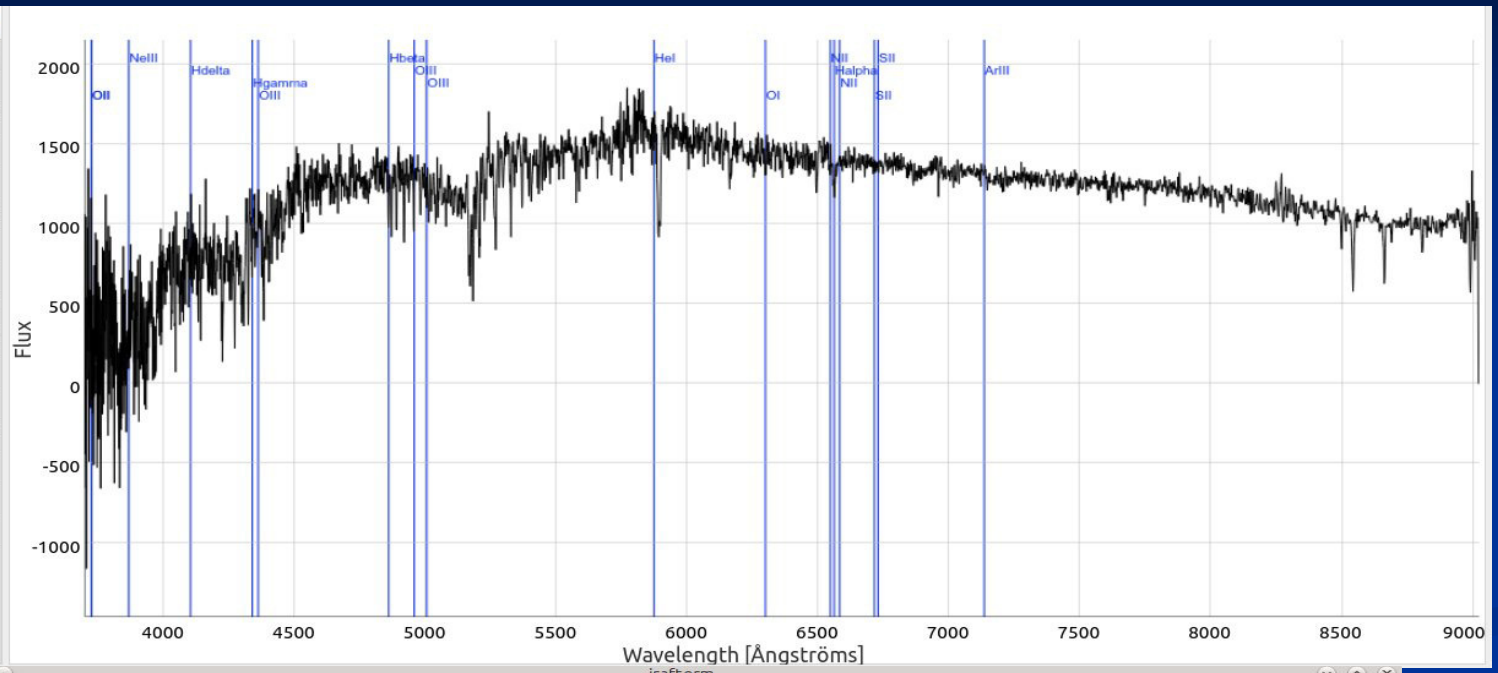
KIC	var type	period	threshold [ppm]	Q	SpT	site
1026895	spots	5 days	5.3	0	K4III	SPM
1160867	spots	6 days	3.4	1	K4III	SPM
1162220	q-per	–	8.6	3	K3III	SPM
2159700	spots	3.5 days	3.6	1	M0.5III	SPM
2450412	spots	–	5.7	3	K5III	SPM
2846051	spots	5 days	4.9	3	K4III	SPM
3101129	const	–	10.0	1	K7V	SPM
3128488	periodic+flares	6 days	15.0	1	K5V	SPM
3222519	spots	–	2.5	1	M1Ia	SPM
3430868	q-per	–	3.5	2	K0IV	SPM
3630240	q-per	–	11.0	2	K0III	SPM
3735269	q-per	–	7.8	2	K1.5III	SPM
3735699	spots	–	5.1	3	K2II	SPM
3836105	spots	2 days	5.1	3	K4III	SPM
3936736	spots	2 days	17.0	0	M0.5III	SPM
4040928	spots	10 days	8.9	3	M0V	SPM
4056079	q-per	–	5.1	2	K0III	SPM
4060593	spots	5 days	3.7	1	M0.5III	SPM
4243486	spots	–	7.8	2	K5III	SPM
4276716	const(?)	3.5 days	11.4	2	K3V	SPM
4346953	q-per	–	9.4	1	K2III	SPM
4373485	spots	–	9.5	2	M0III	SPM
4376841	spots	–	8.4	3	M0.5III	SPM
4385594	spots	–	2.1	3	M0III	SPM
4671547	periodic+flares	8.3+0.3 days	12.4	2	M0V	SPM
4736074	spots	20 days	3.5	1	K3V	SPM
4738764	q-per	–	9.6	2	K2III	SPM
4930560	periodic	10.5 days	7.2	2	M0V	SPM
4935950	periodic	13 days	8.0	2	M0V	SPM
5351659	spots	–	8.4	1	M2III	SPM
5390438	solar-like	1 hrs	7.5	3	K2III	SPM
5436582	spots	16 days	7.7	2	M0V	SPM
5629080	solar-like	40 min	5.6	3	K0III	SPM
5701829	solar-like	2 hrs	3.8	2	K0III	SPM
5707338	q-per	–	5.0	3		
5716526	q-per	–	3.0	1	K4III	SPM
5784204	spots	–	2.0	2	M0II	SPM
6368045	const(?)	–	8.2	3	M0V	SPM
6470598	spots	11 days	11.0	2	K5V	SPM
6531550	q-per	–	6.8	2	K1III	NOT

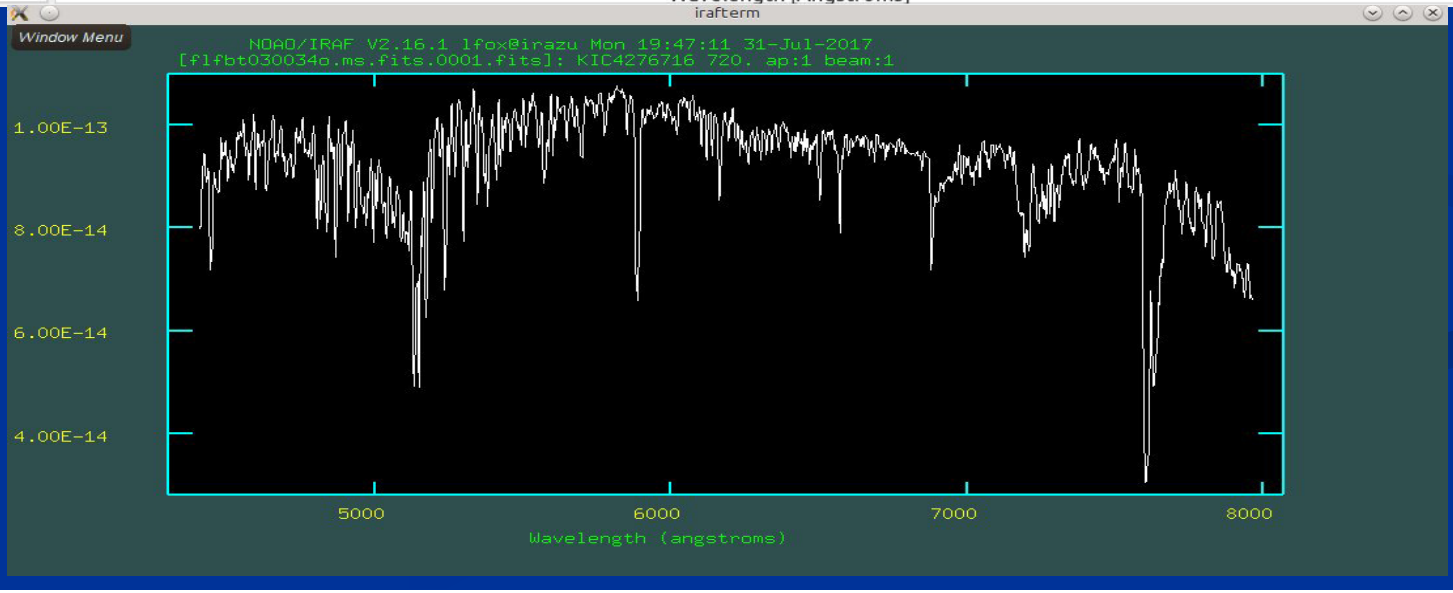
KIC	var type	period	threshold [ppm]	Q	SpT	site
6627606	q-per	–	3.1	1	K2III	NOT
6871713	spots	–	10.2	2	K0III	NOT
7023973	spots	–	10.0	3	M1III	NOT
7034097	spots	–	7.5	3	M0.5III	NOT
7049465	spots	–	7.4	3	K7V	NOT
7176070	spots	1.5 days	4.9	3	K5III	NOT
7499271	const(?)	–	11.8	2	K4V	NOT
7505113	spots	–	5.1	2	M4IIIa	NOT
7694241	const(?)	–	8.5	2	K4V	NOT
7748051	spots	–	9.4	3	M2III	NOT
7799575	spots	–	1.9	2	M0III	NOT
7936309	spots	–	8.4	2	K3V	NOT
8042251	spots	–	7.6	3	K7V	NOT
8211551	q-per	–	2.7	2	K0.5IIIb	NOT
8352528	spots	–	2.4	2	M0.5III	NOT
8386623	const(?)	–	8.8	1	K7V	NOT
8429280	periodic	1.6 days	7.3	2	K7V	NOT
8547390	q-per	–	2.9	2	K3V	NOT
8561221	solar-like	40 min	4.7	2	K0III	NOT
8677933	q-per	–	2.5	2	K0III	NOT
8737920	spots	–	6.8	2	K0IIIb	NOT
8831759	spots	14 days	2.1	2	M2III	NOT
9344010	const	–	9.9	2	K0IIIb	NOT
9455756	const(?)	–	26.0	3	K1V	NOT
9527740	spots	–	9.2	1	M2III	NOT
9532030	q-per	–	2.3	2	K2III	NOT
9896545	spots	–	4.5	2	M4III	NOT
10001154	spots	1.6 days	2.6	2	K2III	NOT
10026749	q-per	–	7.6	2	K5III	NOT
10063343	periodic+flares	8 hrs	–	3	K7V	NOT
10163983	spots	–	7.5	1	M2III	NOT
10230145	spots	–	6.7	1	K3V	NOT
10259462	spots	12 days	9.7	2	K4V	NOT
10490561	const(?)	–	10.5	2	K0IV	NOT
10785374	spots	–	8.5	2	K7V	NOT
10801273	spots	–	5.6	3	K7V	NOT
11099165	spots	–	2.9	2	M0.5III	NOT
11393580	spots	7.5 days	3.2	0,1,2,3,4	M0.5III	NOT
11446143	const(?)	–	3.9	0,1,2,3,4	K4V	NOT
11514682	const(?)	–	99.8	2	K7V	NOT
11560447	eclipsing	12 hrs	–	1,2	K1IV	NOT
11717716	spots	–	11.9	2	K7V	NOT
12010862	spots	–	8.0	3	M2III	NOT
12024065	spots	–	8.0	2	M2III	NOT
12102573	periodic+flares	2.8 days	14.2	2	K4V	NOT
12155015	spots	–	2.3	2	M1Ia	NOT
12644769	eclipsing	–	4.3	2	M1III	NOT

Comparison with LAMOST

Information

Name	Value
obsid	52908159
designation	J193957.64+
obsdate	2012-06-17
lmjd	56096
planid	kepler08B56
spid	8
fiberid	159
ra	294.9902080
dec	39.34638900
class	STAR
subclass	K3
rv	-10.7205783
logg	4.636
teff	4793.08
feh	-0.329

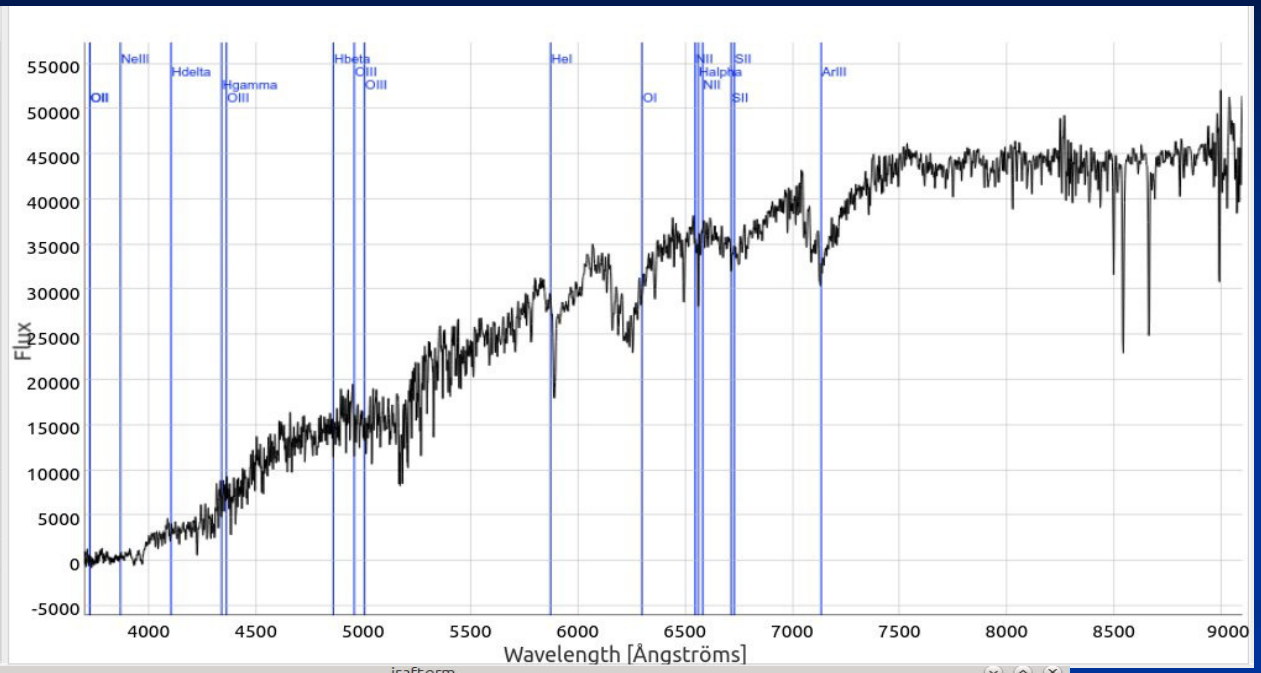


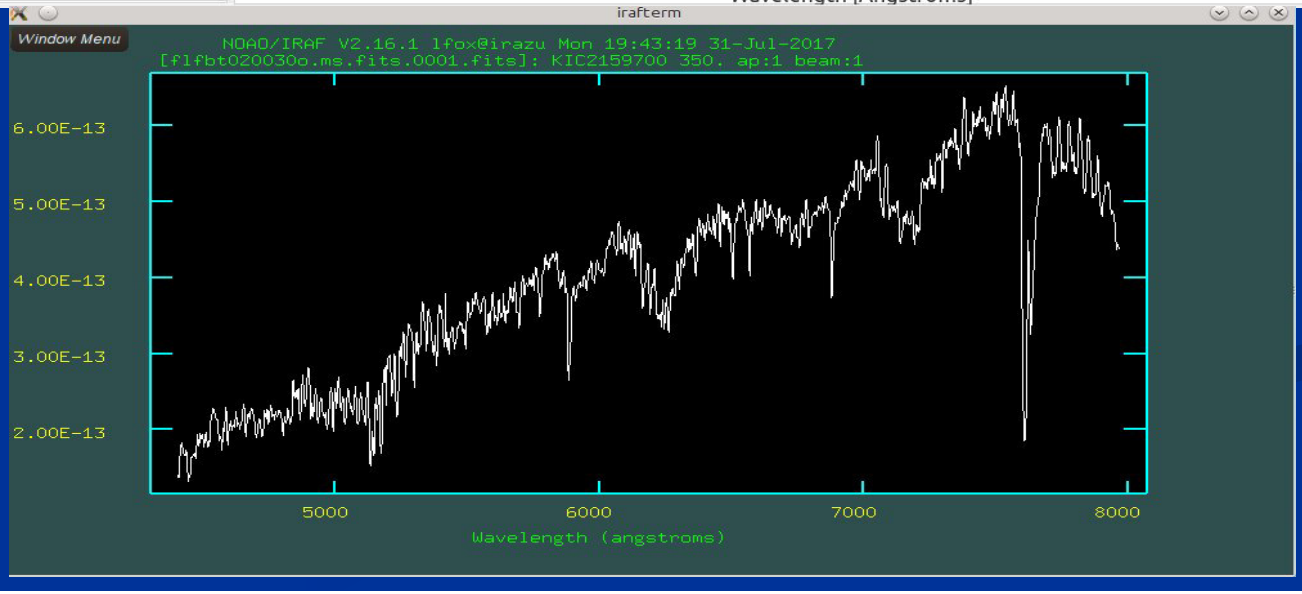


Comparison with LAMOST

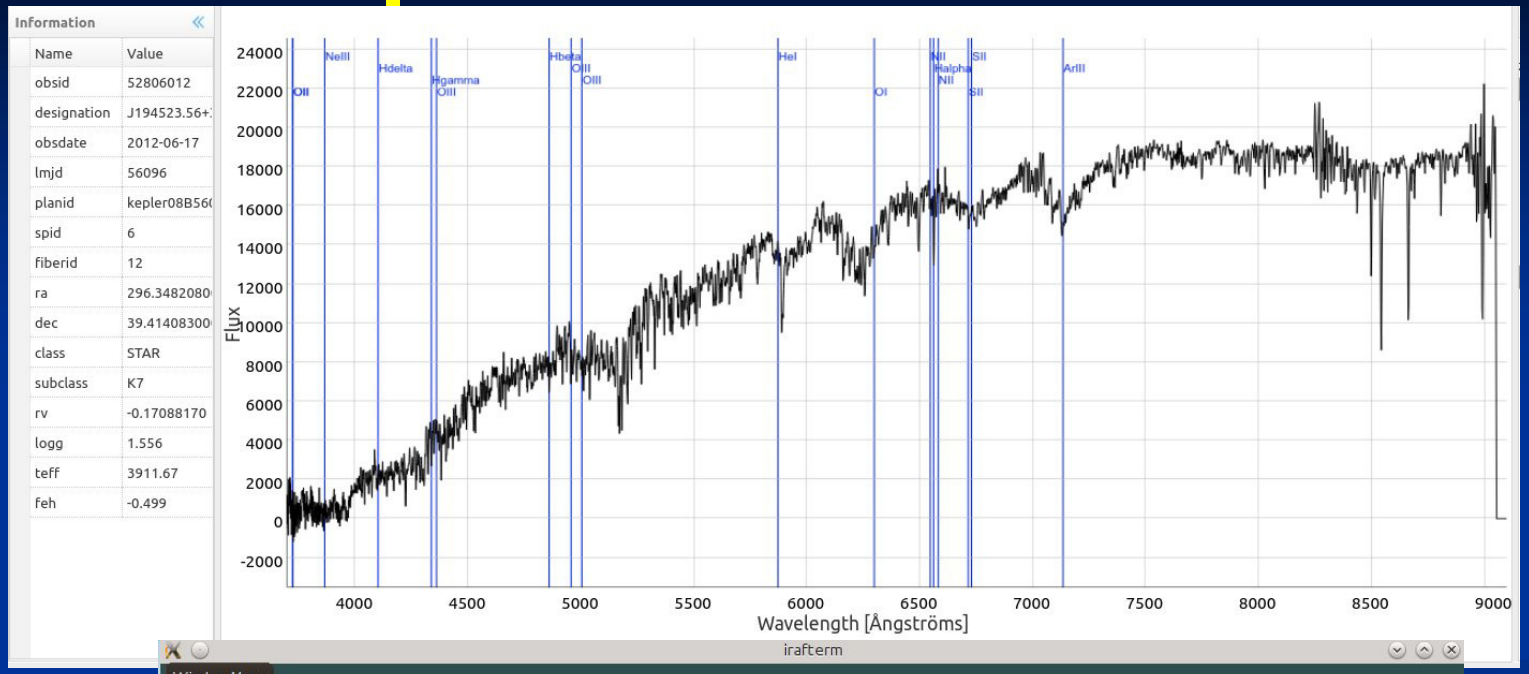
Information

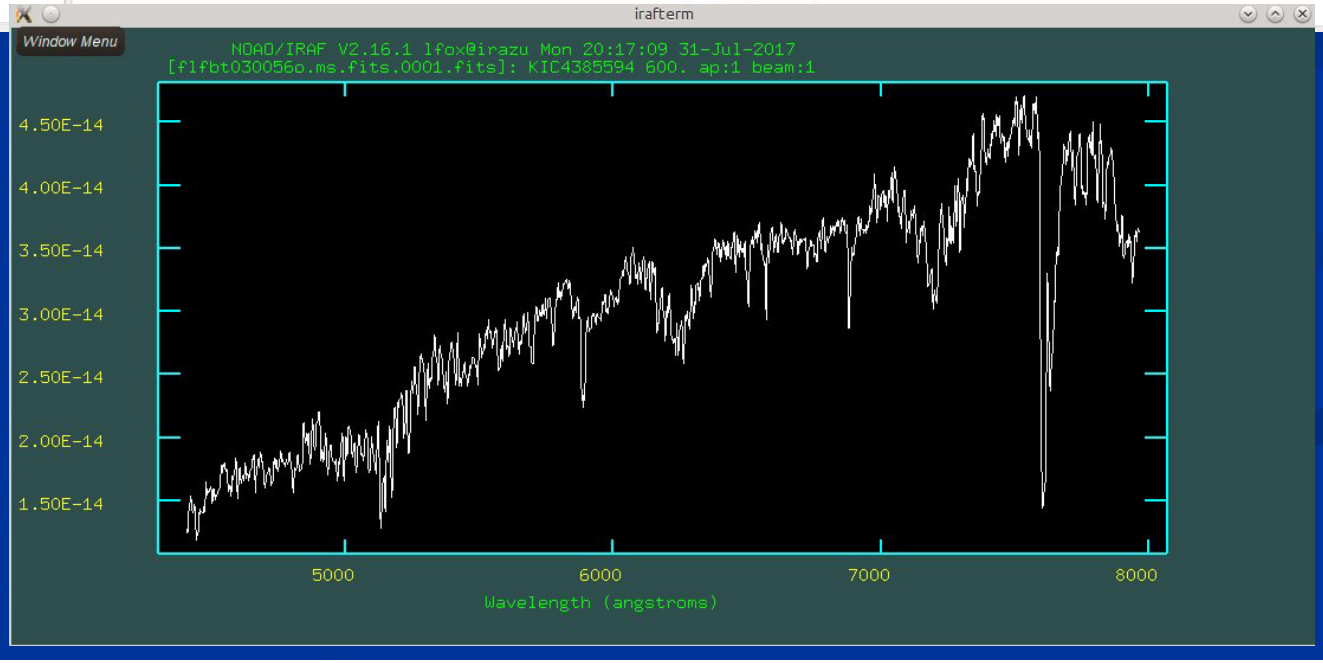
Name	Value
obsid	52501133
designation	J192521.88+373402.4
obsdate	2012-06-15
lmjd	56094
planid	kepler05B56094_2
spid	1
fiberid	133
ra	291.3412080000
dec	37.5673610000
class	STAR
subclass	K7
rv	-10.09101414
logg	1.477
teff	3872.75
feh	-0.130





Comparison with LAMOST

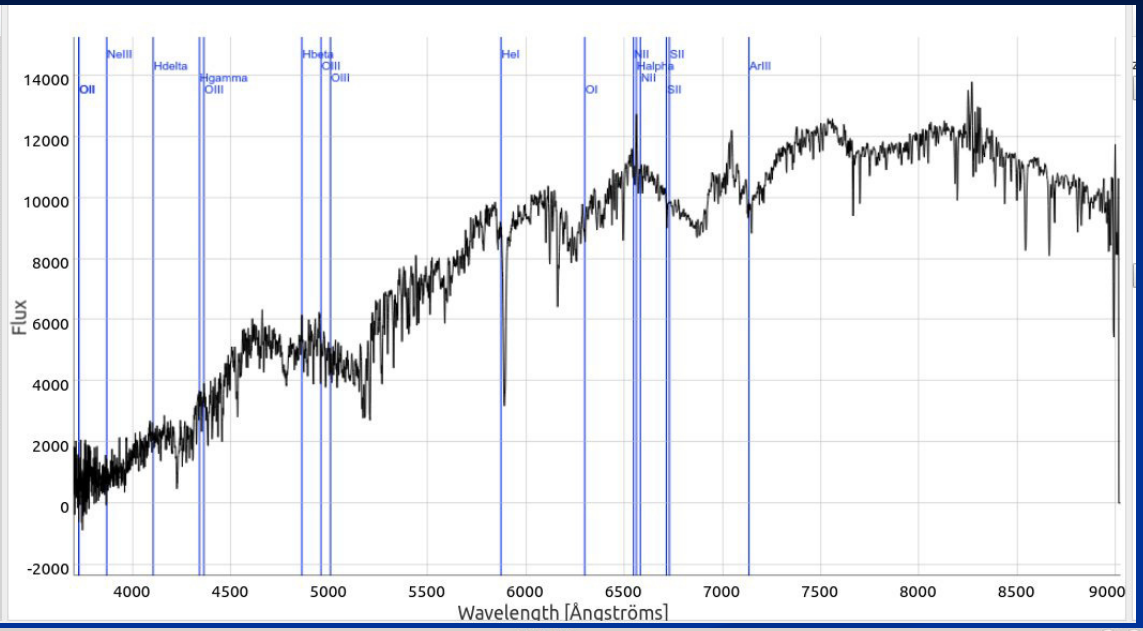


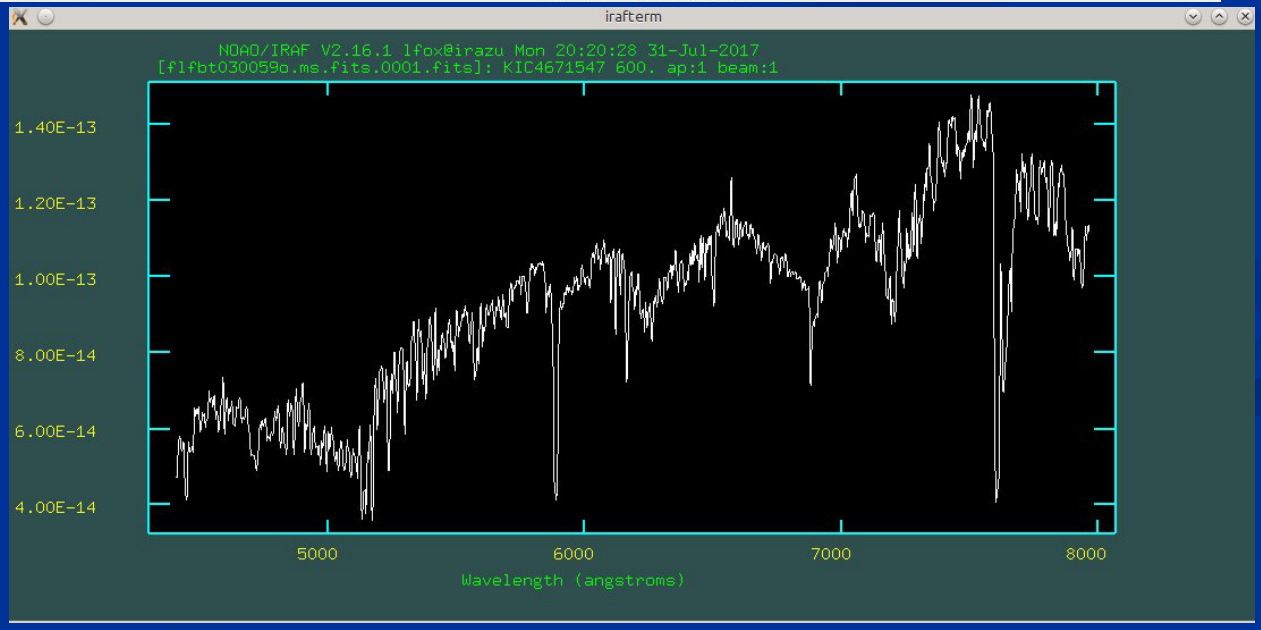


Comparison with LAMOST

Information

Name	Value
obsid	52808064
designation	J194357.52+394549.1
obsdate	2012-06-17
lmjd	56096
planid	kepler08B56096_1
spid	8
fiberid	64
ra	295.9897080000
dec	39.7636390000
class	STAR
subclass	M0
rv	-15.00000000





Comparison with LAMOST

1160867	K4	K5
2159700	M0	K7
4276716	K3	K3
4373485	M0	K5
4385594	M0	K7
4671547	M0	M0
4738764	K2	G5
4930560	M0	K7
5351659	M2	M2
5716526	K4	K3
6368045	M0	M0
7023973	K4	K5
7748051	M2	M1
8429280	K7	K3

Wegpages:
Instituto de Astronomia-UNAM-Ensenada
www.astrosen.unam.mx

San Pedro Martir Observatory
www.astrossp.unam.mx

Thank you