Spectroscopic Study of Solar-Like Stars Selected for Candidates for Kepler Asteroseismic Targets

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We report spectroscopic observations of 23 candidates for Kepler asteroseismic targets and 10 other stars in the Kepler field. For all these stars, we derive the radial velocity, effective temperature, surface gravity, metalicity, the projected rotational velocity, and we estimate their MK type. HIP 97513 and HIP 92132 we classify as suspected new single-lined spectroscopic binaries. For 28 stars, the radial velocity is measured for the first time.

The observations were carried out at the M.G. Fracastoro station (Serra La Nave, Mount Etna) of the Catania Astrophysical Observatory (CAO), Italy and at the F.L. Whipple Observatory (FLWO), Mount Hopkins, Arizona, in May – September 2007 (see **Fig. 2**). Of the 28 observed stars, 21 have been selected for asterosiesmic targets for the Kepler telescope (see **Fig. 1**.) Results obtained for all the 28 targets are discussed in detail in Molenda-Żakowicz et al. 2008.

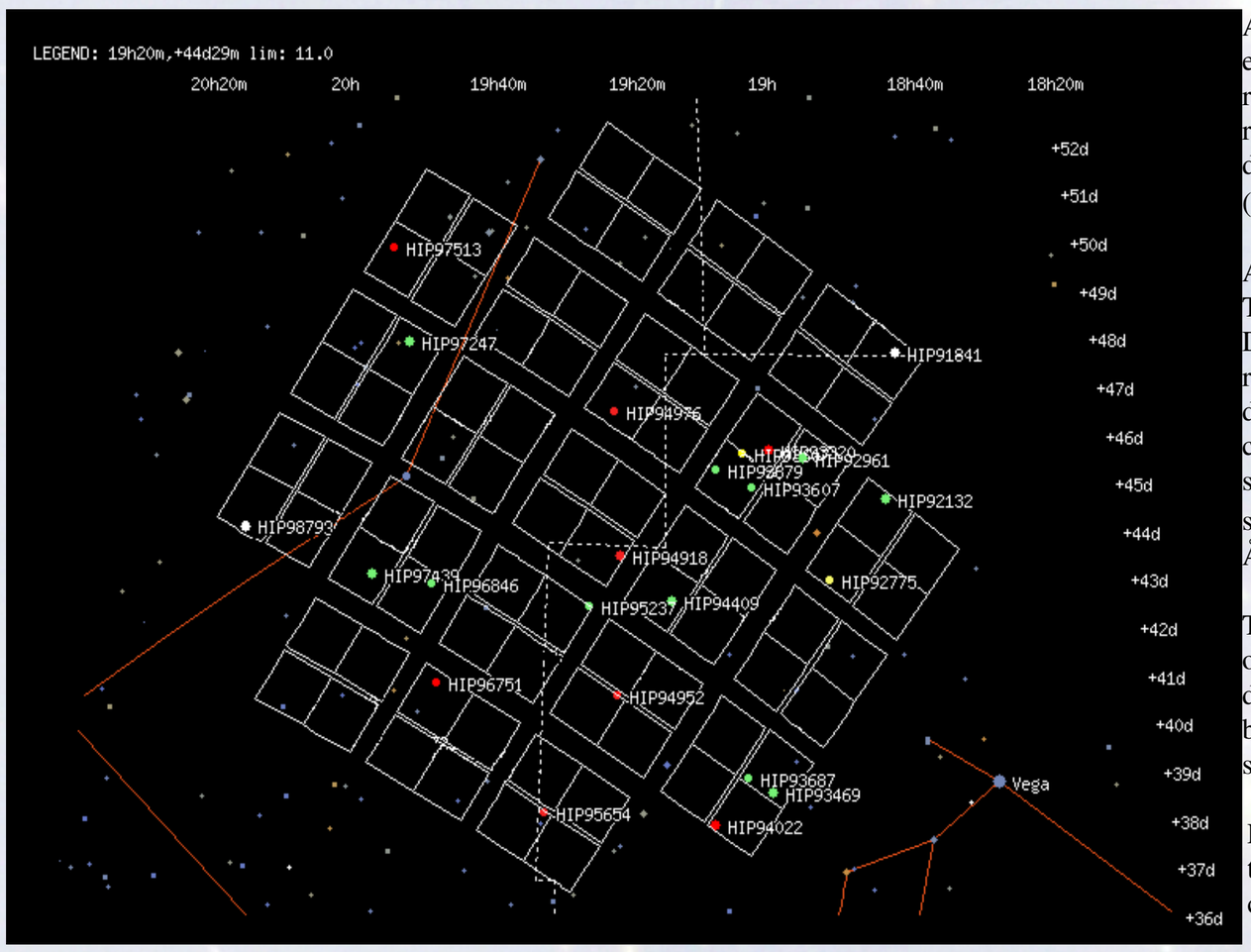

Fig 1. 21 stars selected for asterosiesmic targets for the Kepler telescope. Green – stars likely to be observed, yellow – possible targets, red – potential but unlikely targets. Two white stars are rejected candidates. The dashed lines mark the borders of constellations. The location of the 42 chips of Kepler's CCDs is plotted with lines.

At CAO, we used a 91-cm telescope and the fiber-fed echelle spectrograph FRESCO. The spectra were recorded with resolving power R=21,000 in a spectral range that covered about 2,500 Å in 19 orders. As the detector, a thinned back-illuminated CCD SITe chip (SI033B) with 1024x1024 24x24-μm pixels was used.

At FLWO, we used the 1.5-m Tillinghast reflector and the CfA Digital Speedometer with resolving power R=35,000. As the detector, an intensified photon-counting Reticon was used. In this system, a single 45Å spectrogram, centred at λ ≅5,187 Å, was recorded in one exposure.

The radial velocities of stars observed at CAO were determined via the cross-correlation method provided by IRAF. For the templates, radial velocity standard stars were used.

For the spectrograms measured at FLWO, for the templates, the model atmospheres of R.L. Kurucz and computed by Jon Morse were used (Torres et al.~2002).

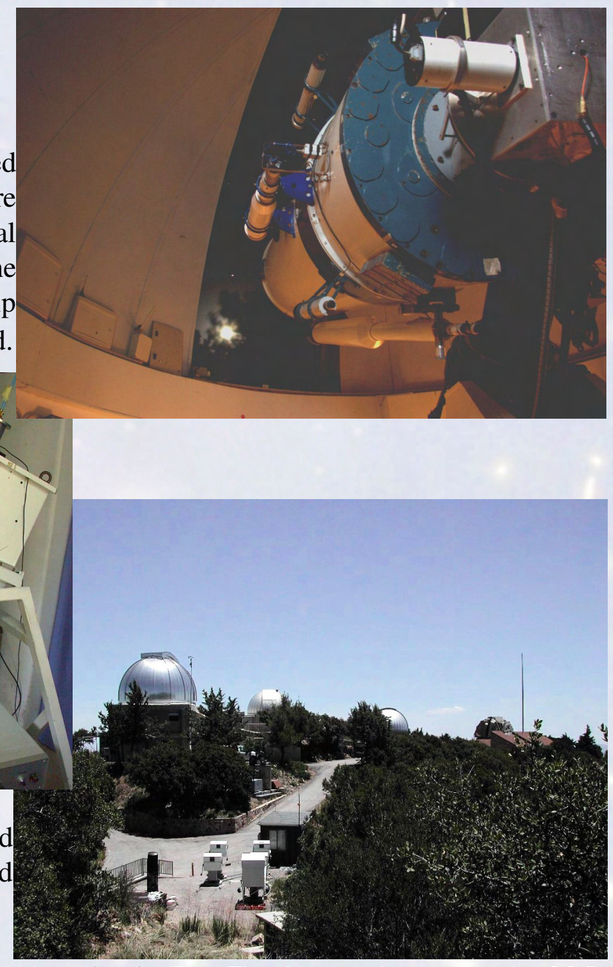

Fig. 2. *Top*: The 91-cm telescope at the M.G. Fracastoro station of the Catania Astrophysical Observatory; *left*: - the FRESCO spectrograph at the CAO; *bottom*: the F.L. Whipple Observatory. Arizona, USA.

In Table 1, we list $T_{\rm eff}$, log g [*Fe/H*] and the MK type of 21 Kepler asteroseismic targets, as computed with the use of the ROTFIT code (Frasca et al. 2003, 2006) and two separate libraries of reference stars: the ELODIE library (regular font), and the Serra la Nave library of stars observed at the CAO (italics). The agreement between atmospheric parameters of program stars based on these two libraries of reference stars is good.

The spectrograms obtained at the FLWO were used to determine $T_{\rm eff}$ and log g by means of a two-dimensional correlation technique TODCOR (Zucker & Mazeh 1994 and Torres et al. 2002). The results are given in Table 1 (bold face). In the computations, the [*Fe/H*] of program stars has been set to zero.

In Table 2, we list the *v*sin*i*, of the program stars, determined with the FWHM method for each star observed at CAO. The upper limit of 5 km/s has been estimated according to the instrumental resolution of the spectrograms. For the three stars that were observed at the FLWO, and for which we used the Kurucz model spectra for the determination of *v*sin*i*, the measured values agree well (see Molenda-Żakowicz et al. 2008).

Table 1. Atmospheric parameters of Kepler asteroseismic targets. In the last column, we list spectral types from the literature.

HIP	$T_{\rm eff}$	s.d.	log g	s.d.	[Fe/H]	s.d.	MK	lit.
92132	4947	155	2.50	0.16	-0.57	0.10	G3IV	G5
92775	5915	182	4.06	0.29	-1.68	0.19	sdF8	G2
92961	5927	104	4.24	0.11	0.00	0.06	G0V	F8
	6061	*38*	*4.14*	*0.11*	*0.01*	*0.04*		
93320	5107	125	4.27	0.13	-0.35	0.14	K1V	K3
	5077	*134*	*4.33*	*0.19*	*-0.15*	*0.12*		
	5000		**4.5**		**0.0**			
93469	6318	171	3.98	0.07	-0.17	0.13	F8IV	G0
	6246	*114*	*4.02*	*0.16*	*-0.23*	*0.09*		
	6750		**3.5**		**0.0**			
93607	6121	101	4.09	0.07	-0.03	0.06	F6IV	F5
	6081	*76*	*4.01*	*0.09*	*-0.03*	*0.04*		
93687	4865	78	2.66	0.09	-0.07	0.12	G9III	K0
93879	6116	144	3.98	0.08	-0.38	0.09	F8IV	F8
	6076	*80*	*4.01*	*0.13*	*-0.39*	*0.10*		
94022	4005	90	1.53	0.29	-0.16	0.07	K4III	K0
	4250		**2.0**		**0.0**			
94292	4895	152	2.68	0.32	-0.27	0.21	G8III	G8V
94409	4011	90	1.63	0.20	-0.13	0.05	K4III	M0
94918	5875	144	4.10	0.15	-0.22	0.14	G0V	G2V
	6038	*70*	*4.12*	*0.15*	*-0.27*	*0.17*		
94952	4072	66	1.75	0.10	-0.19	0.06	K4III	K5
94976	4976	156	2.55	0.09	-0.24	0.21	G5III	K0V
95237	4892	97	2.63	0.08	-0.11	0.12	G7III	G5
95654	6284	173	3.97	0.09	-0.08	0.08	F6IV	F5
96751	4601	44	2.30	0.16	-0.11	0.04	K1III	K2
96846	4599	48	2.27	0.12	-0.07	0.05	K1III	K2
97247	4040	72	1.74	0.07	-0.17	0.08	K4III	K5
97439	5370	118	1.49	0.34	0.06	0.07	G2Ib	G2
97513	4159	152	1.72	0.33	-0.20	0.06	K3III	K0

Table 2. The radial velocities, *R.V.* [km/s], and the projected rotational velocities, *v*sin*i* [km/s], of Kepler asteroseismic targets.

HIP	R.V.	s.e.	$v \sin i$
92132	−2.87	1.40	<5.0
92775	−271.05	0.54	7.0
92961	−29.23	0.15	<5.0
93320	−47.20	0.34	<5.0
93469	−55.16	0.63	8.5
93607	−2.14	0.37	<5.0
93687	10.08	0.19	<5.0
93879	−94.67	0.56	15.7
94022	−24.61	0.31	<5.0
94292	18.41	0.20	<5.0
94409	−29.30	0.25	<5.0
94918	−47.01	0.58	<5.0
94952	−53.92	0.18	<5.0
94976	8.92	0.23	<5.0
95237	−3.39	0.23	17.7
95654	−29.15	0.59	12.2
96751	7.38	0.18	<5.0
96846	−17.42	0.10	<5.0
97247	−4.81	0.19	5.3
97439	−7.19	0.44	12.3
97513	−8.69	2.73	<5.0

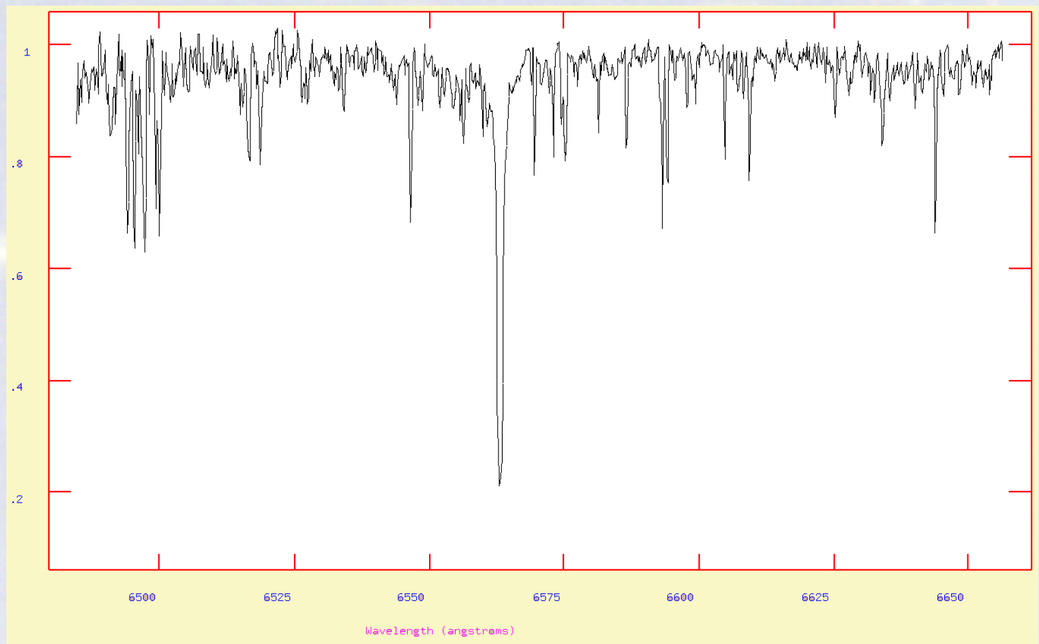

Fig. 3. A fragment of the spectrum a new SB1 system, HIP 92132, V = 9.47 mag, centred at the Hα line. The spectrum is measured with the FRESCO spectrograph with the exposure time 1.5 h.

References:
ELODIE: the stellar library
http://www.obs.u-bordeaux1.fr/m2a/soubiran/elodie_library.html
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