

The Kepler Input Catalog and Follow-Up Observations

Dave Latham for the Kepler Team

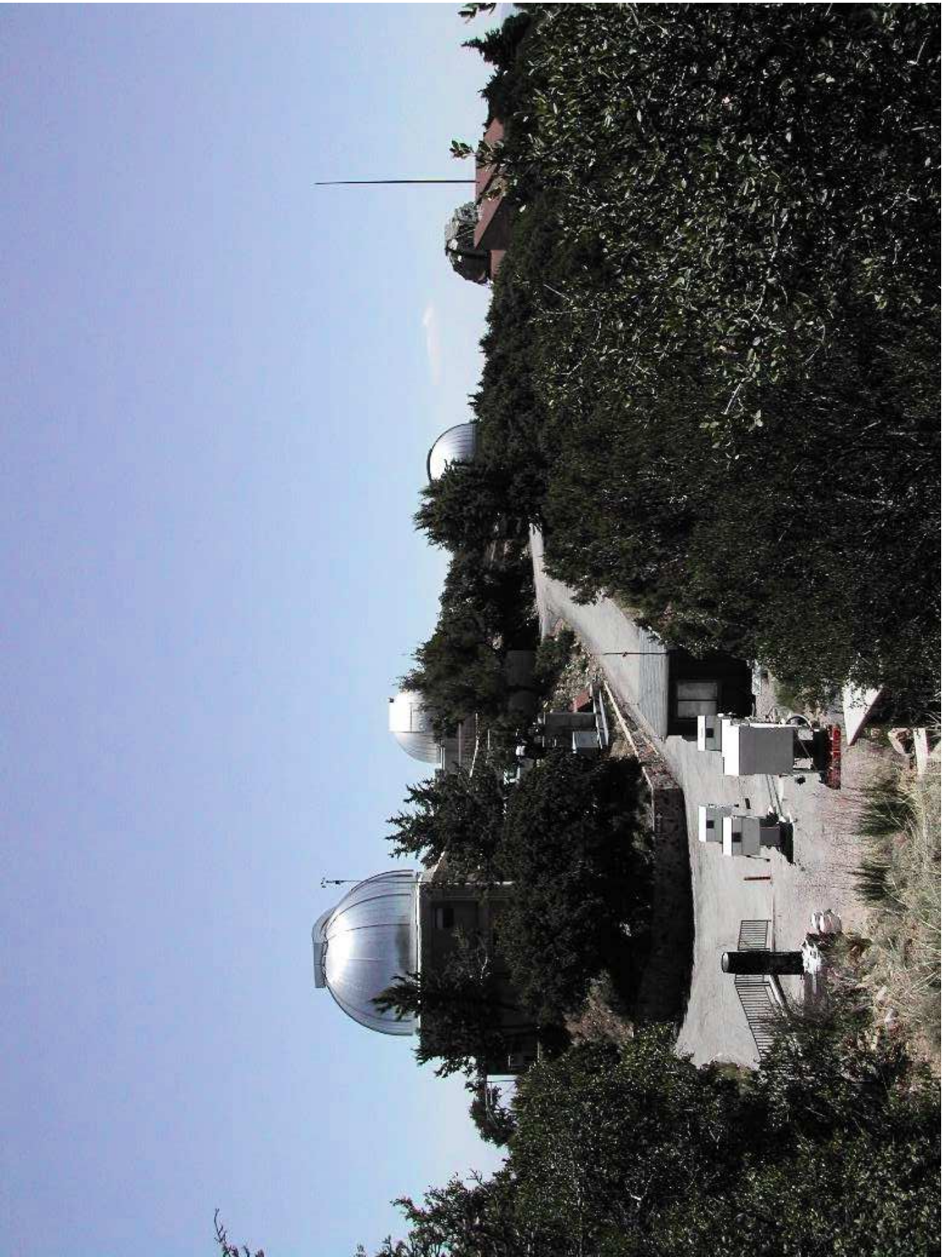
6 June 2006

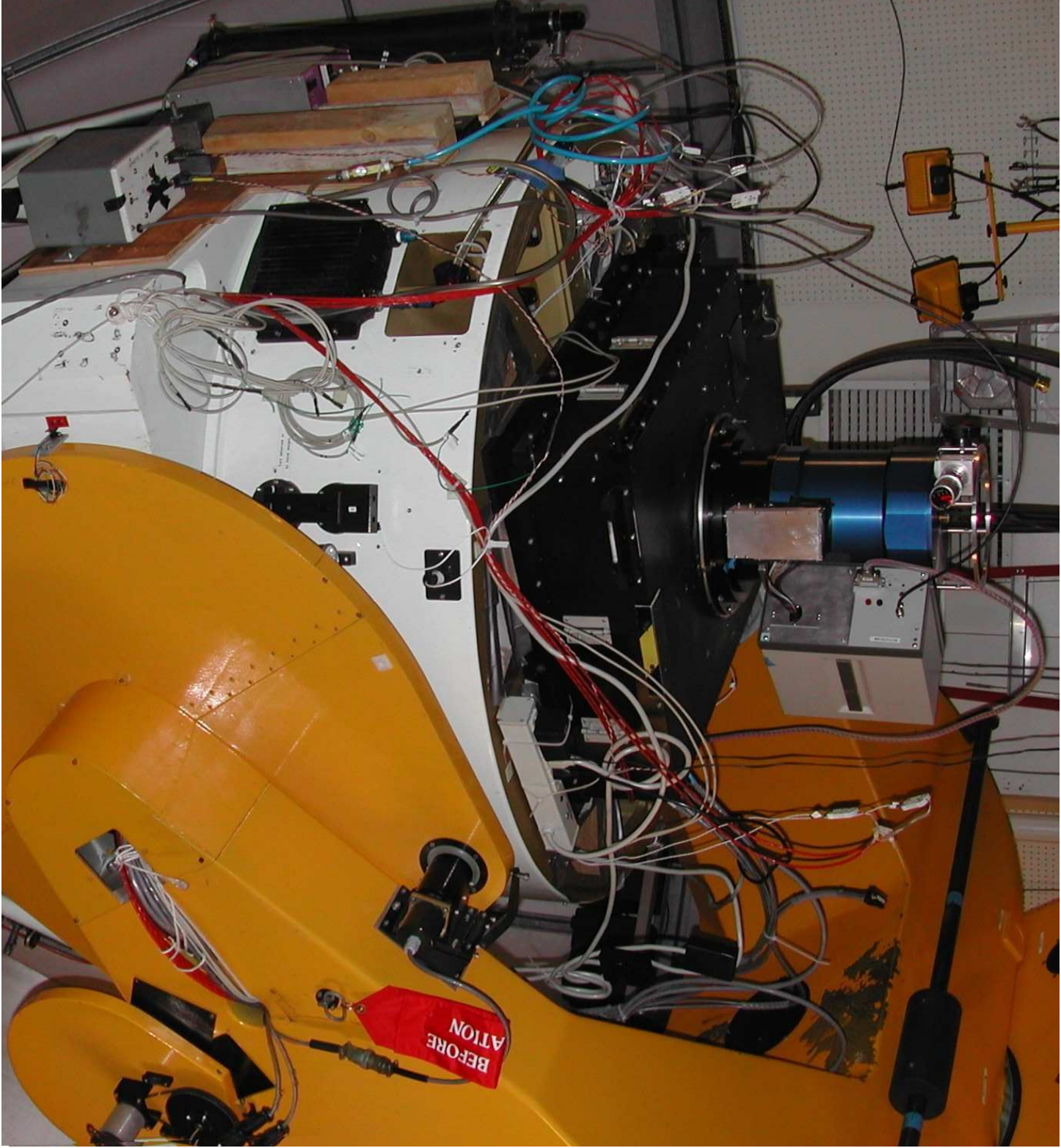
The Kepler Mission

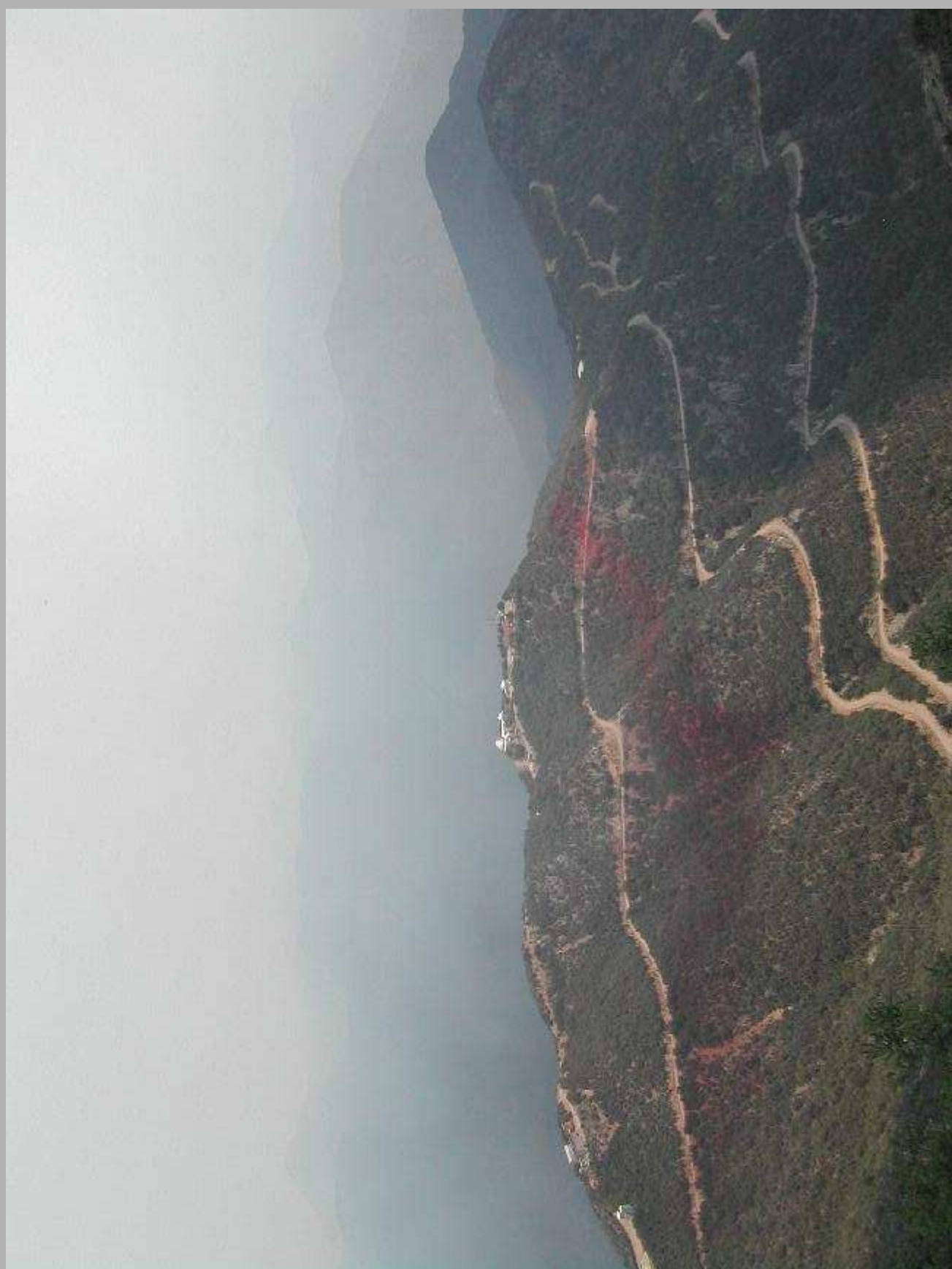
- 1-m Schmidt Telescope
 - 108 deg² on 42 CCDs, 4 arcsec pixels
 - Continuous staring for 4 years
- Targets selected from input catalog
 - 170,000 initially
 - 100,000 after 1 year
 - Pixels returned for processing on the ground

Kepler Input Catalog

- Used to select 170,000 optimum targets
- Photometry (Whipple Observatory, Arizona)
 - 2MASS JHK + SDSS griz + D51
- Includes all known stars in Kepler FOV
 - ~ 20 million stars (USNO-B)
 - ~ 2 million stars down to $K \sim 14.5$ mag
- Astrophysical characteristics
 - T_{eff} , $\log(g)$, $[\text{Fe}/\text{H}]$, reddening; Mass, Radius
 - Radial and rotational velocities









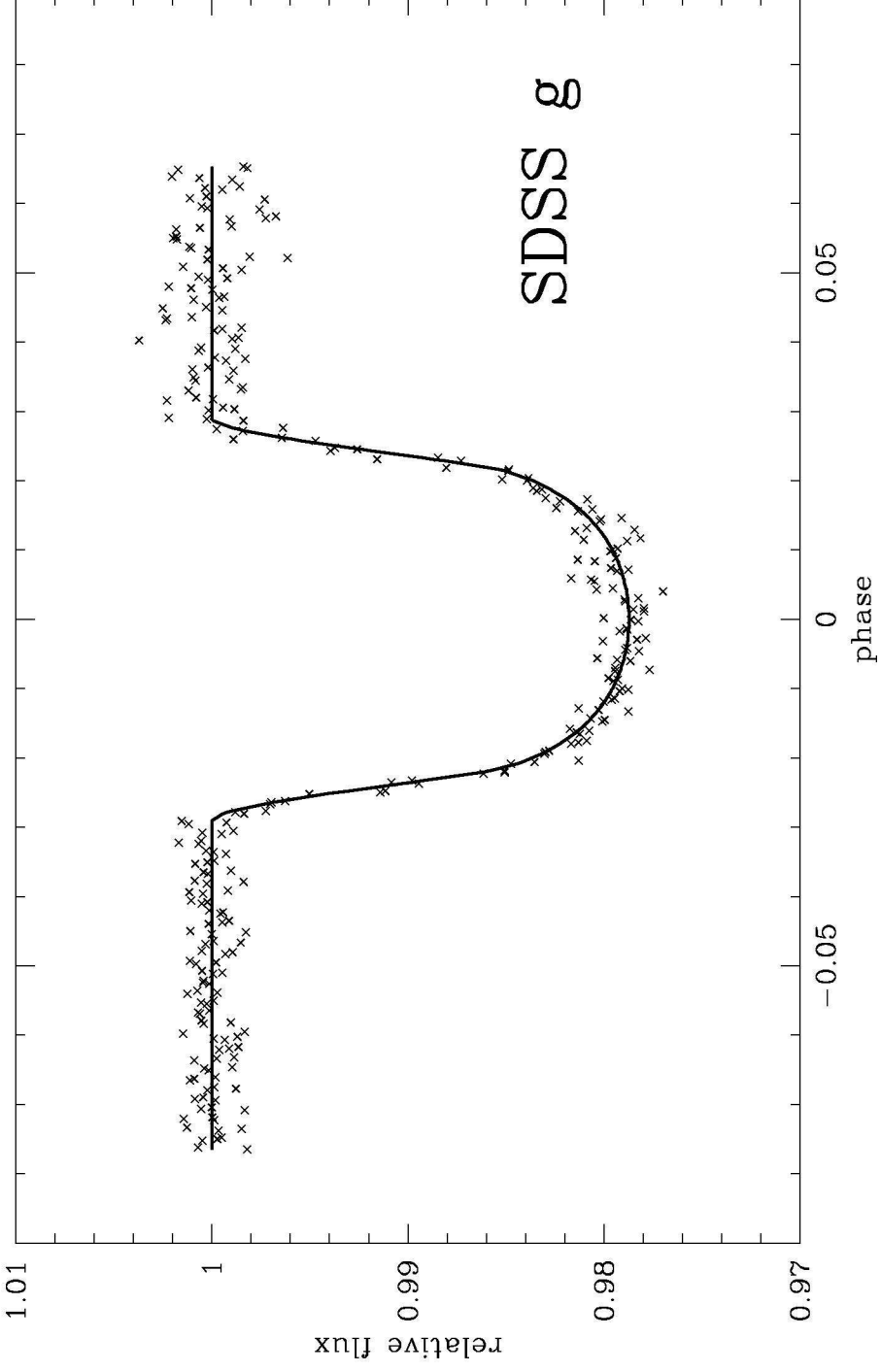




Transit Photometry

- Transit observations are hard to schedule
 - Poor ephemerides
 - They come when they want to
 - Solution: share time with Kepler photometry
- Transiting Planets
 - TrES-1, HD 149026, HD 189733, XO-1b
- F/M eclipsing binaries

HTR205-013

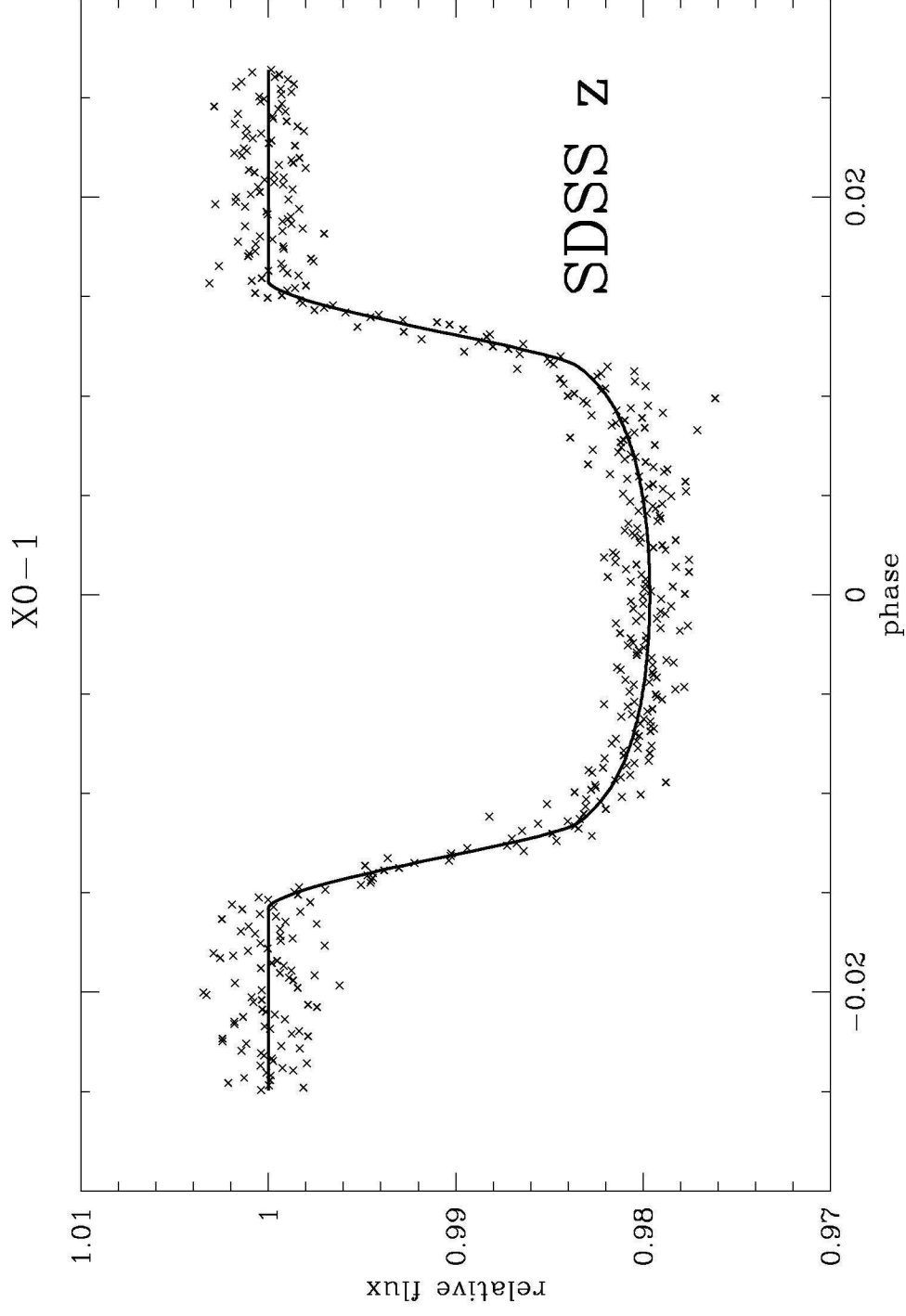


$$R_c/R_s = 0.132 \pm 0.001$$

$$a/R_s = 6.07 \pm 0.03$$

$$b = 0.29 \pm 0.01 \rightarrow i = 87.3 \text{ deg}$$

$$C(R_c/R_s, a) = 0.28 ; C(R_c/R_s, b) = 0.04 ; C(a/R_s, b) = -0.21$$



$$R_c/R_s = 0.134 \pm 0.001$$

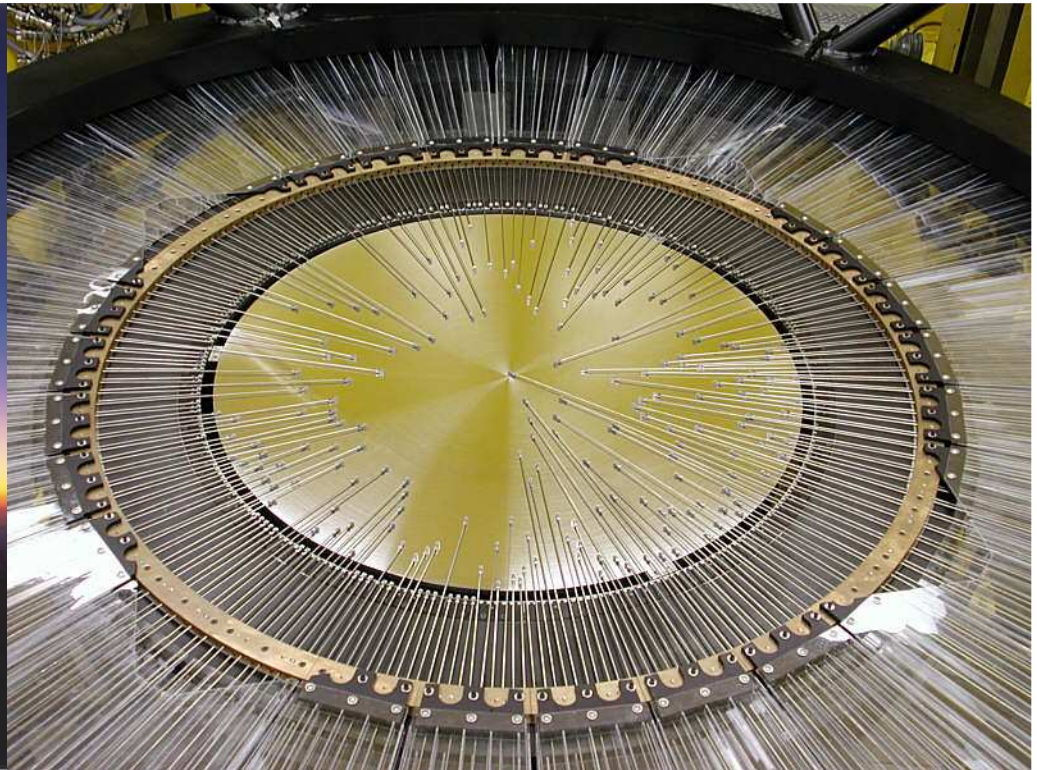
$$a/R_s = 11.00 \pm 0.02$$

$$b = 0.33 \pm 0.01 \rightarrow i = 88.3 \text{ deg}$$

$$C(R_c/R_s, a) = 0.24 ; C(R_c/R_s, b) = 0.05 ; C(a/R_s, b) = -0.28$$

Spectroscopy

- Refine stellar classifications
 - $\text{Log}(g)$ to ± 0.2
 - $[\text{Fe}/\text{H}]$ to ± 0.1 and even $[\alpha/\text{Fe}]$
 - Radial and rotational velocities
- Targets for spectroscopy selected using KIC photometric classifications

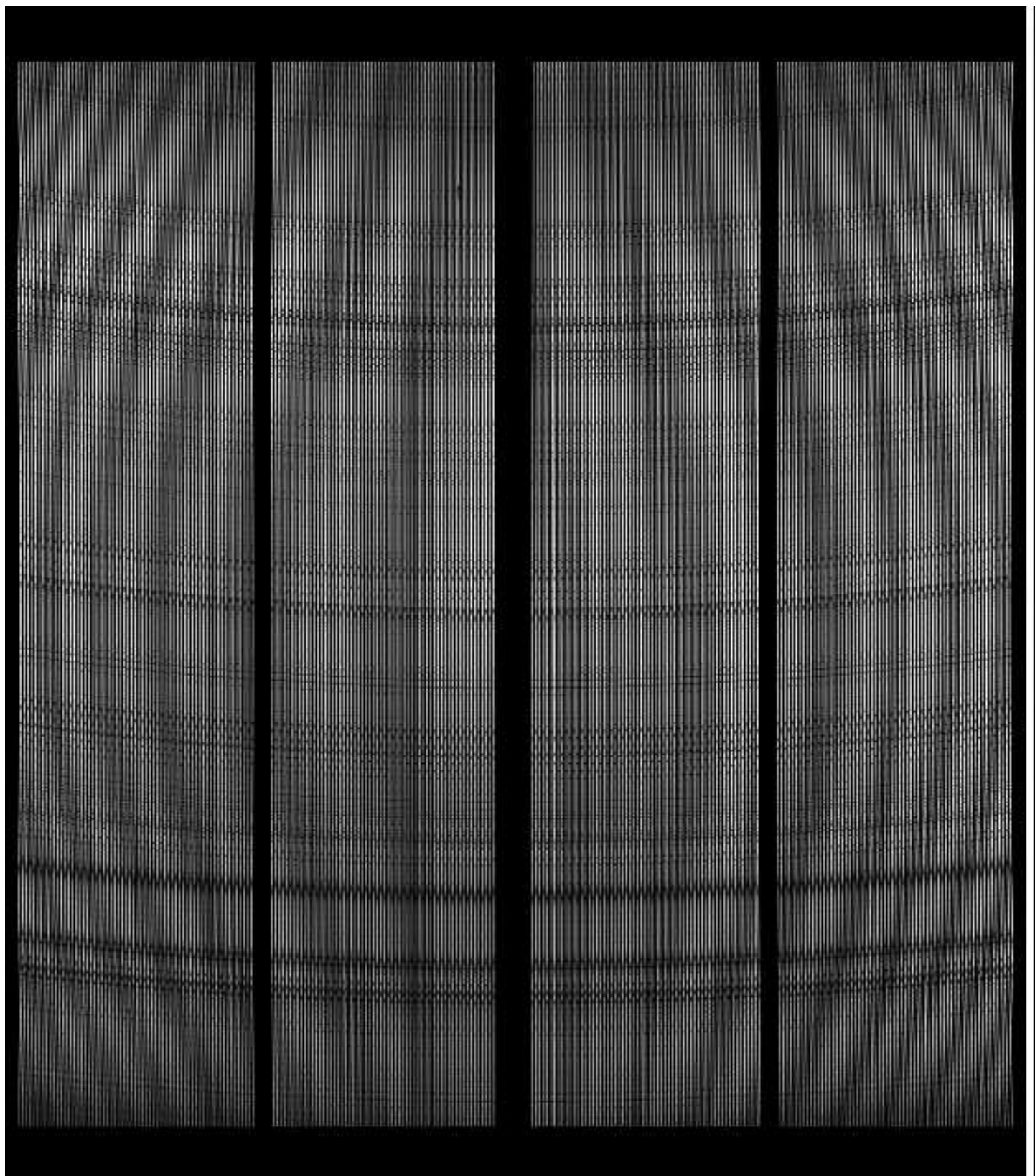


Hectochelle on the MMT

- 240 fibers, 8 km/s resolution
- Single order: RV31 is 5150-5300Å

Synthetic Spectra

- Old library – 32,000 spectra
 - 150A, tuned to CfA Digital Speedometers
- New Library – 1,100,000 spectra
 - 300A, full resolution (useful to everyone)
 - First 50,000 spectra in beta test
 - Solar metallicity, FGK stars, all gravities
- Solar spectrum (dusk sky)



File: OBJECT_cr_fnc.wms.fits[100]

2006-Apr-07 01:34:4

Object: Skyflat_1x RA: -1:00:00.00 DEC: D00000-100. 2000.0

HJD: 2453832 56734

Object BCV: 8.692

lambda: 5150.0 5300.0

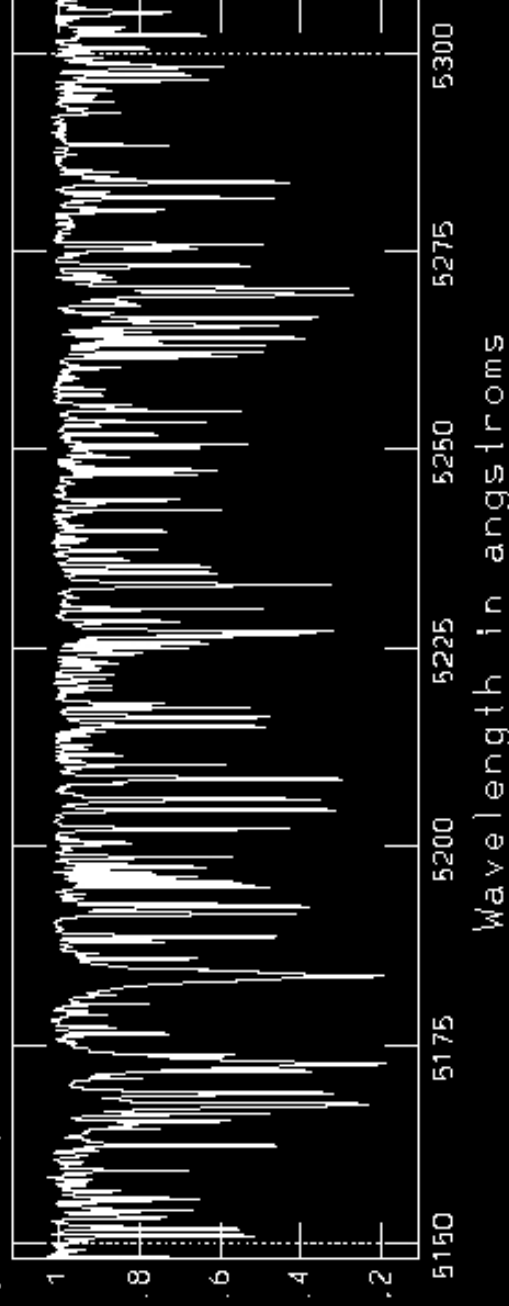
nbins: 4096

Filter: 5 20 125 250

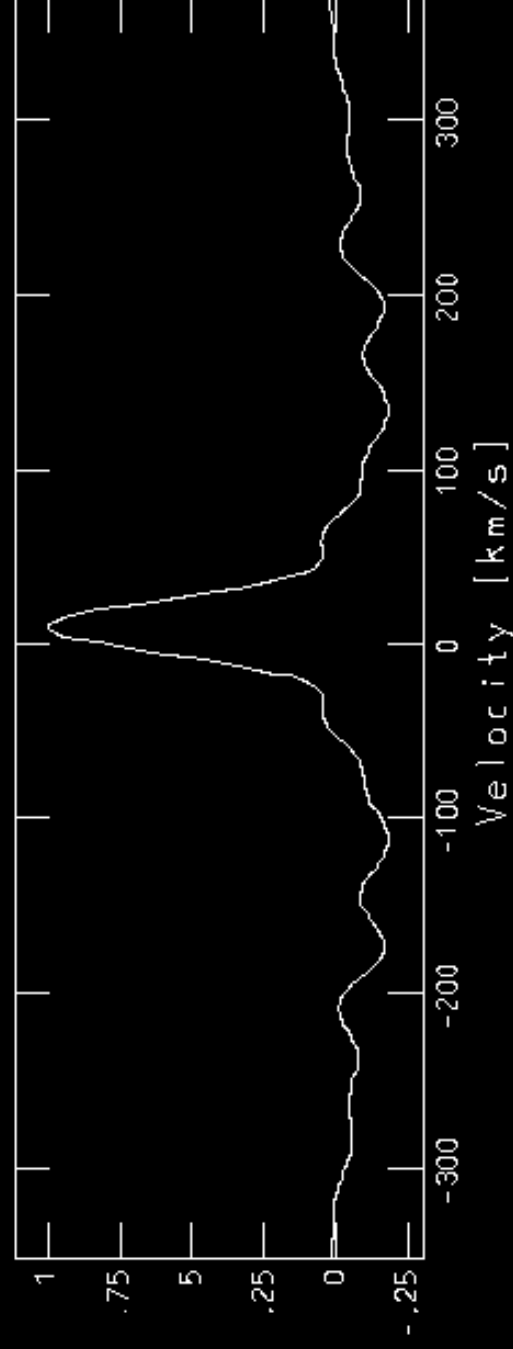
Frac. endmask: 0.05

Template	vel.	bcv	peak
t05750g	0.000	0.000	1.06

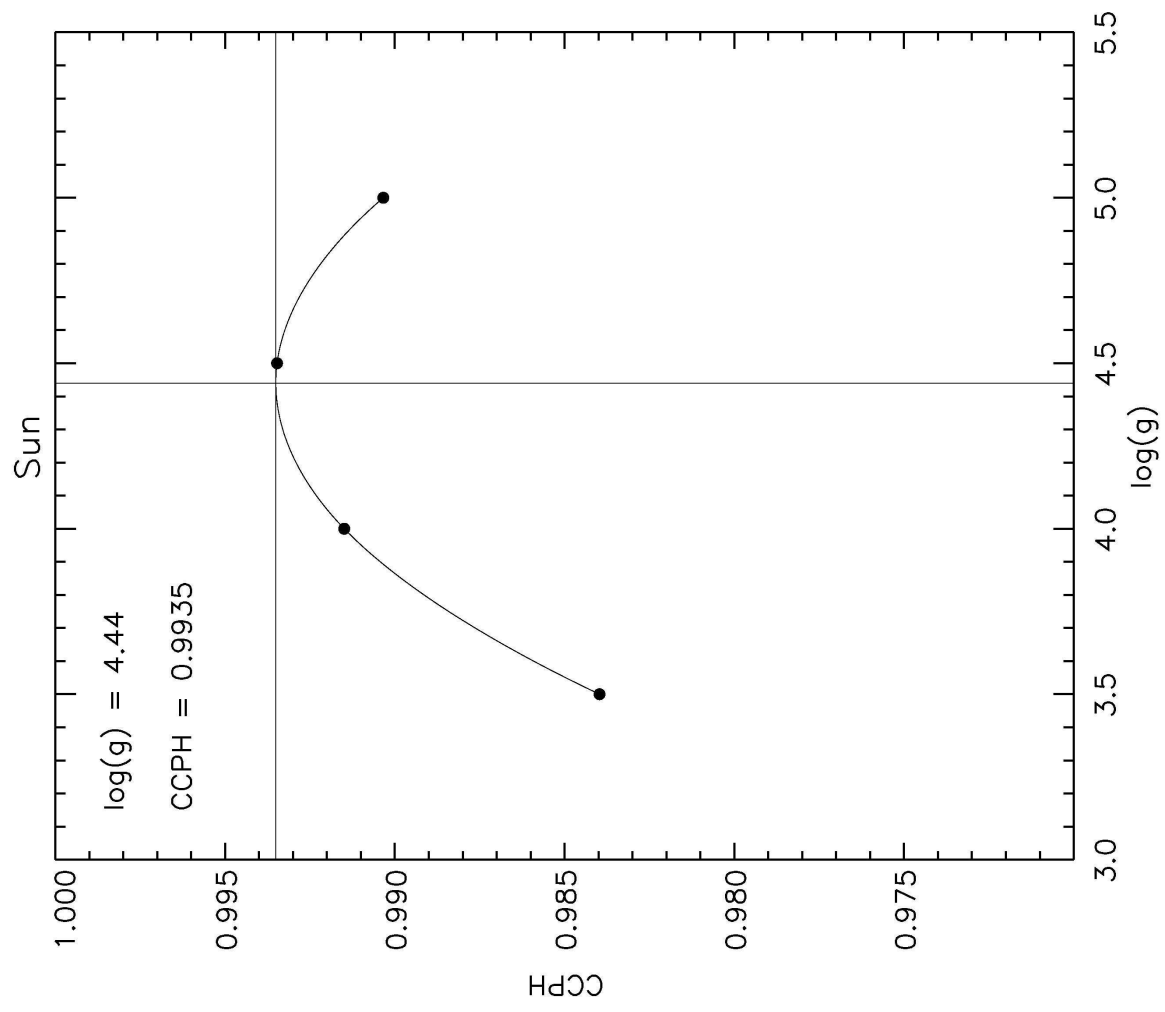
Template	CZ	error	R
t05750g	9.754	0.111	121.7

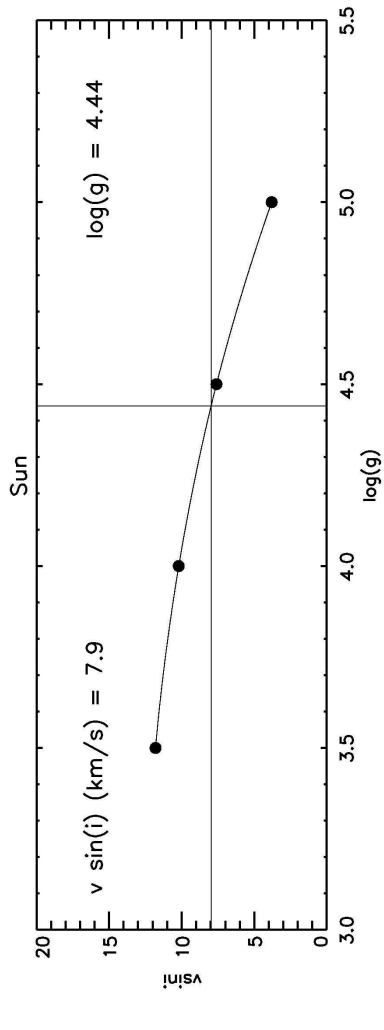
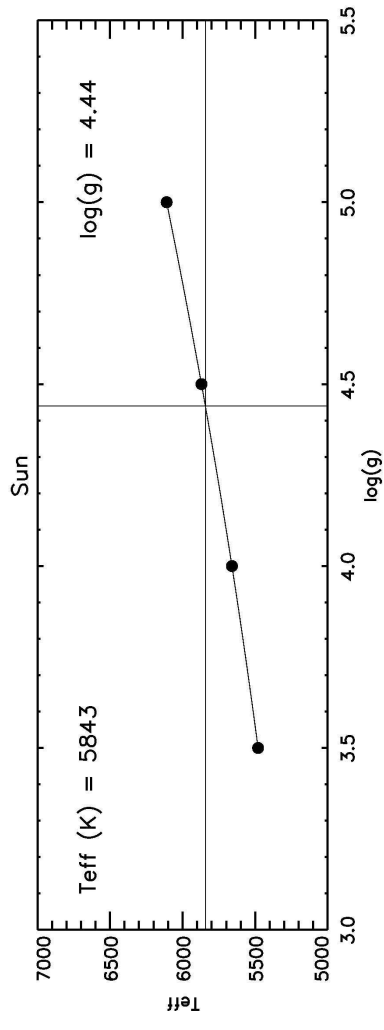
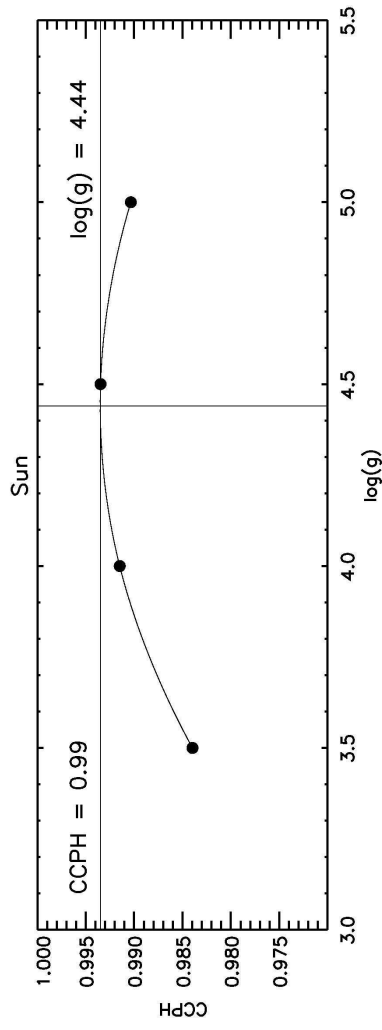


1 Corr. Template: SYN SPEC [100]



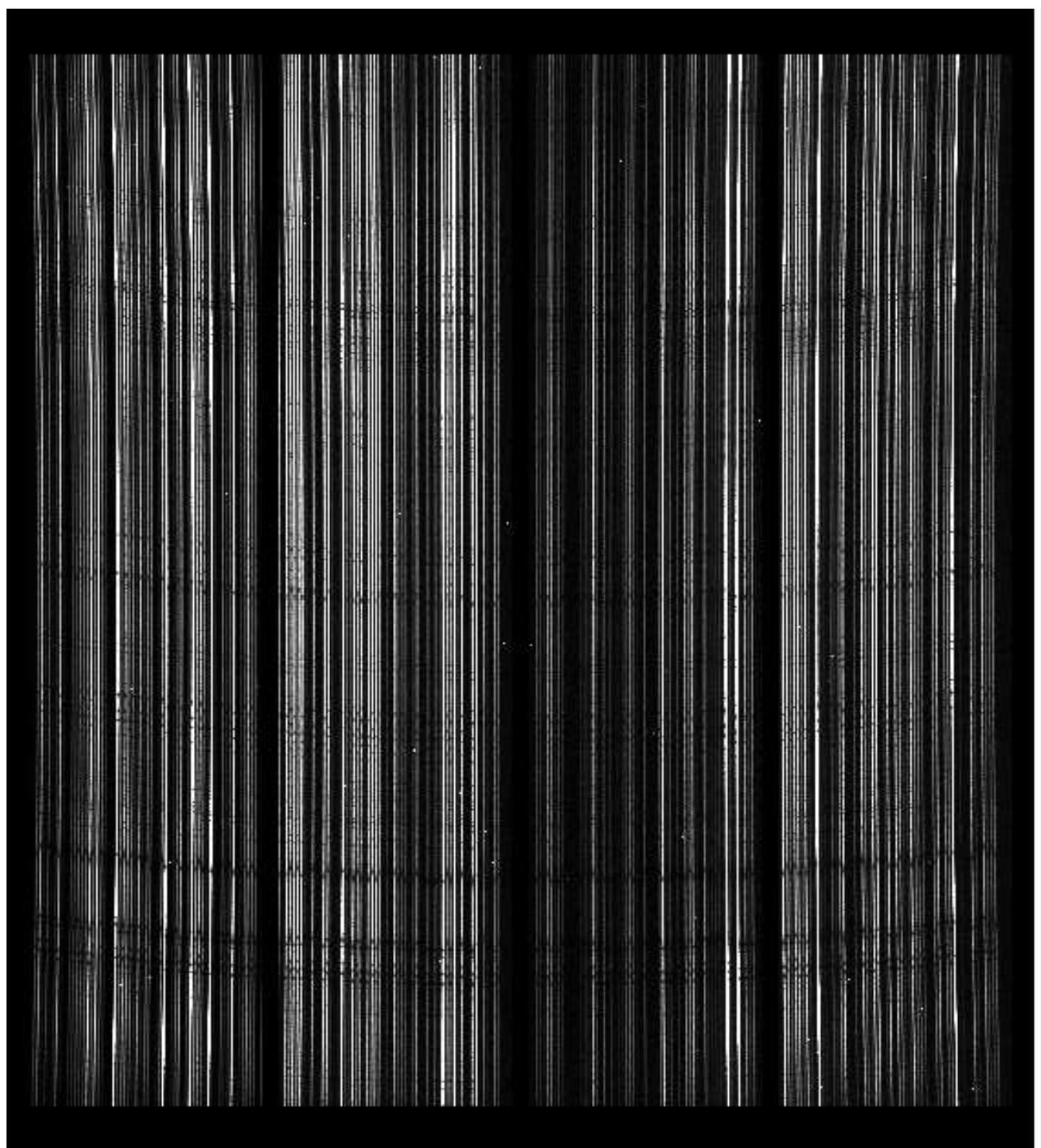
rvsao.dcsao 2.4.8 21-Apr-2006 17 14 0 50-ht. peak fit, 20 pts.



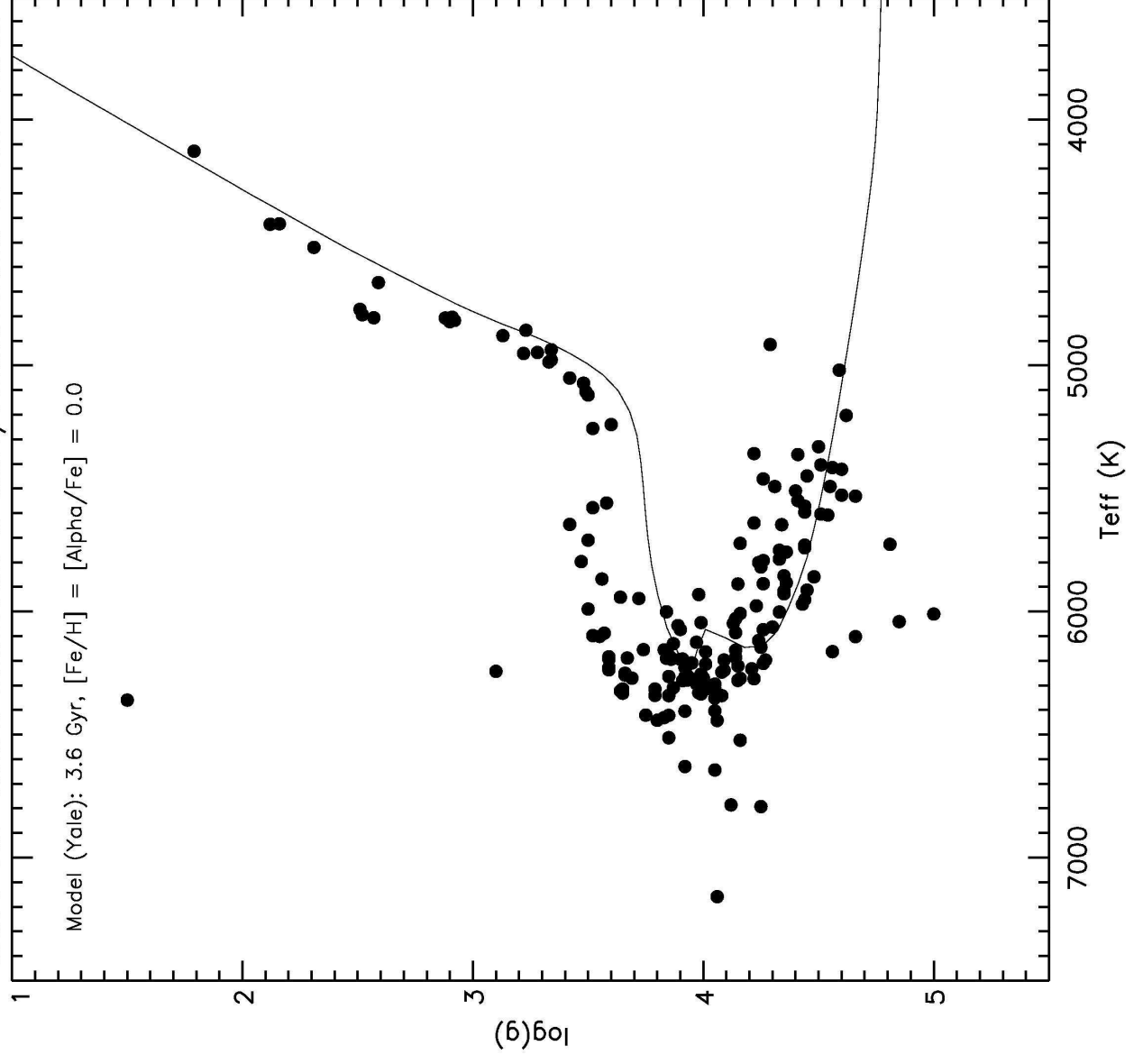


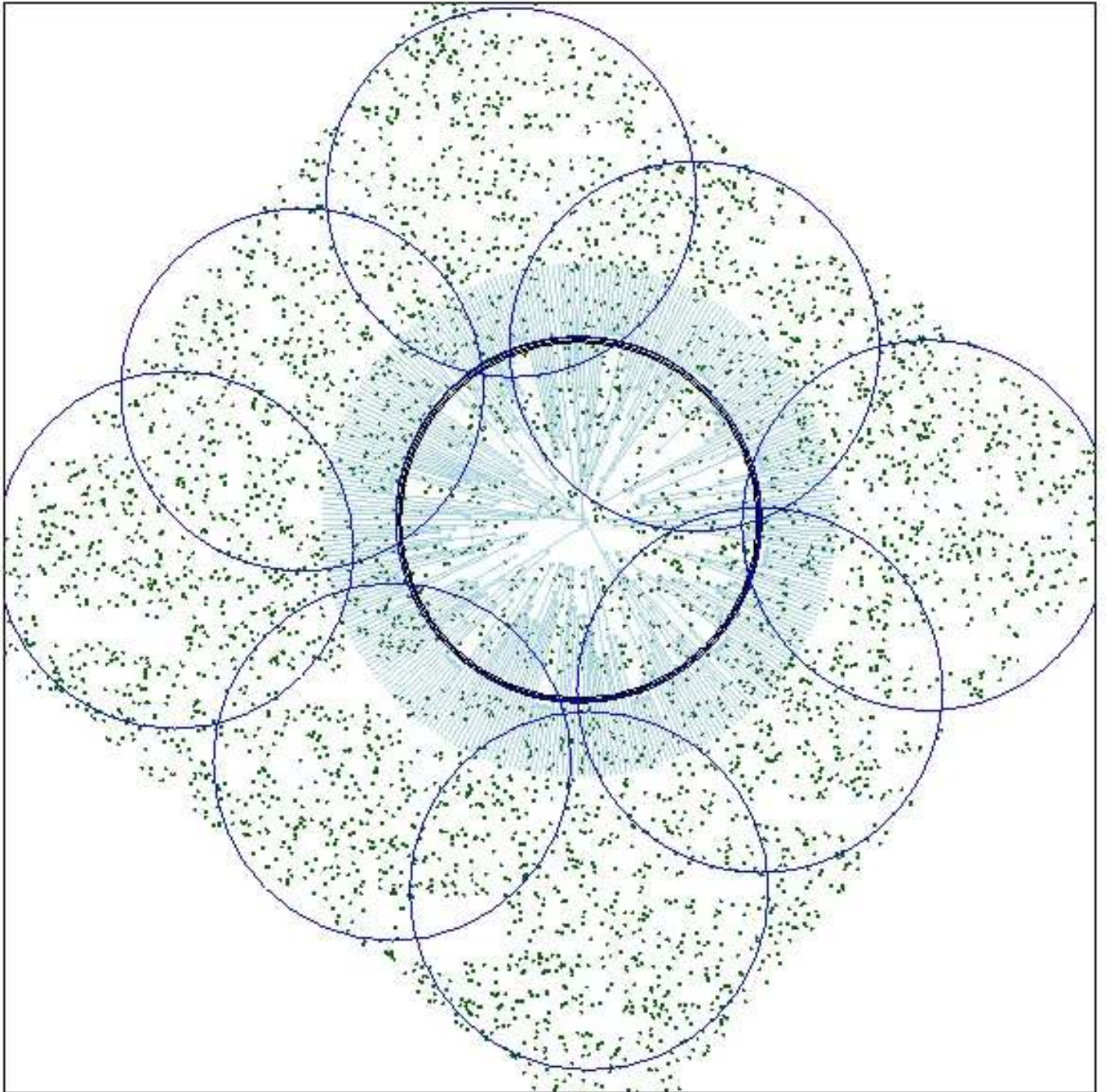
M67

- Old open cluster
 - Solar metallicity, solar age
 - Magnitude range $8 < V < 14$
 - Well studied by others
 - Used to calibrate KIC photometry



M67: 182 Stars observed w MMT/Hectochelle in Nov 2005





Kepler Input Catalog Team

- SAO Mt Hopkins - Whipple Observatory
 - Carl Hergenrother, Gil Esquerdo (observers)
 - Emilio Falco (Director, transit photometry)
 - Ted Groner (computers, software)
 - Wayne Peters (electronics, hardware)
 - Bob Hutchins (facility)
 - Perry Berlind, Mike Calkins (spectro observers)

Kepler Input Catalog Team

- SAO Cambridge
 - Willie Torres (eclipsing binaries, extrasolar planets)
 - John Geary (CCD cameras)
 - Andy Szentgyorgyi, Gabor Furesz (spectrographs)
 - Alex Sozzetti (extrasolar planets)
 - Søren Meibom (spectroscopy, clusters)
 - Steve Amato (electronics)
 - Kevin Bennett (model maker)
 - Cullen Blake, Jose Fernandez (grad students)
 - Thomas Beatty, Lucas Laursen (undergrads)
 - Telescope Data Center Team

Photometry Team

- Mark Everett (PSI)
 - Image reduction pipeline
- Tim Brown, Don Kolinski (HAO)
 - Extinction, SDSS transformation, data archive
 - Astrophysical interpretation
- Dave Monet (USNOFS)
 - Astrometry, catalog builds
- Steve Howell (NOAO, WYIN)
 - Advice

Synthetic Spectra Team

- Jon Morse + students (ASU, Goddard, now Senior Policy Analyst in OSTP)
- Bruce Carney + students (UNC)
- John Laird + students (BGSU)
- Supported by NSF, home institutions

Follow-Up Observing

- Science Office (NASA Ames)
 - Light curve shape, duration
 - Out-of-transit variation? Secondary eclipse?
 - Duration, ingress and egress okay?
 - Differential Image Analysis – photocenter shift
- David Monet (USNO Flagstaff)
 - Astrometry with the Kepler data - parallaxes

Follow-Up Observing - II

- Science team members
 - Spectroscopic reconnaissance
 - Radial velocity variation >0.5 km/s?
 - Composite spectrum?
 - Classify host star: T_{eff} , $\log(g)$, $[\text{Fe}/\text{H}]$, V_{rad} , V_{rot}
 - High spatial resolution images
 - Color effects during transit
 - Precise radial velocities