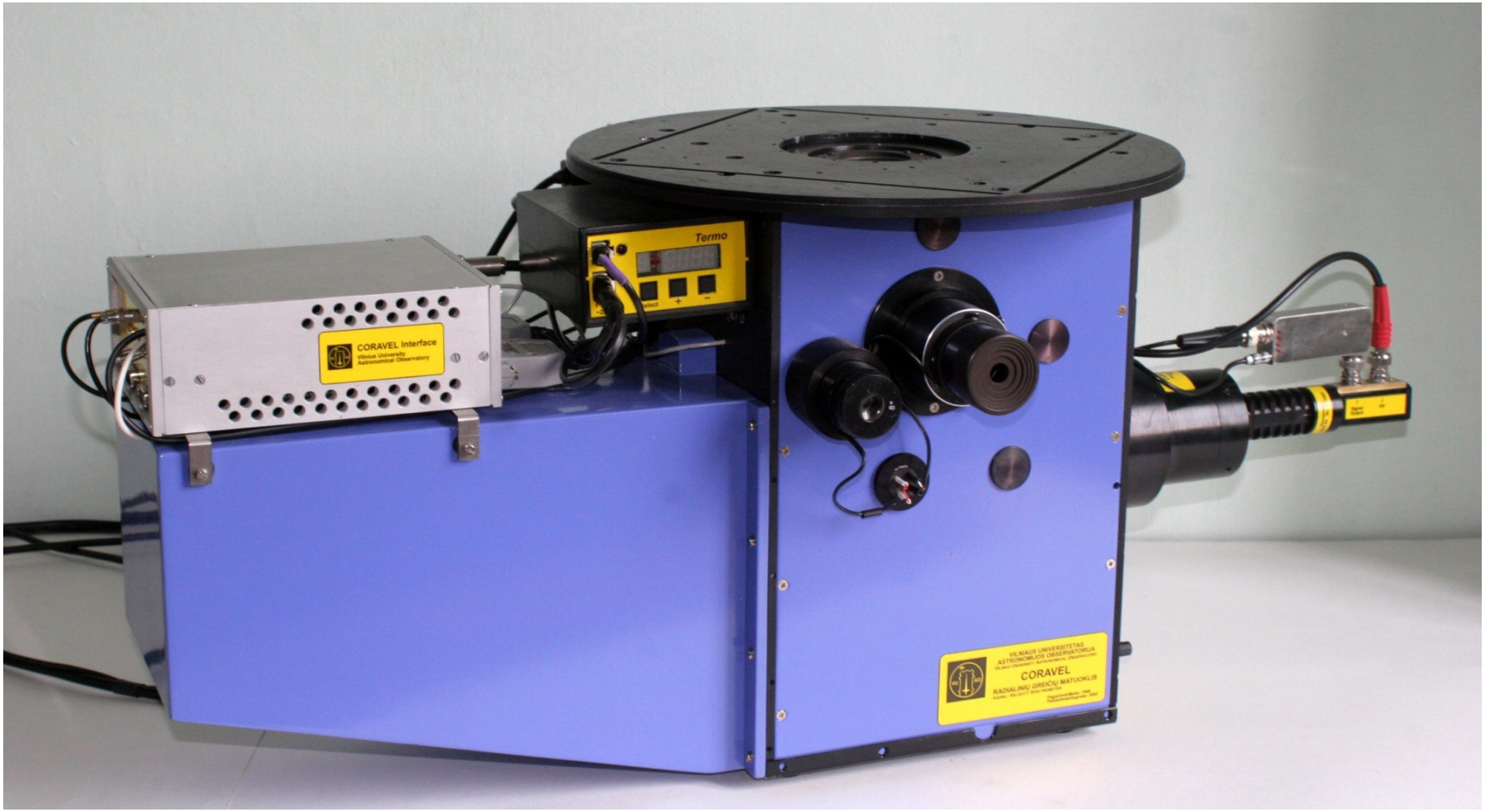
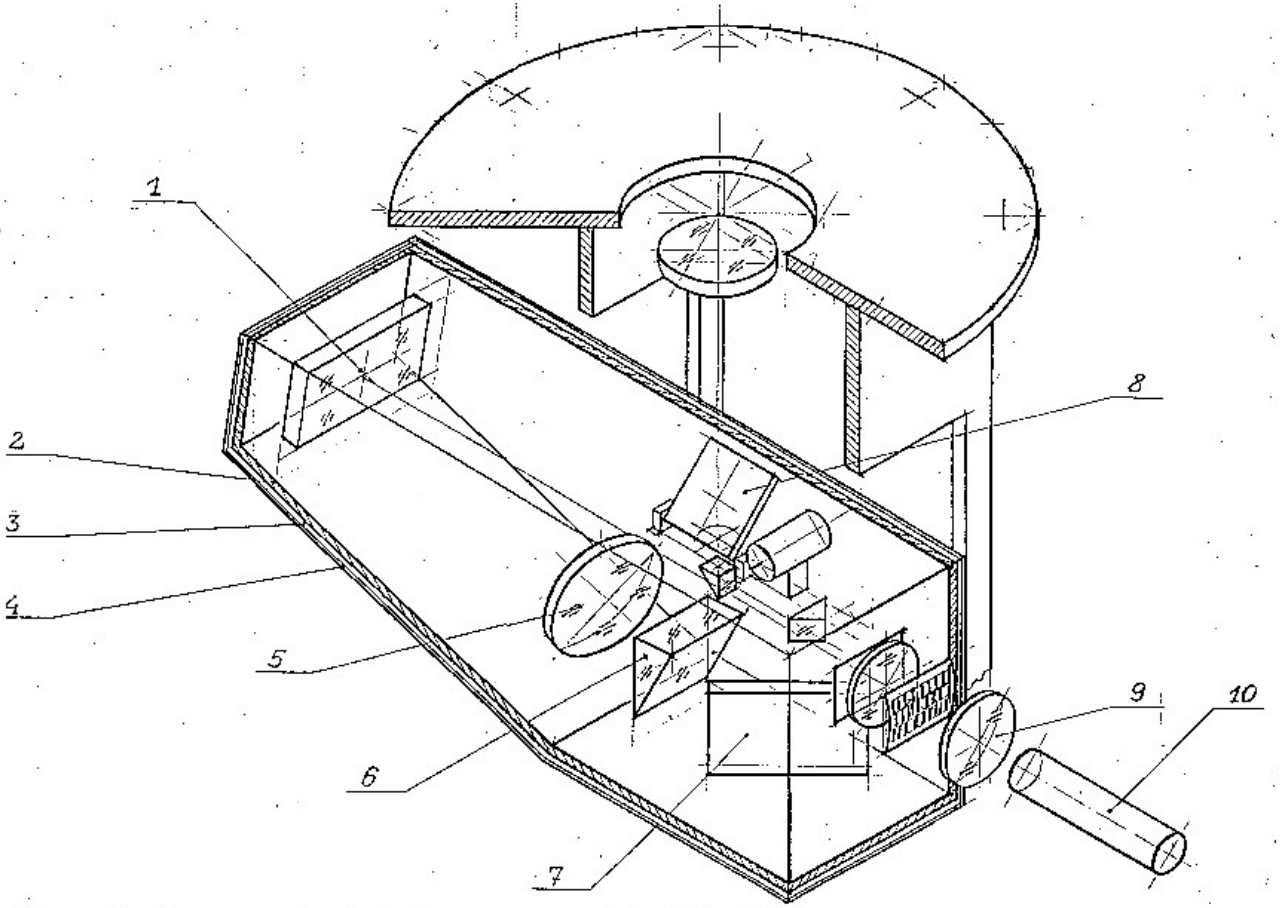
CORAVEL-TYPE RADIAL-VELOCITY SPECTROMETER

(COrraliation RAdial VELocity)





Schematic diagram and principal components of the CORAVEL-type stellar radial-velocity spectrometer
1.Folding mirror (aluminized glass) 2.Case of the spectrograph (aluminum) 3.Thermo-insulating layer (plastics) 4.Thermo insulating layer (plastics with aluminum foil) 5.Camera-colimator lens (glass) 6. Cross-dispersion prism (glass) 7.Ecshelle grating 75 gr/mm (aluminized glass) 8.Movable mirror of field microscope (aluminized glass) 9.Fabri lens (glass) 10.Photoelectric head and photomultiplier

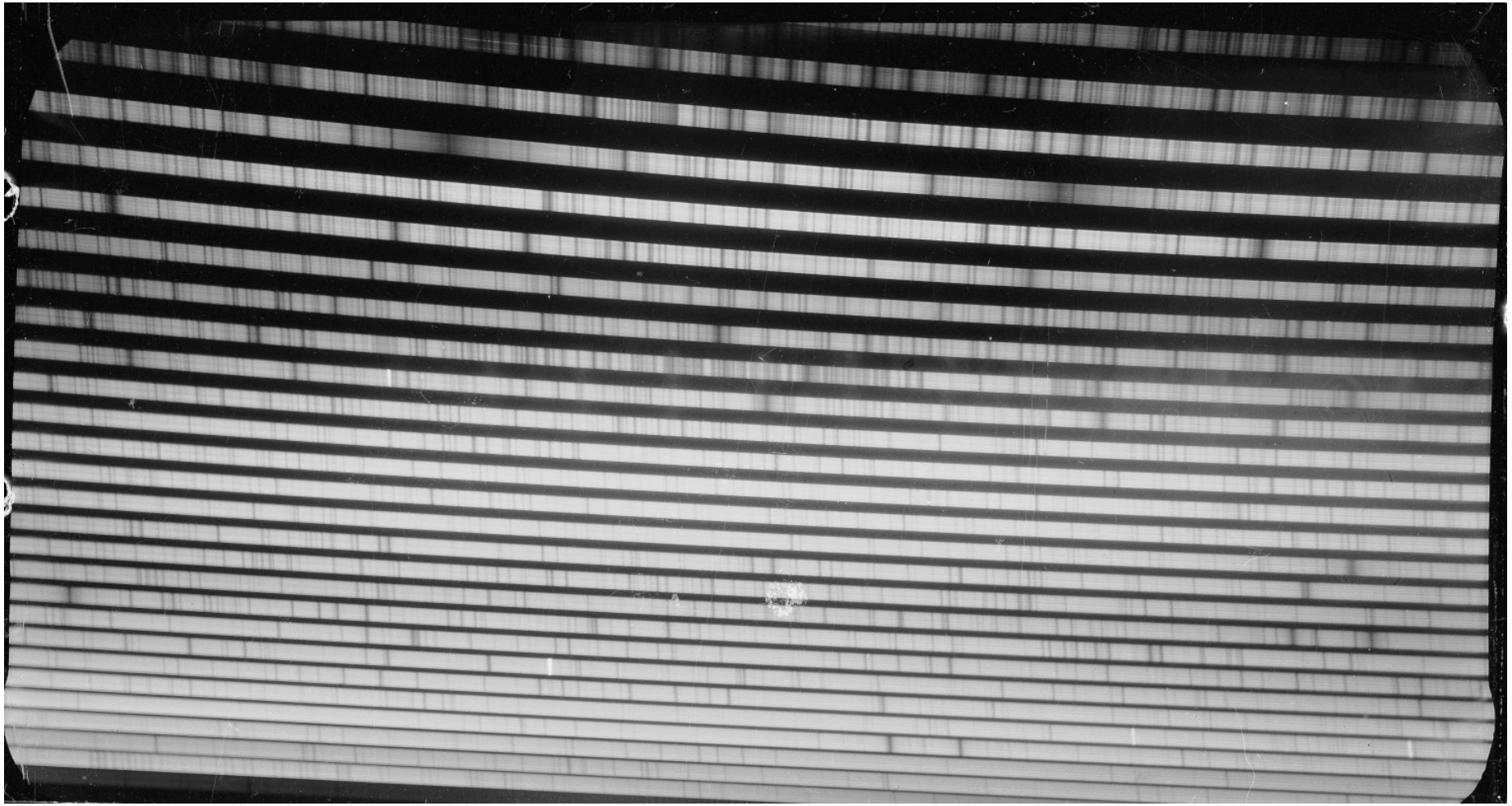
Grating
75 gr/mm
Blaze angel 68 deg

Cross-disperser

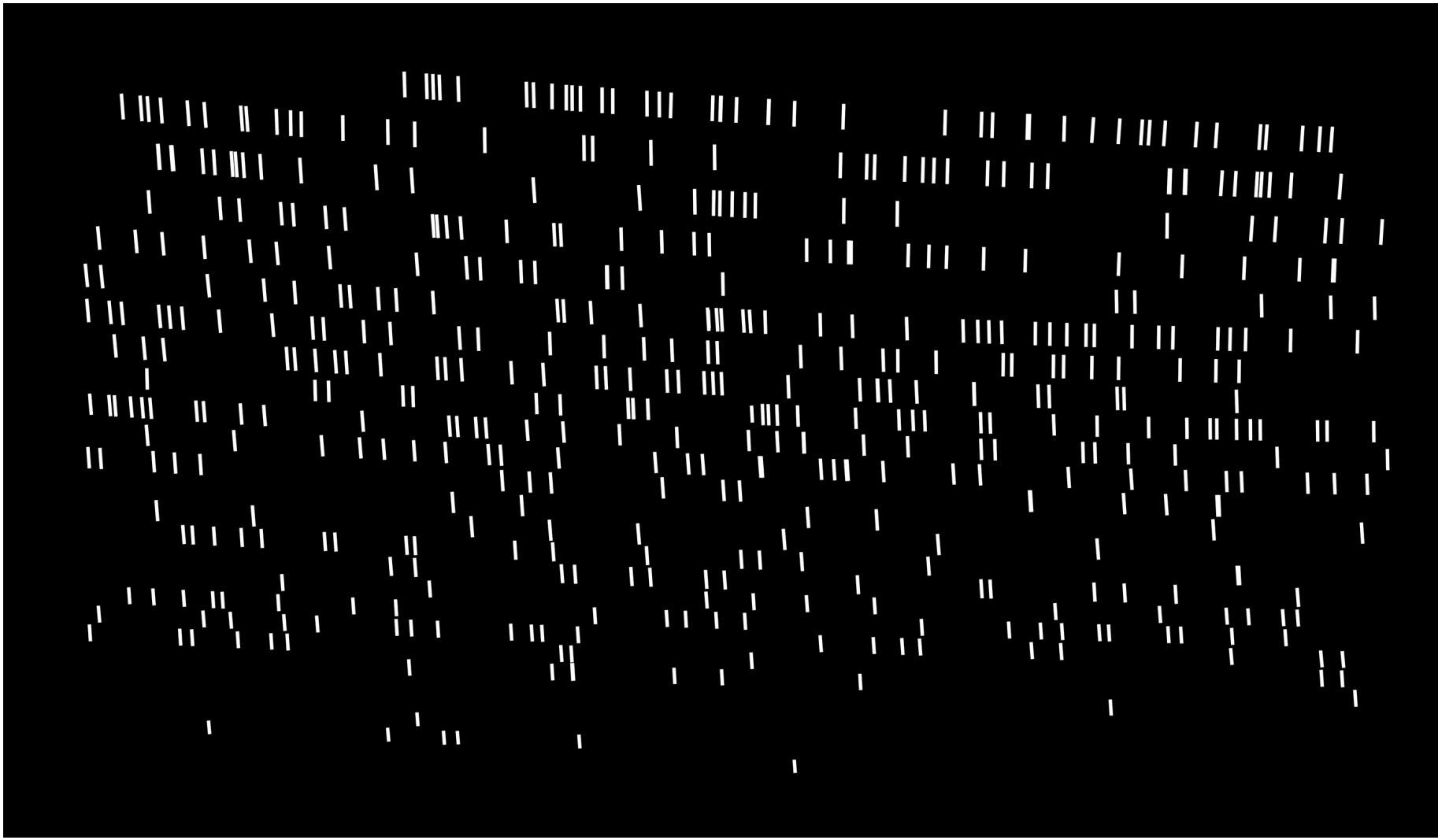
22-grad flint prism in double pass

Collimator-camera lens
F=640 mm, F/11

Slit
0.11 mm(fixed)



Spectral interval	375 – 640 nm
Orders	38 - 63
Dispersion	0.14 – 0.24 nm/mm
R	~20000



Opaque film with dimension W60xH30
containing 1650 transparent slits

A CORAVEL-TYPE PHOTOELECTRIC RADIAL-VELOCITY SPECTROMETER

How it works

Doppler effect:

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

Dispersion of the grating spectrograph:

$$\frac{dx}{d\lambda} = \frac{KNF}{\cos\beta}$$

Shift of a spectral line, at a focal plane of the spectrograph due to the Doppler effect:

$$\Delta X = \frac{NF}{\cos\beta} . \frac{v}{c} . K\lambda$$

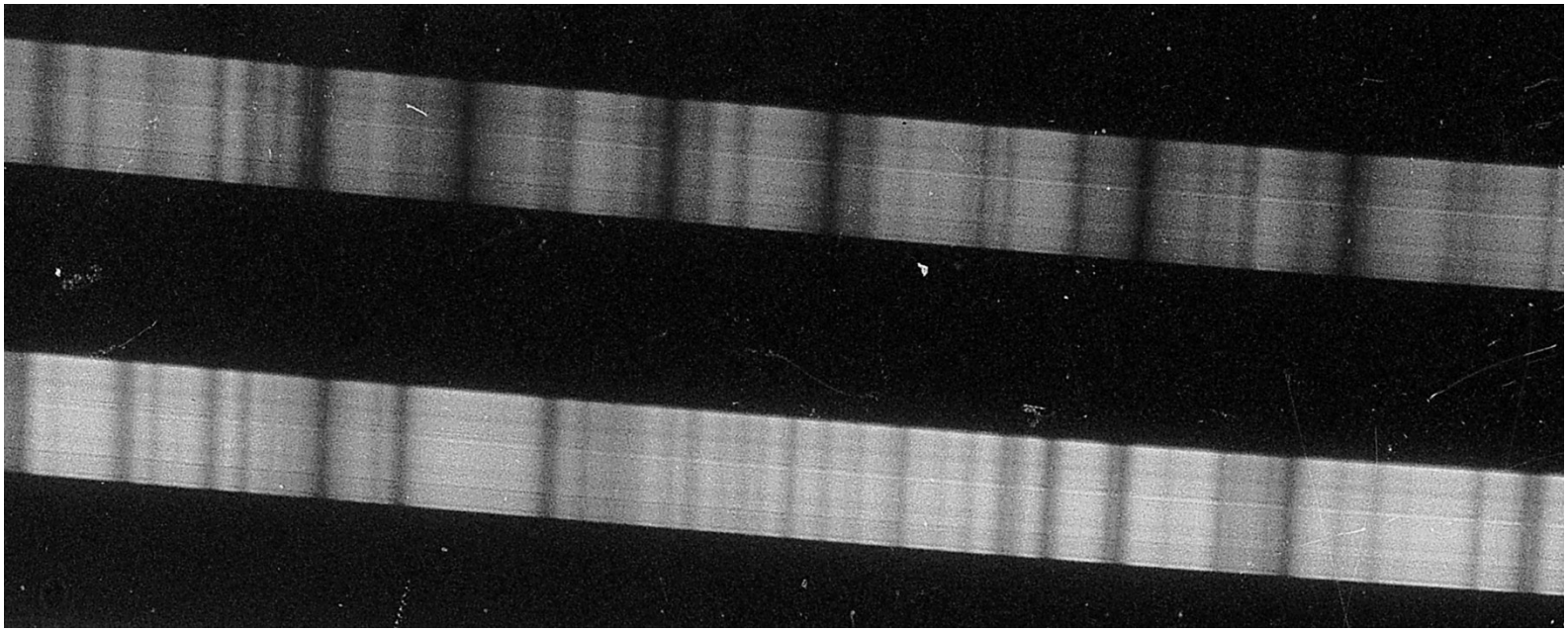
If,

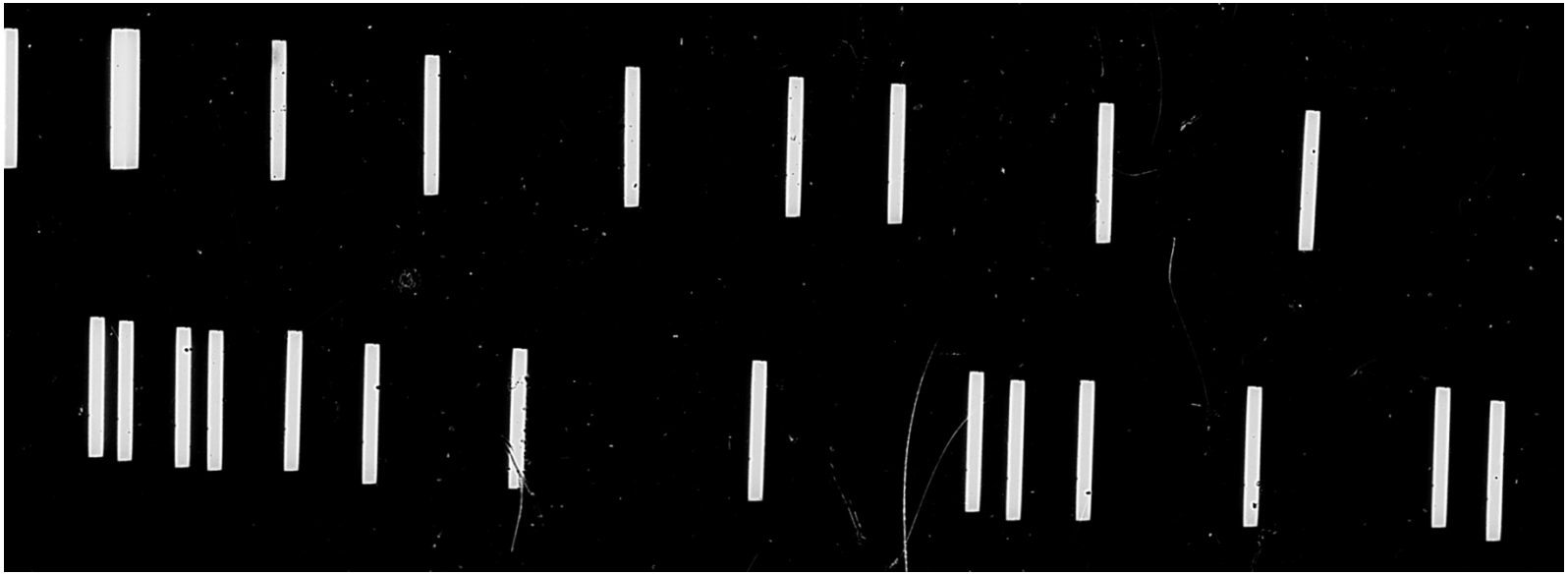
$$K_i\lambda_i = K_j\lambda_j = const$$

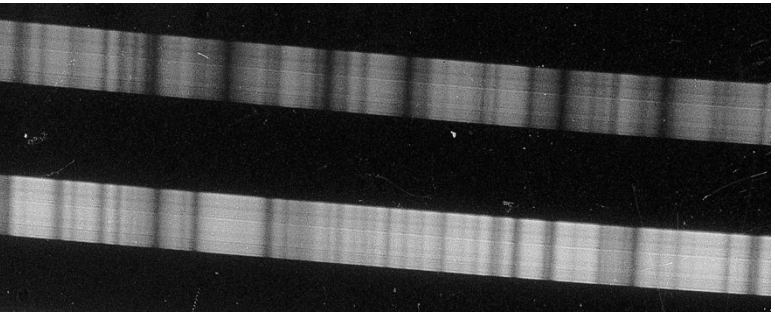
then

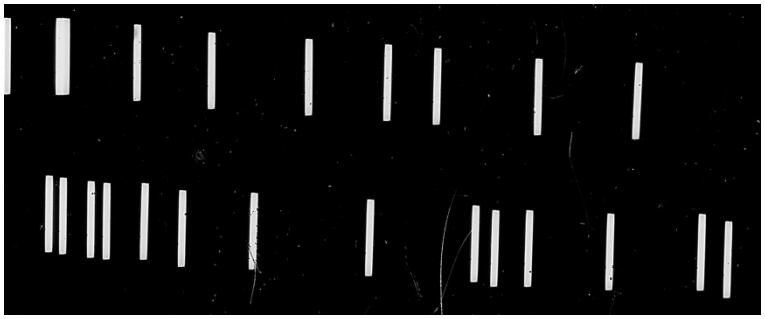
$$CCF = \int I(\lambda) \cdot T(\lambda + x) \cdot dx$$

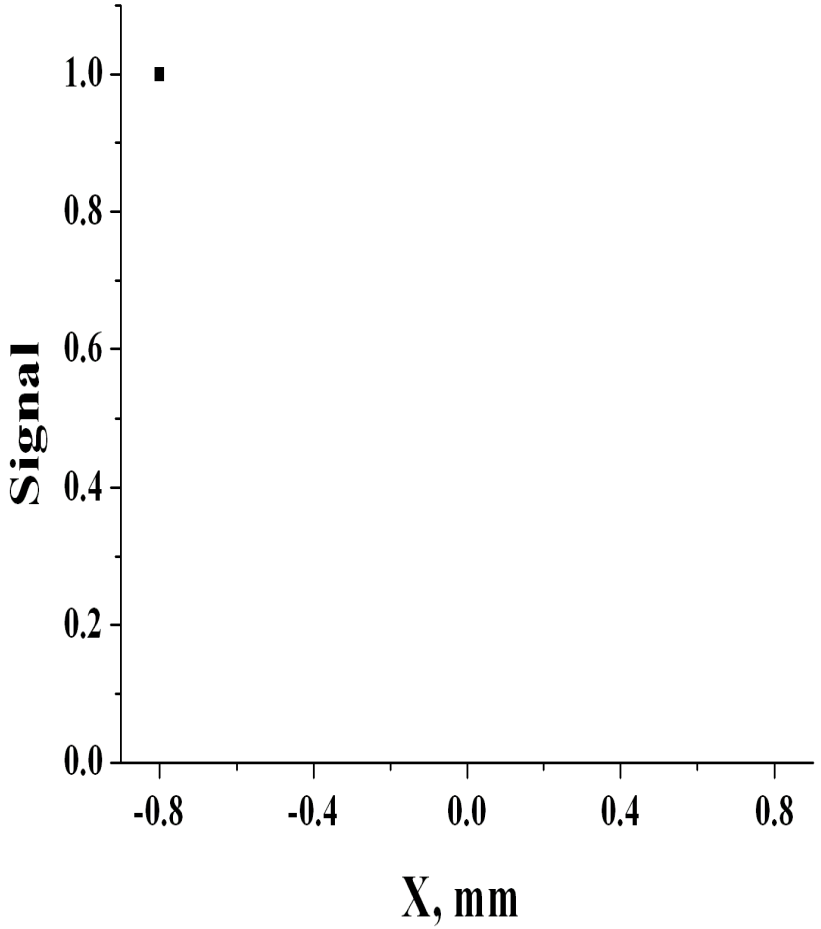
with physical mask can be obtained.

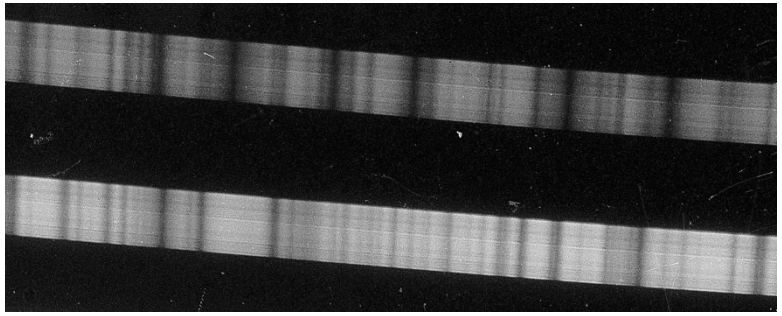


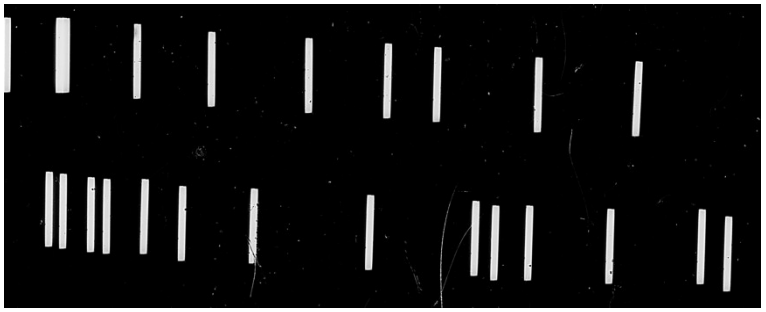


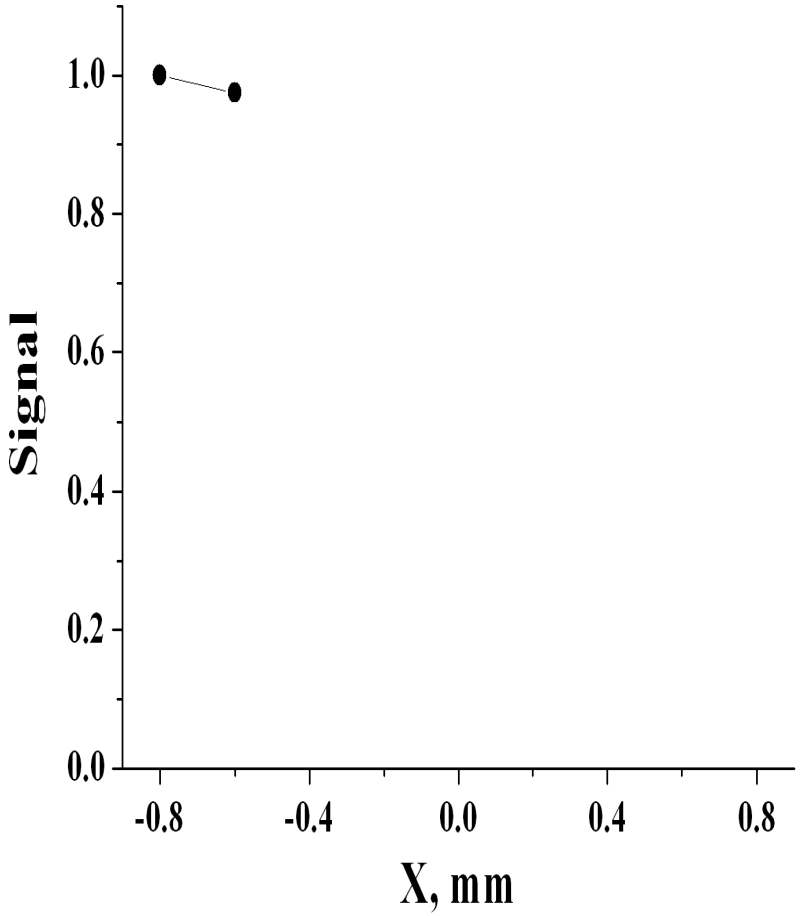


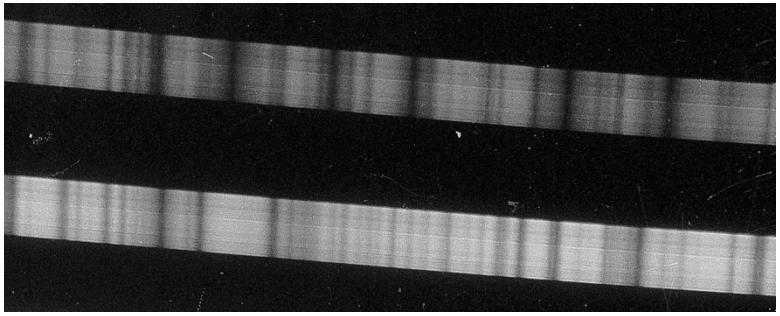


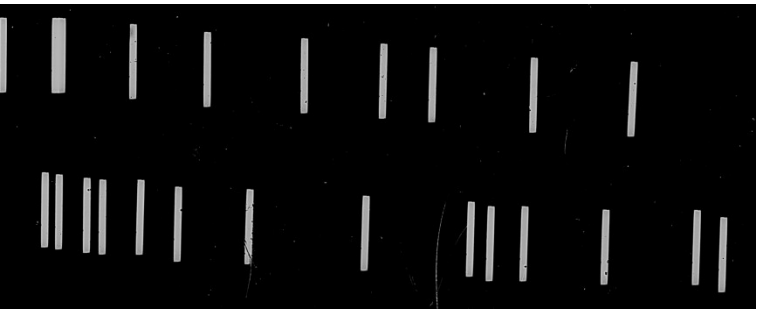

Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X, mm

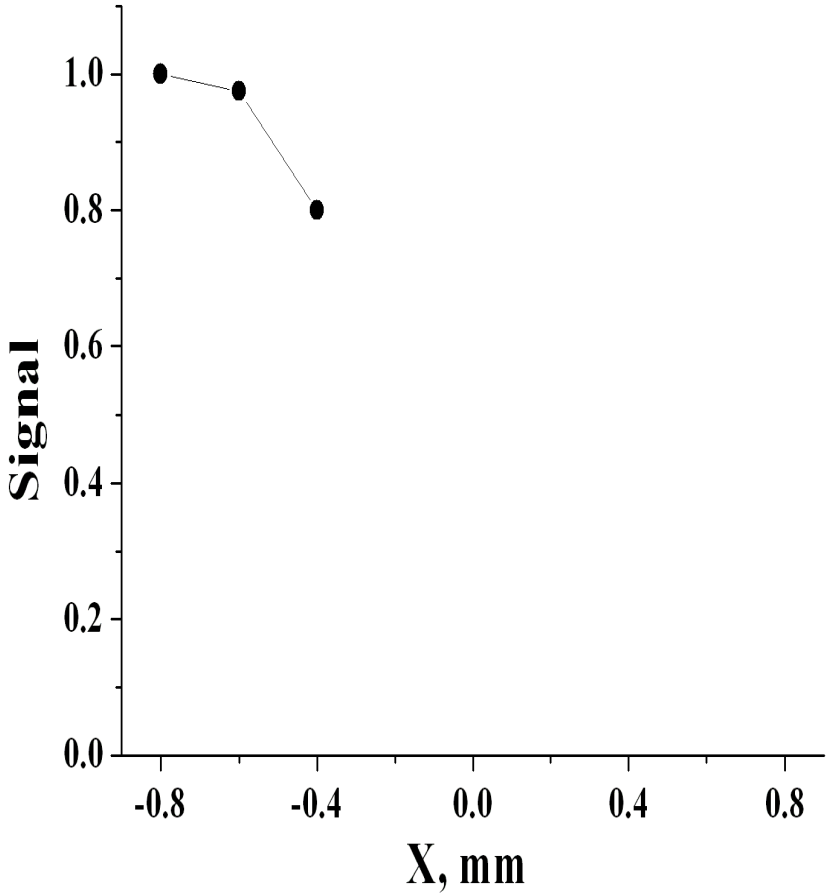


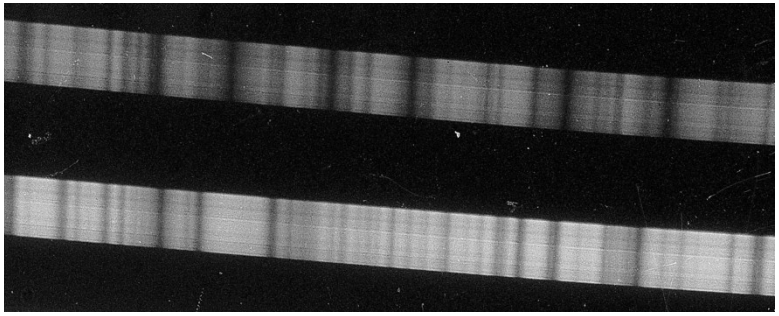


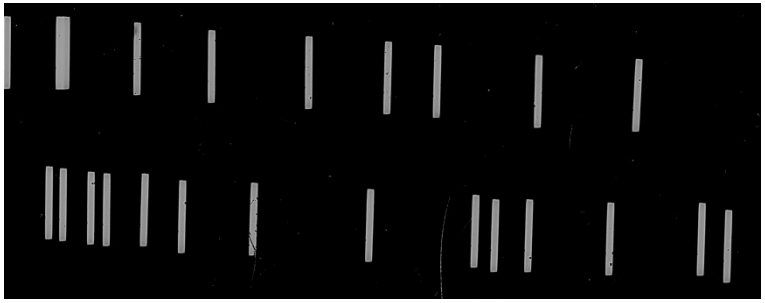

Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X, mm

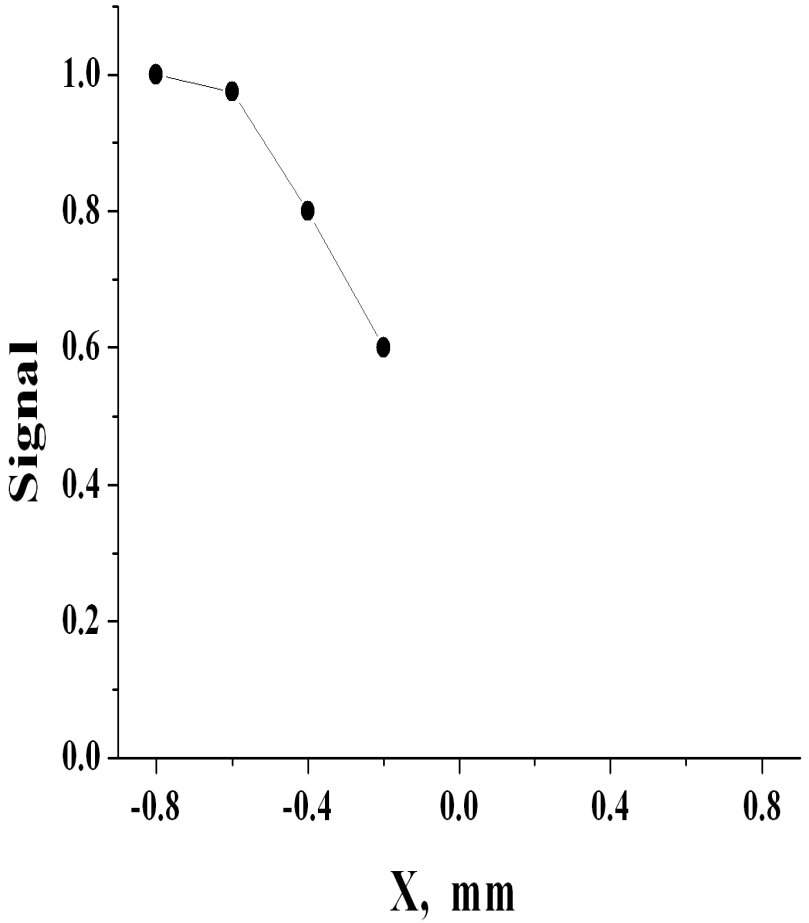


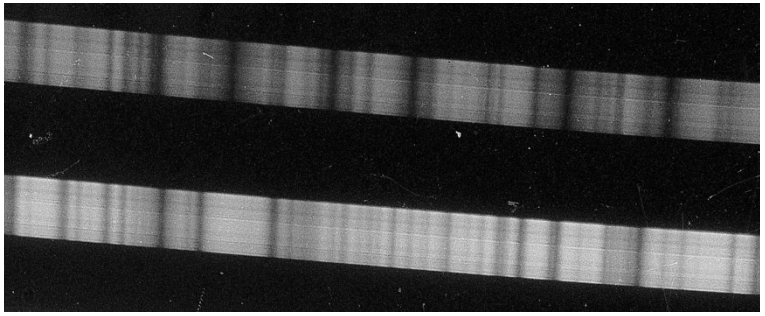


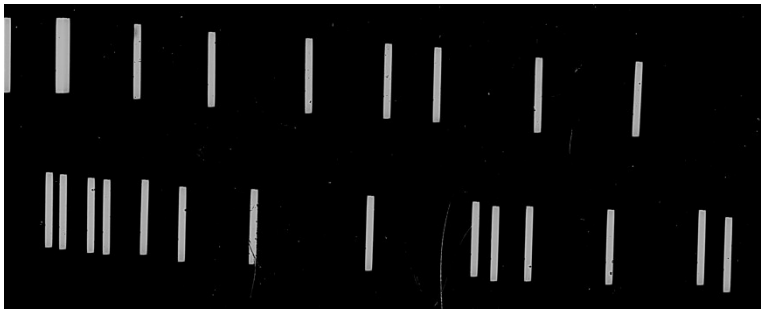

Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X, mm

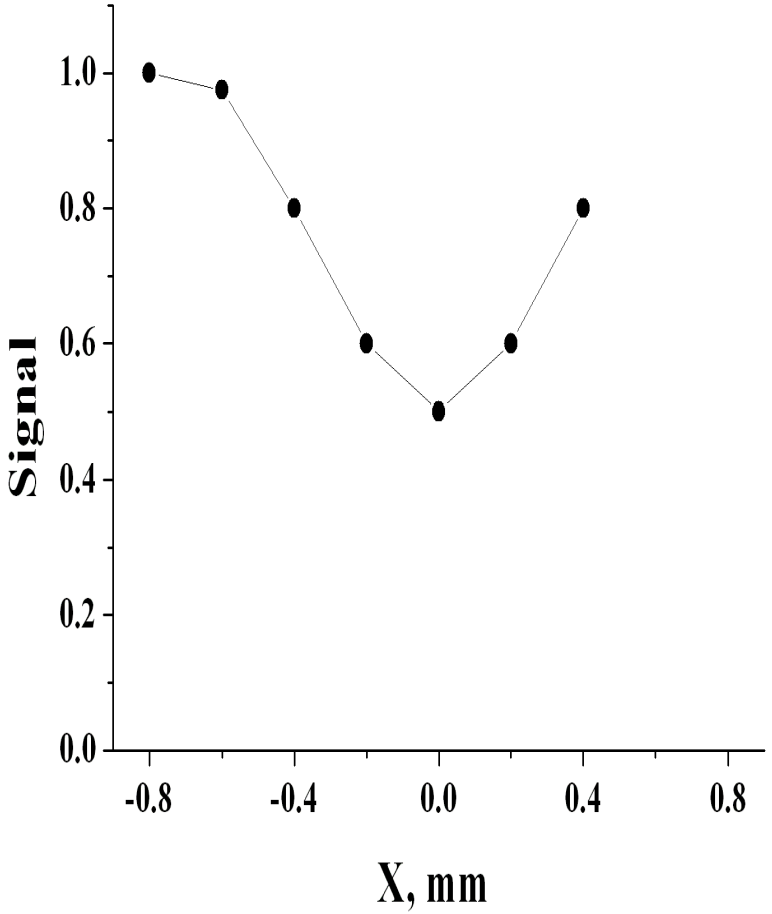


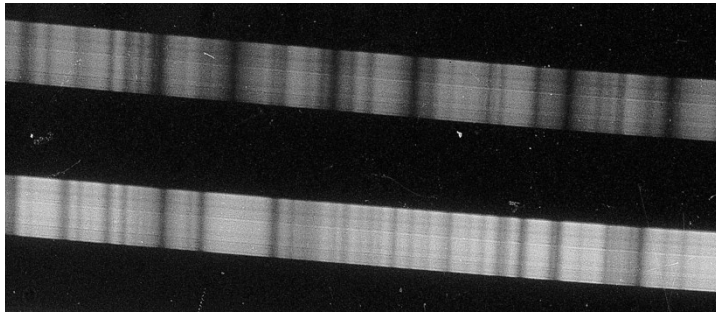


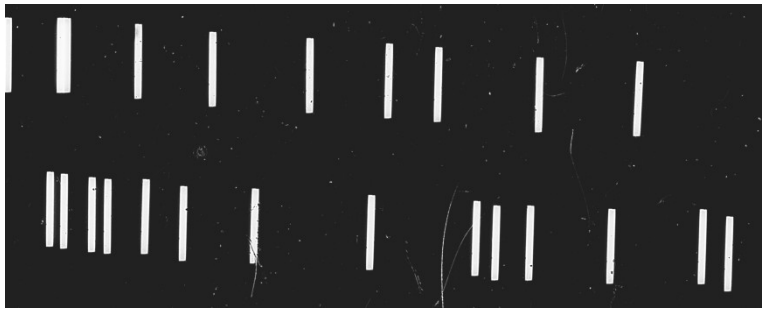

Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X, mm

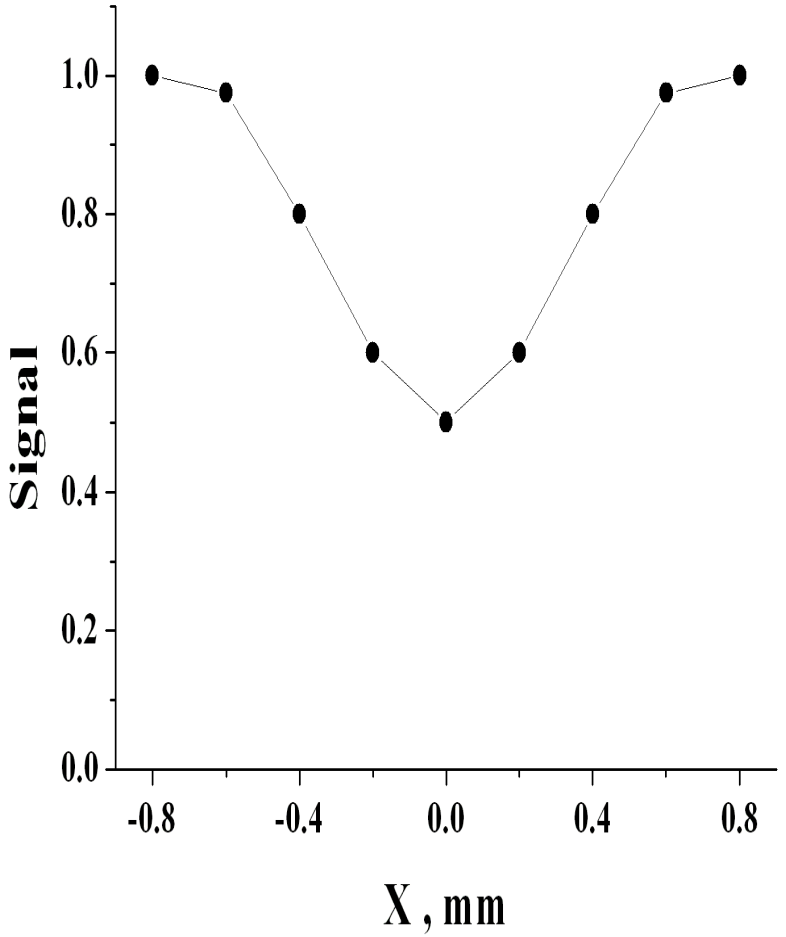


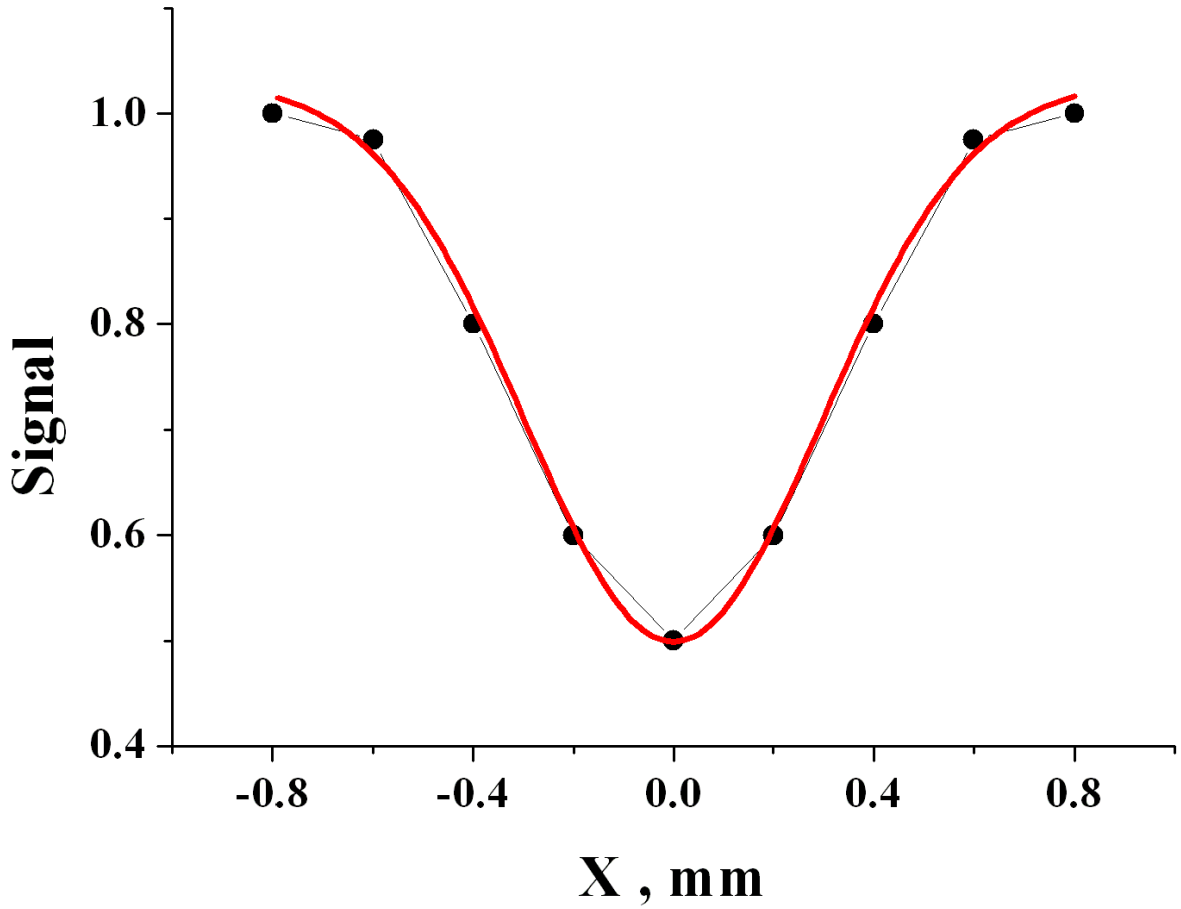



Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X, mm

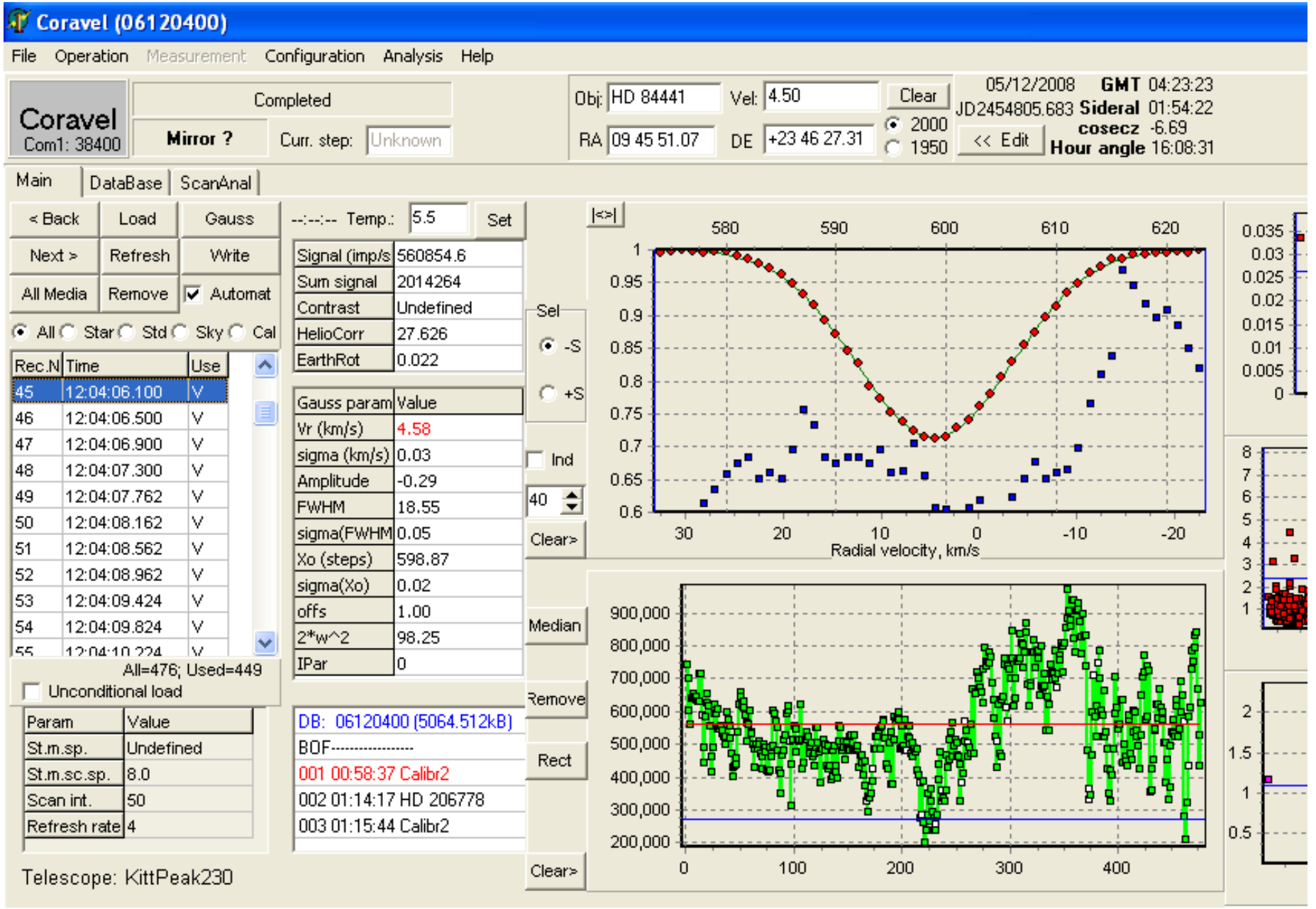





Signal
1.0
0.8
0.6
0.4
0.2
0.0
-0.8
-0.4
0.0
0.4
0.8
X , mm



$$Vr = f(X)$$


Coravel (06120400)
File Operation Measurement Configuration Analysis Help
Coravel
Com1: 38400
Completed
Mirror ?
Curr. step: Unknown
Obj: HD 84441
Vel: 4.50
Clear
RA 09 45 51.07
DE +23 46 27.31
2000
1950
<< Edit
05/12/2008 GMT 04:23:23
JD2454805.683 Sideral 01:54:22
cosecz -6.69
Hour angle 16:08:31
Main
DataBase
ScanAnal
< Back
Load
Gauss
Next >
Refresh
Write
All Media
Remove
Automat
All Star Std Sky Cal
Rec.N Time Use
45 12:04:06.100 V
46 12:04:06.500 V
47 12:04:06.900 V
48 12:04:07.300 V
49 12:04:07.762 V
50 12:04:08.162 V
51 12:04:08.562 V
52 12:04:08.962 V
53 12:04:09.424 V
54 12:04:09.824 V
All=476; Used=449
Unconditional load
Param Value
St.m.sp. Undefined
St.m.sc.sp. 8.0
Scan int. 50
Refresh rate 4
Telescope: KittPeak230
--:--:-- Temp.: 5.5
Set
Signal (imp/s 560854.6
Sum signal 2014264
Contrast Undefined
HelioCorr 27.626
EarthRot 0.022
Gauss param Value
Vr (km/s) 4.58
sigma (km/s) 0.03
Amplitude -0.29
FWHM 18.55
sigma(FWHM 0.05
Xo (steps) 598.87
sigma(Xo) 0.02
offs 1.00
2*w^2 98.25
IPar 0
DB: 06120400 (5064.512kB)
BOF----------
001 00:58:37 Calibr2
002 01:14:17 HD 206778
003 01:15:44 Calibr2
Sel
-S
+S
Ind
40
Clear>
Median
Remove
Rect
Clear>
|<>|
Radial velocity, km/s

Coravel (06120400)

File Operation Measurement Configuration Analysis Help

Coravel
Com1: 38400

Completed

Mirror ?

Curr. step: Unknown

Obj: N7142 0210 Vel: -30.61 Clear

RA 21 44 36.69 DE +65 43 18.18 2000 1950 << Edit

05/12/2008 GMT 04:31:46
JD2454805.689 Sideral 02:02:47
cosecz 1.58
Hour angle 04:18:10

Main DataBase ScanAnal

< Back | Load | Gauss
Next > | Refresh | Write
All Media | Remove | Automat

All Star Std Sky Cal

Rec.N	Time	Use
1	01:36:22.051	V
2	01:36:22.451	V
3	01:36:22.851	V
4	01:36:23.251	V
5	01:36:23.854	V
6	01:36:24.254	V
7	01:36:24.654	V
8	01:36:25.054	V
9	01:36:25.516	V
10	01:36:25.916	V
11	01:36:26.316	V

All=3444; Used=3172

Unconditional load

Param	Value
St.m.sp.	Undefined
St.m.sc.sp.	8.0
Scan int.	50
Refresh rate	4

--:--:-- Temp.: 5.5 Set

Signal (imp/s	35.9
Sum signal	911
Contrast	Undefined
HelioCorr	-8.408
EarthRot	-0.060

Gauss param	Value
Vr (km/s)	-32.15
sigma (km/s)	0.61
Amplitude	-0.15
FWHM	12.99
sigma(FWHM	1.18
Xo (steps)	597.79
sigma(Xo)	0.55
offs	0.95
2*w^2	48.20
IPar	0

DB: 06120400 (5064.512kB)
006 01:28:48 N7142 0222
007 01:34:12 Calibr2
008 01:48:19 N7142 0210
009 02:00:35 Calibr2

Telescope: KittPeak230

Sel -S +S

Ind 40

Clear>

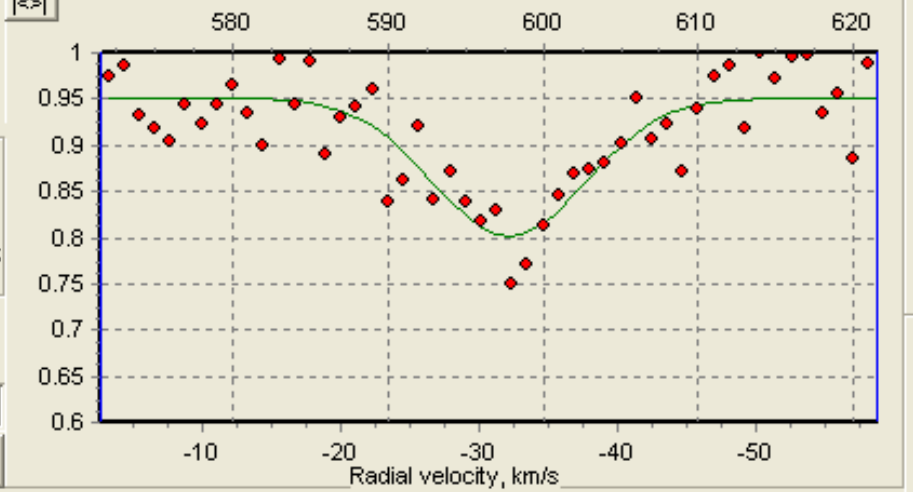
Median

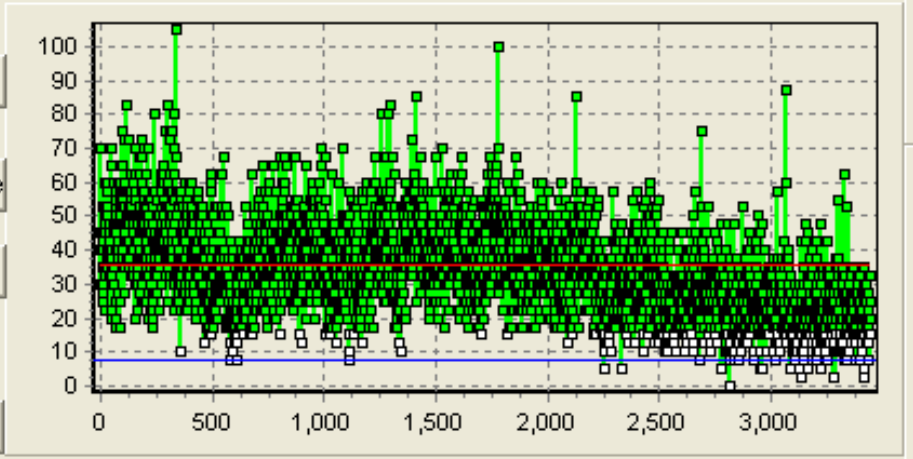
Remove

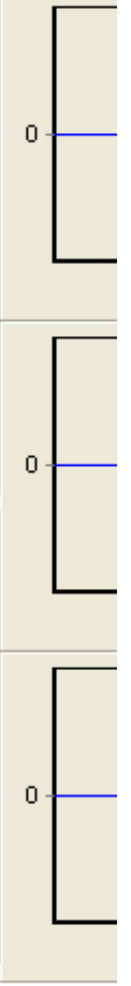
Rect

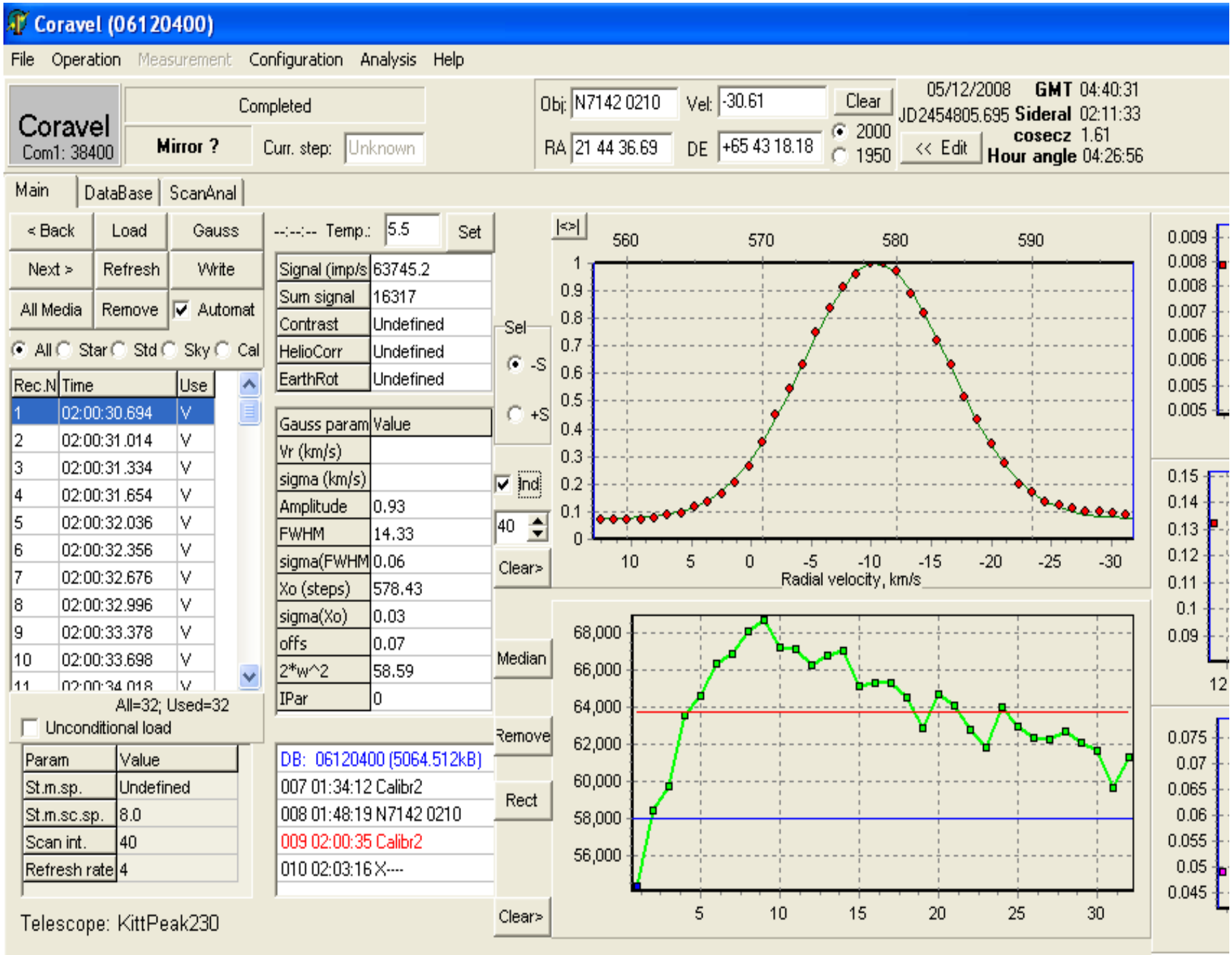
Clear>

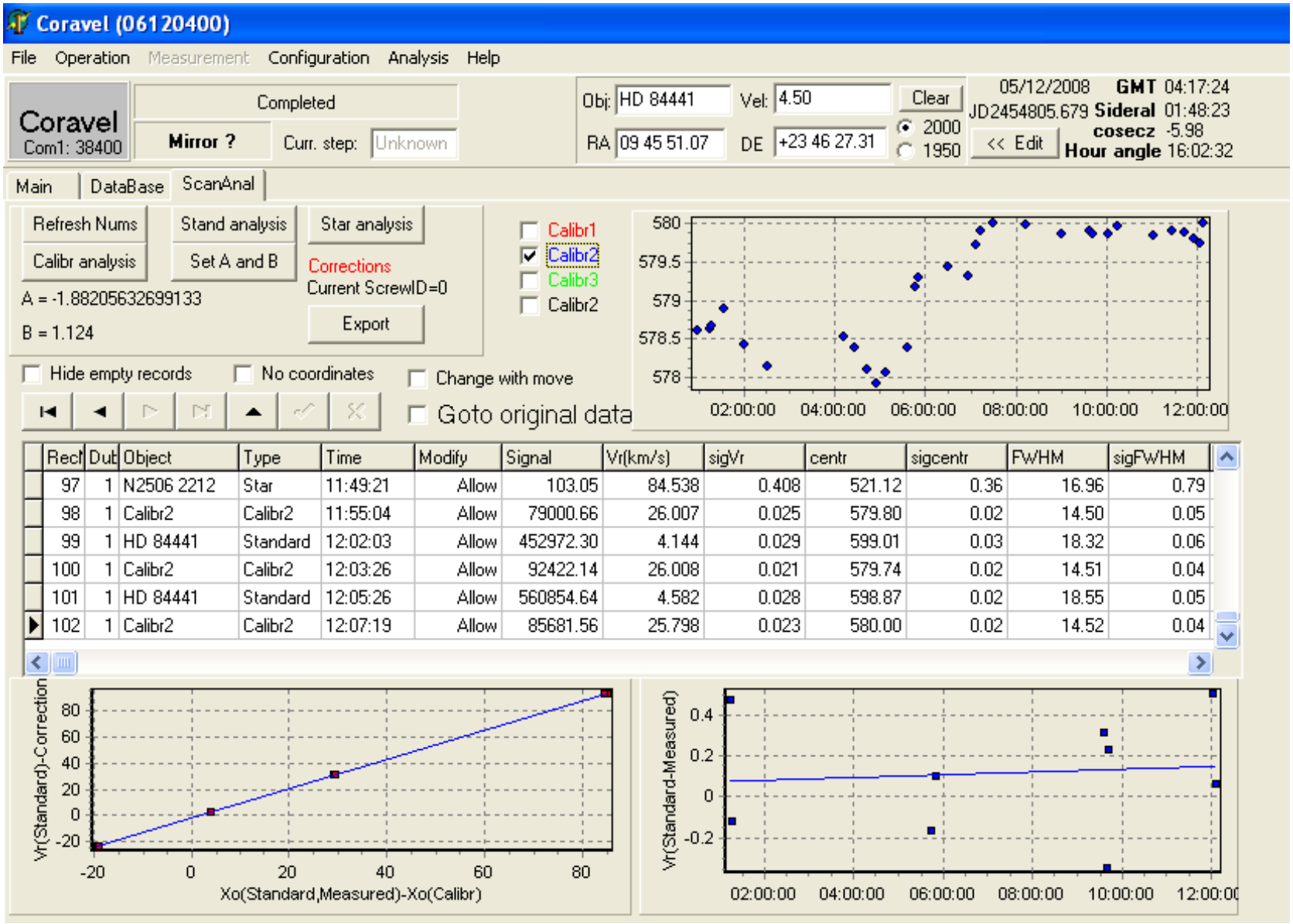
|<>|



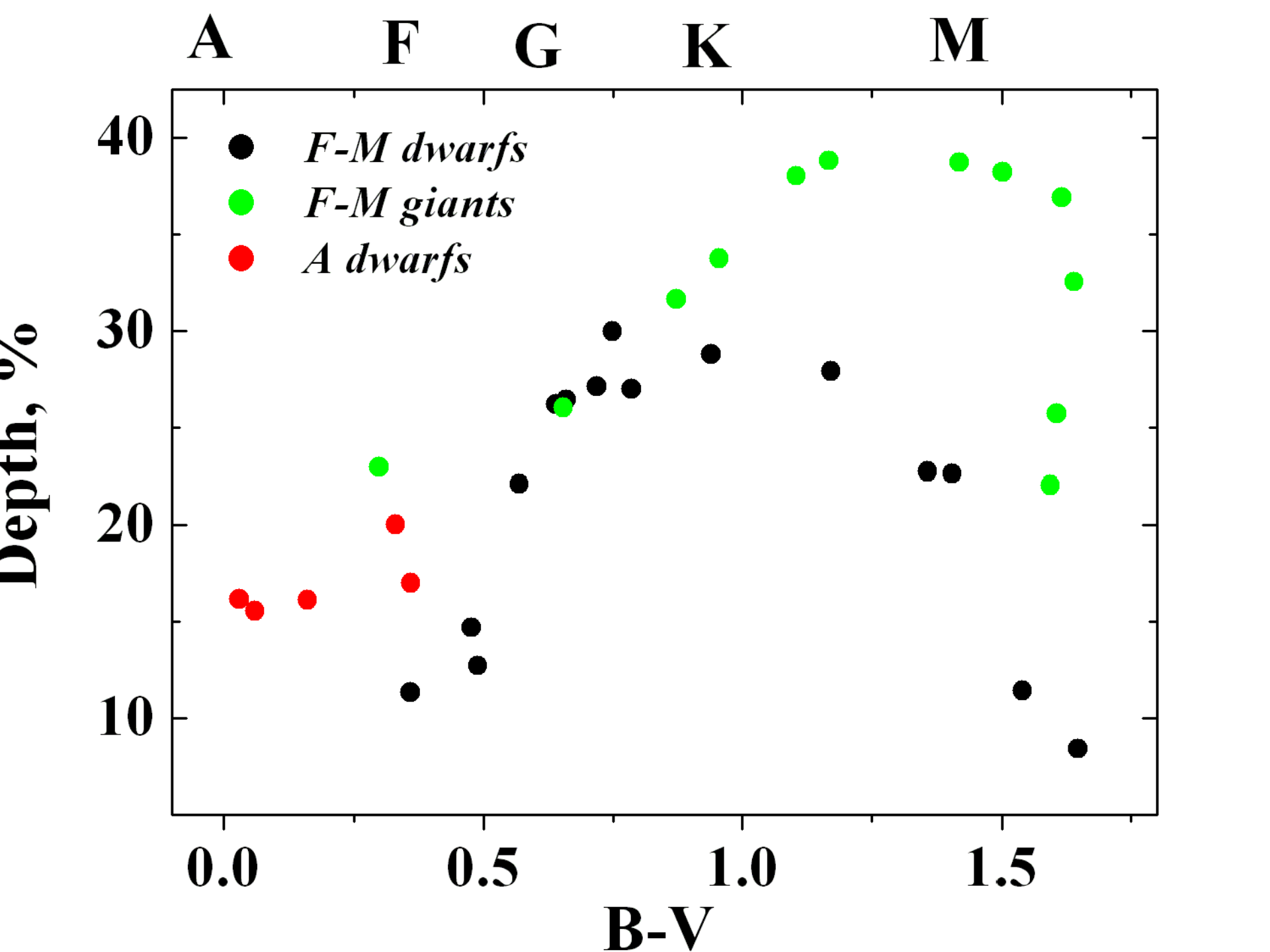


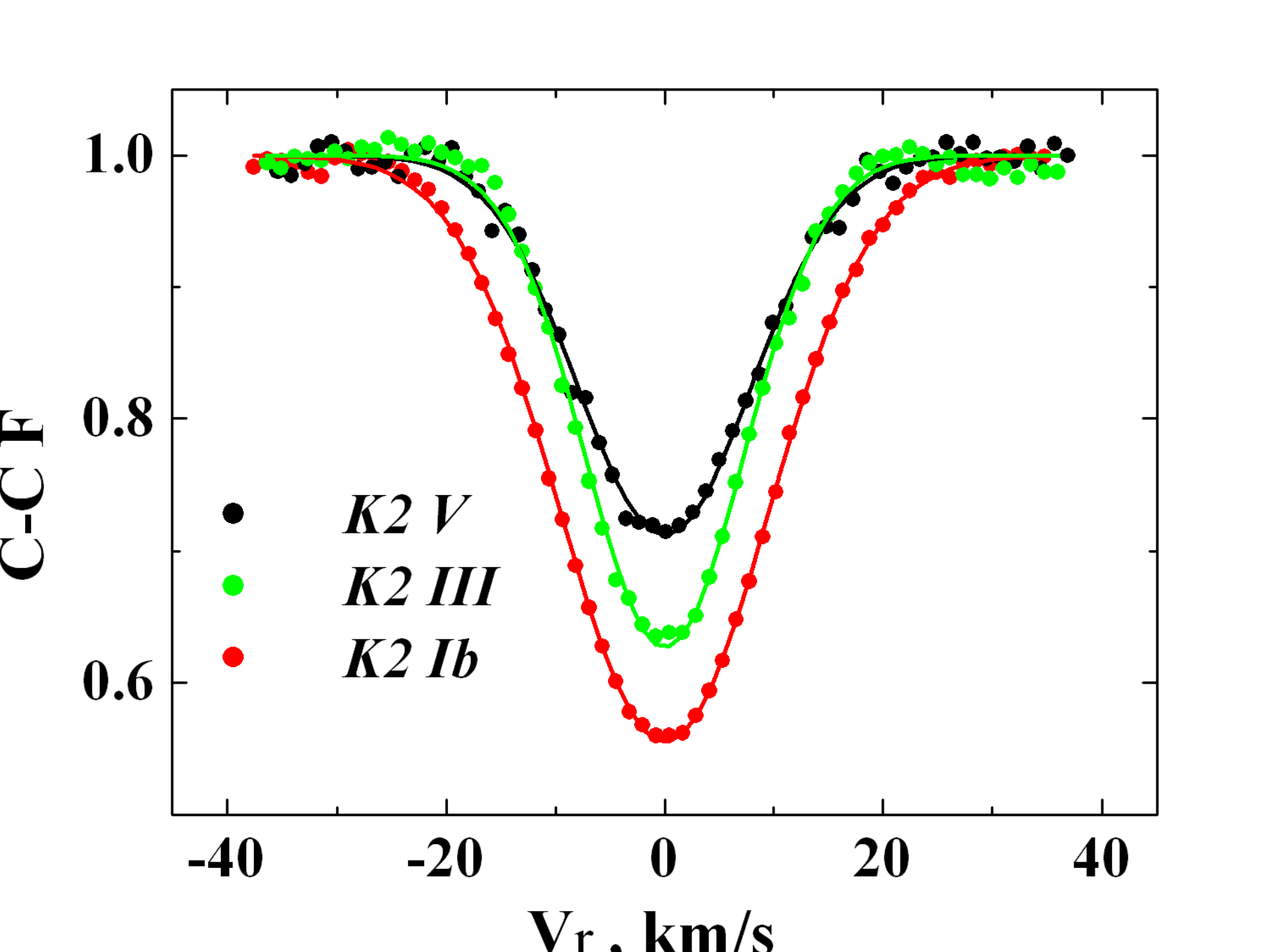


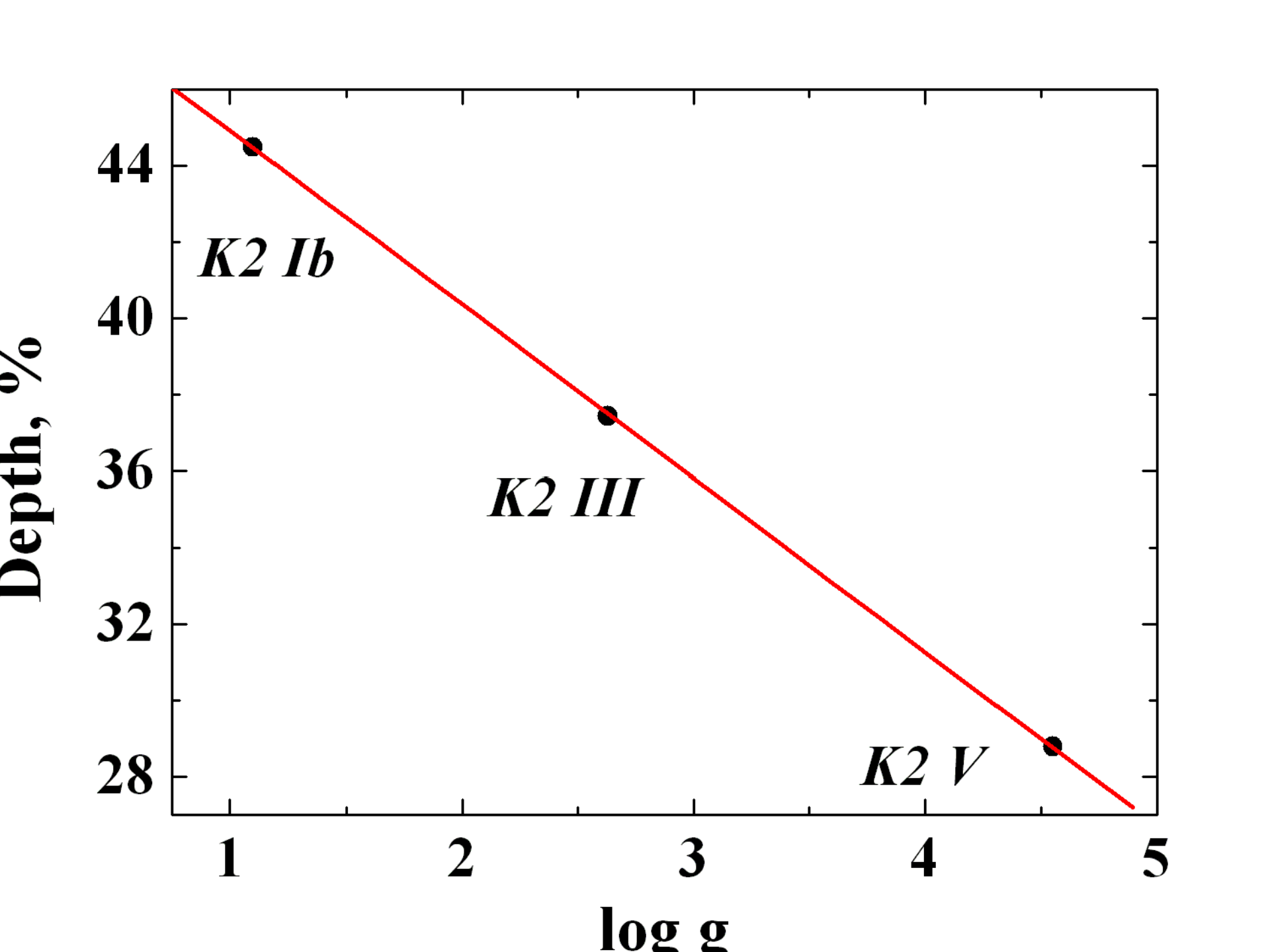

Coravel (06120400)
File Operation Measurement Configuration Analysis Help
Coravel
Com1: 38400
Completed
Mirror ?
Curr. step: Unknown
Obj: N7142 0210
Vel: -30.61
Clear
RA 21 44 36.69
DE +65 43 18.18
2000
1950
<< Edit
05/12/2008 GMT 04:40:31
JD2454805.695 Sideral 02:11:33
cosecz 1.61
Hour angle 04:26:56
Main
DataBase
ScanAnal
< Back
Load
Gauss
Next >
Refresh
Write
All Media
Remove
Automat
All Star Std Sky Cal
--:--:-- Temp.: 5.5
Set
Signal (imp/s 63745.2
Sum signal 16317
Contrast Undefined
HelioCorr Undefined
EarthRot Undefined
Rec.N Time Use
1 02:00:30.694 V
2 02:00:31.014 V
3 02:00:31.334 V
4 02:00:31.654 V
5 02:00:32.036 V
6 02:00:32.356 V
7 02:00:32.676 V
8 02:00:32.996 V
9 02:00:33.378 V
10 02:00:33.698 V
All=32; Used=32
Unconditional load
Gauss param Value
Vr (km/s)
sigma (km/s)
Amplitude 0.93
FWHM 14.33
sigma(FWHM 0.06
Xo (steps) 578.43
sigma(Xo) 0.03
offs 0.07
2*w^2 58.59
IPar 0
Sel
-S
+S
Ind
40
Clear>
|<>|
Radial velocity, km/s
Median
Remove
Rect
Clear>
Param Value
St.m.sp. Undefined
St.m.sc.sp. 8.0
Scan int. 40
Refresh rate 4
DB: 06120400 (5064.512kB)
007 01:34:12 Calibr2
008 01:48:19 N7142 0210
009 02:00:35 Calibr2
010 02:03:16 X----
Telescope: KittPeak230

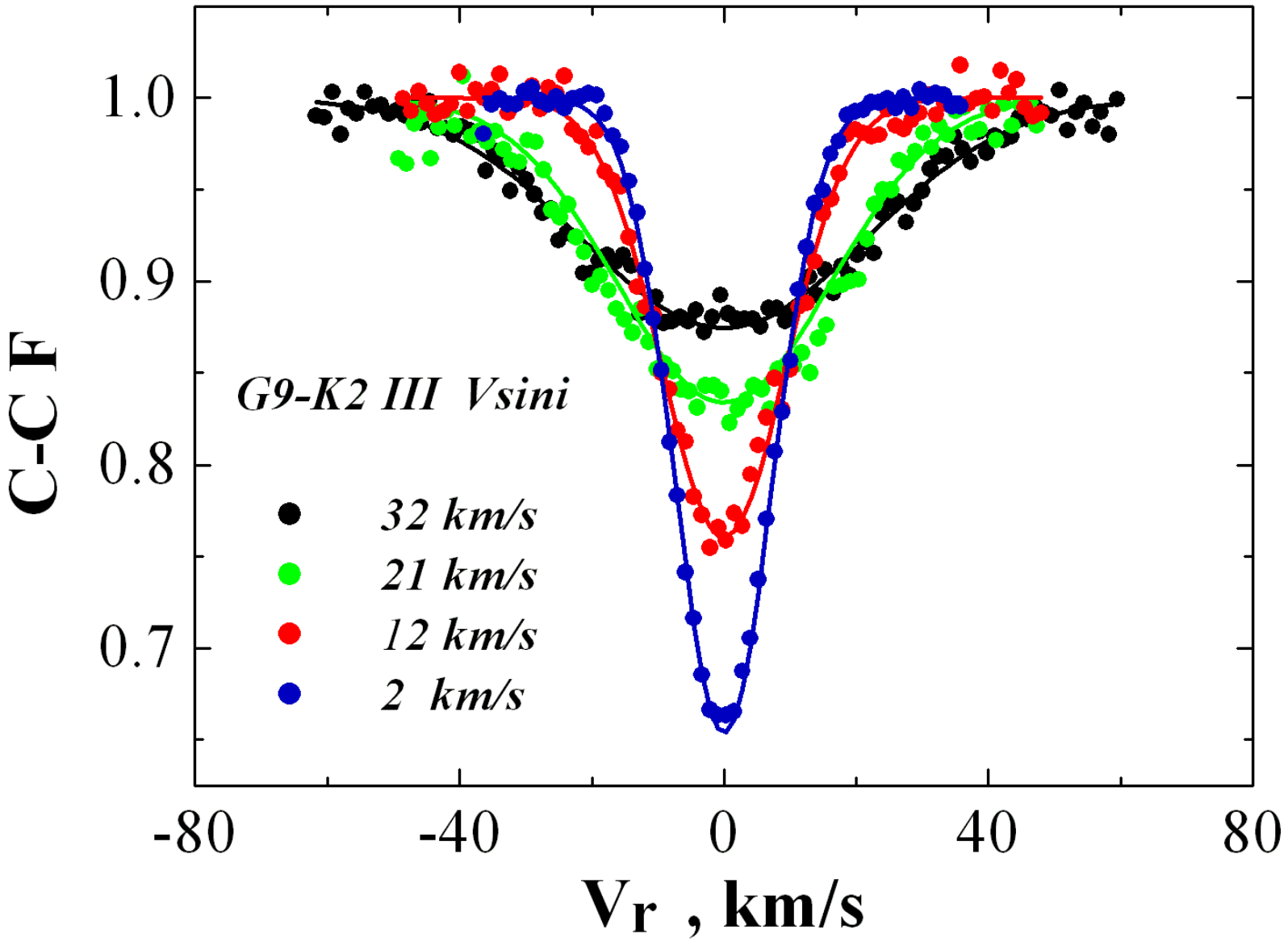


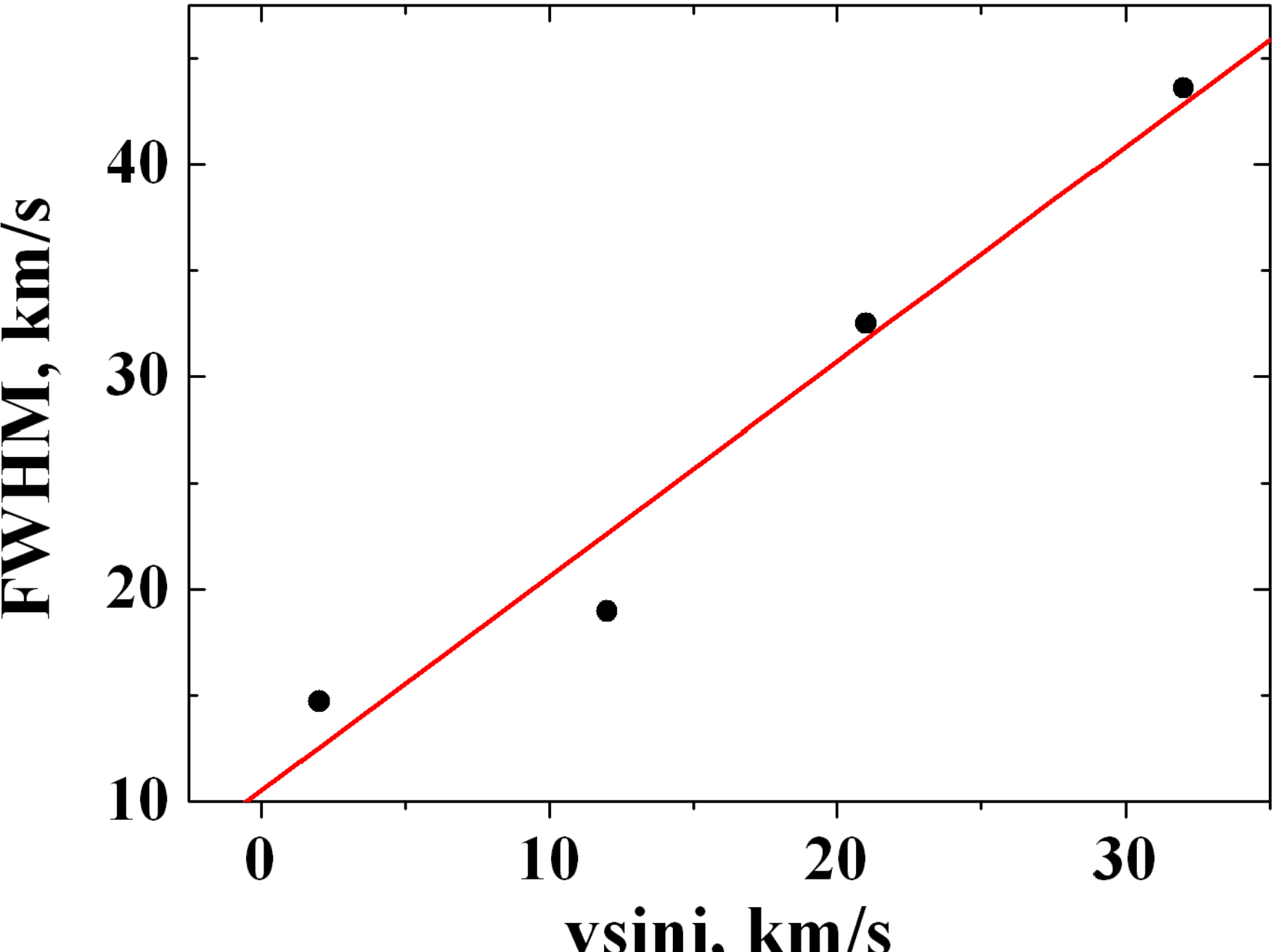
Udry, s., Mayor, M., Maurice, E., et al.1999, in Precise Stellar radial Velocities, IAU Coll., ASP Conf. Ser. 185, 383

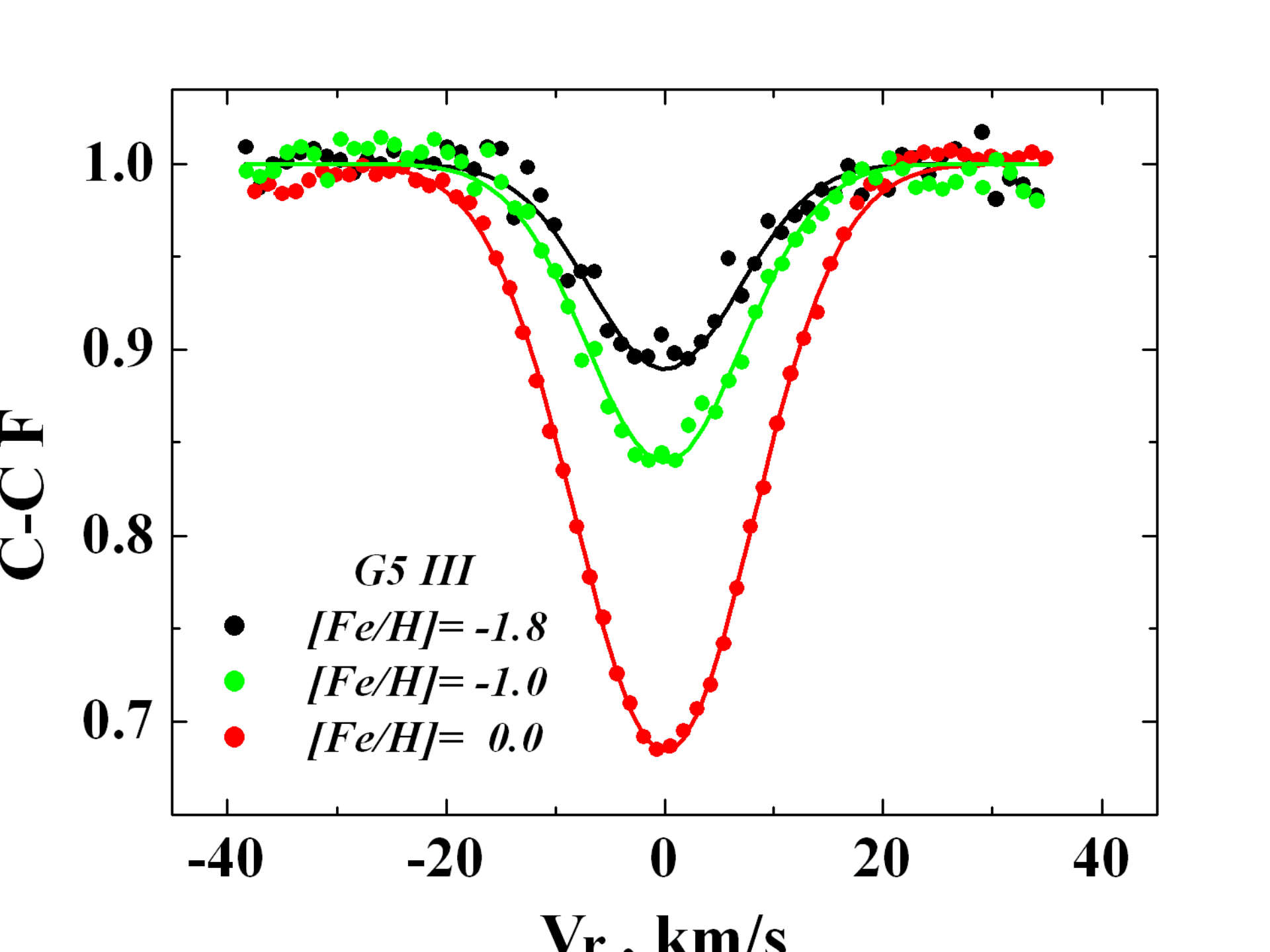

A
F
G
K
M
40
30
20
10
Depth, %
F-M dwarfs
F-M giants
A dwarfs
0.0
0.5
1.0
1.5
B-V

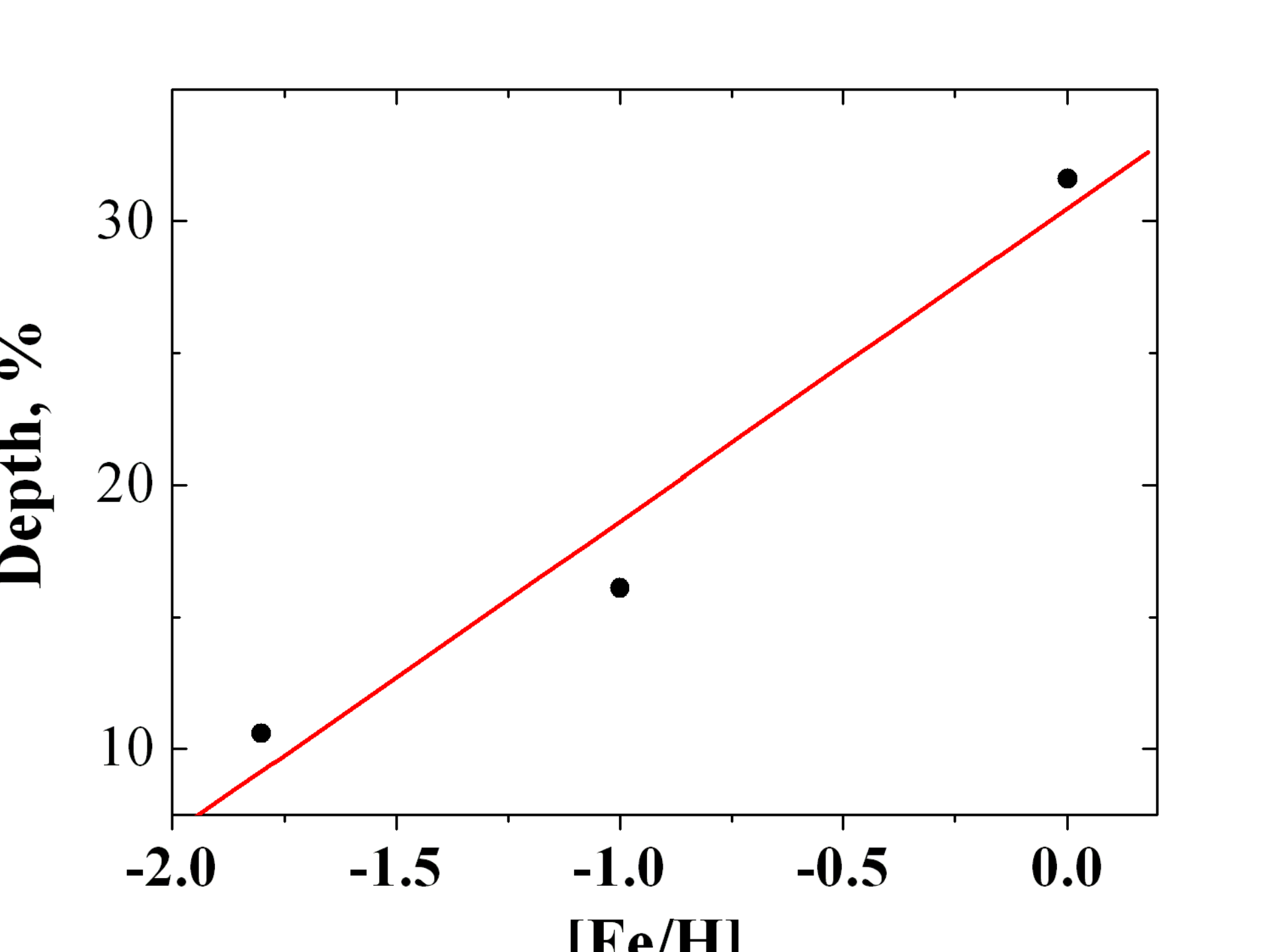

1.0
0.8
0.6
C-C F
K2 V
K2 III
K2 Ib
-40
-20
0
20
40
Vr , km/s


Depth, %
44
40
36
32
28
1
2
3
4
5
log g
K2 Ib
K2 III
K2 V


1.0
0.9
0.8
0.7
C-C F
G9-K2 III Vsini
32 km/s
21 km/s
12 km/s
2 km/s
-80
-40
0
40
80
Vr , km/s


FWHM, km/s
40
30
20
10
0
10
20
30
vsini, km/s


1.0
0.9
0.8
0.7
C-C F
G5 III
[Fe/H]= -1.8
[Fe/H]= -1.0
[Fe/H]= 0.0
-40
-20
0
20
40
Vr , km/s


Depth, %
30
20
10
-2.0
-1.5
-1.0
-0.5
0.0
[Fe/H]

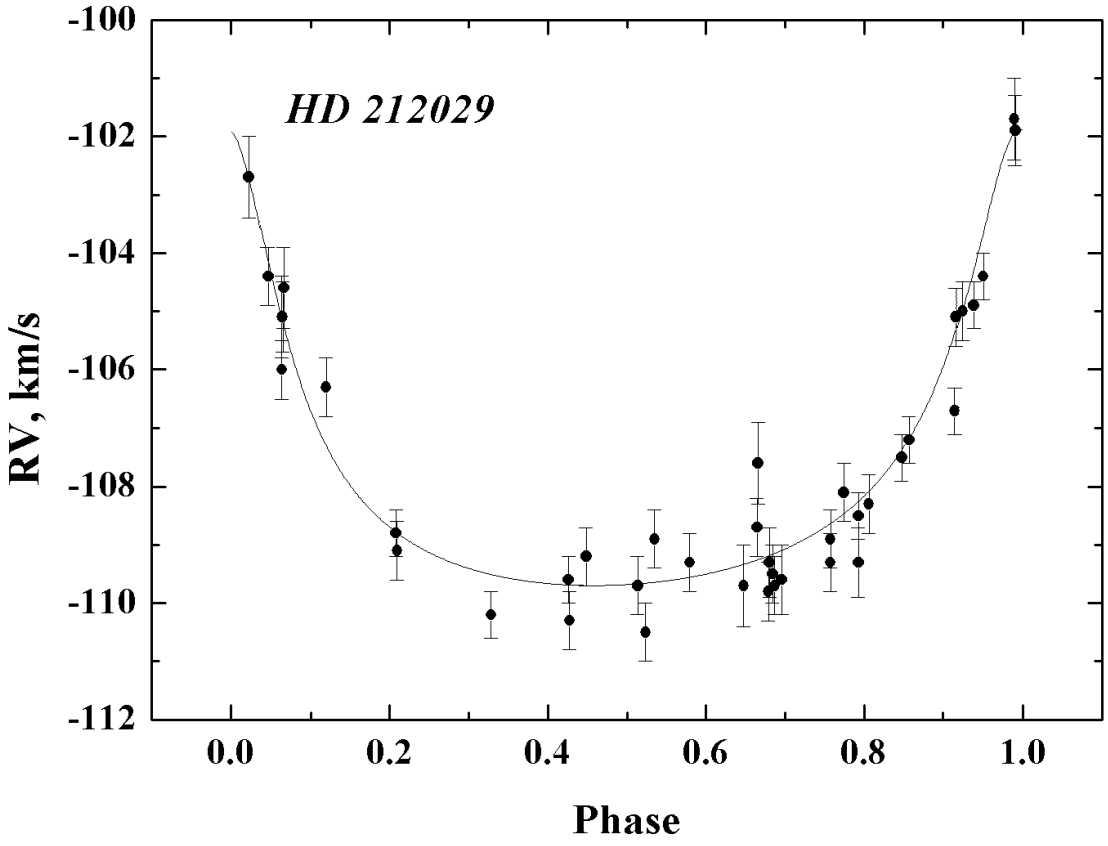
ERRORS

$$\sigma^2 = \sigma_{fit}^2 + \sigma_{std}^2 + \sigma_{slit}^2$$

σ_{fit} ~ 0.01 – 2 km/s

σ_{std} ~ 0.1 – 0.5 km/s

σ_{slit} ~ 0.3 km/s ? 1/t ?

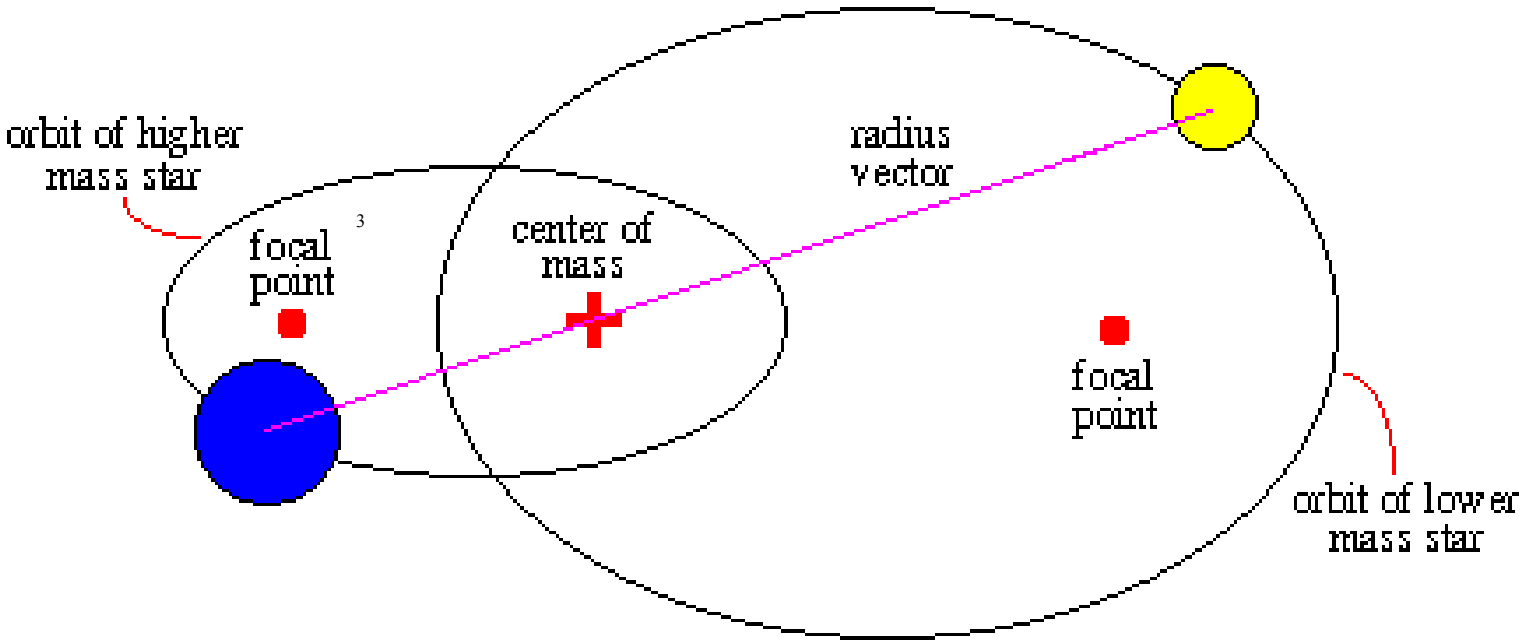


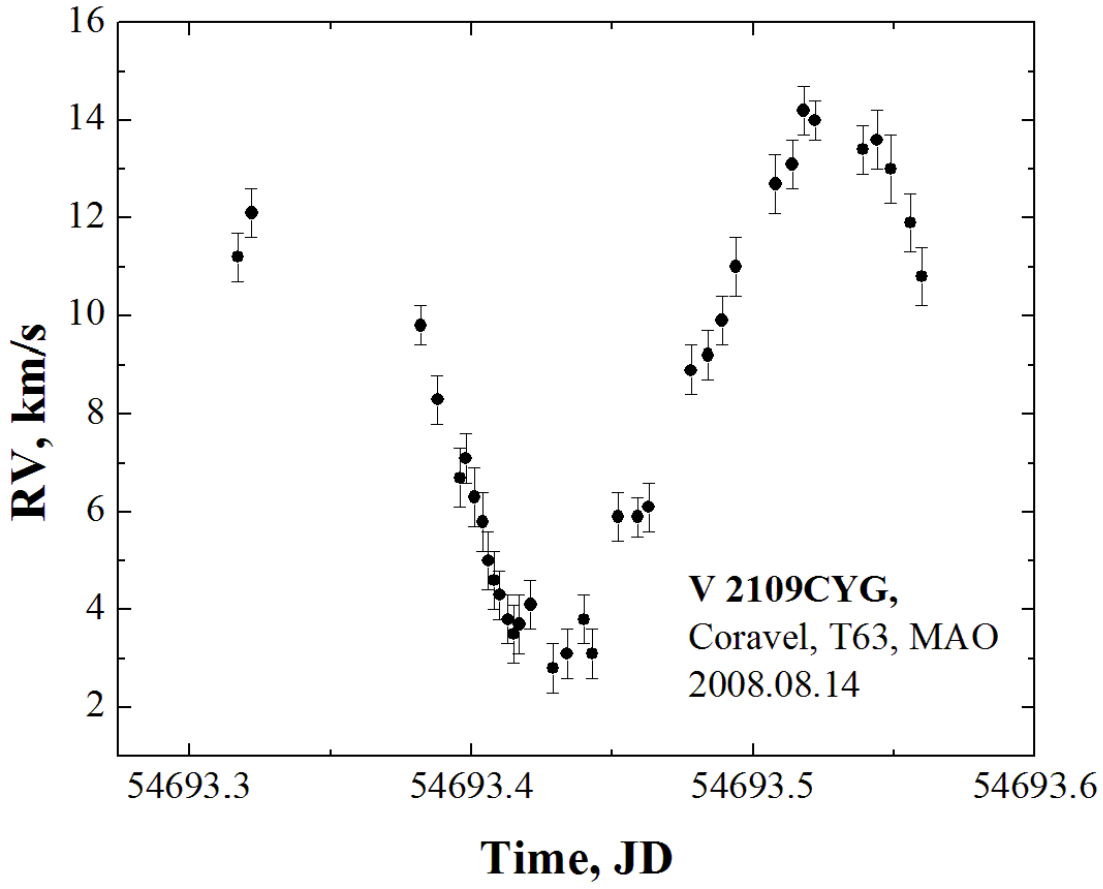
P= 764.0 d, K=3.9 km/s, e=0.56,
Δ T=1572 d. (4.3 yr.)

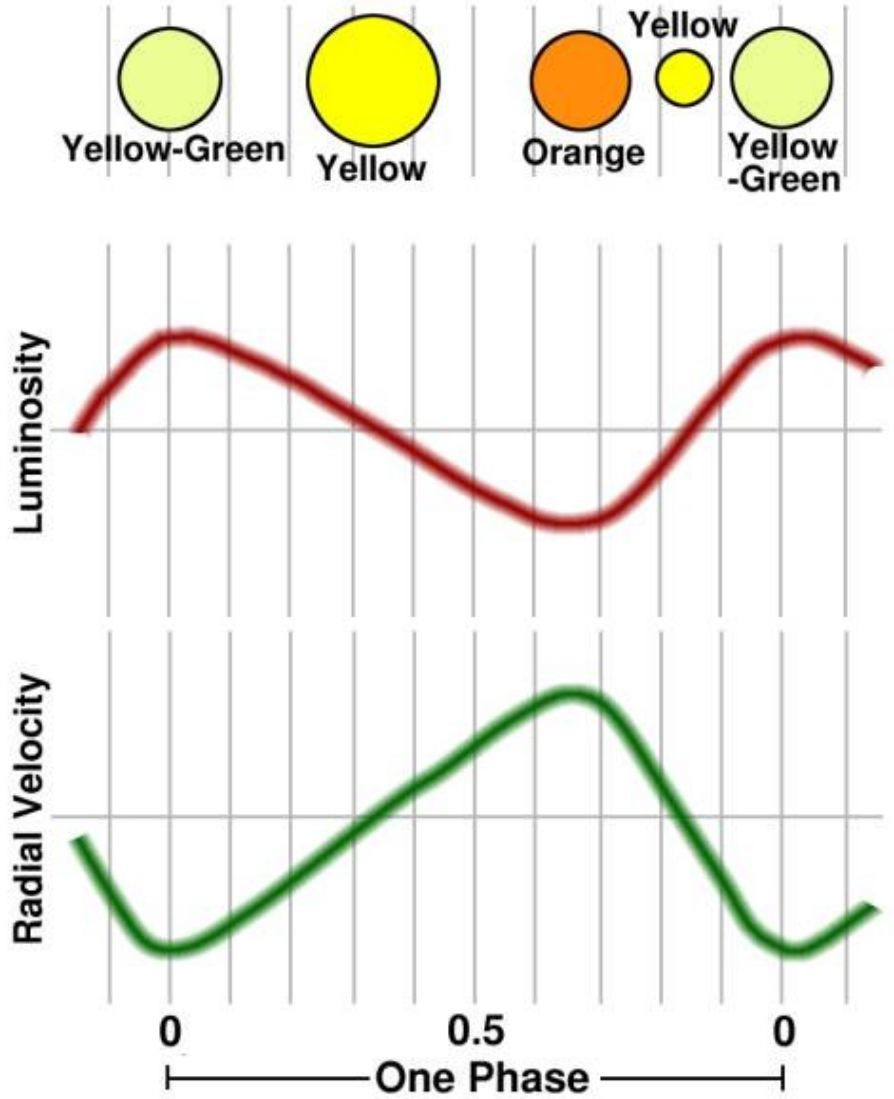
σ(O-C) = 0.56 km/s

$$M_1 + M_2 = (a_1 + a_2)^3 / P^2$$

Binary Star Orbit




16
14
12
10
8
6
4
2
RV, km/s
54693.3
54693.4
54693.5
54693.6
Time, JD
V 2109CYG,
Coravel, T63, MAO
2008.08.14


Yellow-Green
Yellow
Orange
Yellow
Yellow
-Green
Luminosity
Radial Velocity
0
0.5
0
One Phase

Transiting exoplanets from the CoRoT space mission

II. CoRoT-Exo-2b: A transiting planet around an active G star*

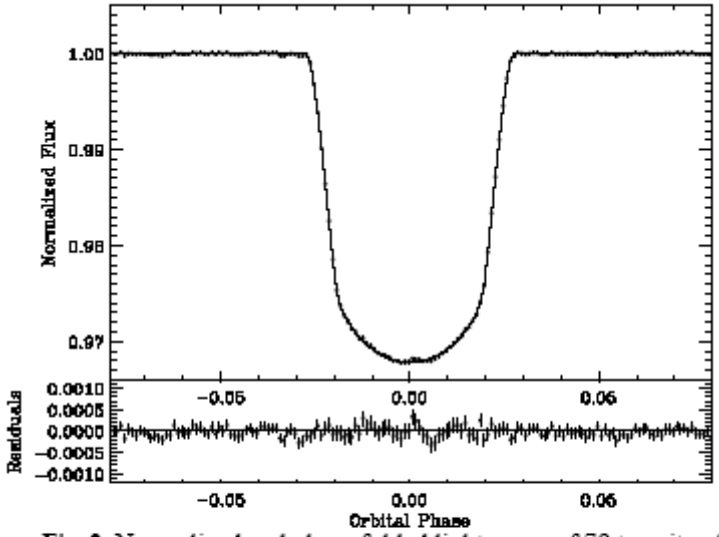


Fig. 2. Normalized and phase folded light curve of 78 transits of CoRoT-Exo-2b (top), and the residuals from the best-fit model (bottom). The bin size corresponds to 2.5 min, and the 1-sigma error bars have been estimated from the dispersion of the points inside each bin. The residuals of the in-transit points are larger due to the effect of successive planet occultations of stellar active regions.

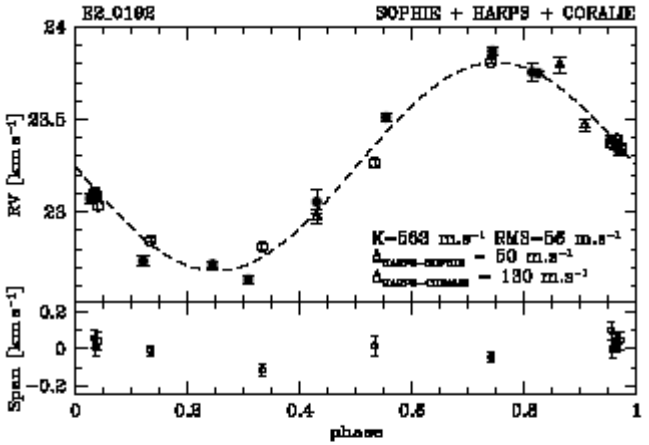
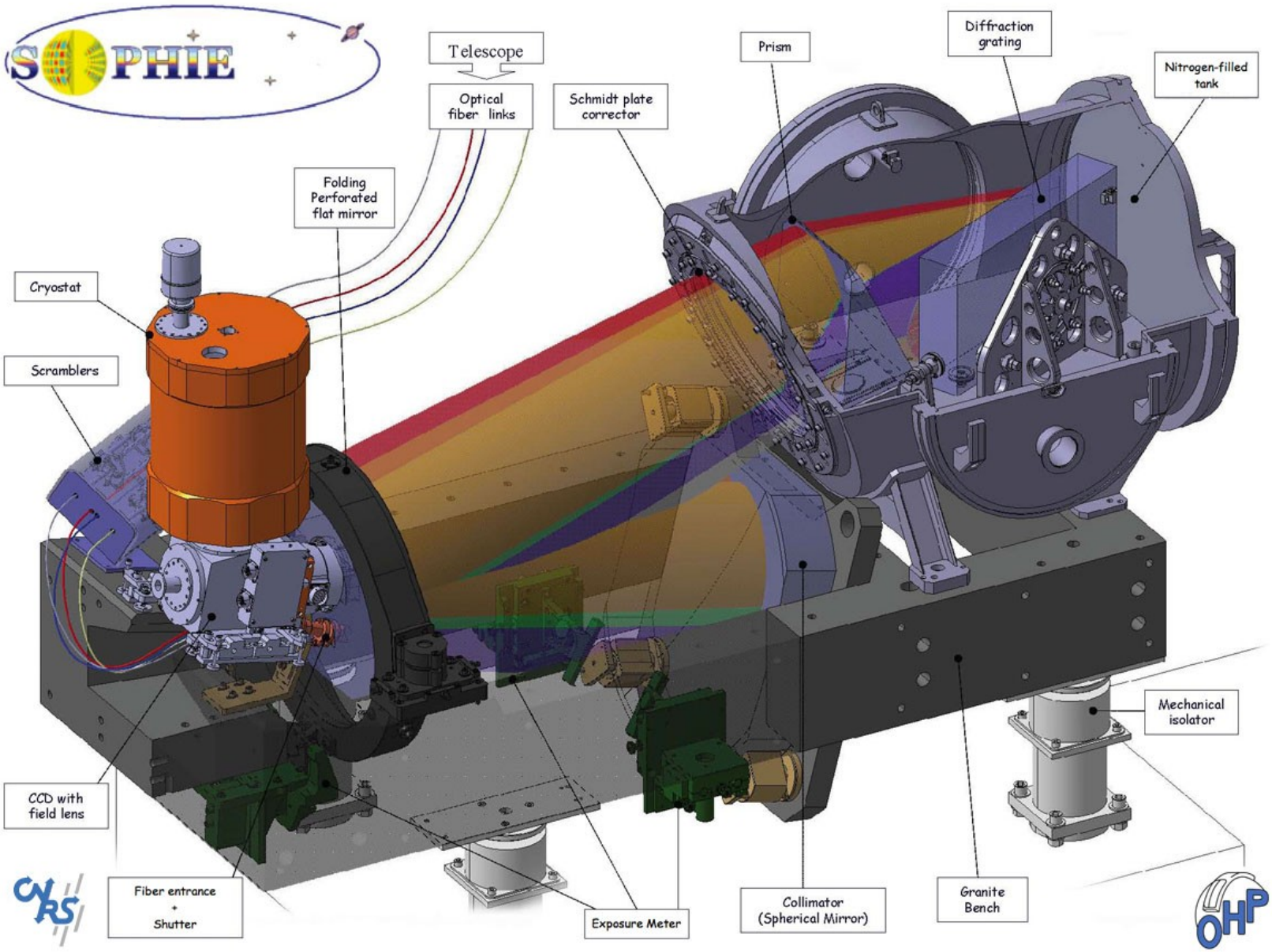


Fig. 3. Phase folded radial velocity measurements of CoRoT-Exo-2, together with the final fitted semi-amplitude (K) and the applied offsets between the instruments. Filled circles: SOPHIE, open circles: HARPS, open triangles: CORALIE. In the bottom panel, the total span of the CCF bisectors, as measured in the HARPS spectra.


SOPHIE
Telescope
Optical fiber links
Schmidt plate corrector
Prism
Diffraction grating
Nitrogen-filled tank
Folding Perforated flat mirror
Cryostat
Scramblers
Mechanical isolator
CCD with field lens
Fiber entrance + Shutter
Exposure Meter
Collimator (Spherical Mirror)
Granite Bench
CNRS
OHP


HEAD LIFTING POINT
ADCO

Observational Stellar Astrophysics School, 2008, p.p. xxx–xxx.

TRANSITING EXTRA-SOLAR PLANET HD 147506b

Daniel Adén
Lund Observatory, Box 43, SE-221 00 Lund, Sweden

Received 2008 September 24; revised 2008 XXX

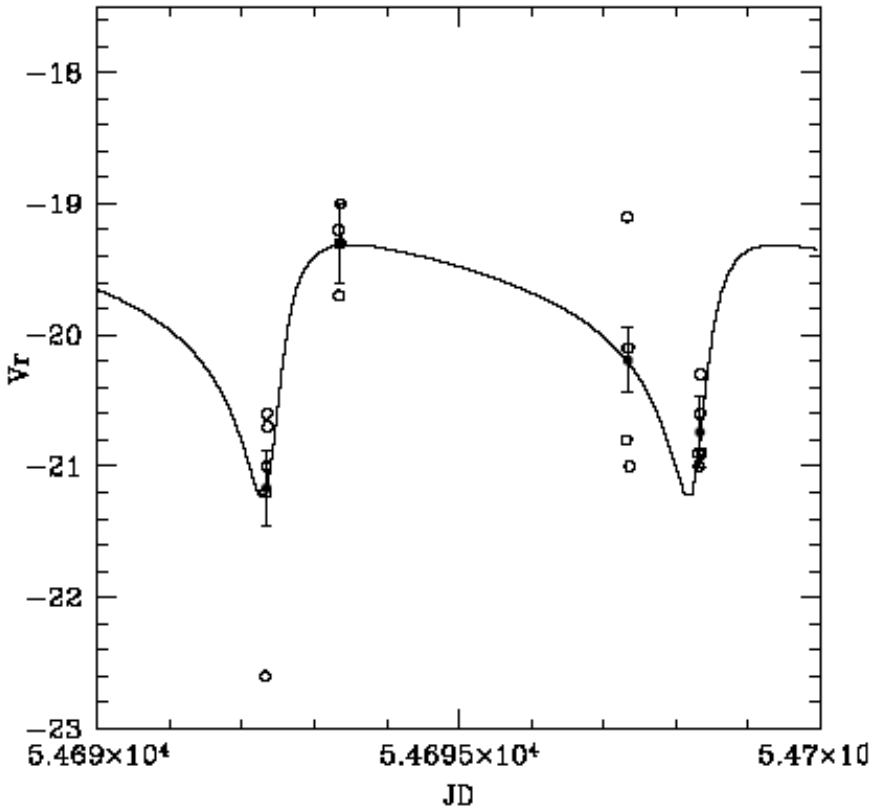
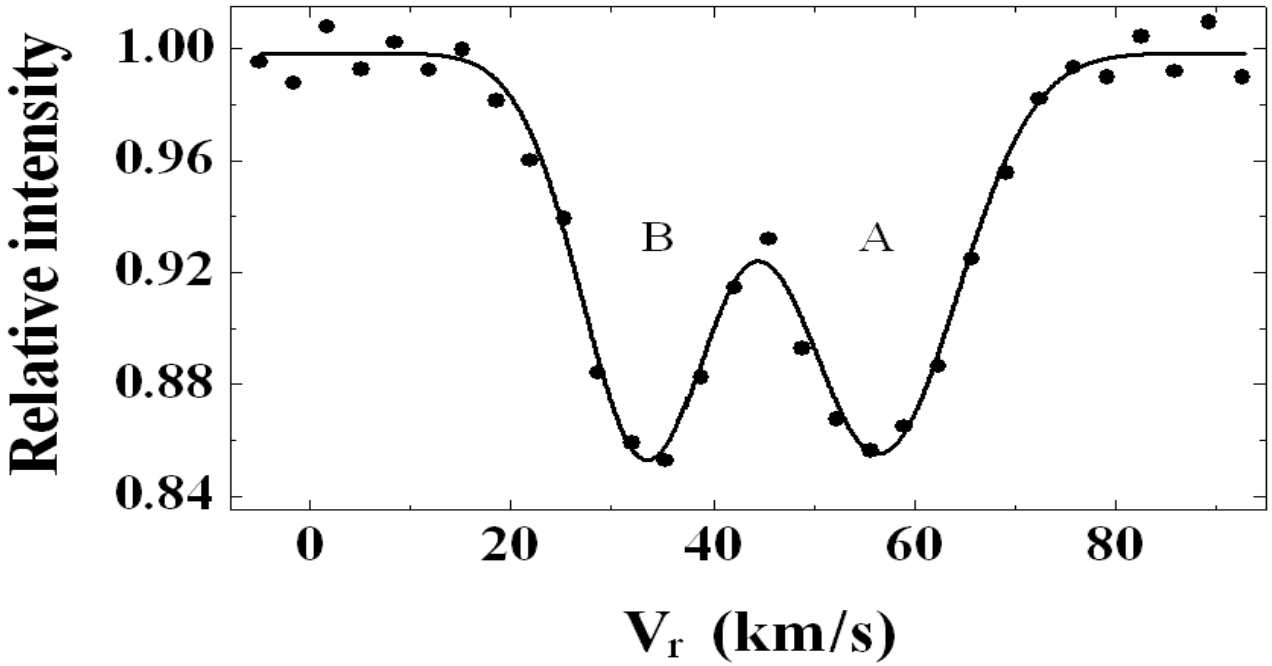


Fig. 1. Radial velocity vs. Julian date. The solid line is the model with the orbital parameters from our fit. Open circles are individual measurements and filled circles are the weighted mean of those individual measurements. Error bars are from the standard deviation of the weighted mean, Eq. 3.


Relative intensity
1.00
0.96
0.92
0.88
0.84
0
20
40
60
80
B
A
V_r (km/s)