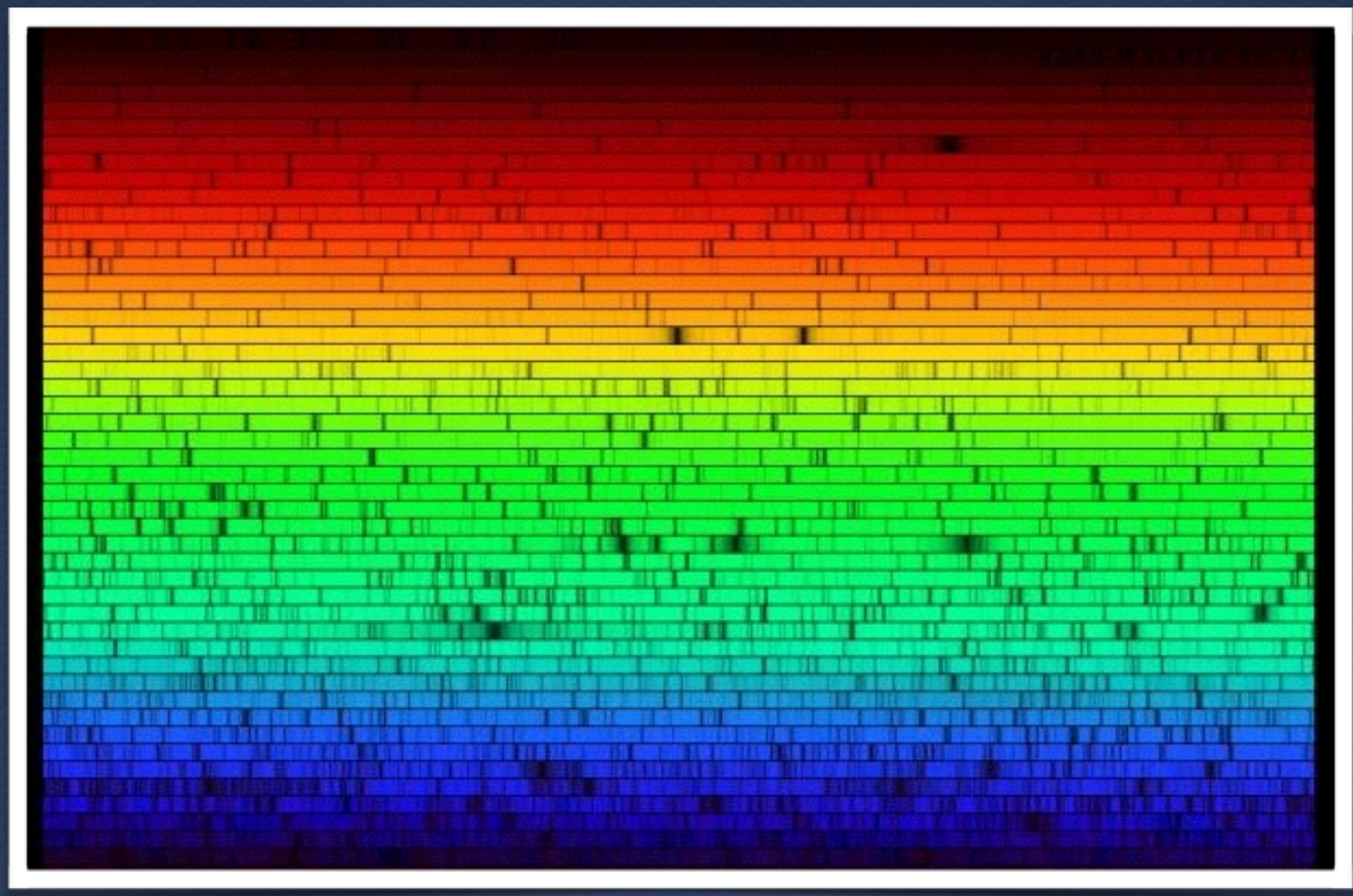


Égi színképek bűvöletében

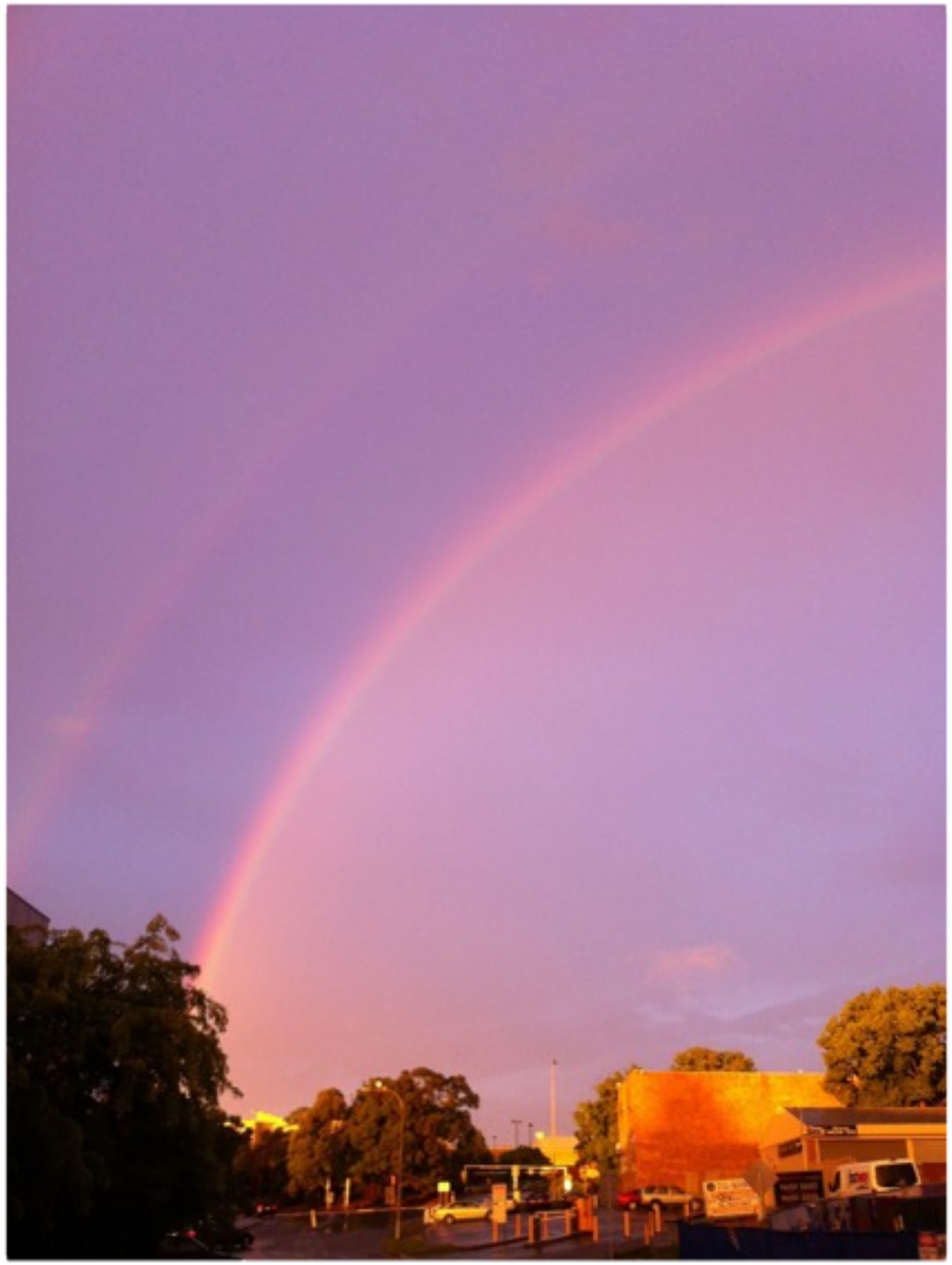
Kiss László - MTA CSFK KTM CSI

XVIII. Szabadkai Nyári Akadémia, 2014.08.12.

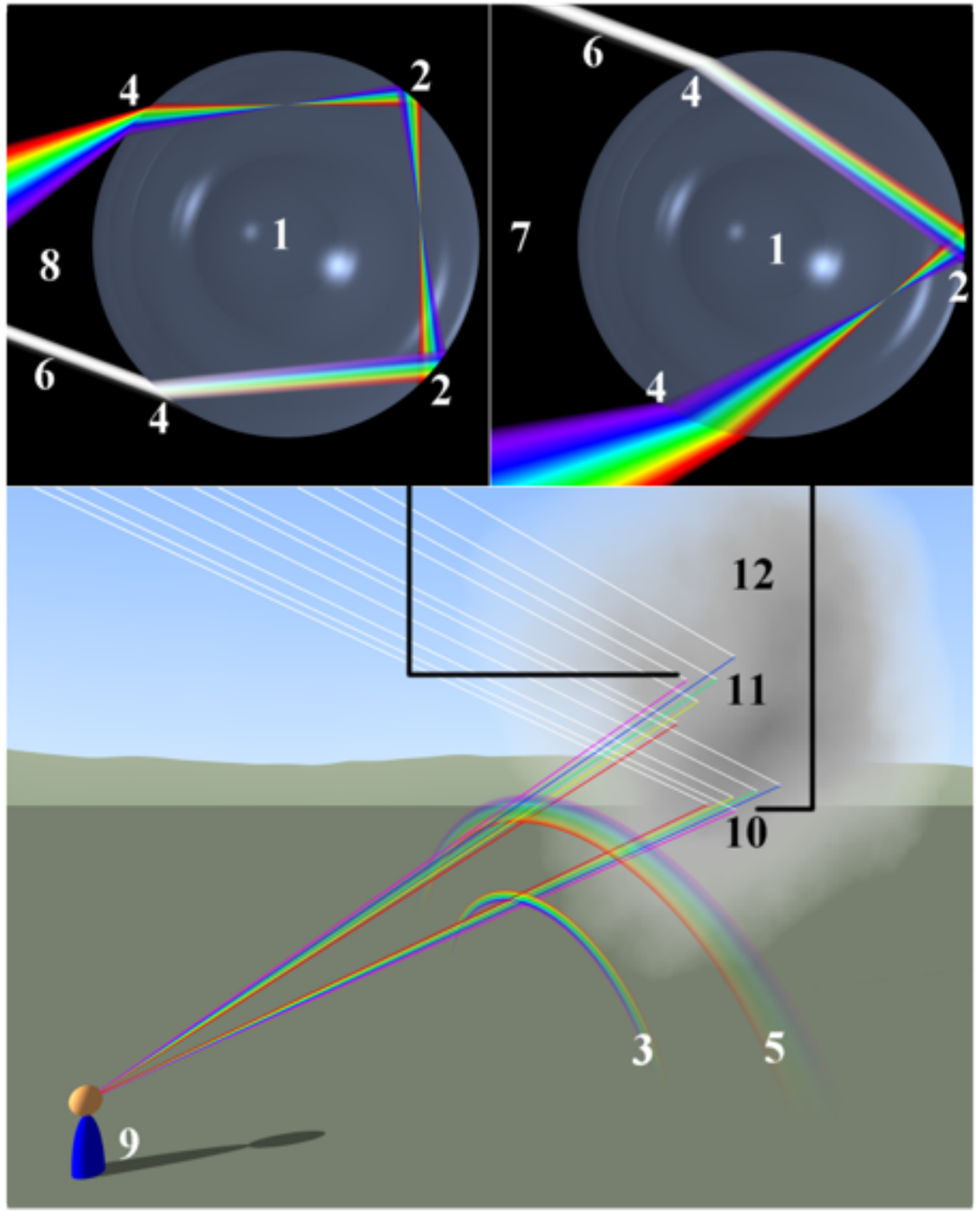
Csillagászati spektroszkópia

- Fizikai alapelvek
- Klasszikus fénybontó elemek
- Példák alkalmazásokra
- Égi spektroszkópia az oktatásban

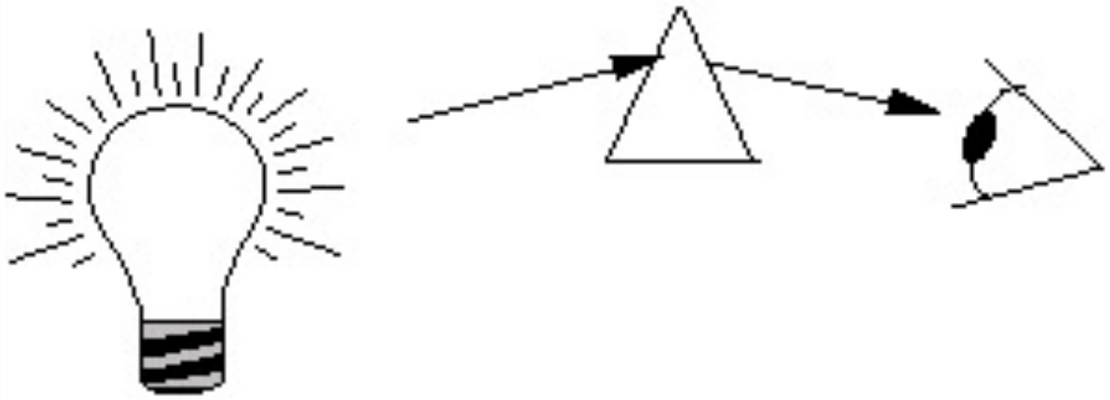
Egy kis fizika



(Kiss L.)



(Wikipedia)



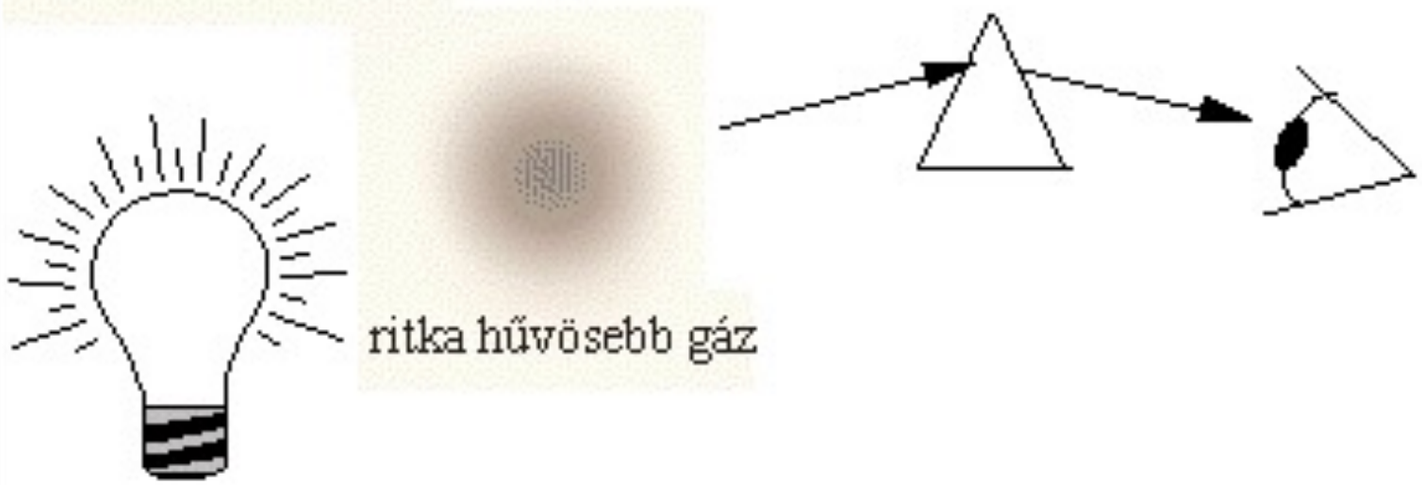
izzó szilárd test vagy
magasnyomású gáz

folytonos spektrum

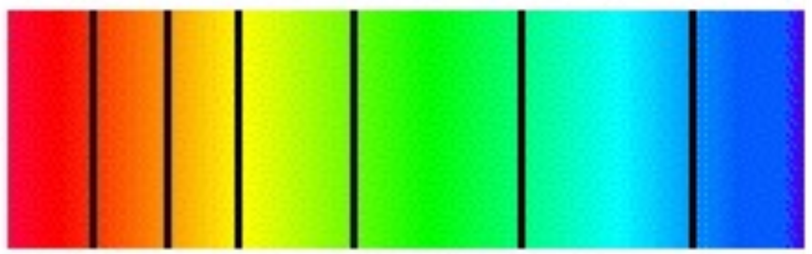
emissziós vonalas spektrum

izzó alacsony nyomású gáz

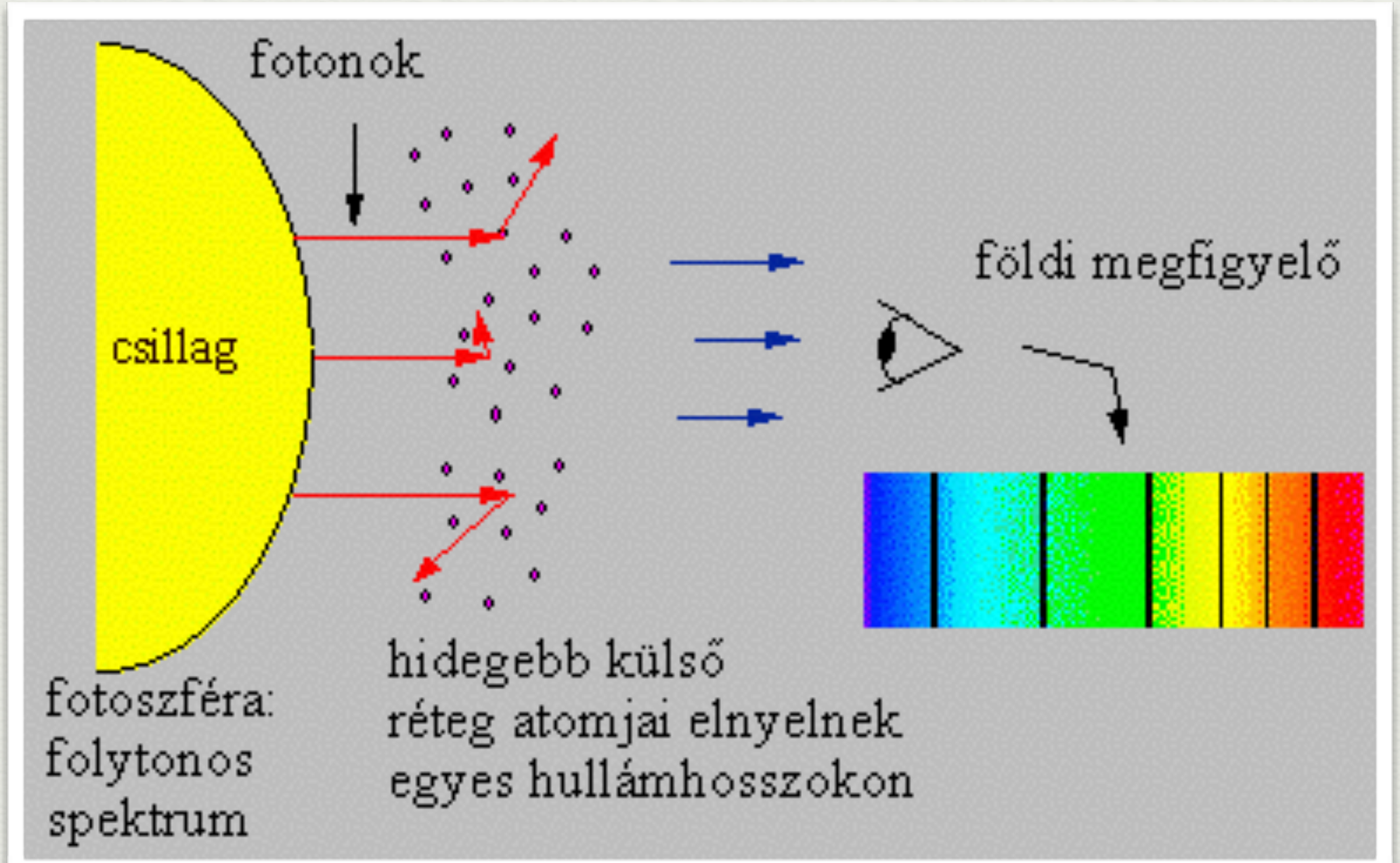
abszorpciós vonalas spektrum



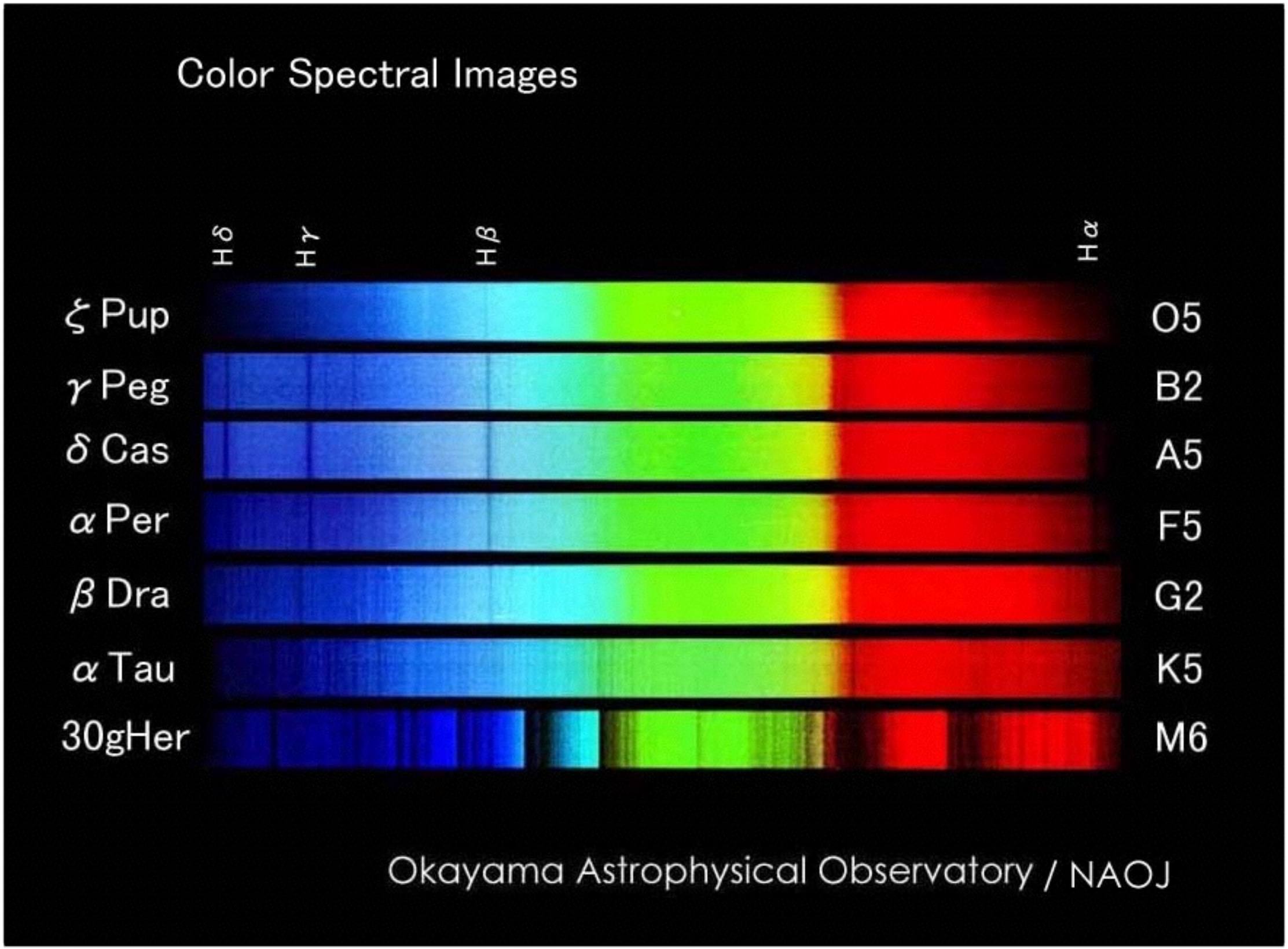
ritka hűvösebb gáz

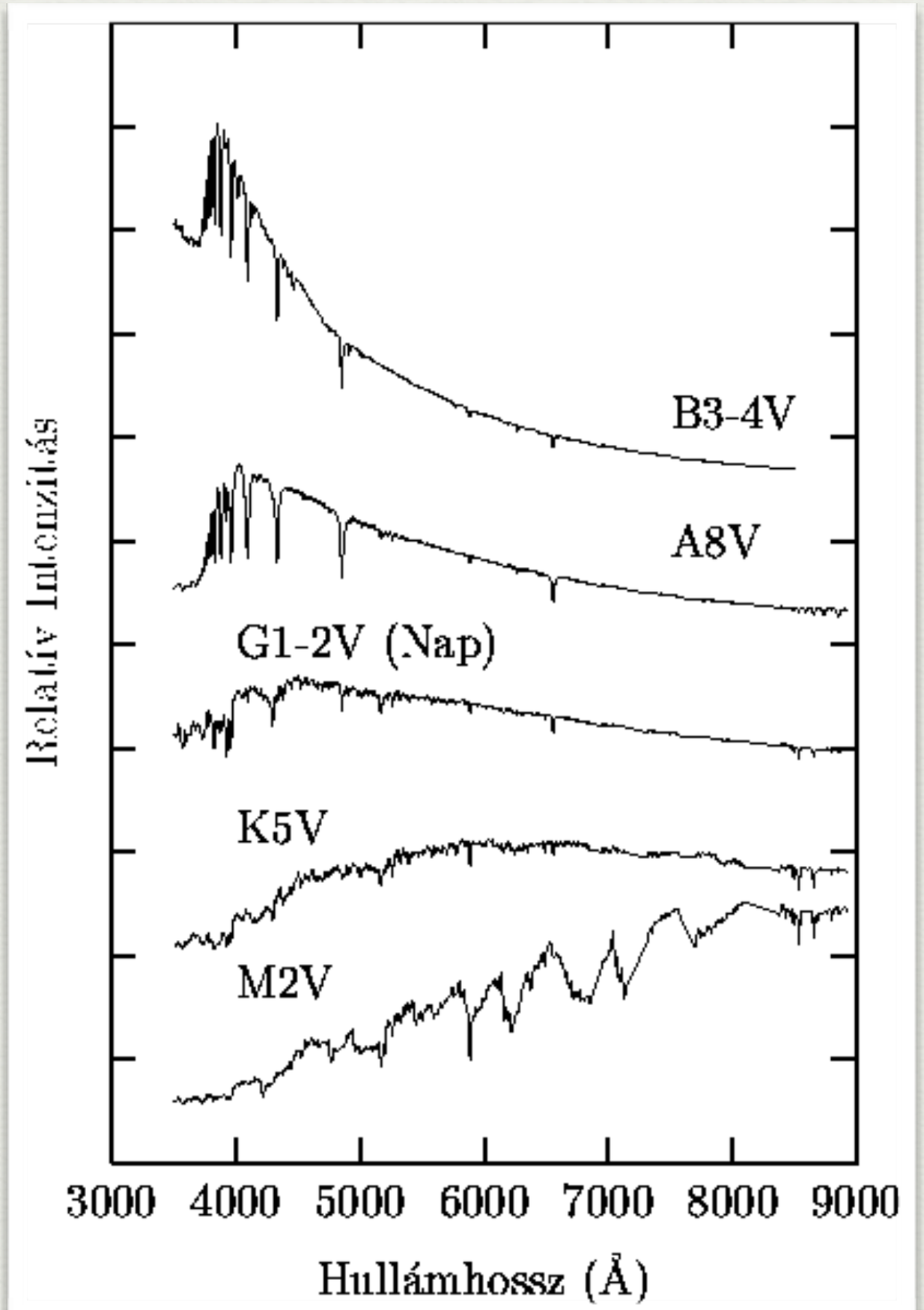


(Meteor Csill. Évk. 1998)



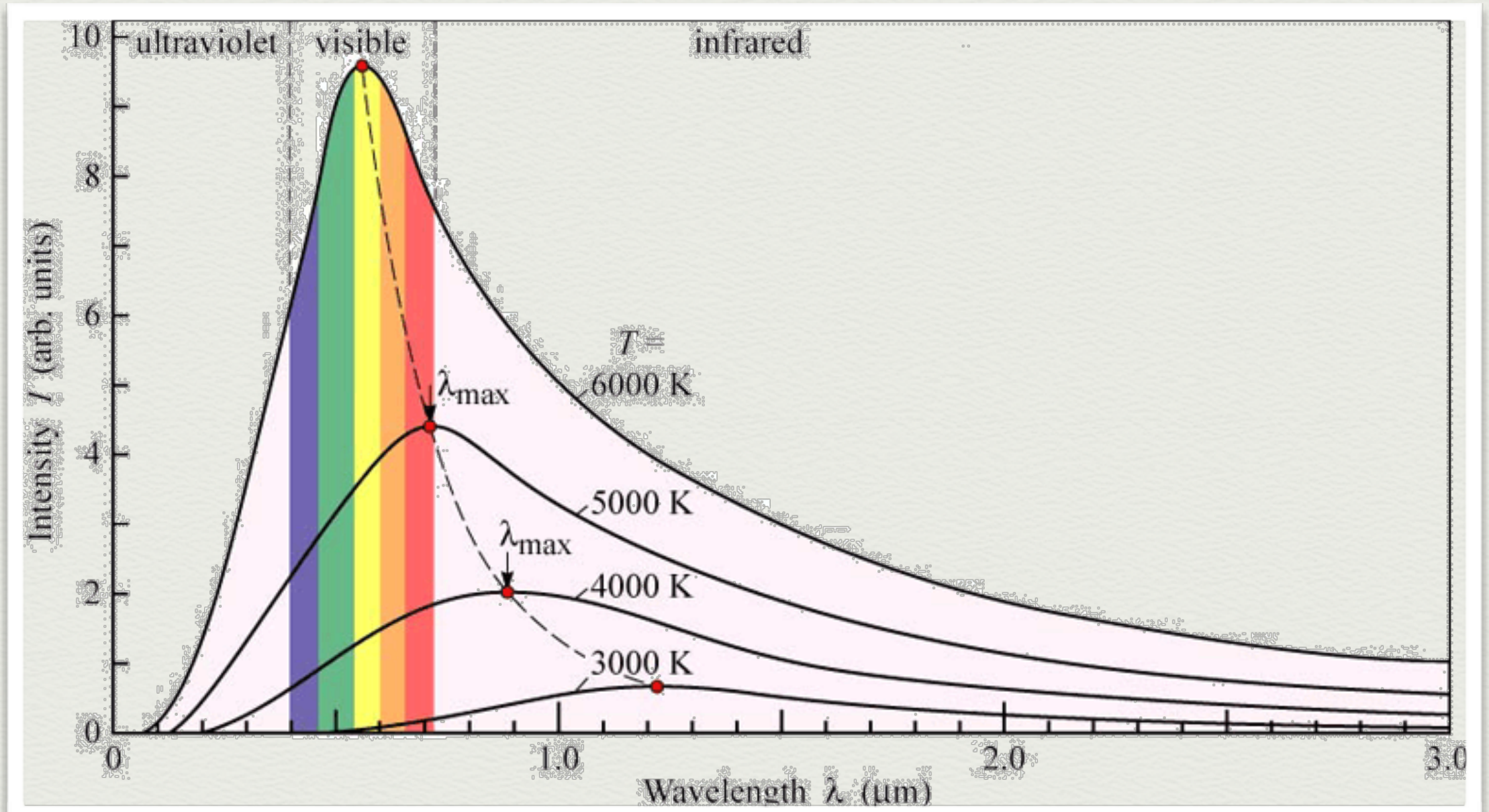
(Meteor Csill. Évk. 1998)


Color Spectral Images
Hδ
Hγ
Hβ
Hα
ζ Pup
O5
γ Peg
B2
δ Cas
A5
α Per
F5
β Dra
G2
α Tau
K5
30gHer
M6
Okayama Astrophysical Observatory / NAOJ



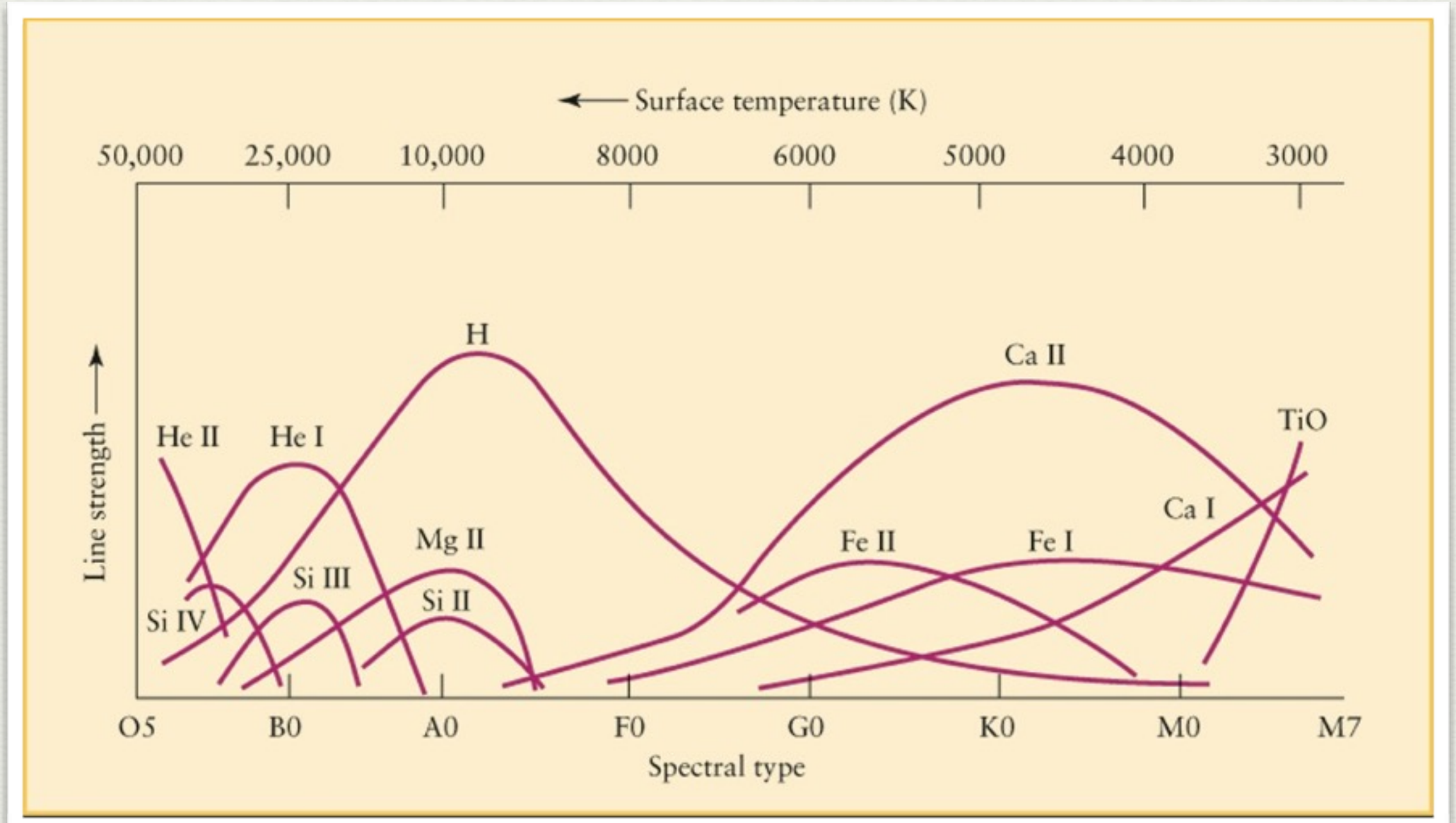
(Meteor Csill. Évk. 1998)

Folytonos színkép: hőmérséklet



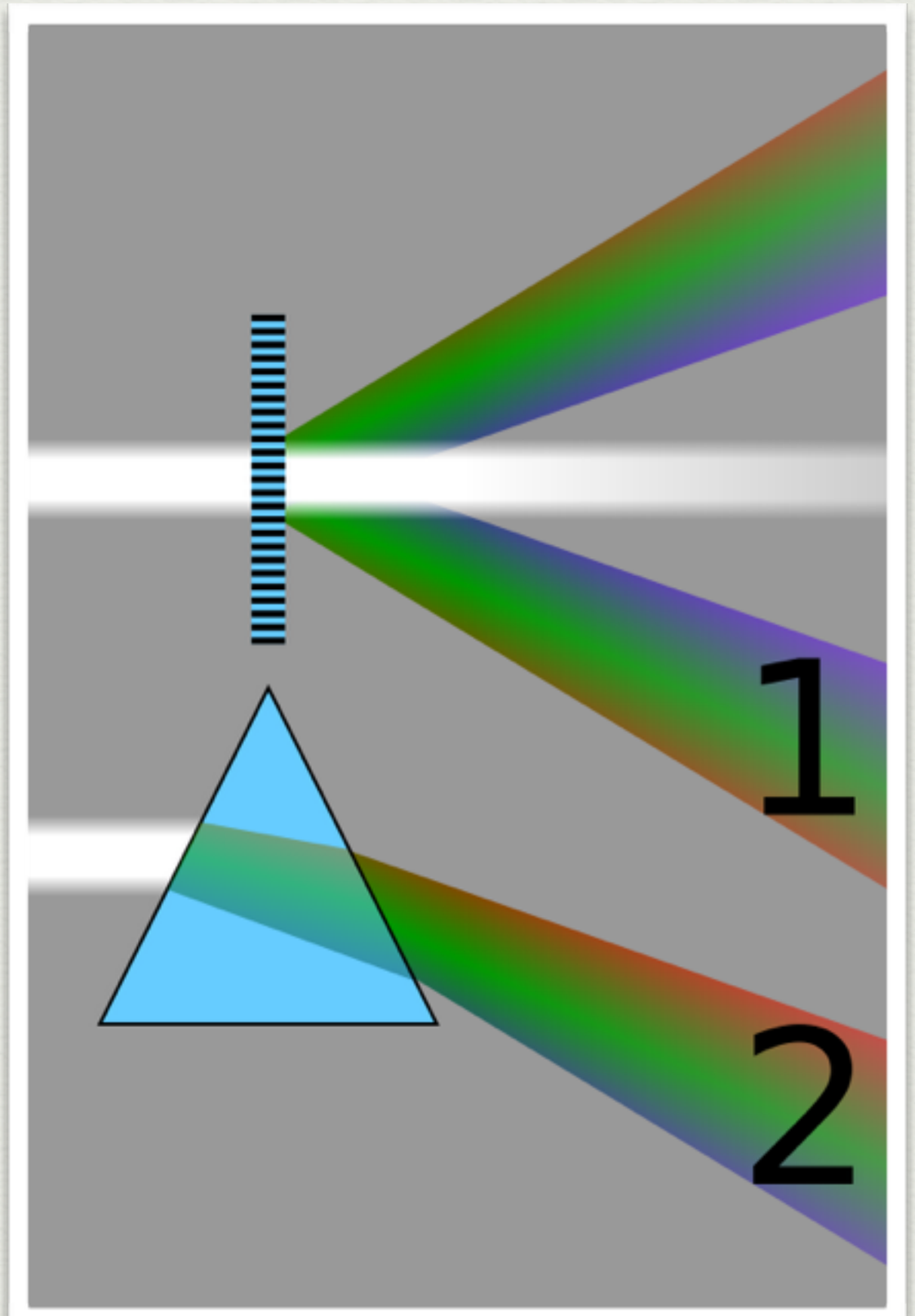
(Univ. of Oregon)

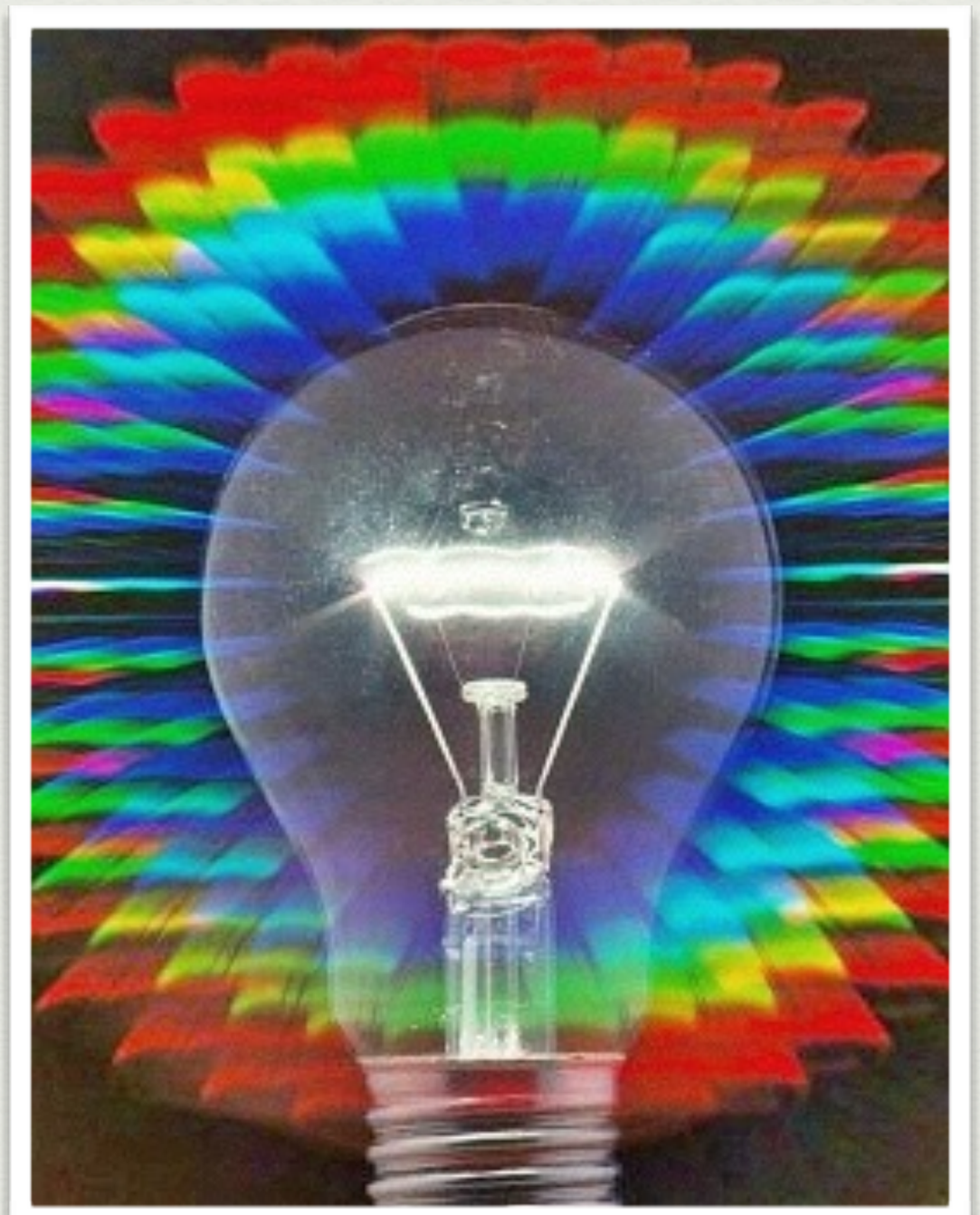
Vonalas színkép: hőmérséklet!



(Univ. of Alberta)

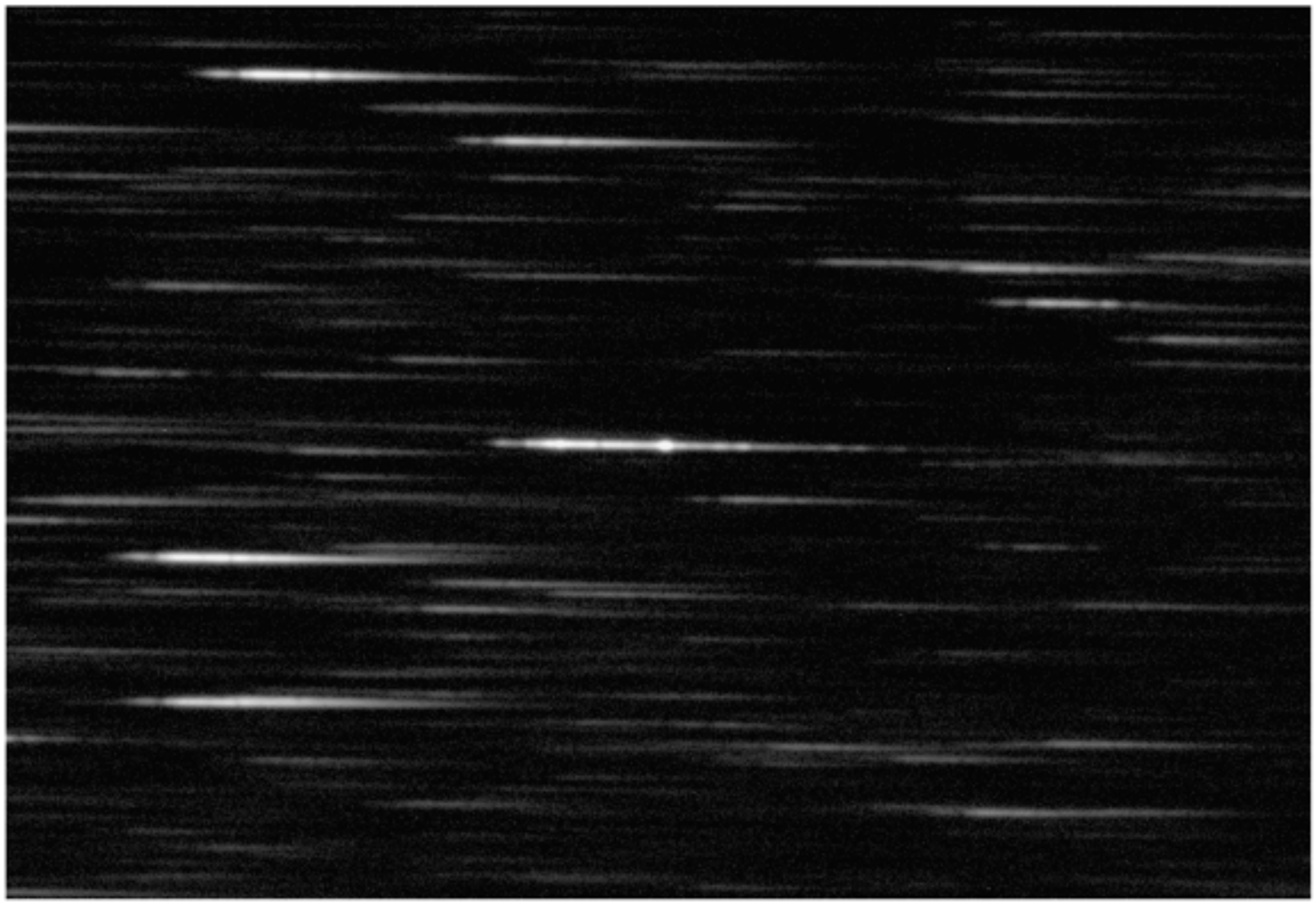
Bontsuk fel a fényt!





(Wikipedia)


RÁCZ M

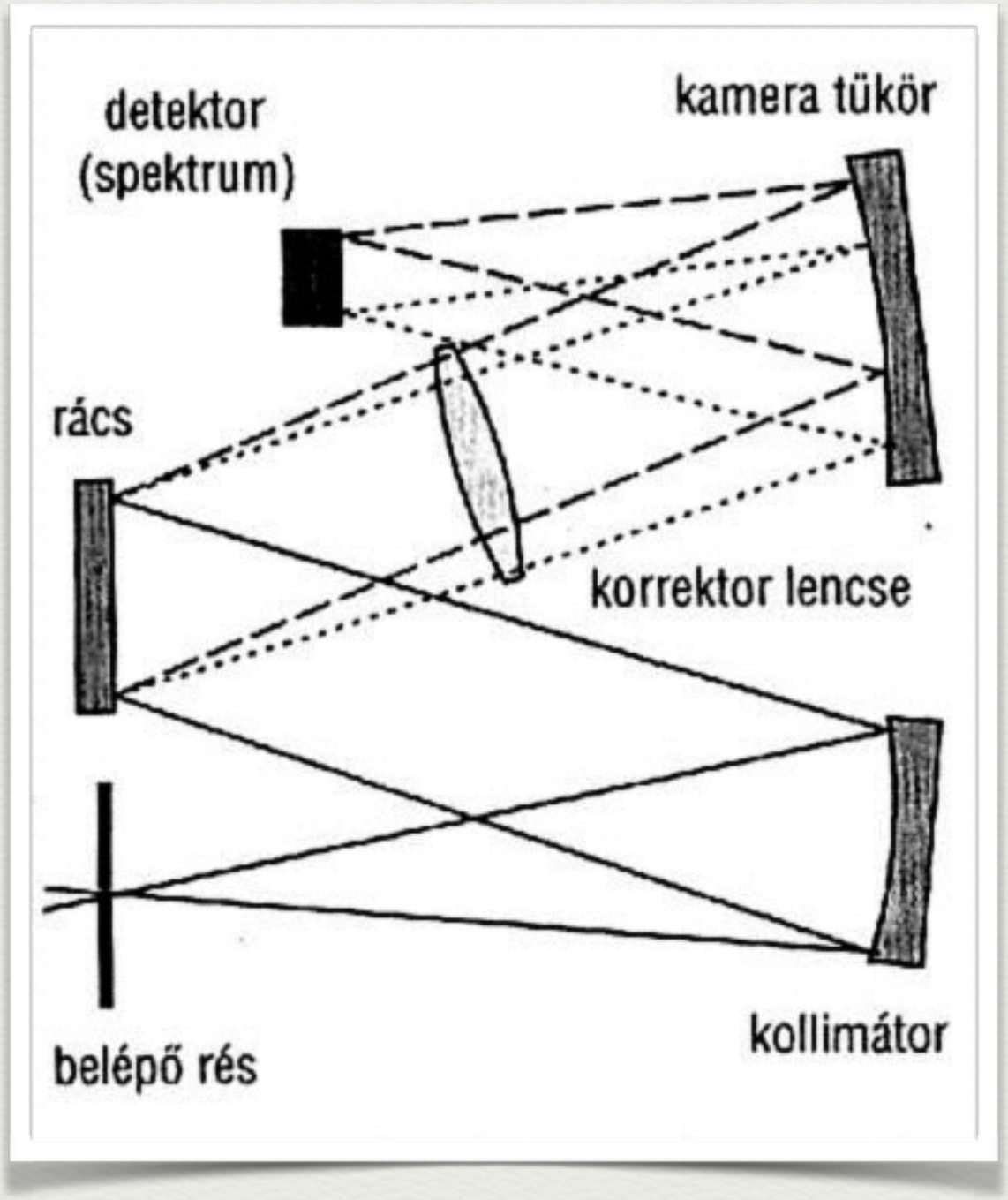


Mûszer: 60/90/180 Schmidt
+ Photometrics AT200 CCD
LM= 29x18'

szûrõ nélkül

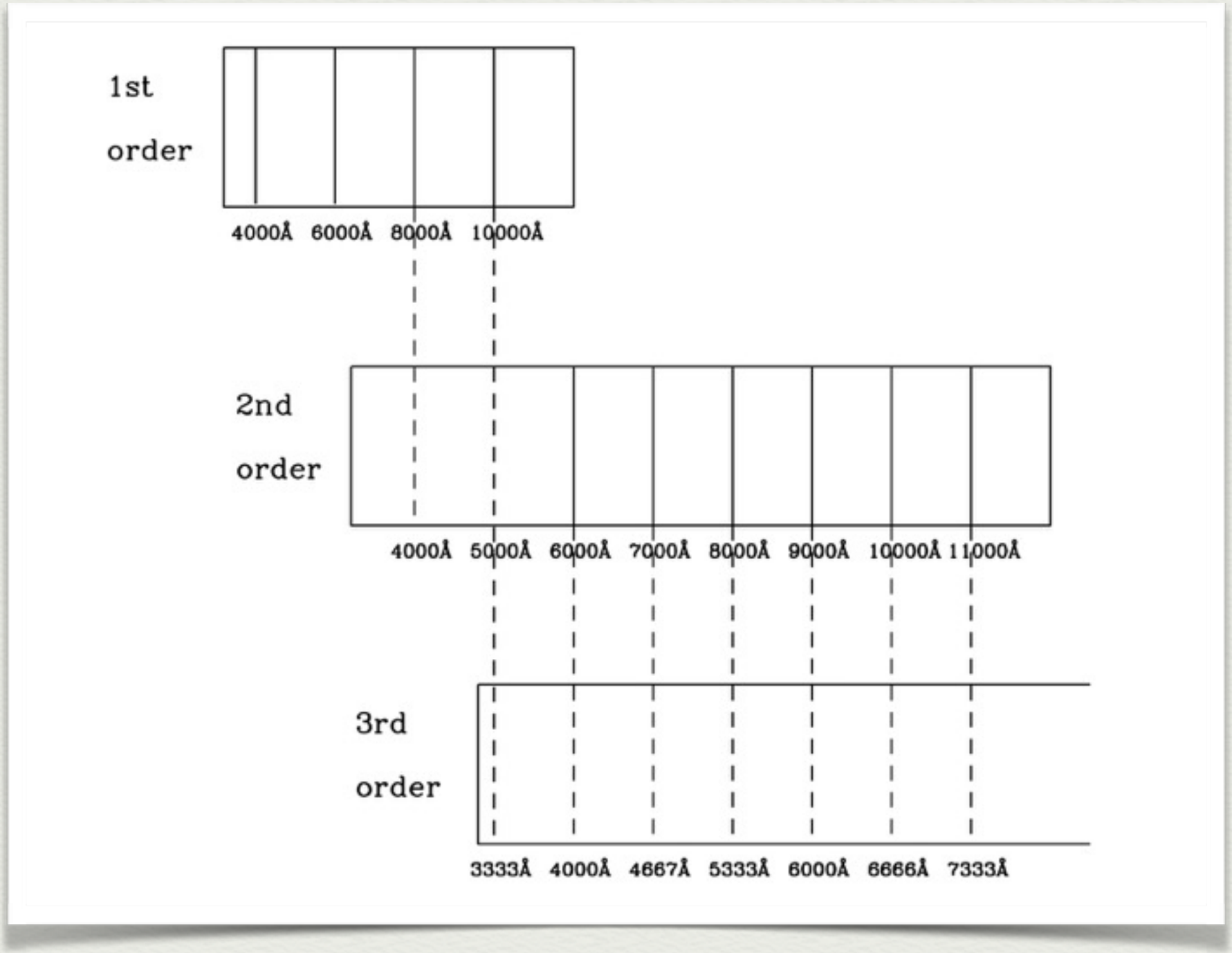
spektrum c.c. 600 pixel (max.)

Spektrográf alapelemei

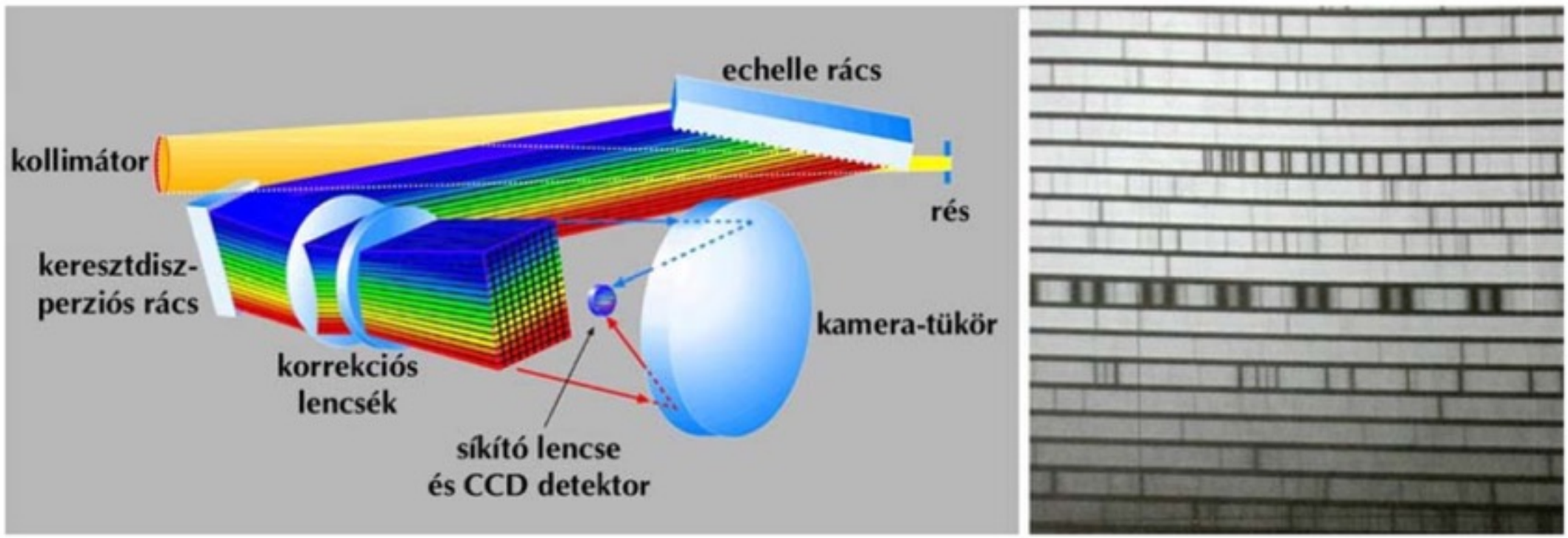


(Fűrész 2002)

Elhajlási rendek átfedése



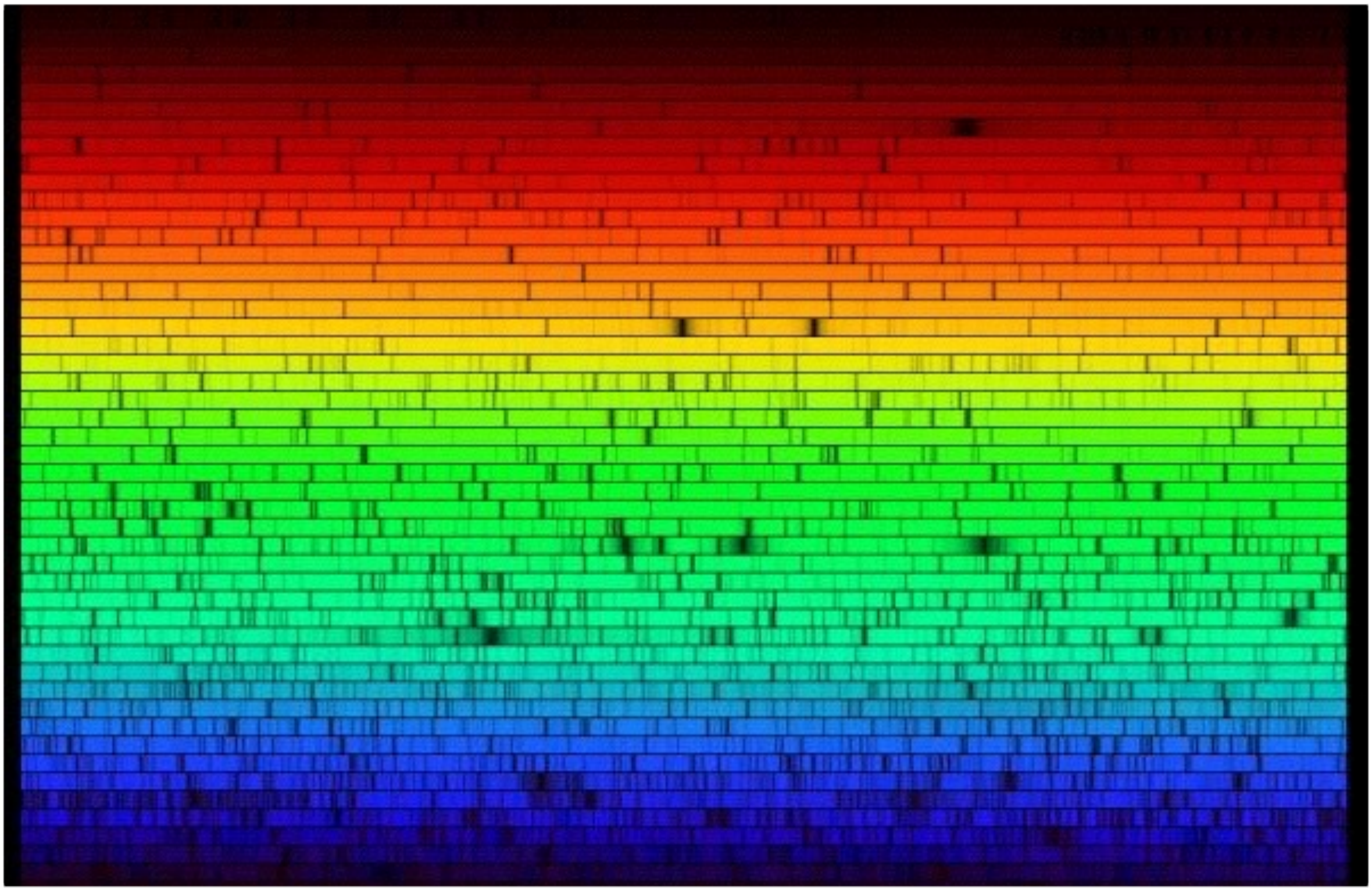
(Massey & Hanson 2011)



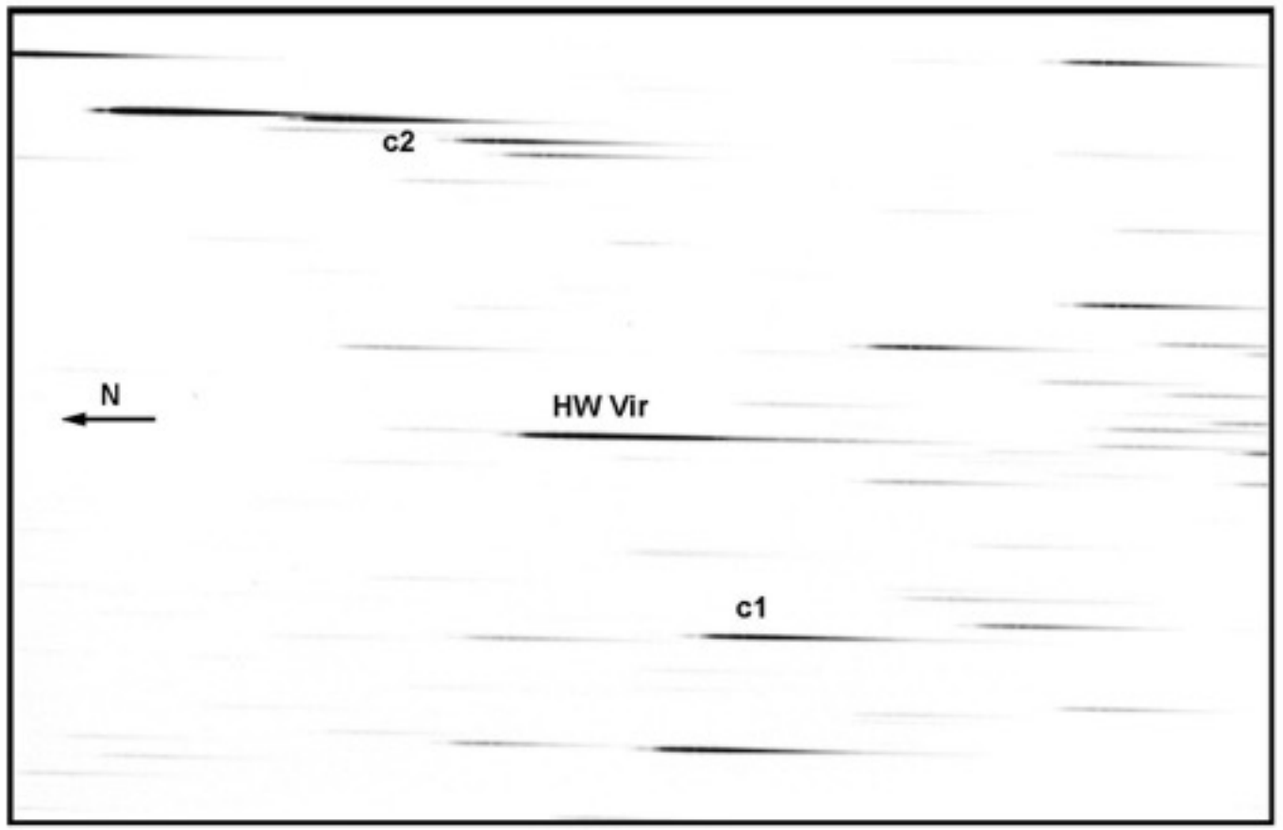
8. ábra.
Echelle spektrográf felépítése és egy echelle spektrum

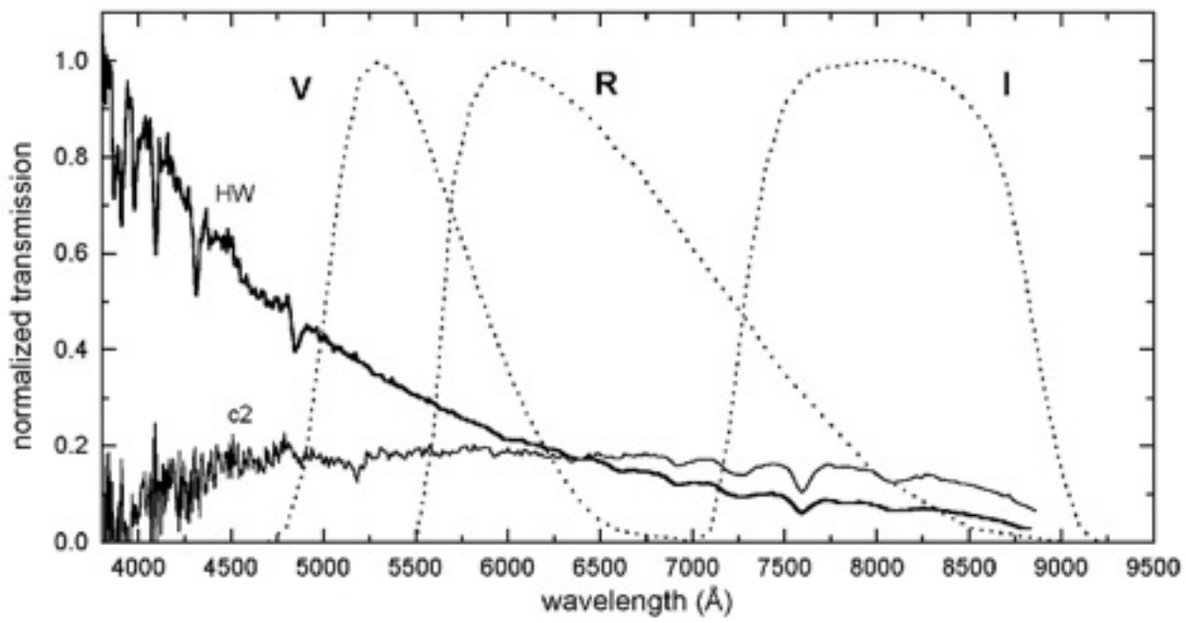
(Fűrész 2002)

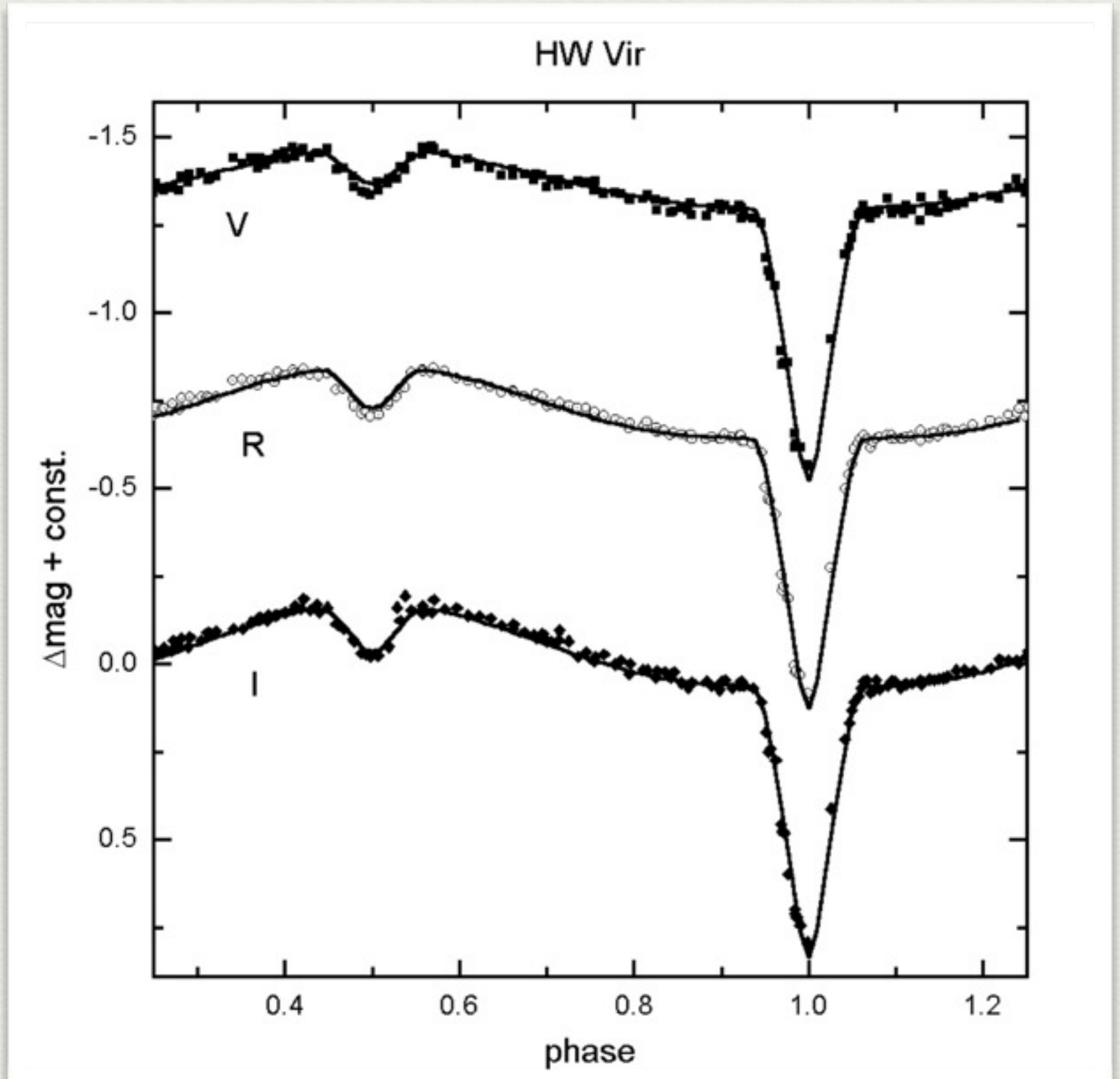
A Nap echelle spektruma



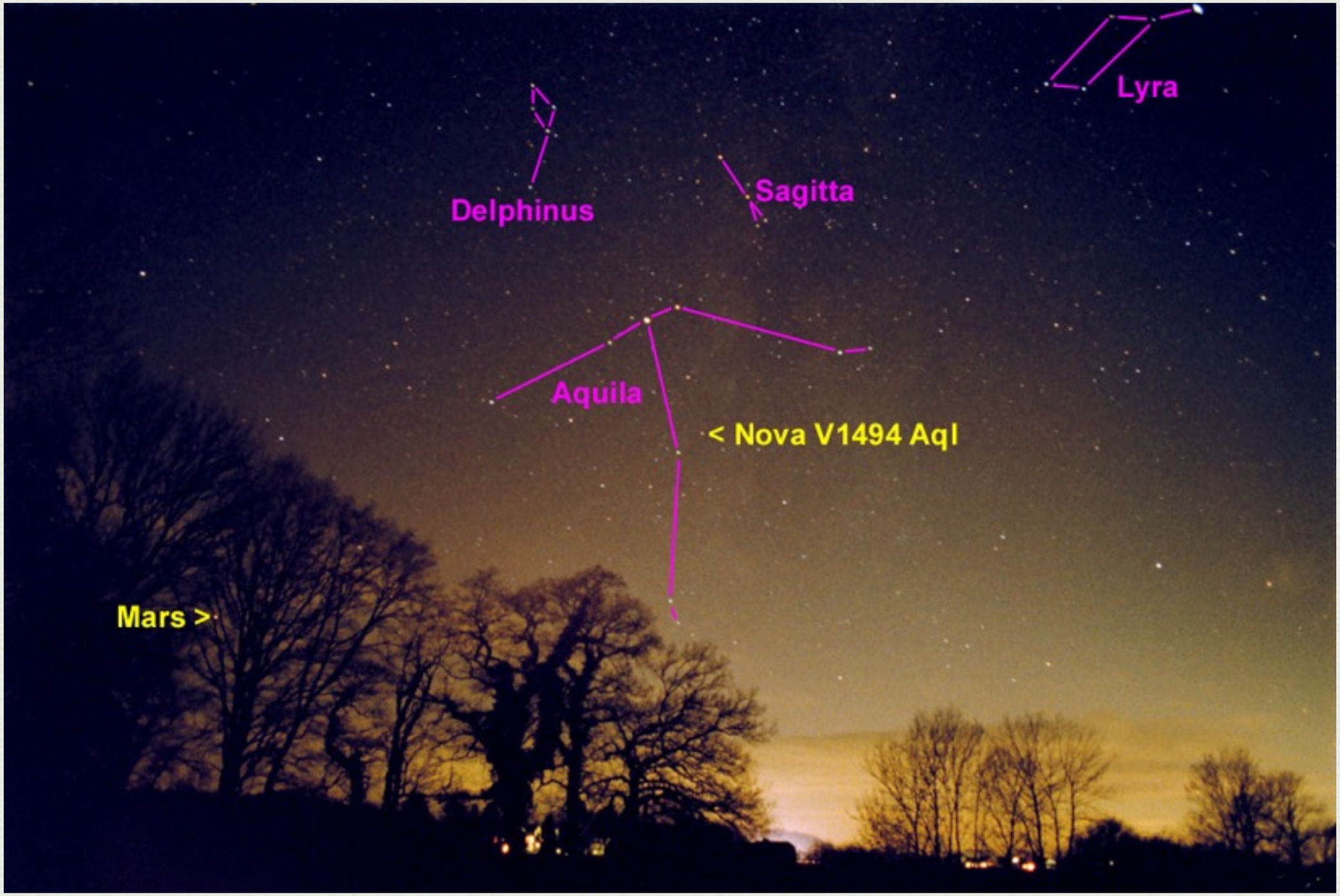
Alkalmazások


c2
N
HW Vir
c1


V
R
I
HW
c2
normalized transmission
wavelength (Å)
0.0
0.2
0.4
0.6
0.8
1.0
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500


HW Vir
-1.5
-1.0
-0.5
0.0
0.5
V
R
I
Δmag + const.
0.4
0.6
0.8
1.0
1.2
phase

Tranziens égi objektumok

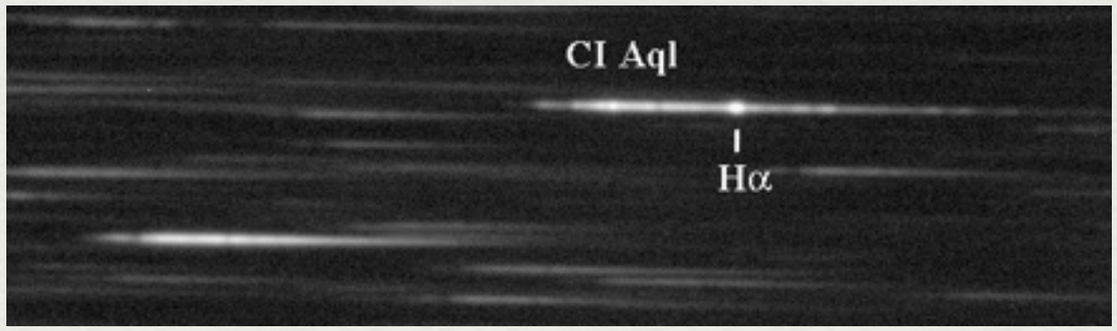


APOD

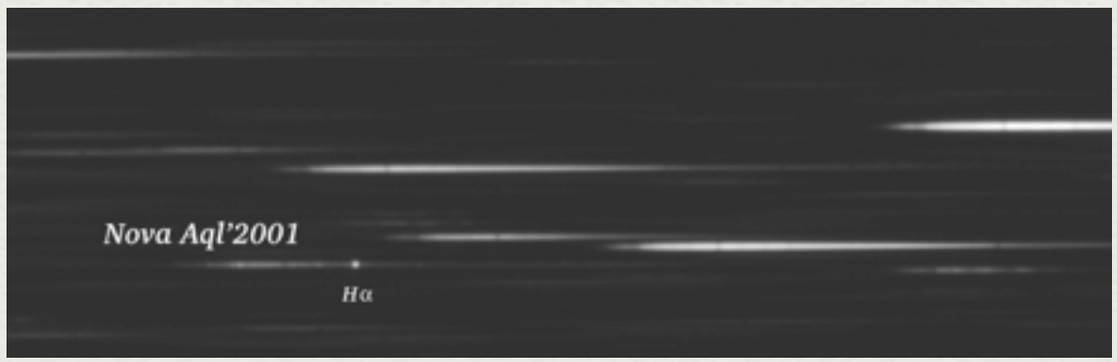
Első spektroszkópiai feladat: megerősítés

Egyetlen színkép elárulja a különbséget

- Törpe nóva?
  H vonalak abszorpcióban (optikailag vastag akkréciós korong)

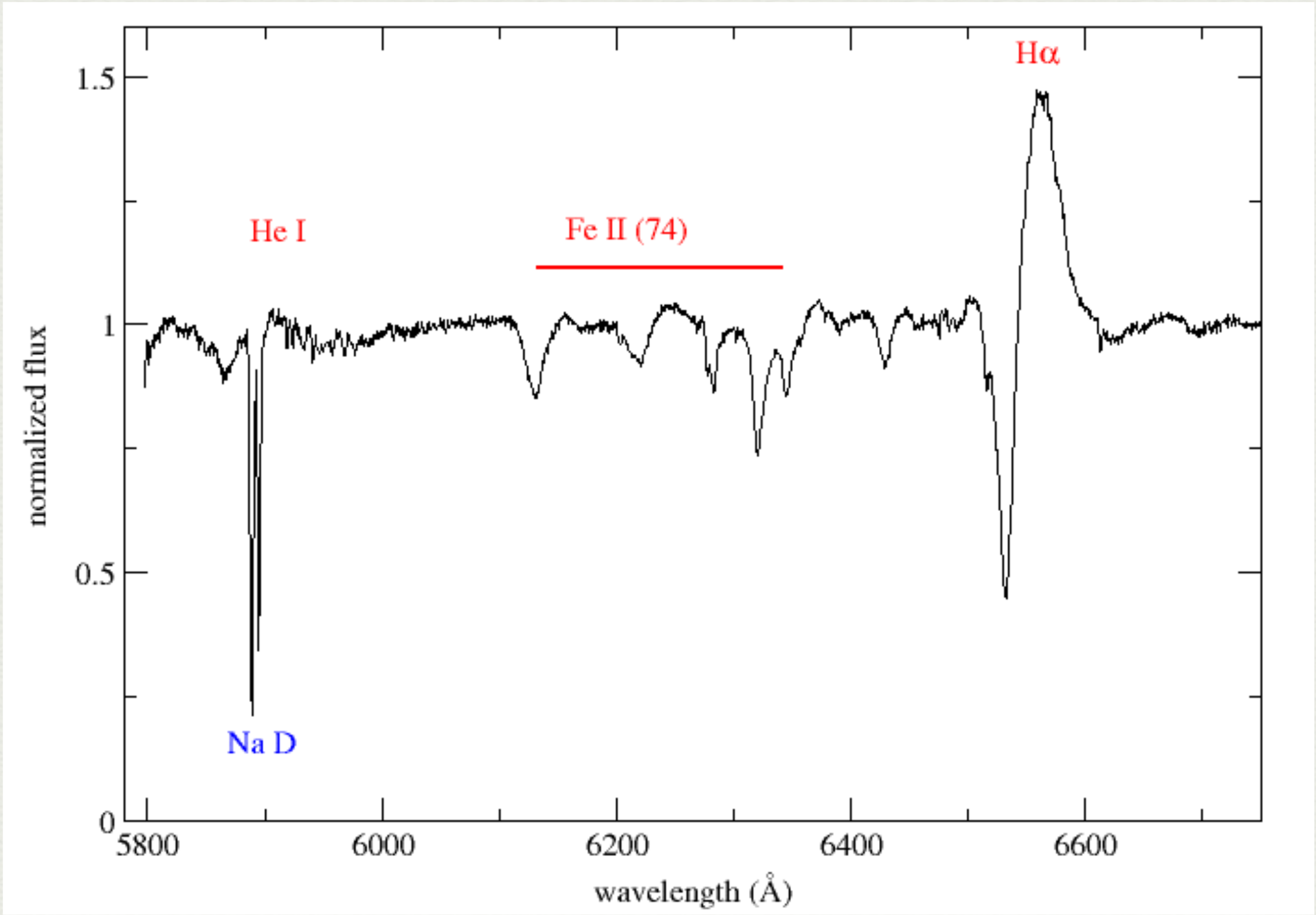


- Nóva?
  H, He, Fe, ... vonalak emisszióban (ledobódott forró gázfelhő)



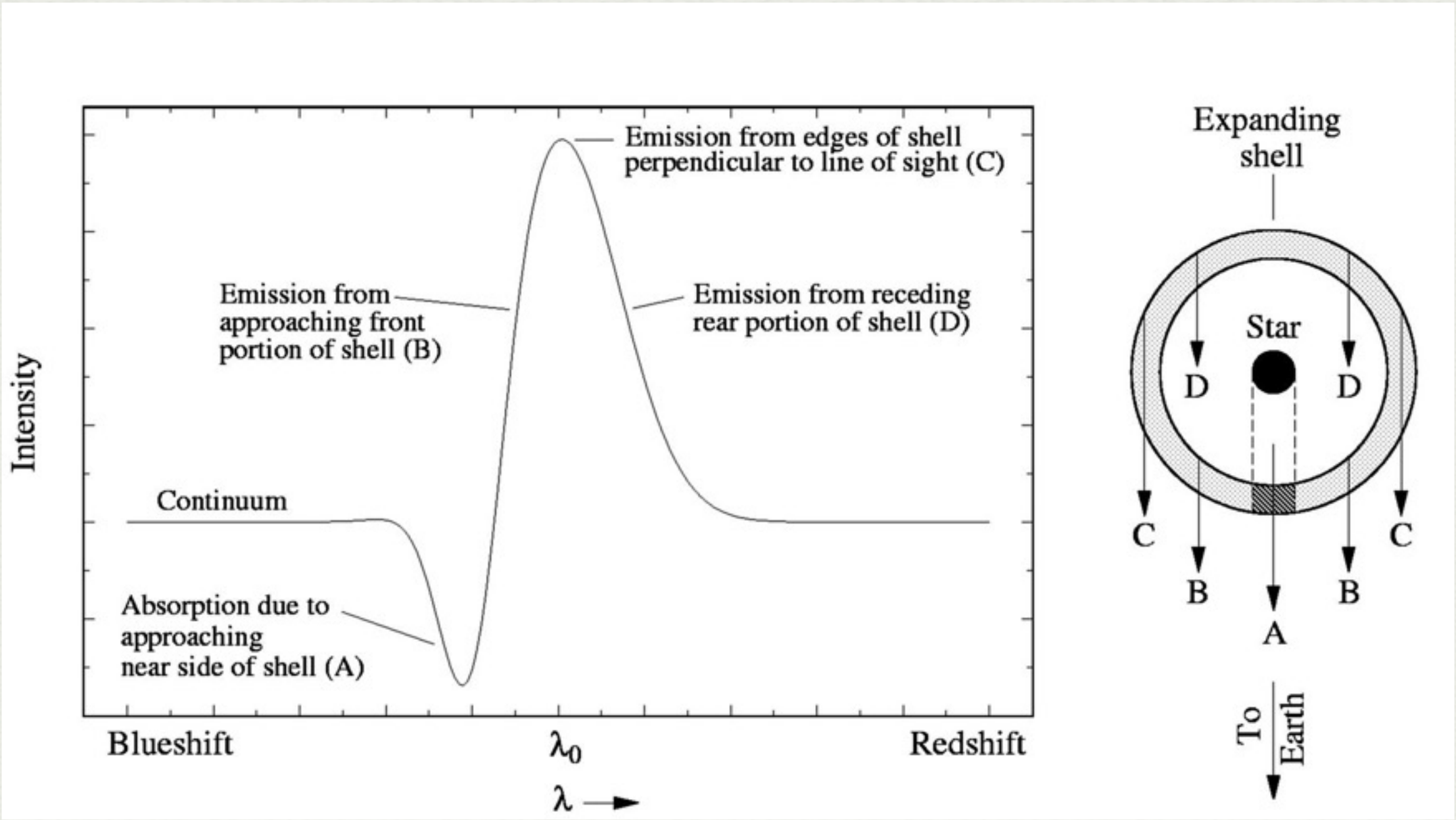
- (Ia) szupernóva?
  Nincsenek H vonalak, néhány széles abszorpciós gödör

Nova Sgr 2005



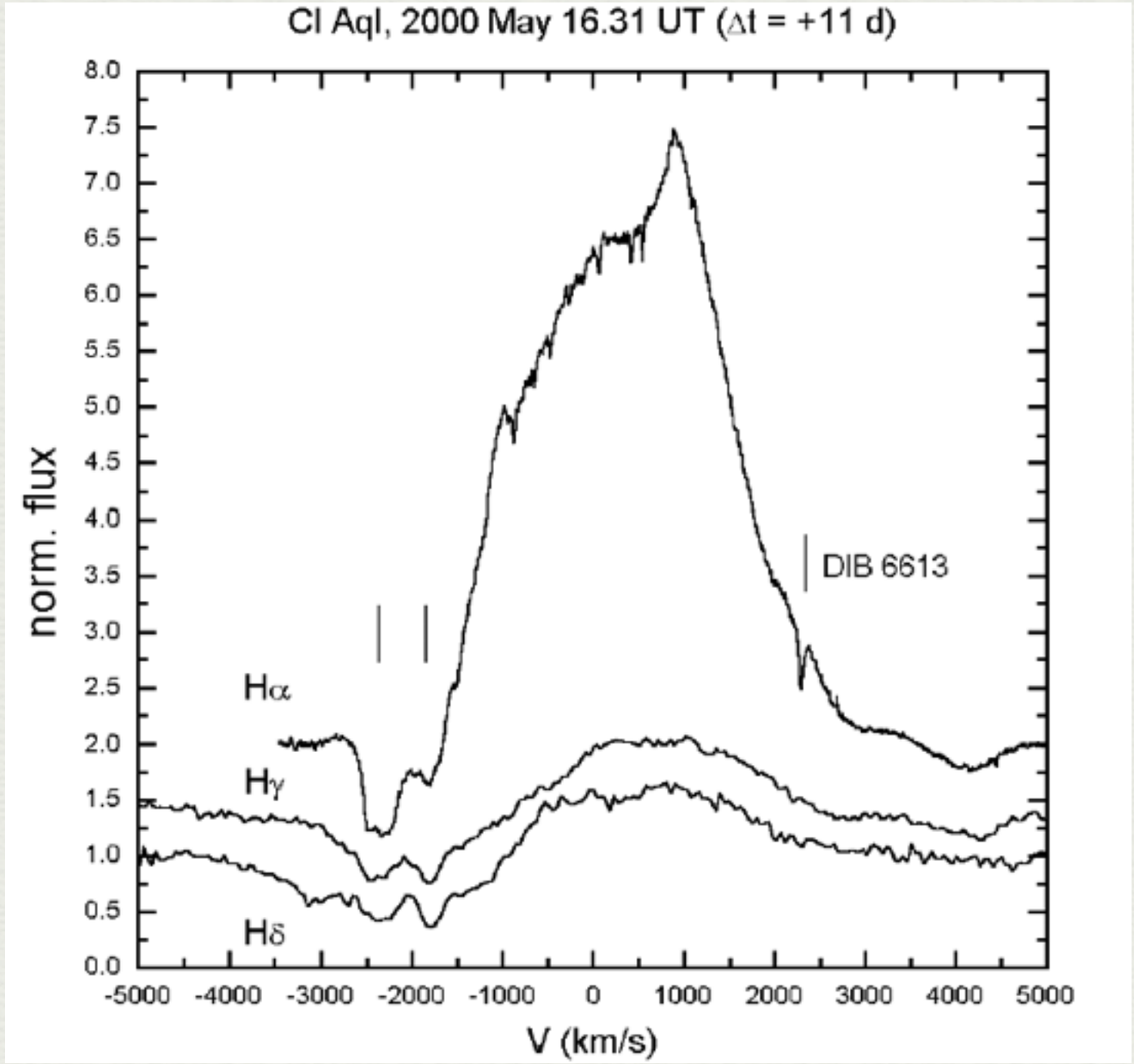
(Kiss & Derekas, 2005, IAUC 8501)

A táguló gázfelhő kinematikája: a P Cygni vonalprofil



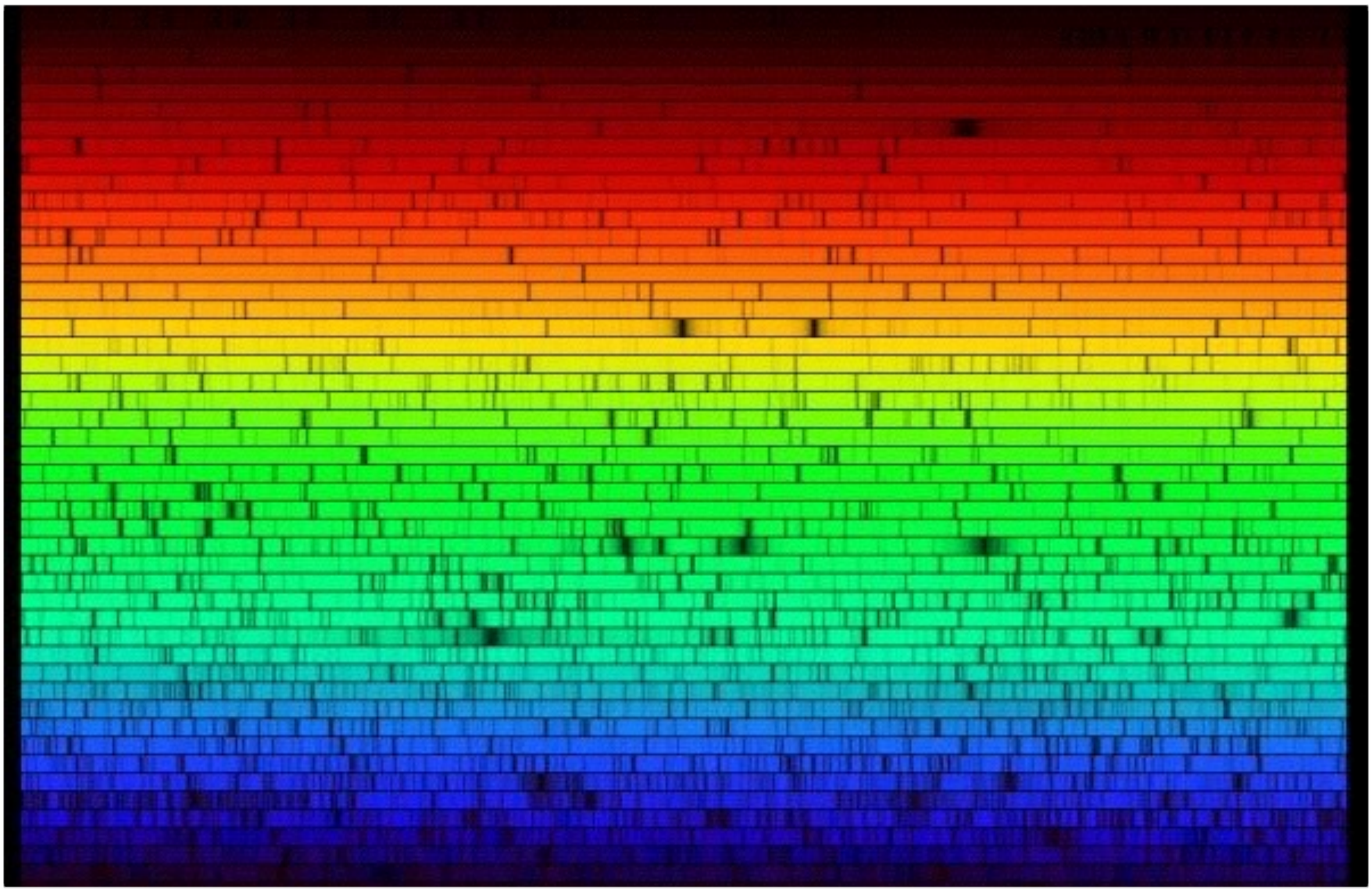
(Carroll & Ostlie 1996)

Cl Aql (Nova Aql 1917 and 2000)

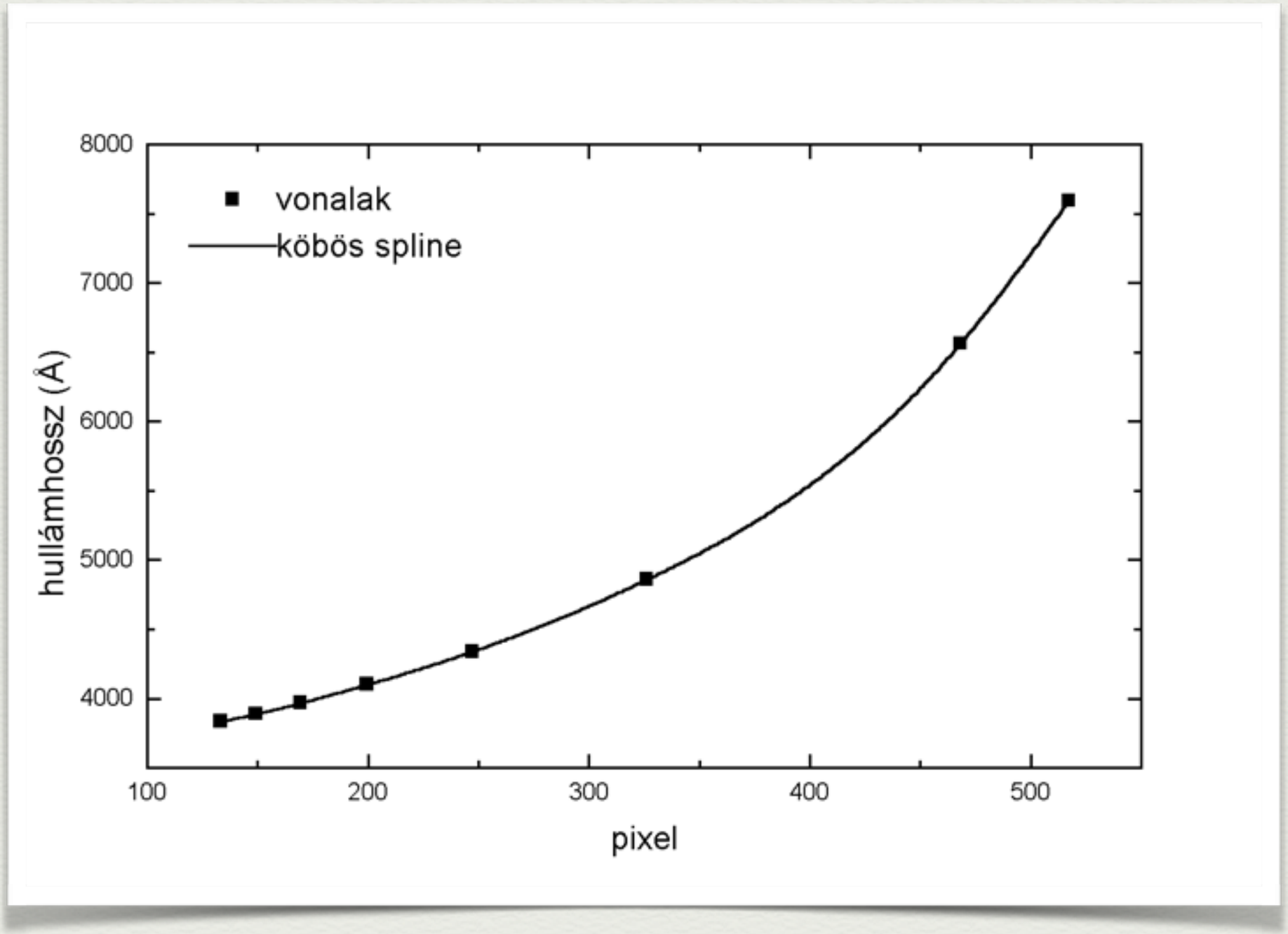


(Kiss et al. 2001, A&A, 366, 858)

Színképvonalak - kozmikus traffipax

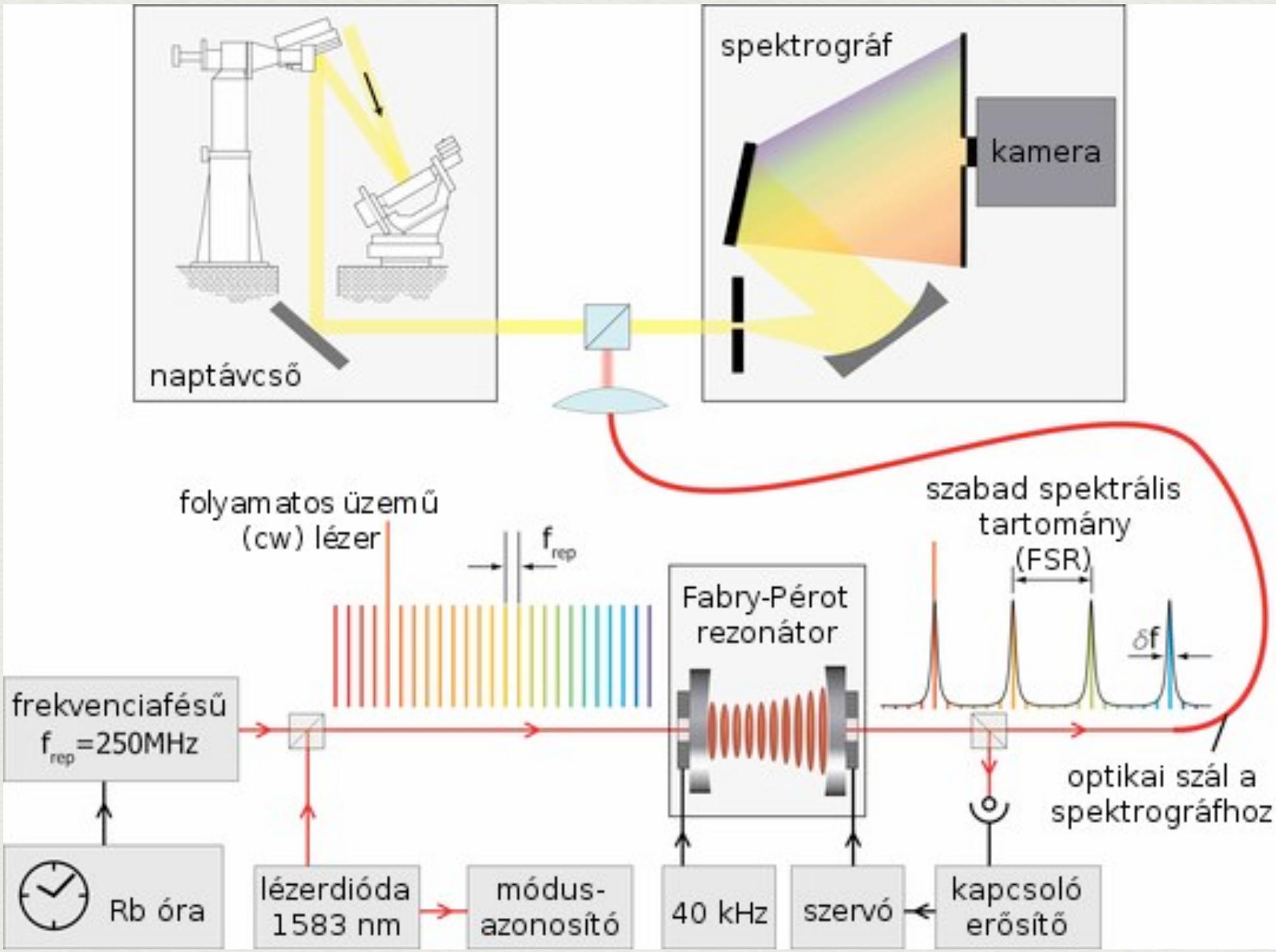


Hullámhossz-kalibráció: a pontosság kulcsa



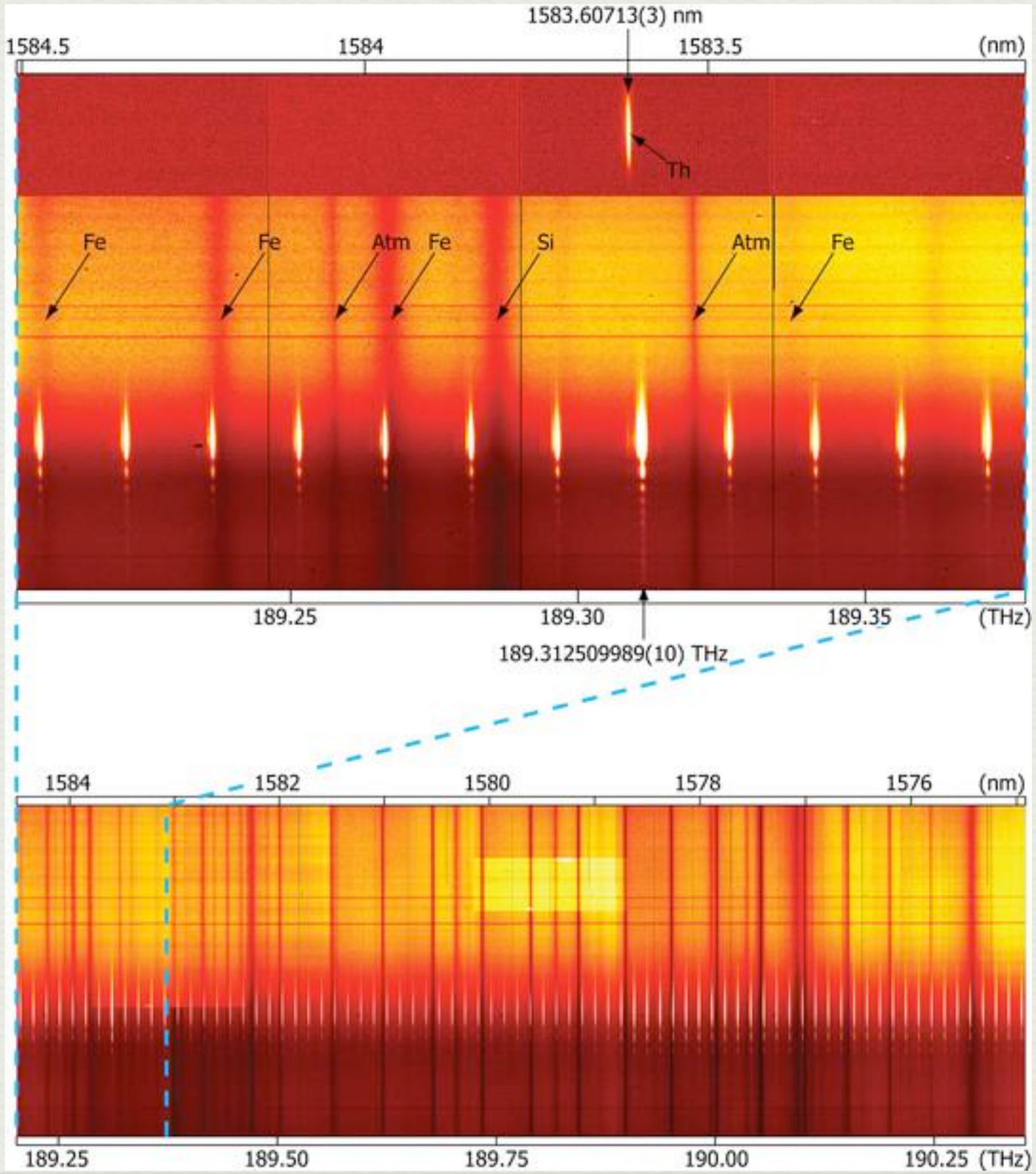
Egy jódcella

Lézerfésűk: továbblépés a cm/s pontosság irányába?

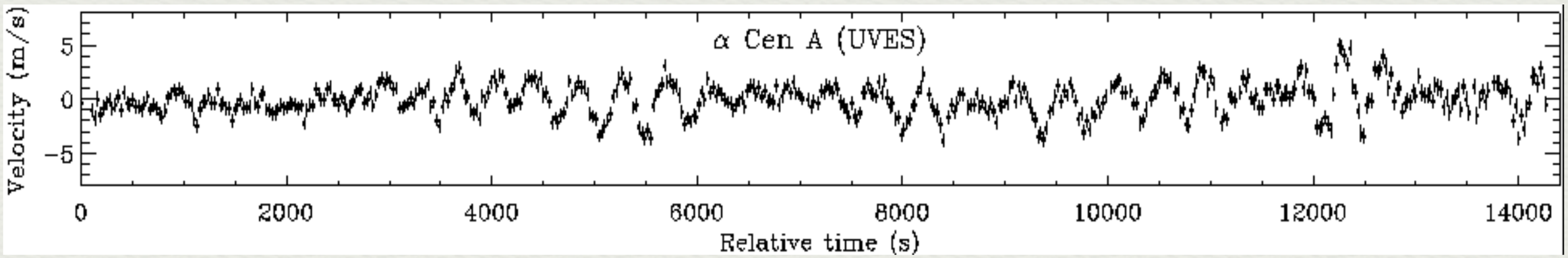


Steinmetz et al. 2008, Science

Napfény és a lézerfésű szimultán spektruma



Az alfa Cen A az UVES/VLT műszerrel

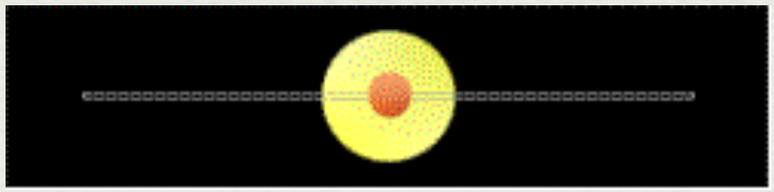


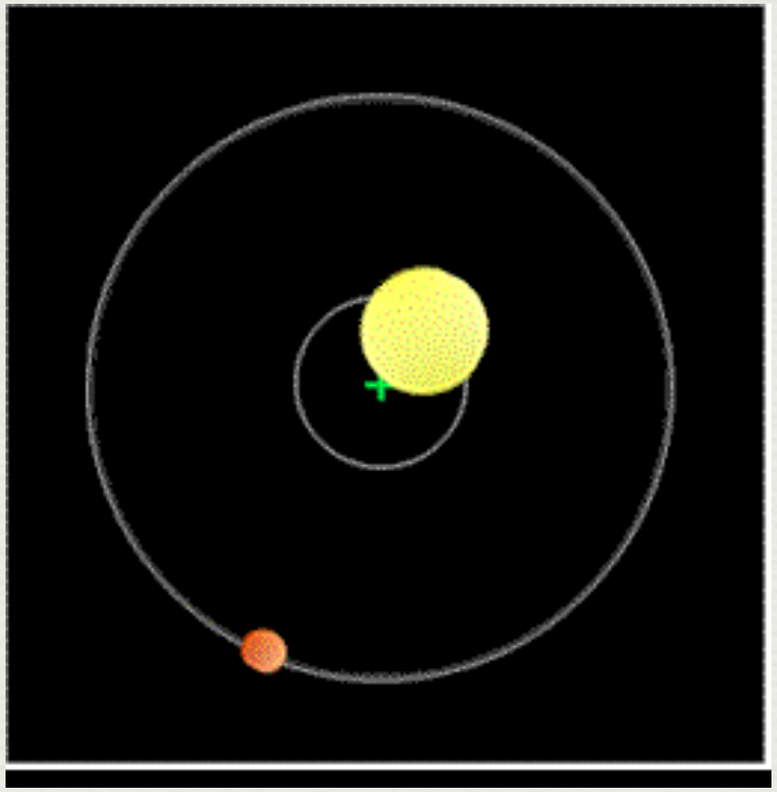
Pontosság: 50-70 cm/s. 3 s expozíciók, 8m-es távcső, a déli ég 3. legfényesebb csillaga

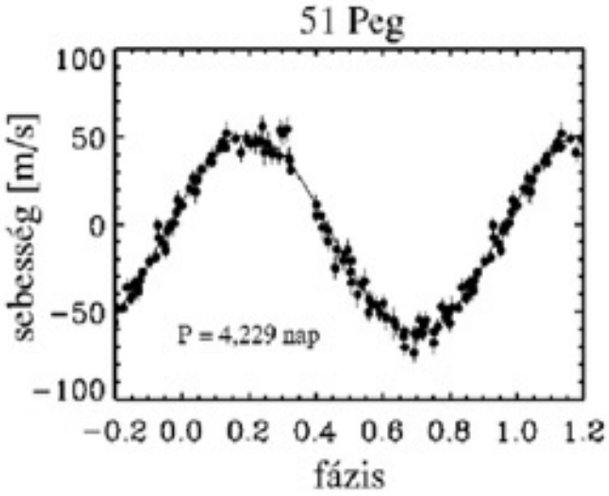
Butler et al. (2003)

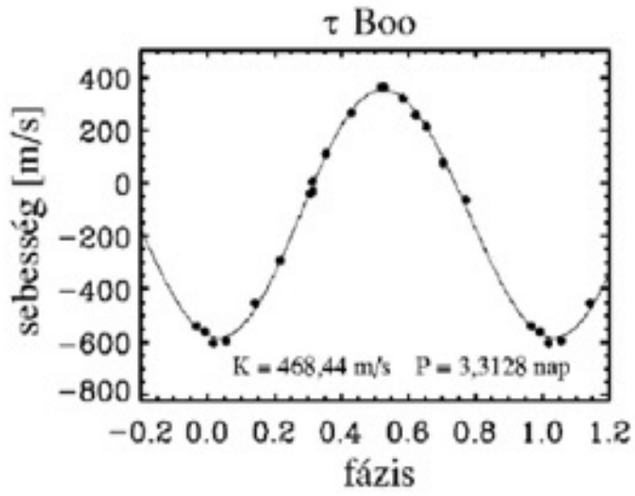
Pontosság: 10-50 cm/s. 10-20 perc expozíciók, 1-4m-es távcsövek, szabad szemmel látszó csillagok (kb. 6000)

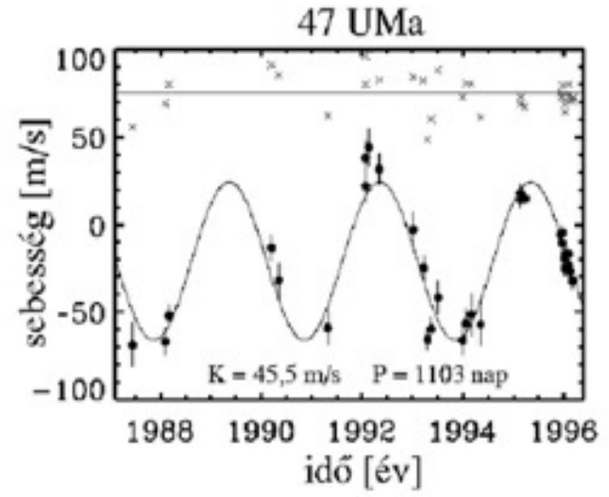
Néhány csoport (2014)

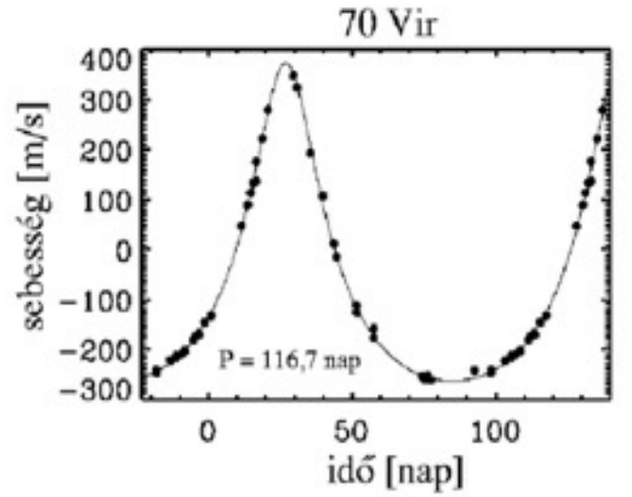


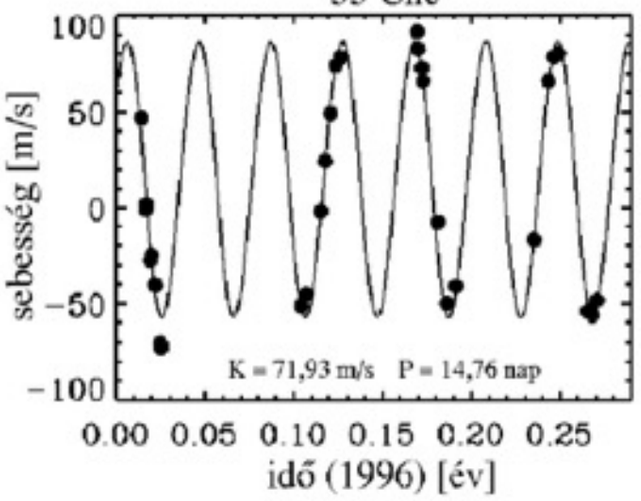


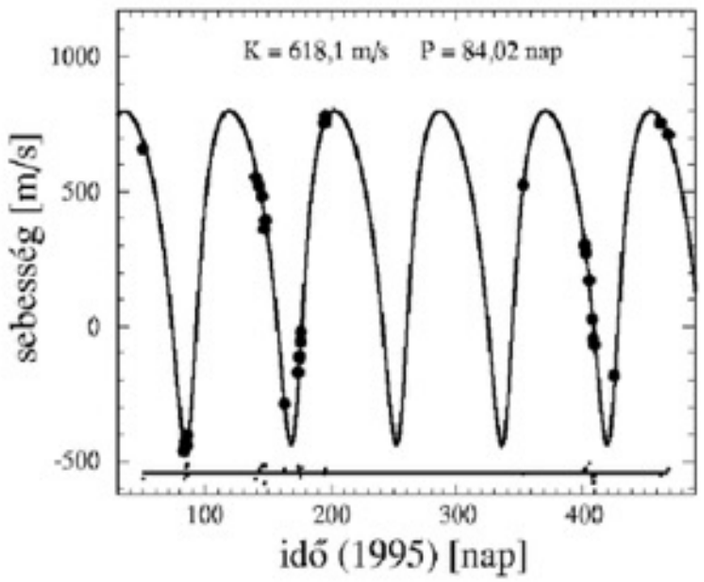

51 Peg
sebesség [m/s]
100
50
0
−50
−100
P = 4,229 nap
−0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2
fázis


τ Boo
sebesség [m/s]
400
200
0
−200
−400
−600
−800
K = 468,44 m/s P = 3,3128 nap
−0.2 0.0 0.2 0.4 0.6 0.8 1.0 1.2
fázis


47 UMa
sebesség [m/s]
100
50
0
-50
−100
K = 45,5 m/s P = 1103 nap
1988 1990 1992 1994 1996
idő [év]


70 Vir
sebesség [m/s]
400
300
200
100
0
−100
−200
−300
P = 116,7 nap
0 50 100
idő [nap]


55 Cnc
sebesség [m/s]
100
50
0
−50
−100
K = 71,93 m/s P = 14,76 nap
0.00 0.05 0.10 0.15 0.20 0.25
idő (1996) [év]


HD114762
sebesség [m/s]
1000
500
0
-500
K = 618,1 m/s P = 84,02 nap
100 200 300 400
idő (1995) [nap]

Égi spektroszkópia az oktatásban: “olcsó” műszerek lehetőségei

Christian Buil: http://www.astrosurf.com/buil
Shelyak Instruments: http://www.shelyak.com

www.astrosurf.com/buil/spectrographs.htm

Keresés

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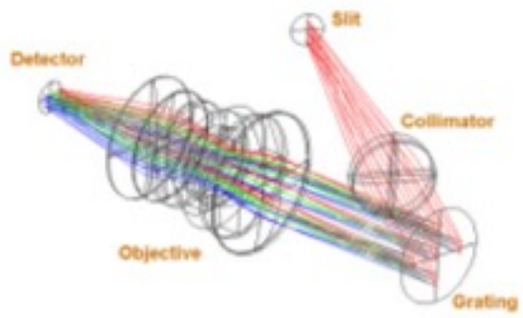
Spectrograph techniques

SPECTROSCOPY, CCD & ASTRONOMY

Welcome to Christian Buil's home page

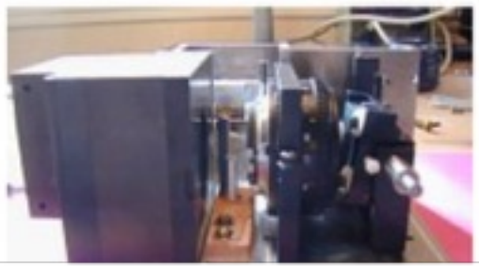
Spectrographs conception and techniques

An introduction to spectrography (text in french)



How to calculate the parameters of a classical spectrograph (MERIS)

How to construct a simple spectrograph



CAPAS 2012
Colloquium Am/Pro of Astrophysics of Stars
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eShel observation of eps Aurigae
Torun university published their eShel observation of epsilon Aurigae
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Star Analyser

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* protected by optical glasses
* optimized for first order
* standard filter ring (1.25 inch)
* power of resolution R ~100
* prism available to boost to R ~130

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Star Analyser
100 gr/mm spectroscope
PF0003

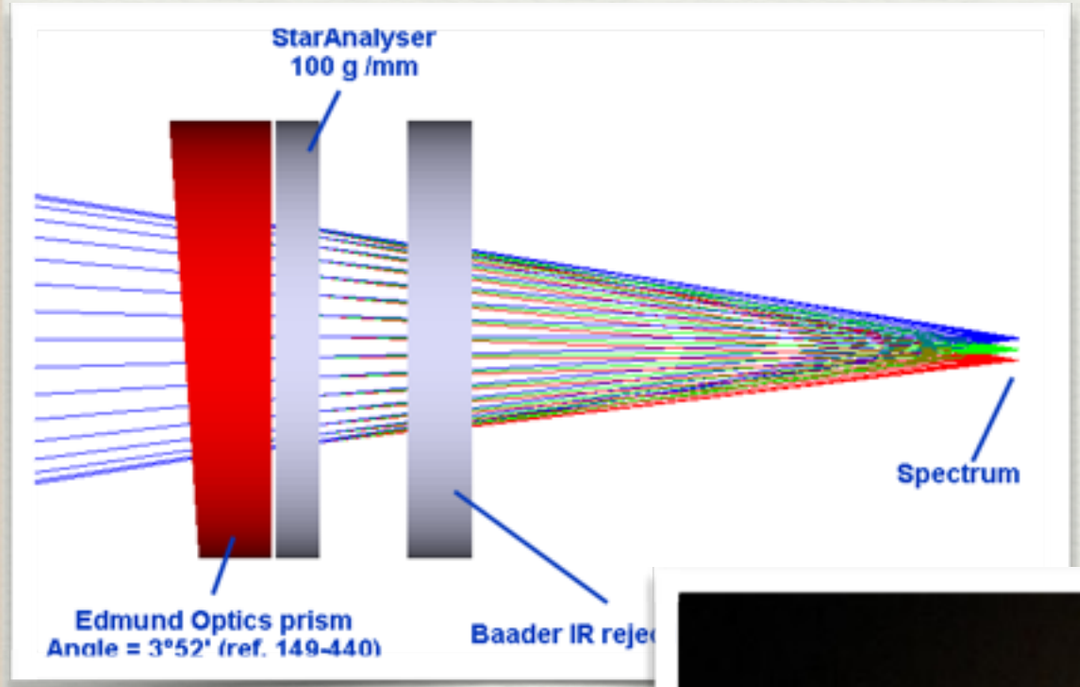
139.00 € TTC
116.22 € HT
Add to basket

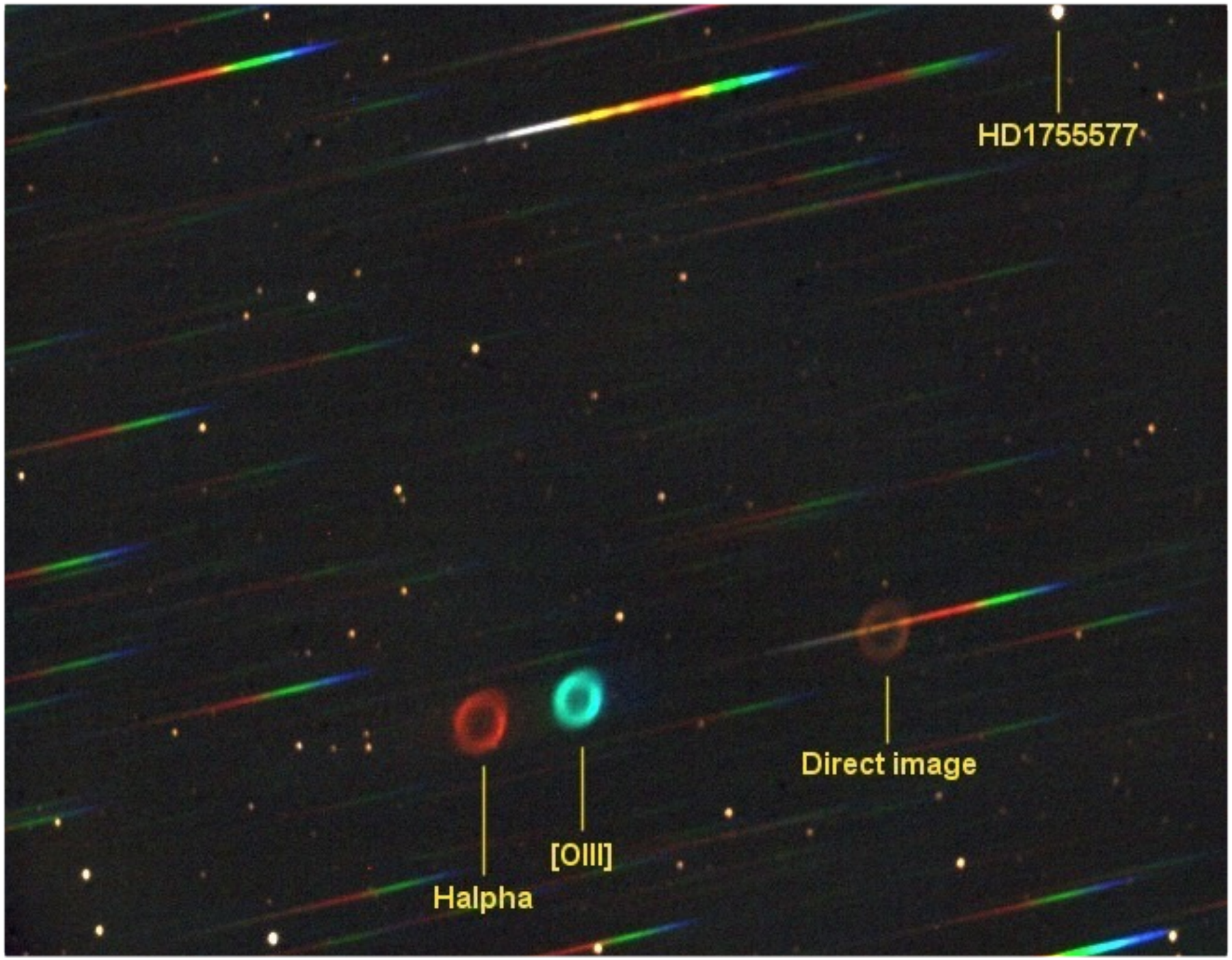
Spacer SA
Spacer for Star Analyser
BA0014

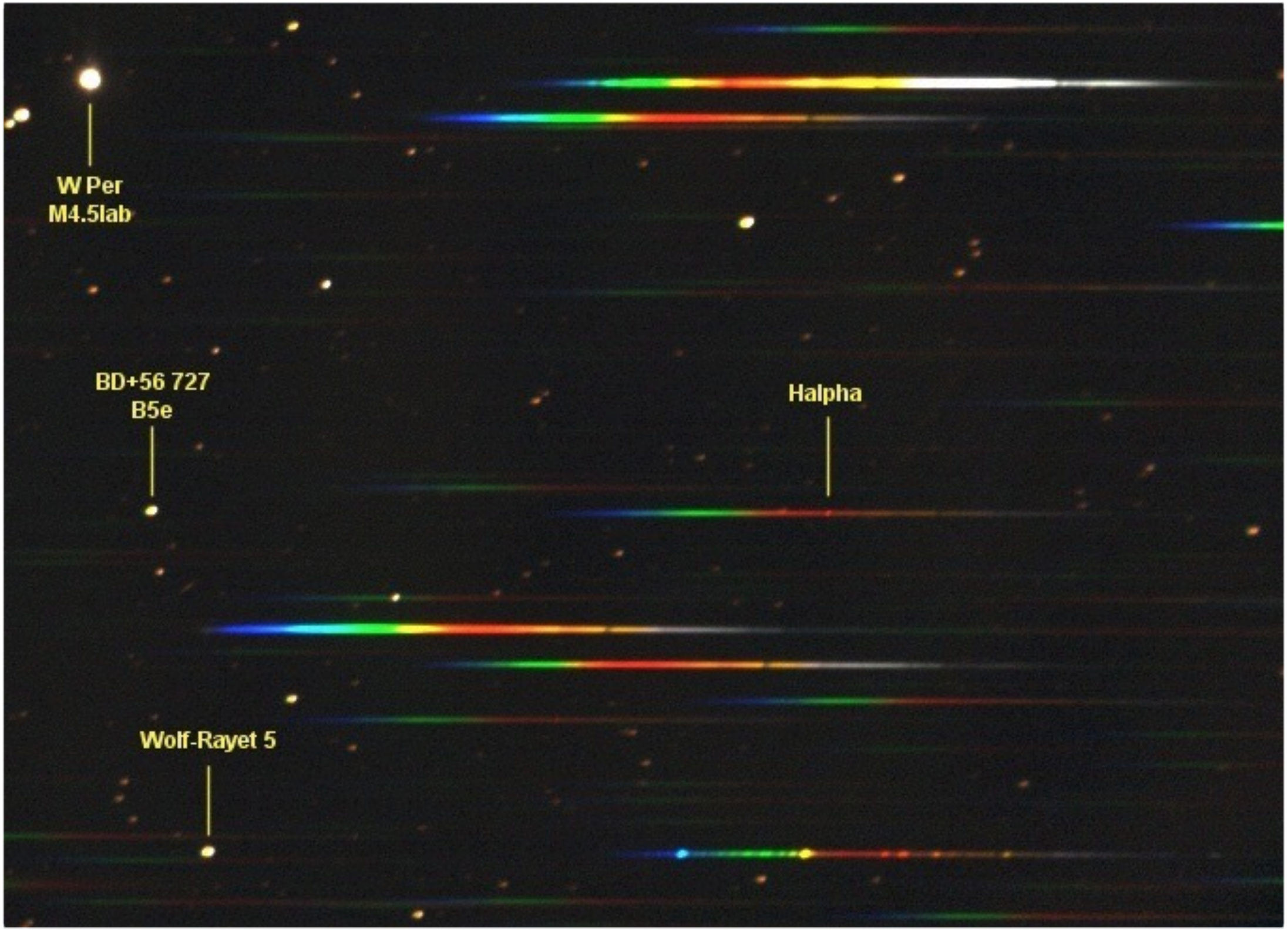
12.00 € TTC
10.03 € HT
Add to basket

Prism 3.8°
Prism for Star Analyser
OP0040

65.00 € TTC
54.35 € HT
Add to basket


StarAnalyser
100 g /mm
Spectrum
Edmund Optics prism
Angle = 3°52' (ref. 149-440)
Baader IR reje


HD1755577
Direct image
[OIII]
Halpha


W Per
M4.5Iab
BD+56 727
B5e
Halpha
Wolf-Rayet 5

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Colloquium Am/Pro of Astrophysics of Stars
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eShel observation of eps Aurigae
Torun university published their eShel observation of epsilon Aurigae
▸ Read more

LISA / LISA Pack

Explore to the limit of your telescope with our LISA low resolution high luminosity spectrograph. With its slit, LISA is specially designed for faint or extended objects.

It is an educational tool for student to quickly record spectra of stars and nebulae and focus on actual project rather than long observing hours.

It is also a scientifical tool to study faint objects (novae, variable stars, comets, asteroids, nebulae, galaxies, quasars...), to monitor group of stars, to analyse chemicaly planets in visible or near infra-red domain, etc...

LISA specifications
* Collimator F=130mm F/5
* Custom objective F=88mm F/2.4
* Power of resolution R ~600-1000
* Available for Visible (400-700nm) or near Infra-Red (650nm-1µm)
* Slit 15/19/23/35µm
* Weight: 1.4kg
* Telescope interface M42 (T-standard), 41mm backfocus

Accessories
- Slit 50/75/100µm with 19µm hole
- Near Infra-Red kit
- Automatic Calibration module [*]
- Guiding camera (Atik Titan recommanded) [*]
- Acquisition camera (Atik 314L+ recommanded) [*]

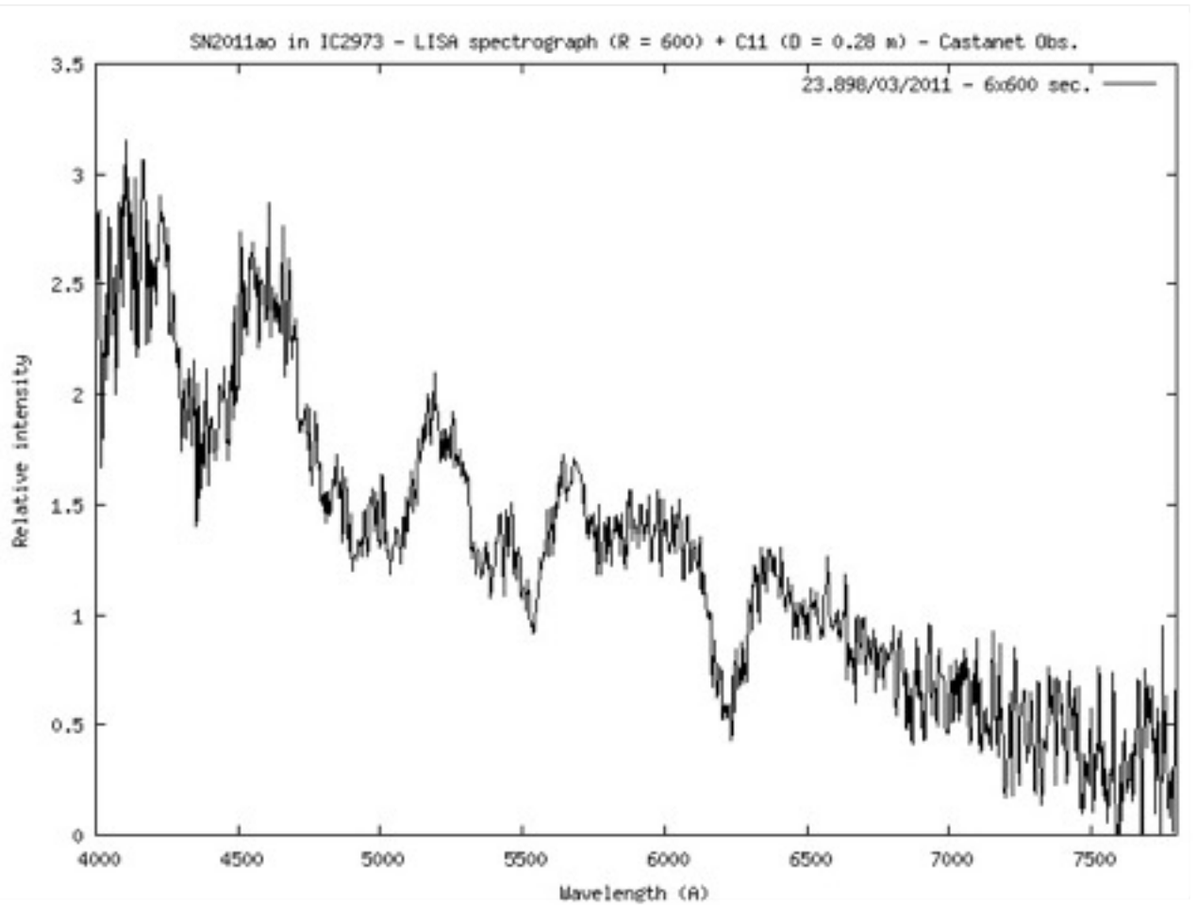
[*] included in LISA Pack complete solution.

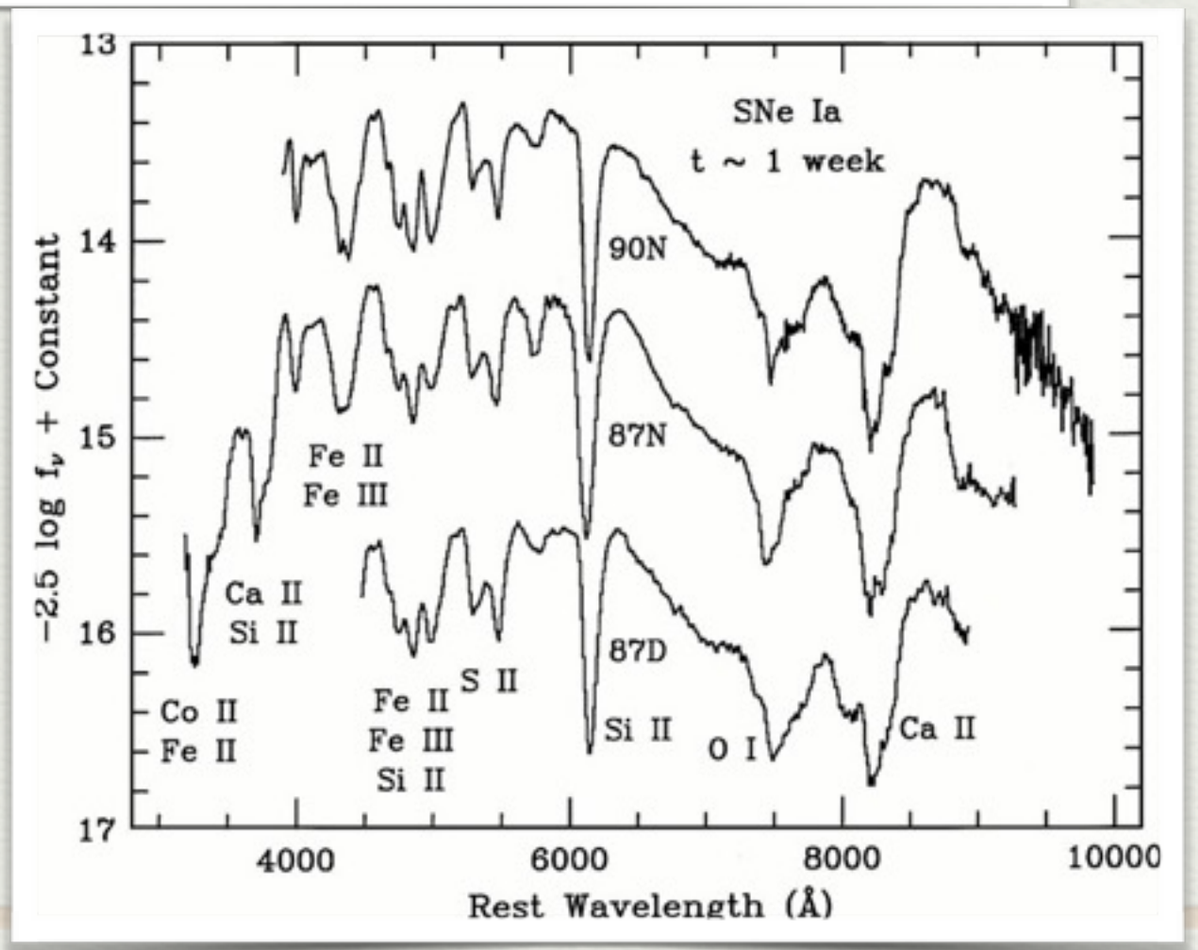
See a more detailed description of LISA with several applications linnks:
http://www.shelyak.com/dossier.php?id_dossier=72

Video at pic du midi (C. Gillier / O. Thizy) :


CELESTRON


SN2011ao
20110323.898
LISA spectrograph
guiding camera
V = 14.0


SN2011ao in IC2973 - LISA spectrograph (R = 600) + C11 (D = 0.28 m) - Castanet Obs.
23.898/03/2011 - 6x600 sec.
Relative intensity
Wavelength (A)
3.5
3
2.5
2
1.5
1
0.5
0
4000
4500
5000
5500
6000
6500
7000
7500


SNe Ia
t ~ 1 week
90N
87N
87D
−2.5 log f_ν + Constant
Rest Wavelength (Å)
Ca II
Si II
Fe II
Fe III
Co II
Fe II
Fe II
Fe III
Si II
S II
Si II
O I
Ca II
13
14
15
16
17
4000
6000
8000
10000

Shelyak INSTRUMENTS

Vous ne verrez plus les étoiles comme avant !

version française

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+33(0)4 76 41 36 81
contact@shelyak.com

Shelyak Product Range

Spectrographs
- Educational
- Star Analyser
- Alpy
- Lhires Lite
- LISA / LISA Pack
- Lhires III
- eShel

Cameras
- Guiding / Video
- CCD
- Adapters

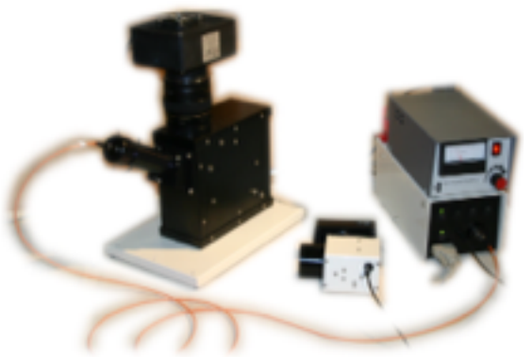
Observatories
- Dome Tracker
- Sentinel

Miscellaneous
- Books

Home / Spectrographs /eShel

eShel

eShel is your complete and fully operational spectroscopy solution specially designed for astronomy. This unique and highly performing instrument will allow you to productively run your spectroscopic observations.



* F/6 - 50µm - fibre injection & guiding unit
* object optical fibre 50µm, protected by inox
* echelle spectrograph F/5; R >10000
* calibration unit controled by computer
* calibration fibre 200µm, protected by inox
* software module for AudeLA (Tcl/Tk)

See detailed page on eShel

See also a typical observing session illustrated: http://www.shelyak.com/dossier.php?id_dossier=71&lang=2

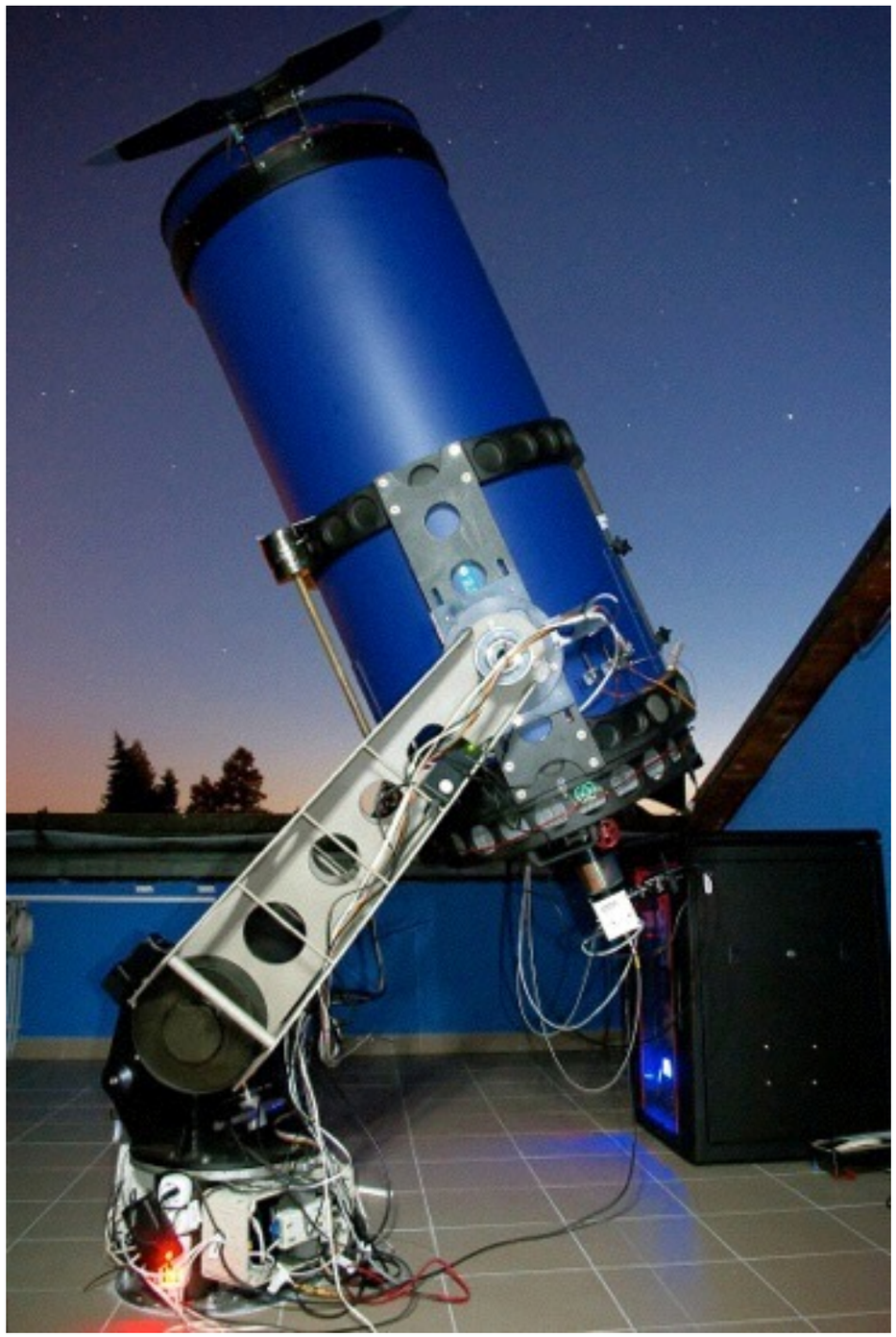
Installation & Maintenance manual and User Guide are available from our resources / documentation web page.

Affordable Doppler velocities to 50 m/s with sub-meter telescopes

László L. Kiss
Konkoly Observatory, Budapest, Hungary

Future Science with Metre-Class Telescopes, Belgrade 2012 September

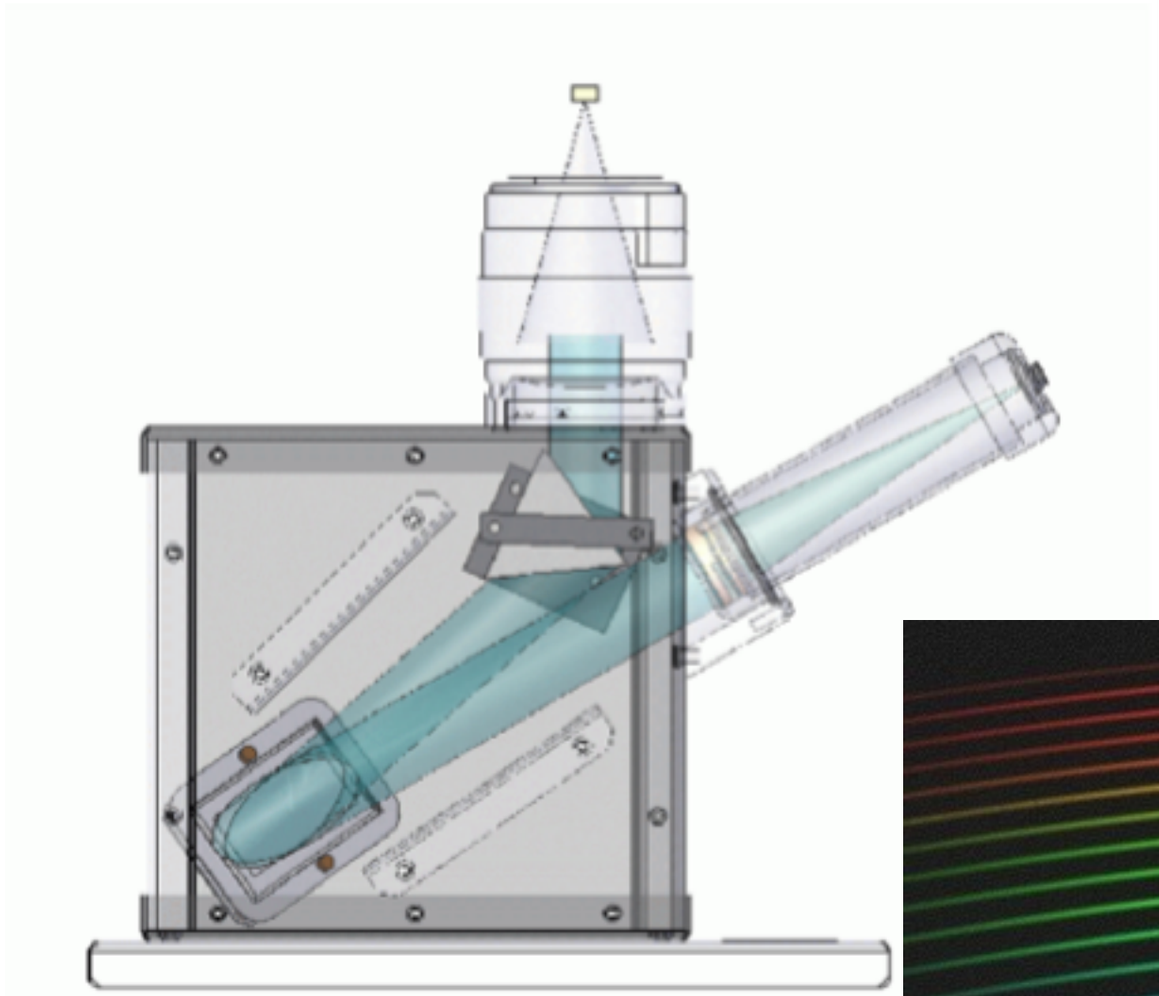
A szombathelyi ELTE Gothard Asztrofizikai Obszervatórium 50 cm-es távcsöve

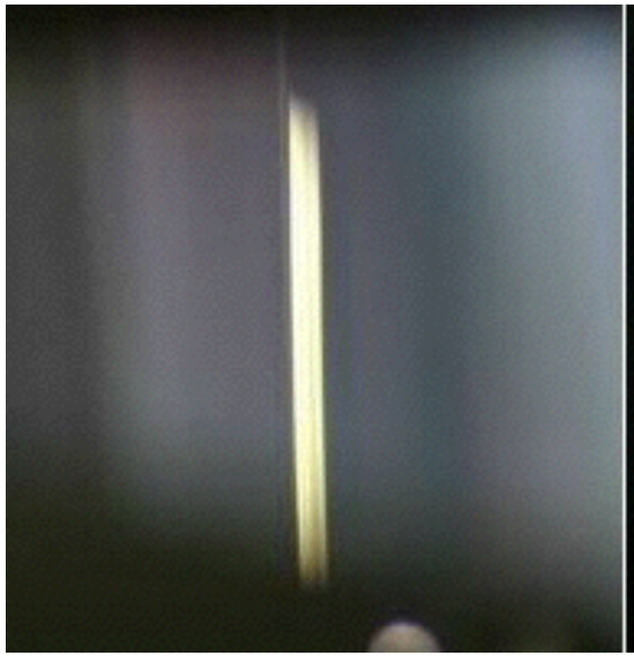


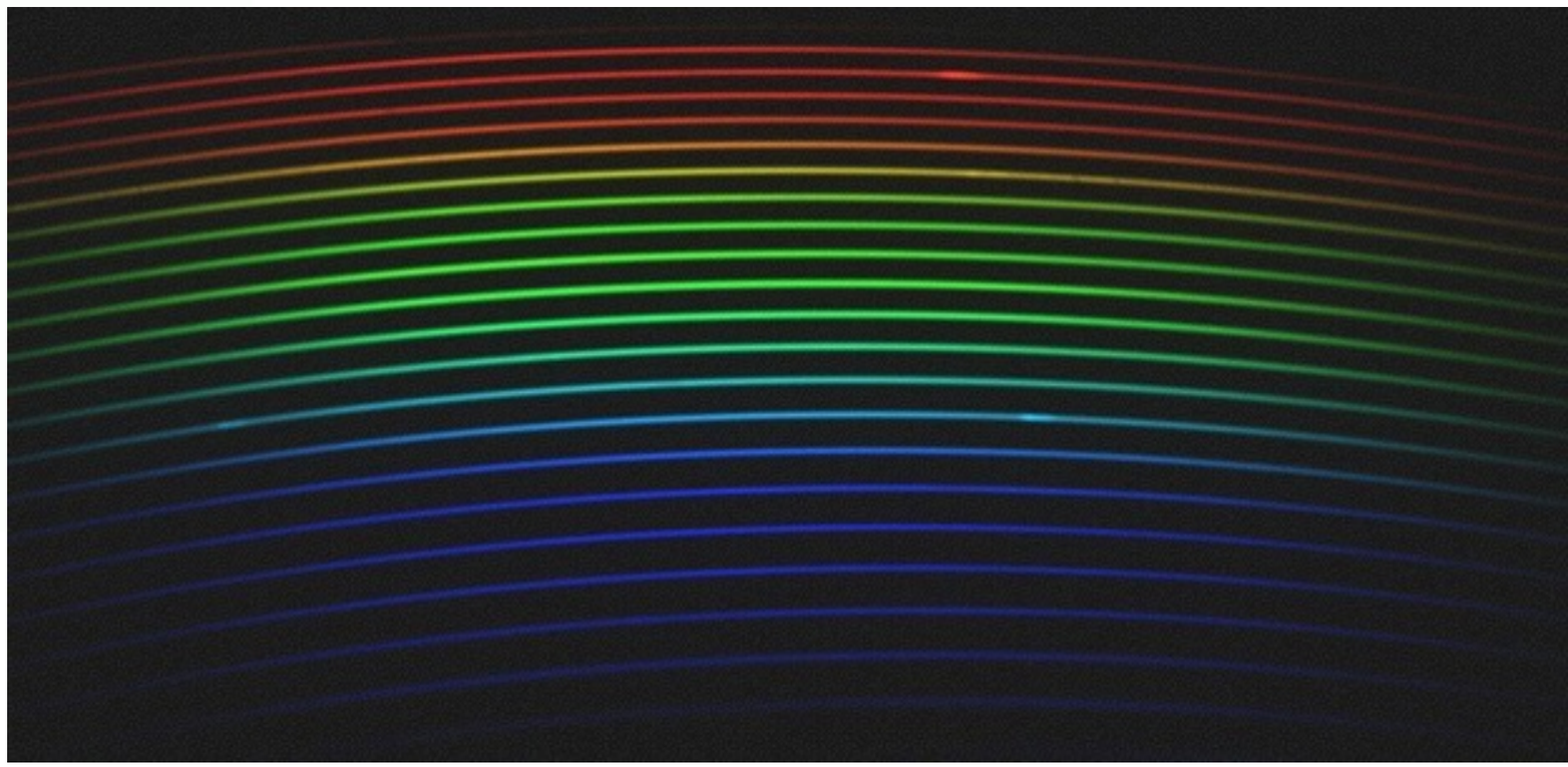
...és egy echelle spektrográf

Shelyak eShel

- A francia Shelyak Instruments terméke
- R = 11000 az optikai tartományban (4300–8400 Å)
- ThAr kalibrációs lámpa, flat lámpa
- Optikai szálak, max. 30 m → termális és mechanikai stabilitás
- CCD-kamera: QSI 532ws
  - KAF-3200E: 3,2 Mpx, 6,8 um, max. 65% QE, RON < 8 e^-, ΔT = 40 °C (vízhűtéssel: 50 °C)







Telescope

6

3

2

1

5

3

4

2

Fibre Injection & Guiding Unit

5

7

4

Power Supply

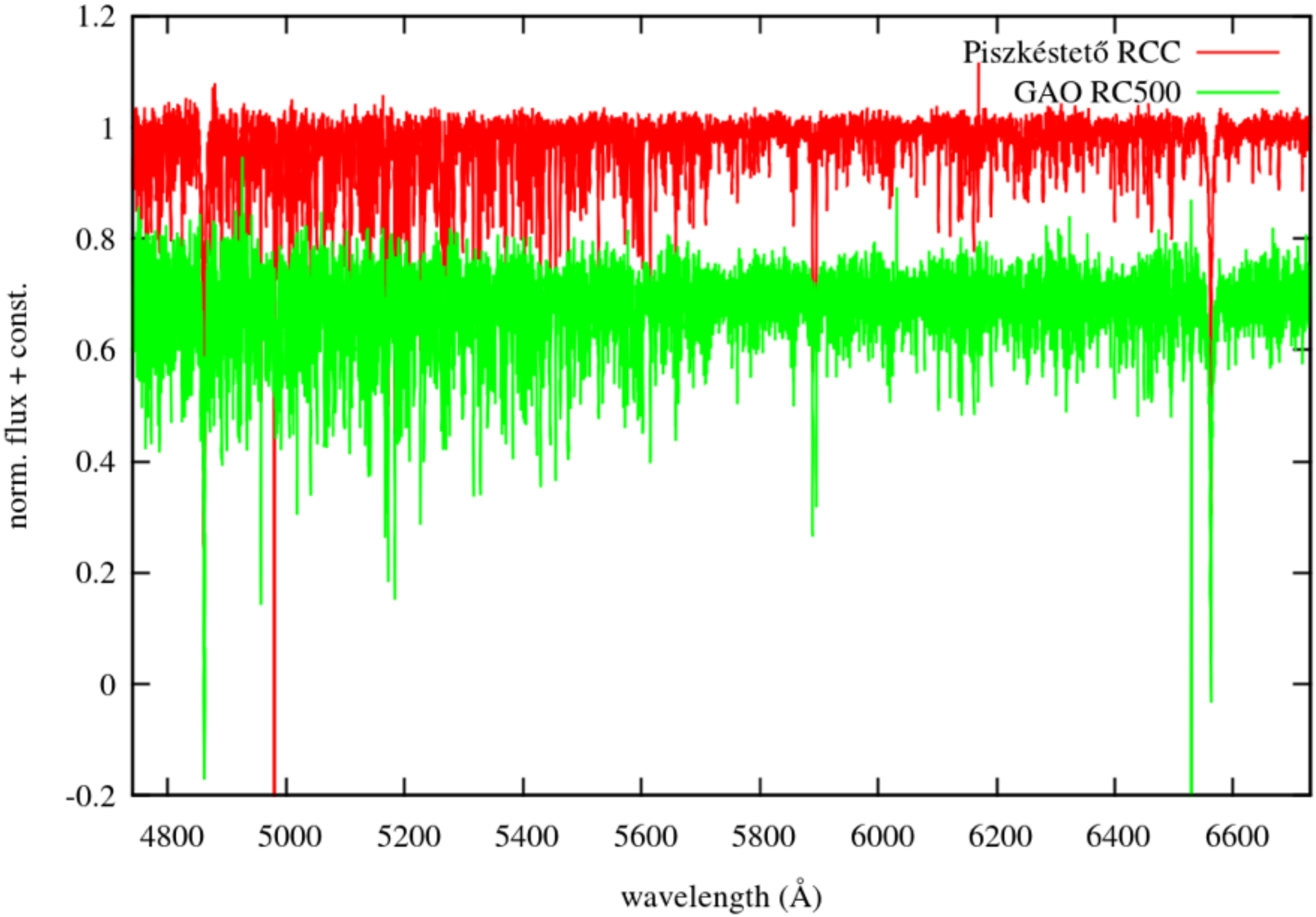
Calibration Unit

8

Acquisition

Telescope Control

HAT-P-2


Piszkéstető RCC
GAO RC500
norm. flux + const.
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
4800
5000
5200
5400
5600
5800
6000
6200
6400
6600
wavelength (Å)

HAT-P-2b

V=8.7 mag

GAO+PO

model

v_r (km/s)

-18

-18.5

-19

-19.5

-20

-20.5

-21

0

5

10

15

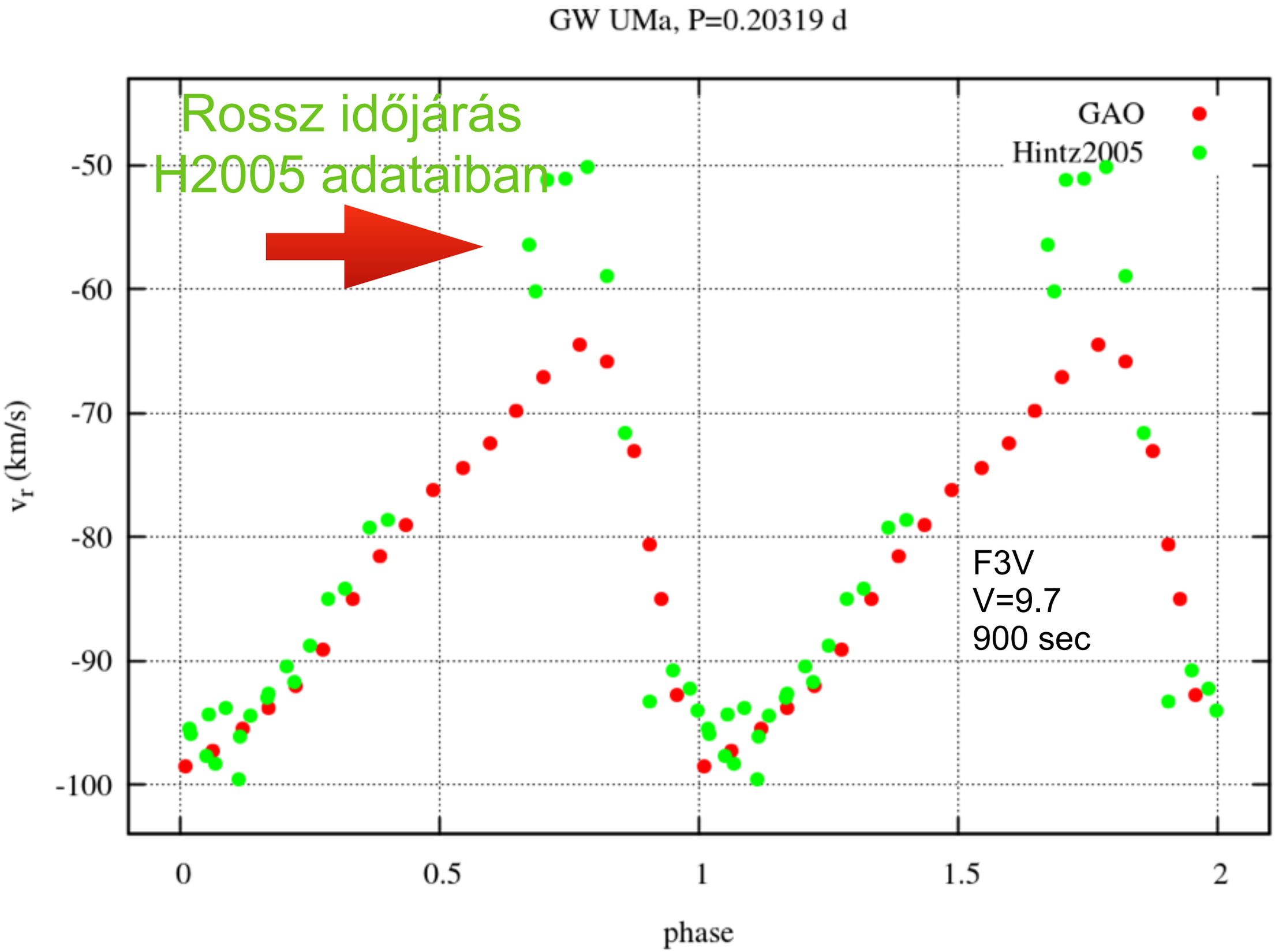
20

25

30

35

BJD-2455980


GW UMa, P=0.20319 d
Rossz időjárás
H2005 adataiban
GAO
Hintz2005
F3V
V=9.7
900 sec
-50
-60
-70
-80
-90
-100
v_r (km/s)
0
0.5
1
1.5
2
phase

CAPAS 2012
Colloquium Am/Pro of Astrophysics of Stars
Read more

eShel observation of eps Aurigae
Torun university published their eShel observation of epsilon Aurigae
Read more

2012 spectro week-end

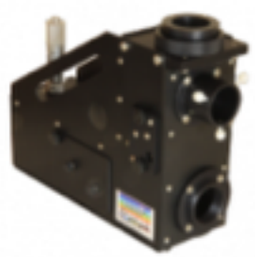
Lhires III

Lhires III is a very high resolution spectrograph designed for amateur and educational astronomy. Numerous projects are within reach thanks to the technology involved in this instrument. Professional/amateur collaborations have been done with Lhires III spectrographs.

* power of resolution R ~18000
* resolution of 0.035nm near Halpha
* wavelength selected by micrometer
* mirror slit 15-35µm, reflective for guiding
* Schmidt-Cassegrain telescope adapter delivered in standard (two inch available)
* internal neon lamp for calibration
* switchable grating modules (2400 gr/mm in standard; 1200 gr/mm, 600 gr/mm, 300 gr/mm et 150 gr/mm in option)
* possibility to put an eyepiece
* photo tripod adapter available for public outreach (visual solar spectrum)

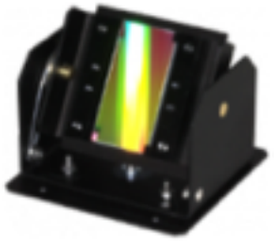
See detailed page on Lhires III

Lhires III
High Resolution Spectrograph
ES0002



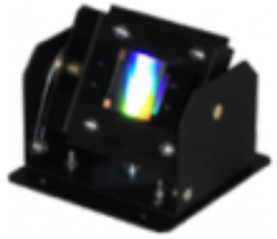
3150.00 € TTC

1200 gr/mm grating module
High resolution
SE0006

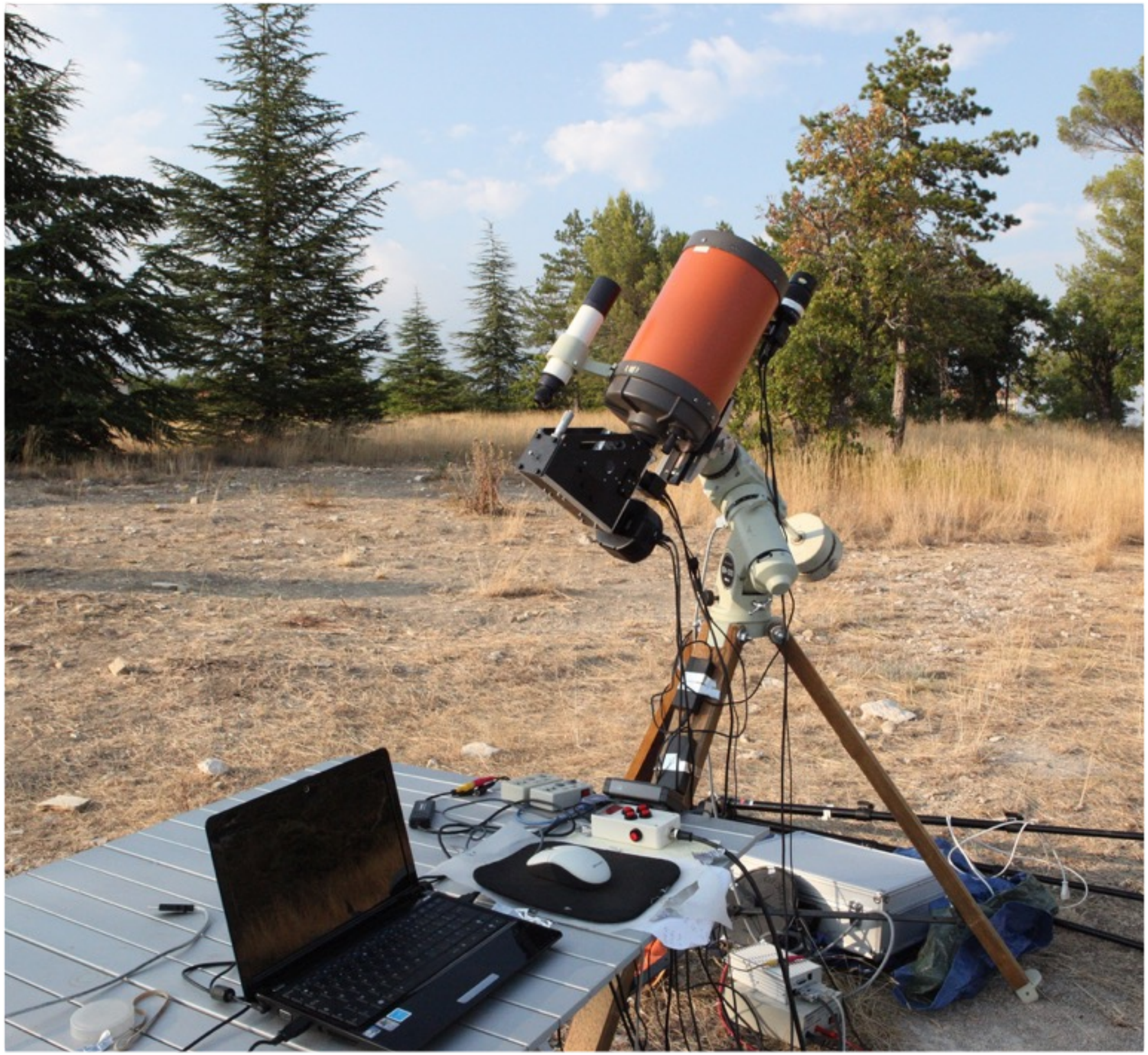


455.00 € TTC

600 gr/mm grating module
Medium resolution
SE0007

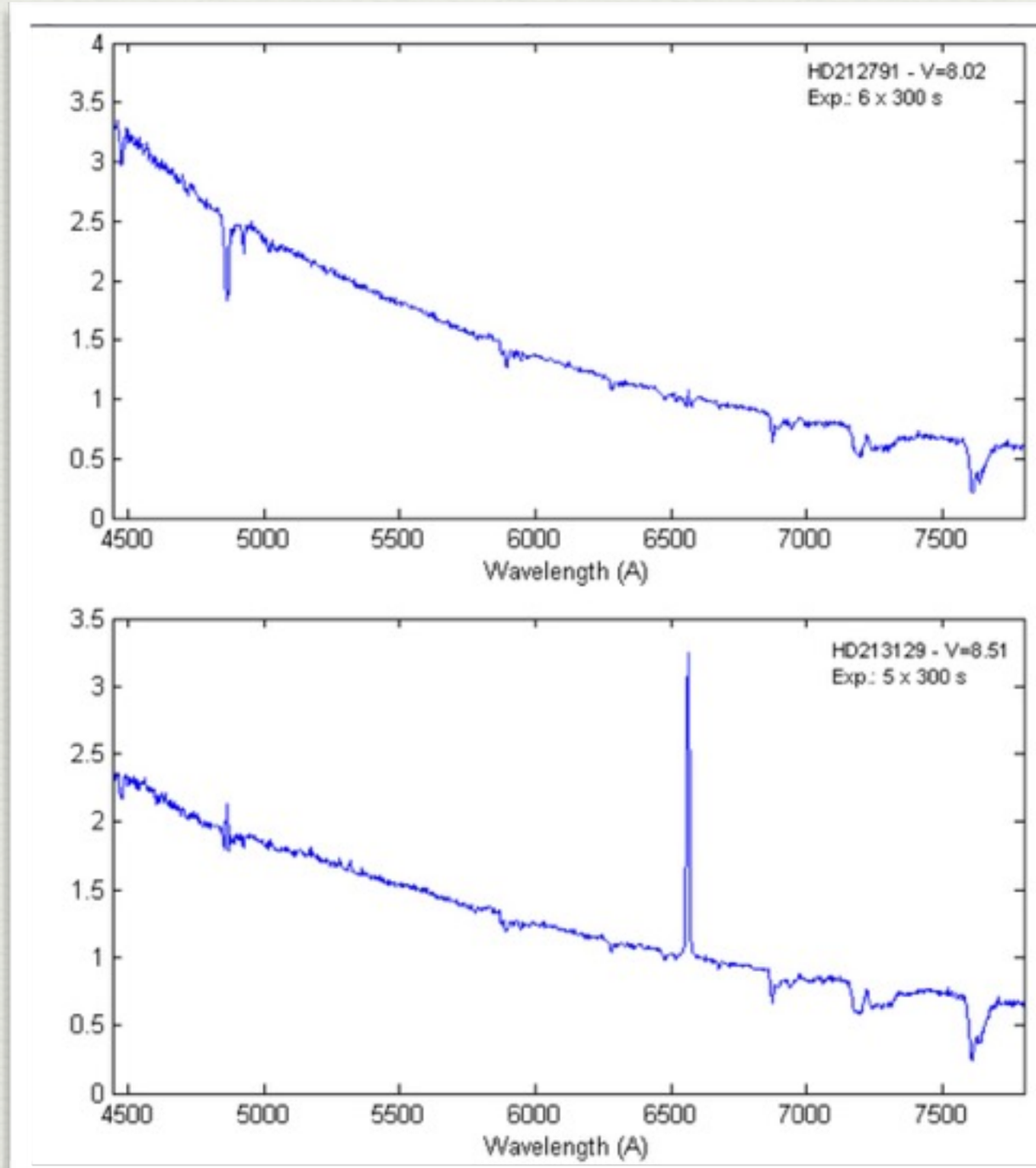


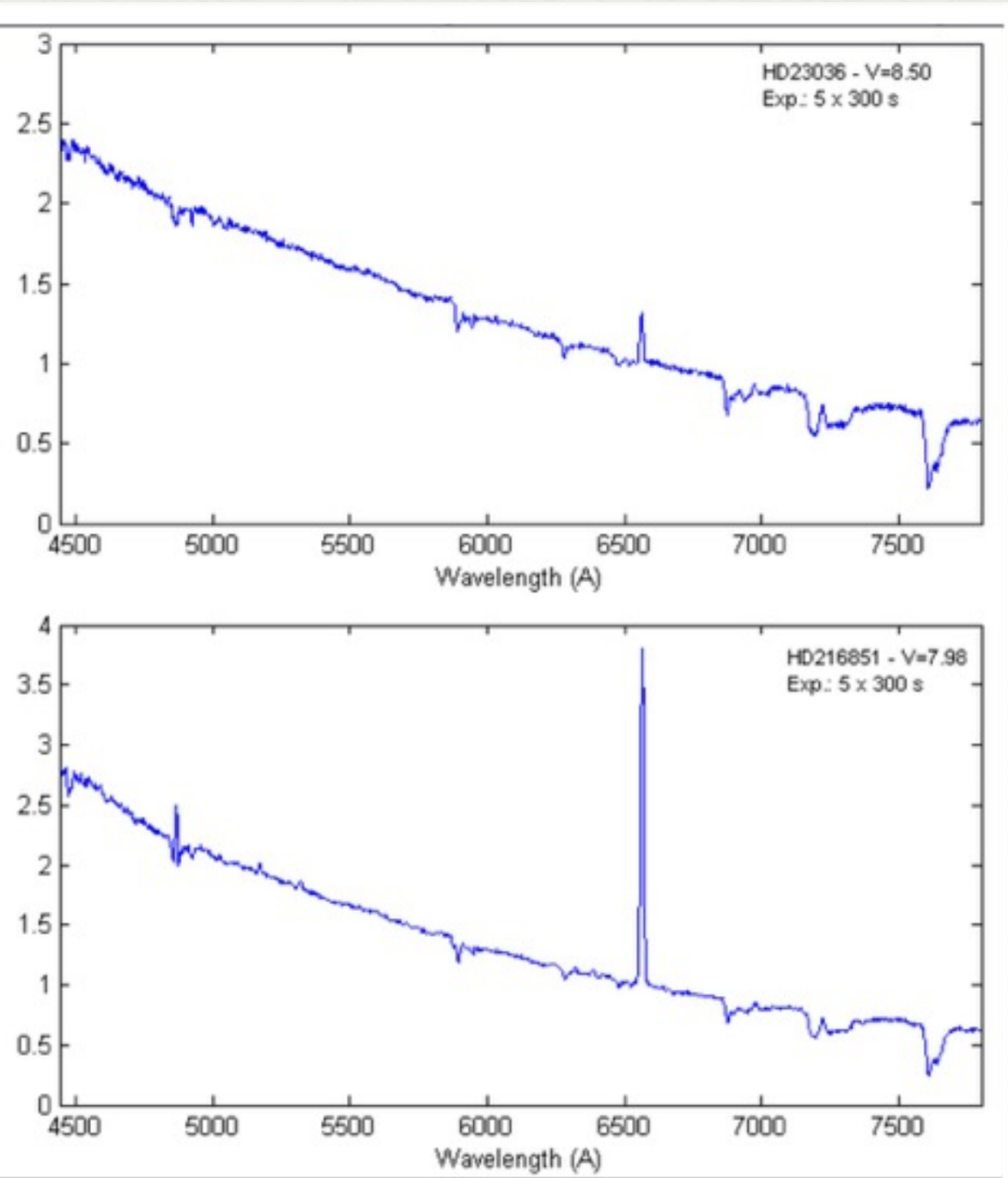
425.00 € TTC



Images of 2009 OHP spectroscopic school. More than 20 spectrographs in the field... a very impressive concentration of these exciting type of instrument !

Halvány Be csillagok





Összefoglaló gondolatok

- A spektroszkópia a csillagászat egyik legizgalmasabb vizsgálati módszere
- Kis-, közepes és nagyfelbontású spektrográfok léteznek megfizethető áron (kis közösségek, egyesületek, iskolák, egyetem…)
- Elsősorban CCD/DSLR megfigyelések, de lehet vizuálisan is gyönyörködni
- Adatok feldolgozása jelentősen nagyobb feladat, mint a digitális fotometria esetén…
- …de a mérések (általában) sokkal kevésbé érzékenyek az égbolt minőségére.