

**Spektroskopisch interessante
Objekte
mit
Amateur-Spektrographen
beobachtet**

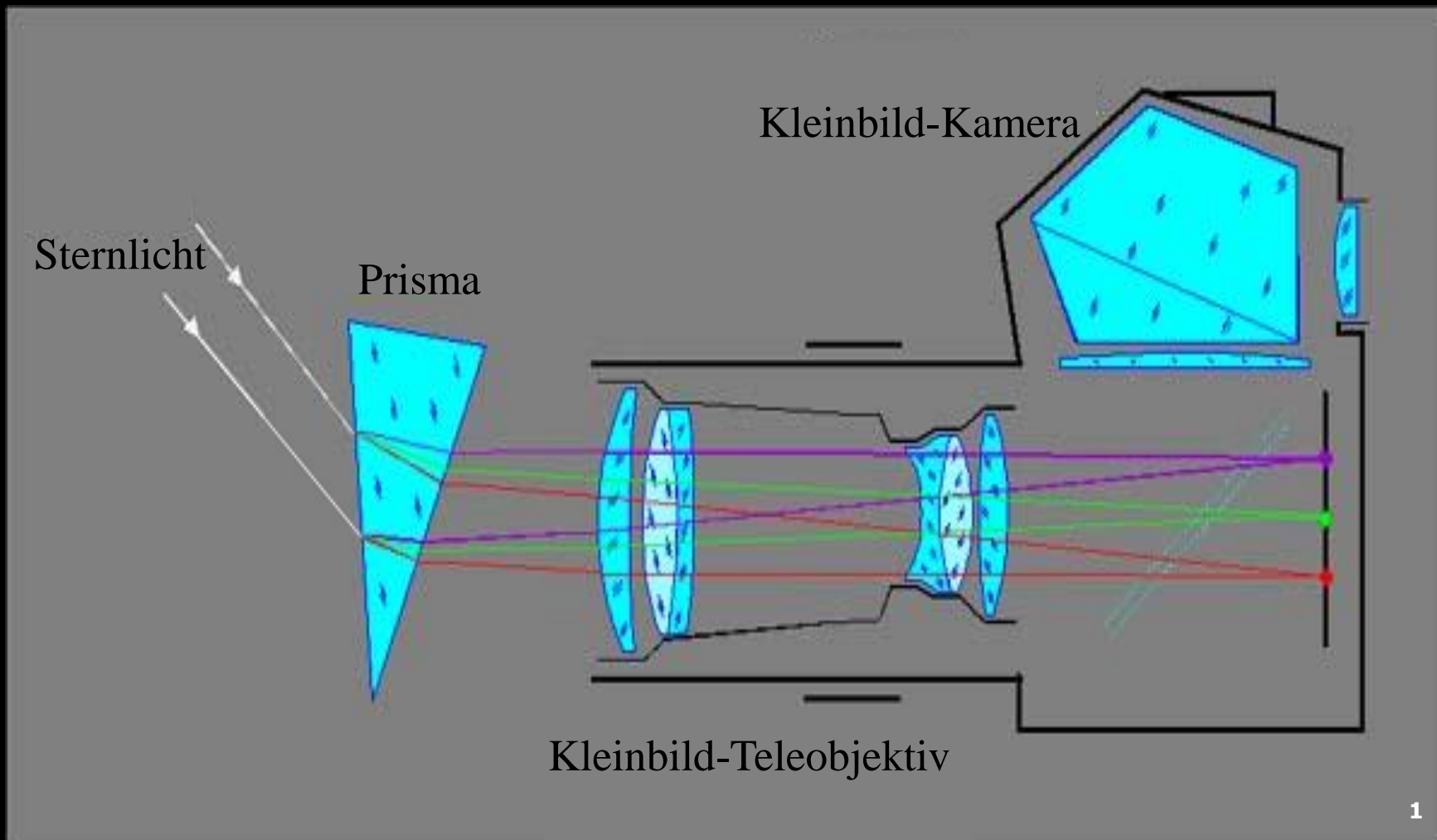
Ernst Pollmann

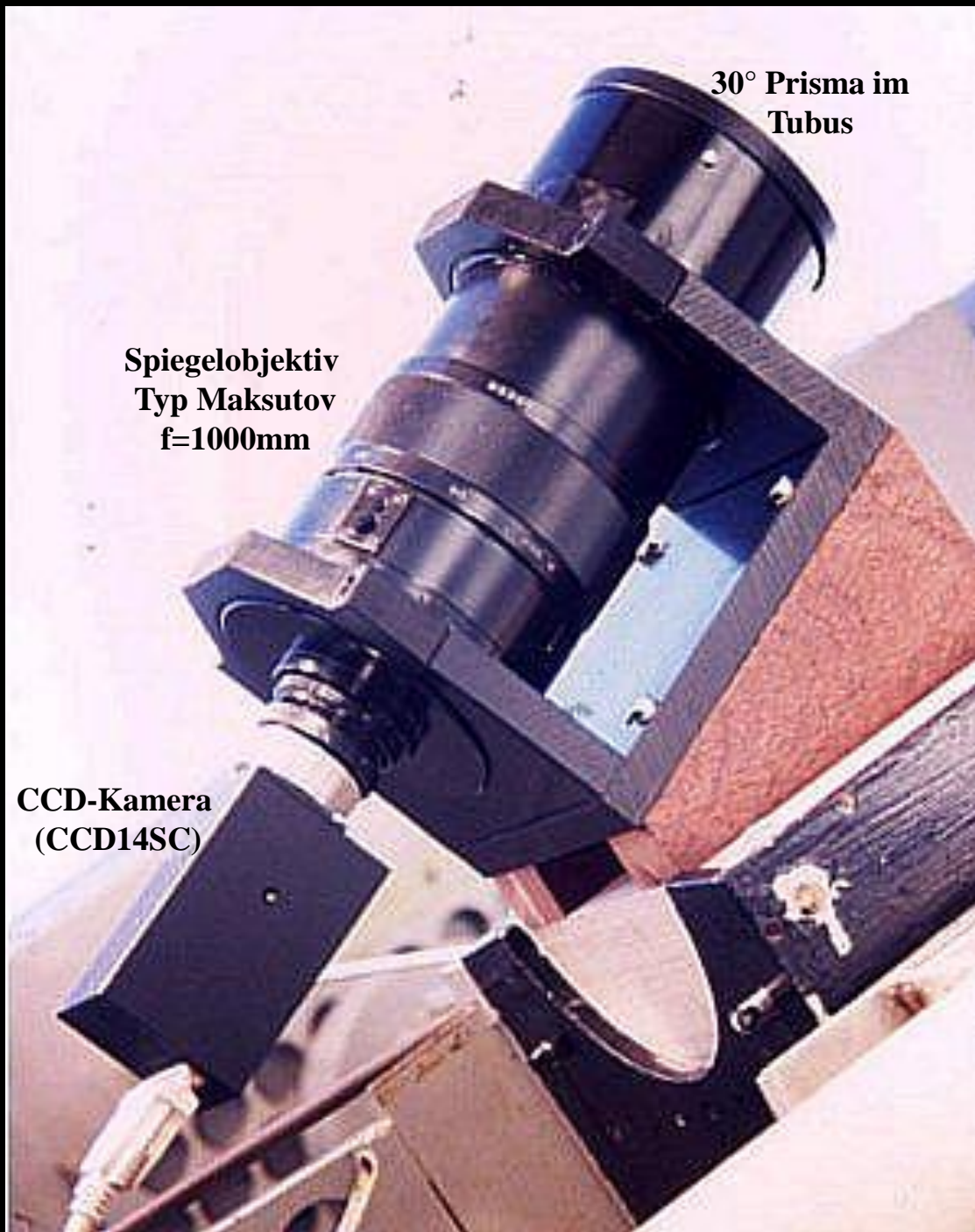
Arbeitsgemeinschaft **ASPA**

*Aktive **SP**ektroskopie in der **A**stronomie*

<http://www.astrospectroscopy.de>

Der klassische Objektiv-Primenspektrograph





**30° Prisma im
Tubus**

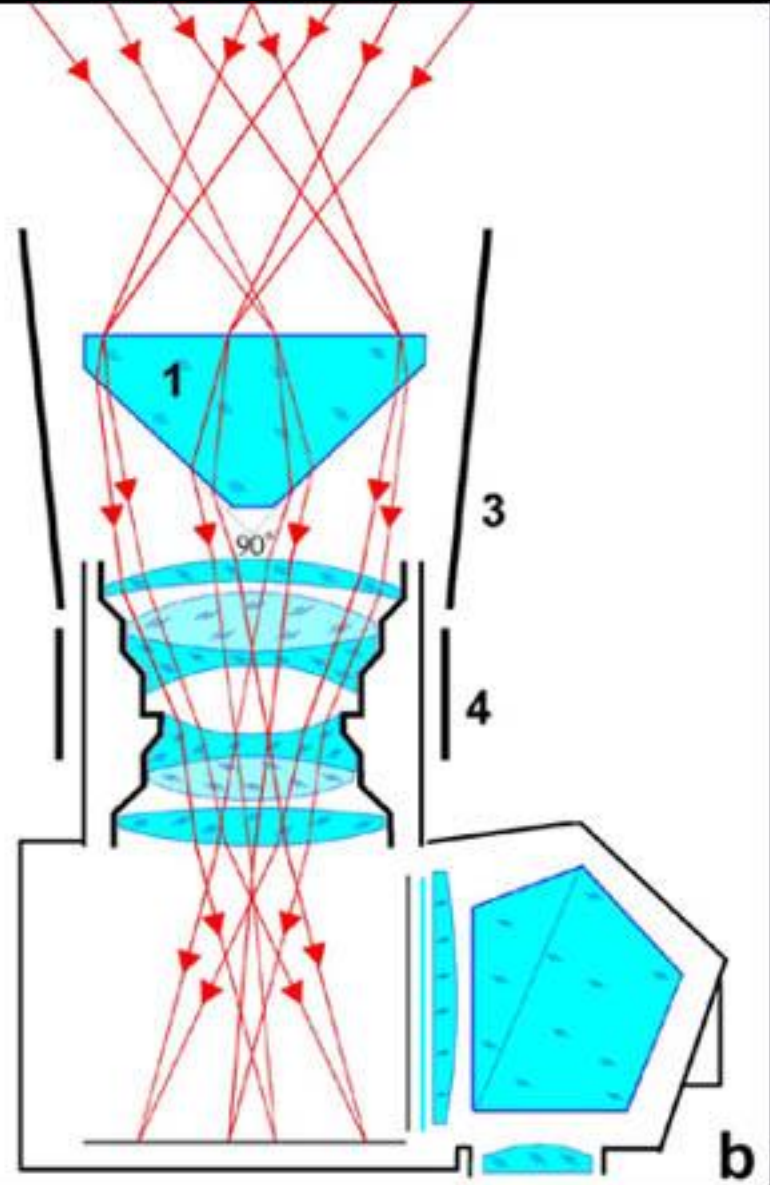
**Spiegelobjektiv
Typ Maksutov
f=1000mm**

**Dispersion H γ - H δ
64 Å/mm**

**CCD-Kamera
(CCD14SC)**



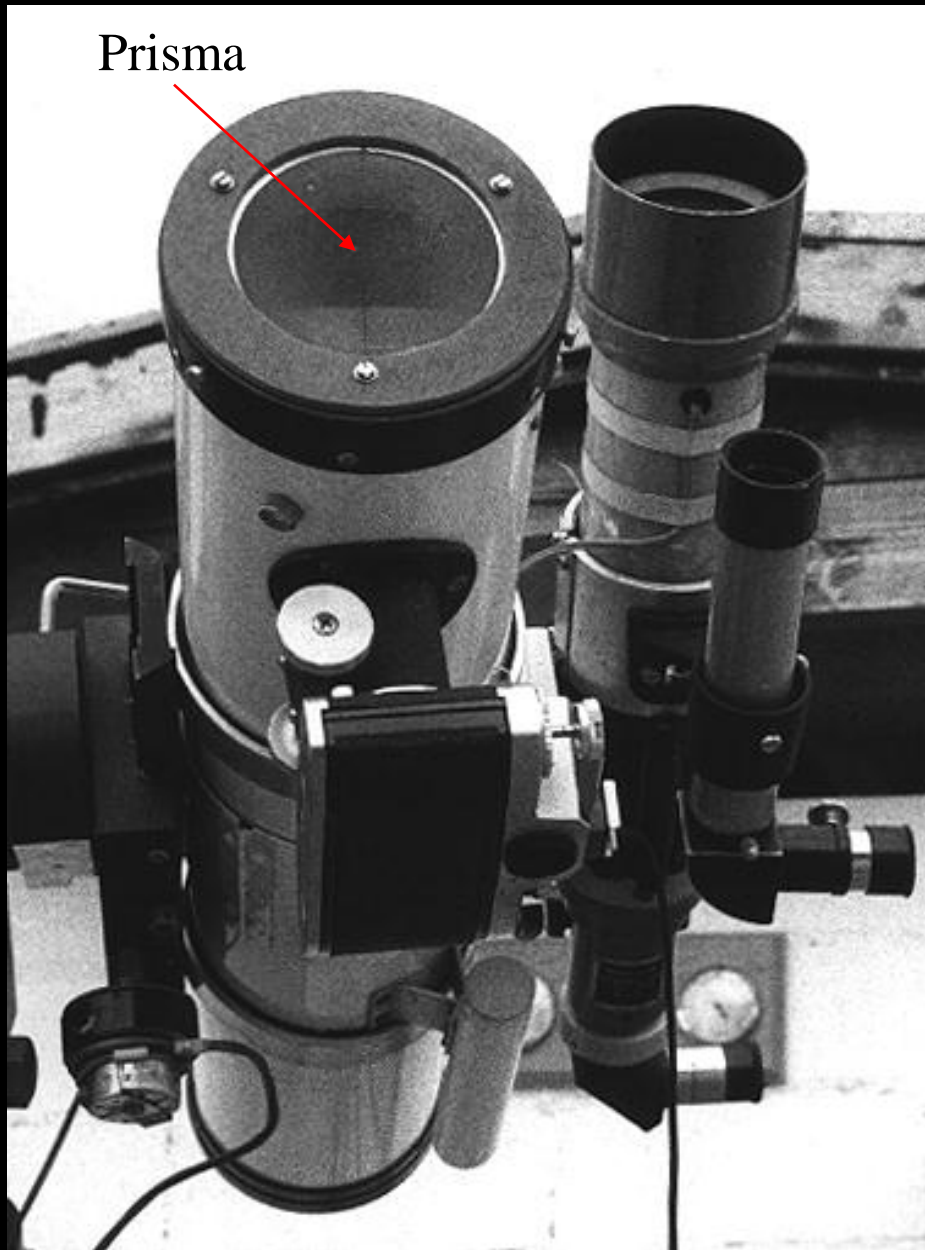
a



b

Objektivprismenspektrograph
Newton 120/690 mit 45°- Prisma BK 2





Prisma

Objektiv-Prismen-Spektrograph im Tubus eines Newton-Teleskops

$f = 700 \text{ mm}$ (1:10)

30° Kronglas-Prisma

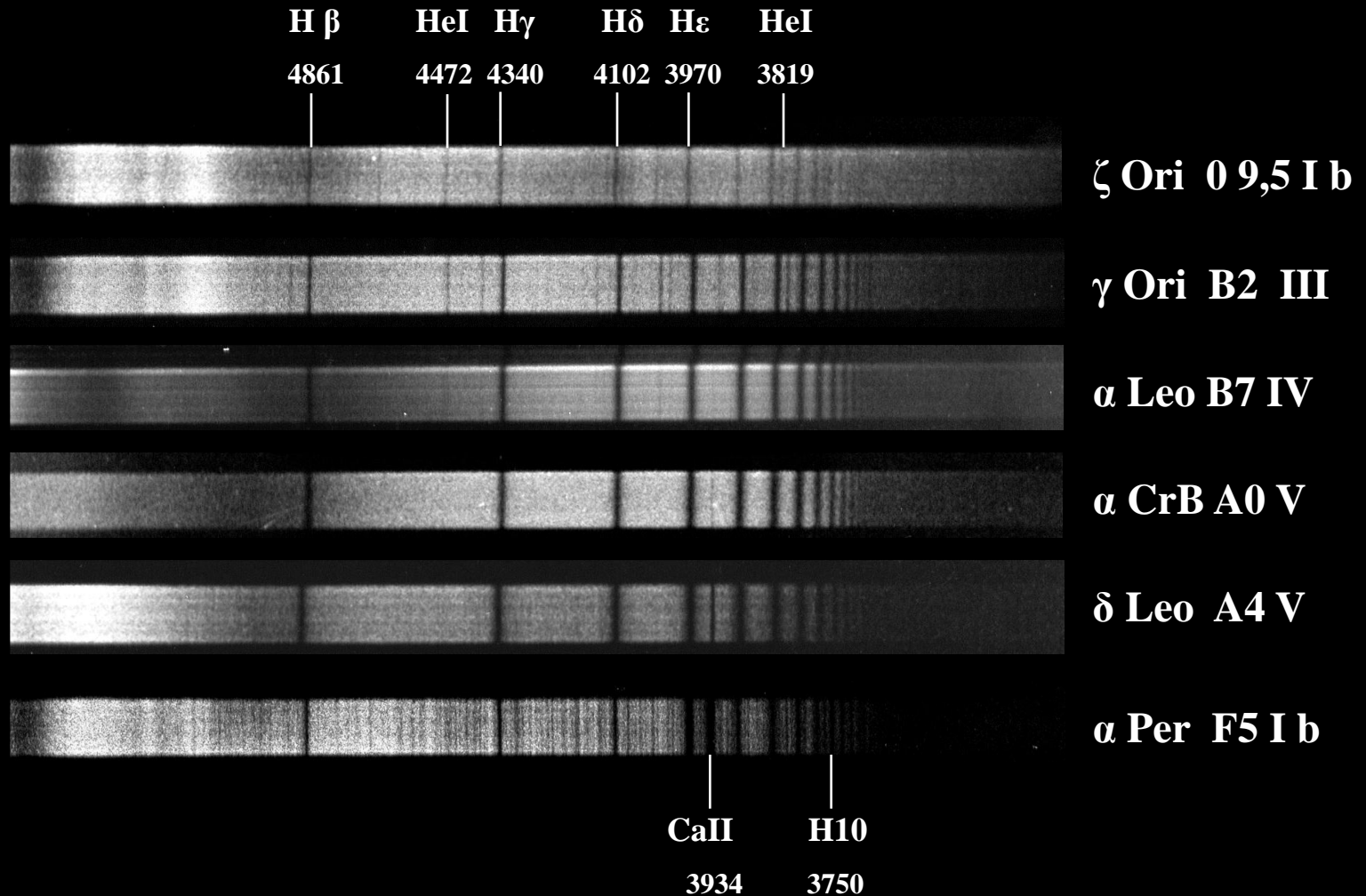
Dispersion 104 \AA/mm (bei H β -H ϵ)



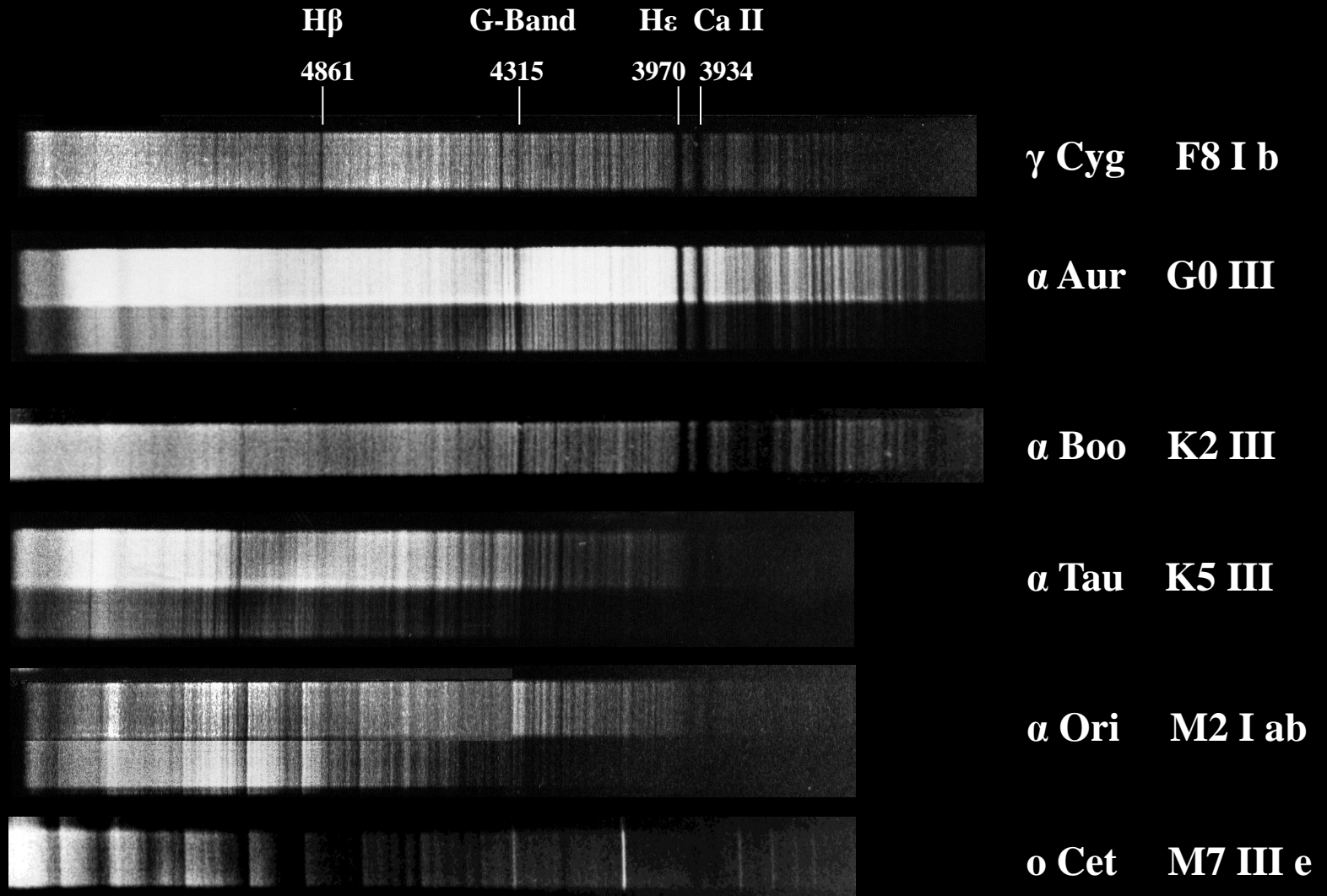
**Prismen-Spektrograph-
Ansatz SPG 25
(Lichtenknecker Optics)
im Fokus eines SC
Teleskops 1:10**

Dispersion $H\delta - H\epsilon$
146 Angstr./mm

Spektraltypen O-F



Spektraltypen F-M



TiO 5167 TiO 4955 TiO 4761 H γ 4340 H δ 4102

Leuchtkraft-Klassifikation anhand der Linienbreite

α Lyr (Wega)

H β

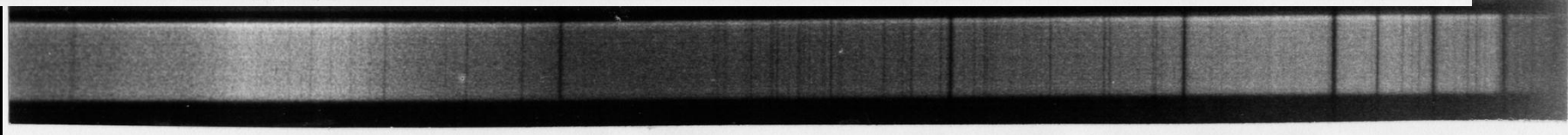
H γ

H δ

H ϵ Ca II



α Cyg (Deneb)



Veränderungen im Spektrum von Mira (o Cet)

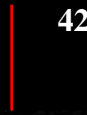
Titanoxid-Banden

5167 4955 4761



H γ Ca I

4227



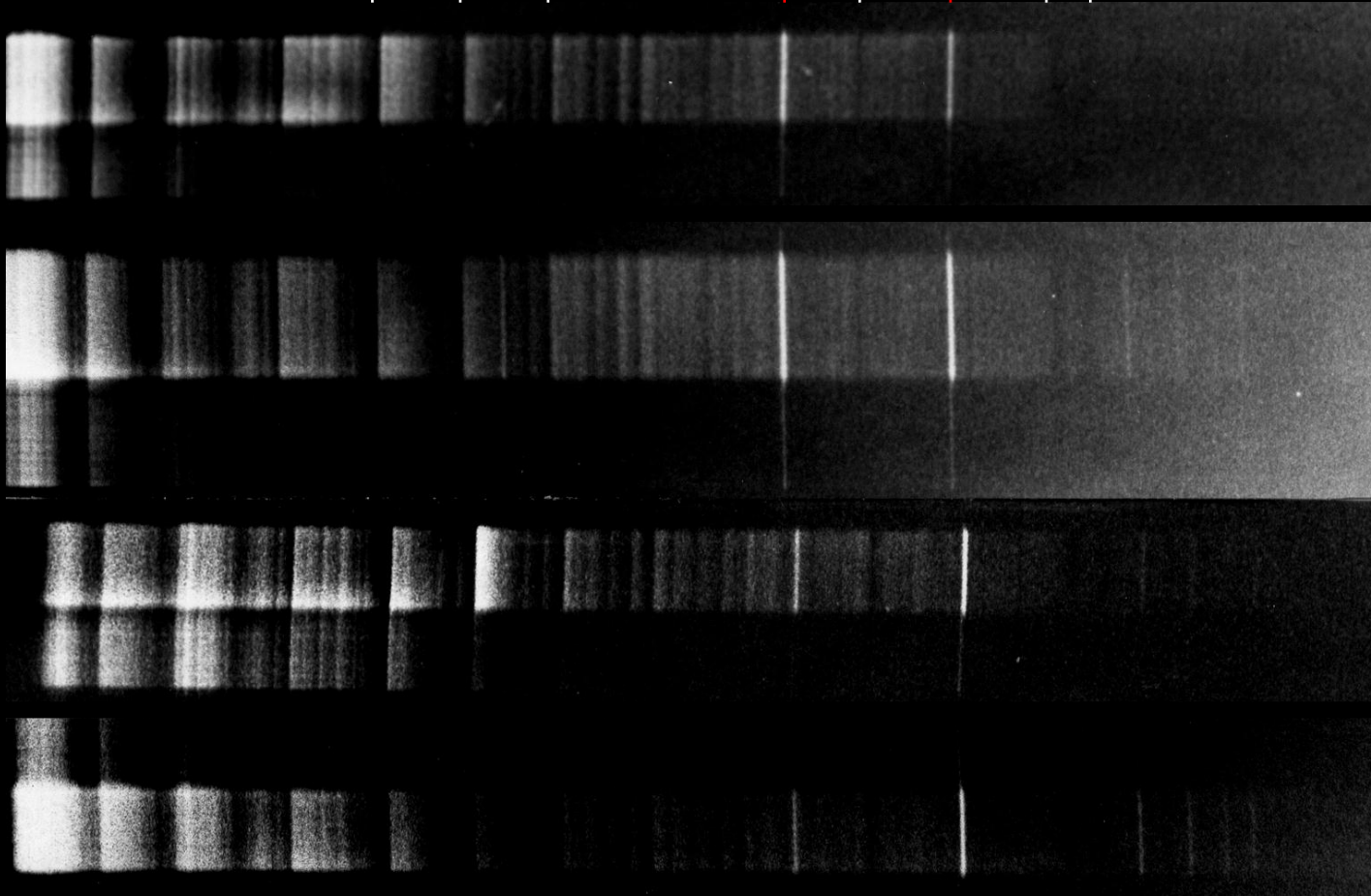
H δ

Ca II

3968 3934



Tage vor (-) bzw.
nach (+)
Helligkeitsmaximum



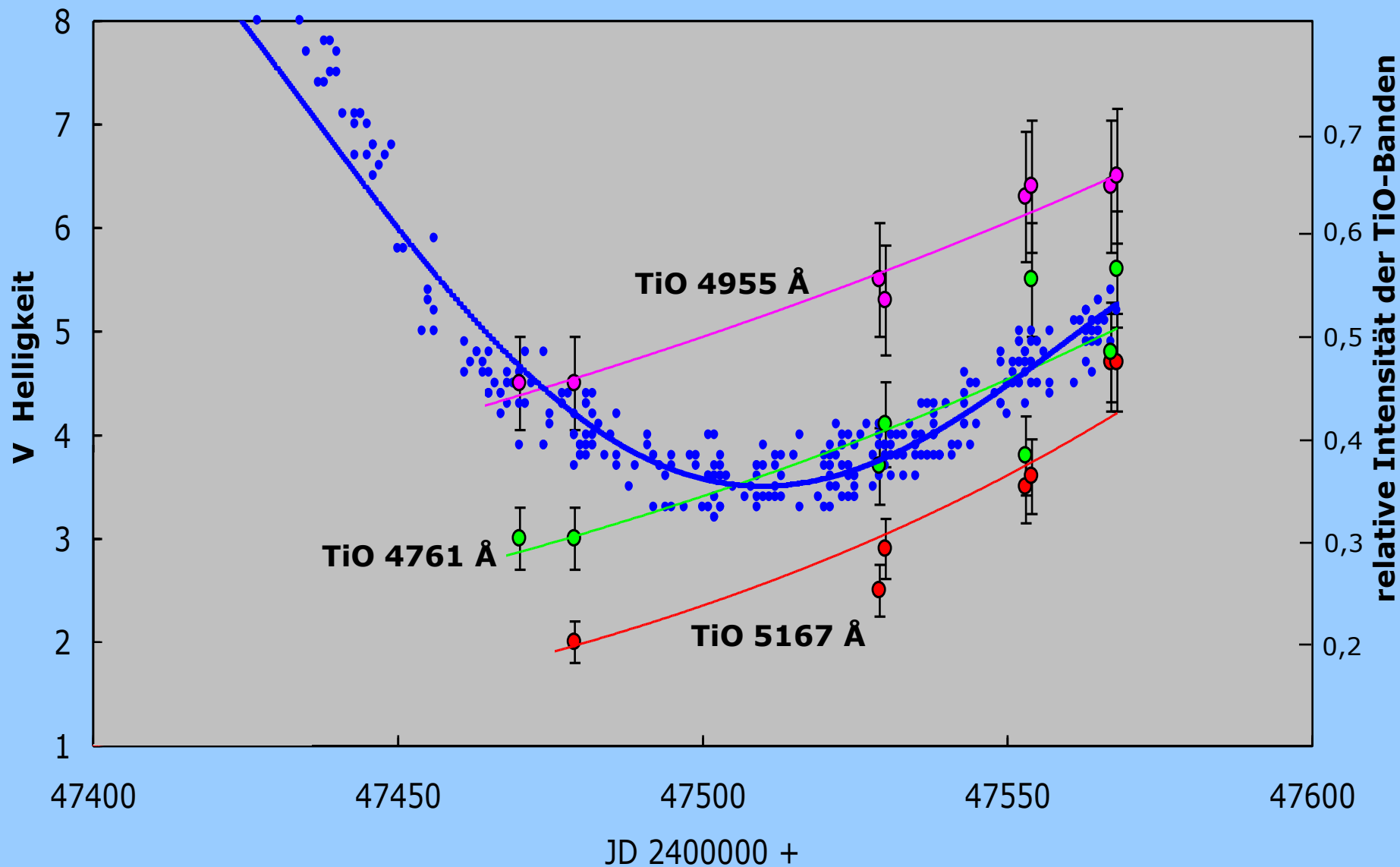
- 27

-5

+ 23

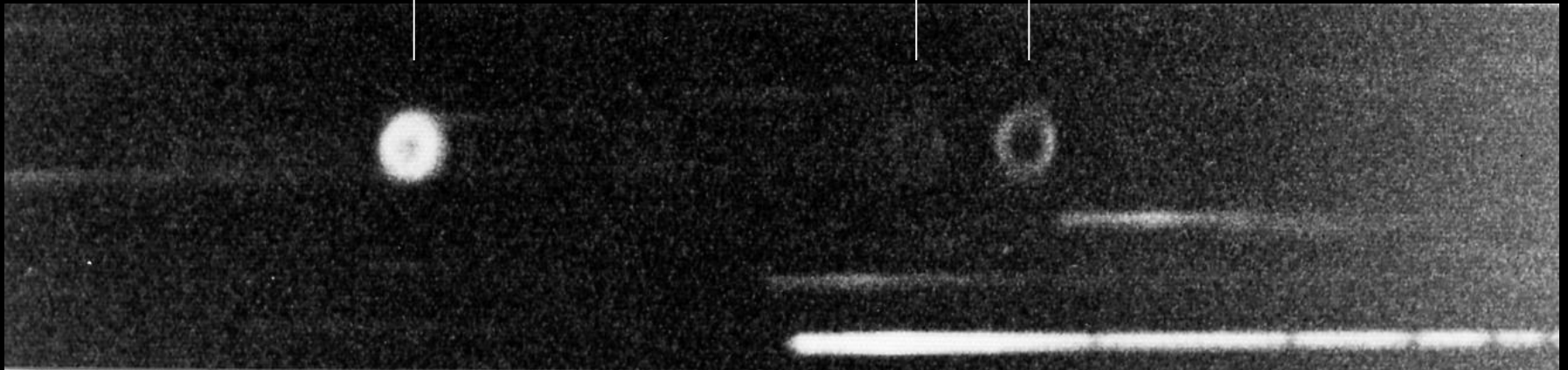
+ 35

Intensitätsverlauf der TiO-Absorptionen synchron zum Helligkeitsverlauf



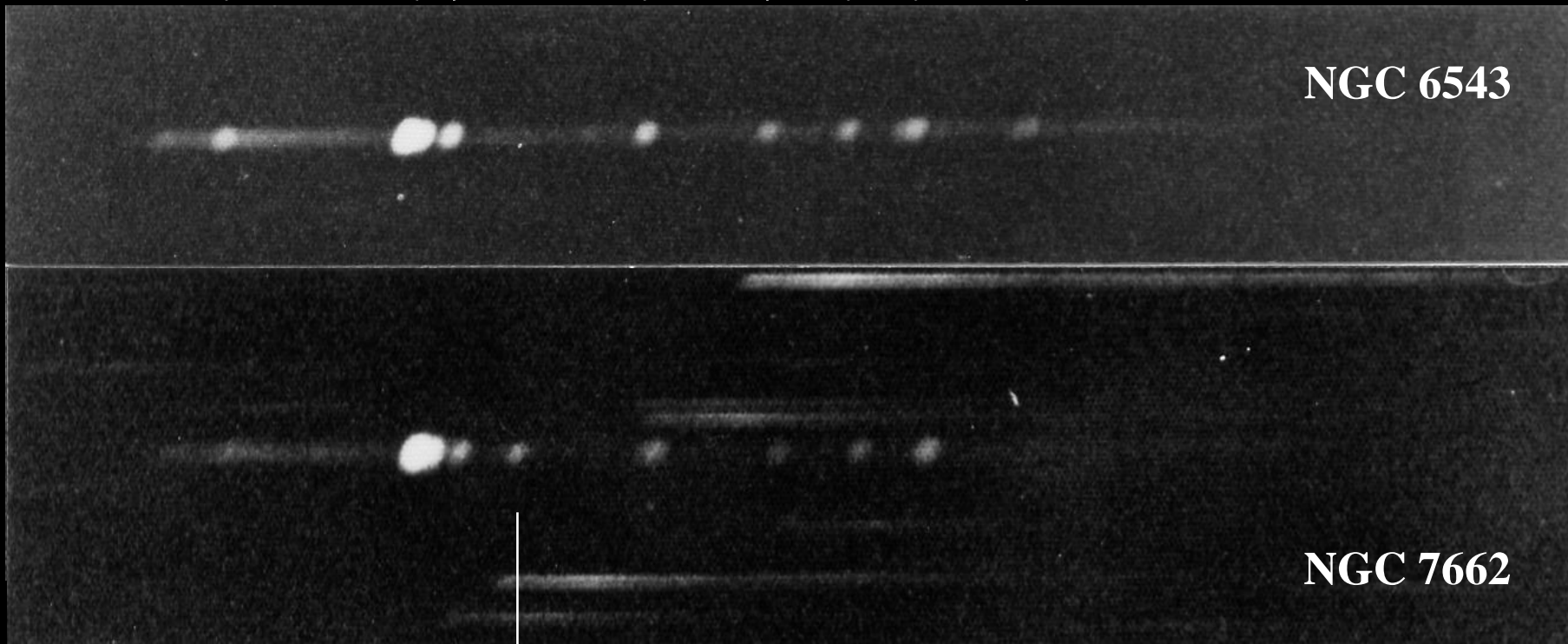
Spektrum des Ringnebels (M 57)

[O III] [Ne III] [O II]
5007 4995 3869 3728



Planetarische Nebel

He I O III H β H γ H δ H ϵ Ne III O II



NGC 6543

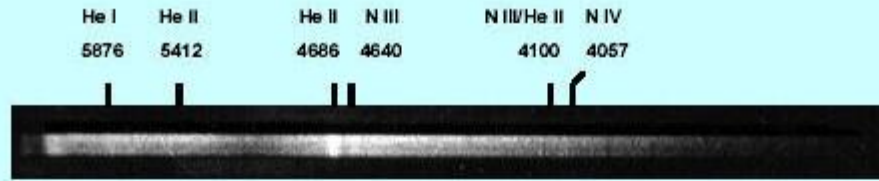
NGC 7662

He II 4686



Wolf-Rayet-Sterne

WR 133



WN5 + O9

WR 134



WN6

WR 136



WN6

WR 138

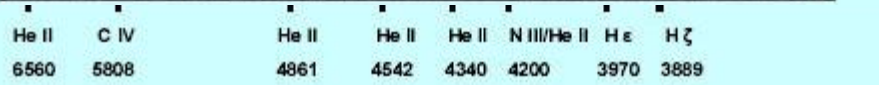


WN5 + B

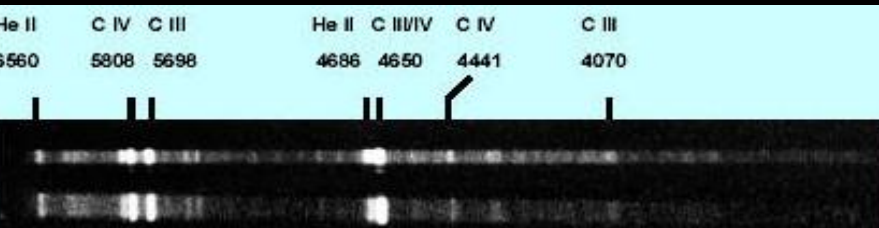
WR 137



WC 7 pd +O9

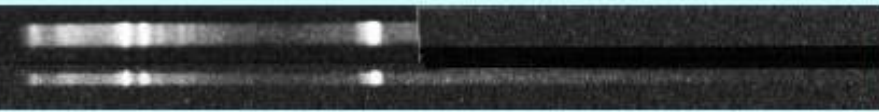


WR 135



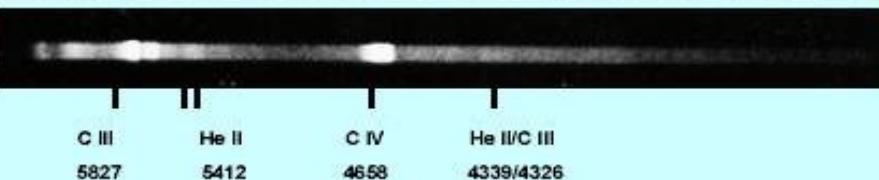
WC 8

WR 137



WC 7 pd +O9

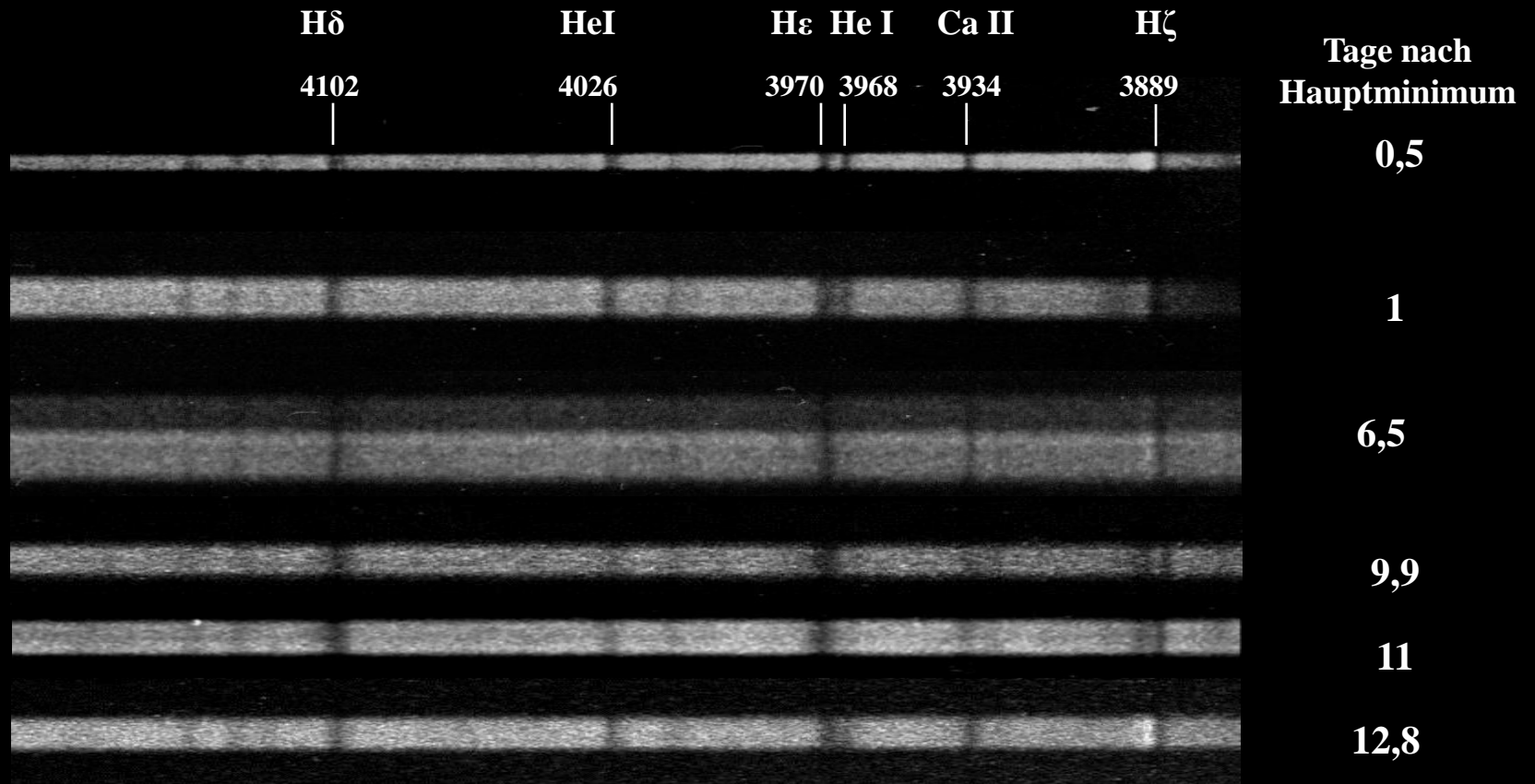
WR 140



WC 7 pd +O4-5

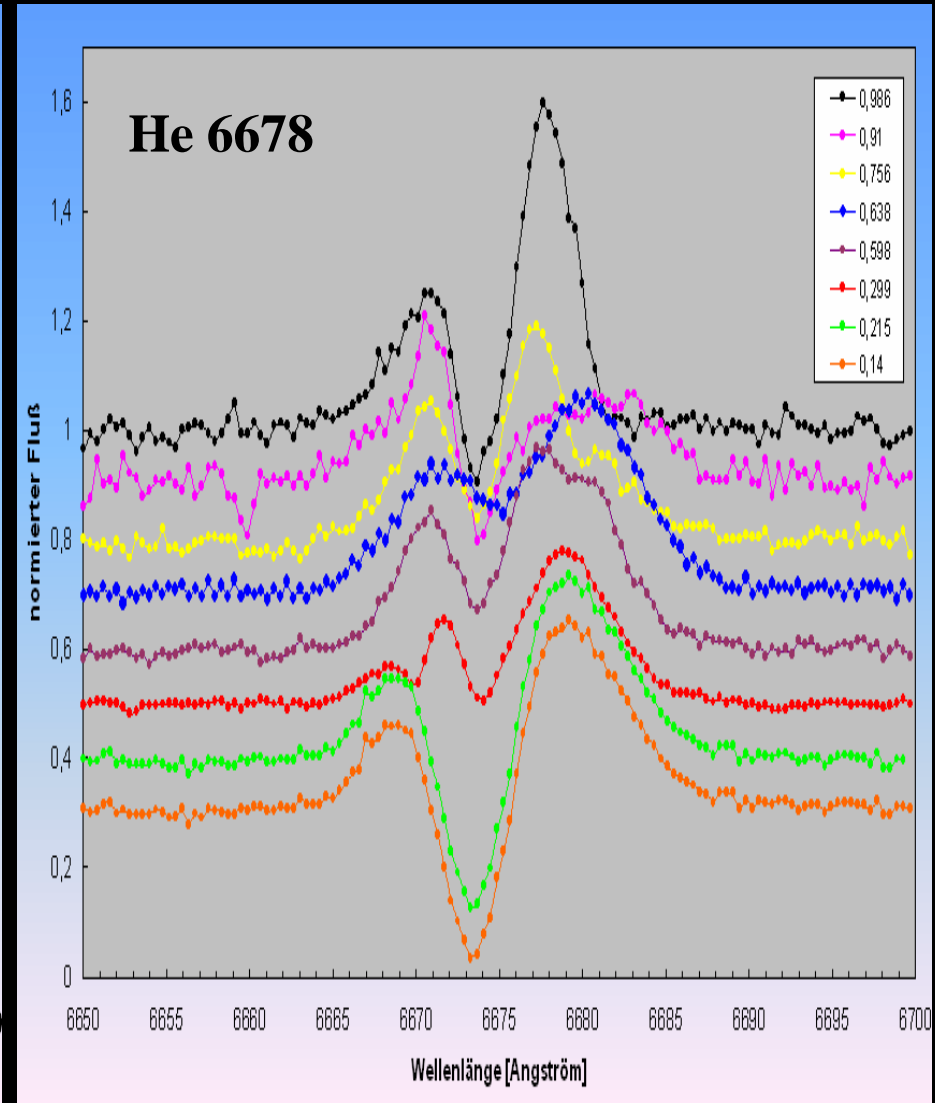
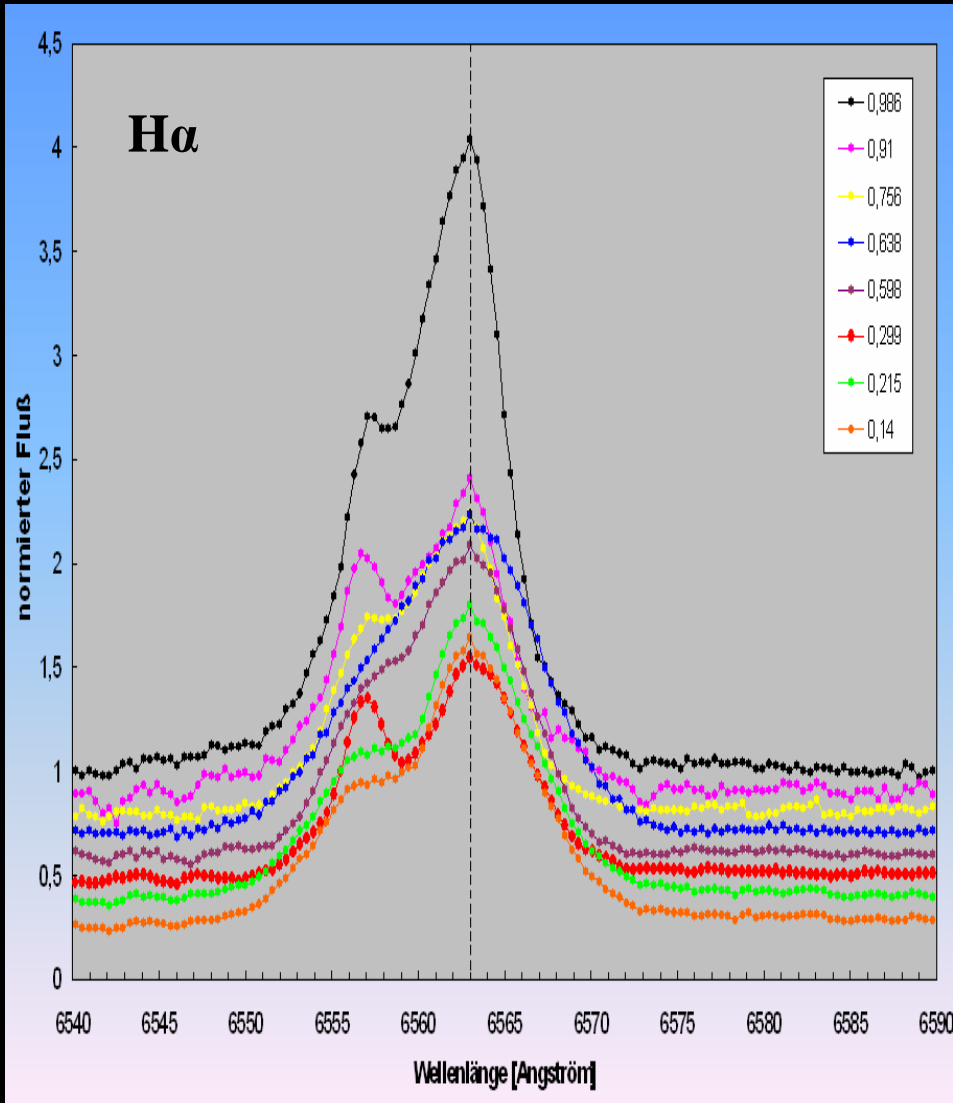
Das Bedeckungssystem β Lyrae

Änderung des Spektrums im Bedeckungszyklus



β Lyr

phasenabhängige Profilvariation der $H\alpha$ - und He6678 Emission



Prinzipieller Aufbau eines Spalt-Spektrographen

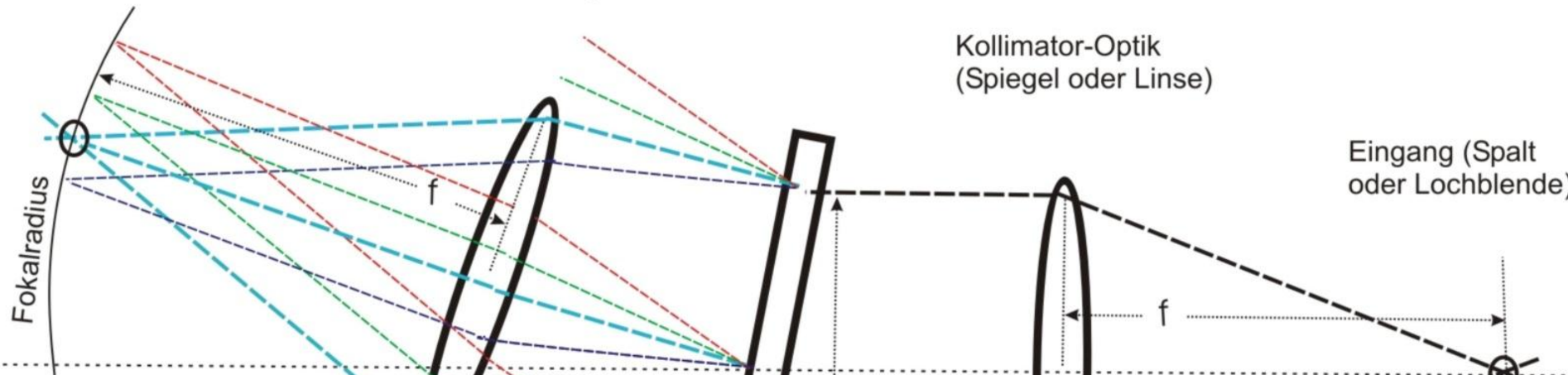
Ausgang (Spalt, Lochblende oder Detektorfläche)

Fokussier-Optik (Spiegel oder Linse)

Dispersionselement (Gitter oder Prisma)

Kollimator-Optik (Spiegel oder Linse)

Eingang (Spalt oder Lochblende)



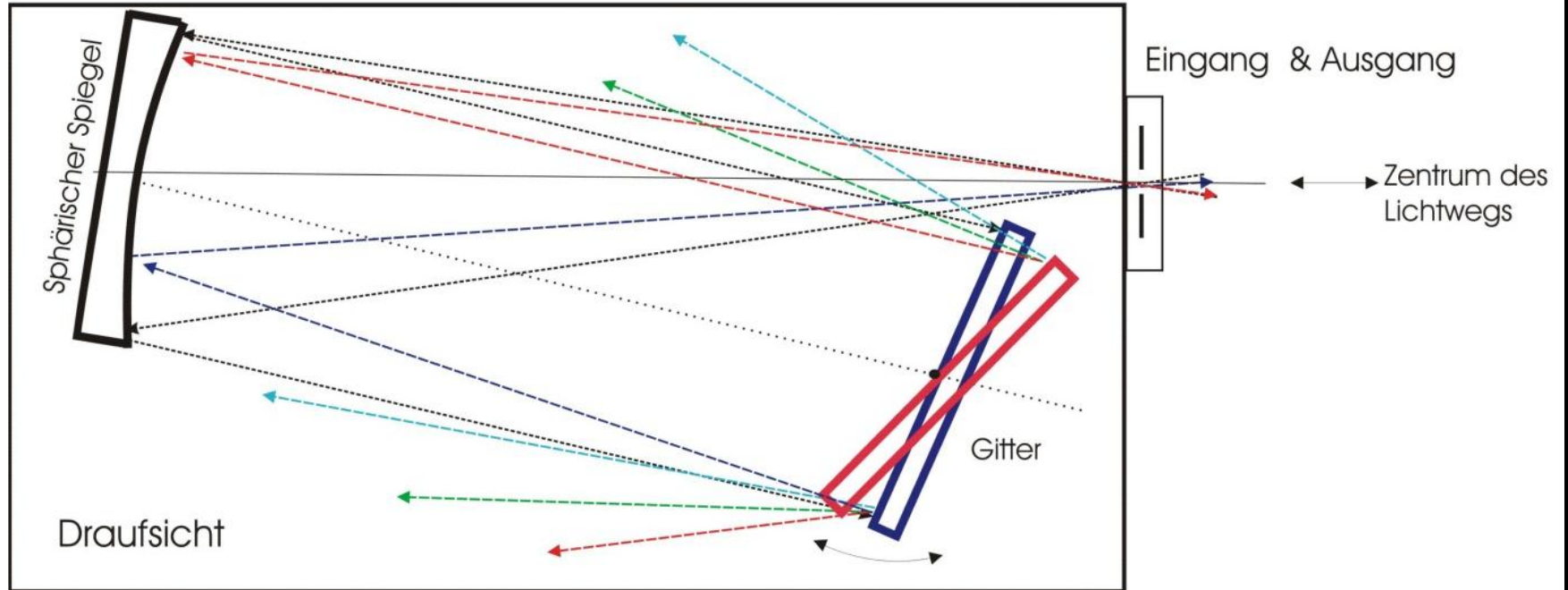
Fokussierter Strahl, jede Wellenlänge bildet einen separaten Konus

Dispergiertes Strahl, jede Wellenlänge läuft parallel aber unter eigenem Winkeln

Kollimierter Strahl, paralleles Licht

Divergierender Strahl, konusförmig

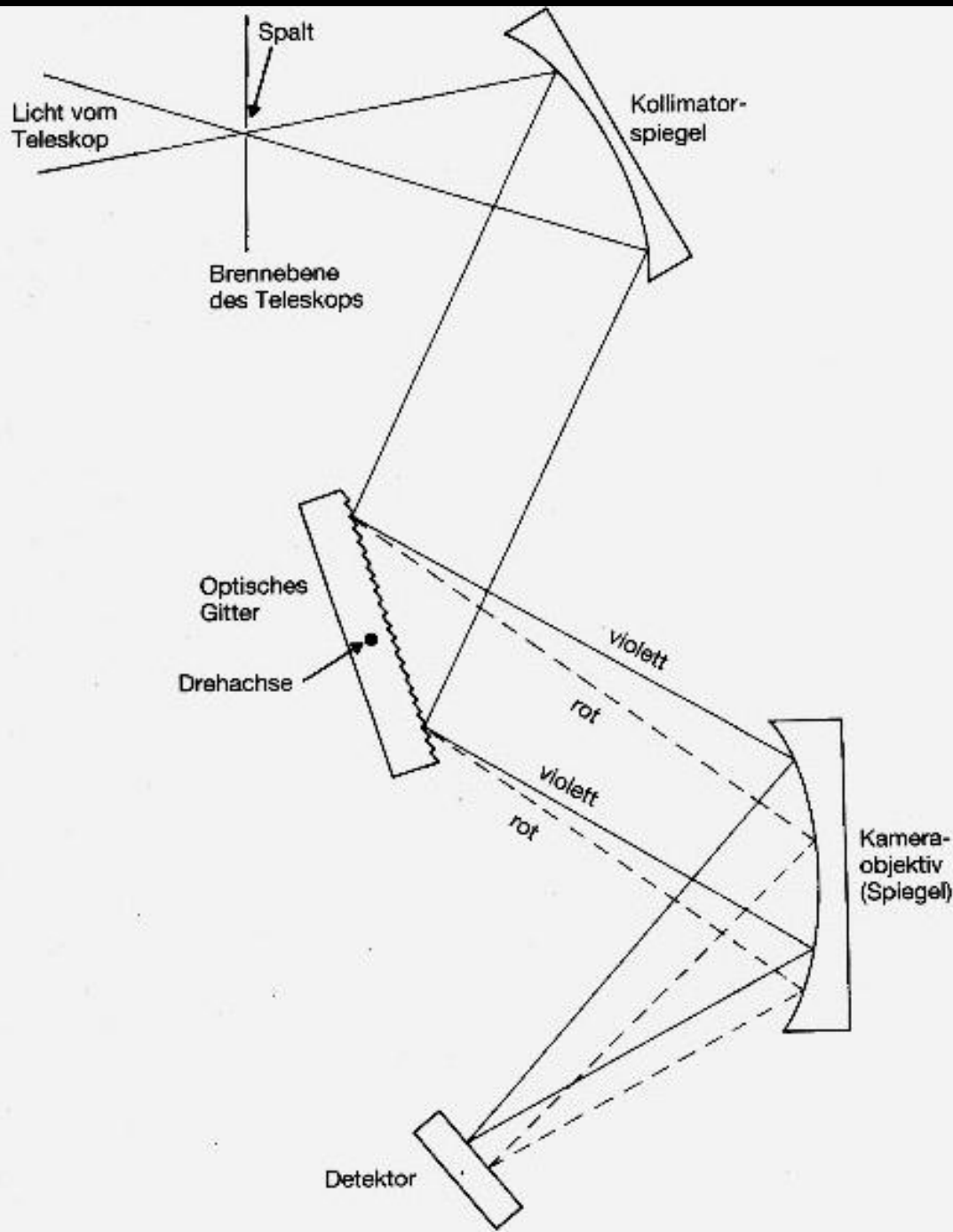
Die Littrow-Konfiguration





**Der Littrow-Spektrograph
LHIRES an einem C14
Schmidt-Cassegrain-Teleskop**

**Hier in der Arbeitssternwarte
der VdS-Köln**



Der Czerny-Turner-Aufbau

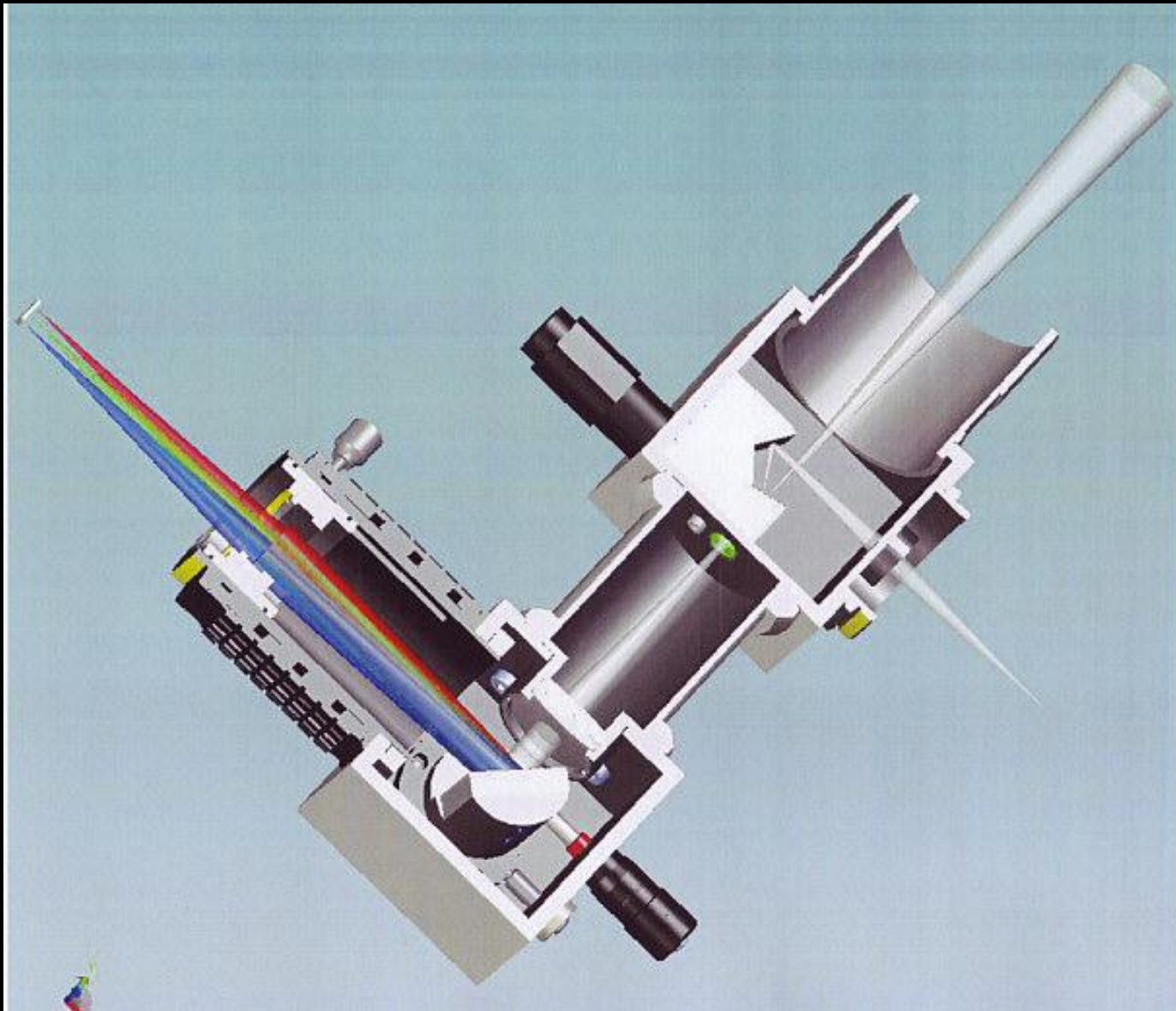
Er unterscheidet sich vom Littrow-Aufbau dadurch, dass er mit zwei Spiegel arbeitet.

Das bietet wesentlich mehr Flexibilität in konstruktiver Hinsicht.

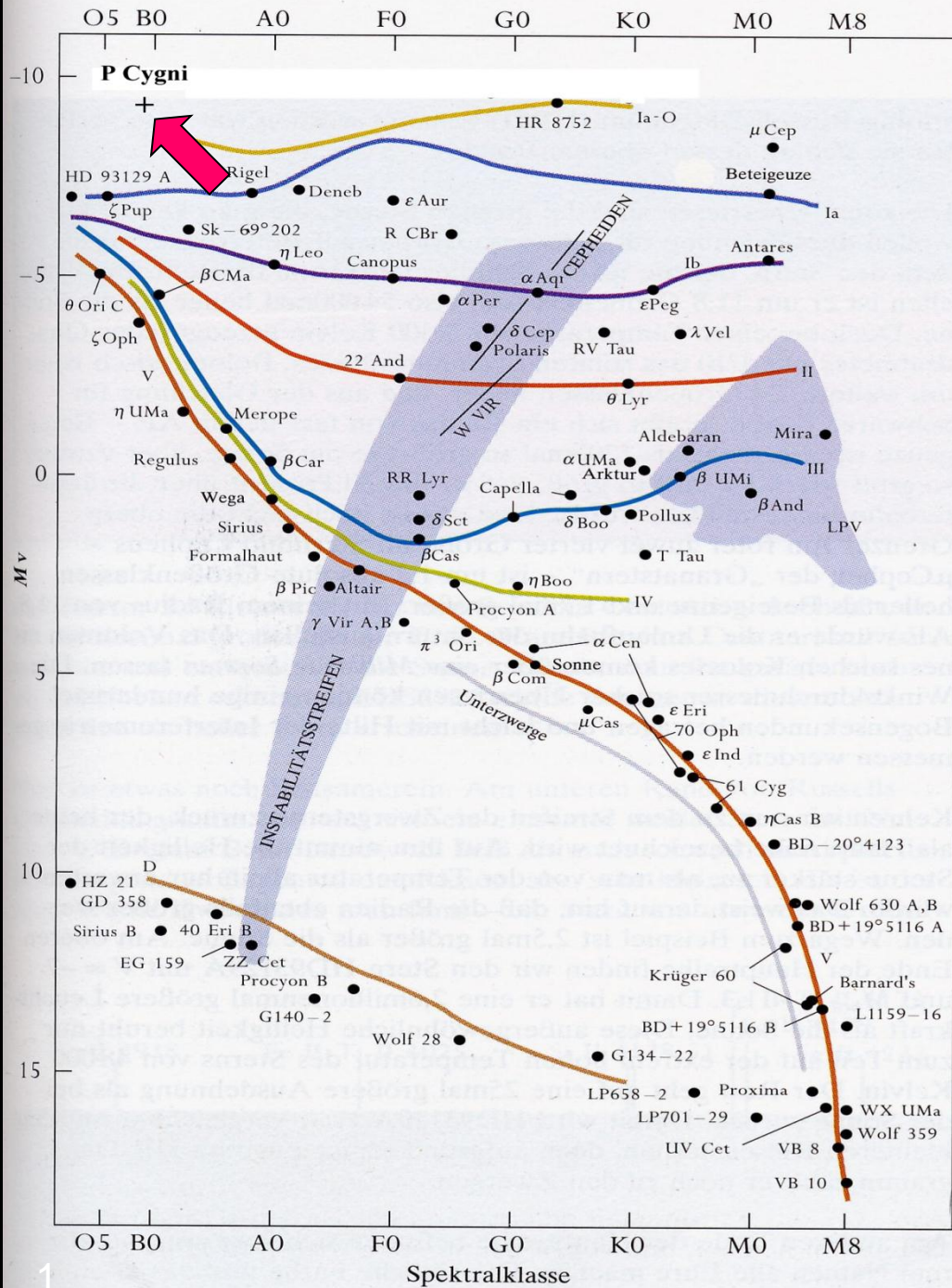
Die direkte Reflexion von Eingang zu Ausgang ist nicht möglich.

Die beiden Spiegel können unterschiedlich groß sein

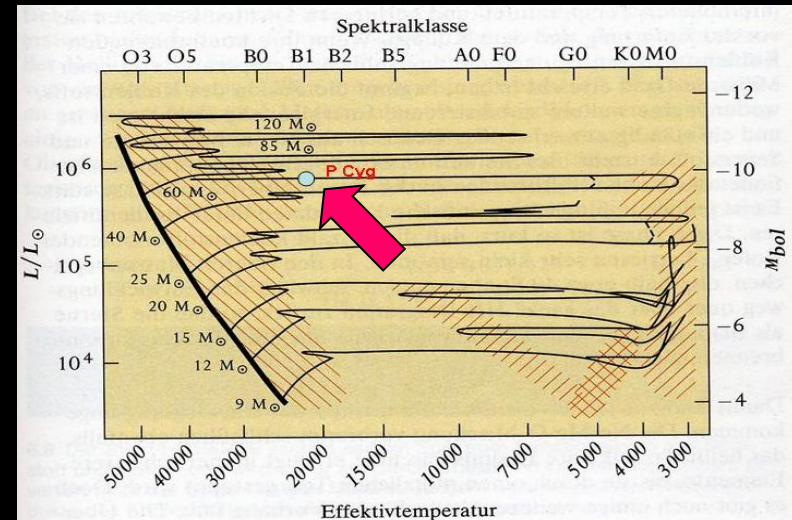
Der Spektrograph DADOS von Baader

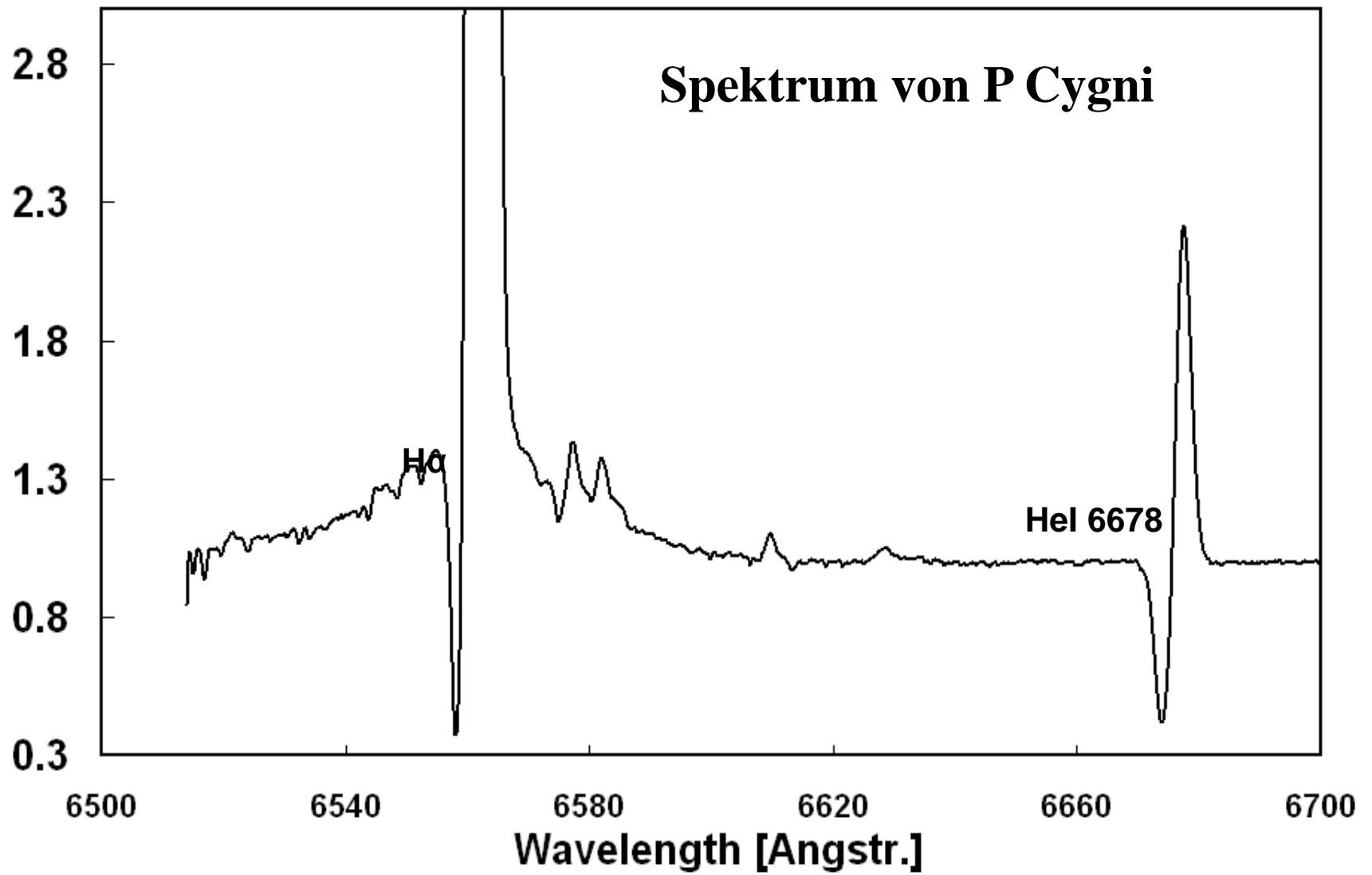


**H α -Beobachtungen am Leuchtkräftigen
Blauen Veränderlichen (LBV-Stern) P Cygni**



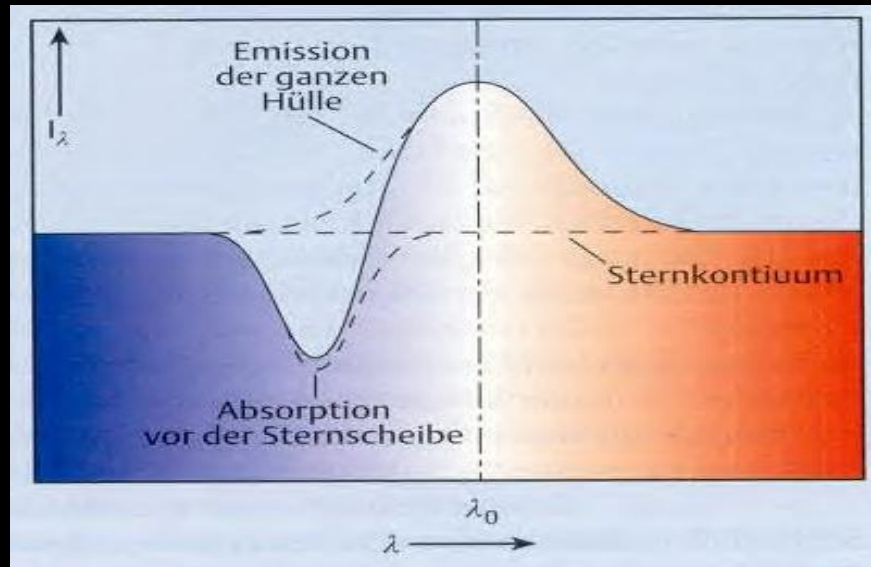
Der Leuchtkräftige Blaue Veränderliche P Cyg





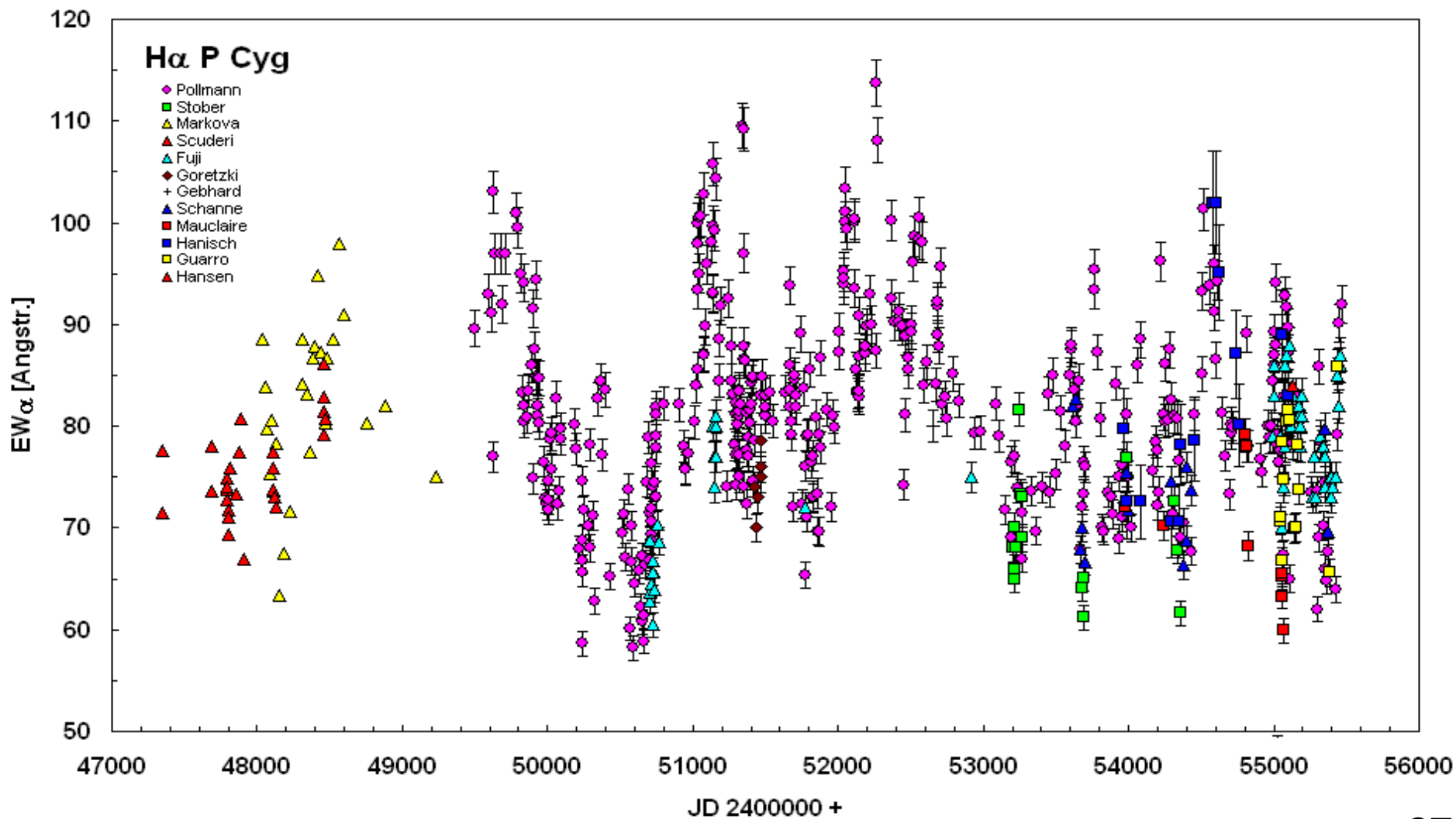


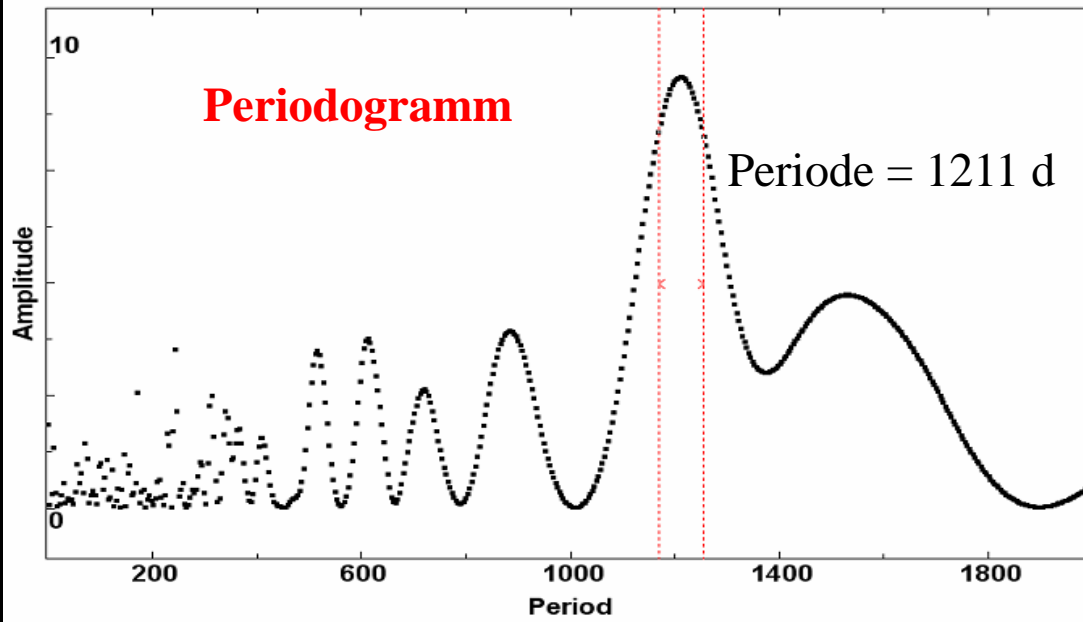
Beobachter



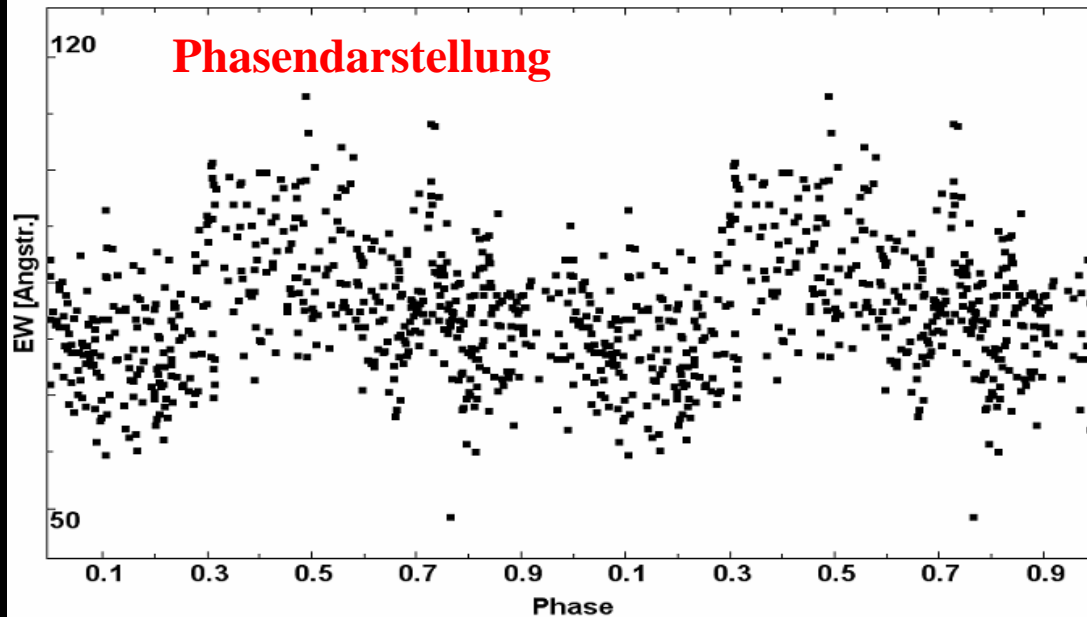
Das Linienprofil im
Spektrum
von P Cygni

Zeitverhalten der H α -Emissionsstärke (Äquivalentbreite)

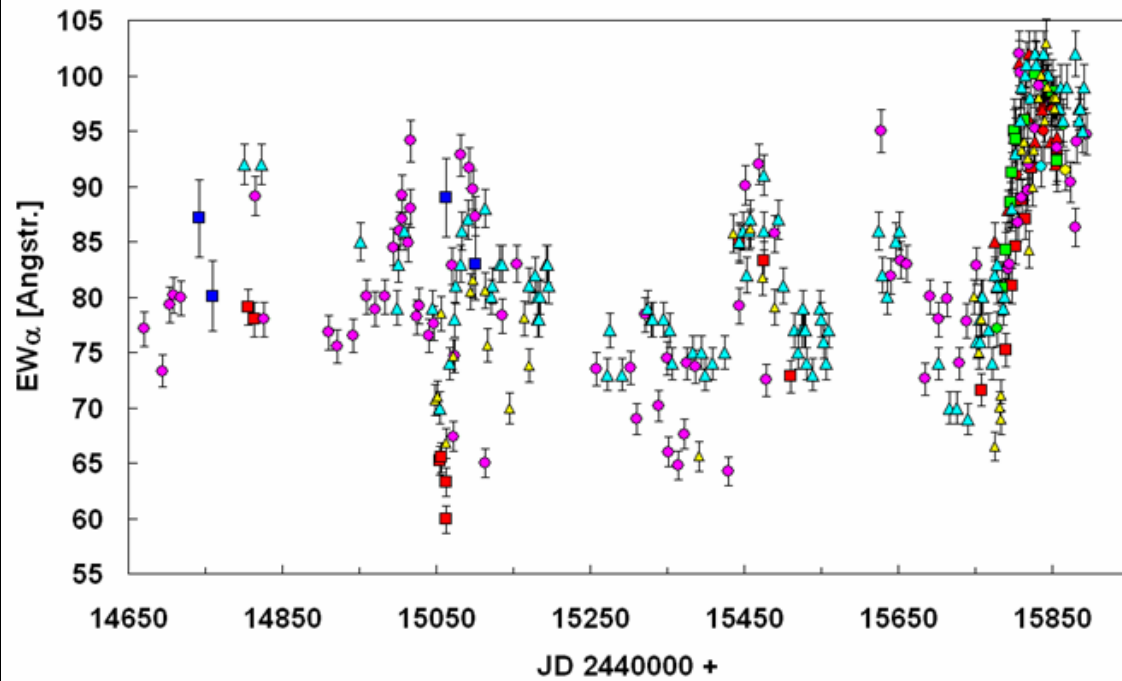
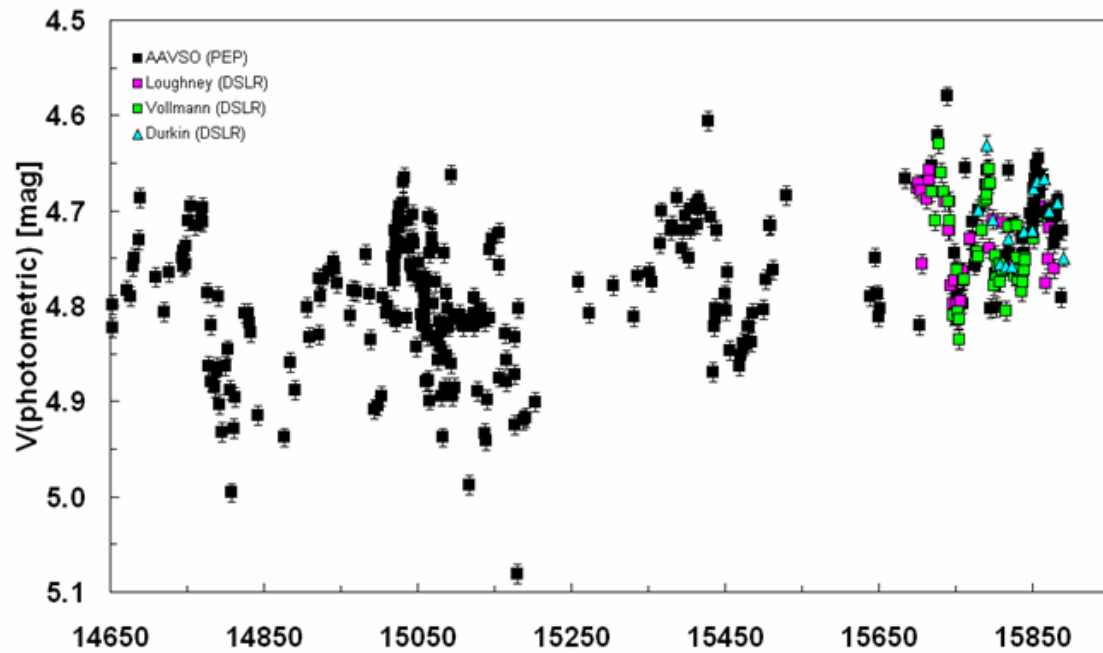


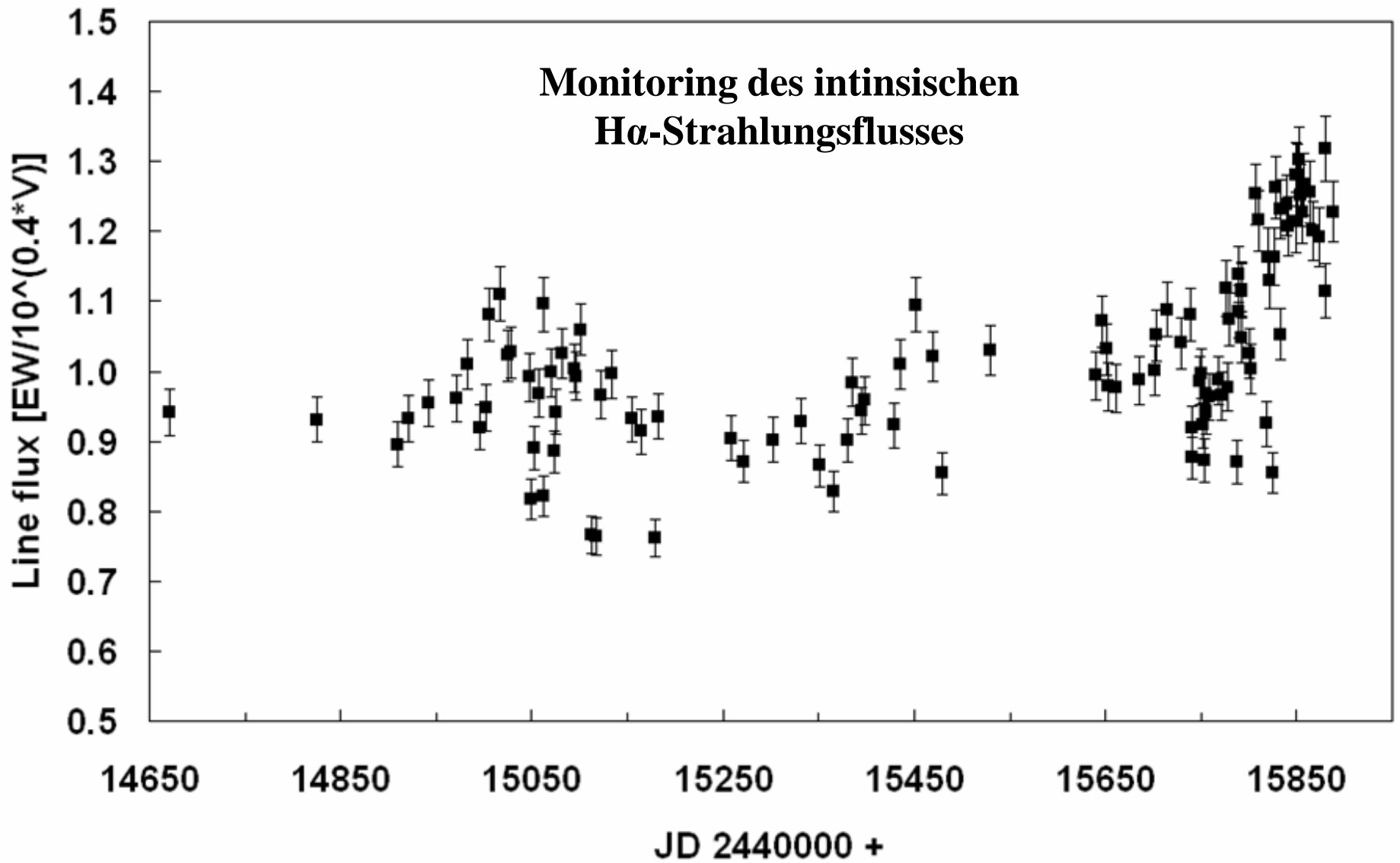


Ephemerides: $2448041 + 1211.1 * T$

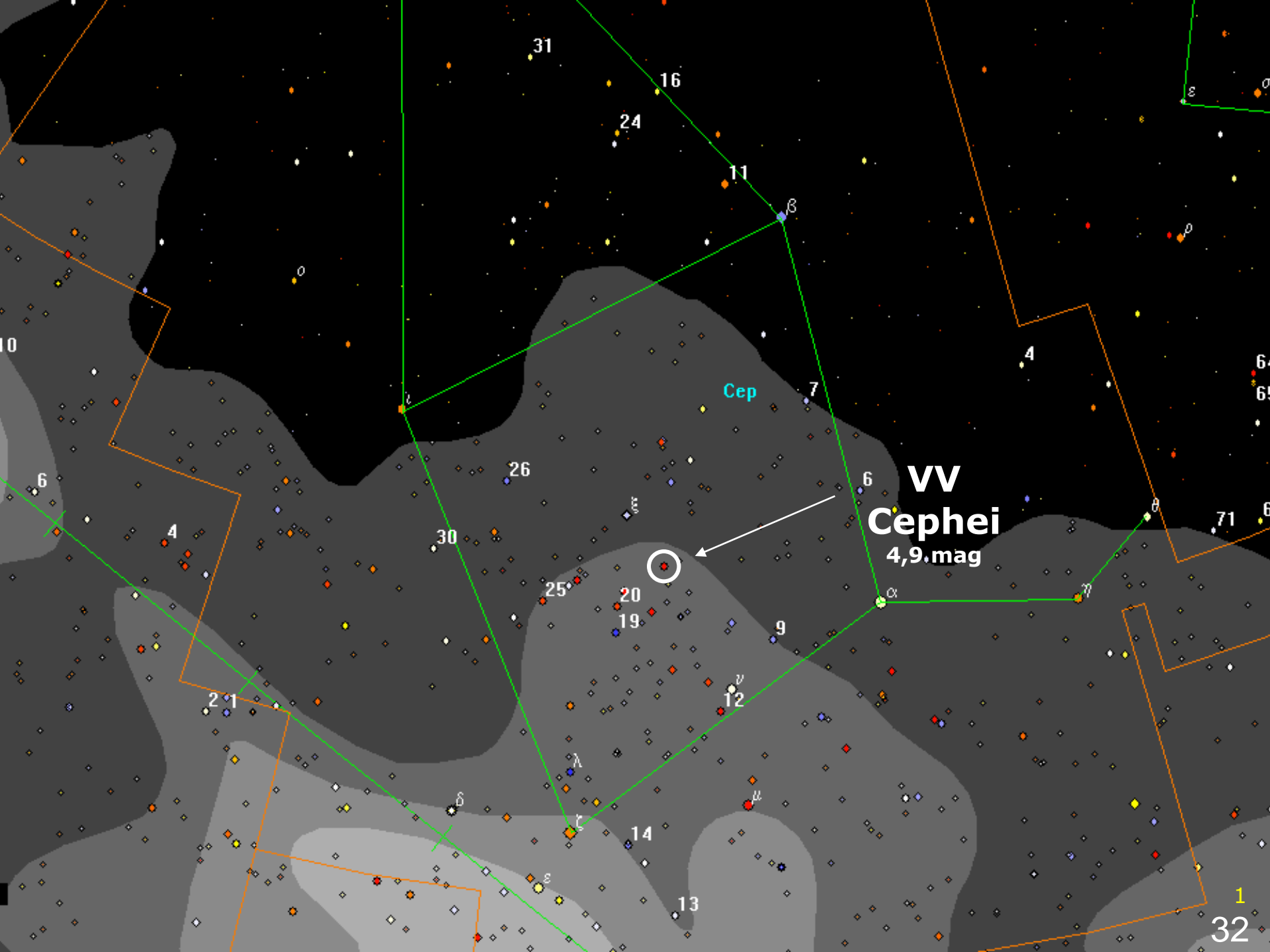


Perioden Analyse der H α -Emission





H α -Beobachtungen am Doppelsternsystem VV Cephei



VV
Cephei
4,9 mag

Cep

1
32

Sonne



VV Cephei A

**Der Orbit des Be-Sterns + Gasscheibe
führt zur Bedeckung durch den M-Überriesen**

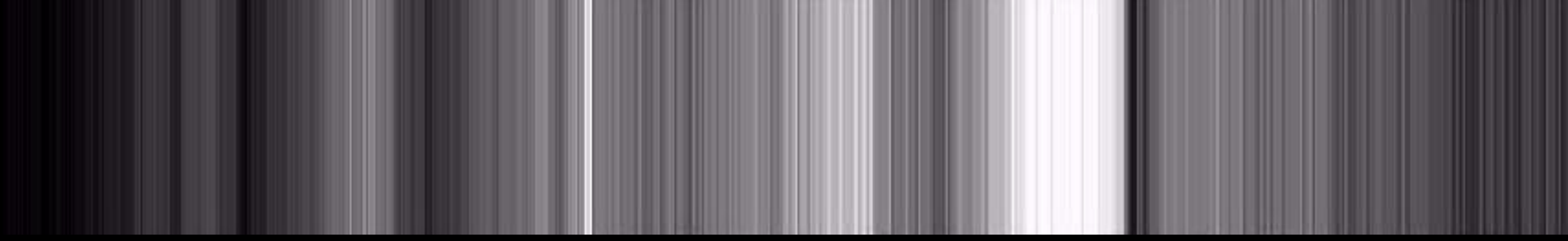
**Dauer der Bedeckung: 673 Tage
Periode: 20,4 Jahre**



**M2Iab Supergiant
2-3 Solar masses
1600 Solar radii**

Letzte Bedeckung: Juni/1996 – August/1998

CCD-Rohspektrum von VV Cep



CrI 5785

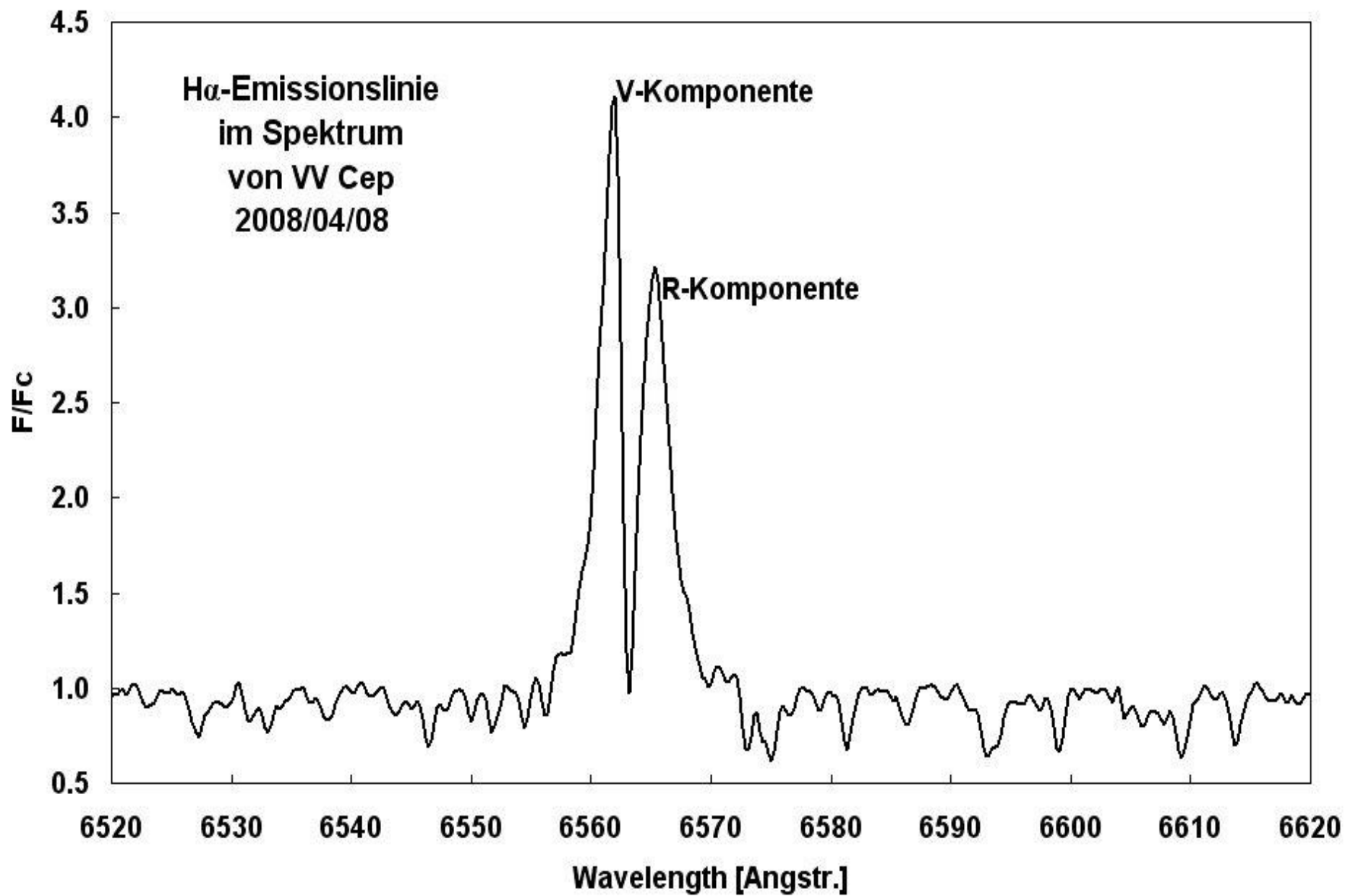
Intst. NaI 5889-5895

CaI 6161-6170

TiI 6360

H α

atm. O₂ 7640

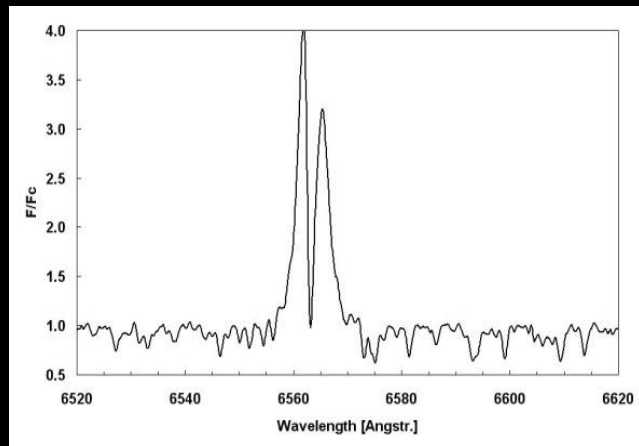


Rotierende Wasserstoff-Gasscheibe und ihr heißer Be-Stern mit 8 Sonnenmassen

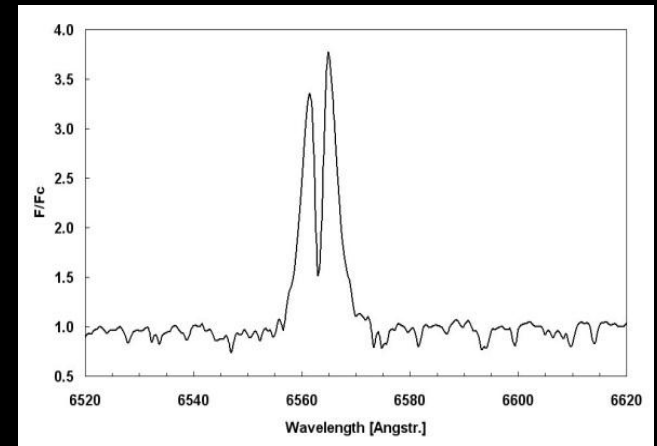


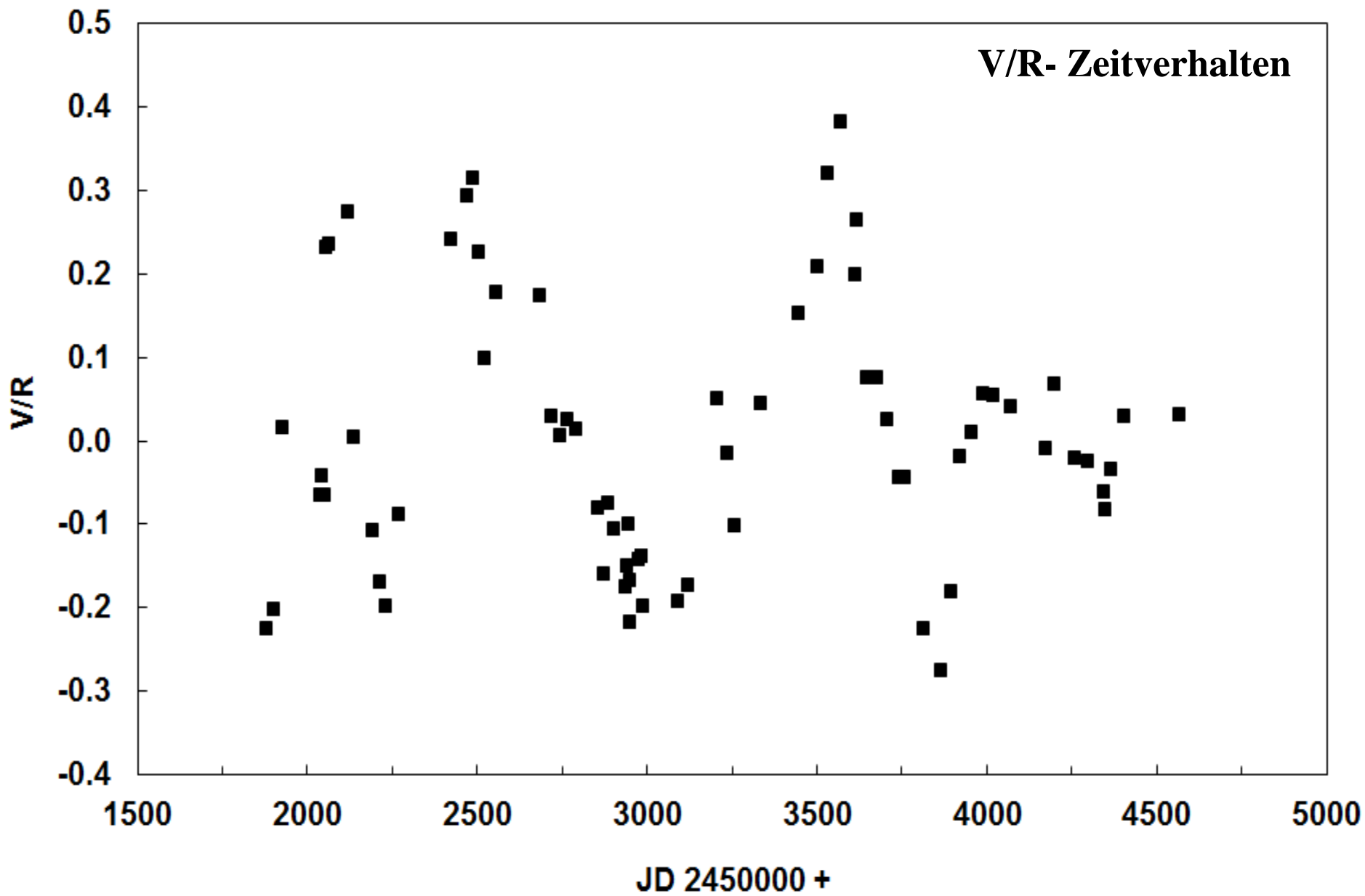
blauverschoben

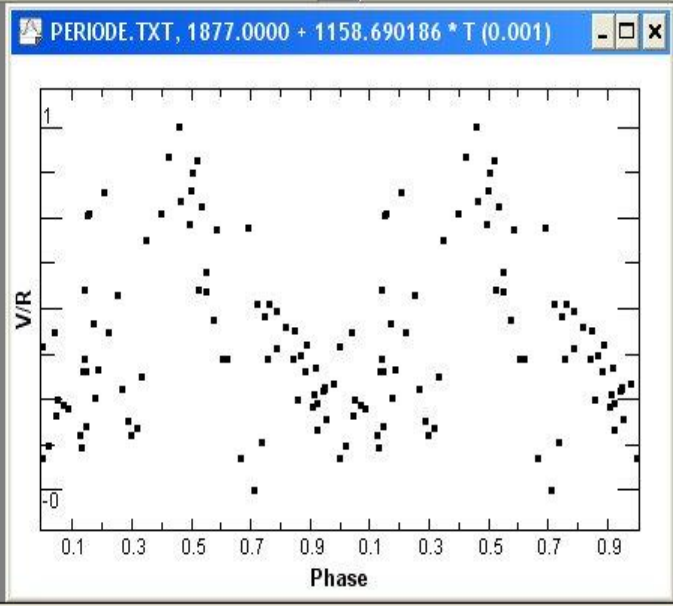
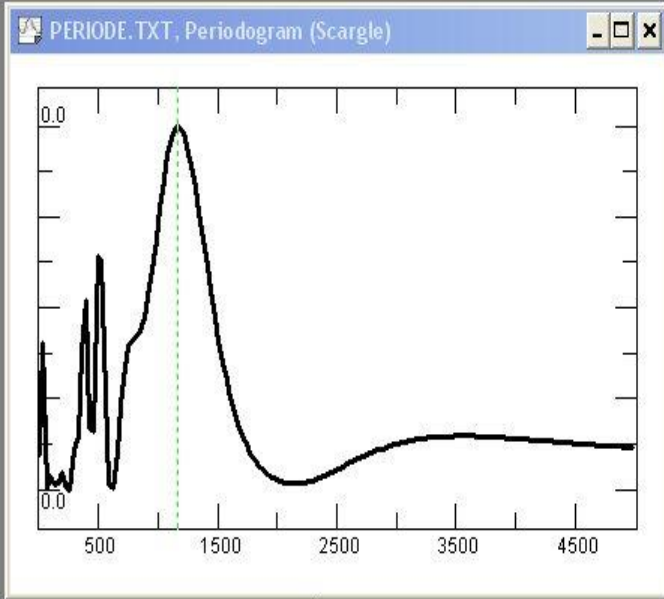
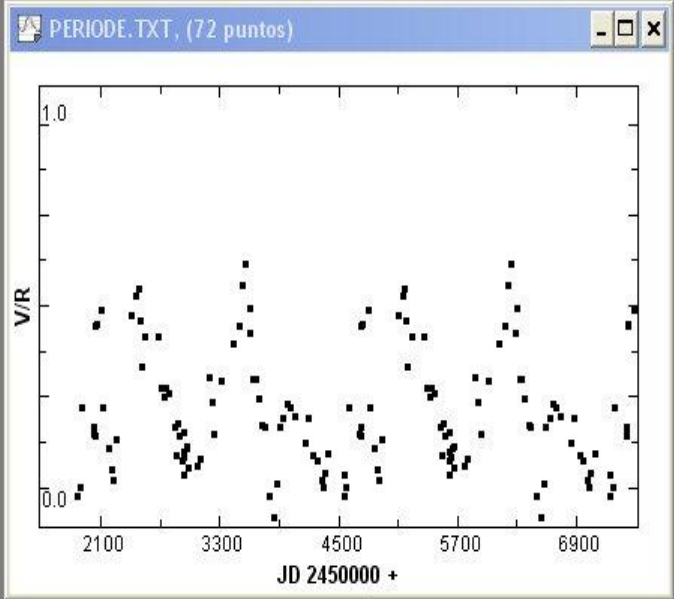
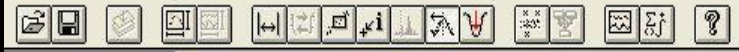
Rot verschoben



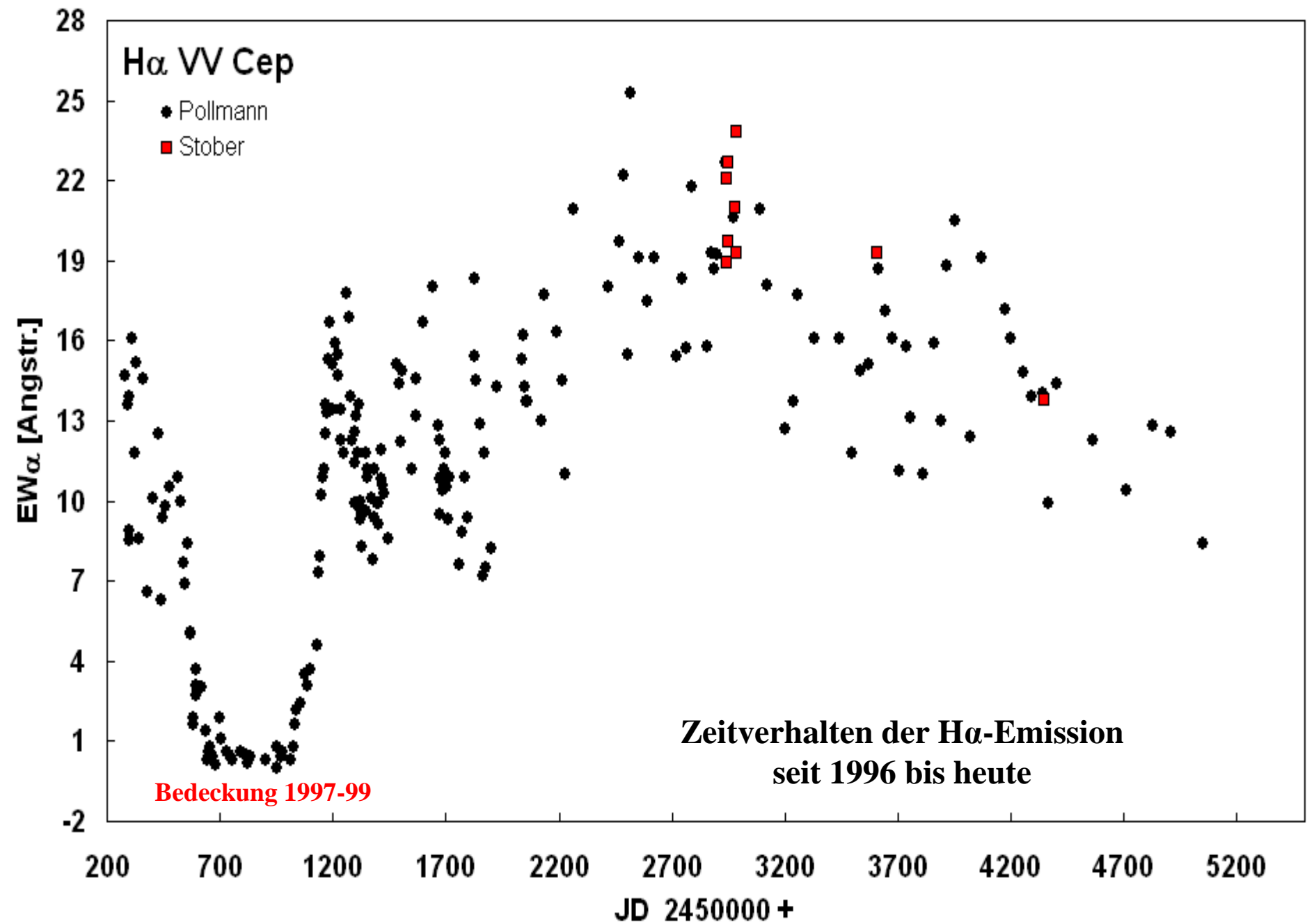
Beobachter





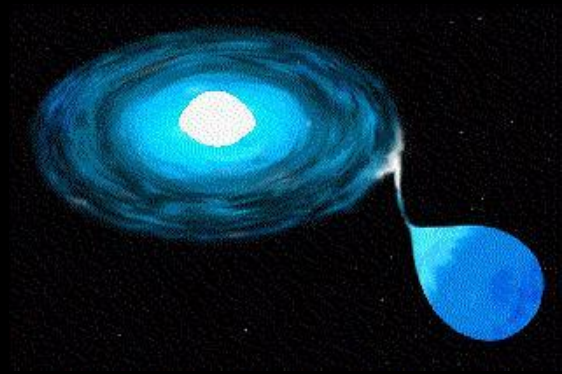


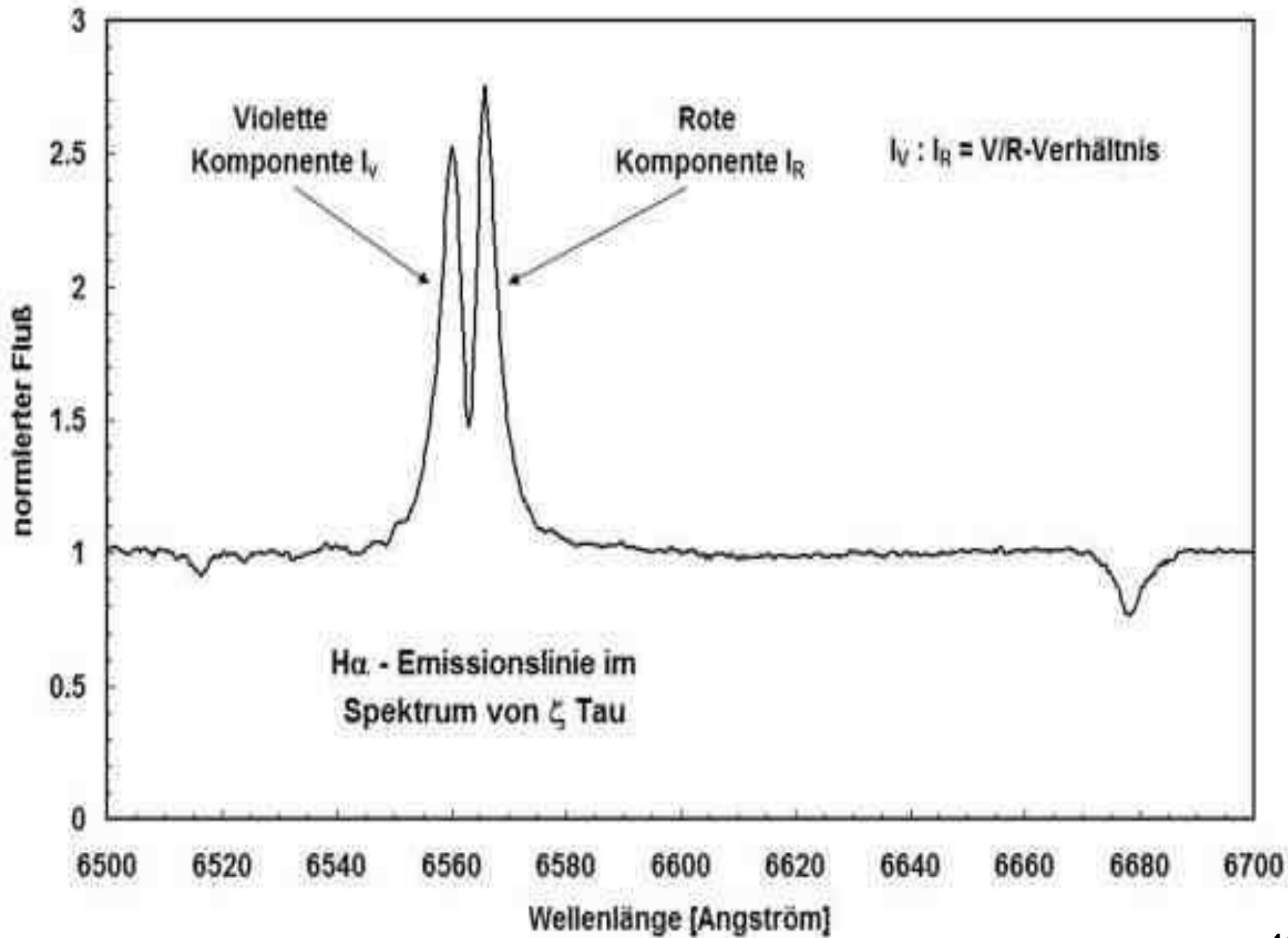
V/R-Periode
1100 Tage



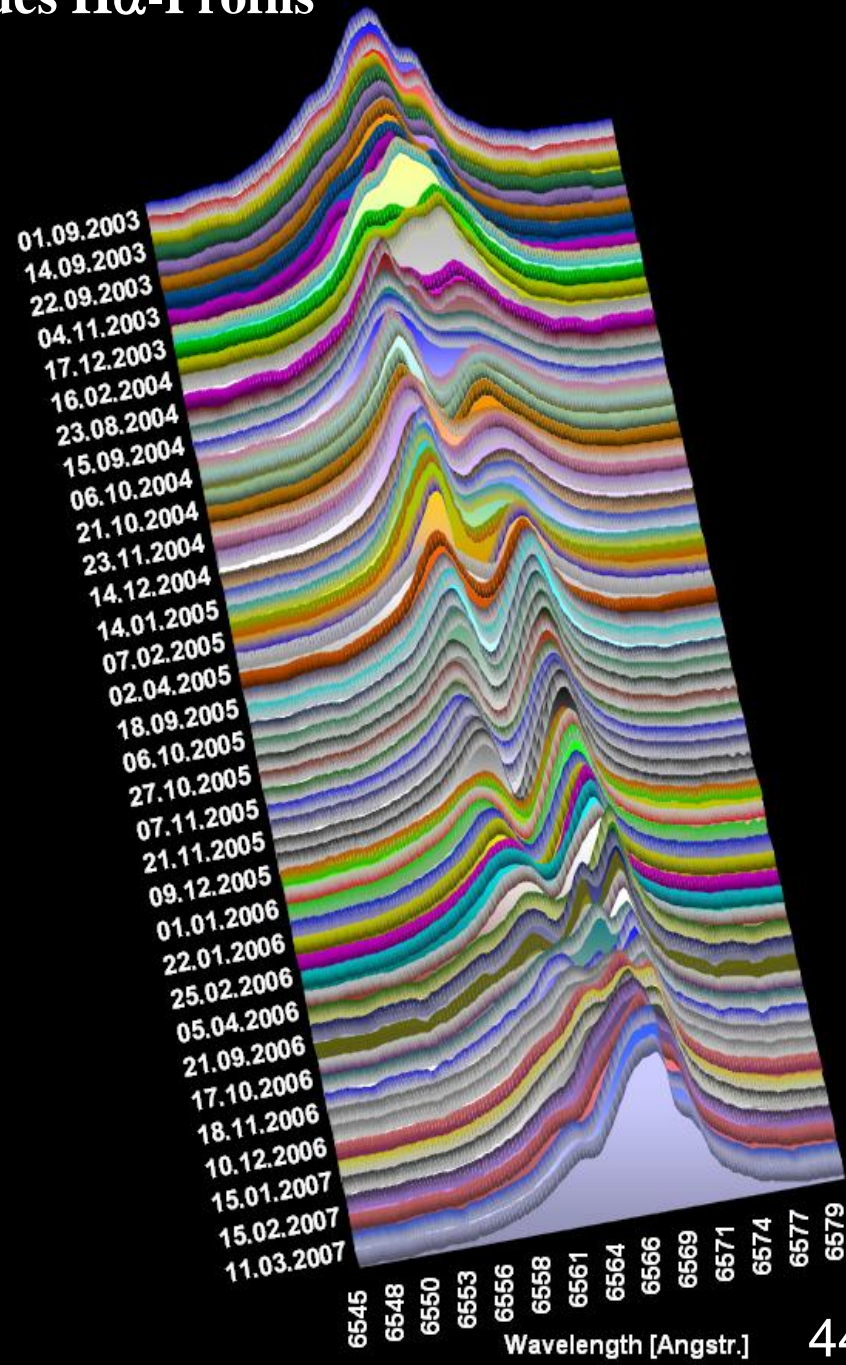
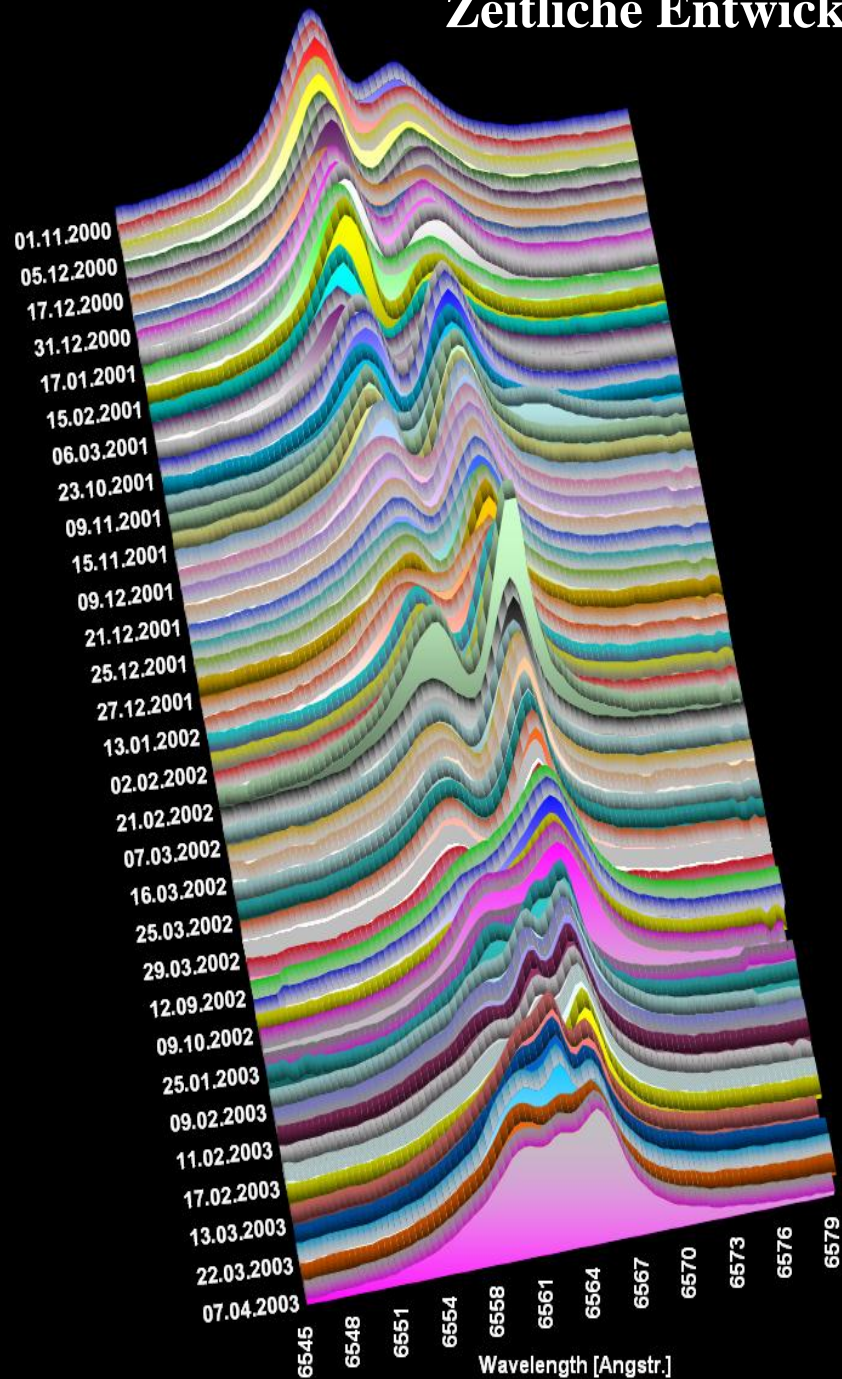
H α -Beobachtungen am Doppelsternsystem

ζ Tauri

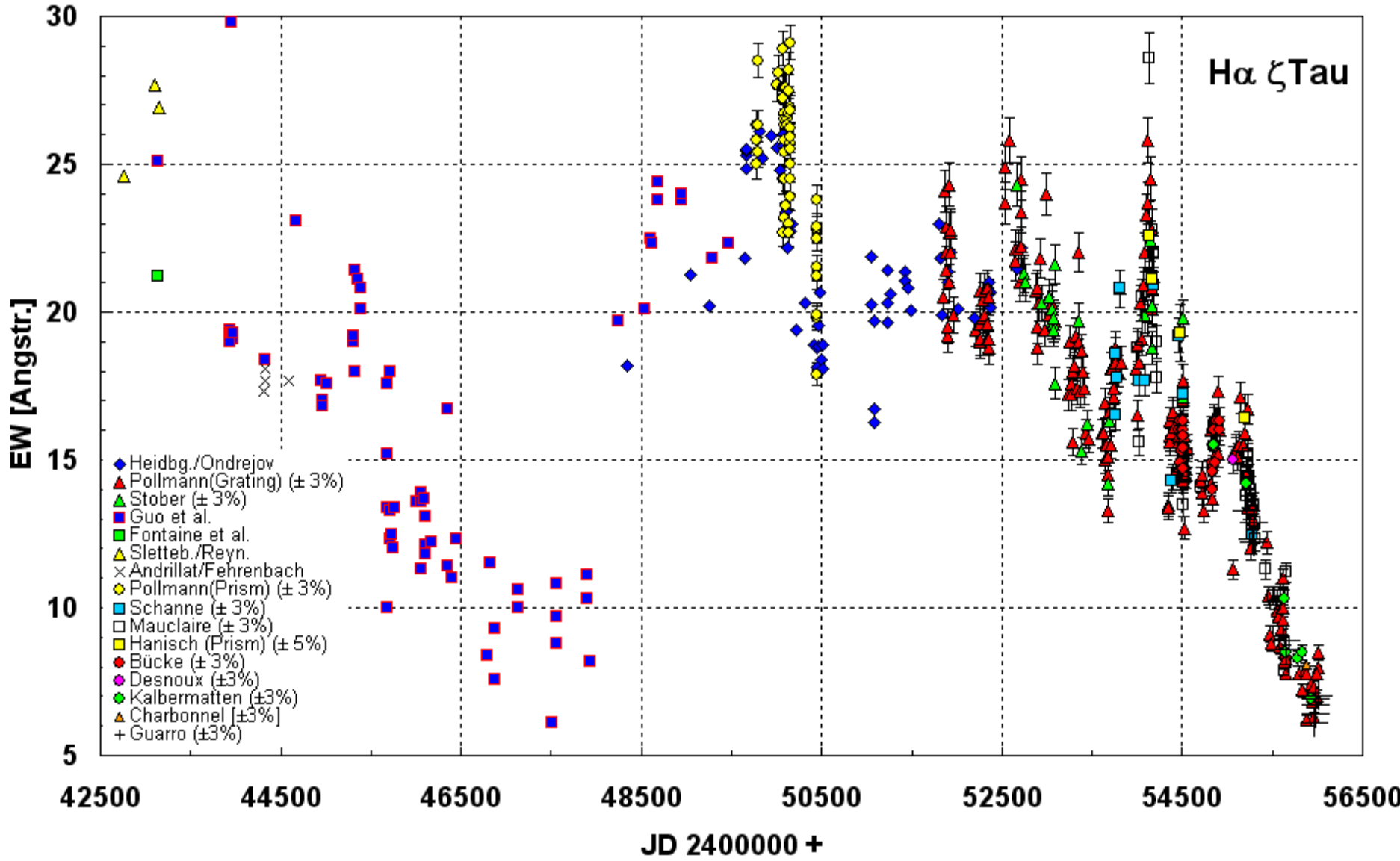


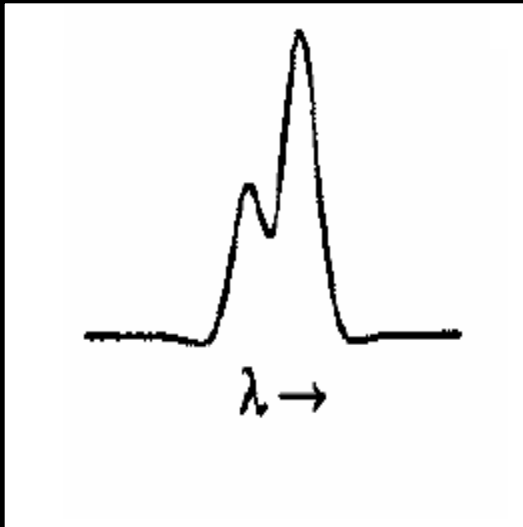
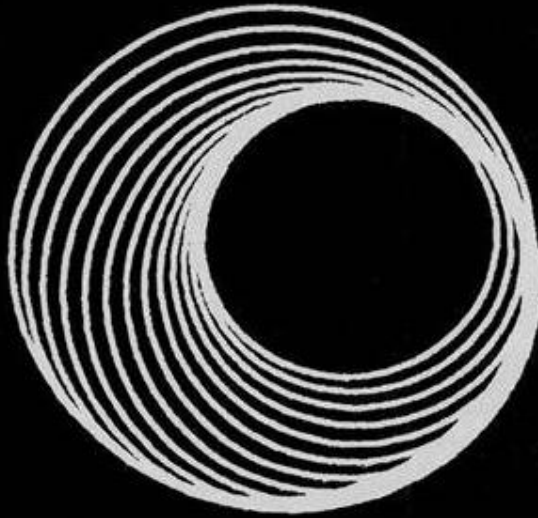


Zeitliche Entwicklung des H α -Profils



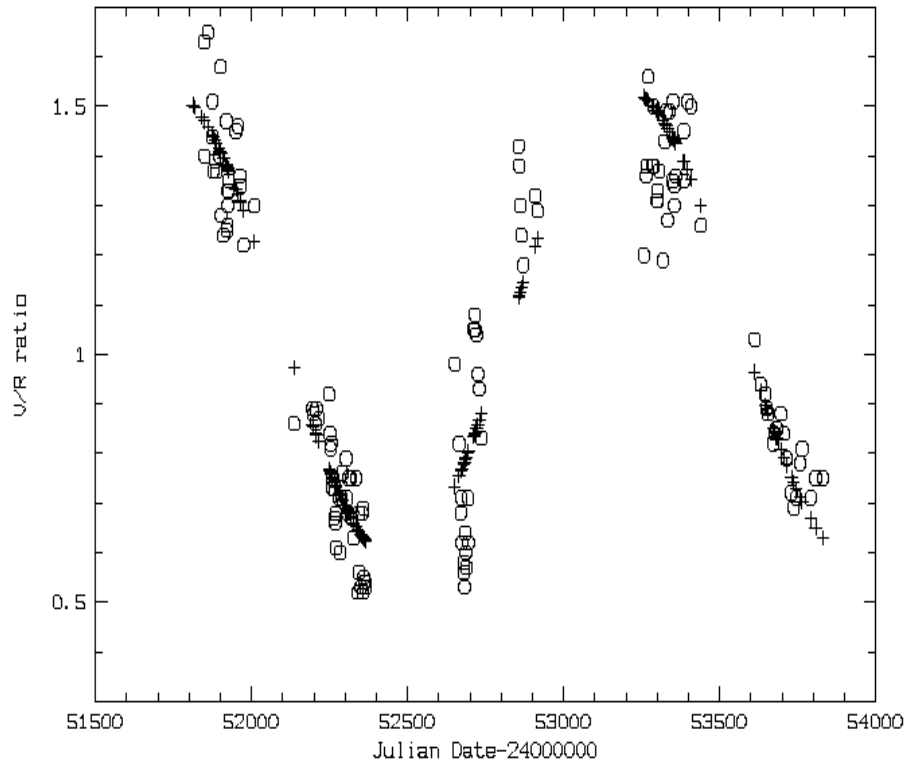
H α ζ Tau



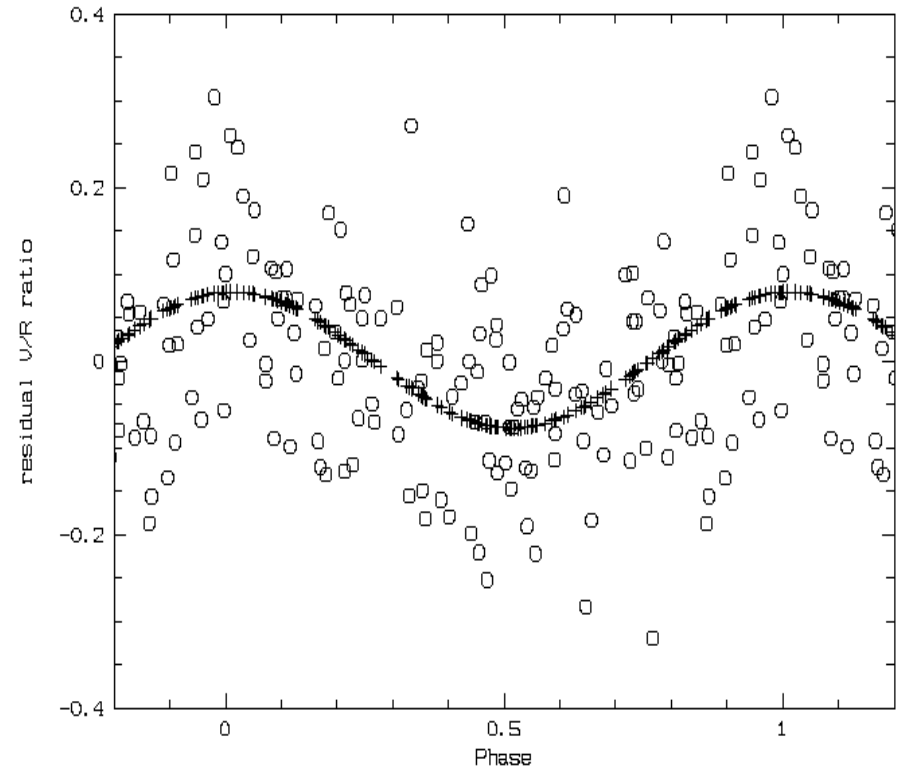


- **Development of a rotating one-armed density wave by disturbed orbits**
- **Due to a radial disturbance the gas particles of the disk are moving on excentric Kepler-orbits**
- **This leads to V/R-variations**
- **V/R of H α show the same period as the radial velocities**
- **Period duration = 1500 d**

H α V/R-ratio



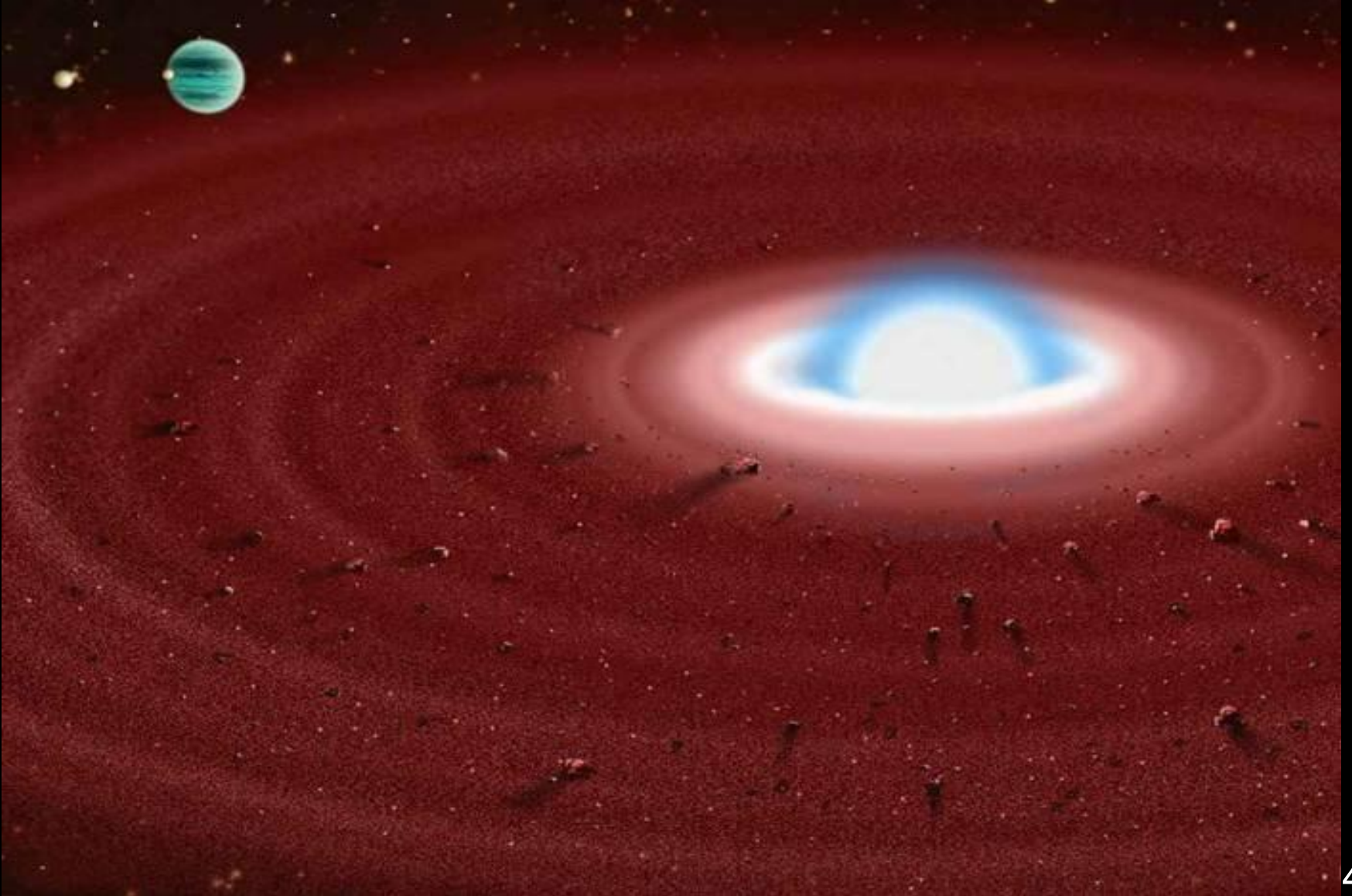
The measured values vs. Julian date (open symbols) and the sine wave with $P = 1471$ d (plus signs).

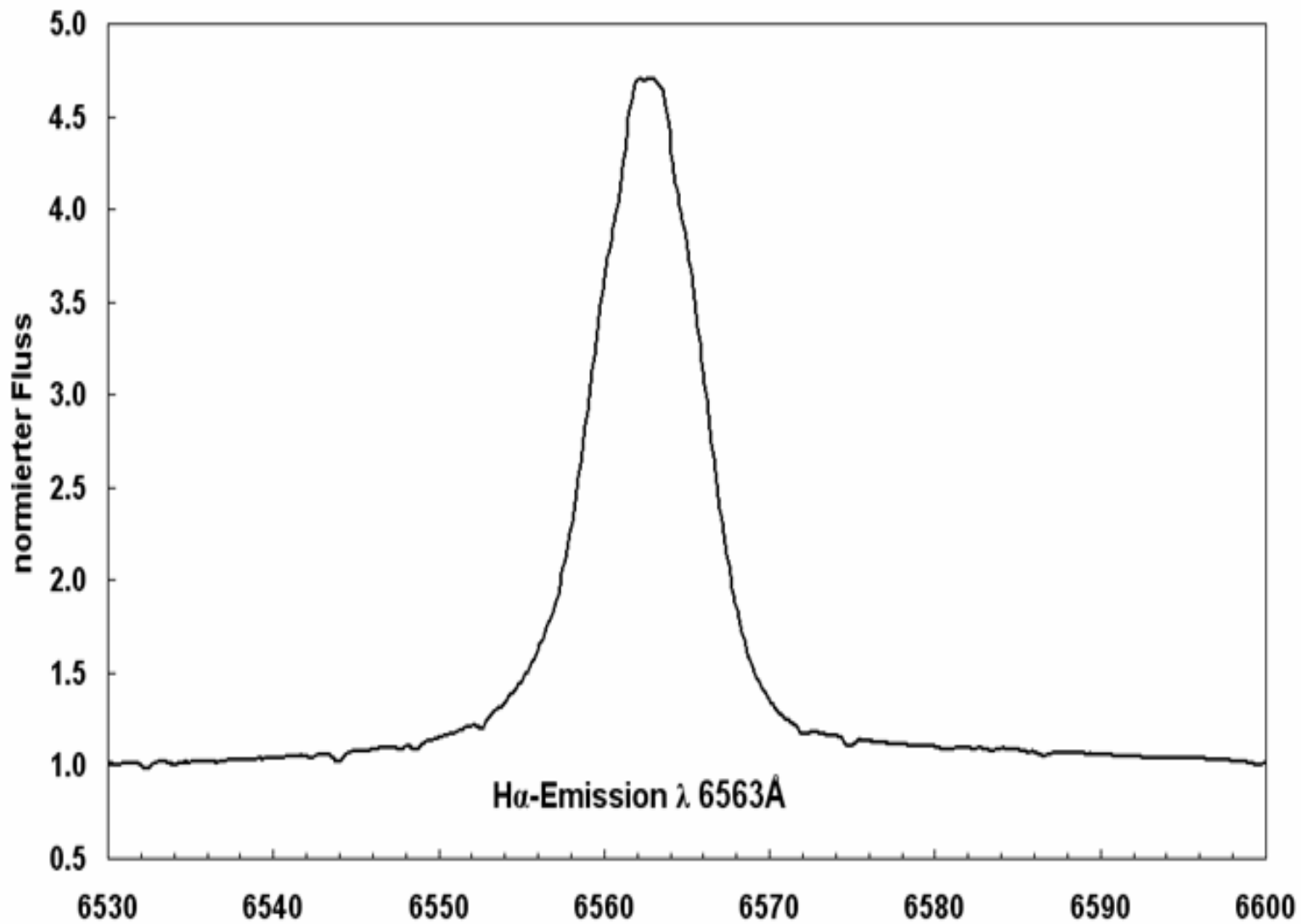


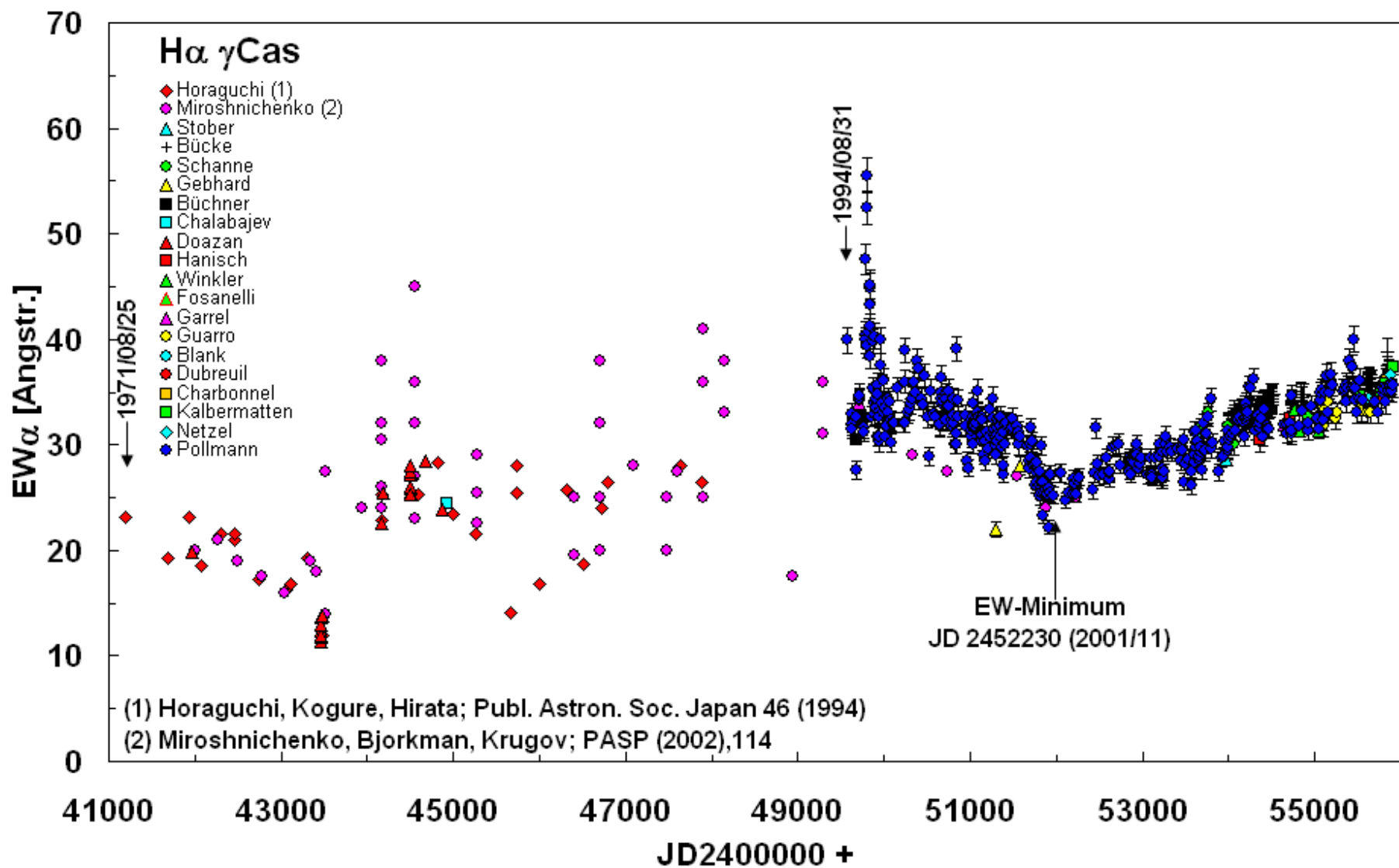
The residuals of the left panel, folded with $P = 69.3$ d and the respective sine fit. Shown are 1.4 cycles for clarification, i.e. 40% of the points are redundant.

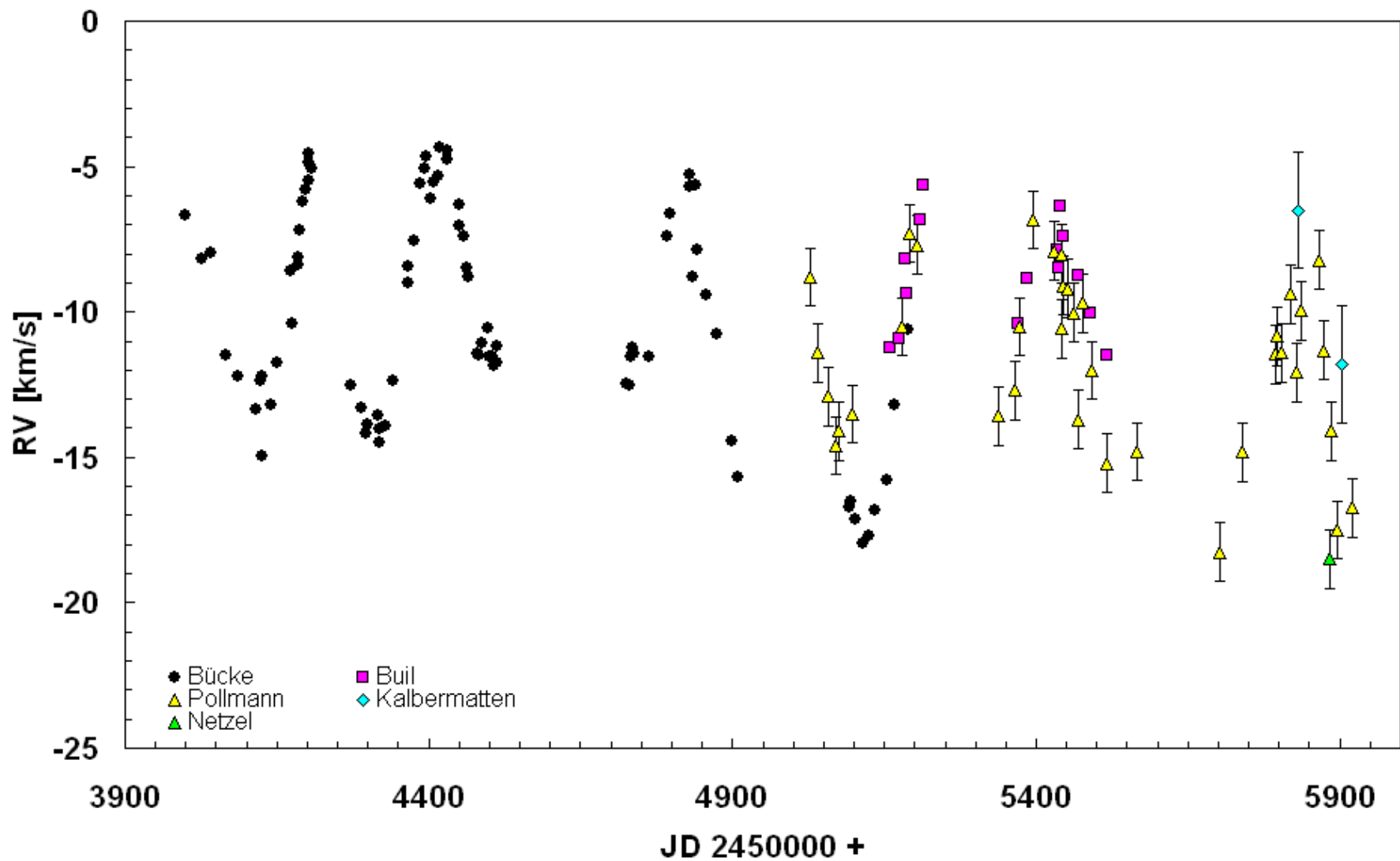
H α -Beobachtungen Be-Stern γ Cas

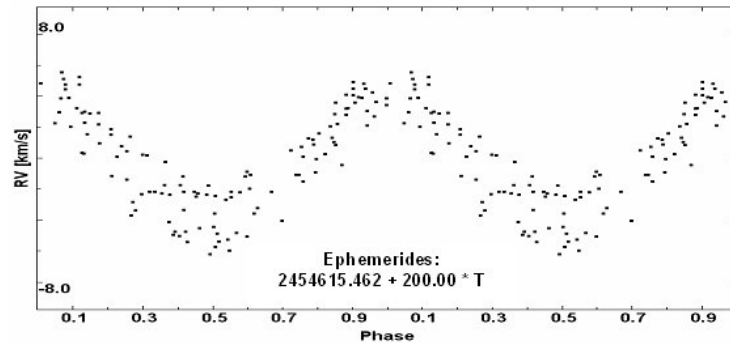
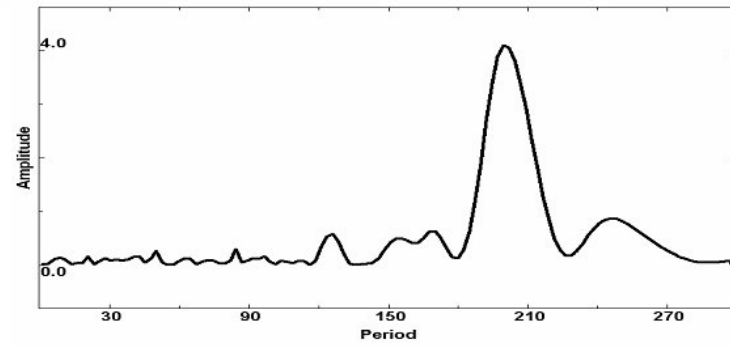
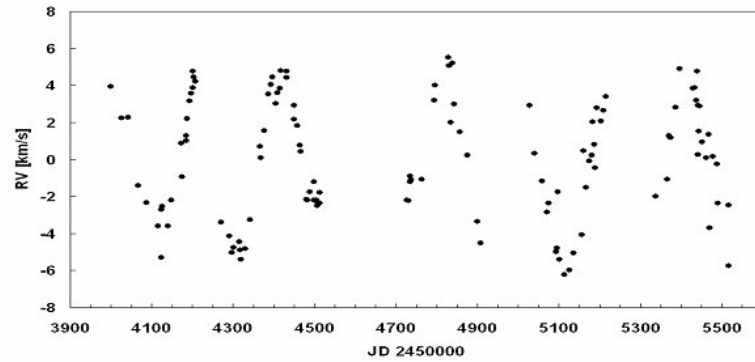
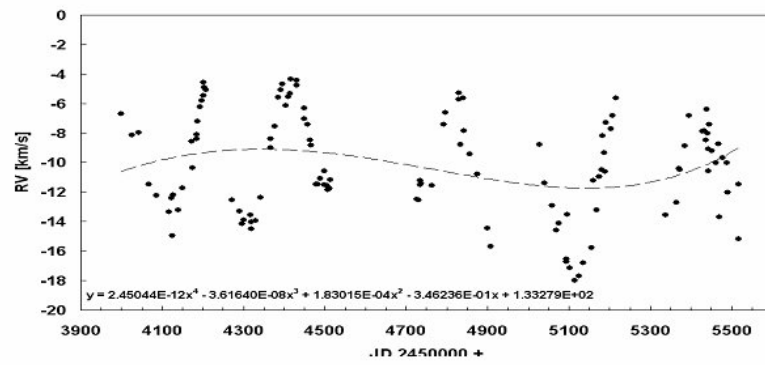
Das berühmte Doppelsternsystem γ Cas



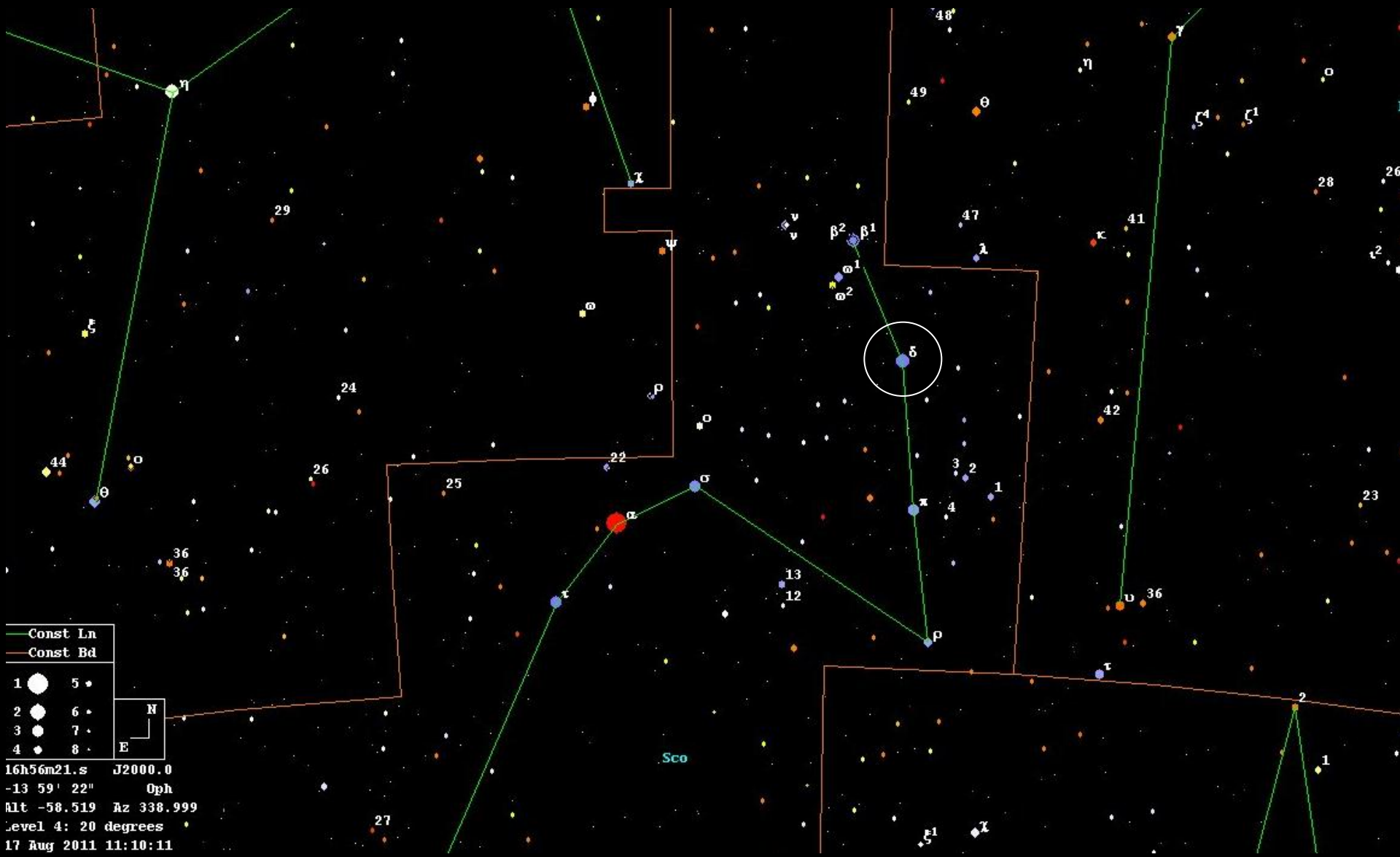








**Die Periastron-Passage
des Doppelsternsystems
 δ Scorpii
Juli-August 2011**



— Const Ln	
— Const Bd	
1 ●	5 ●
2 ●	6 ●
3 ●	7 ●
4 ●	8 ●

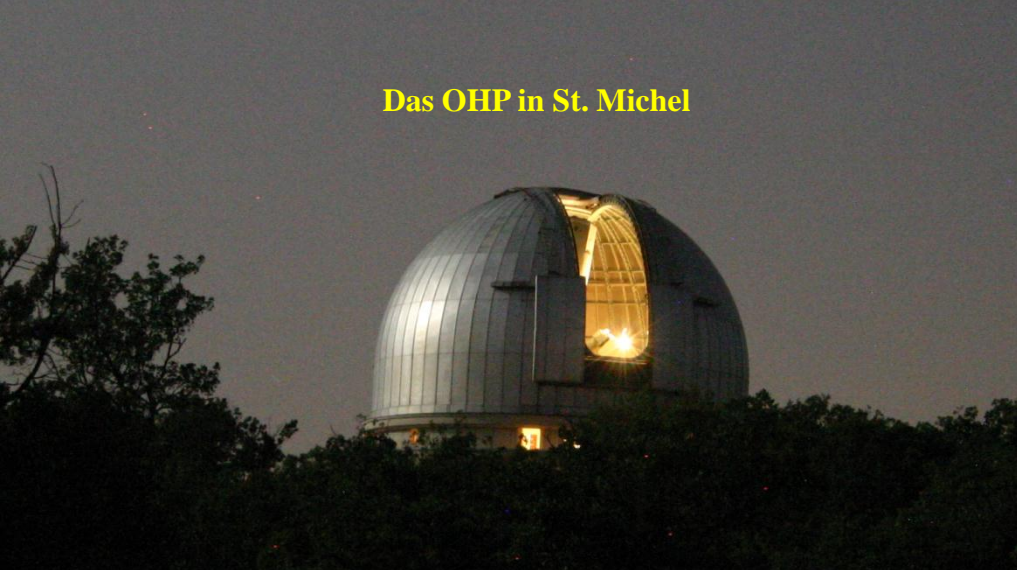
16h56m21.s J2000.0
 -13 59' 22" Oph
 Alt -58.519 Az 338.999
 Level 4: 20 degrees
 17 Aug 2011 11:10:11

Sco

Periastronpassage =
Annäherung des Begleitsterns auf seiner elliptischen Bahn
um den Hauptstern bis zu dem Punkt,
an dem er dem Hauptstern am nächsten kommt.

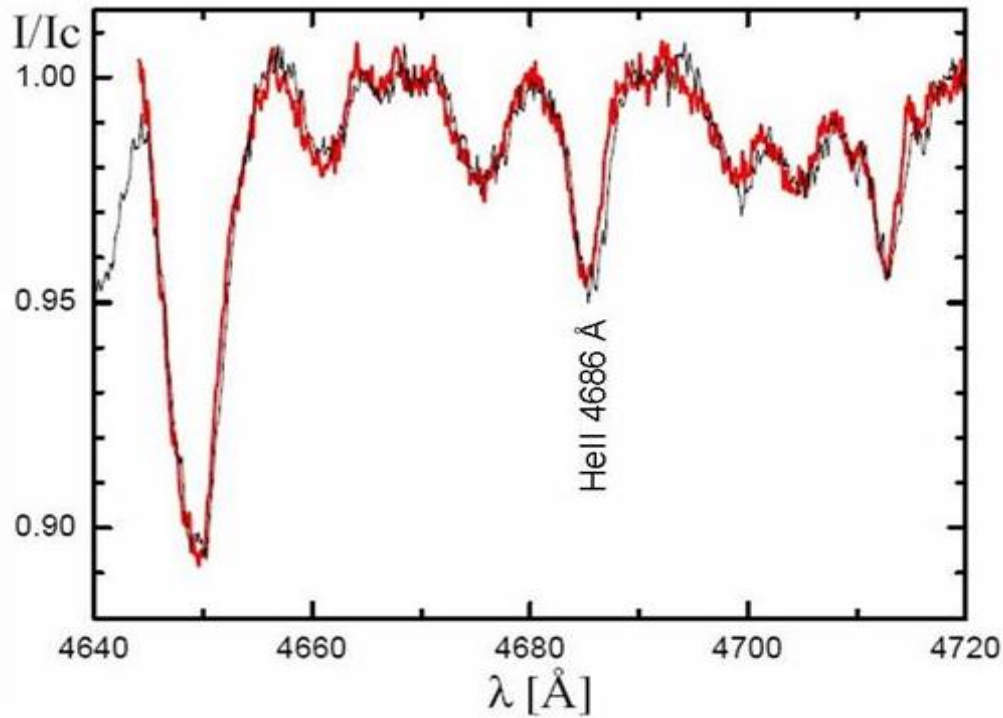


Das OHP in St. Michel

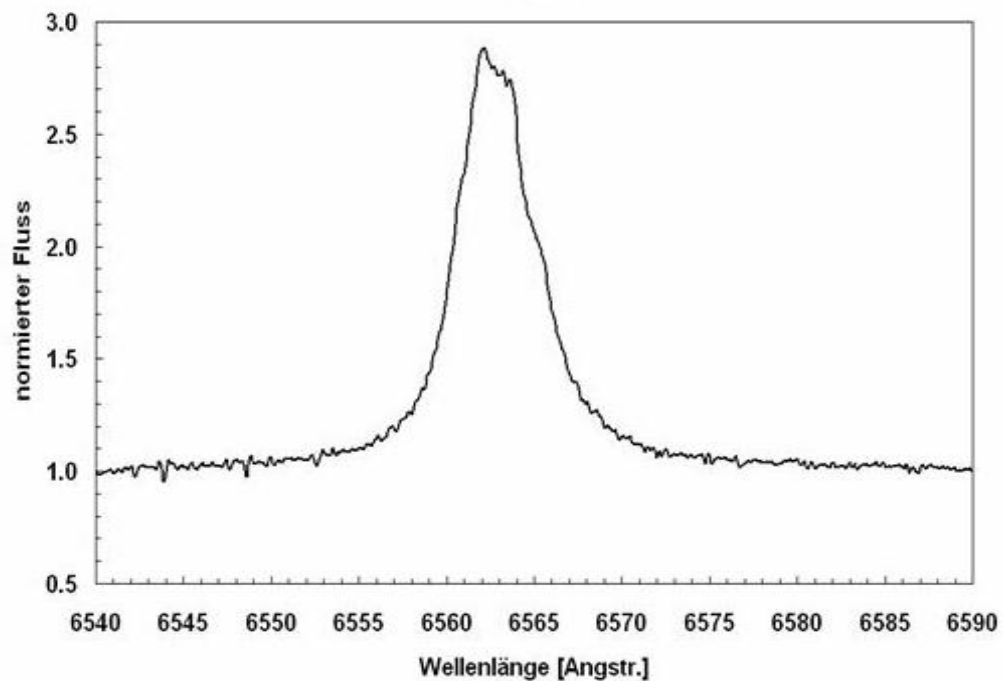


Spektroskopie Workshop





*Spektralbereich
He II 4686 \AA*



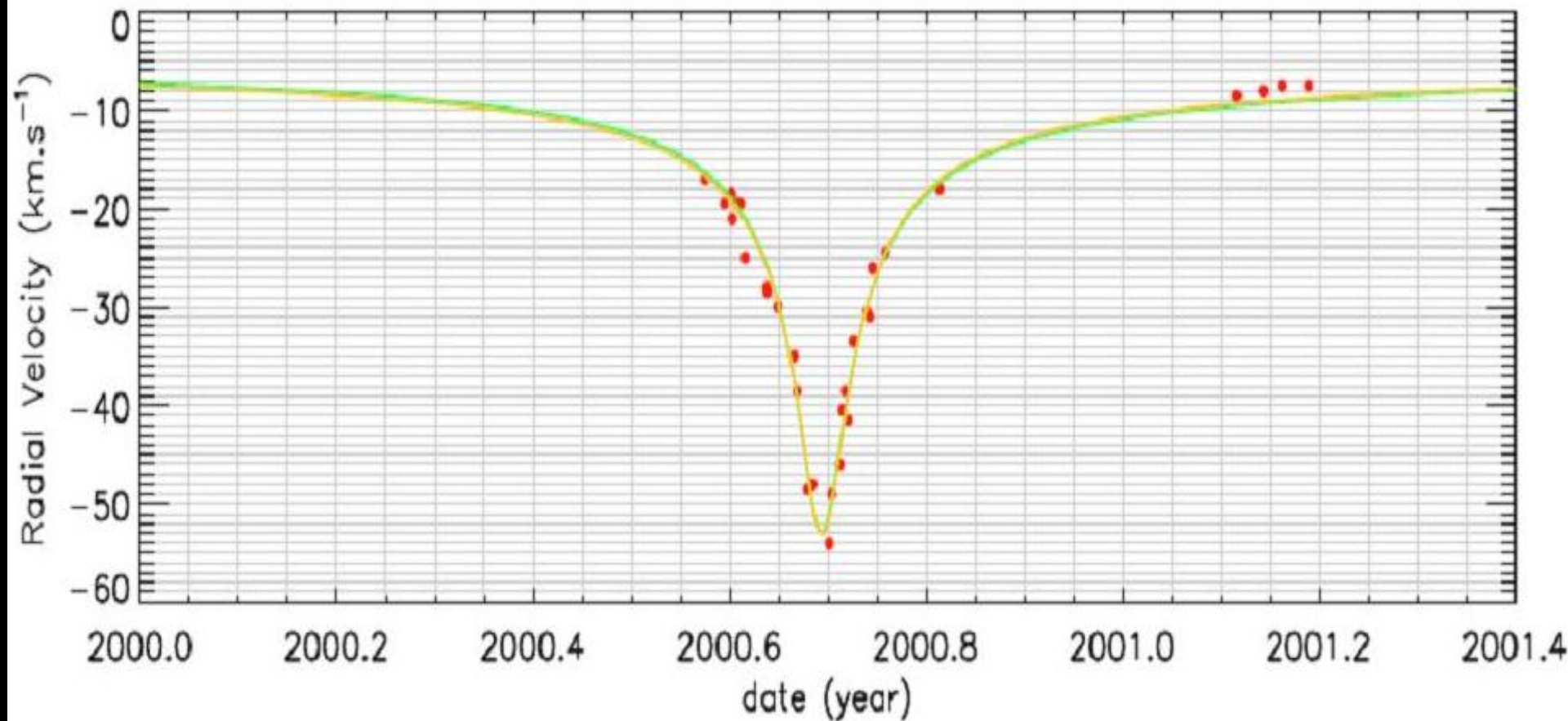
H α -Emission 6563 \AA



**Der Spektrograph
LHIRES III**

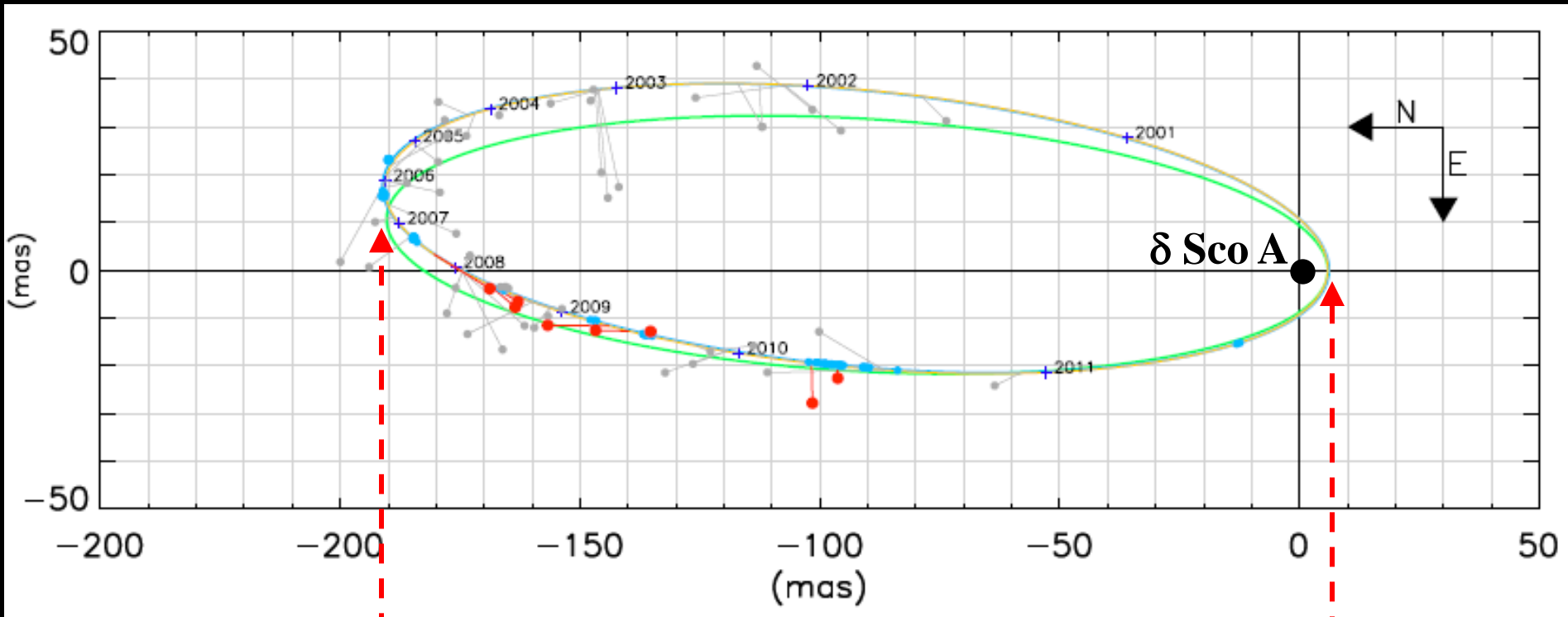
**am C14 in der
Arbeitssternwarte
der VdS-Köln**

Beispiel von Messungen der H α -Radialgeschwindigkeit



Orbit von δ Sco

Winkeltrennung der beiden Komponenten δ Sco A - B

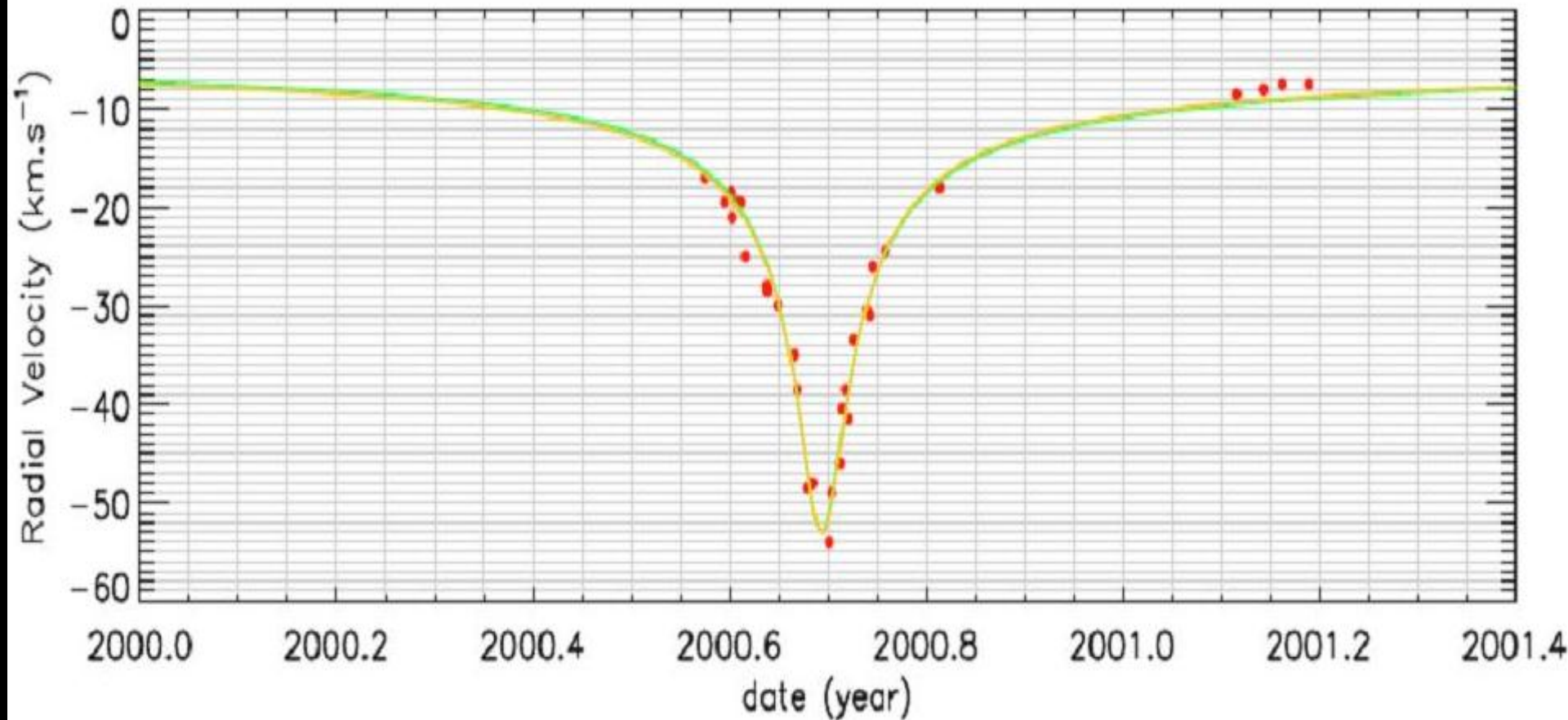


Apastron
200 mas

Periastron
6 mas

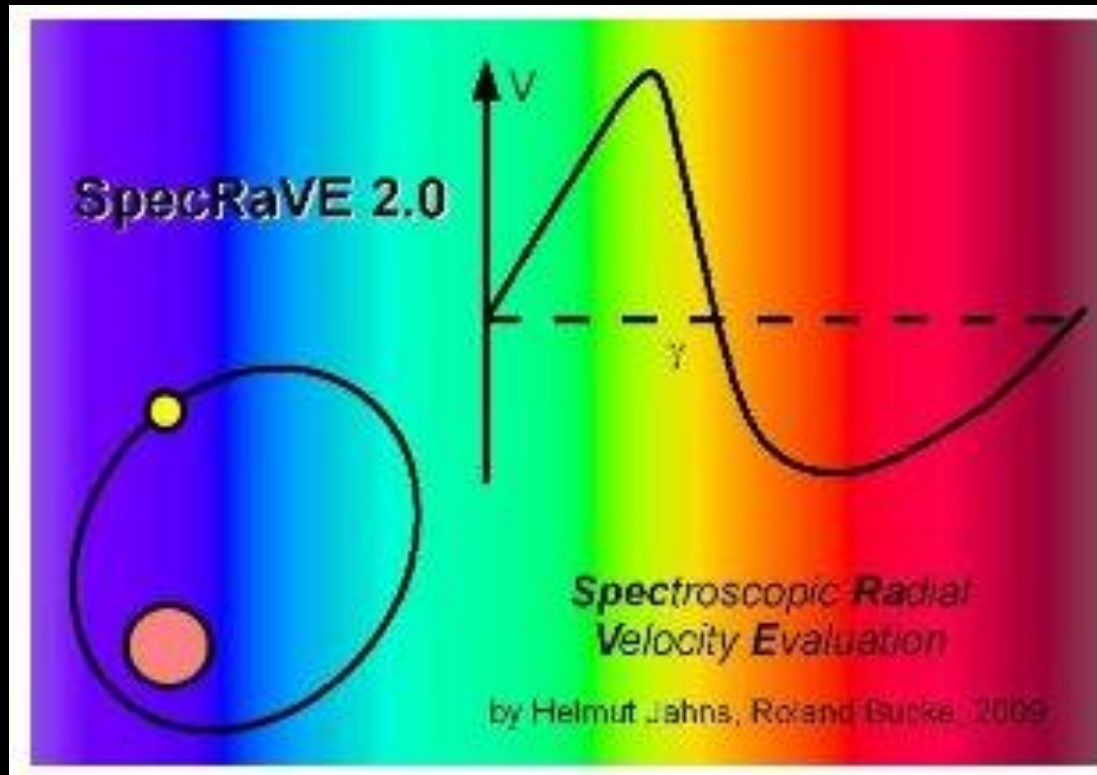
Messungen der H α -Radialgeschwindigkeit der Periastronpassage August/September 2000

Rote Punkte = A. Mirshnichenko (University Greensboro, USA); grüne und orange Linie repräsentieren Berechnungen von Tango et al. (2009) und das "best-fit model" von Mailland et al. (A&A, June 2011)

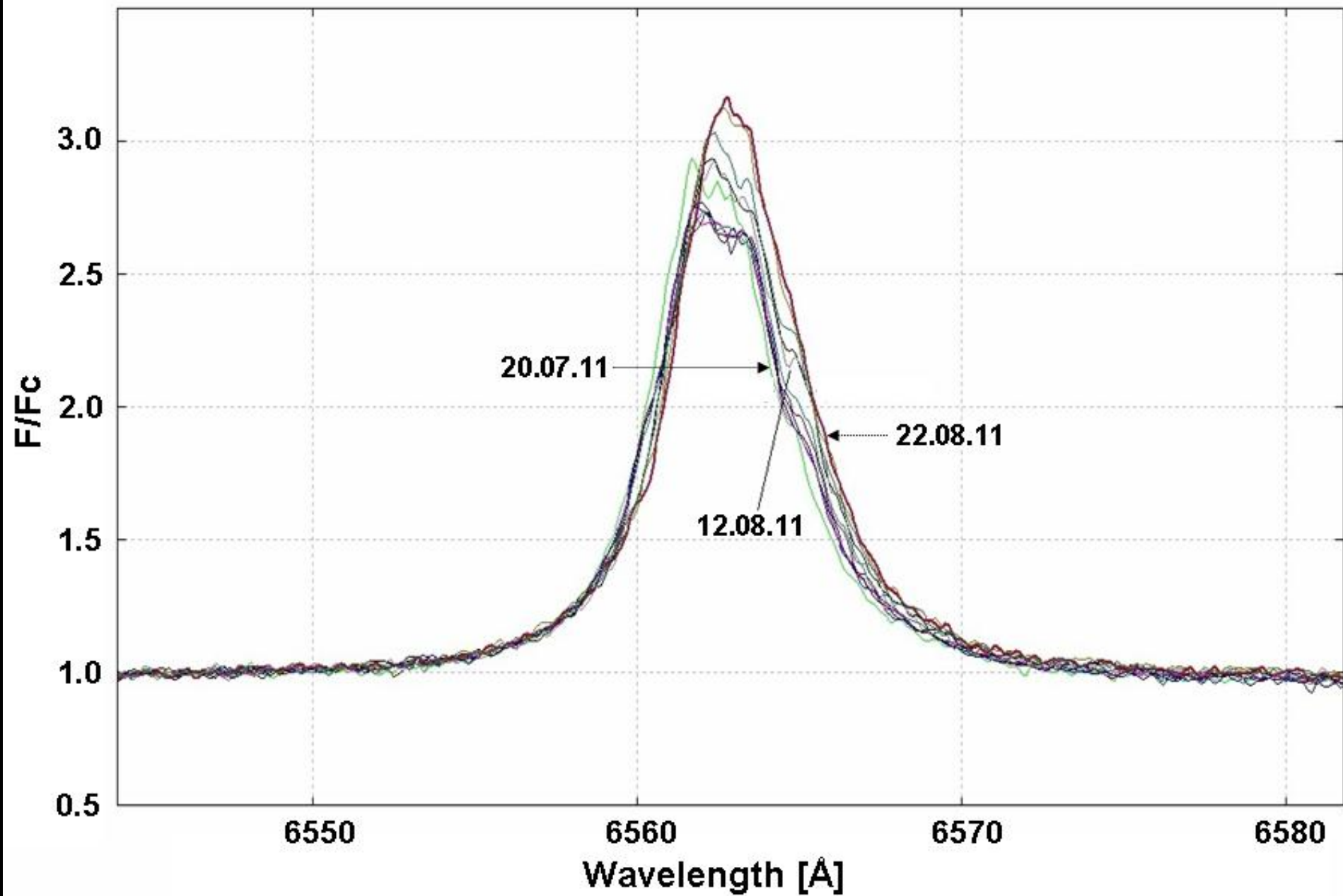




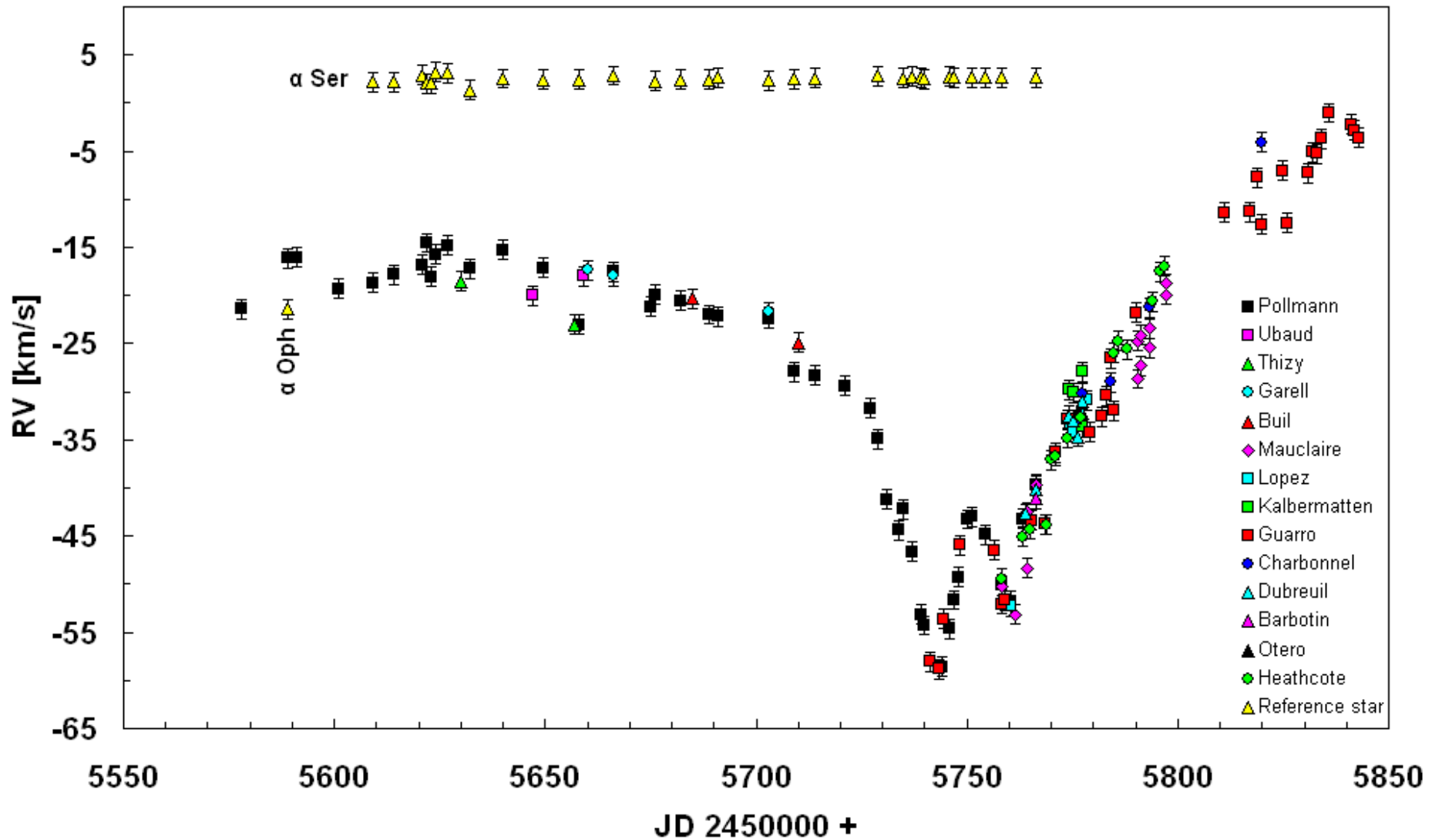
Das Programm SpecRave zur Messung von Radialgeschwindigkeiten



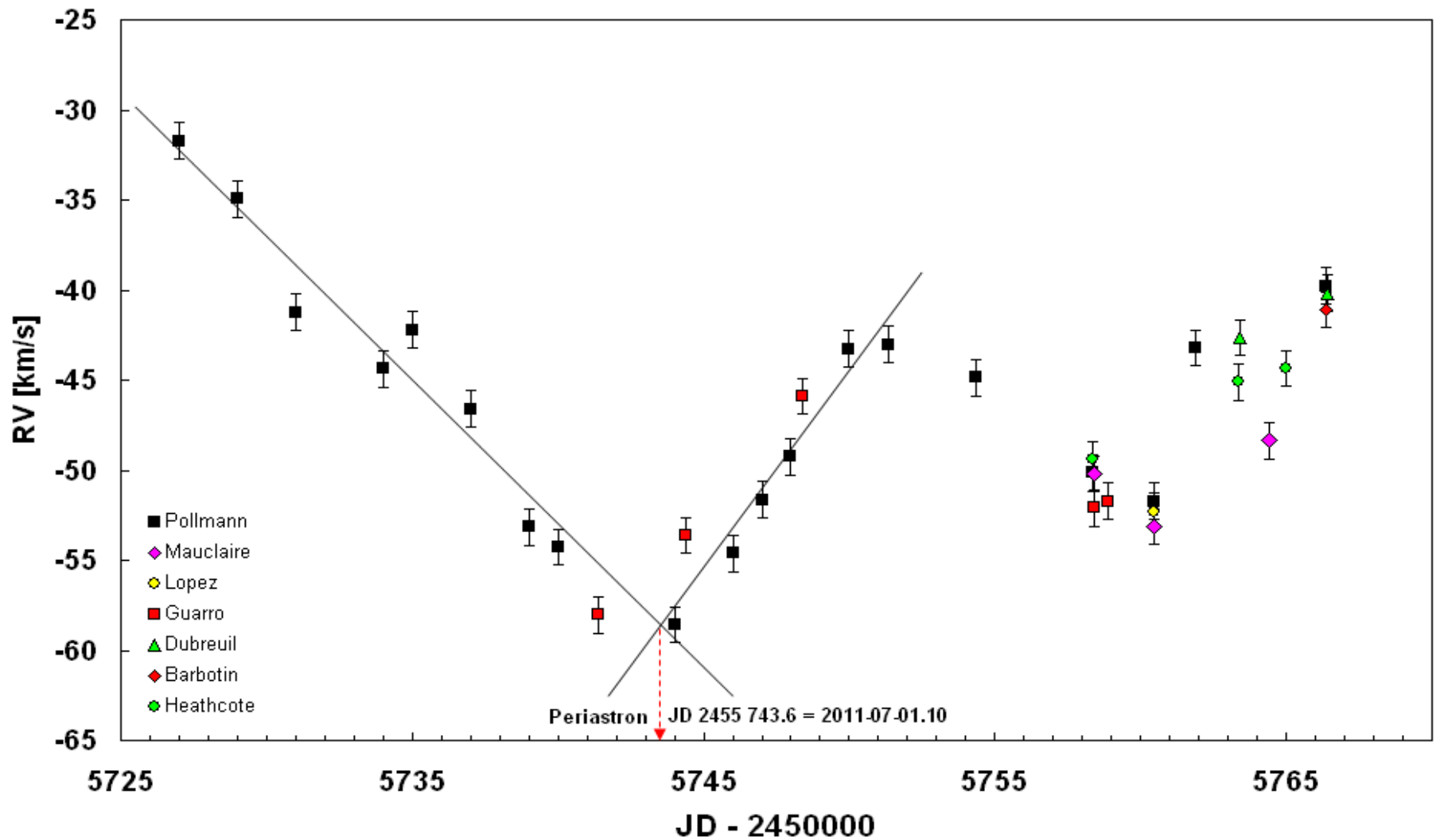
Das H α -Linienprofil im Spektrum von δ Sco



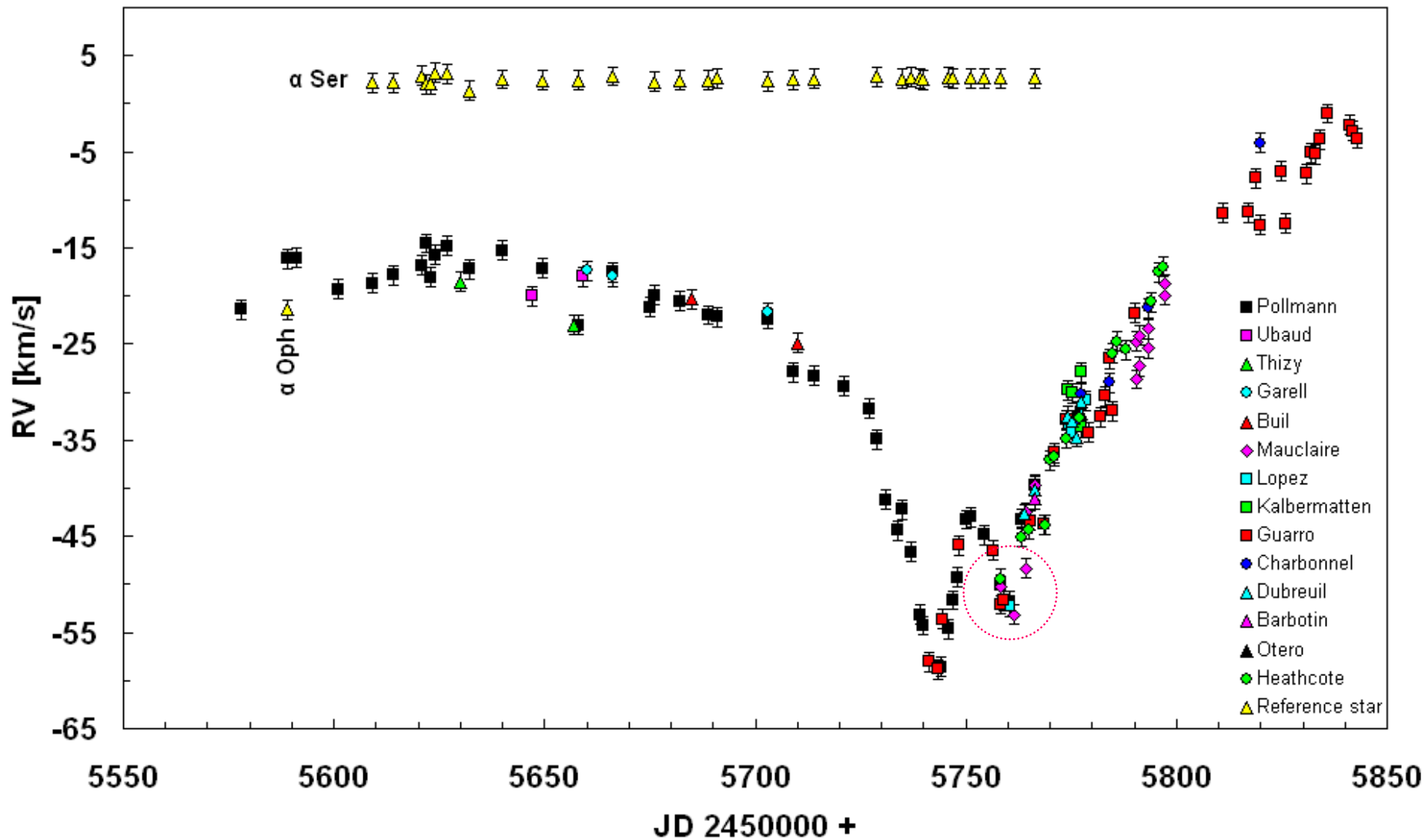
Verlauf der H α -Radialgeschwindigkeit Amateurmessungen seit Januar – November 2011

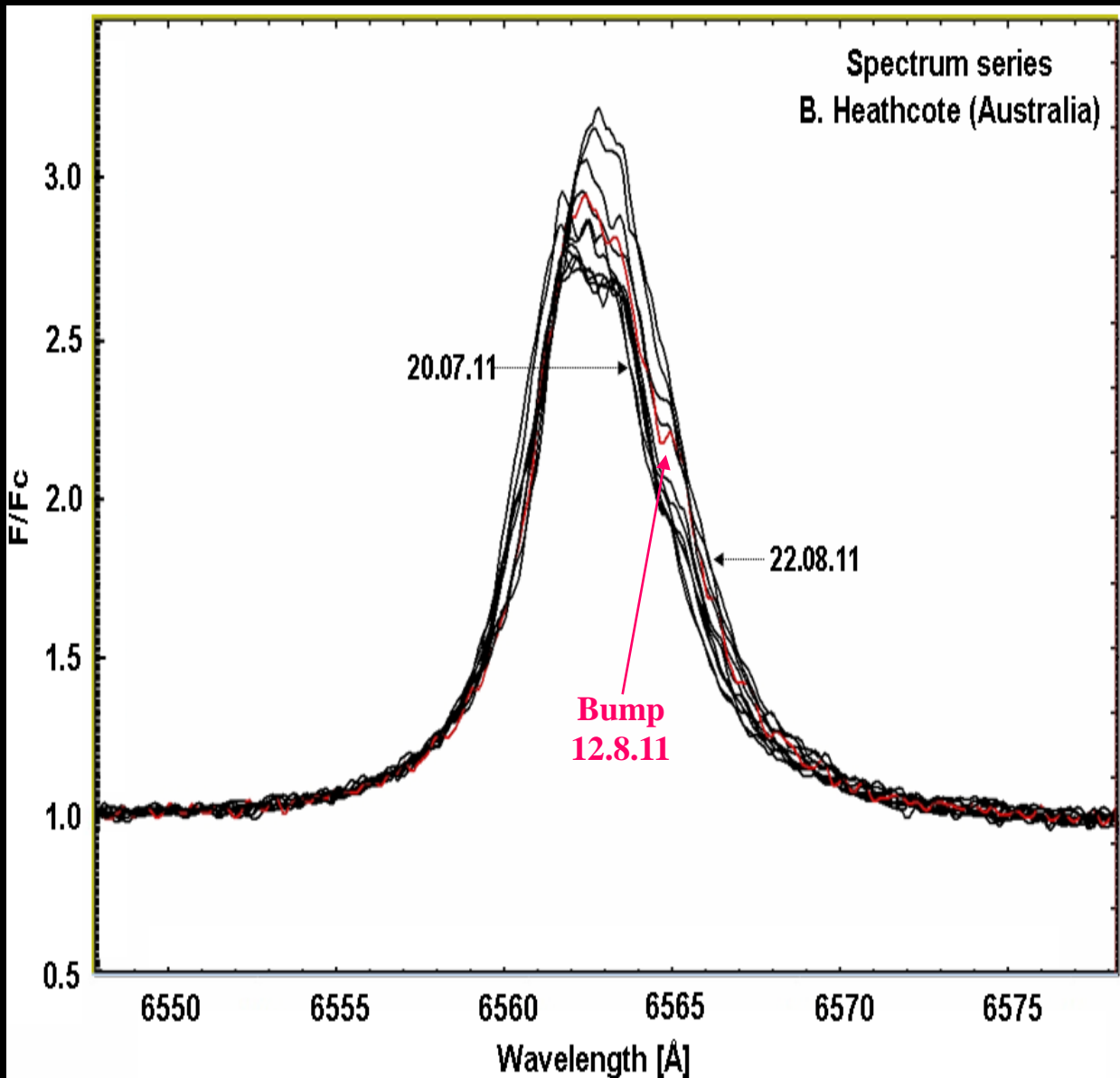


Bestimmung des Periastronzeitpunktes

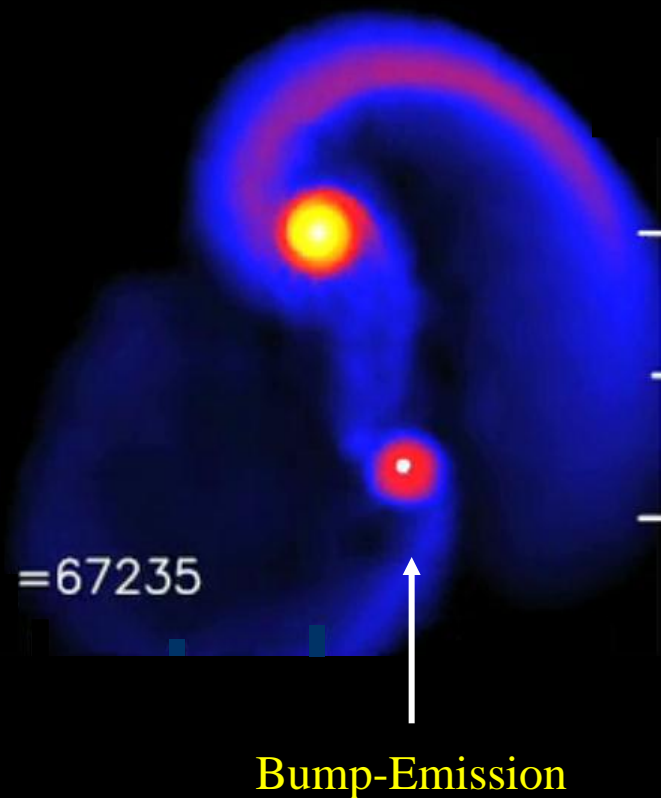


Verlauf der H α -Radialgeschwindigkeit Amateurmessungen seit Januar – Oktober 2011





Okazaki's Modell 20-30 Tage nach Periastron



thanks for
attention

