

YILDIZ AKTİVİTESİ



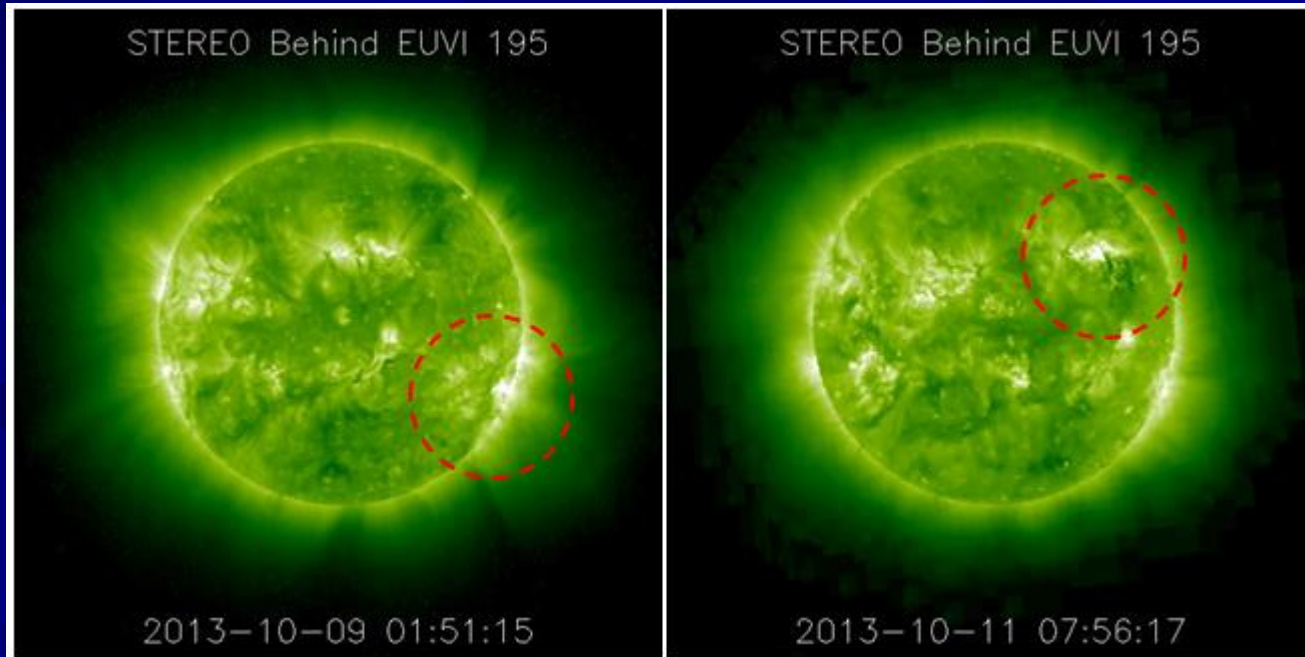
Serdar Evren

İÇERİK

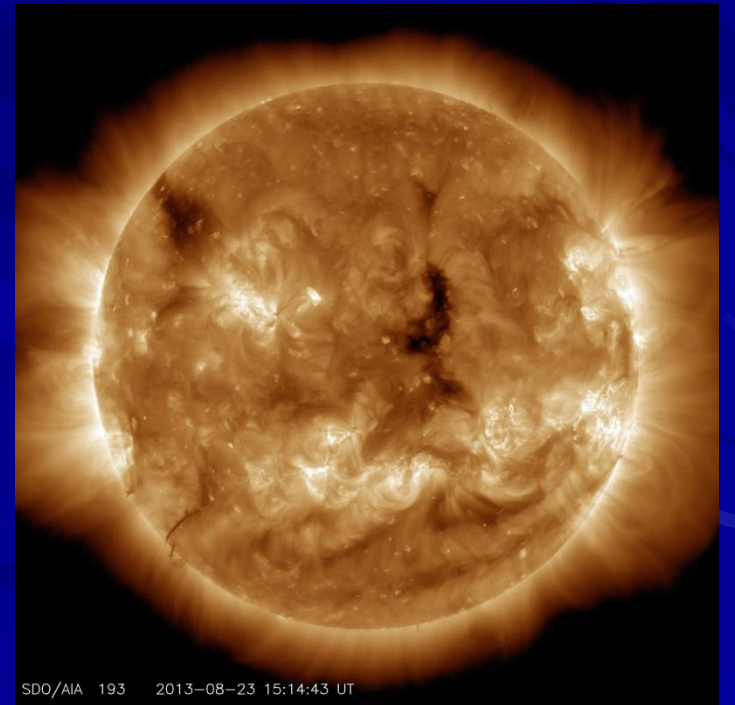
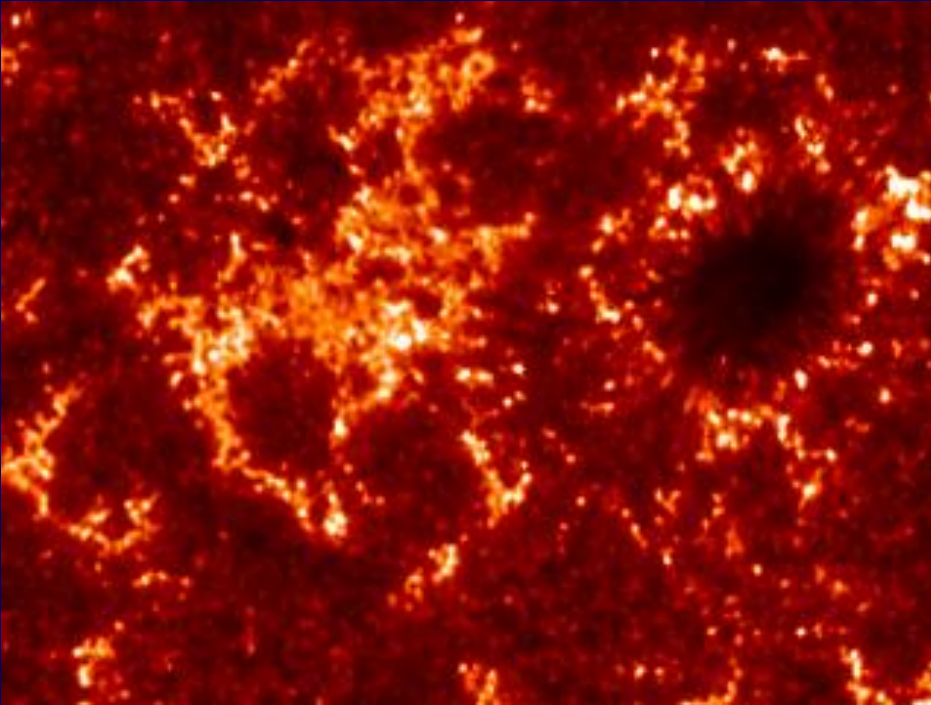
- Yıldız Aktivitesi
- Aktiviteye ilişkin gözlem türleri
- H-R diagramında aktivite
- Dış atmosferi görüntüleme
- RS CVn-türü aktif çift yıldızların bulunuşu
- Aktivite düzeyini belirleyen parametreler
- Aktivite çevrimleri
- Yıldızlarda diferansiyel dönme
- Leke ve faküla
- Aktif boylamlar ve flip-flop

YILDIZ AKTİVİTESİ

- Parlaklık deęiřimi
(Dönemli veya çevrimli → Lekeler
Düzensiz → Flareler)
- Parlak aktif bölgeler



- Isınmış kromosferler (Call H&K salma)
- Yüksek ısılı koronalar (X-ışın)
- Yıldız rüzgarları



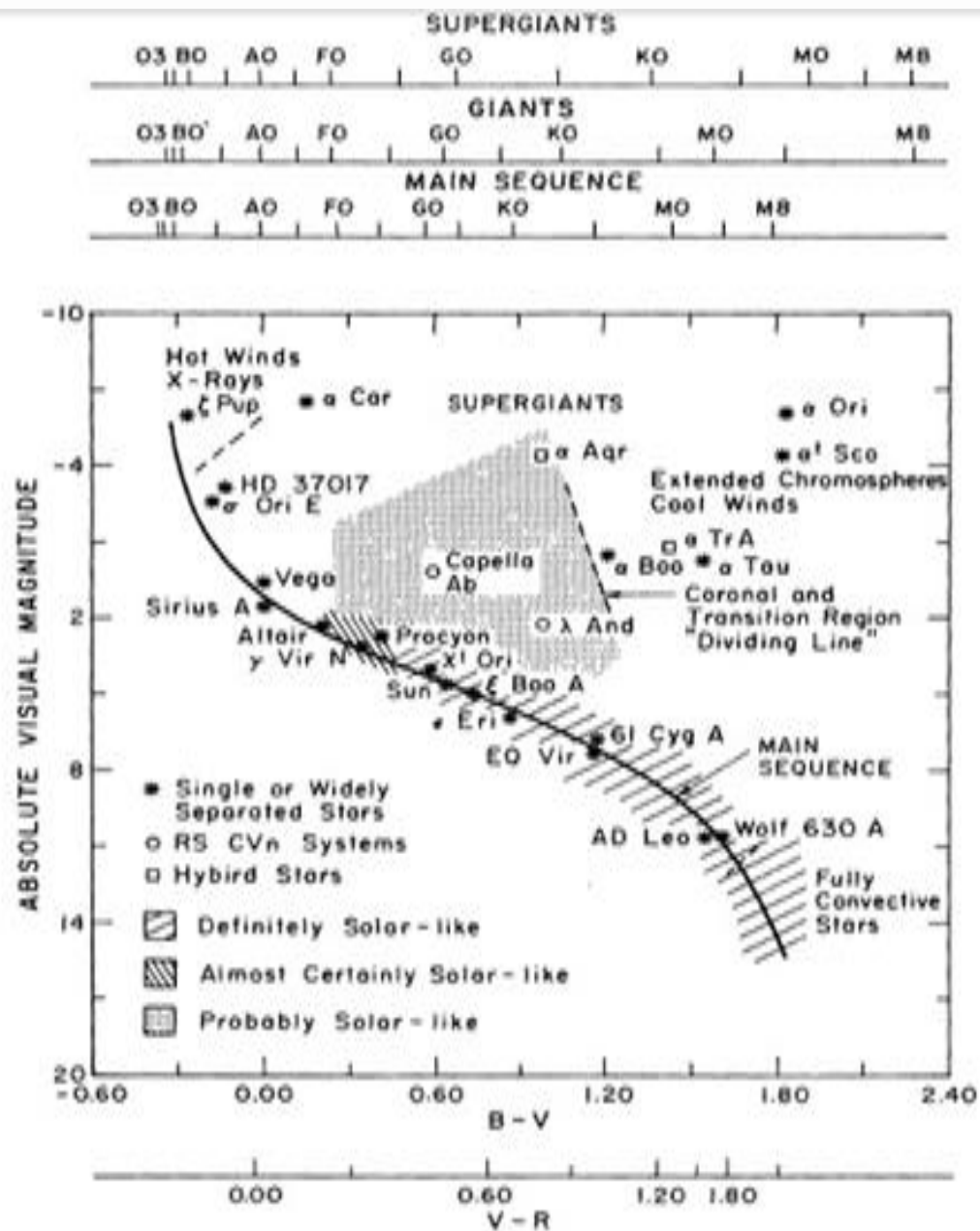


Fig. 1. An H-R diagram showing schematically which types of stars are definitely or probably solar-like on the basis of direct or indirect indicators of strong, turbulent magnetic fields. Also indicated are the regions of the H-R diagram where massive winds occur and hot plasma is apparently absent. Important stars mentioned in the text are identified in the diagram.

Types of Stellar Activity

- Solar type stars
- Young stars/Active stars
- M dwarfs
- T Tauri stars
- The Sun is not representative
 - Different spot locations and sizes
 - Different migration patterns
 - Filling factors
 - Cycles or no cycles
 - Different dependences on rotation rates

Stellar Surface Structures

- Surface features associated with activity
 - Chromospheres
 - Spots
 - Plage
 - Coronal holes
 - Flares
- Types of stellar activity
 - Solar-type stars
 - M dwarfs
 - Active stars
- Star spots
- Doppler imaging
- Spots on A stars
- Stellar oscillations

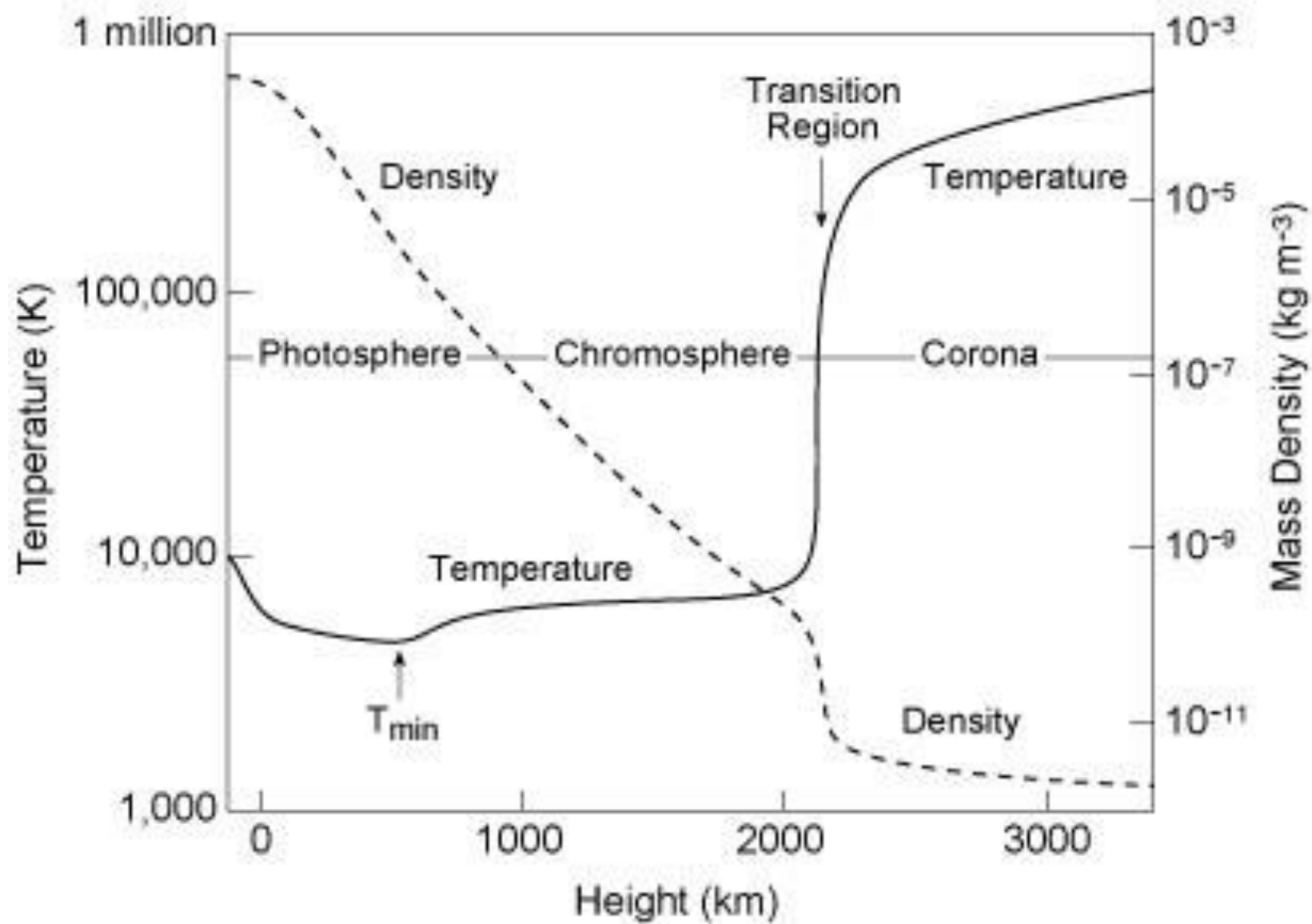
AKTİVİTEYİ BELİRLEYEN TEMEL TAYF ÇİZGİLERİ

■ Temel Optik Çizgiler

Ca II H ($\lambda 3968$) ve **K** ($\lambda 3934$),

Kromosferik sıcaklıklarda oluşabilen
kuvvetli salma çizgileri

H α ($\lambda 6563$)



Example Spectra



white light spectrum



hydrogen lamp spectrum



helium lamp spectrum



lithium lamp spectrum



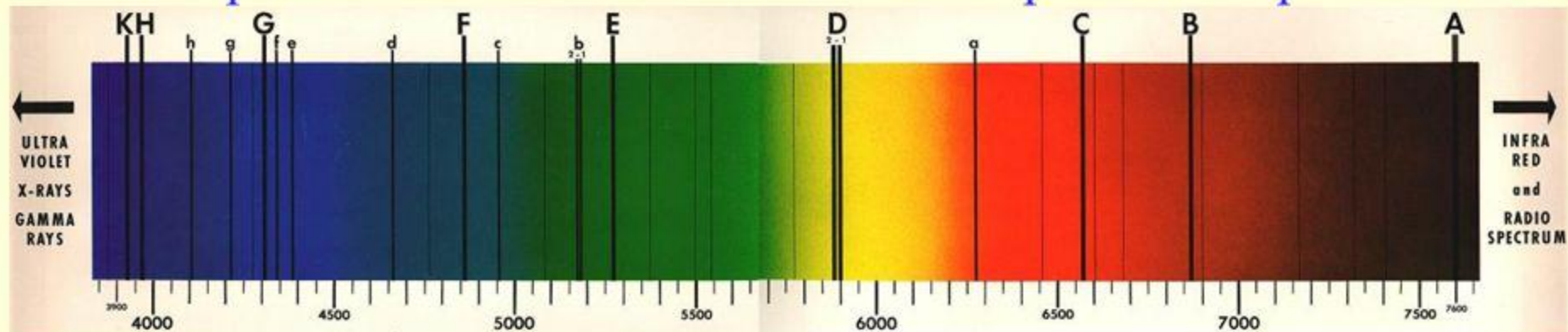
mercury lamp spectrum



hydrogen absorption spectrum

Spectra provide
"fingerprints" of
atomic species,
which can be used
to identify atoms
across the universe!

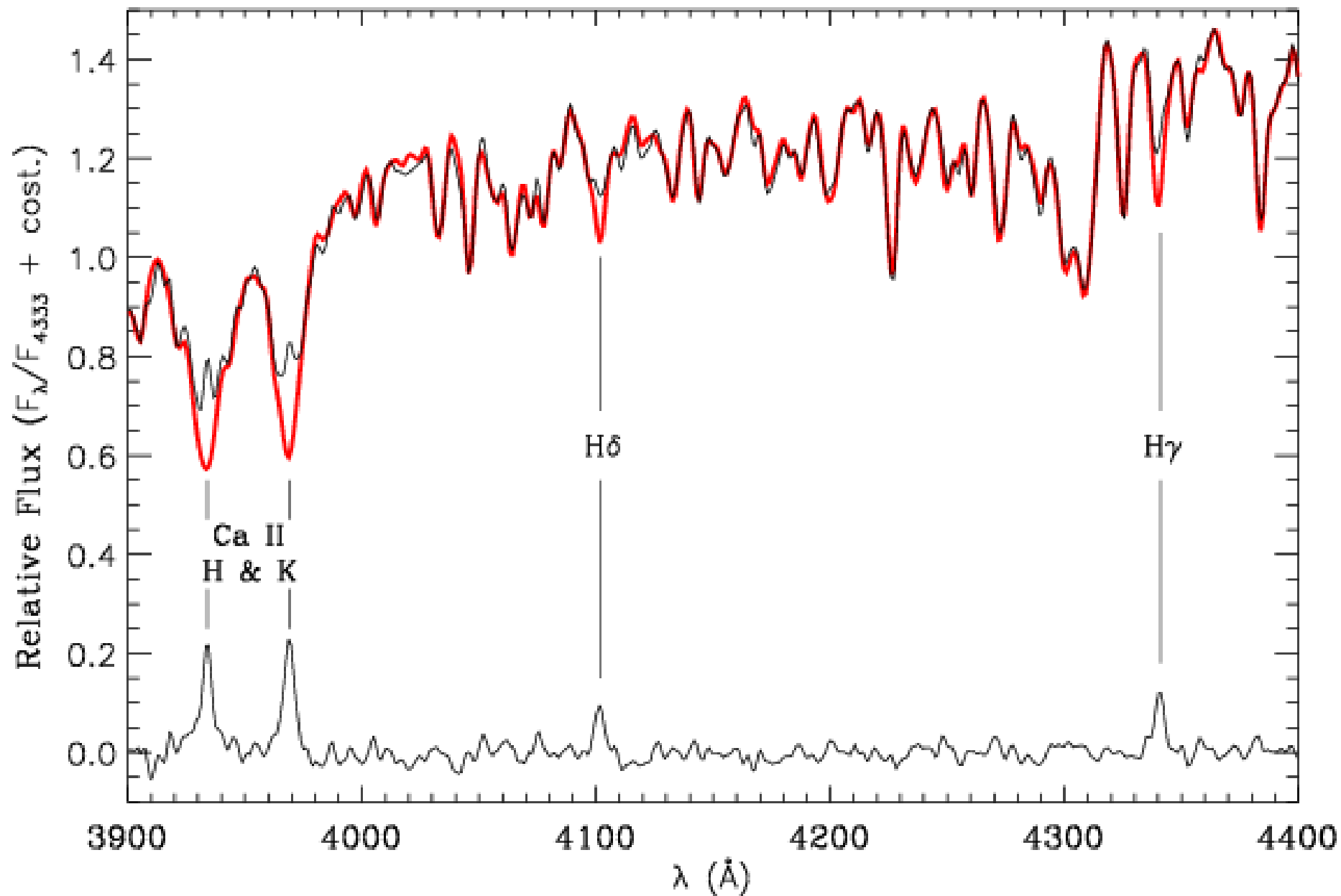
Solar Spectrum with Fraunhofer solar atmosphere absorption lines

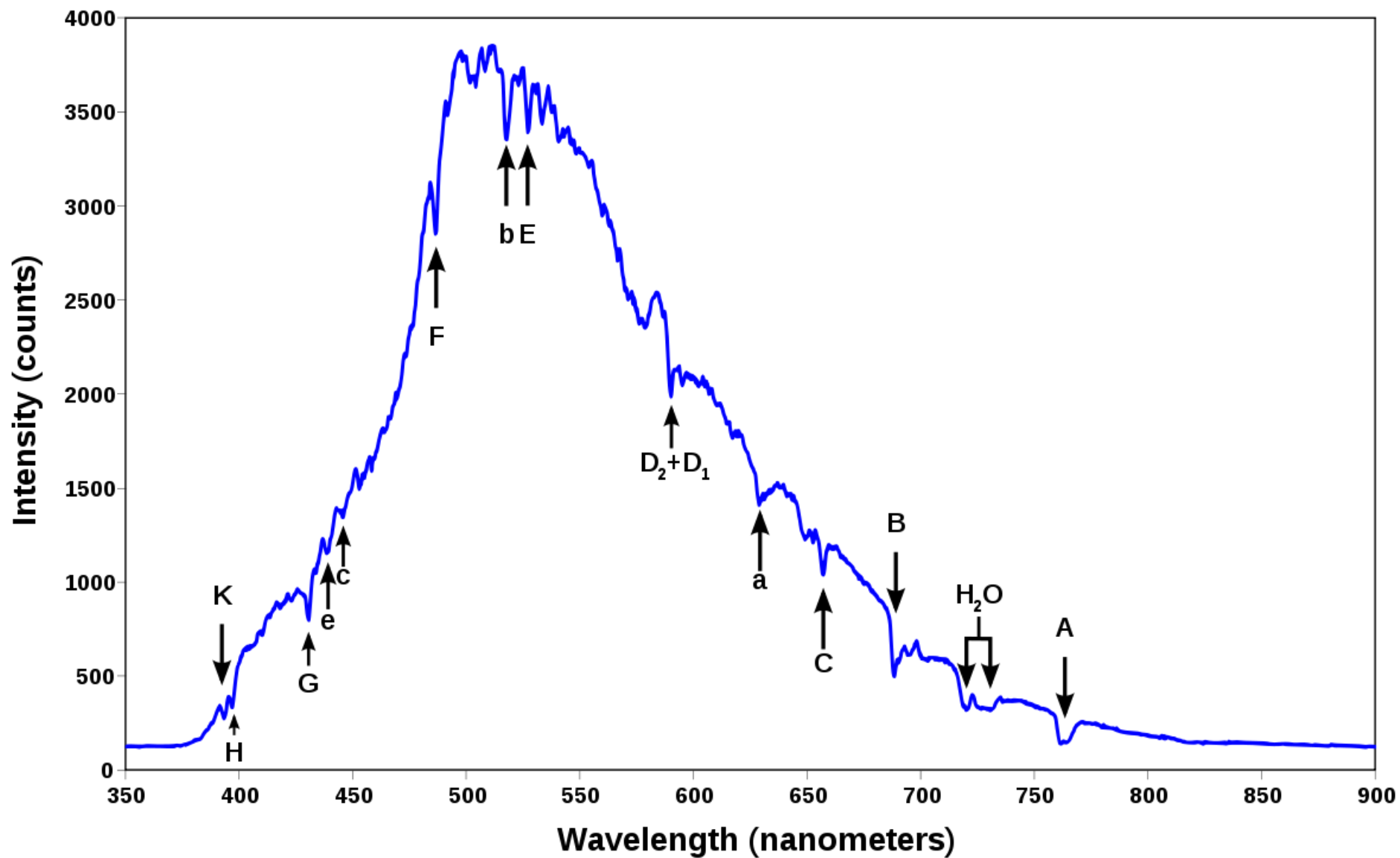


C: Hydrogen; D: Sodium; E: Iron; F: Hydrogen; G: Iron; H&K: Calcium

Name	λ (Å)	Origin
A	7594	terrestrial oxygen (O ₂)
a	7165	terrestrial water vapor
B	6867	terrestrial oxygen
C	6563	H α
D	5890, 5896	neutral sodium (Na I)
E	5270	neutral iron (Fe I)
b	5167, 5173, 5184	neutral magnesium (Mg I)
F	4861	H β
d*	4384	neutral iron (Fe I)
G	4300	CH band
g*	4227	neutral calcium (Ca I)
h*	4102	H δ
H	3968	ionized calcium (Ca II)
K*	3934	ionized calcium (Ca II)

* Not an original Fraunhofer designation: added later.





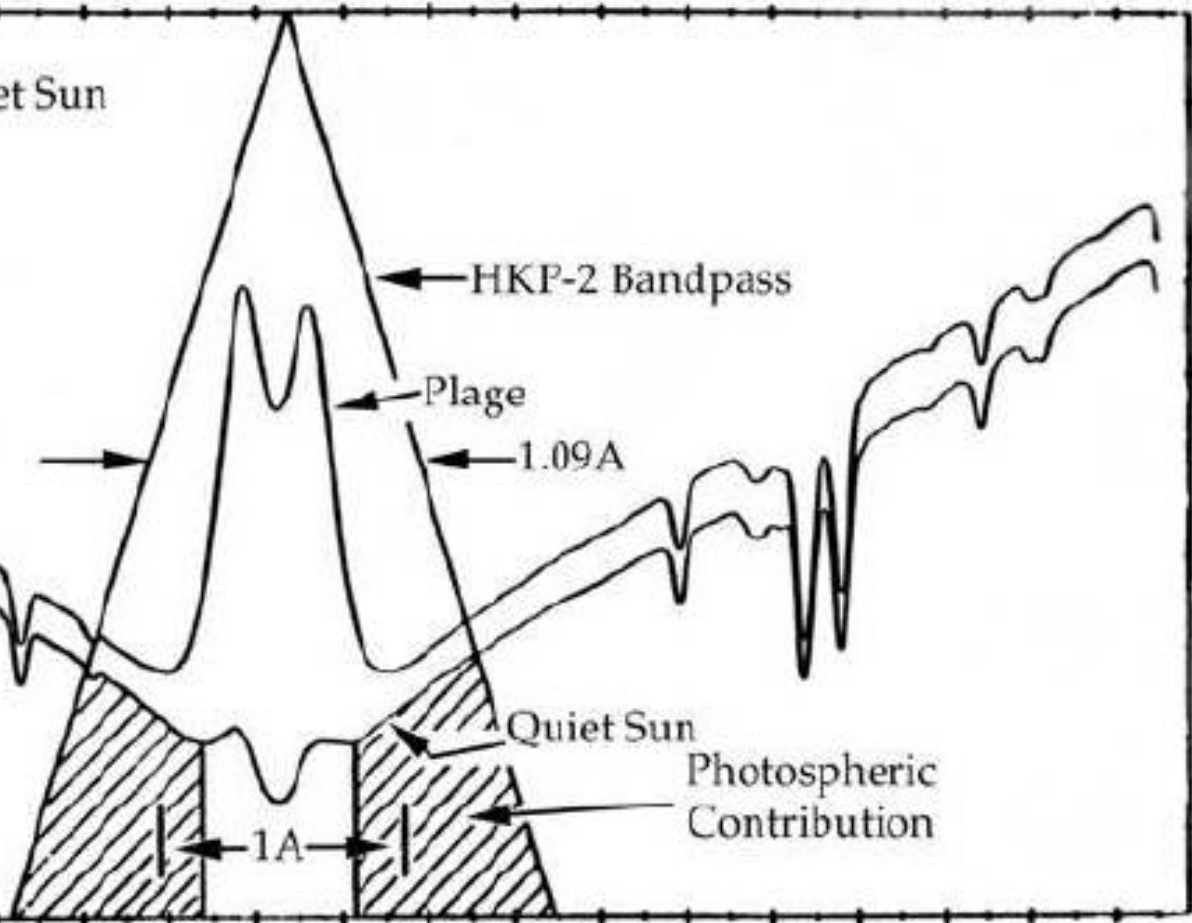


5.3 Chromospheres

- Low density, hot gas
- Strong emission lines :
 - Fraunhofer H & K lines of Ca II
- Self absorbed emission
 - Ca K abs (photosphere) : K1
 - Narrow bright emission (chromosphere) : K2
 - Narrower abs : K3
- Wilson-Bappu effect
 - Width of K2 $\sim M_v$
 - Distance indicator

Plage or Active Star vs. Quiet Sun
Ca II K line

Intensity



HKP-2 Bandpass

Plage

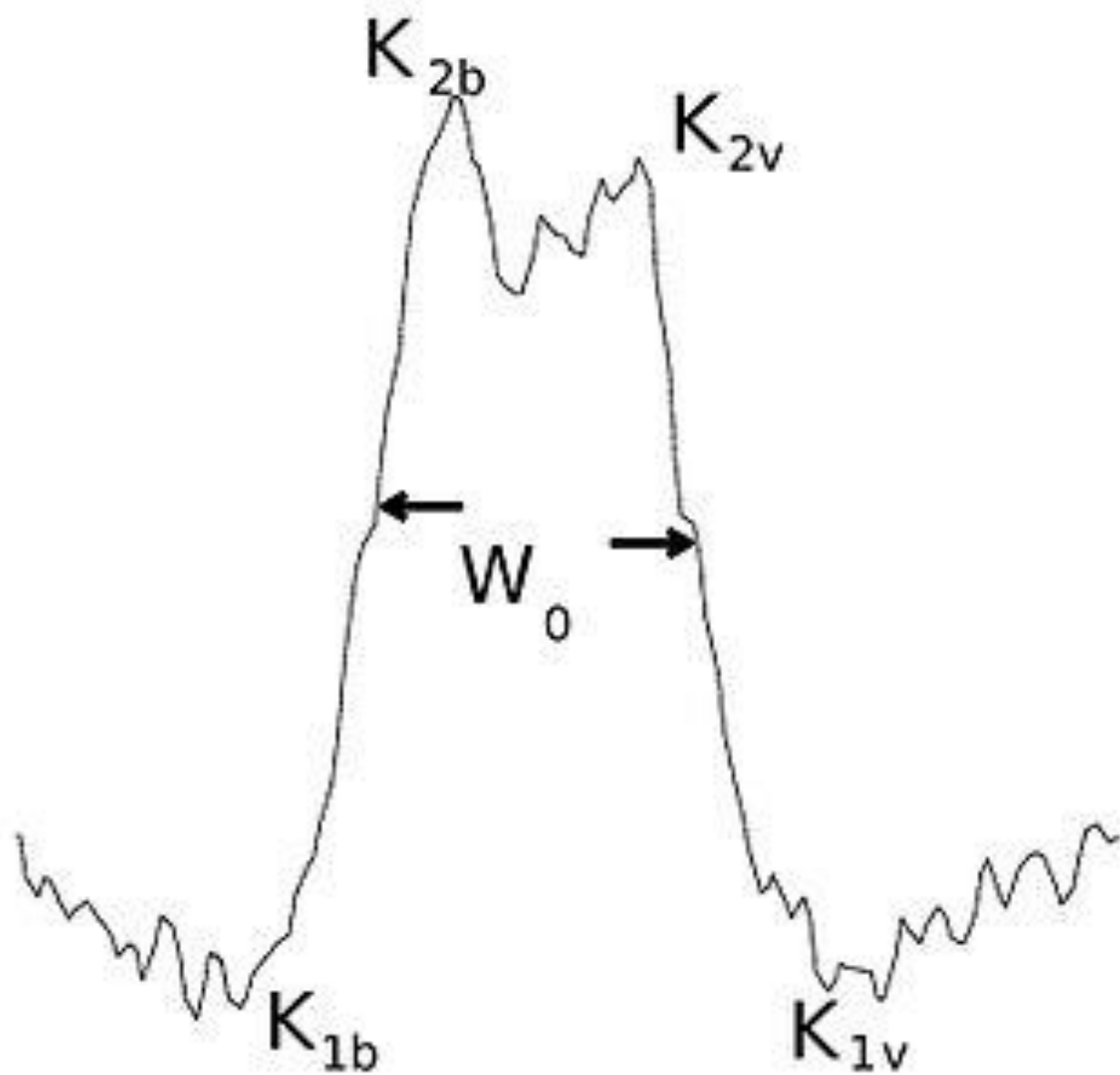
1.09 Å

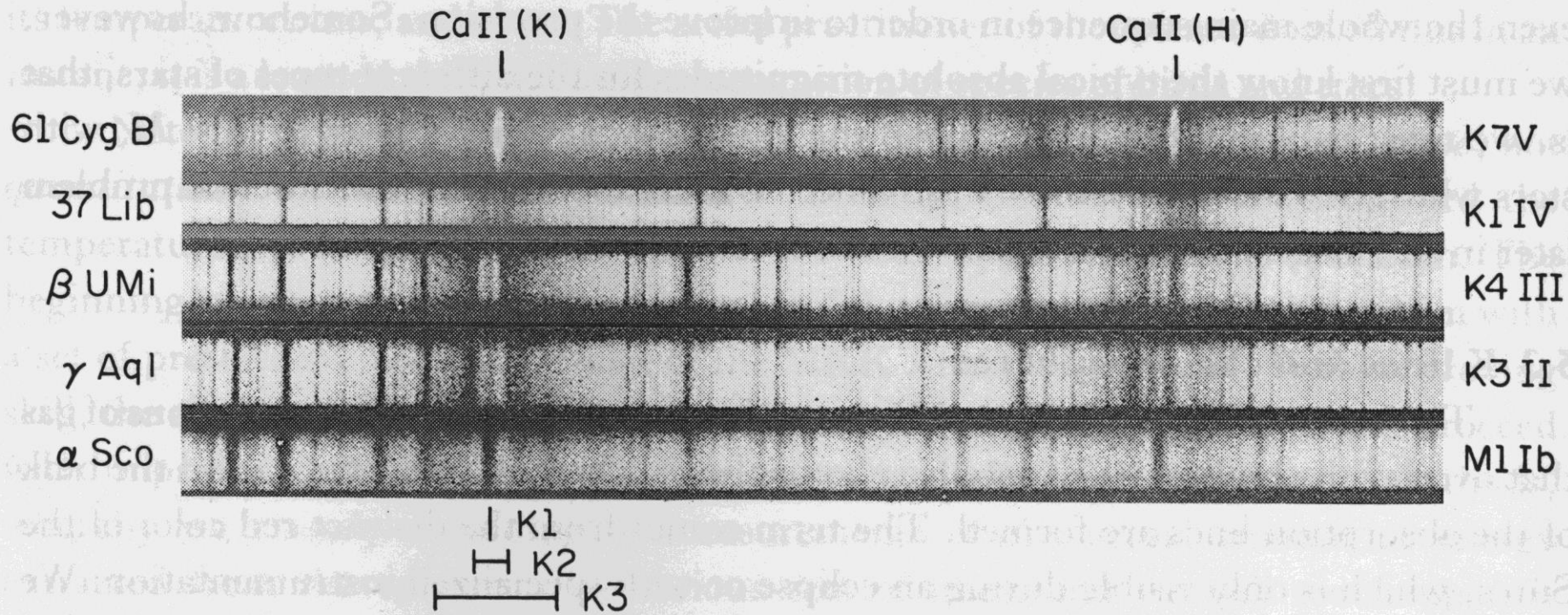
Quiet Sun

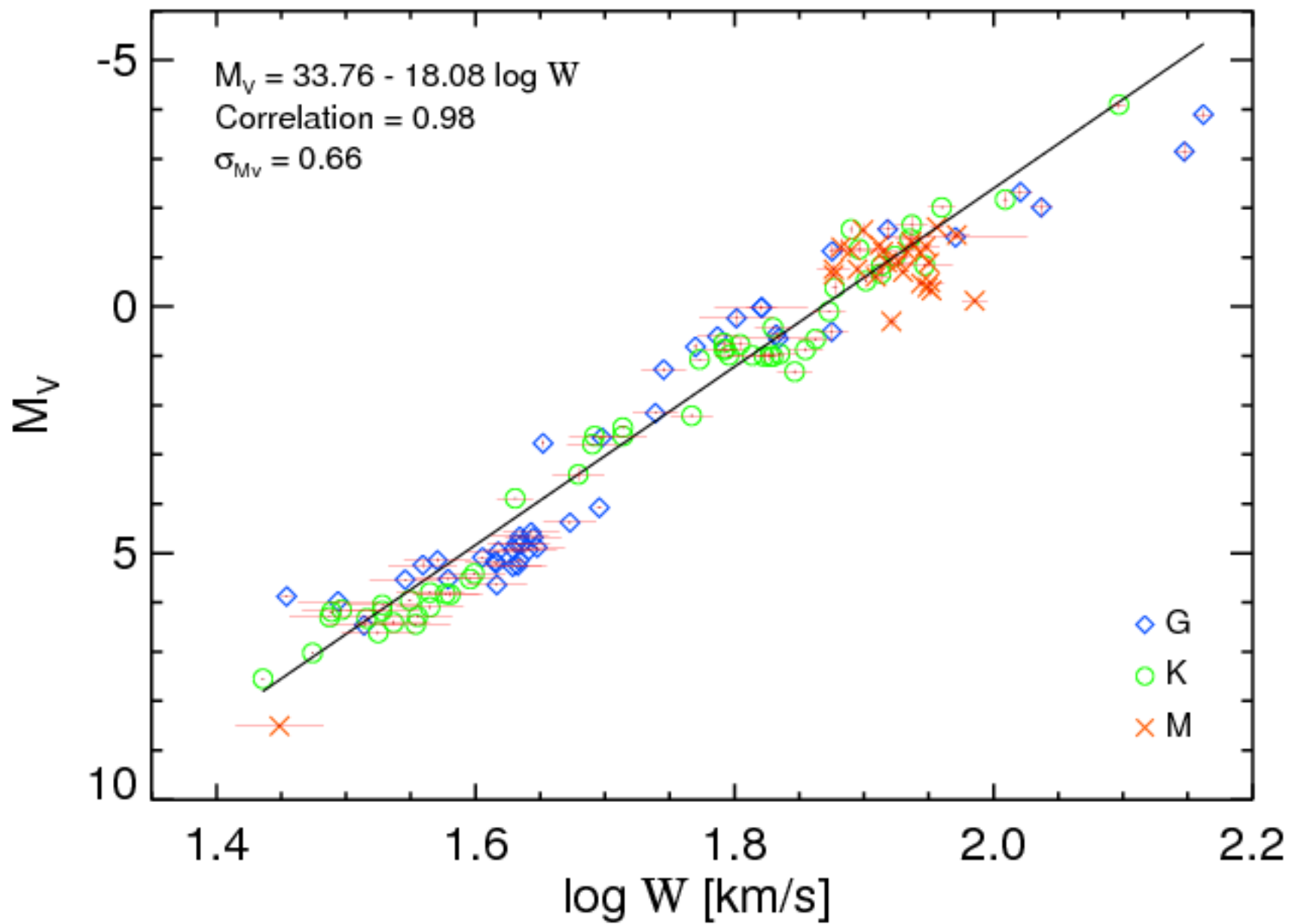
Photospheric
Contribution

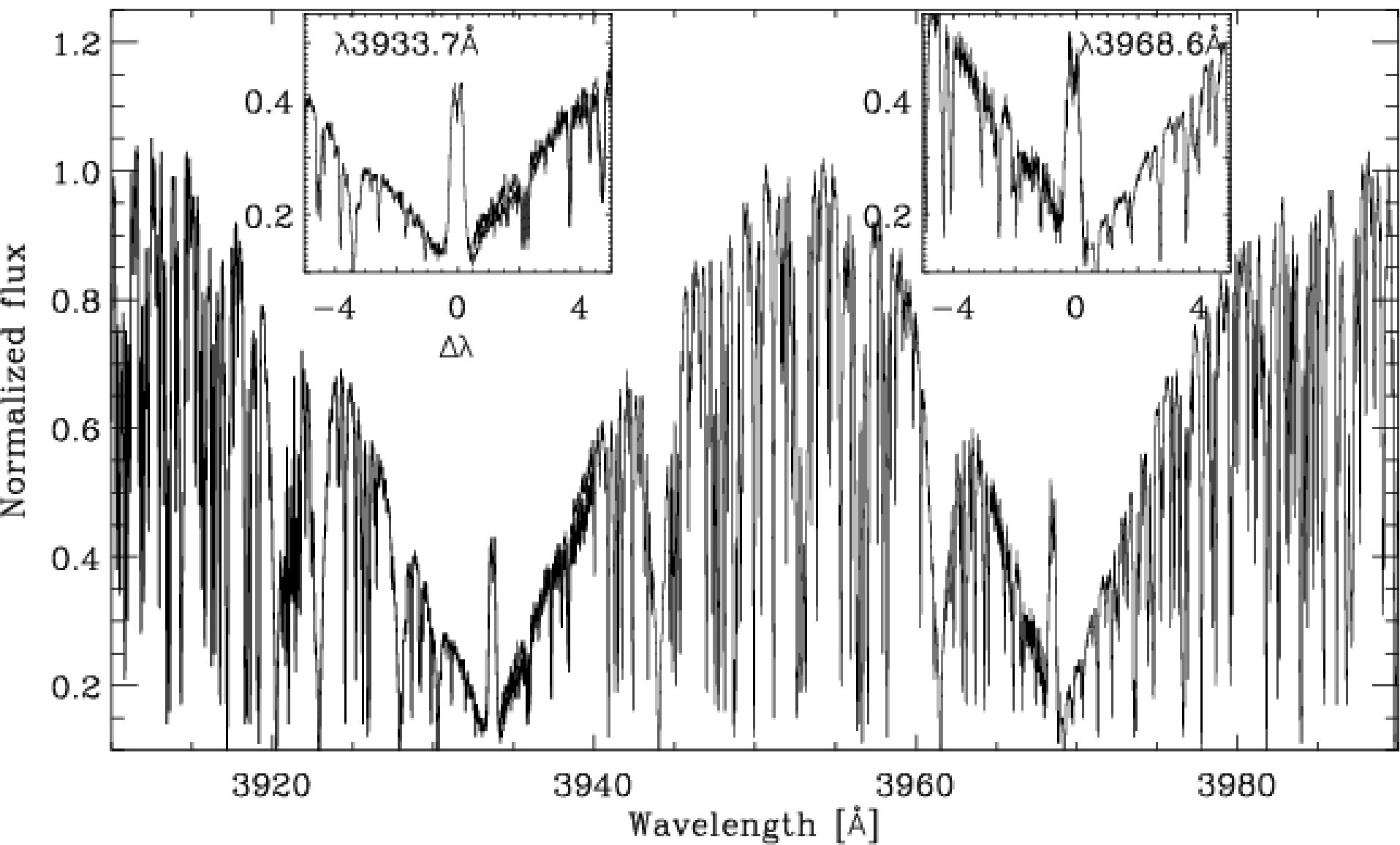
1 Å

Wavelength





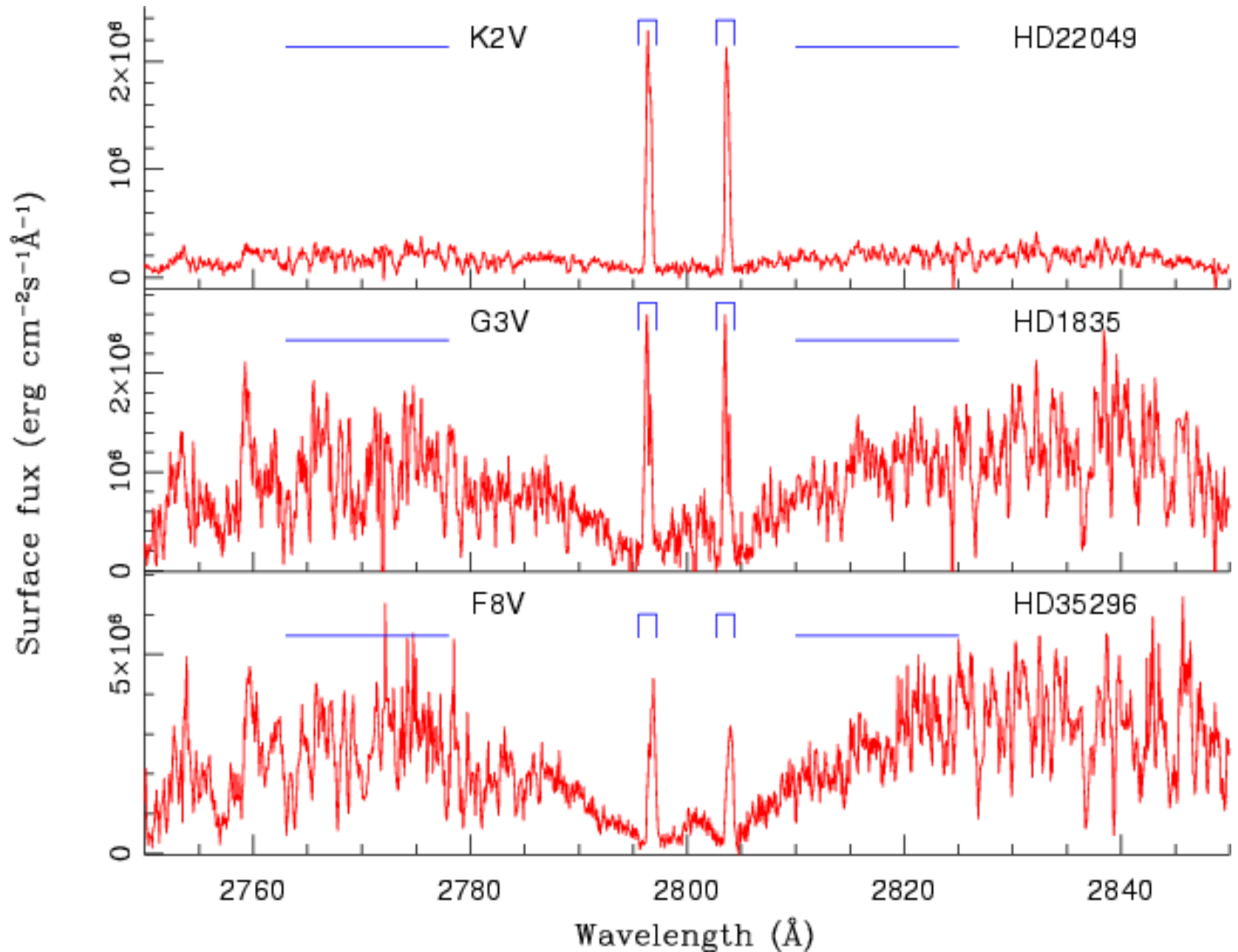




Kromosfer ve fotosfer arasındaki kontrastın önemi

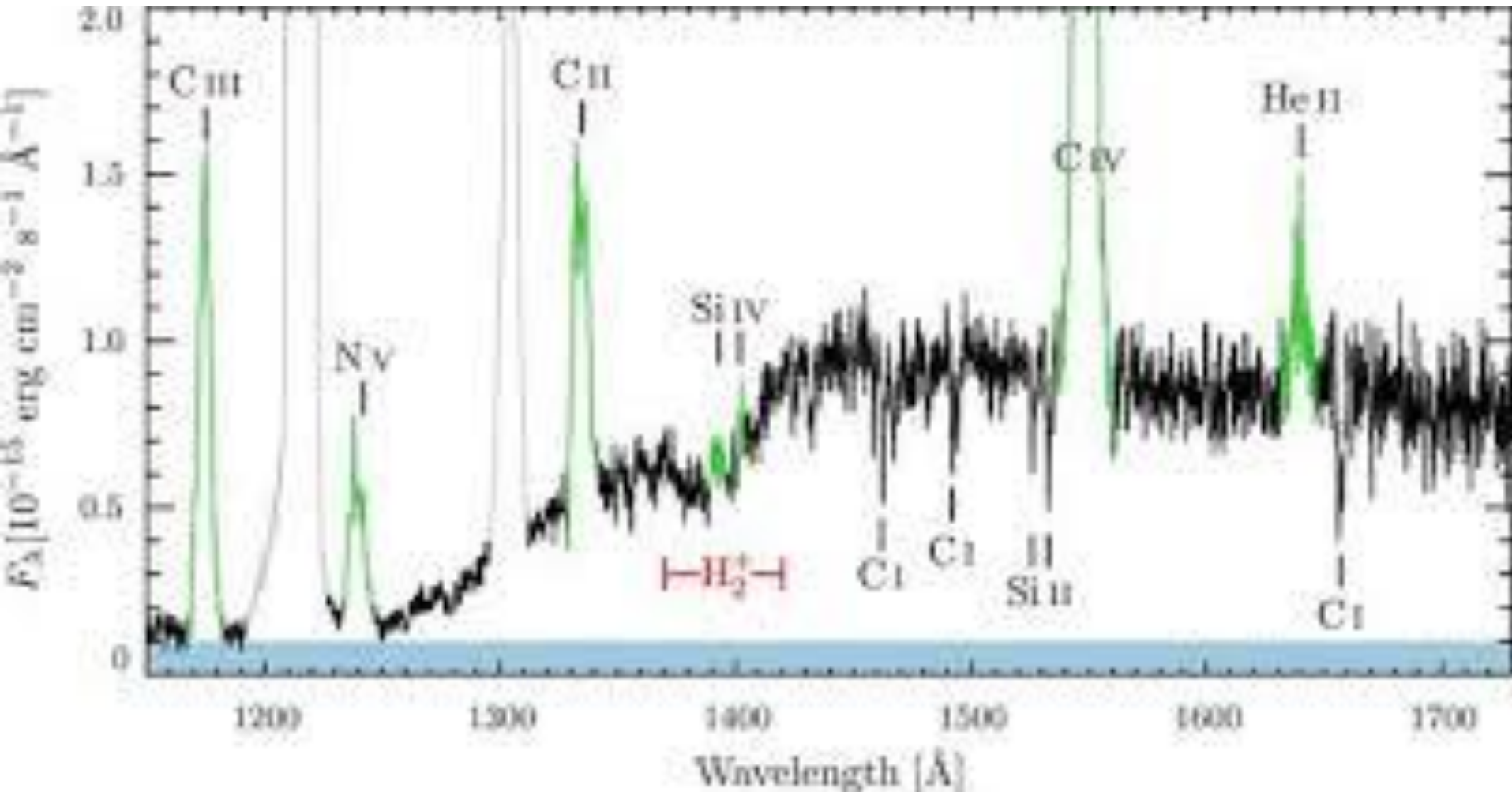
- Fotosfer soğudukça salma özelliği daha açık belli olur.
- Aynı tür kromosfere sahip geri-K yıldızı, erken-G yıldızından daha çarpıcı özelliklere sahip olur.

Moröte bölgesinde **Mg II h** ($\lambda 2802$) ve **k** ($\lambda 2796$)

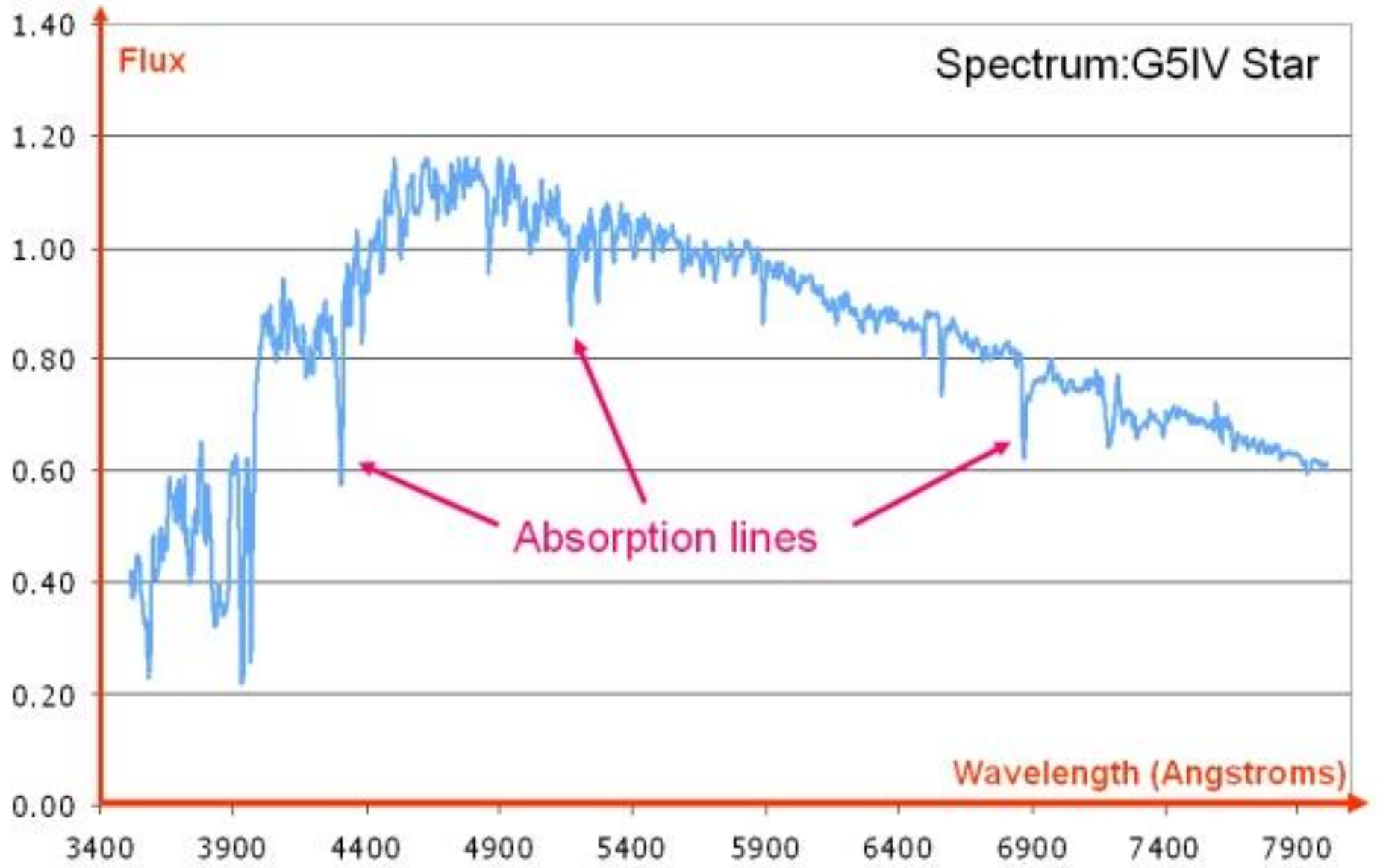


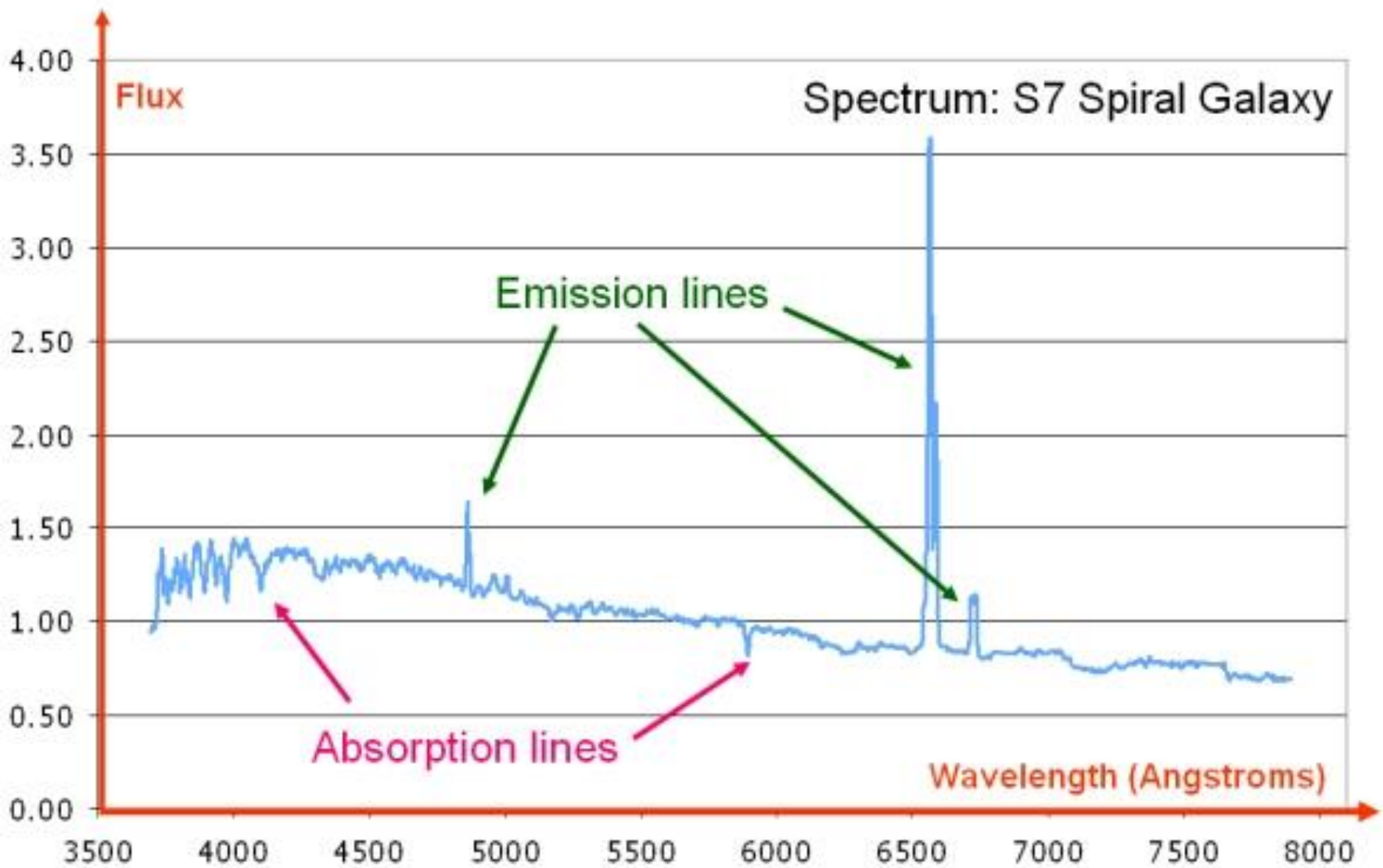
Üst kromosfer ve geçiş bölgesinde

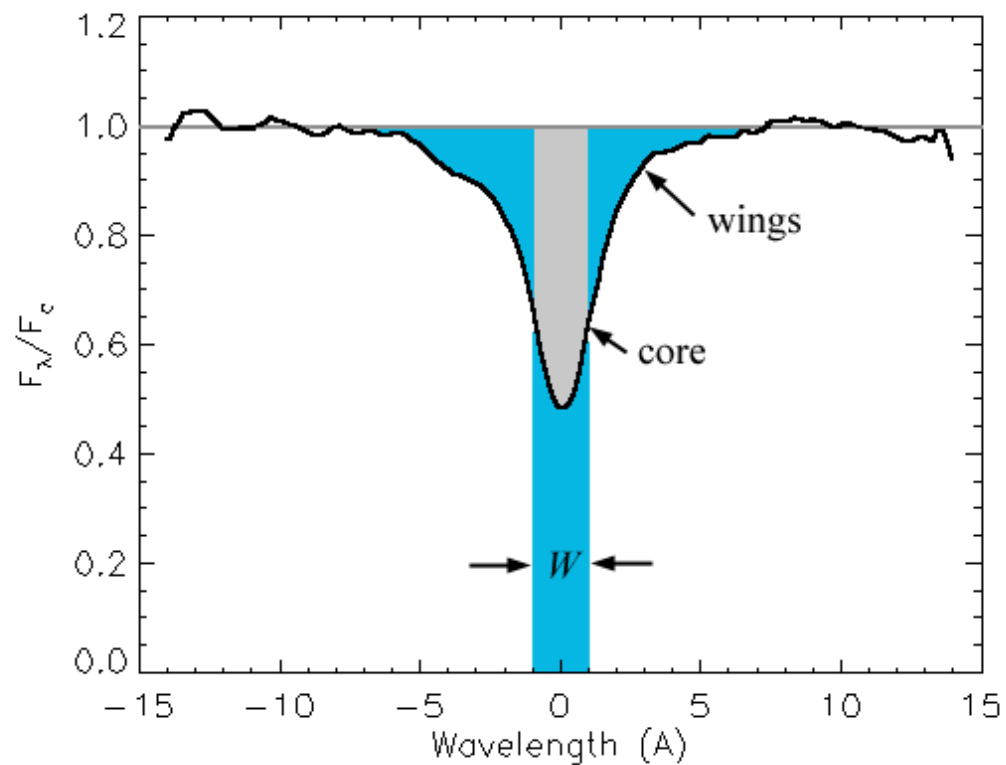
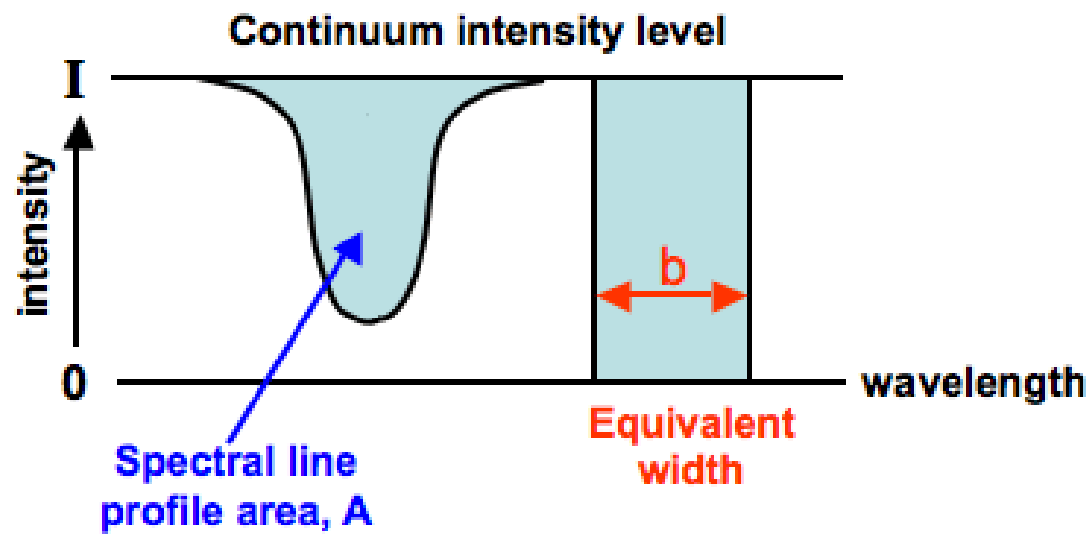
C II, C IV, Si II, Si IV ve He II



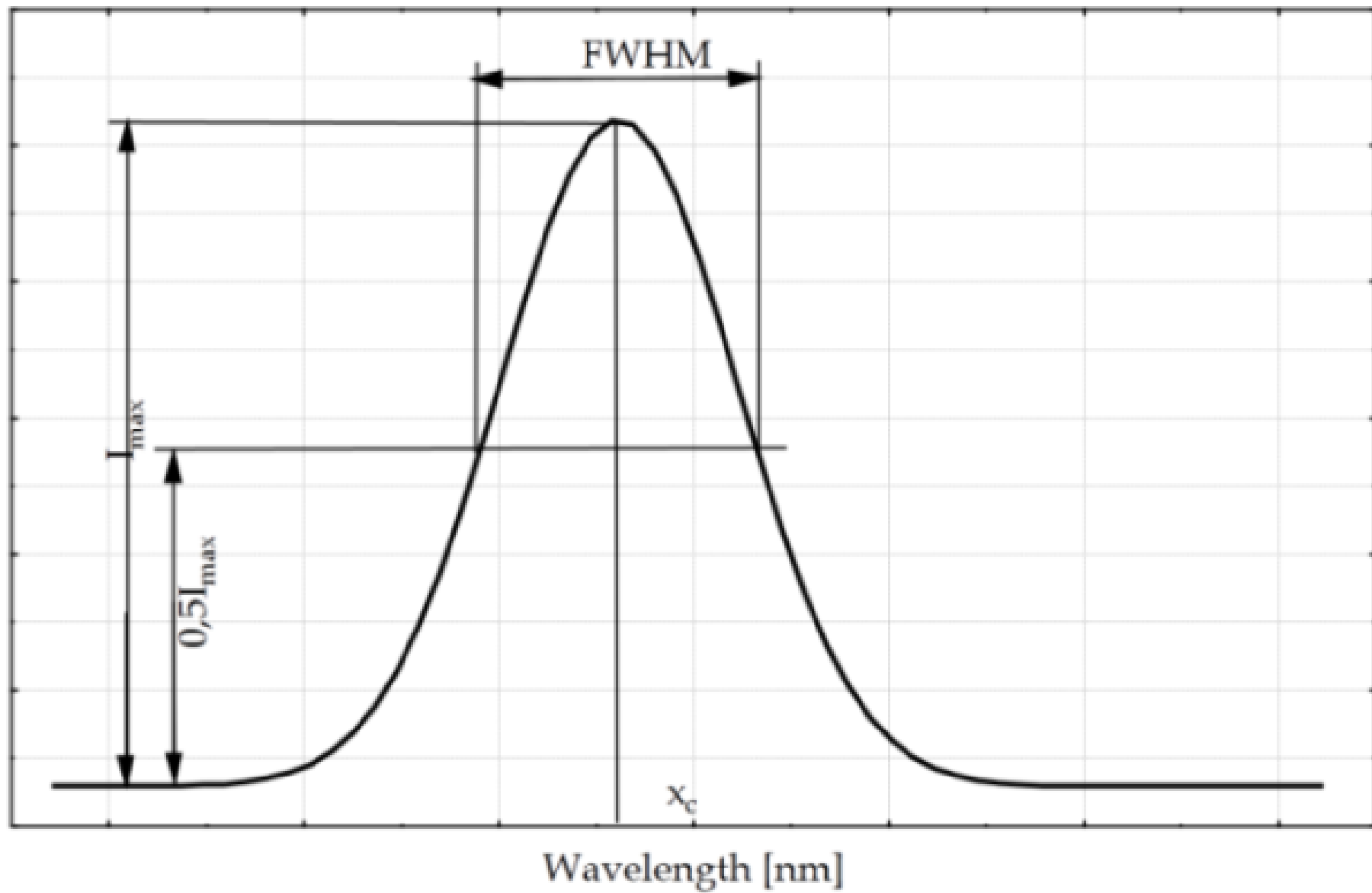
Spectrum: G5IV Star

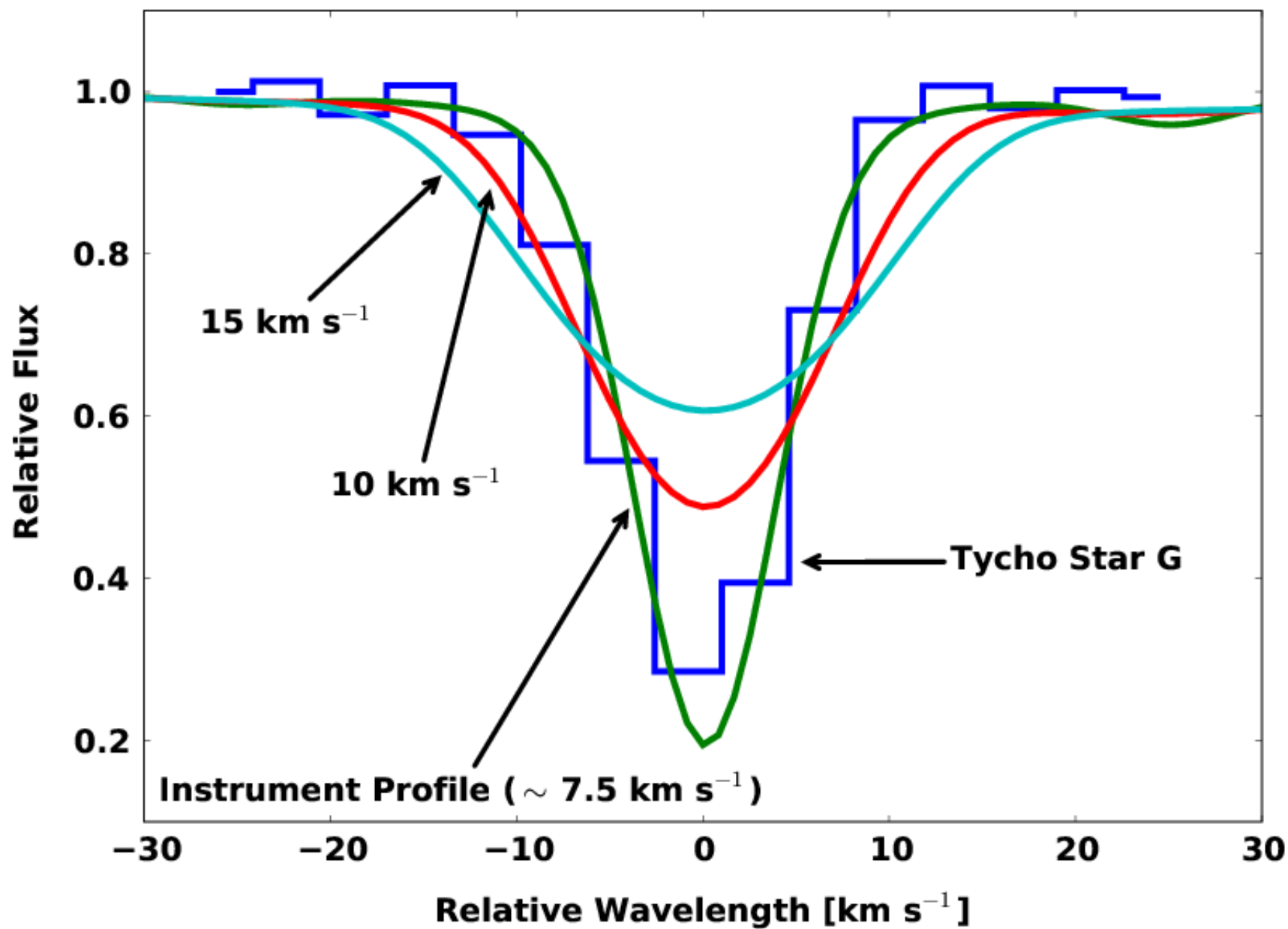






Intensity of arc emission [photon/m²s]





AKTİVİTEYE İLİŞKİN GÖZLEM TÜRLERİ

■ Dönme hızı

- ▶ tayf çizgi kesiti eşleştirmesi
- ▶ UBVR fotometrik değişimler
- ▶ tayfsal belirteçlerin dönemselliği

■ Manyetik alan

- ▶ Zeeman genişlemesi

■ Kütle kaybı

- anakol öncesi ▶ Asimetrik Balmer salması
- ▶ Jetler ve ilmikler
- anakol sonrası ▶ Soğuk yıldız rüzgarları

Rotation in Evolved Stars

- conserve angular momentum, so as R increases, v decreases
- Magnetic braking continues (as long as magnetic field exists)
- Tides in close binary systems lead to synchronous rotation

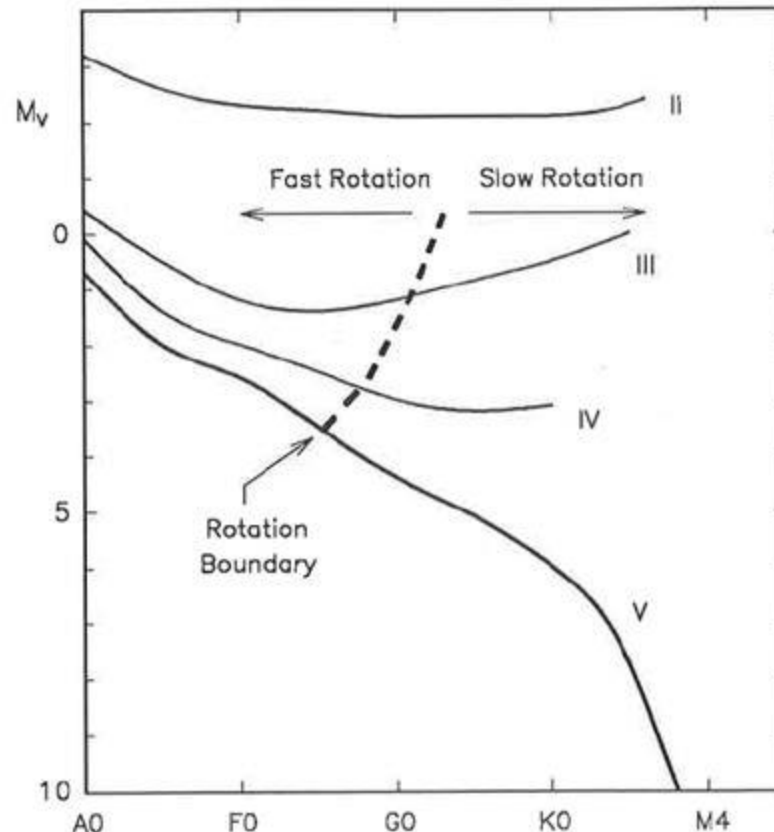
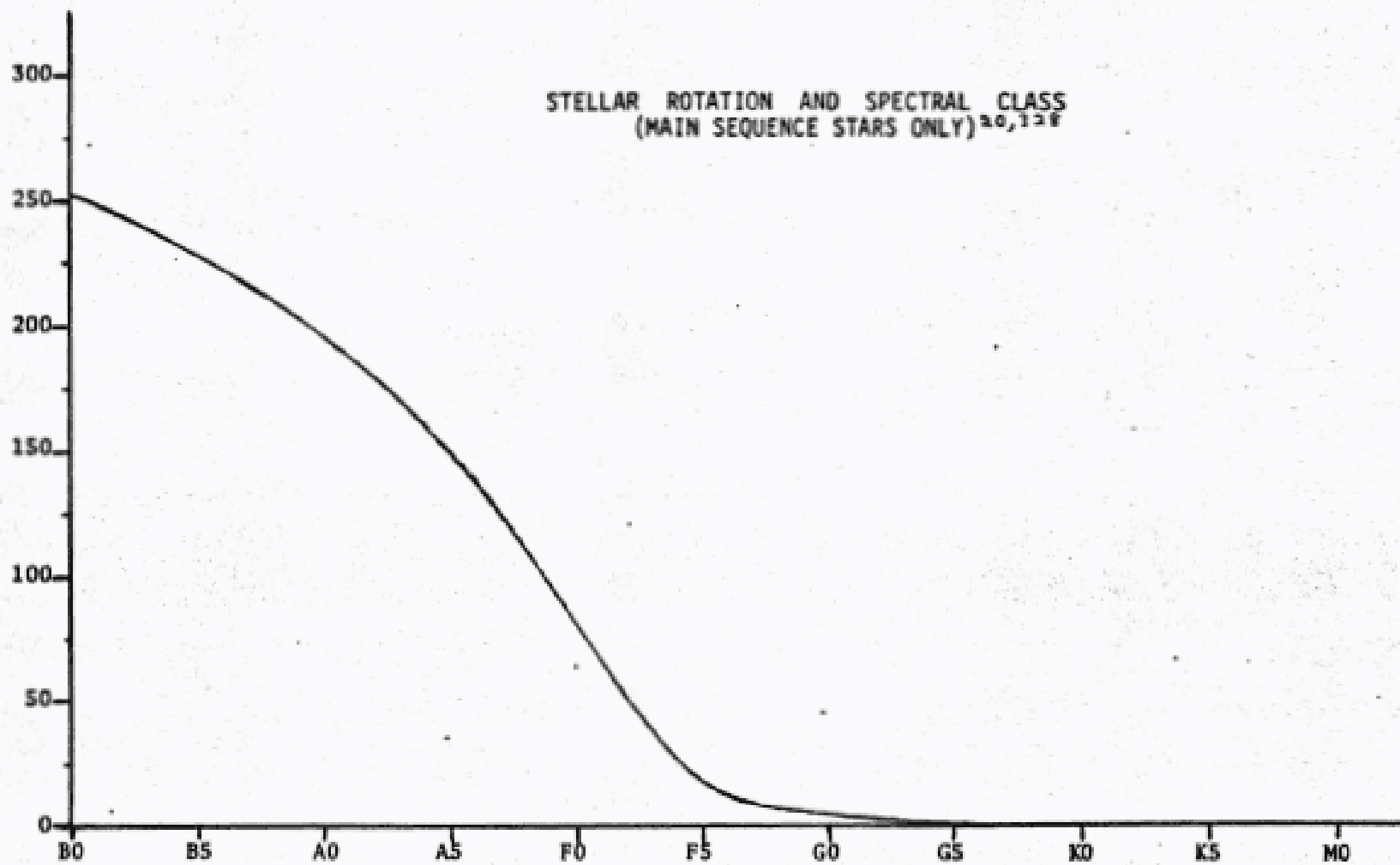


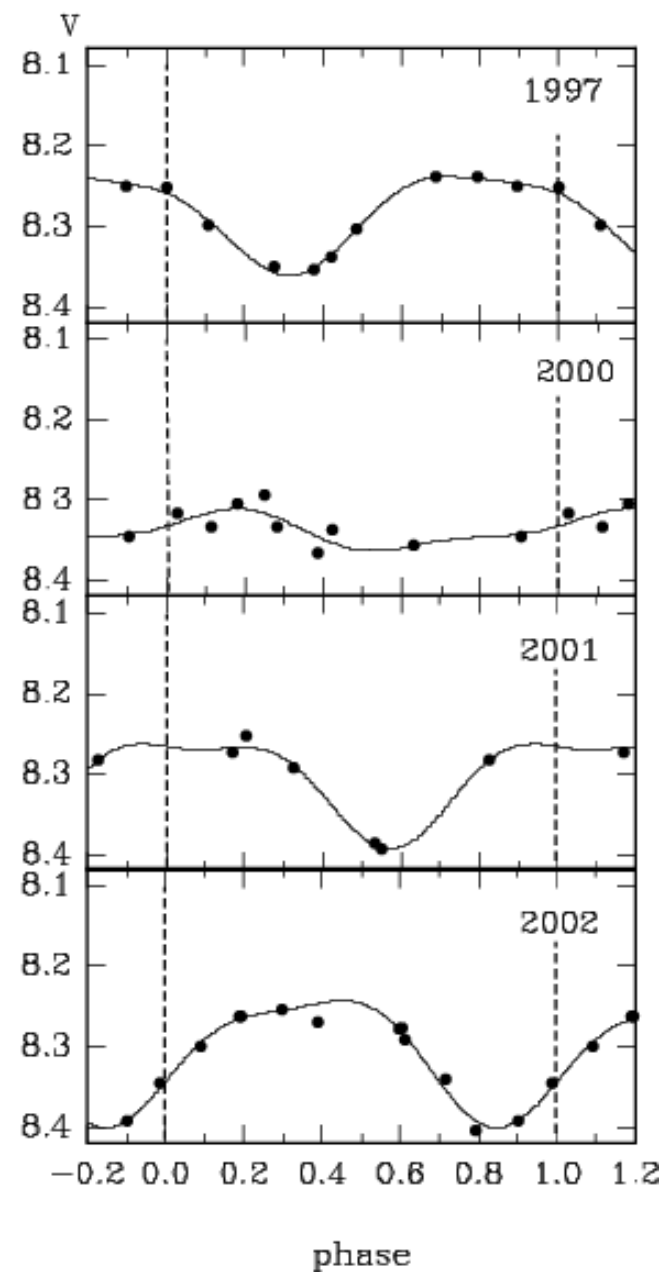
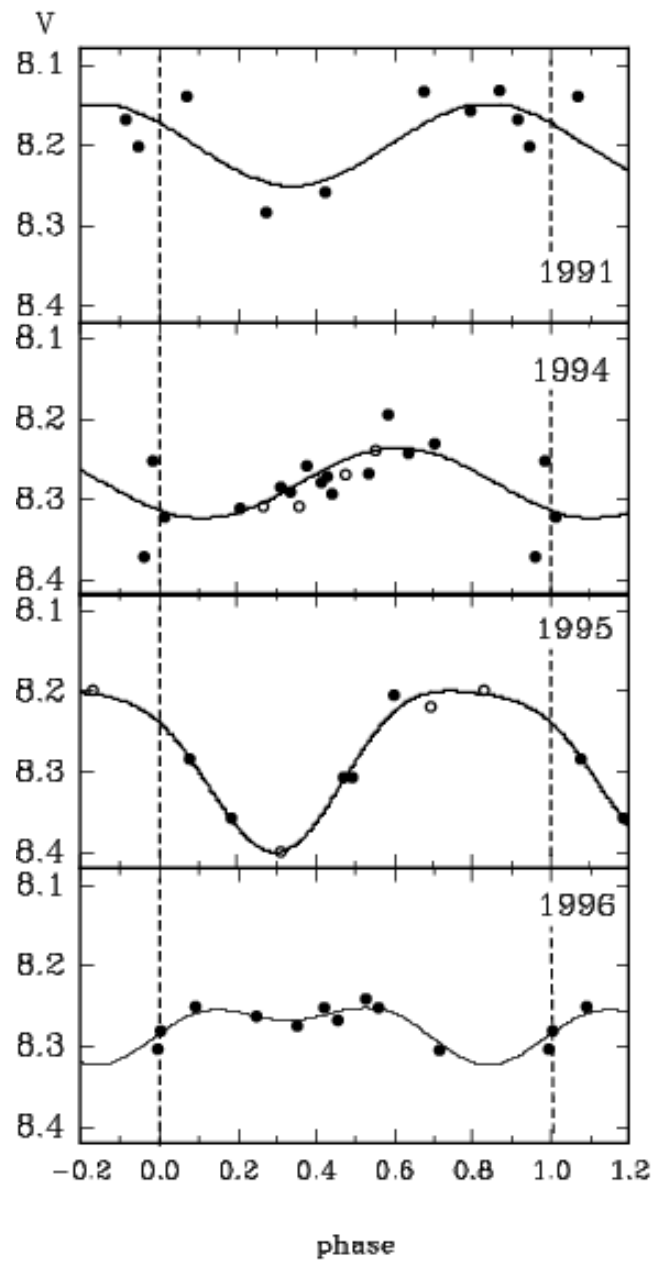
Fig. 17.21. The rotation boundary separates fast rotation from slow rotation.

Equatorial
Rotational
Velocity
(km/sec)

STELLAR ROTATION AND SPECTRAL CLASS
(MAIN SEQUENCE STARS ONLY)^{20, 128}



Spectral Class



One of the first members of RS CVn-type systems: MM Herculis

G. Taş* and S. Evren

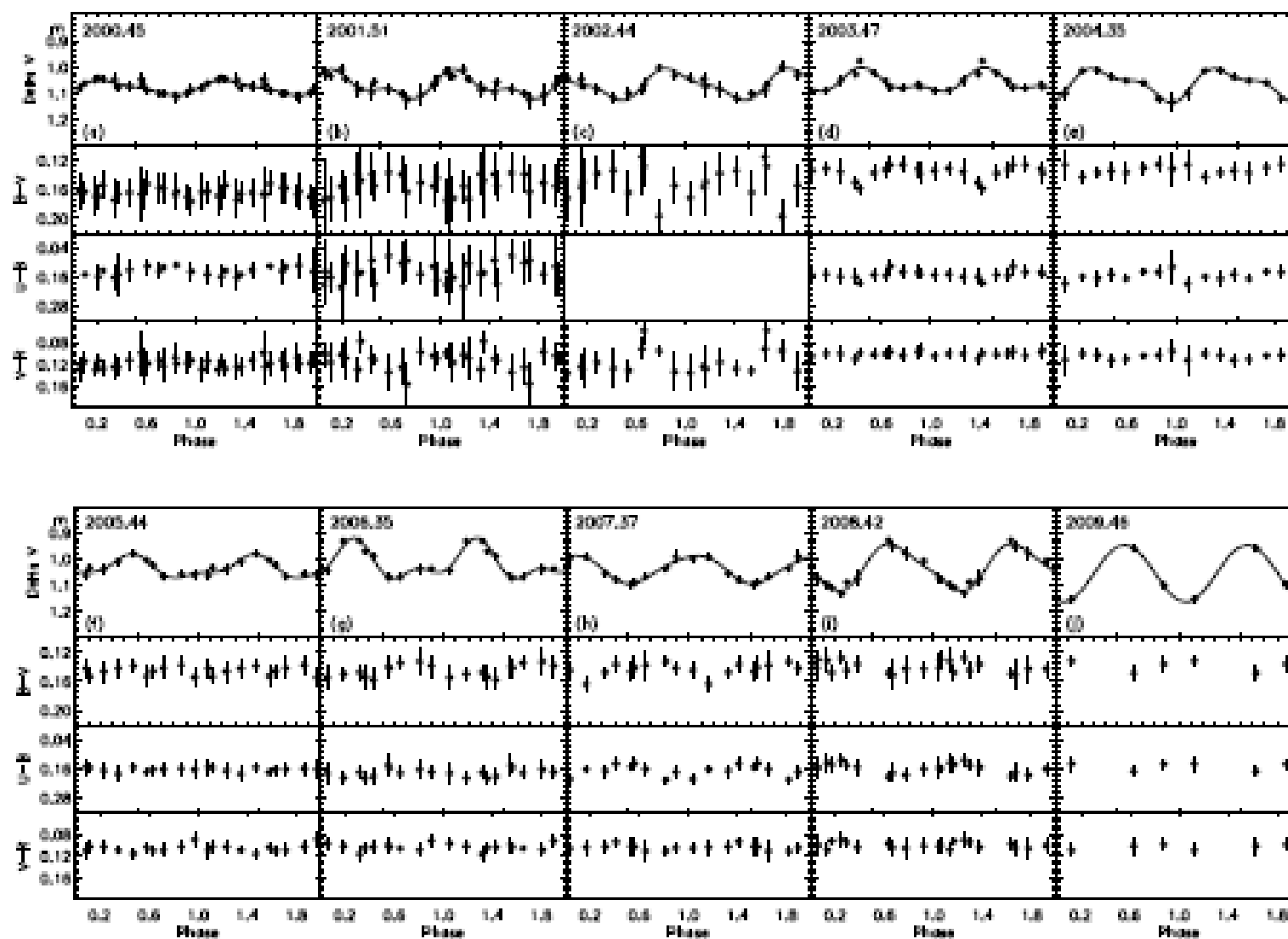
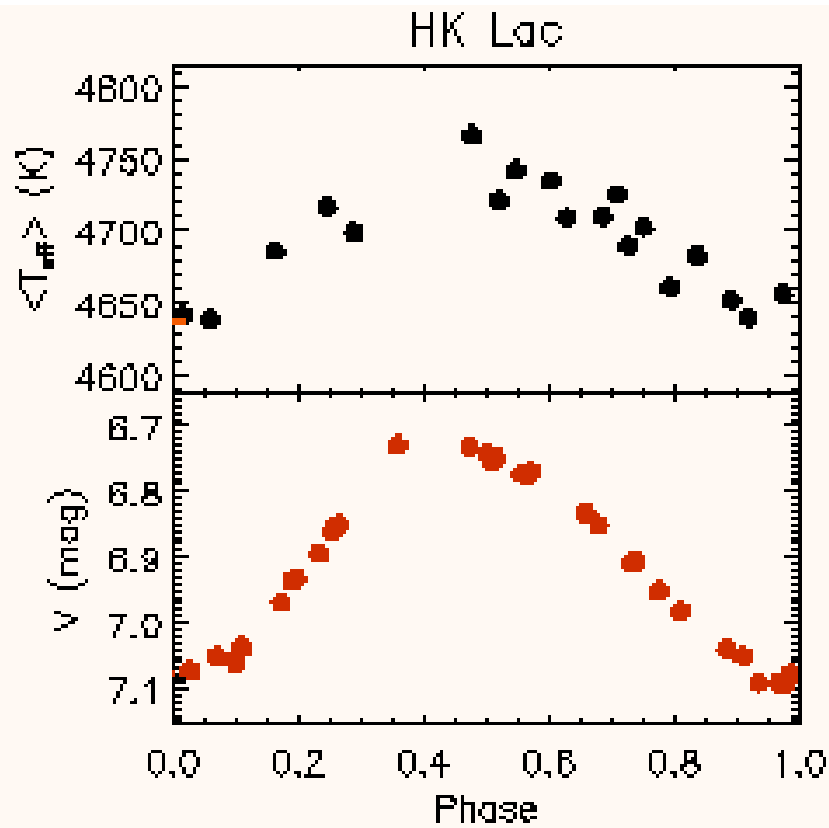
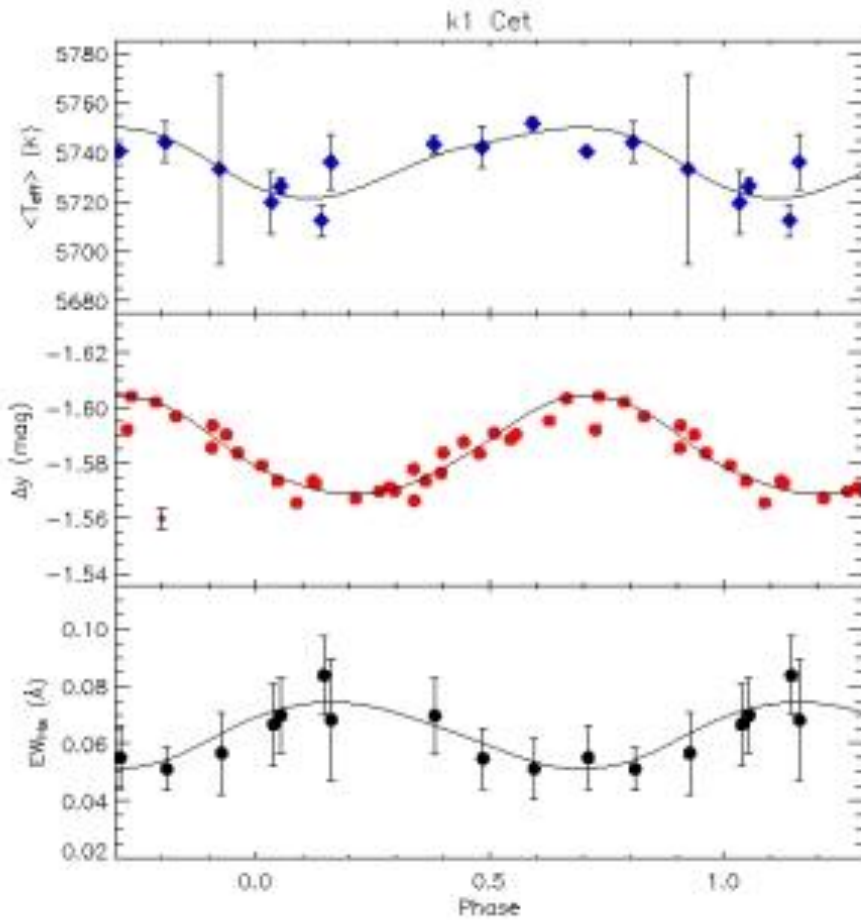


Fig. 3 The variation of the out-of-eclipses in the V light, and the $U - B$, $B - V$, and $V - R$ colour curves obtained between the years 2000 and 2009.





Sıcaklık, parlaklık ve H-alpha eşdeğer genişlik değişimi

**Güneş-türü genç yıldız
k1 Cet (G5V)**

**(Biazzo et al. 2007, ApJ 656,
474).**



$\phi = 0.00$

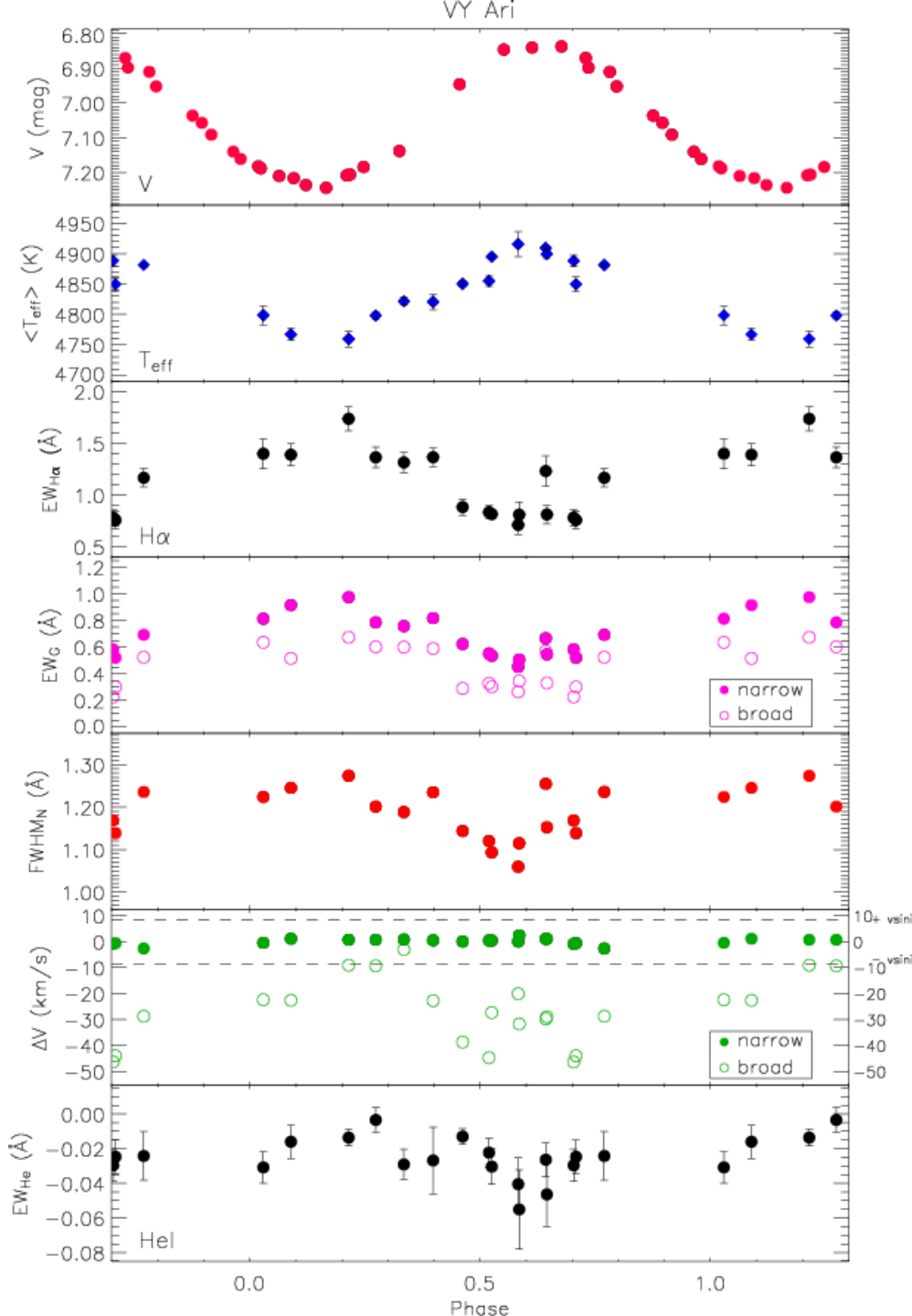


$\phi = 0.20$

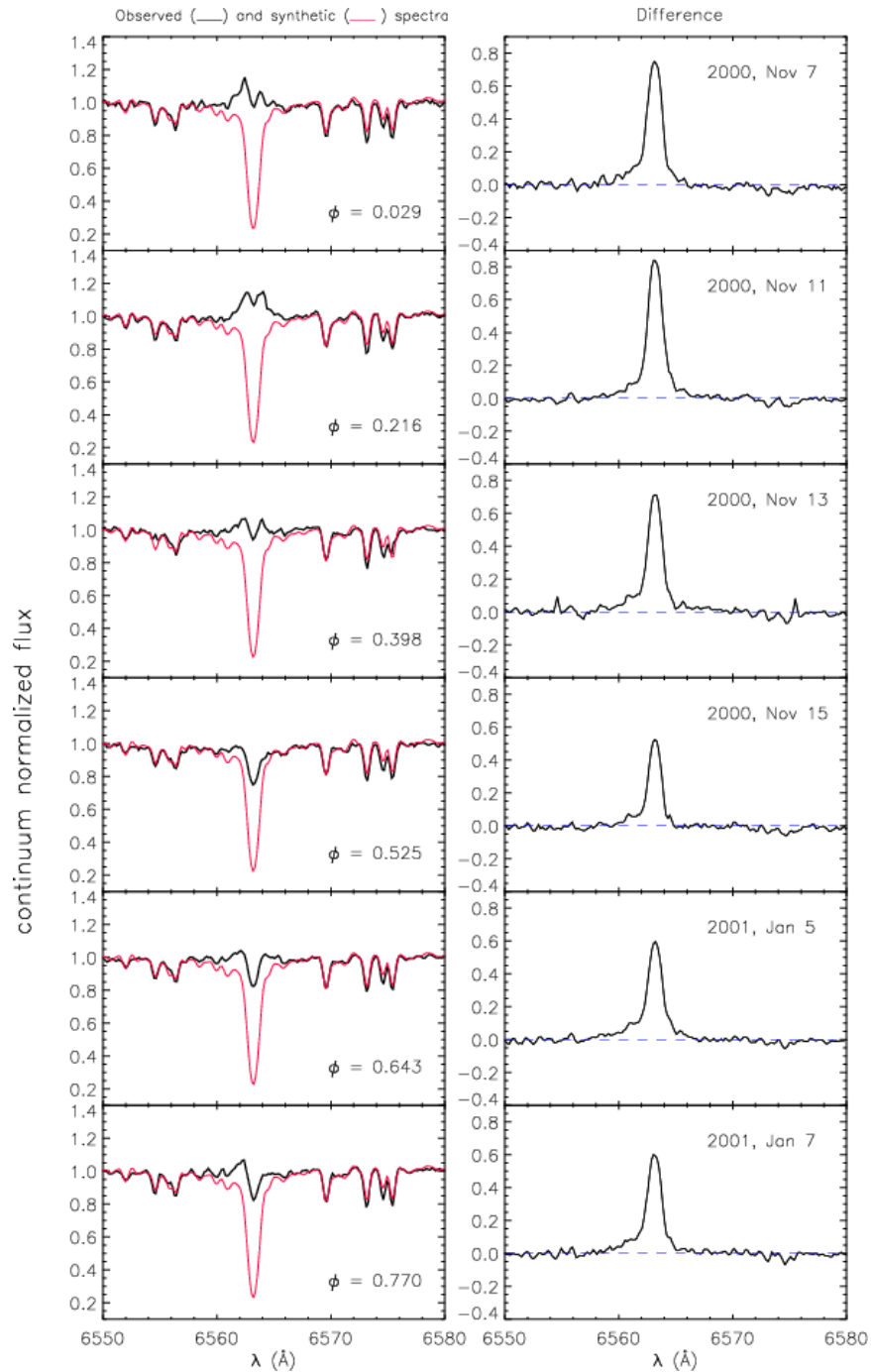
Photospheric and chromospheric active regions on three single-lined RS CVn binaries

K. Biazzo¹ - A. Frasca² - S. Catalano² - E. Marilli²

Johnson V photometry, average effective temperature, total H alpha emission, equivalent width, relative radial velocity of the two-Gaussian fitting and He I D₃ equivalent width as a function of the rotational phase for VY Ari.



VY Ari - H α

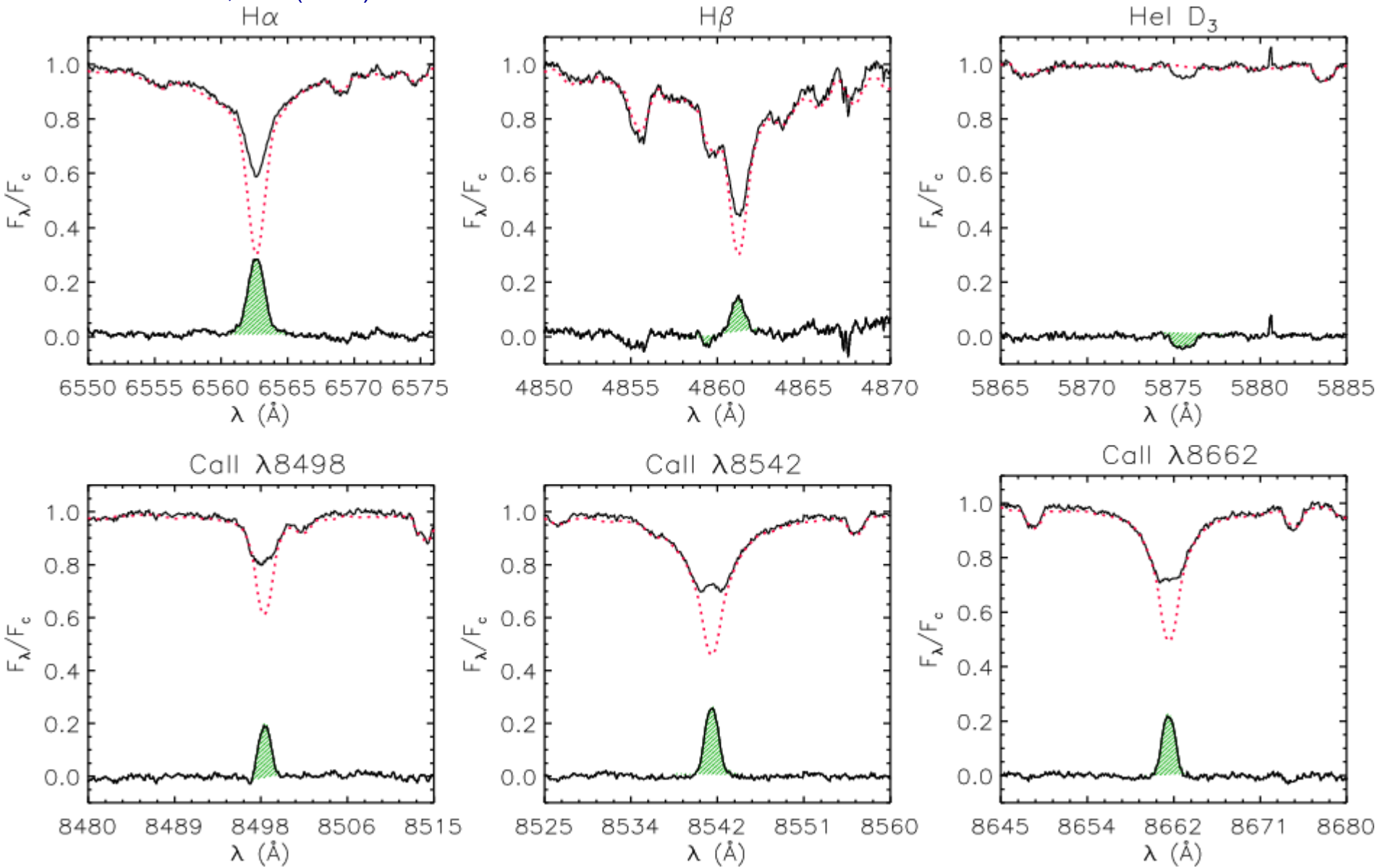


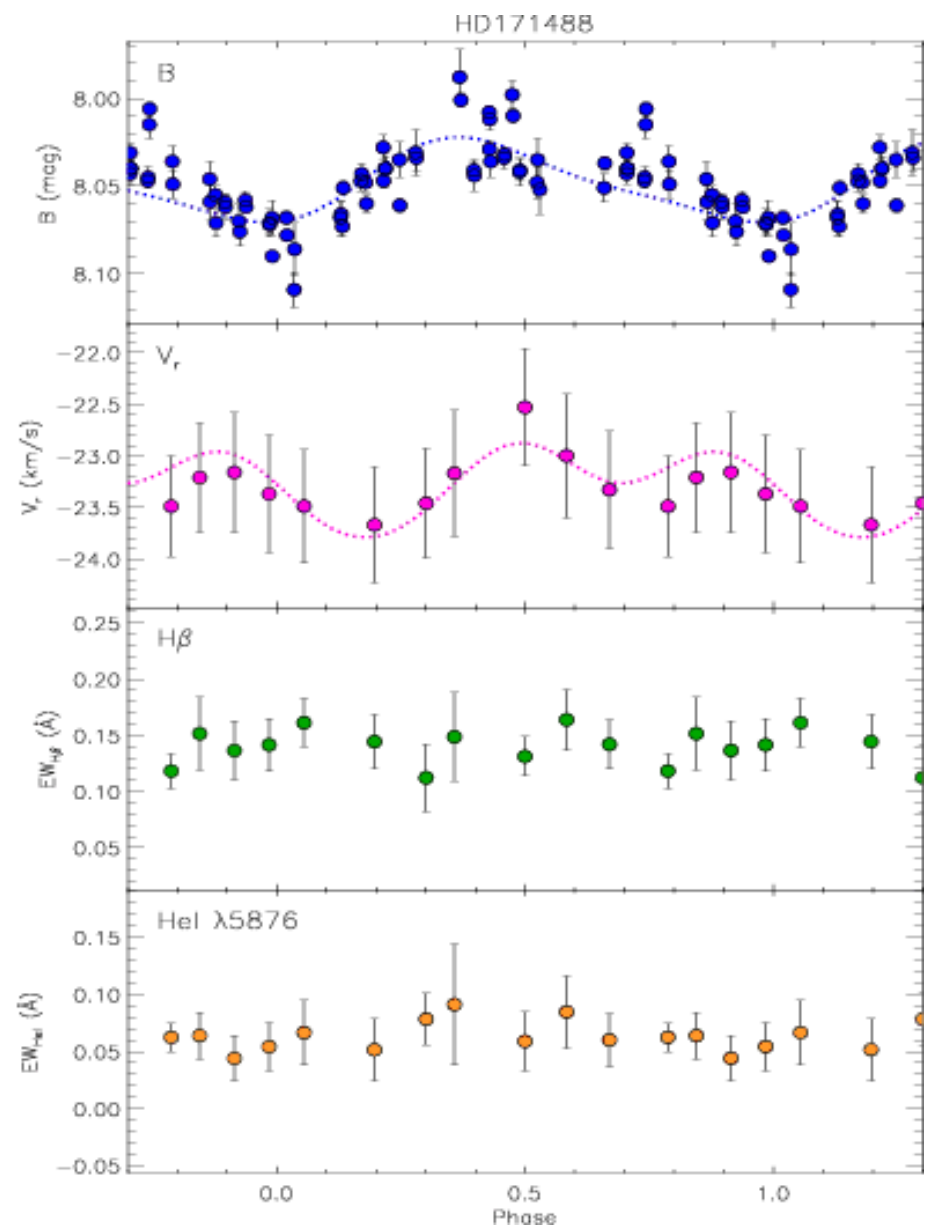
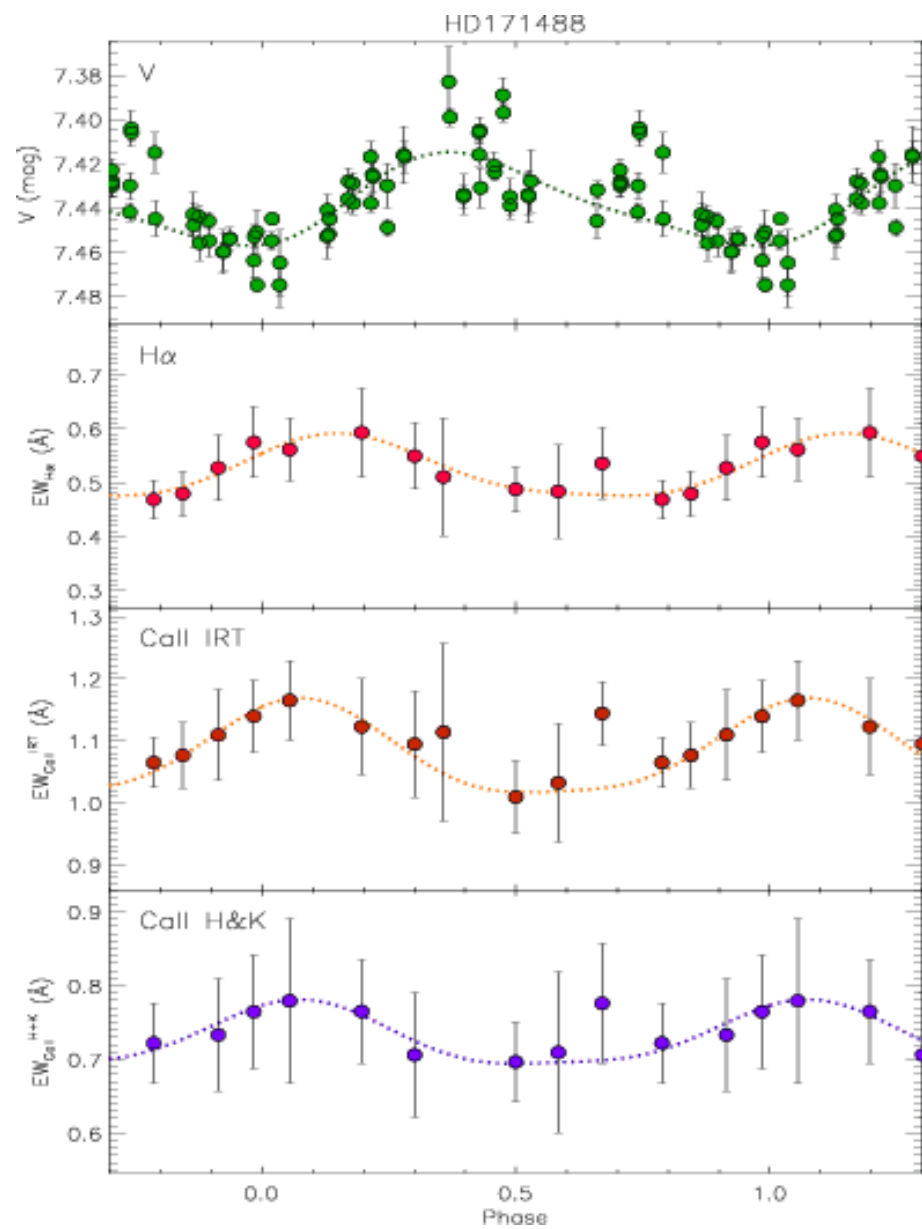
Left panels: sample of observed and continuum-normalized spectra of VY Ari in the H region together with the non-active template.

Right panels: difference between observed and template spectra.

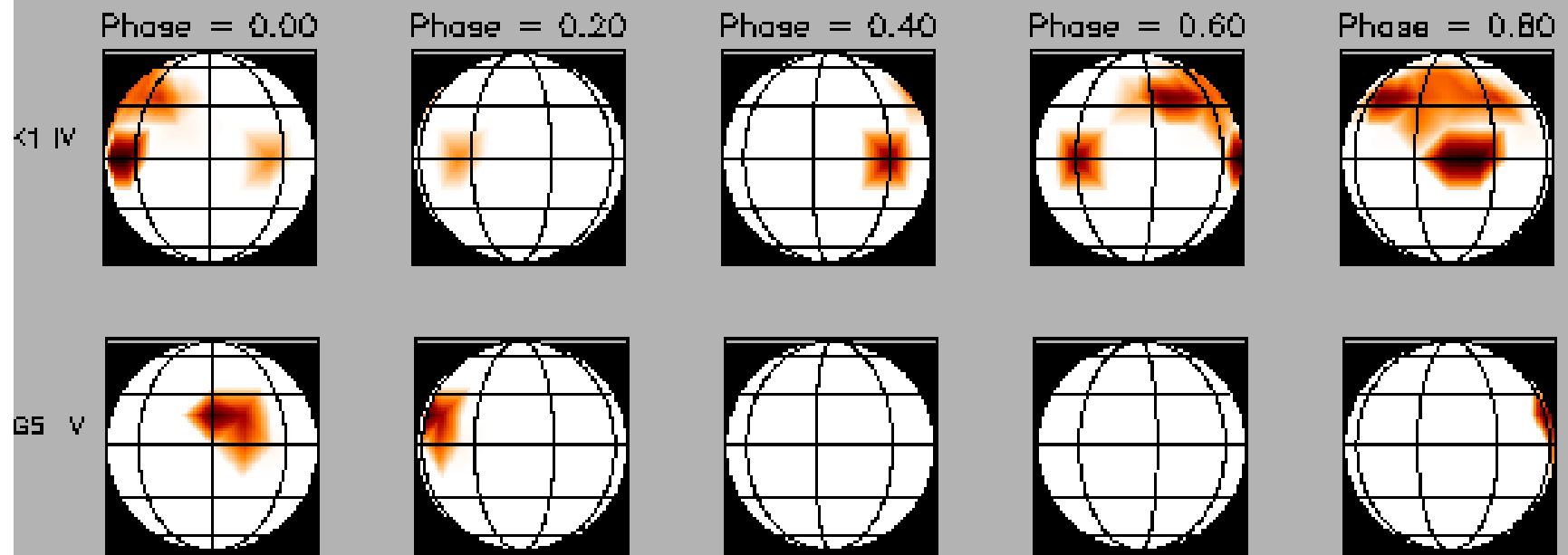
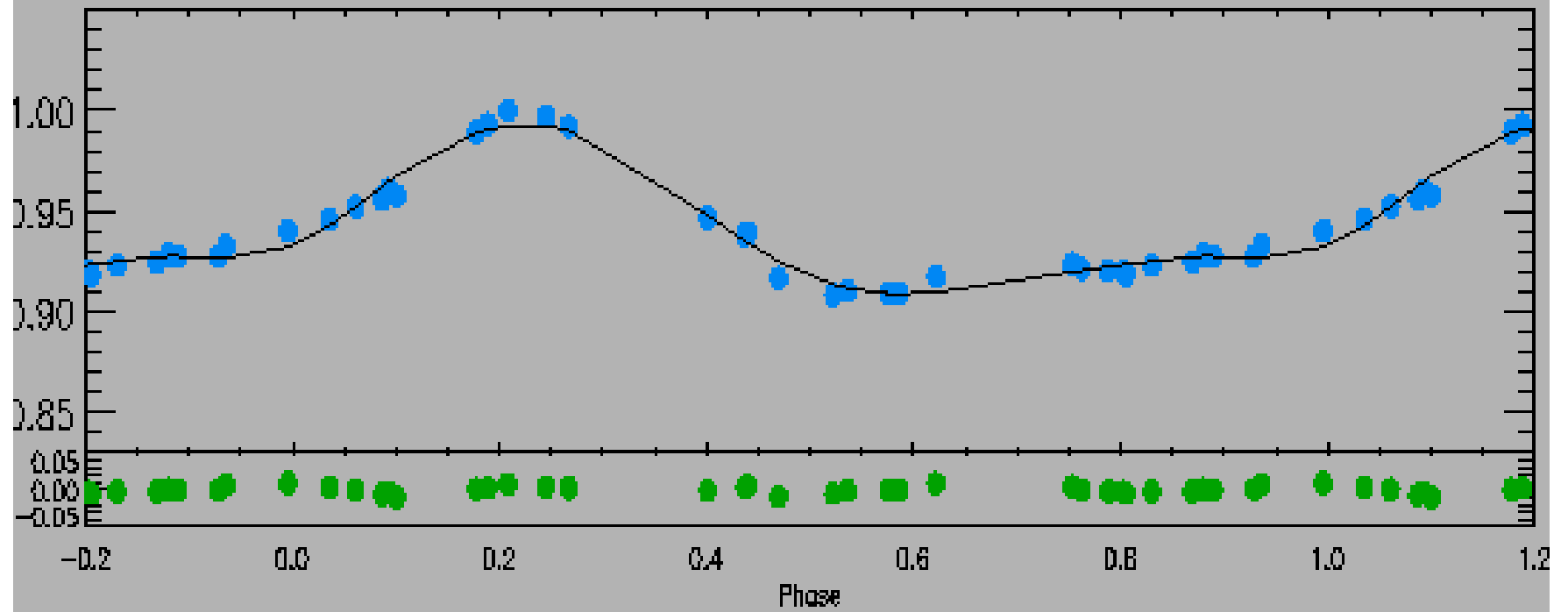
<http://www.aanda.org/articles/aa/full/2006/06/aa3213-05/aa3213-05.right.html>

Photospheric and chromospheric activity on the young solar-type star HD 171488
(V889 Herculis)
Frasca - K. Biazzo - Zs. Kovári - E. Marilli - Ö. Çakirli
A&A, 518 (2010)



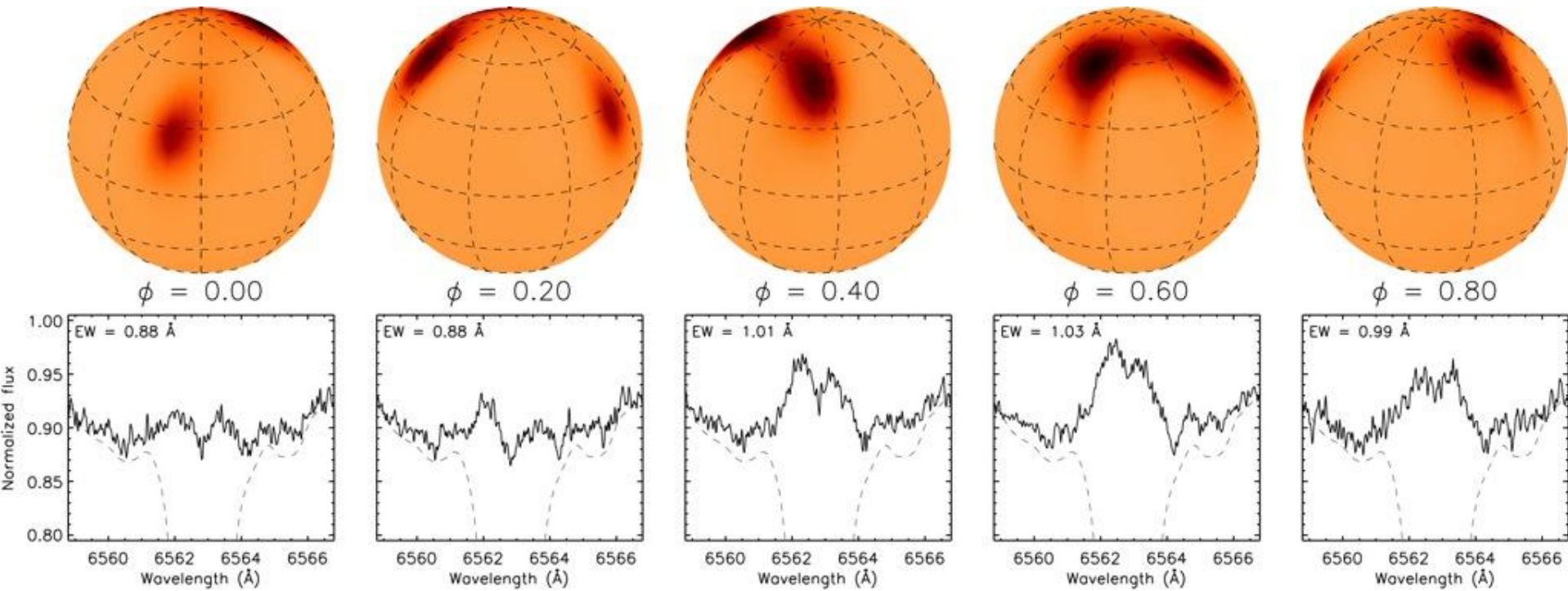


HR 1099 1998.89 V band - MEM maps



Short-term evolution and coexistence of spots, plages and flare activity on LQ Hydrae [SSA]

Posted on October 18, 2016 by arxiv
<http://arxiv.org/abs/1610.05067>



Spots, plages, and flares on λ Andromedae and II Pegasi*

A. Frasca¹, K. Biazzo¹, G. Tag², S. Evren², and A. C. Lanzafame³

560

A. Frasca et al.: Spots, plages, and flares in λ And and II Peg

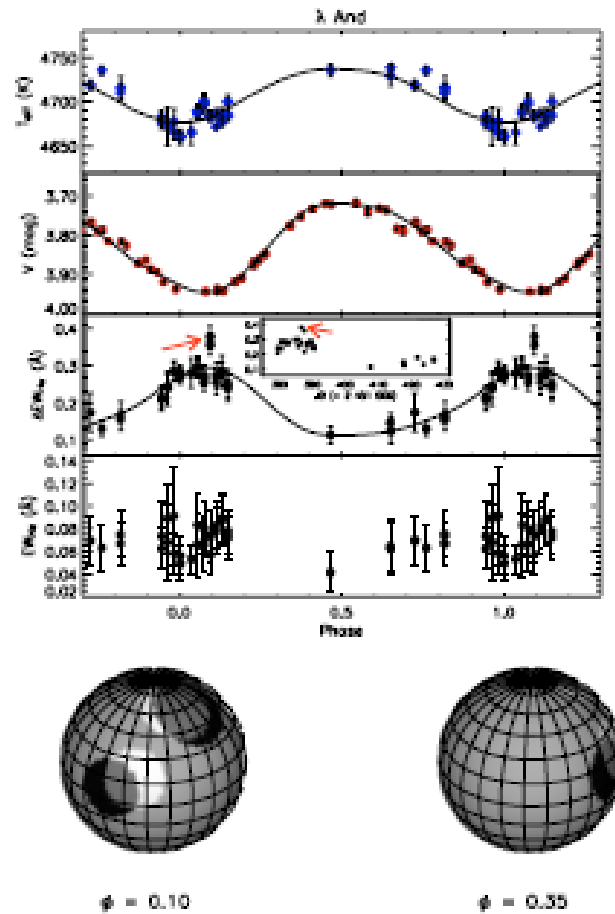


Fig. 2. From top to bottom. T_{eff} , Johnson V photometry, $\Delta EW_{\text{H}\alpha}$, and $EW_{\text{H}\alpha}$ as a function of the rotational phase for λ And. The synthetic temperature, light, and $EW_{\text{H}\alpha}$ curves, calculated with our spot/plage model (see Sect. 5), are reproduced with full lines in each box. The inset displays the $\Delta EW_{\text{H}\alpha}$ versus Julian Day. The arrows mark a possible flare event. A schematic map of the spot and plage distributions, as seen at two different rotational phases, is also shown at the bottom.

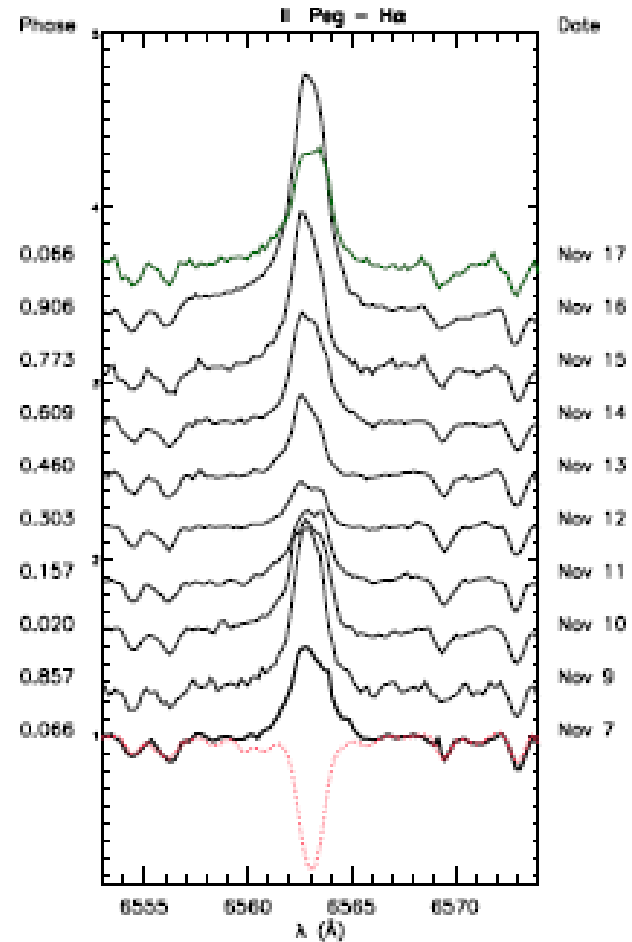


Fig. 3. Time series of the H α profile of II Peg (full lines), together with the non-active template (dotted line). Note the very strong H α profile with broad wings observed during a strong flare on November 16 followed by a nearly “normal” emission profile the next night (thin line).

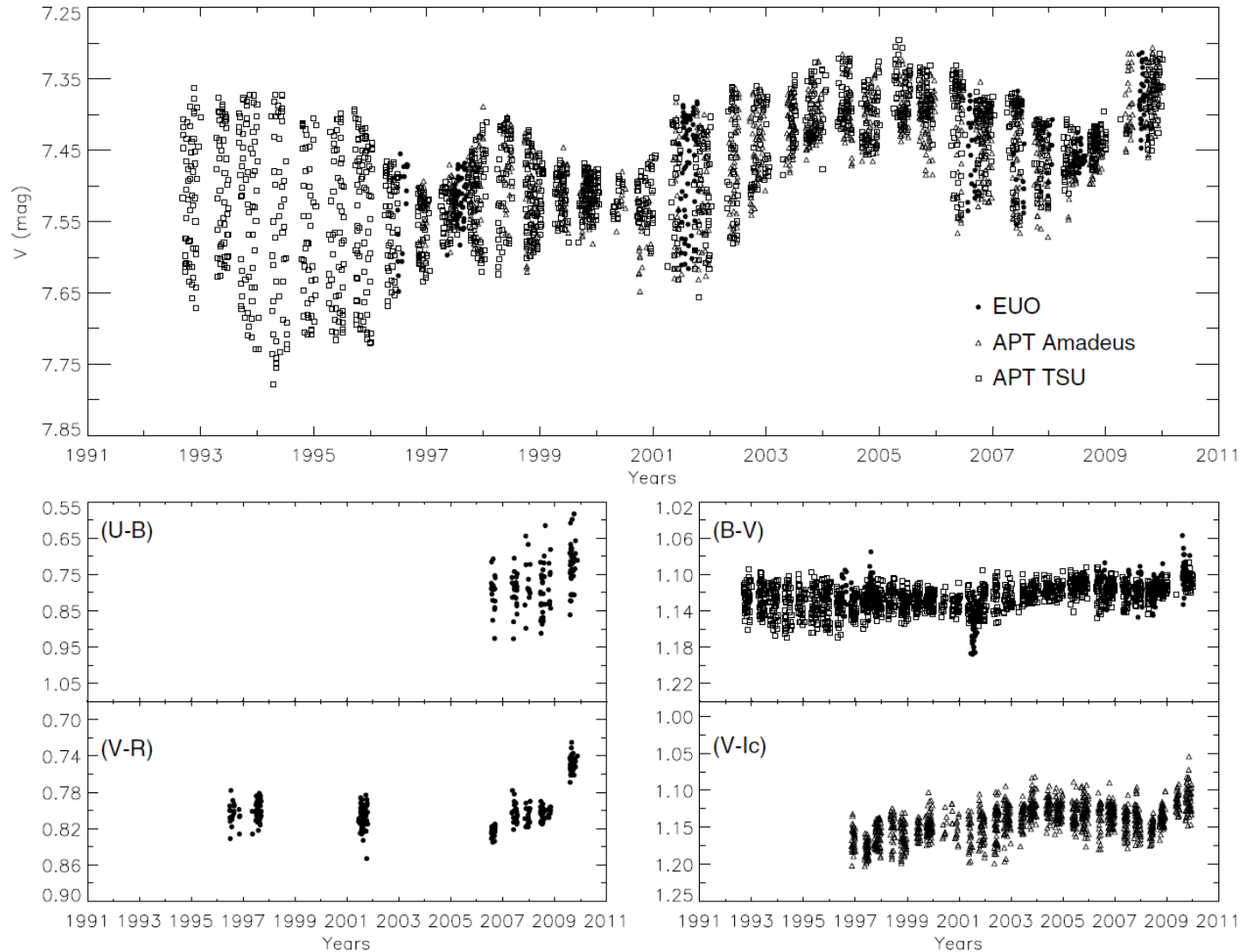
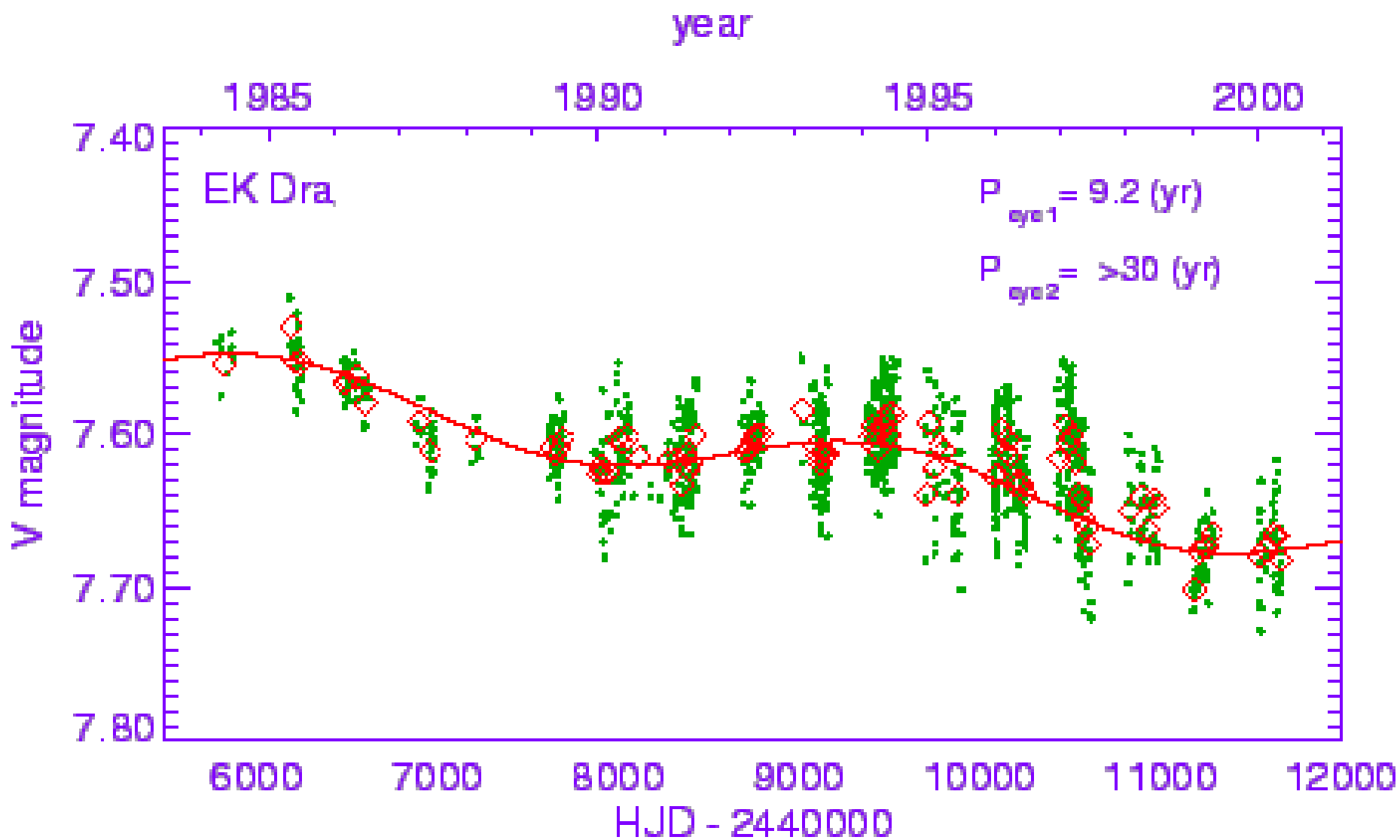
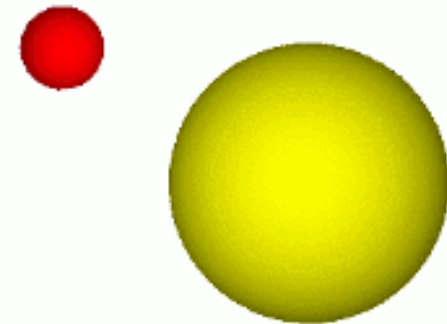
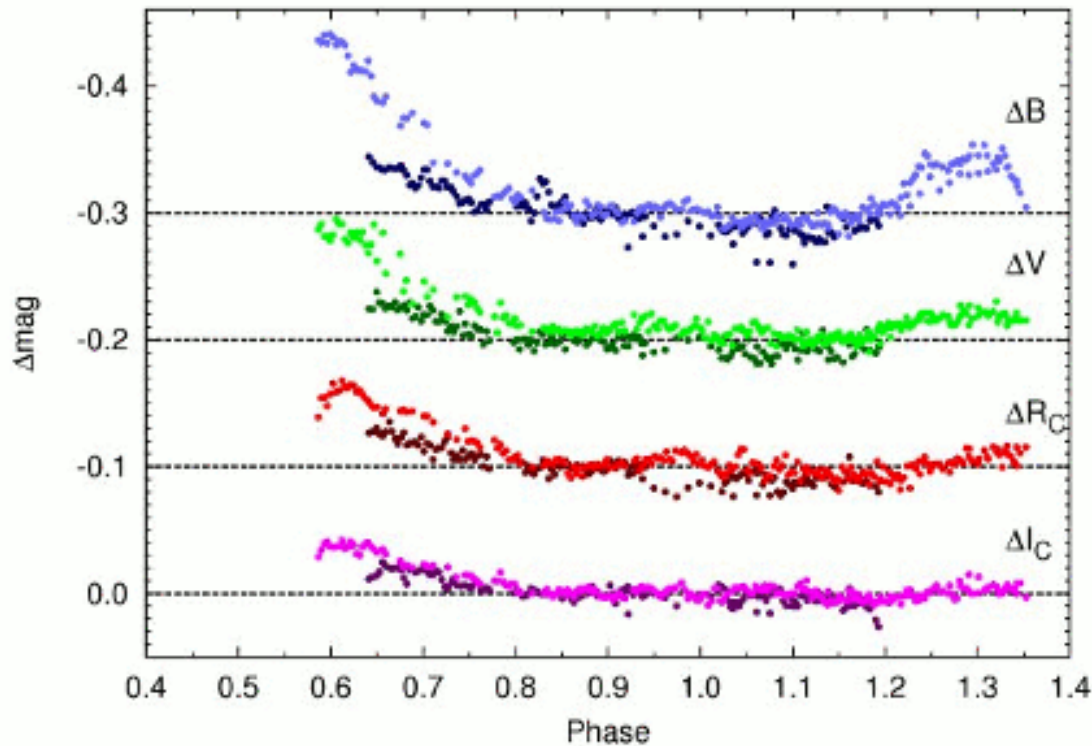
O. Özdarcan^{1,2,**}, S. Evren¹, K.G. Strassmeier², T. Granzer², and G.W. Henry³

Fig. 1 Seventeen years of V -band photometry of HD 208472 (*upper panel*) together with all available color indices (*lower panels*). Open squares denote data from the TSU 0.40 m APT, open triangles denote data from the 0.75 m Amadeus APT, and filled circles represent EUO data.

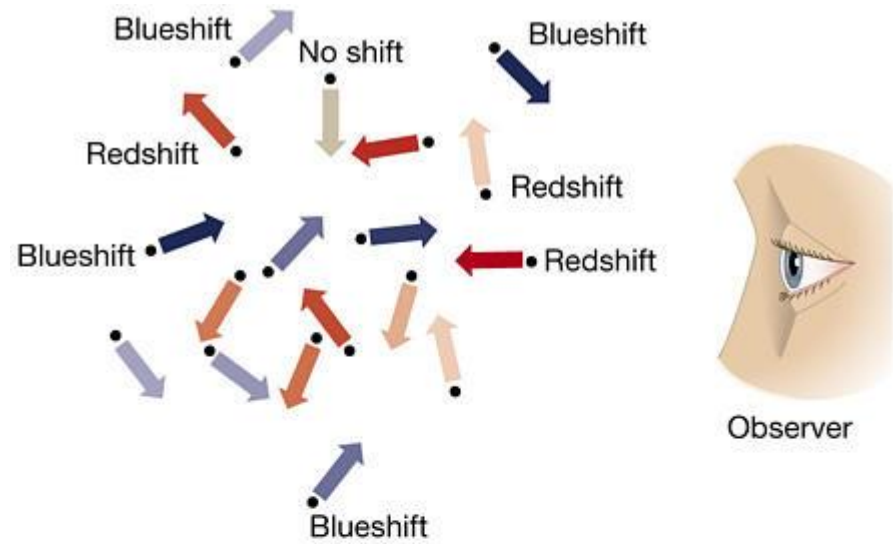
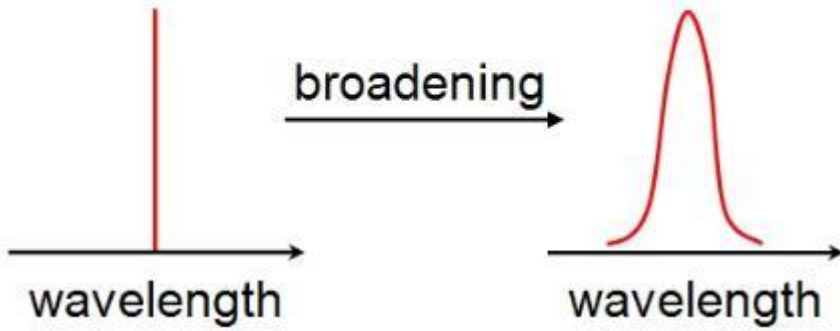


fast-rotating ($P_{\text{orb}}=P_{\text{rot}}=0.465\text{d}$), active dwarf binary V405 And (M0V+M5V)

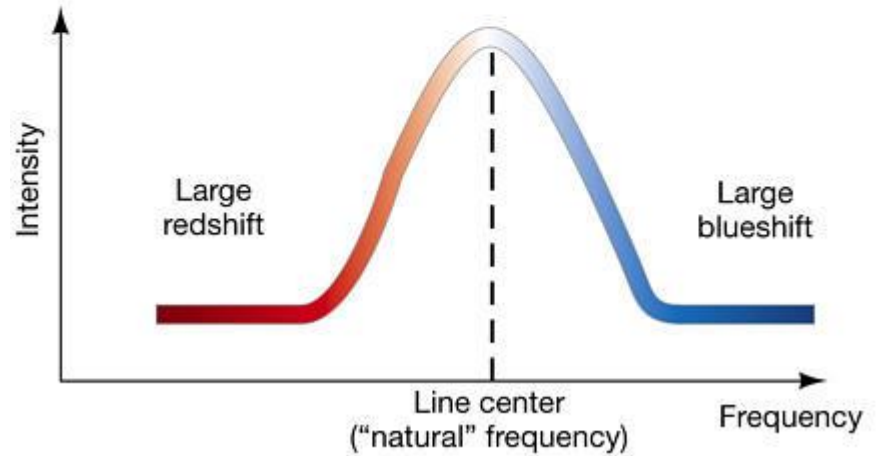


phase = 0.40

Spectral-line broadening

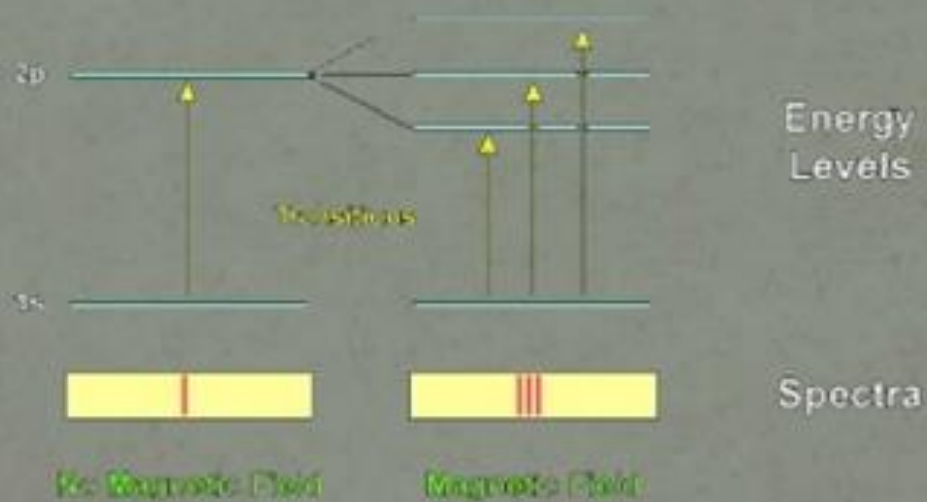


(a)



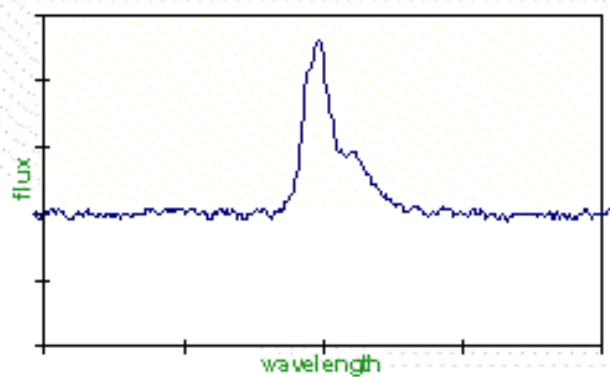
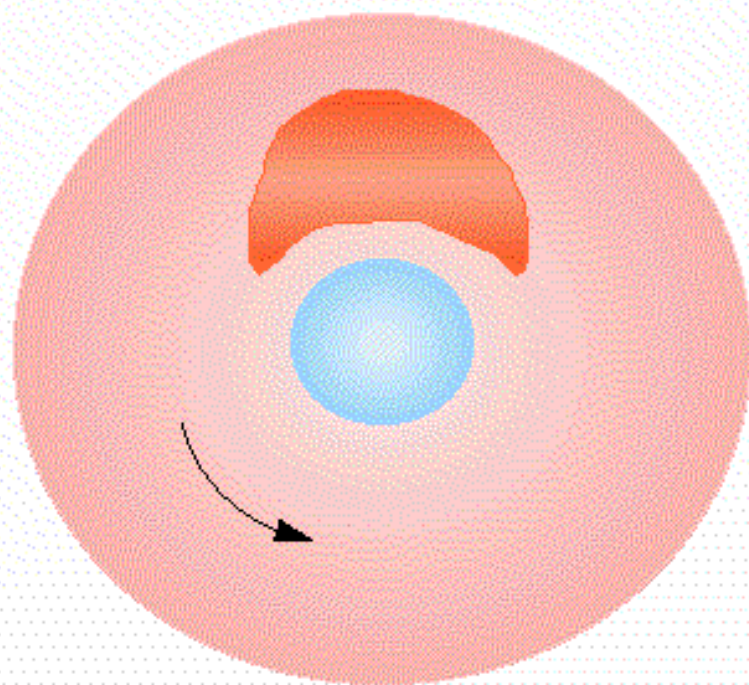
(b)

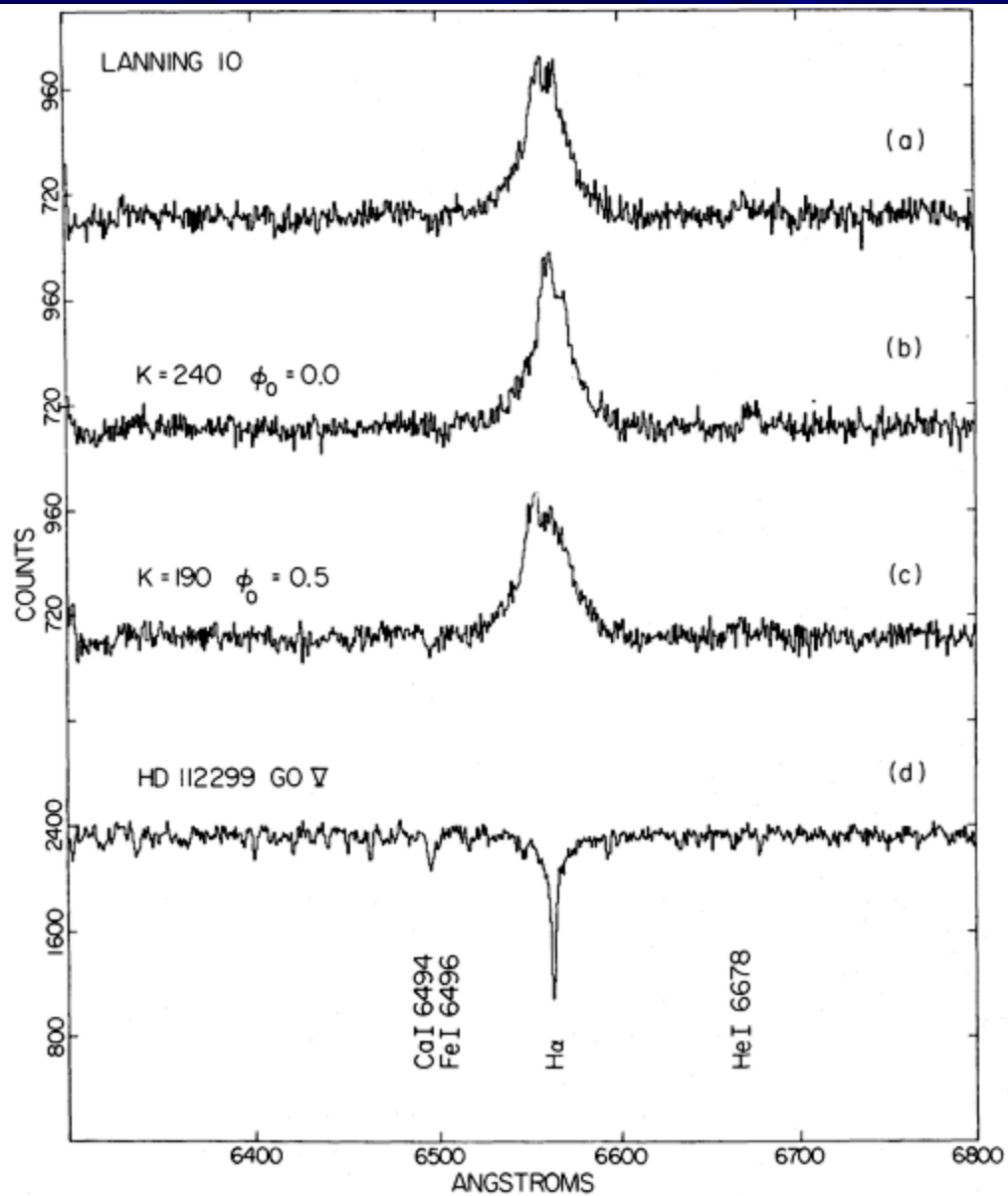
Zeeman effect



V/R variability in the H α line of LS I +61 235

observer

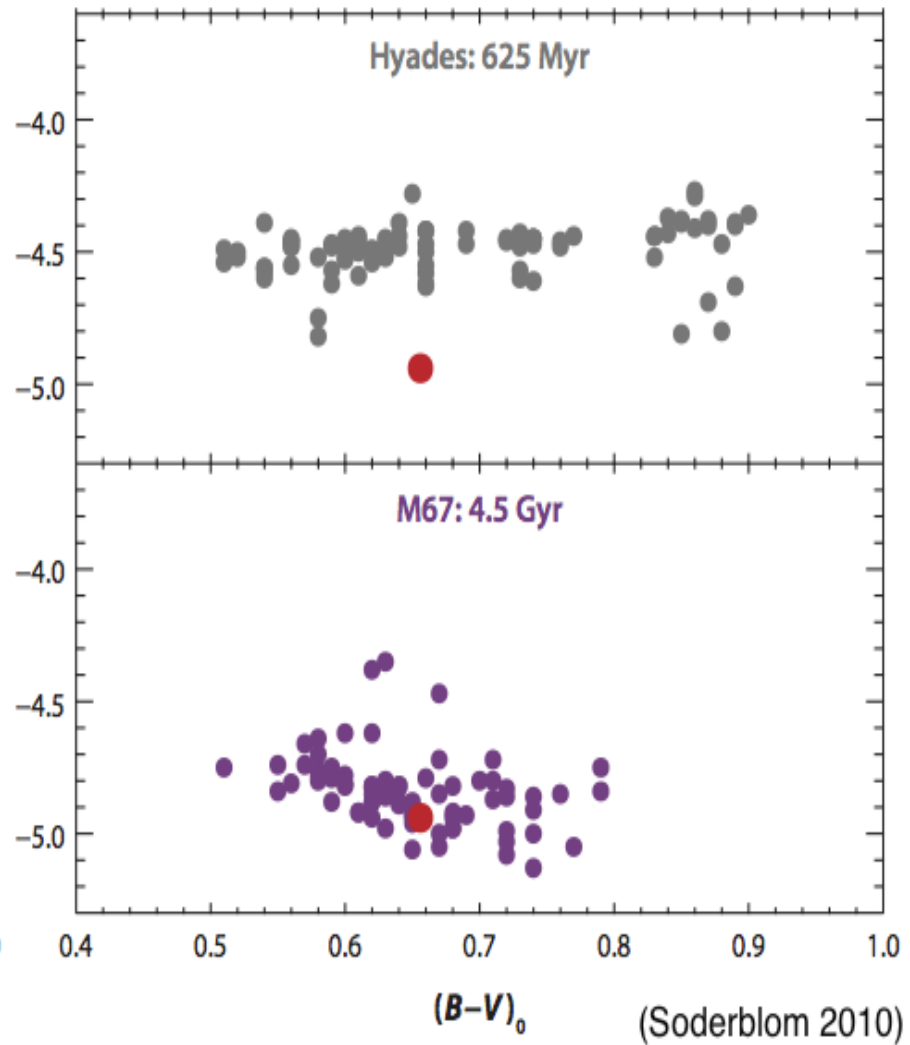
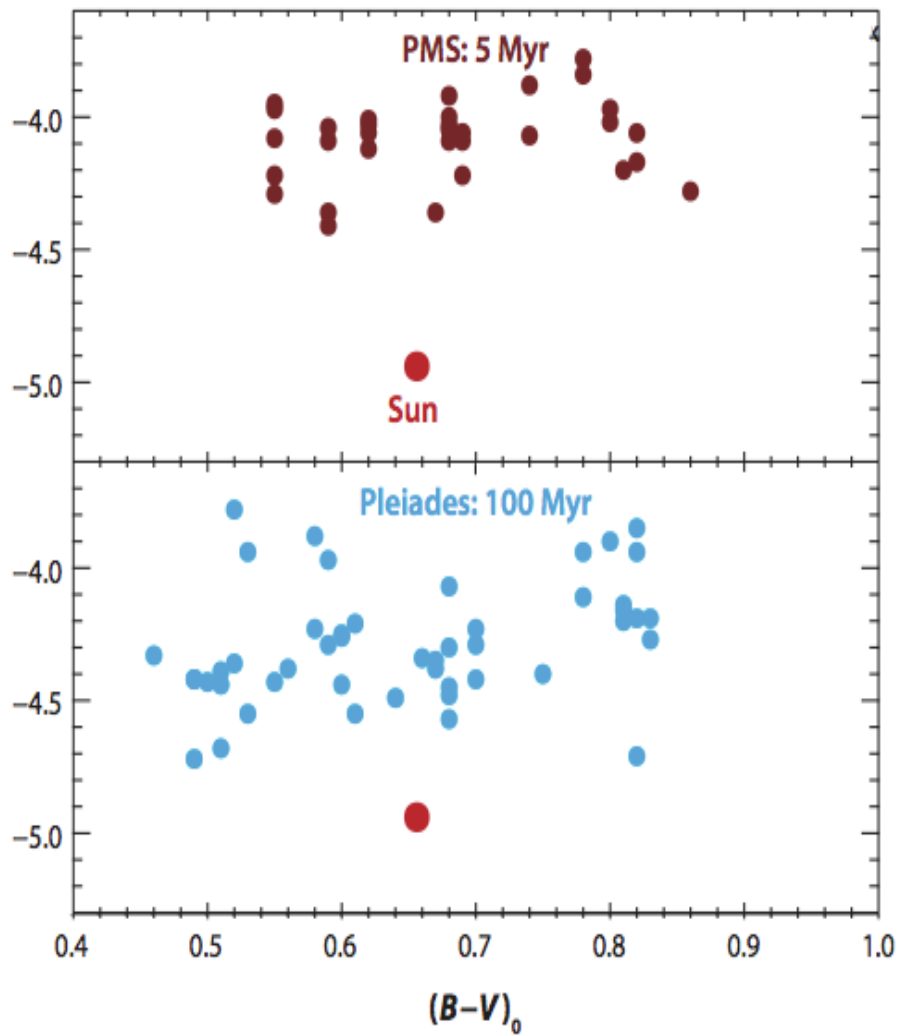


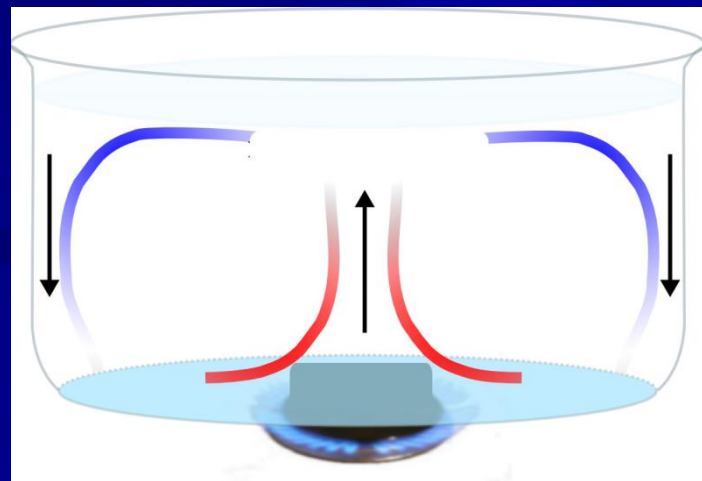
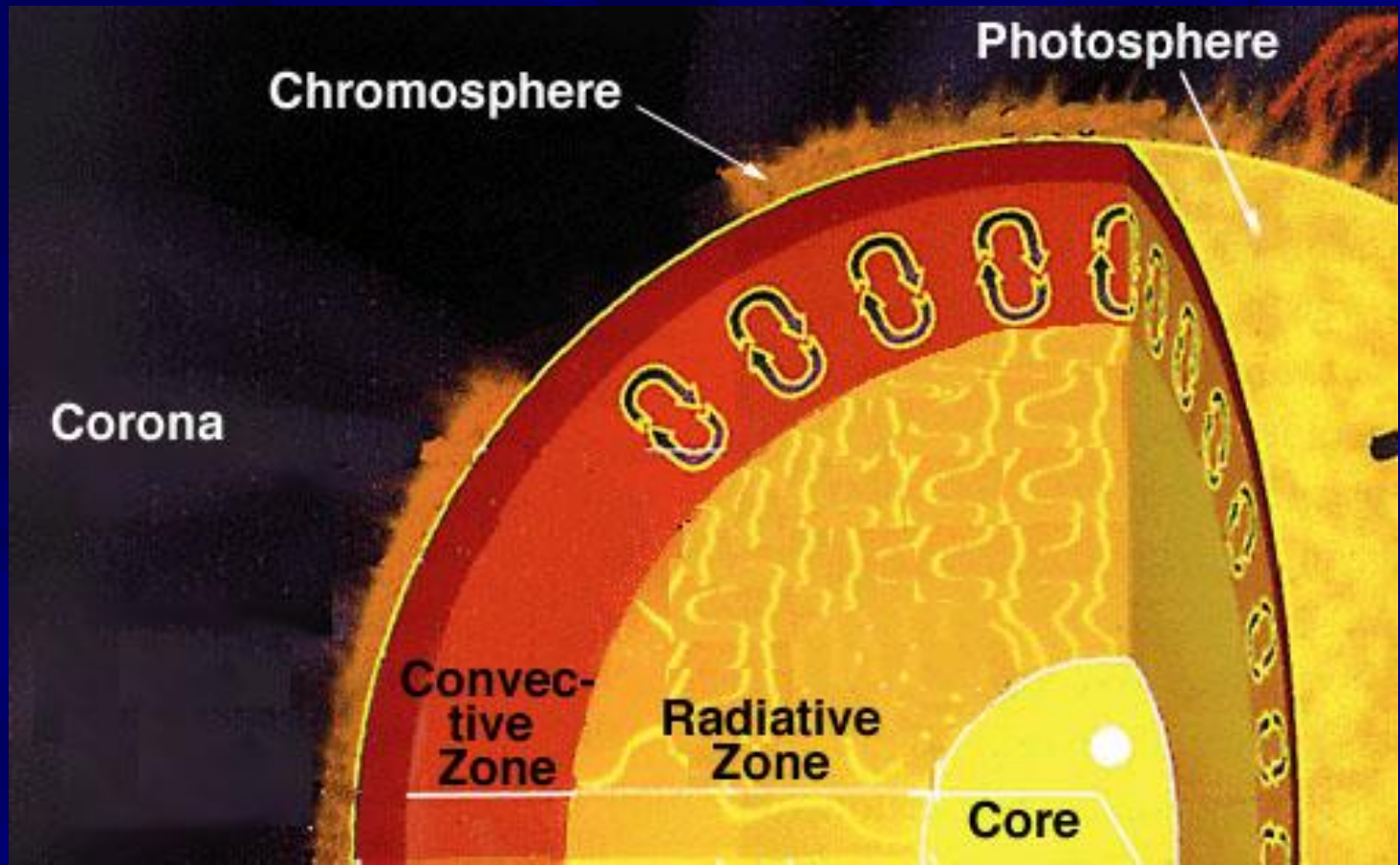


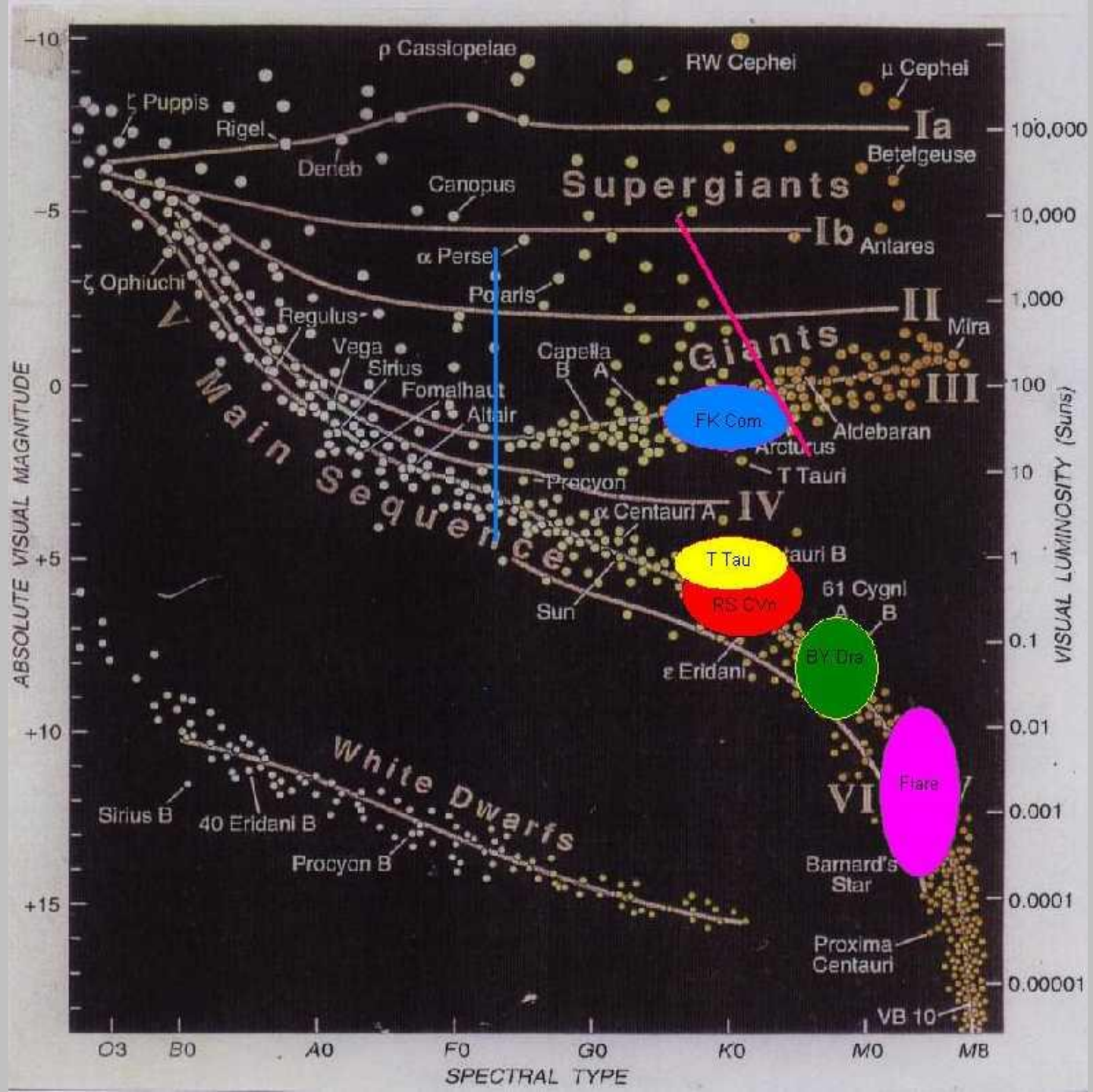
H-R DİAGRAMINDA AKTİVİTE

- Konvektif zarf → Manyetik aktivite için gerekli, fakat yeterli değil
- Gerekli → Çünkü, aktivite belirteçleri yalnız konvektif zarflı yıldızlarda bulunur.
- Konvektif Zarflı Yıldızlar → Bulgurlanma sınırının sağ tarafında

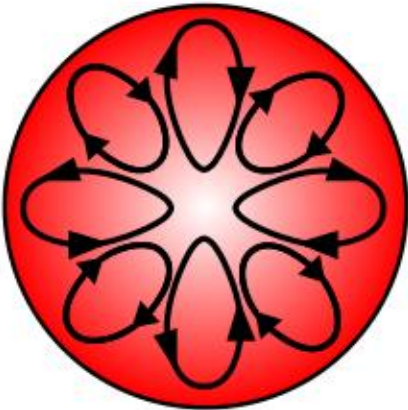
Chromospheric Emission



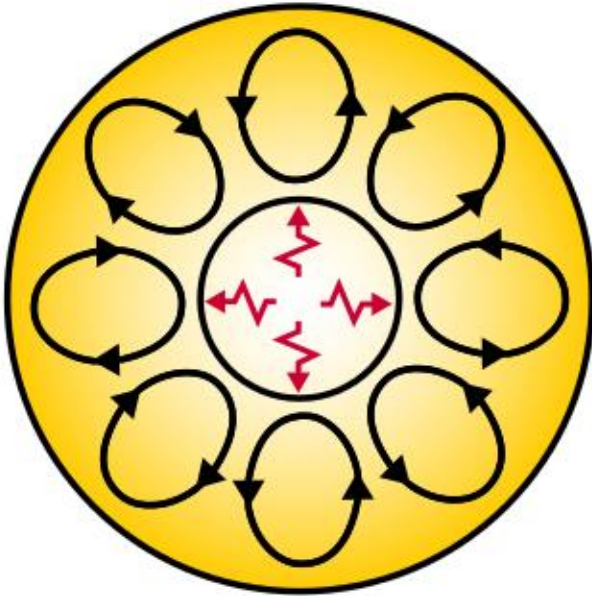




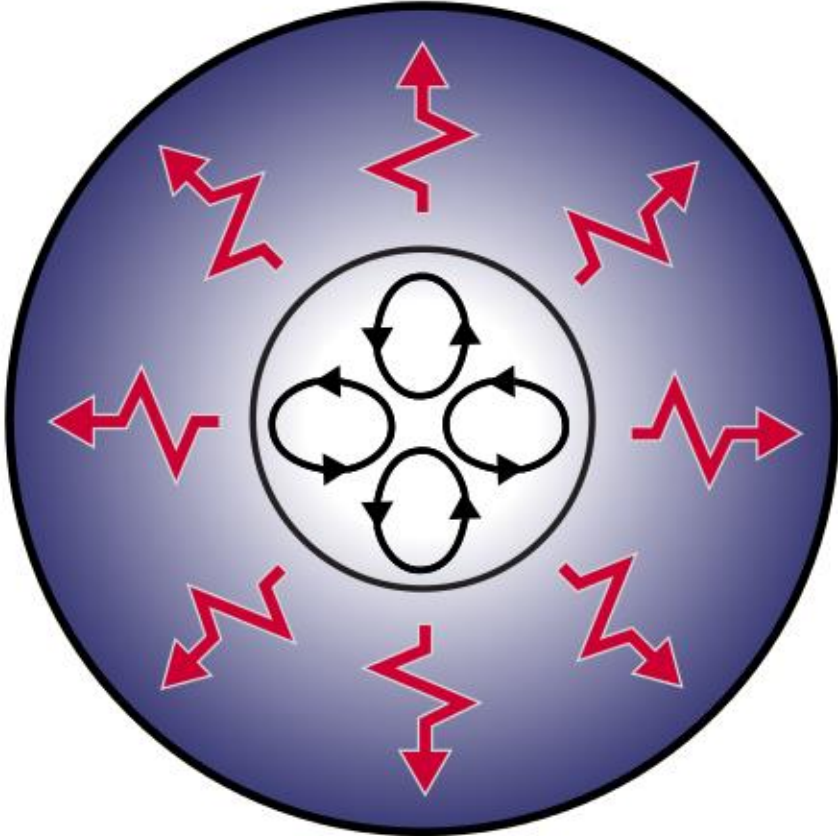
- Aktivite → Dönme hızına da bağlı
- Anakol yıldızları arasında, en aktif tek yıldızlar, ZAMS'a yeni ulaşmış, hızlı dönen yıldızlardır.
- Bu yıldızlar, manyetik frenleme yüzünden hemen yavaşlamaya başlar ve aktivite düzeyleri azalır.



$M < 0.5$



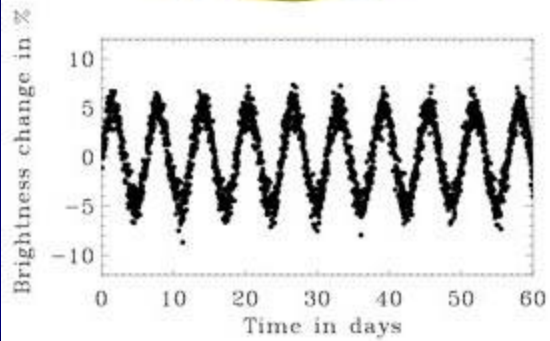
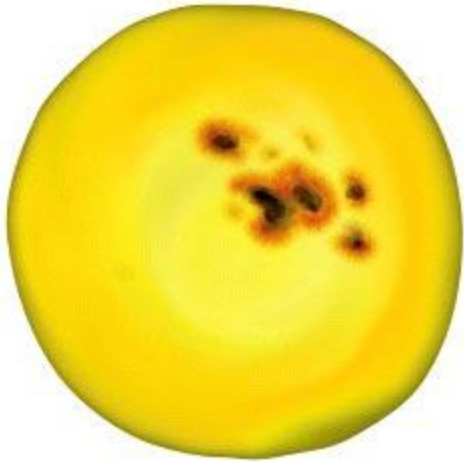
$0.5 - 1.5$



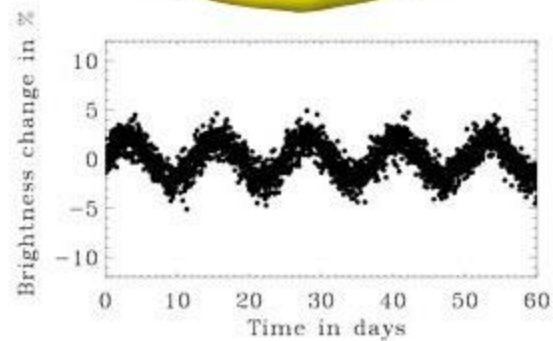
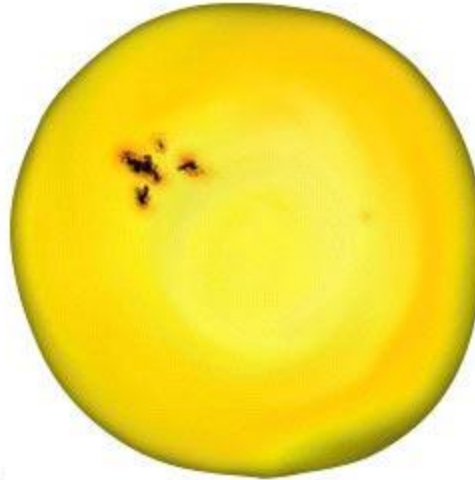
$M > 1.5$

Yaş-Aktivite ilişkisi

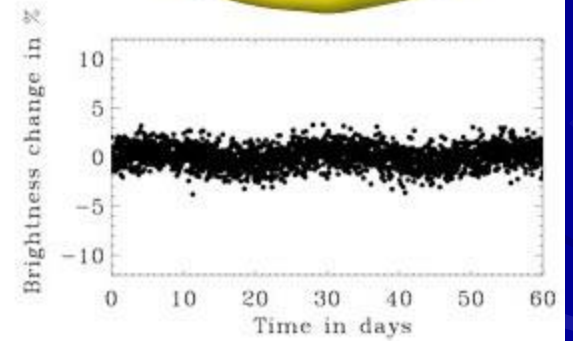
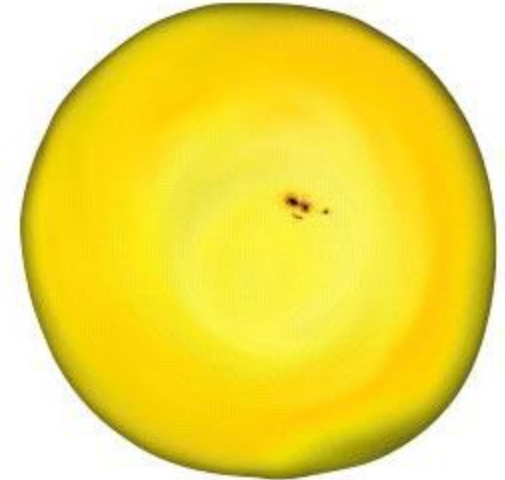
100 million old star



1 billion old star

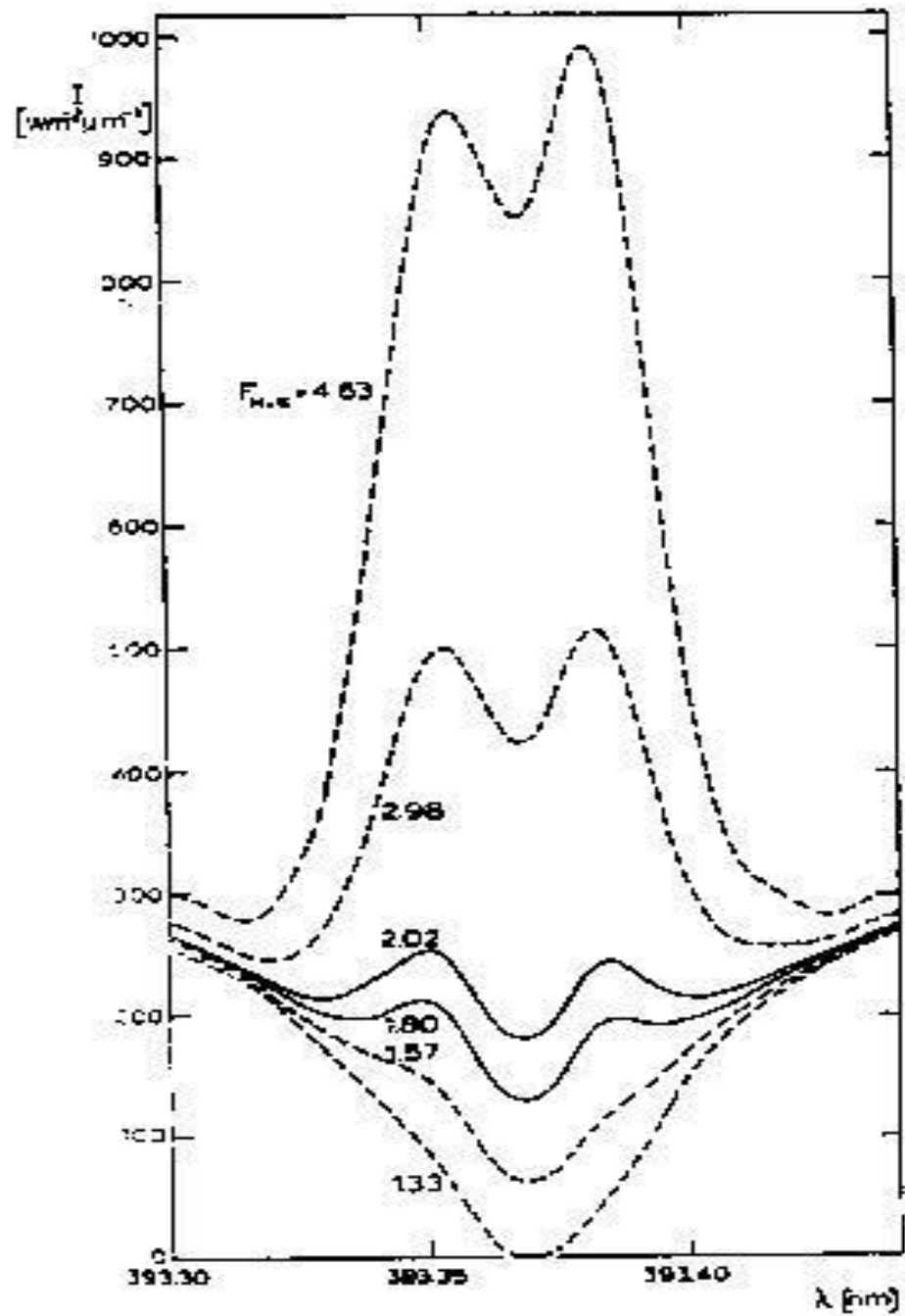


5 billion old star



- Anakol boyunca, F'den M'ye kadar
F \rightarrow sıg bir konvektif zarf
M \rightarrow tamamen konvektif
- Anakol sonrasında \rightarrow desenler karmaşık
Ca II H&K verisi
IUE ve EINSTEIN uydu gözlemleri
- 500 evrimleşmiş yıldızın kromosferik aktivite çalışması (Wilson 1976)
- Ca II H&K salma çizgi çekirdeği şiddetlerinin sınıflaması

Ca II K çizgi profili



DIŐ ATMOİFERİ GÖRÜNTÜLEME

- Soğuk yıldız atmosferlerinin yapısını keşfetmeye yarayan beş temel yöntem vardır:
 - Doğrudan görüntüleme
 - Girişimölçüm
 - Tutulmaların kullanıldığı haritalama
 - Doppler görüntüleme
 - Dönmeden kaynaklanan deęişimin haritalanması

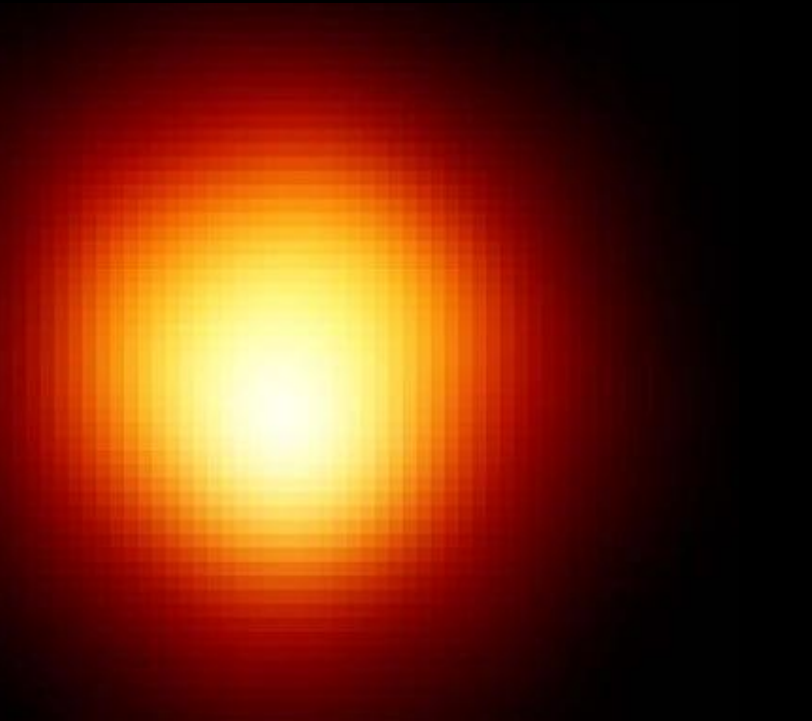
1. DOĐRUDAN GÖRÜNTÜLEME

Gilliand, R.L. ve Dupree, A.K. 1996, ApJ. 463L, 29

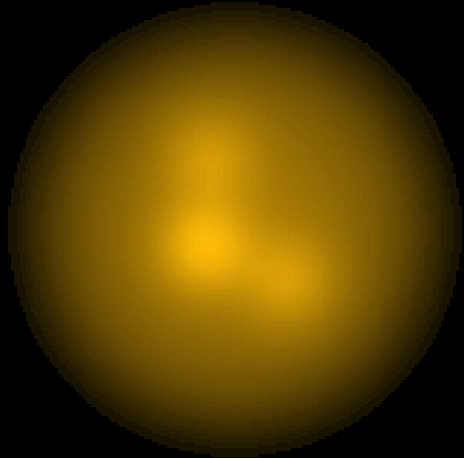
“First Image of the Surface of a Star with the Hubble Space Telescope”

Betelgeuse (M2 Iab)

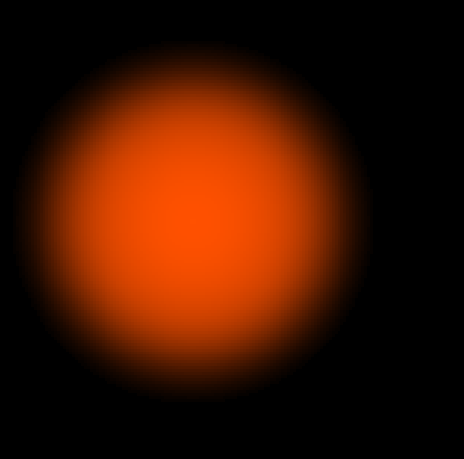
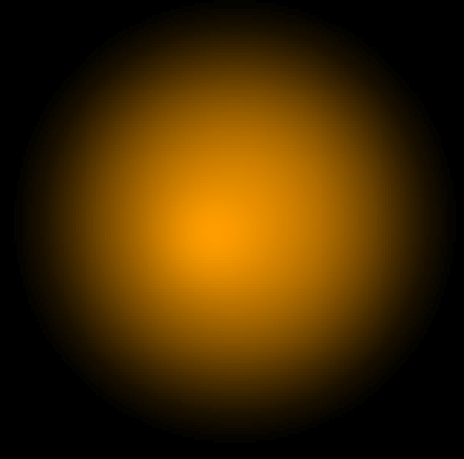
- Kromosferin yarıçapı:
2 yıldız yarıçapı
- Sıcak leke



Young et al. 2000, MNRAS 315, 635



- Betelgeuse
- William Herschel Telescope
- 700 nm
- 905 nm
- 1290 nm
- Ayırma gücü 20-30 milyaysaniye
- Kasım 1997

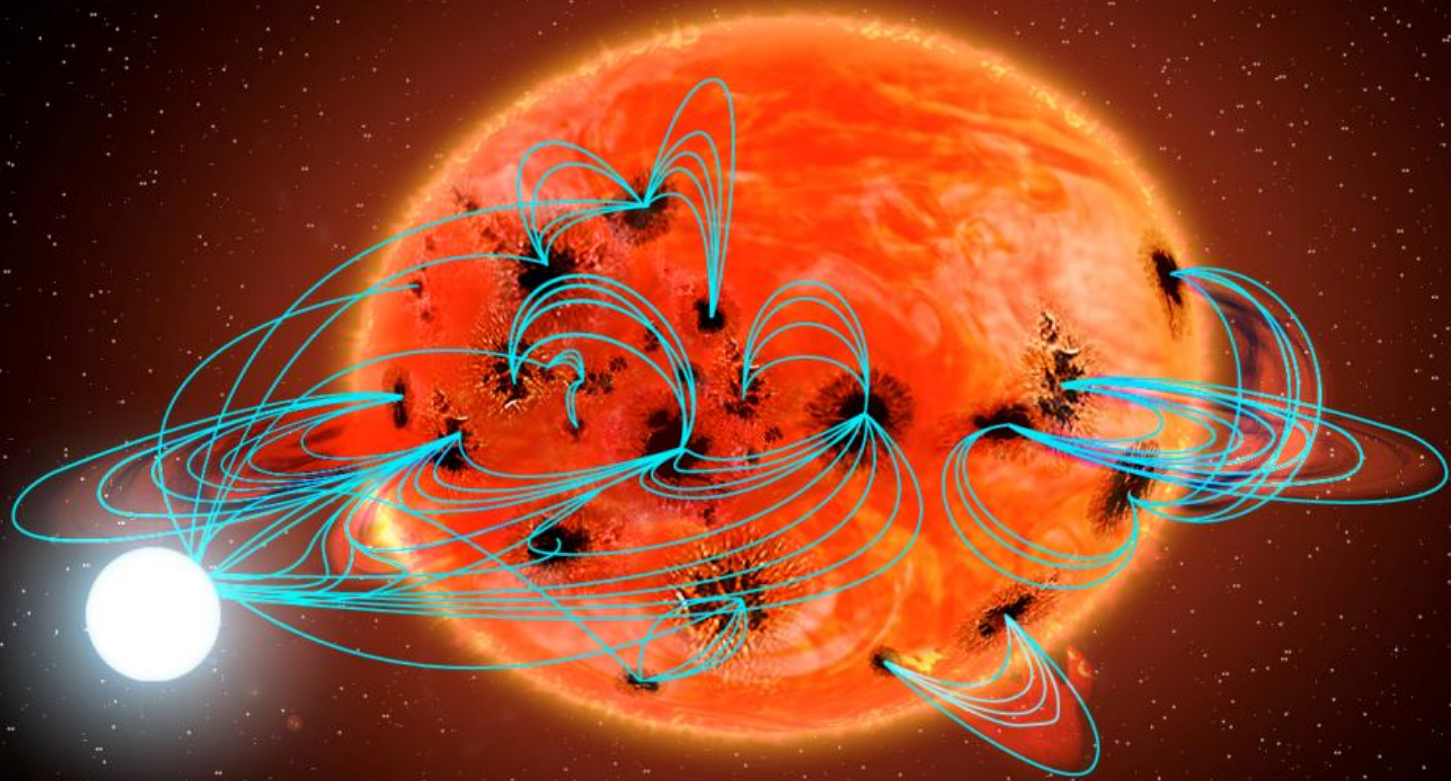


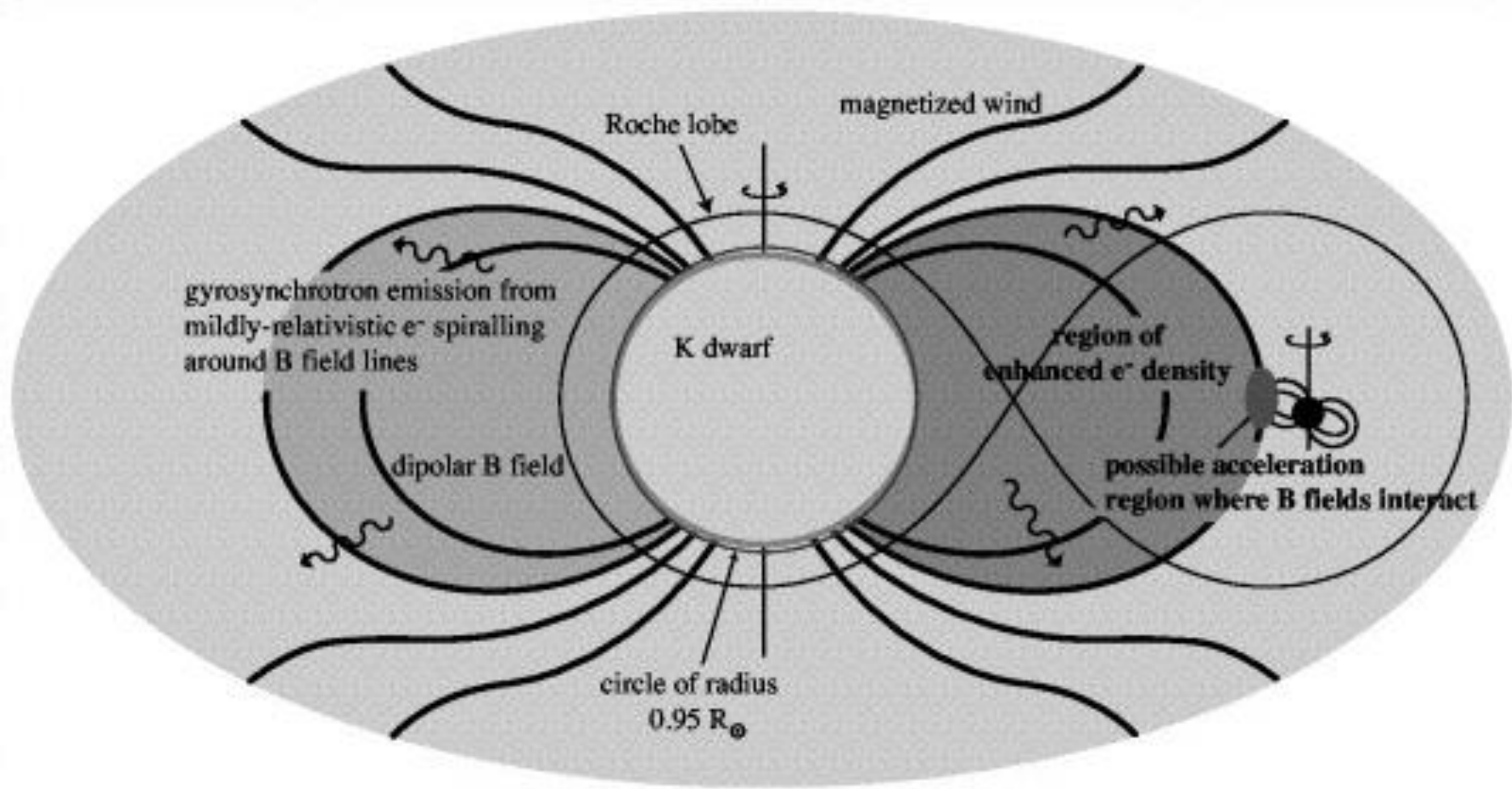
2. GİRİŞİMÖLÇÜM

- Yakın çift yıldızlarda veya anakol öncesi genişlemiş kaynaklarda kullanılır.
- Radyo dalgalarında iyi sonuç verir.
- ESO-VLT ile yüzlerce soğuk yıldızın diski çözümlenmiş

3. TUTULMALARIN KULLANILDIĐI HARİTALAMA

- Soğuk anakol + WD
- Soğuk dev + sdOB
- Sıcak ve küçük yarıçaplı bileşenler, genişlemiş atmosfere sahip aktif bileşenin arkasından geçerken dış atmosferin yapısı incelenir
- V471 Tau (K2V+WD); ζ Aur (BV+KII); FF Aqr (sdB+G8III); toplam 12 yıldız





V471 Tau is a well-known eclipsing close binary with a period of 12.5 h, containing a hot DA white-dwarf (hereafter WD) and a detached cool main-sequence K2 companion. Ever since its discovery as an eclipsing binary with a WD component by Nelson & Young (1970), V471 Tau has been an object of considerable importance for two reasons. Interest was at first directed to the WD companion because of its total occultation every half-day: this allowed us to discover its dimensions and thermal properties. Light and radial velocity curve analyses by various researchers revealed the physical parameters of the system. Wave-like distortion in its light curve, as in the RS CVn and BY Dra systems, has been discovered by İbanoğlu (1978). Thereafter, considerable interest has also been directed to the chromospherically active red dwarf (hereafter RD) primary.

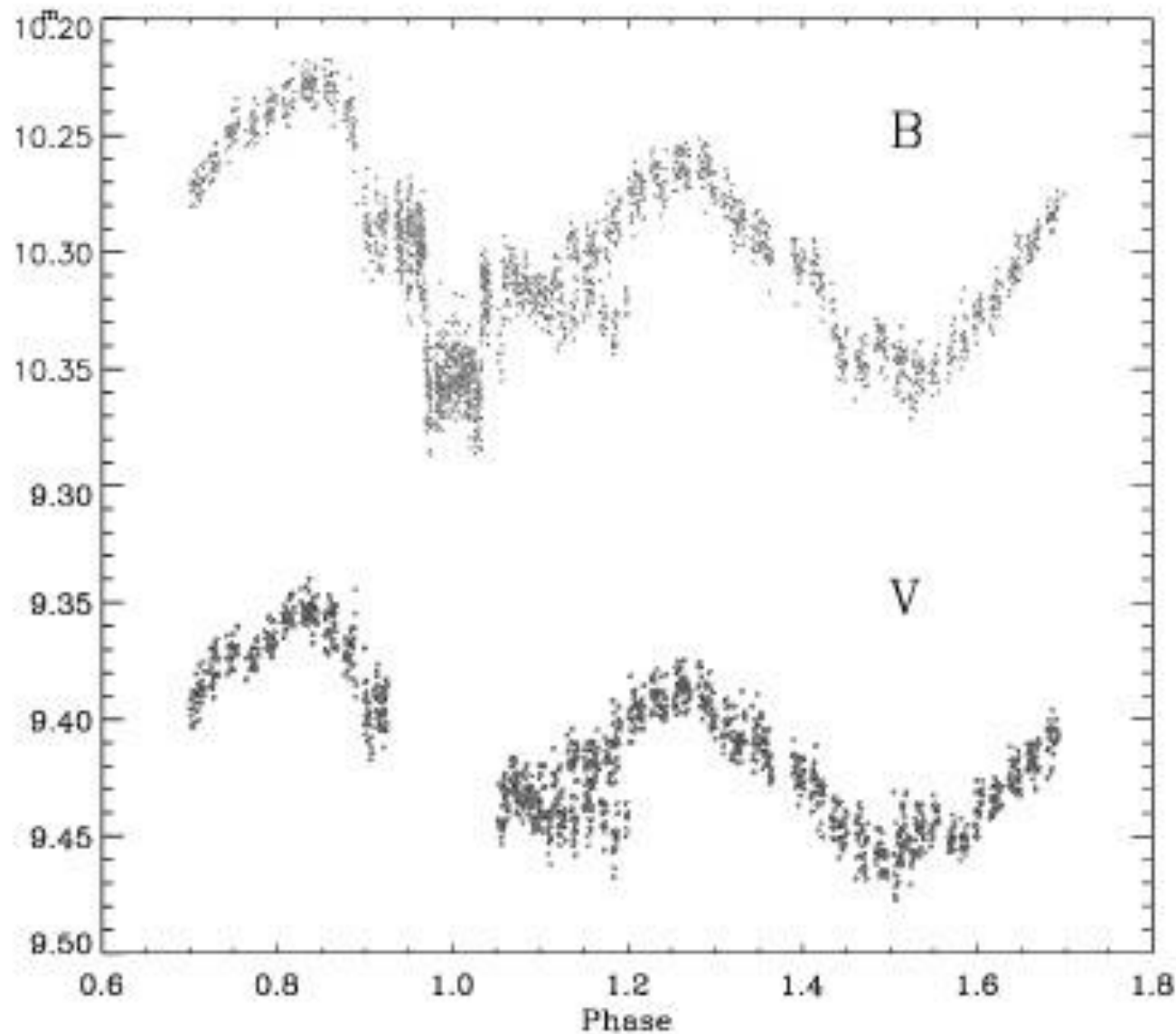


Figure 1. The *B* and *V* light curves obtained in late 2004. During the eclipse of the WD, observations were made only in the *B* band. Note that the two wave minima are separated by about 180° .

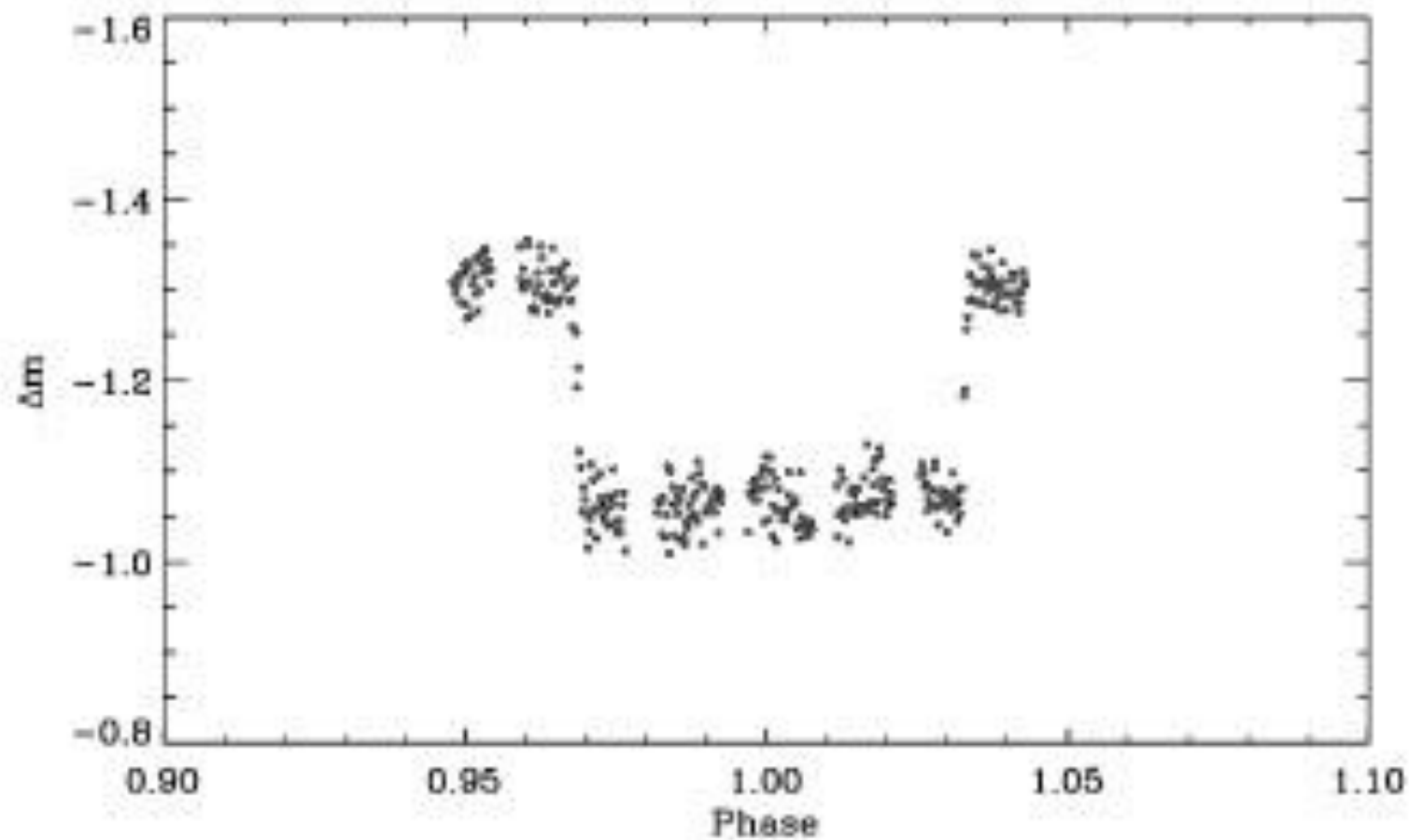


Figure 2. A typical *U*-band brightness variation due to occultation of the white dwarf companion.

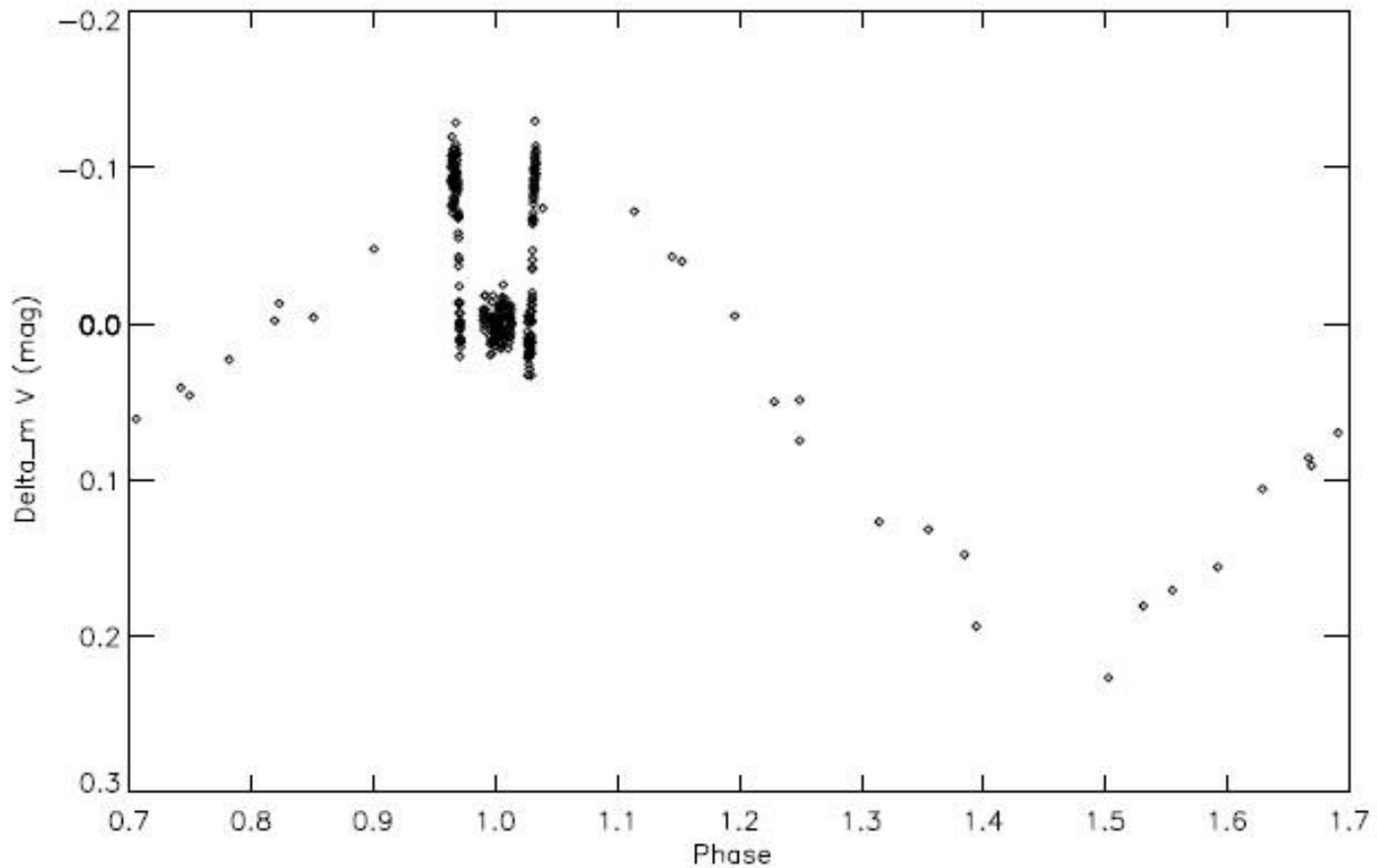


Figure 2. The V light curve of FF Aqr from 2003 observations.

FF Aqr is an eclipsing binary containing a hot subdwarf OB star and a chromospherically active companion as G8 III star.

XY UMa (G2V+K2V)



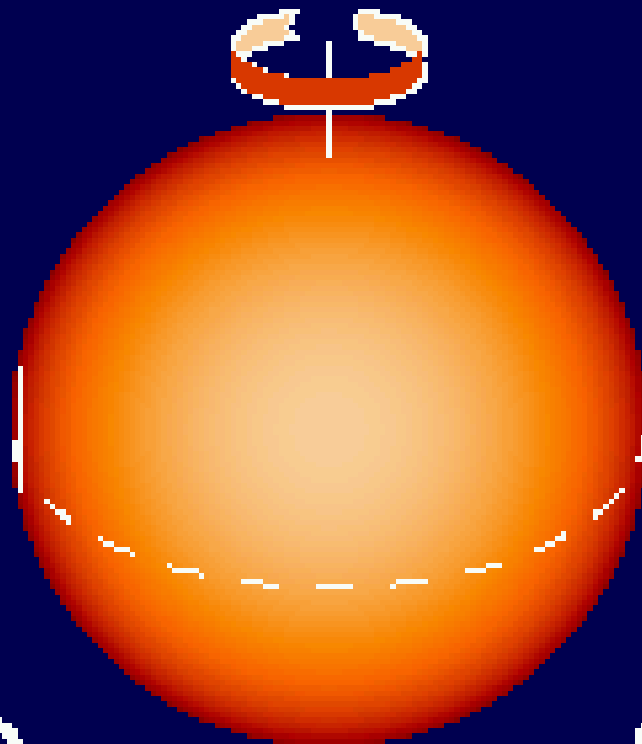
V361 Lyr (F8V+K5)

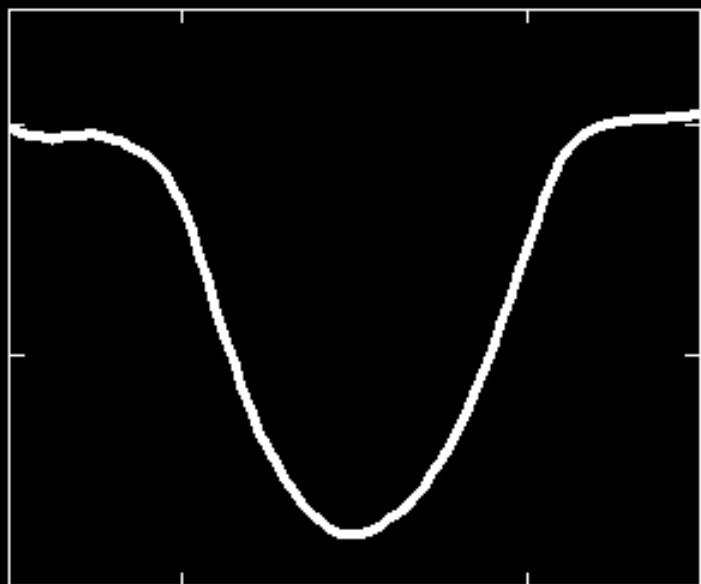
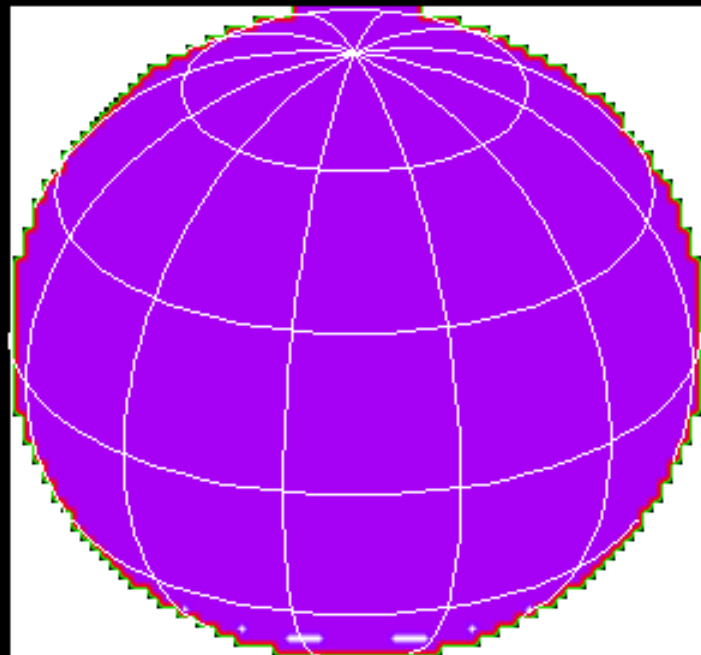


4. Doppler Görüntüleme

- Yüzeydeki yapıların dönmeden dolayı disk üzerindeki hareketi, Doppler etkisinden dolayı çizgi kesitlerinde bozulmalara neden olur.
- Sinyalin gözlenen hız genliğinden giderek enlem bilgisine ulaşılabilir.
- Tekniğin kullanılabilmesi için, bünyesel çizgi genişliğini aşacak bir hızda dönmesi gerekir.

$\phi = 0.00$

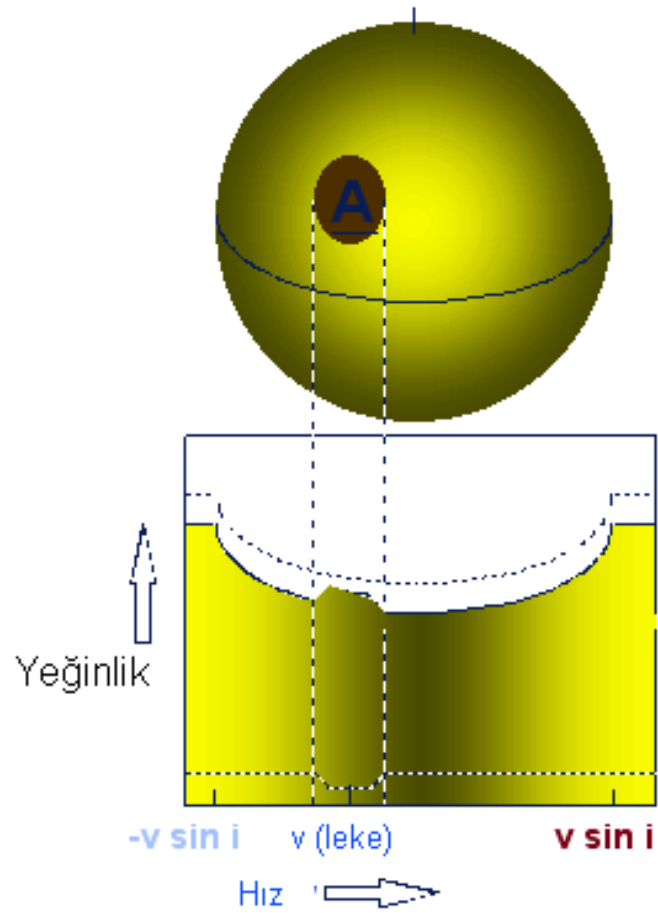
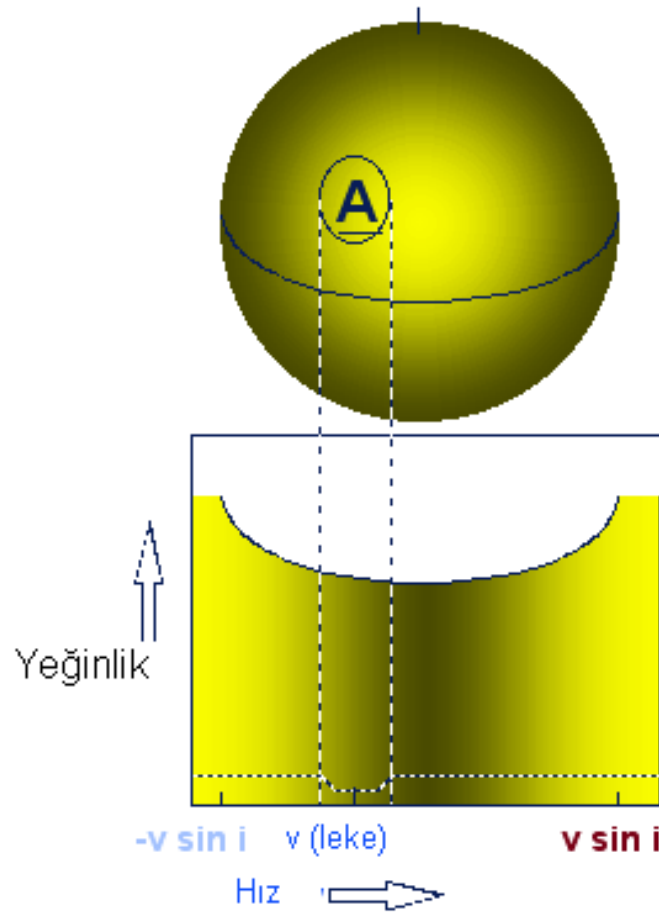




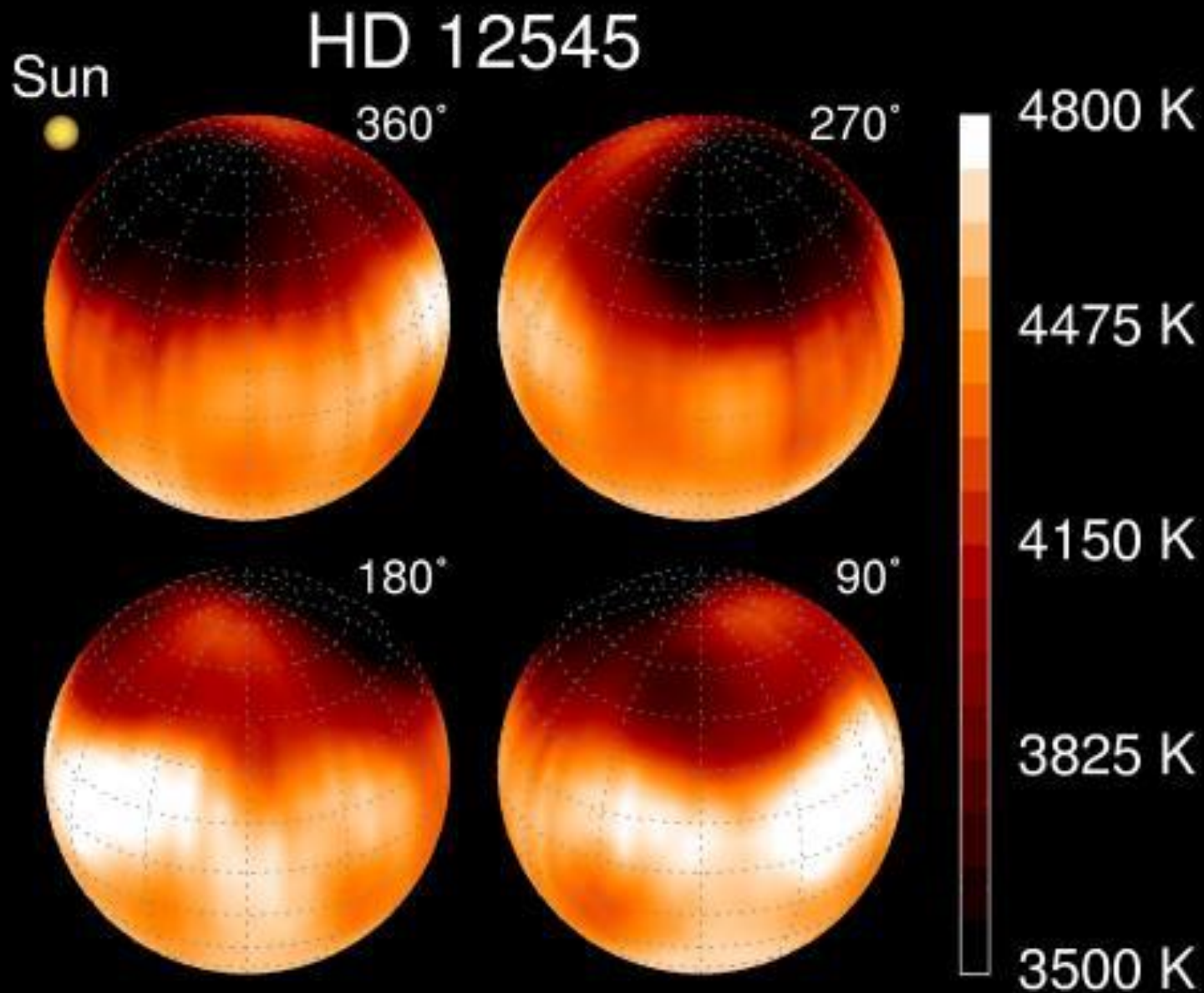
6438

6440

Doppler Görüntüleme



XX Tri (K0 III)



HII314 Doppler Image

phase=0



phase=45



phase=90



phase=135



phase=180



phase=225



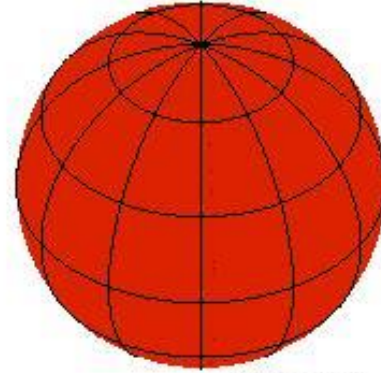
phase=270



phase=315



Grid, Phase=0



4000K

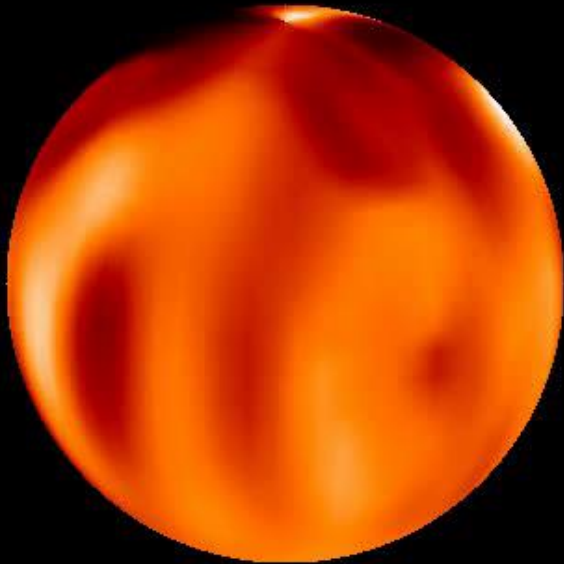
6570K



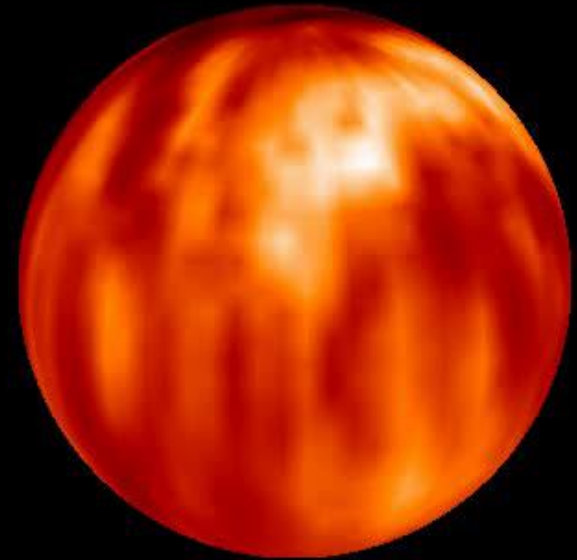
5. Dönmeden Kaynaklanan Değişimin Haritalanması

- Aktif yapılar yıldız döndükçe parlaklık değişimine neden olur.
- Boylamsal dağılımın haritası
- Anahtar parametre: **LEKE ÖMRÜ**
- Aktif yapıların yaşam süresi, dönme döneminden büyük olmalıdır.
- Bu şekilde dönme dönemi çok iyi saptanabilir.

V410 Tau (K4, T Tauri türü)



V410 Tau wtts K4 P=1.9d



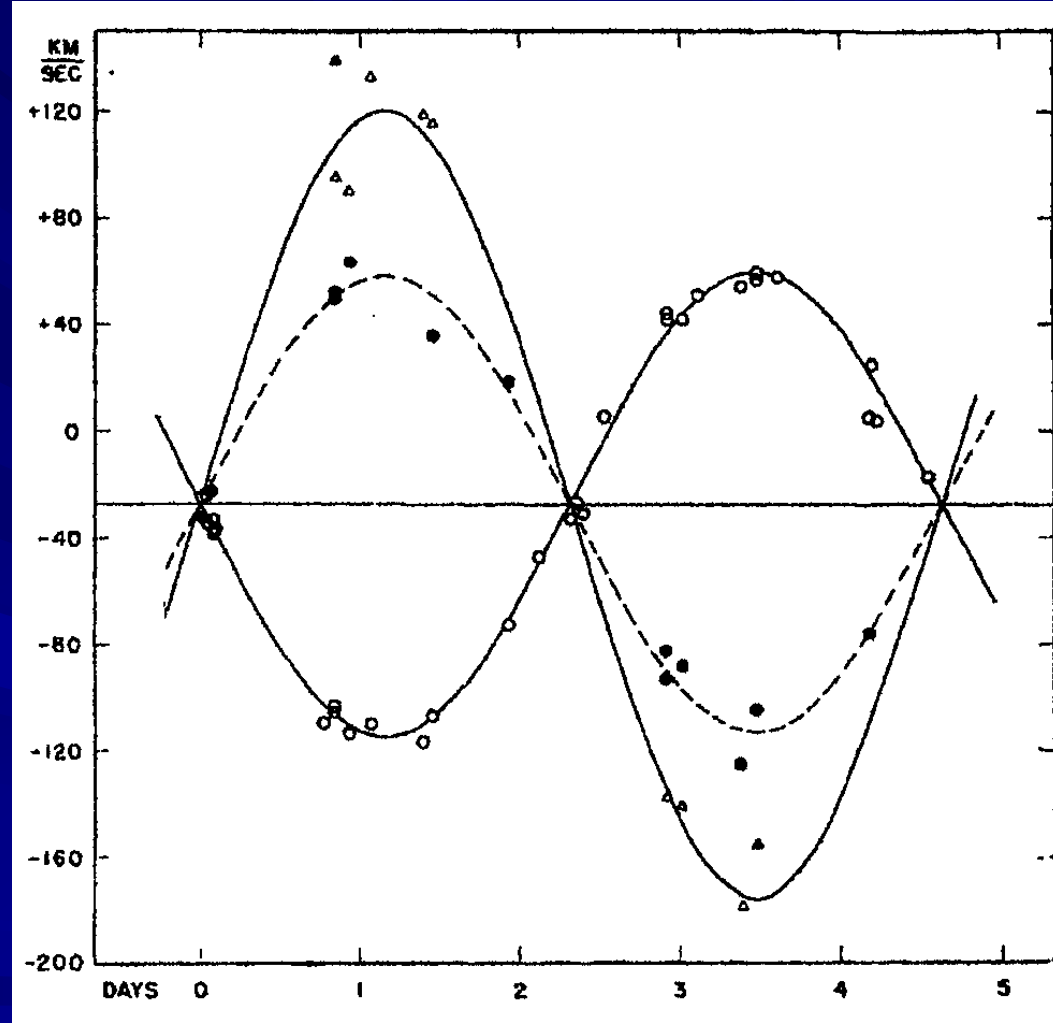
V410 Tau WTTs K4 P=1.9d

RS CVn-türü Aktif Çift Yıldızların Bulunuşu

- Aktif çift (ve tek) yıldızlar içinde bulunan ilk tür
- Adlandırılış → 1976
- İlk bulunuş → tayfsal, 1940'lı yıllar

WW Dra (G2+K0)'nın dikine hız deęiřimi (Joy 1941)

- Örten çift
- tayfta Call H&K salma çizgileri
- Yoldařın soęurma çizgileriyle aynı yönde yerdeęiřtirme
- Yoldař, **kalsiyum gaz zarf** ile sarılmış, çekim etkisinden dolayı baş yıldıza doğru genişlemiş
- Gaz daha küçük yörüngeye sahip



- AR Mon (Sahade ve Cesco 1944)
- SS Boo (Sanford 1945)
- RZ Eri (Cesco ve Sahade 1945)
- RZ Cnc (Hiltner 1946)

Yeni bir grup yıldız

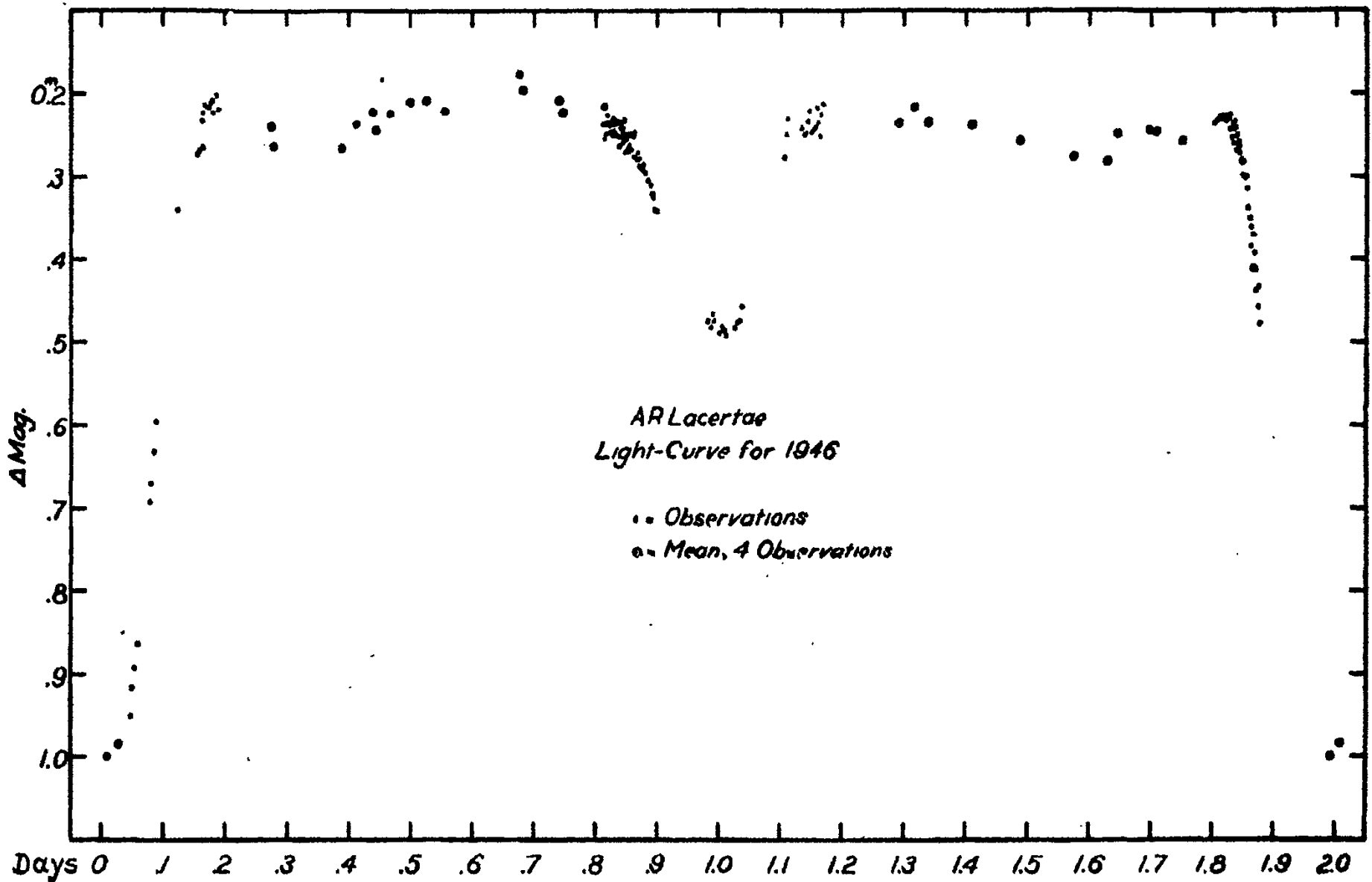
Ca II salmalı örten çiftler (Hiltner 1947)

TABLE 1

Star	Ca II Emission	Period (Days)	Spectrum	Reference
RZ Eri.....	Secondary (visible only at minimum)	39.28	F5+G8	Cesco and Sahade, <i>Ap. J.</i> , 101, 370, 1945
SS Cam.....	Secondary?	4.82	G1+F5	Popper, letter
AR Mon.....	Primary	21.21	K0+F?	+Sahade and Cesco, <i>Ap. J.</i> , 100, 374, 1944
RU Cnc.....	Secondary	10.73	F9+G9	Struve, <i>Ap. J.</i> , 102, 110, 1945
RZ Cnc.....	Primary	21.64	K2+K5	+Hiltner, <i>Pub. A.S.P.</i> , 58, 166, 1946 +
RW UMa.....	Secondary	7.33	F9+G9	Struve, <i>Ap. J.</i> , 102, 116, 1945; <i>Ann. d'ap.</i> , 9, 1, 1946
RS CVn.....	Secondary	4.80	F4+G8	
SS Boo.....	Secondary	7.61	G5+?	Struve, <i>Ap. J.</i> , 102, 118, 1945; Sanford, <i>Pub. A.S.P.</i> , 57, 217, 1945
WW Dra.....	Secondary	3.50	G2+K0	+Joy, <i>Ap. J.</i> , 94, 407, 1941
Z Her*.....	Secondary	3.99	F2+F2	
AW Her.....	Secondary	8.80	K2+G4	
RT Lac.....	Both components	5.07	G9+K1	Popper, <i>Yerkes Obs. Rept.</i> , <i>Pub. A.A.S.</i> , 10, 292, 1942
AR Lac.....	Secondary	1.98	K0+G5	Wyse, <i>Lick Obs. Bull.</i> , 17, 39, 1934

* Added in proof.

AR Lac üzerinde parlaklık değişimi yaratan lekelerin olası saptanışı (Kron 1947)



- Asimetri ve yıldan yıla deęişen ışık eęrileri
- Bu durum, RS CVn'de de görölüyor (Sitterly 1930)
- Garip deęişimler aydınlık ve karanlık leke (patch) varsayımıyla açıklanabilir
- Leke varsayımının ileri bir çalışması ve bir modeli yapılmalı
- Bu model, lekelerin hareketlerini açıklar

Bazı cüce yıldızların özellikleri (Kron 1950)

Fotometrik delillerden elde edilen sonuçlar;

→ Düzgün olmayan yüzey parlaklık dağılımı,
küçük alanlar şeklinde

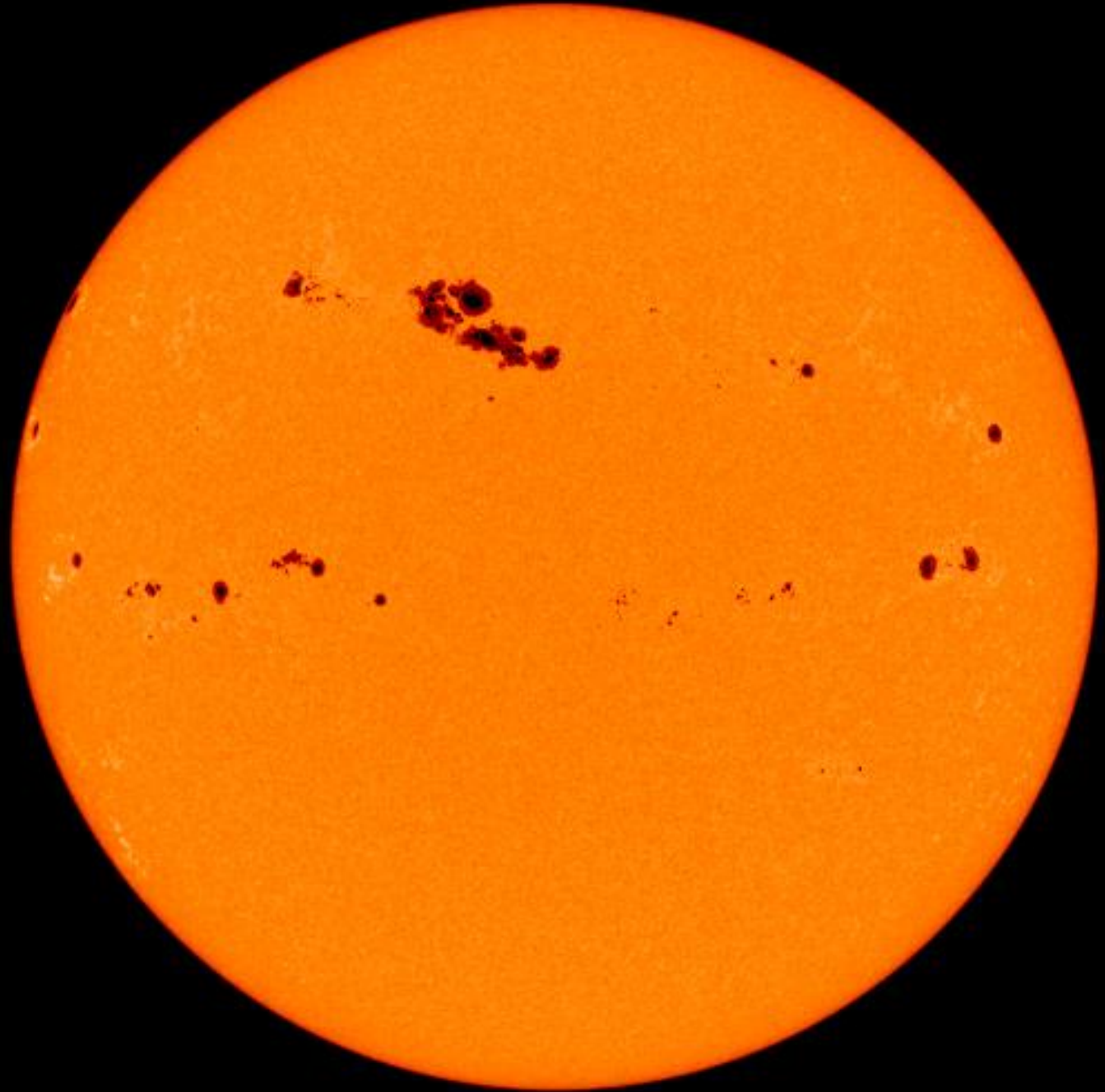
→ Parlak H&K çizgileri bu alanlarla ilişkili

→ Flareler bu alanlarla ilişkili

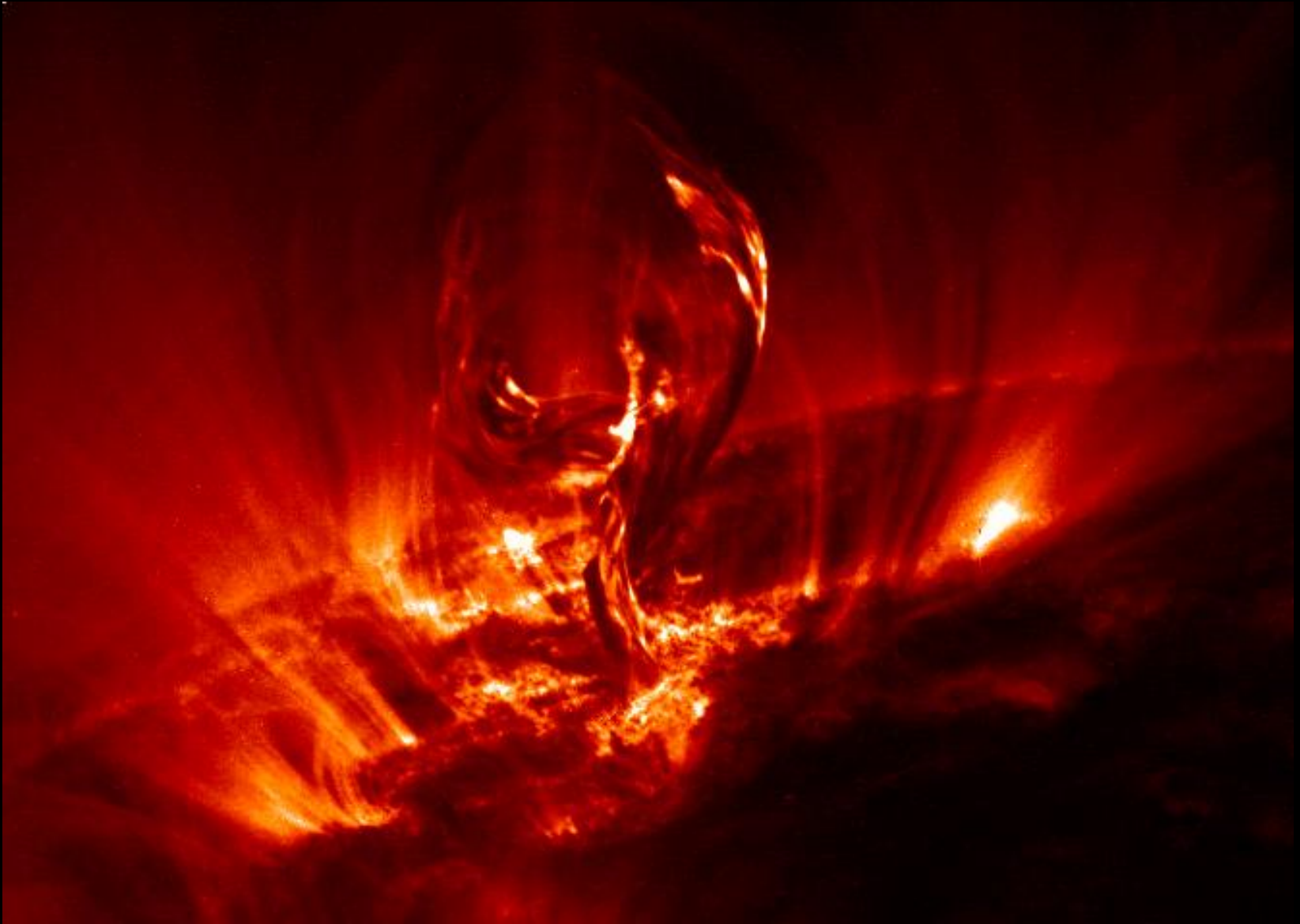
■ **SONUÇ:** Cüce Me yıldızlarının tayfsal ve fotometrik garipliklerinin çoğu, ***güneş lekeleriyle ilişkili aktiviteye benzerlikten*** kaynaklanabilir

■ Büyük bir güneş lekesi

■ 28 Mart 2001

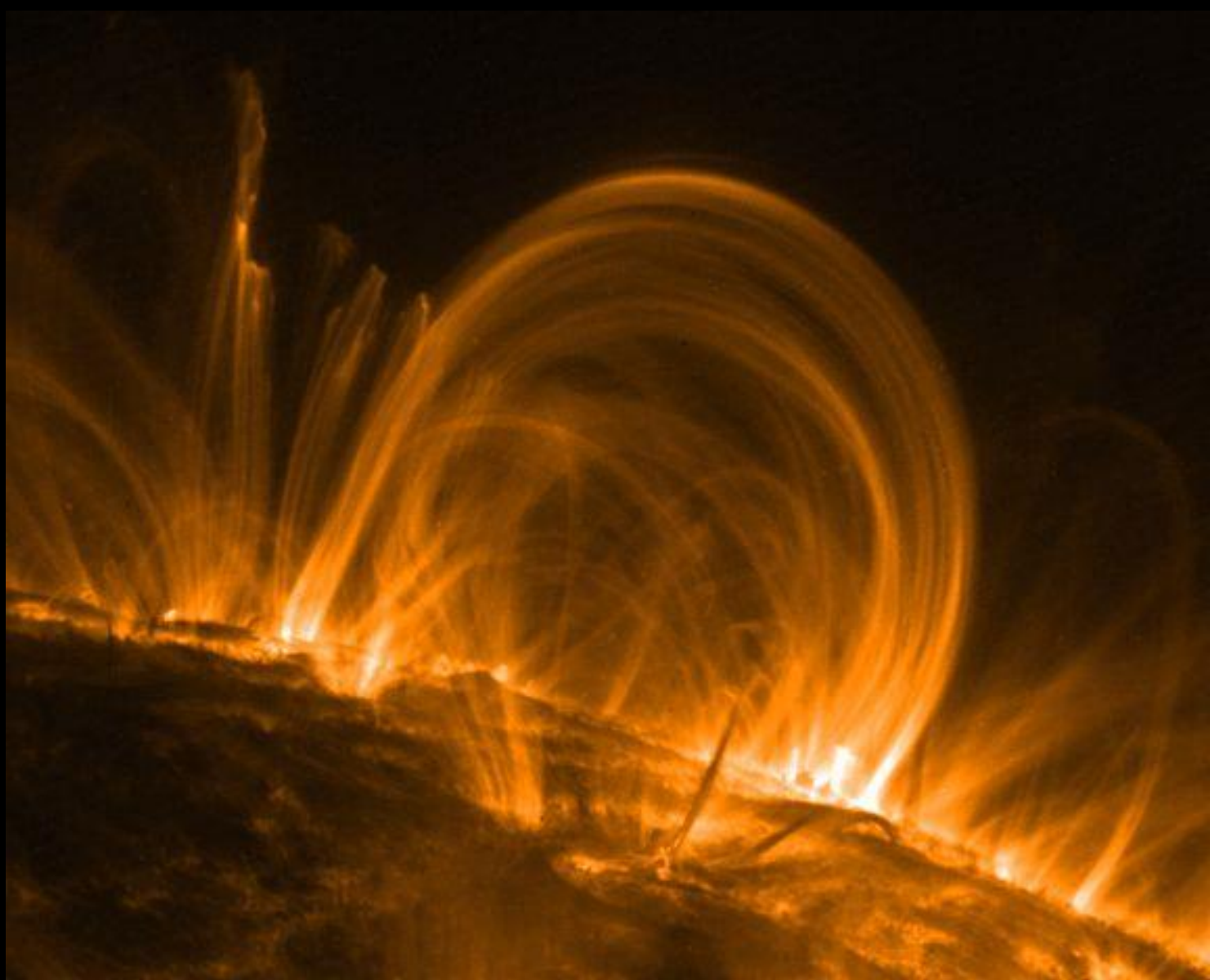


Filament yapı (19 Temmuz 2000)



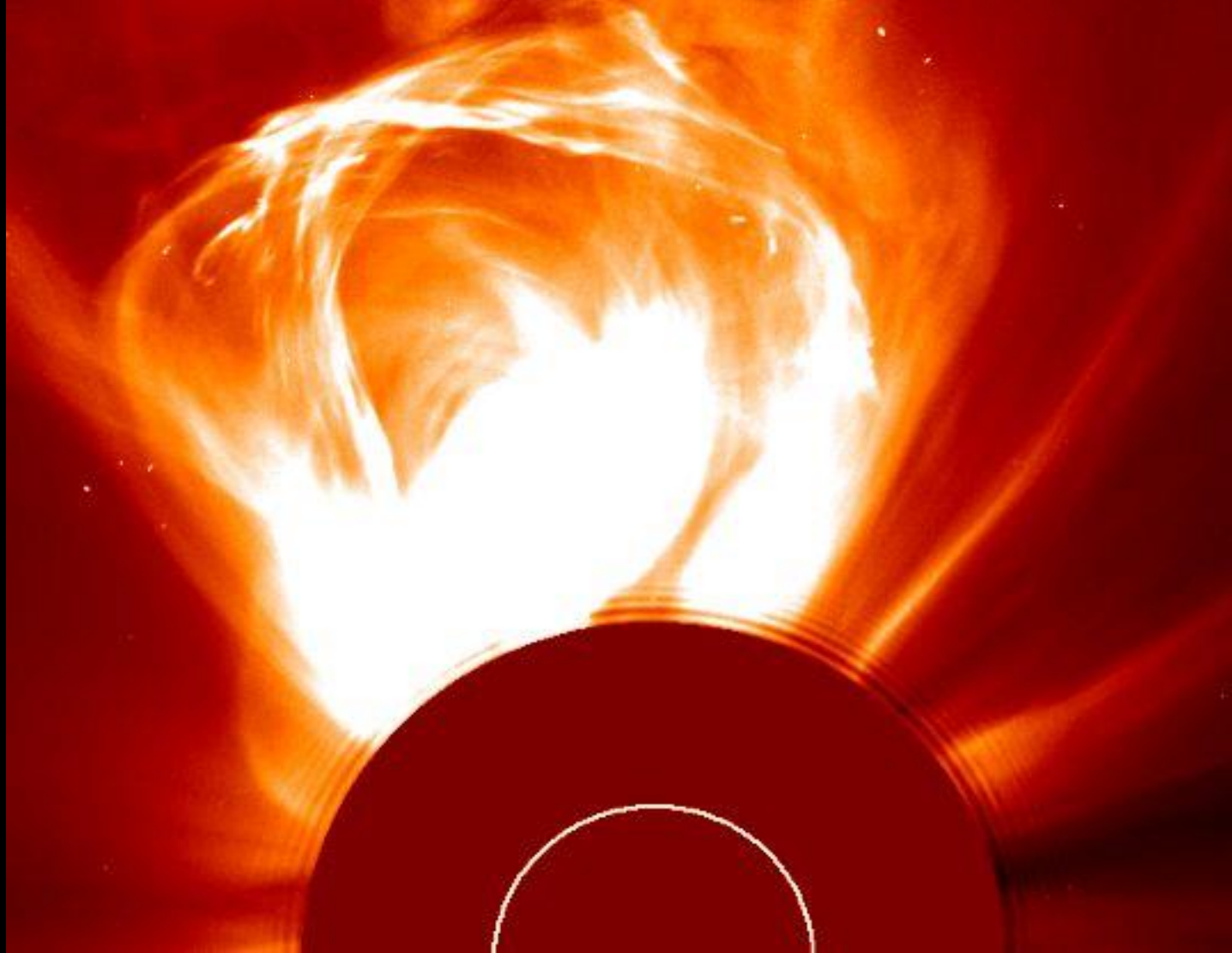
Koronal İlmik (28 Eylül 2000)

Yer apından
30 kat daha
buyk

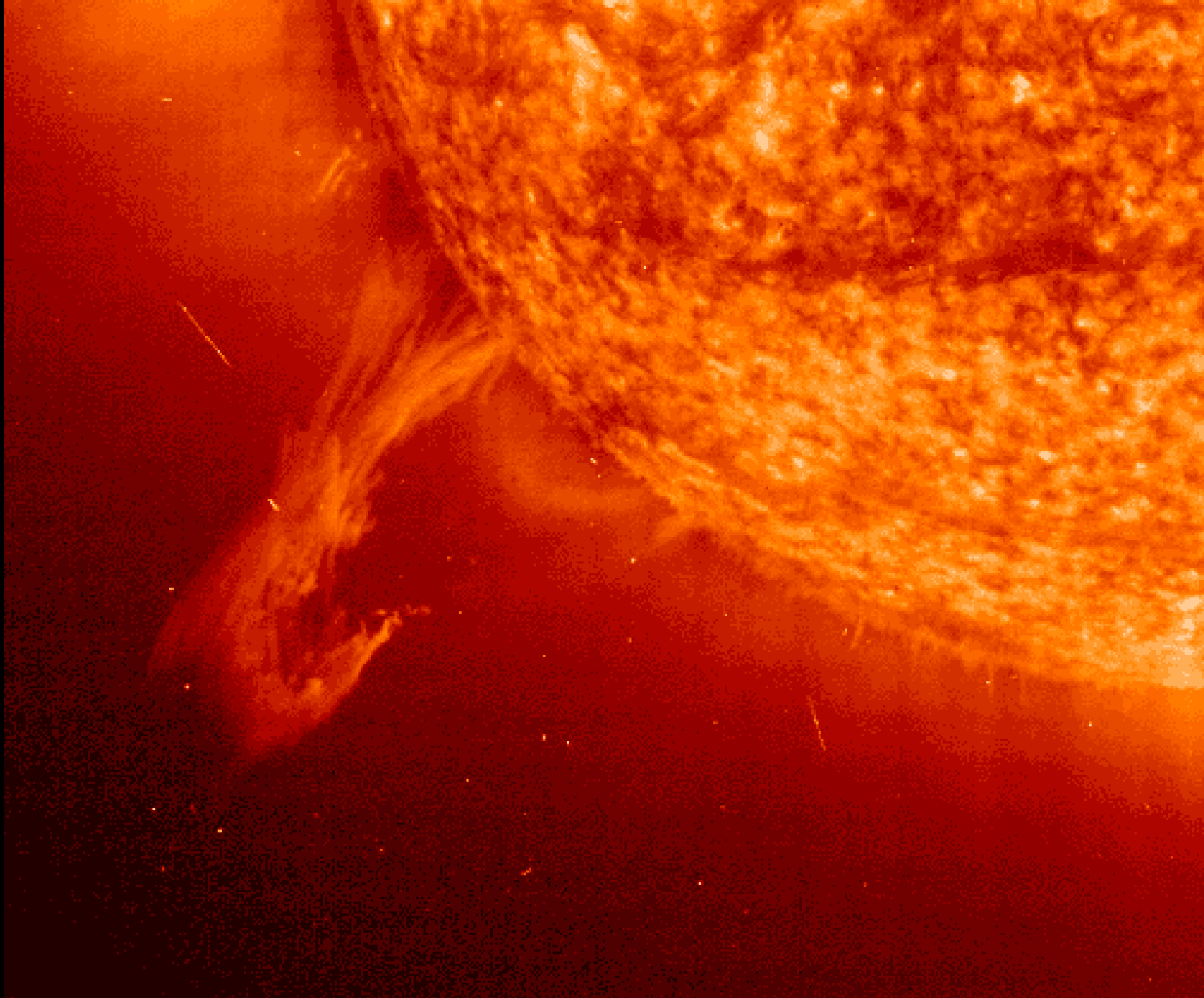


Koronal Kütle Atımı (9 Mart 2000)

Yüzeyden
2 milyon km
uzağa



Dev
alev



Adlandırma

- Hall (1976), IAU toplantısı
- RS CVn çiftlerinin tüm özelliklerini açıklar
- RS CVn'nin ışıkölçümünün ayrıntılı analizi Hall (1972).
- Leke modeli ile açıklama
dalga, kırmızı renk, dalga göçü, baş minimum derinlik değişimi, genlik değişimi

Kampanya

- 1976' dan itibaren tüm dalgaboylarında uluslararası kampanyalar
- Ege Üniversitesi Gözlemevi
V471 Tau, RT Lac, II Peg, MM Her, Z Her,
RS CVn, WW Dra, ER Vul, RT CrB, LX Per,
AR Lac, SZ Psc, UV Psc

Fotometrik bakış açısıyla, aktivite düzeyini belirleyen parametreler

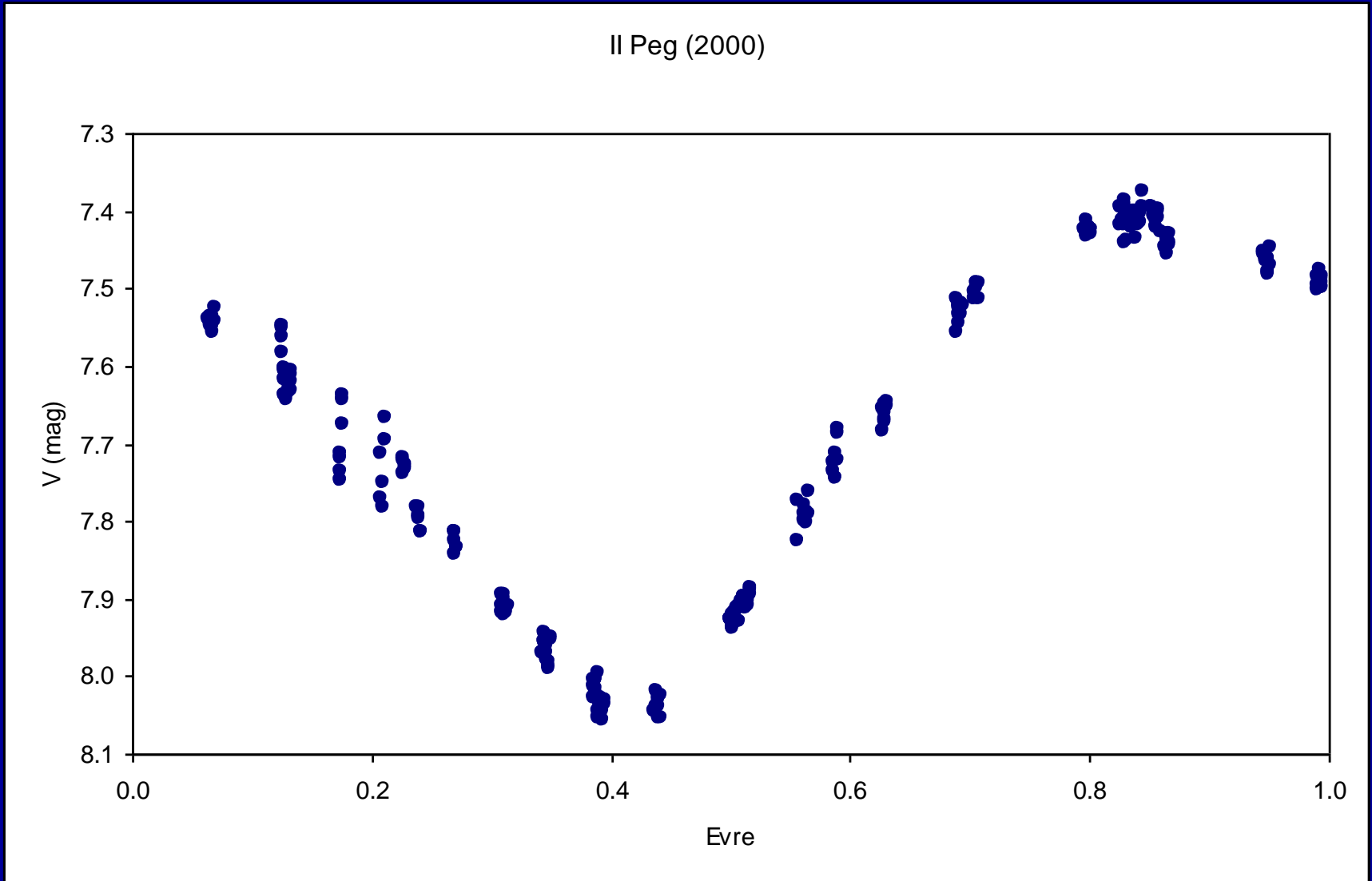
- Maksimum dalga genliği
- Genlik değişiminin zaman ölçeği
- Flare olayları
- Ortalama parlaklığın uzun dönemli değişimi

DALGA GENLİĞİ

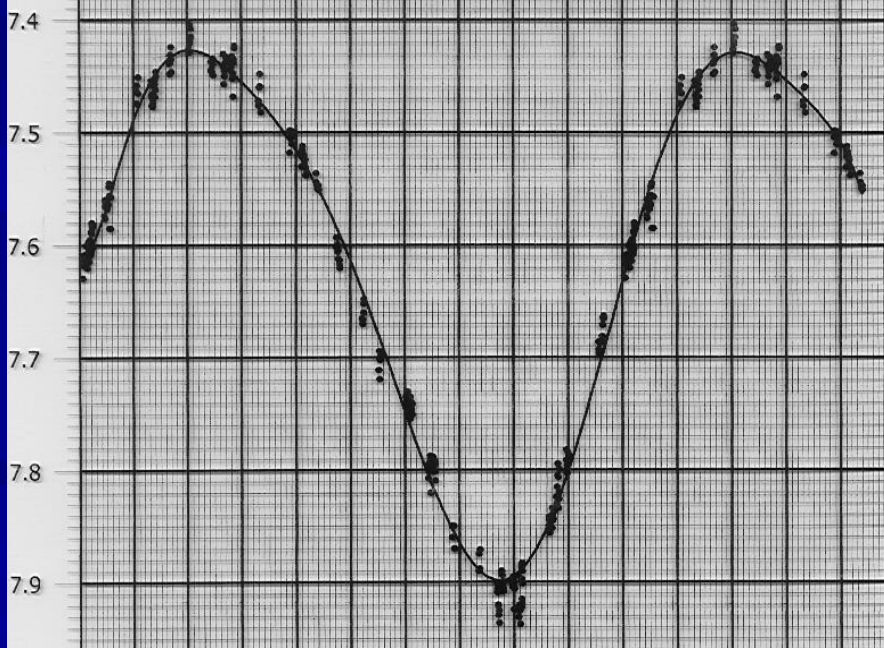
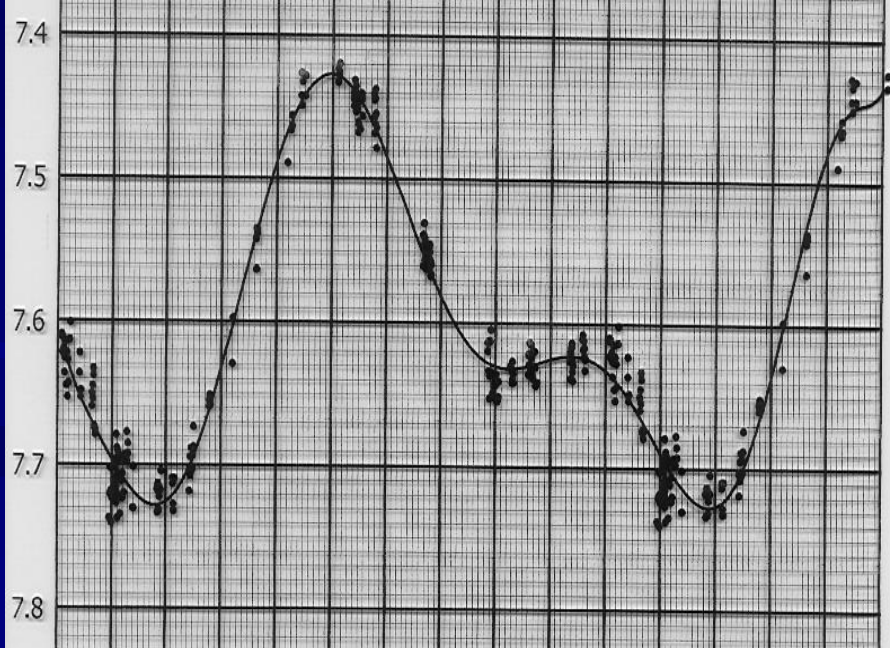
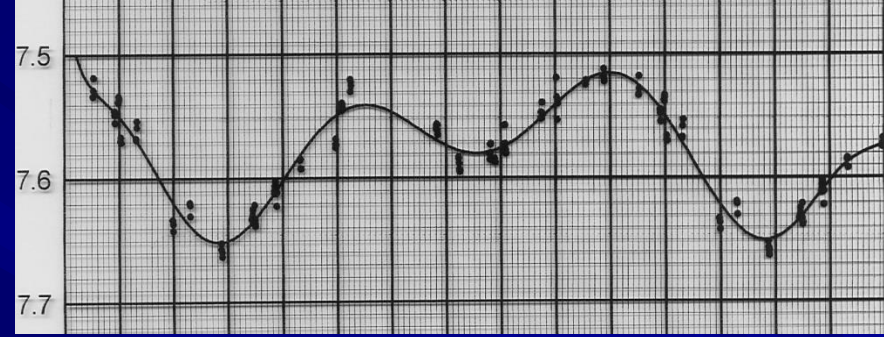
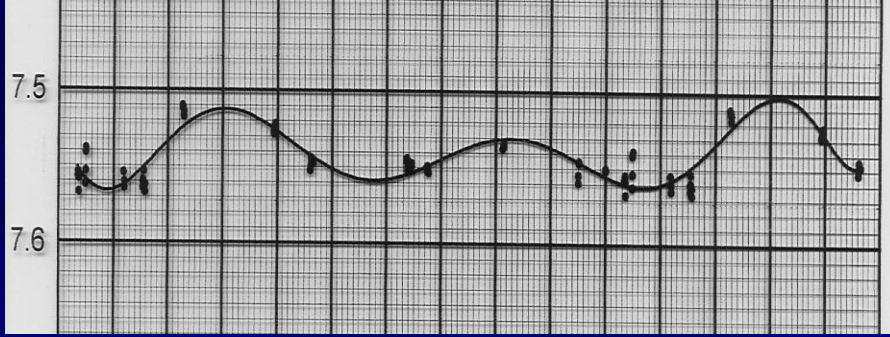
- lekelerin alanından
 - sıcaklığından
 - yüzeydeki asimetric dağılımdan
 - enleminden
 - yörünge eğikliğinden
- etkilenir.

- Kısa dönemli aktif çift yıldızlarda, lekeli yıldızlar sistemdeki daha sönük bileşen olduğundan, dalga genliği genelde daha azdır. Sıcak bileşenin toplam ışığa katkısı daha fazladır.
- Uzun dönemli sistemlerde, lekeli bileşen daha büyüktür ve anakol bileşeninden daha parlaktır. Dolayısıyla, genlik daha büyüktür.

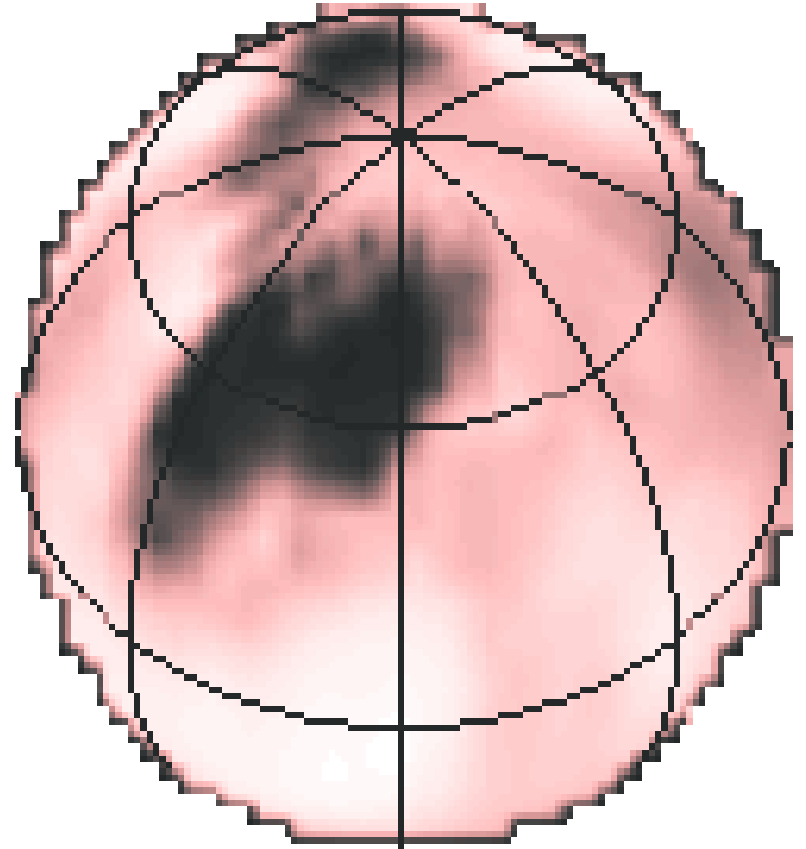
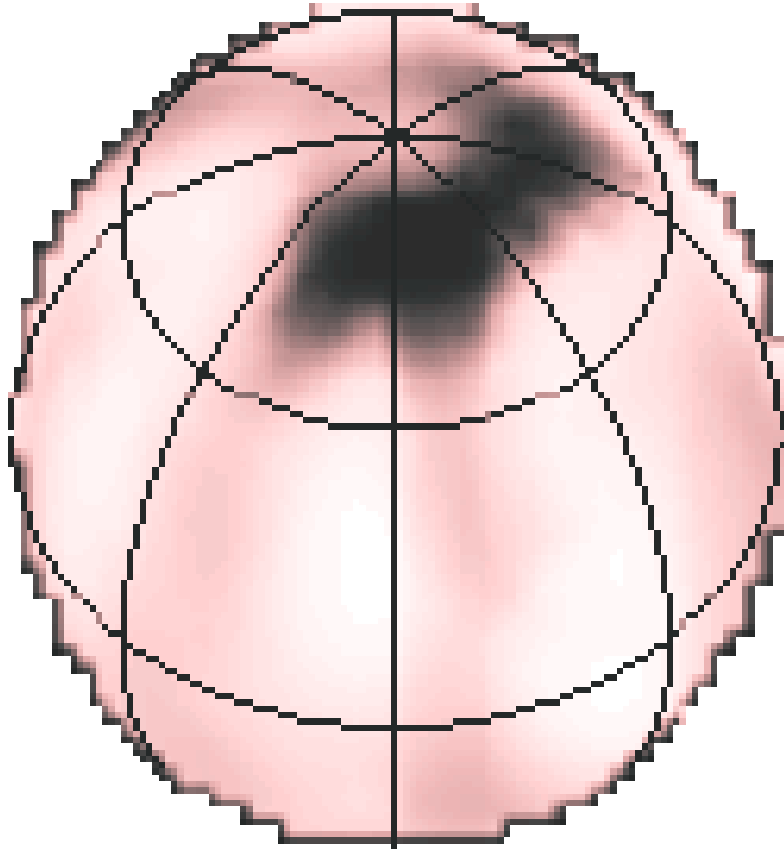
En büyük dalga genliğine sahip yıldız: II Peg (Taş ve Evren 2000) Genlik (V) = 0.62 mag



II Peg, en deęişken ışık eğrilerine sahip aktif çift yıldız (1983, 1991, 1996, 1999)

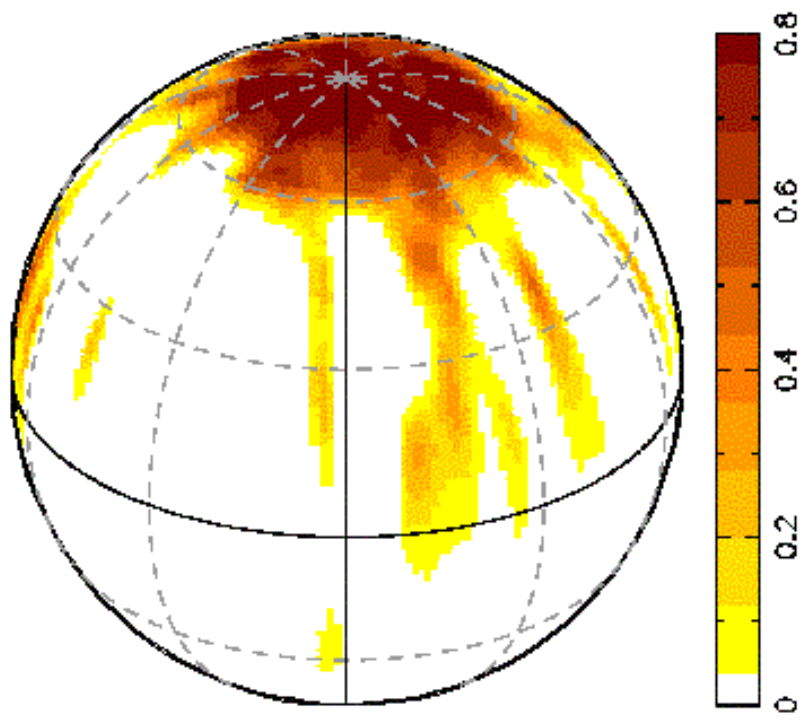


II Peg, 1995 ve 1996



Aktivite çevrimlerini bulmak

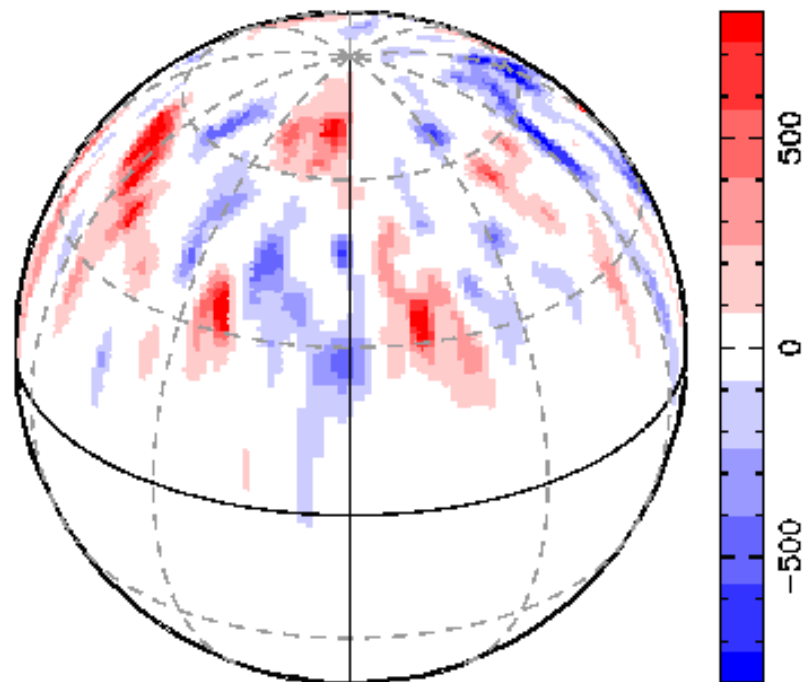
- Ortalama parlaklık deęiřimi
- veya leke hareketleri, dalga göçü incelenir.
- Diferansiyel dönme, yıldızlara ilişkin Kelebek Diagramı'na neden olur



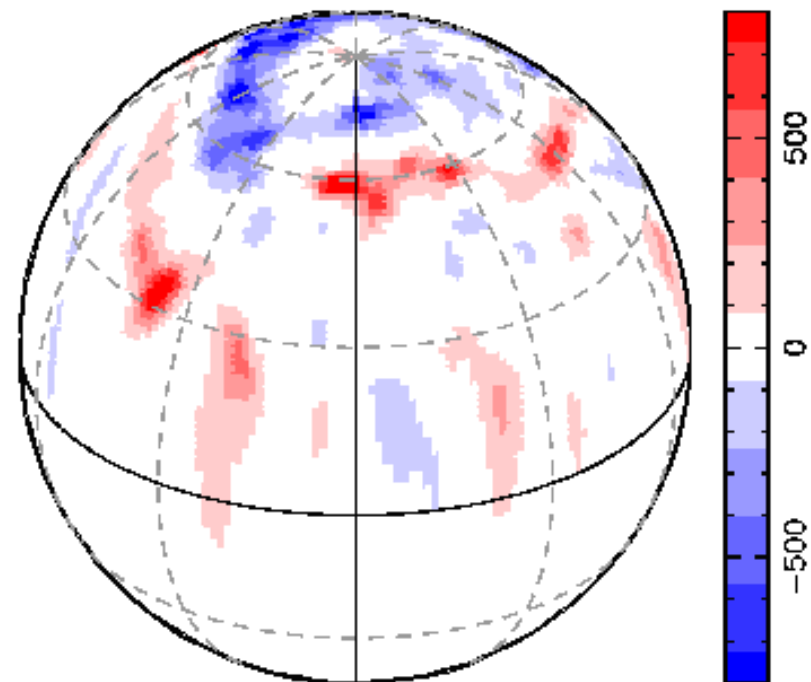
AB Dor

AB Dor

Radial magnetic field



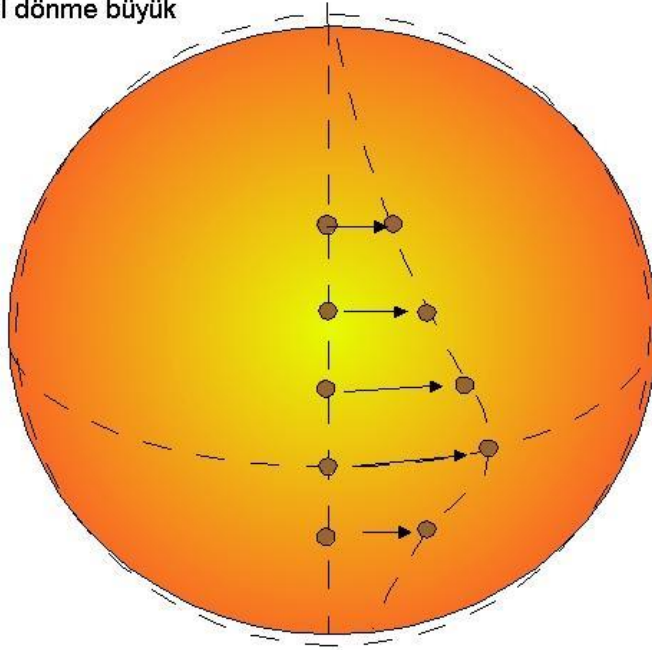
Azimuthal magnetic field



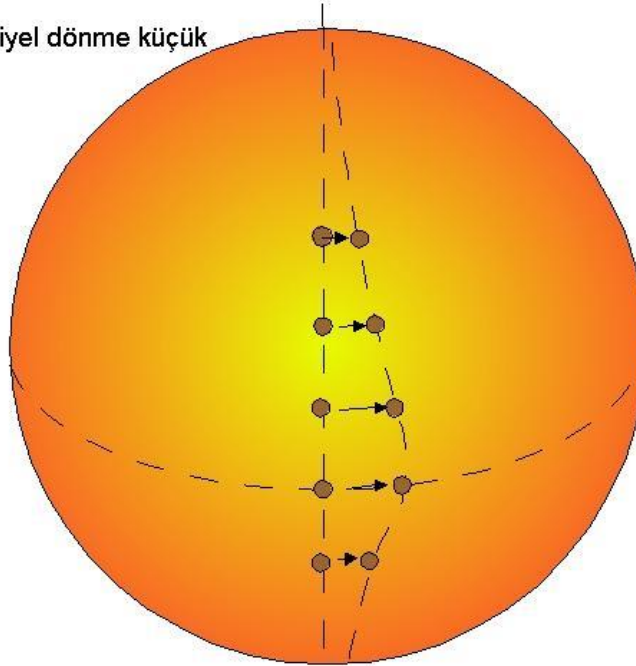
Diferansiyel Dönmenin Saptanışı

- Dalga göçü, dönme ve yörünge hareketi arasındaki eşdönmenin tam olmadığını gösterir.
- Fark, genelde %1'den daha az
- Göç hızındaki değişim ve doğrultu değişikliği (veya ters dönmesi), lekeli alanların görelî hareketlerini açıklar.
- Bu olay, diferansiyel dönmeye ve enlemsel sürüklenmeye atfedilir.

Diferansiyel dönme büyük

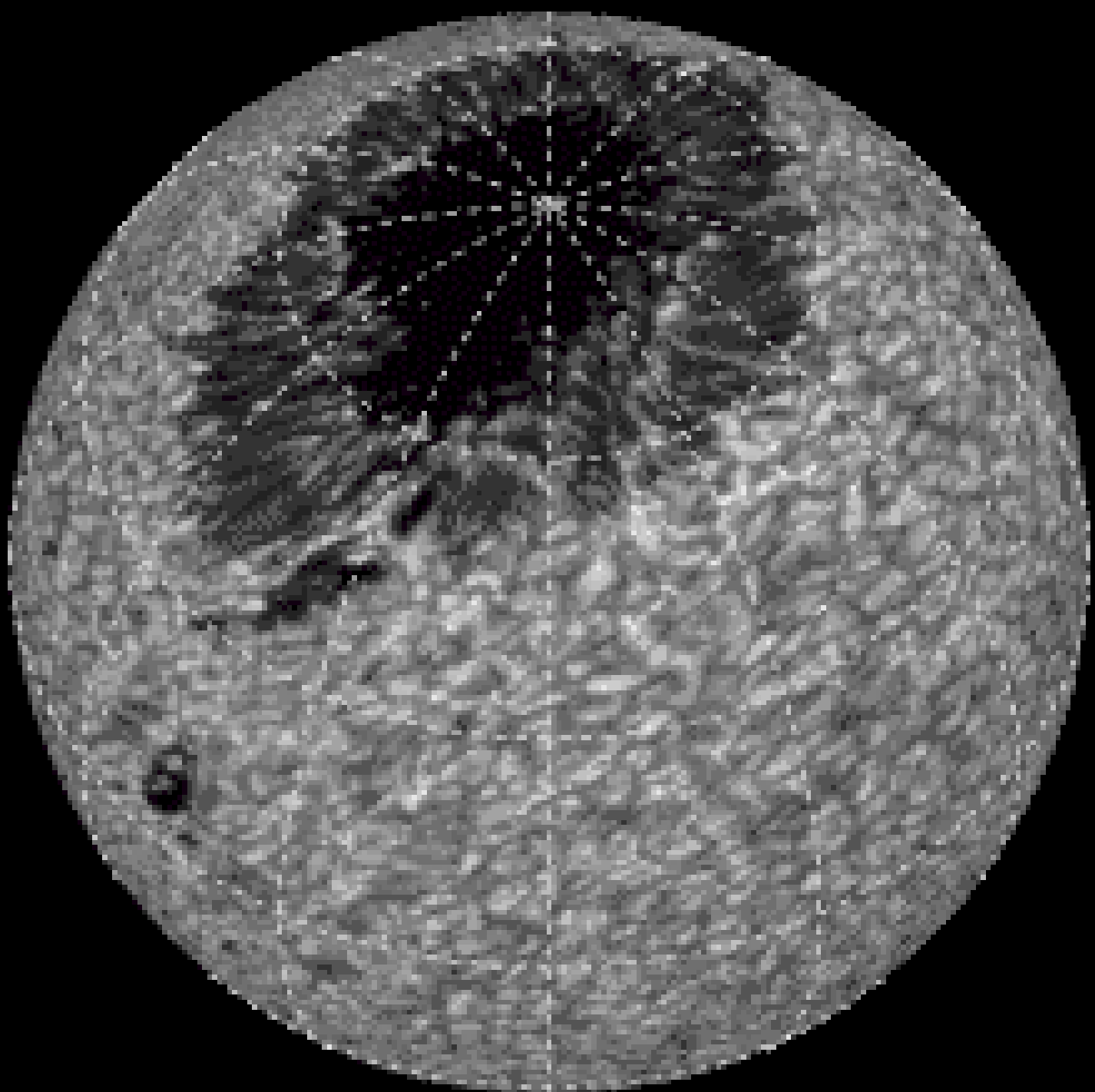


Diferansiyel dönme küçük

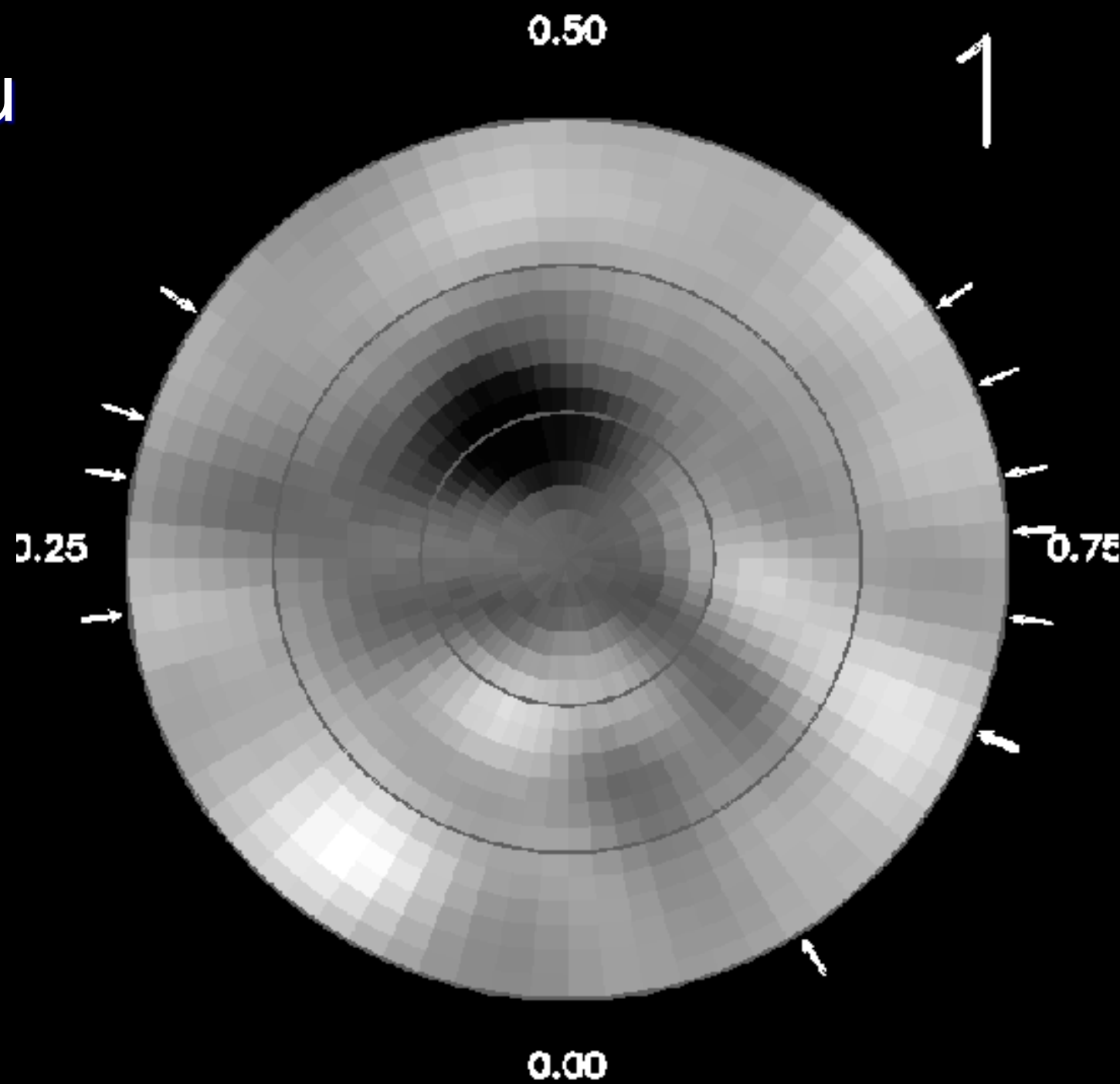


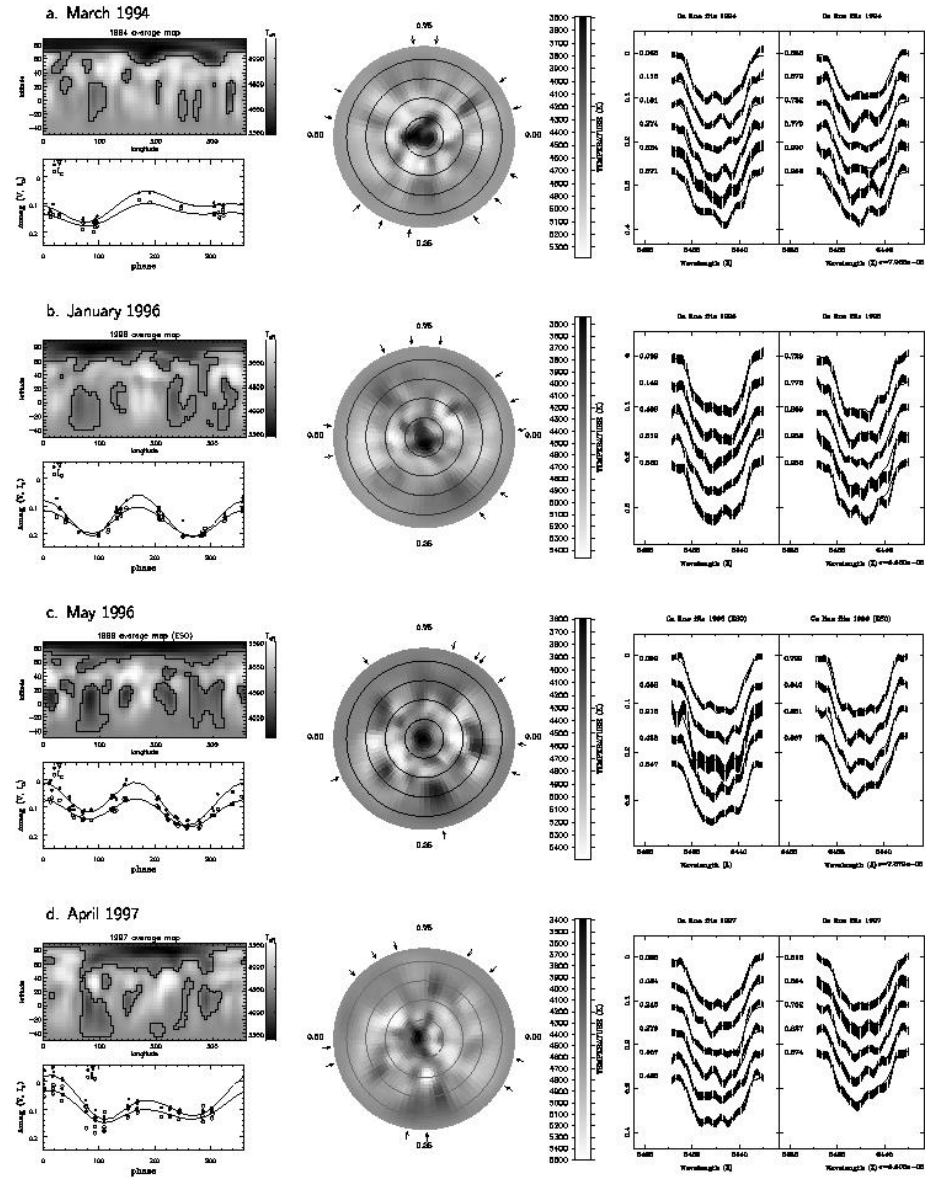
- Azalan veya artan evrelere doğru olan göçler, yörünge döneminden daha küçük veya daha büyük dönme dönemlerini belirtir.
- Yıldızlardaki diferansiyel dönmeyi saptama araştırmaları devam ediyor. Bunun için uzun zaman aralığına yayılmış fotometrik veriye gerek var.

Uçlak Lekesi



V711 Tau





EK Dra

genç yıldız
G1.5V



EK Dra young G1.5V P=2.6d

LQ Hya

genç yıldız
K2V

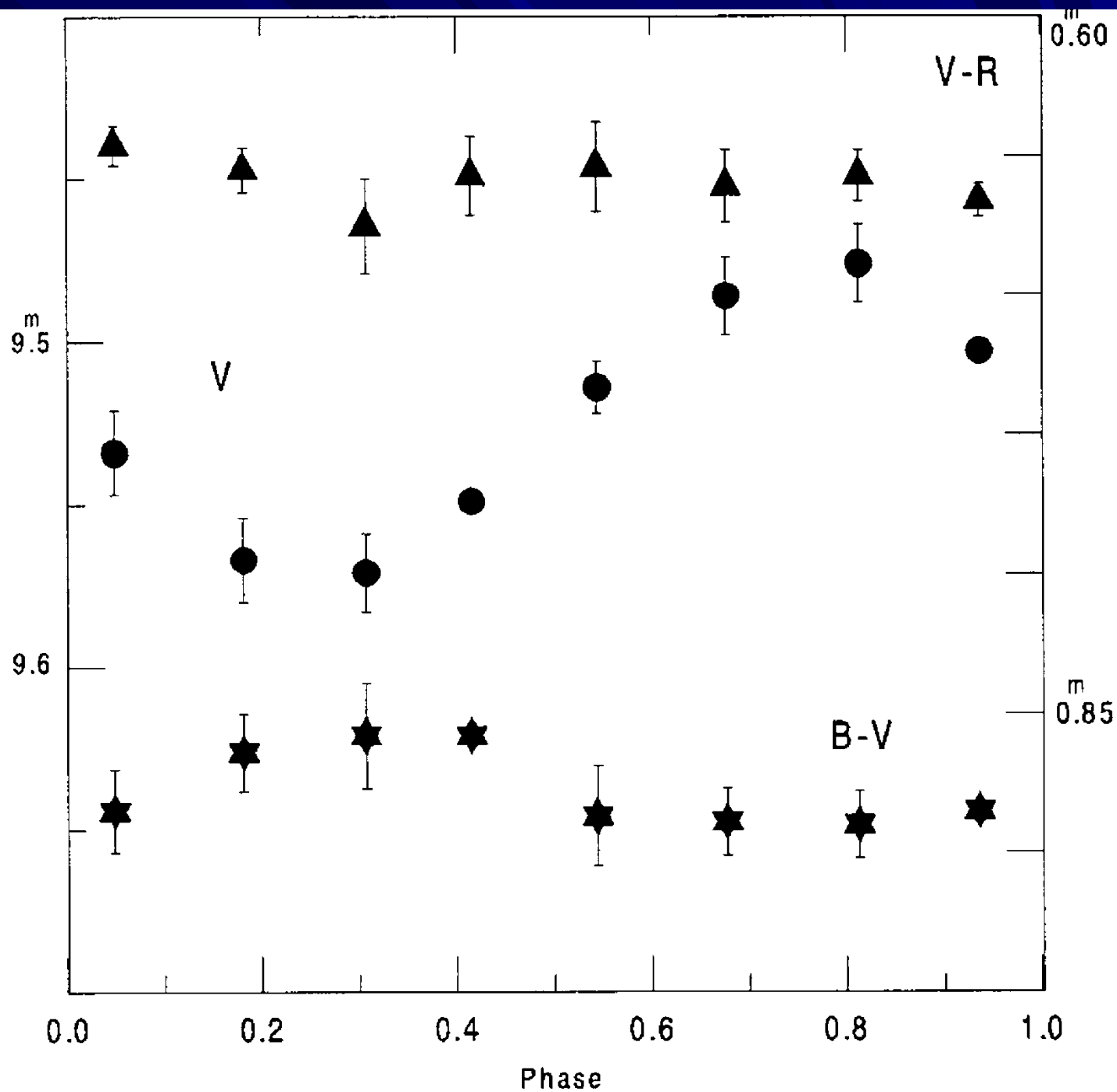


LQ Hya young K2V P=1.6d

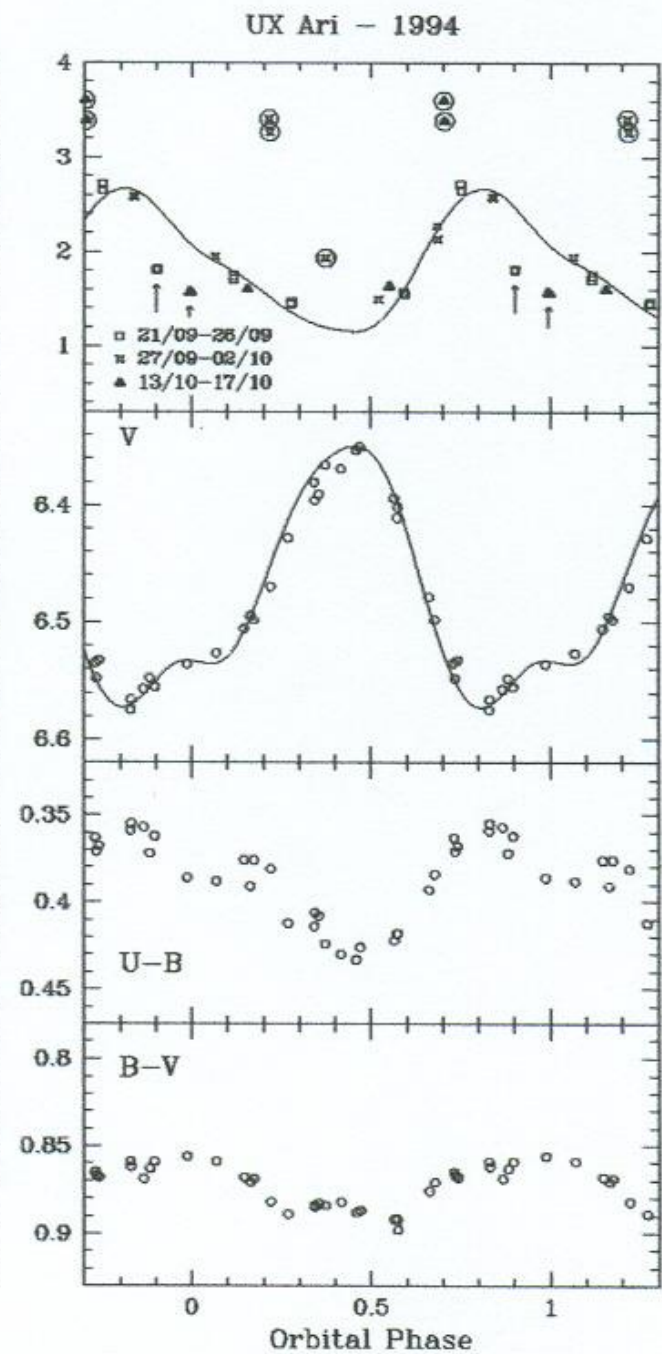
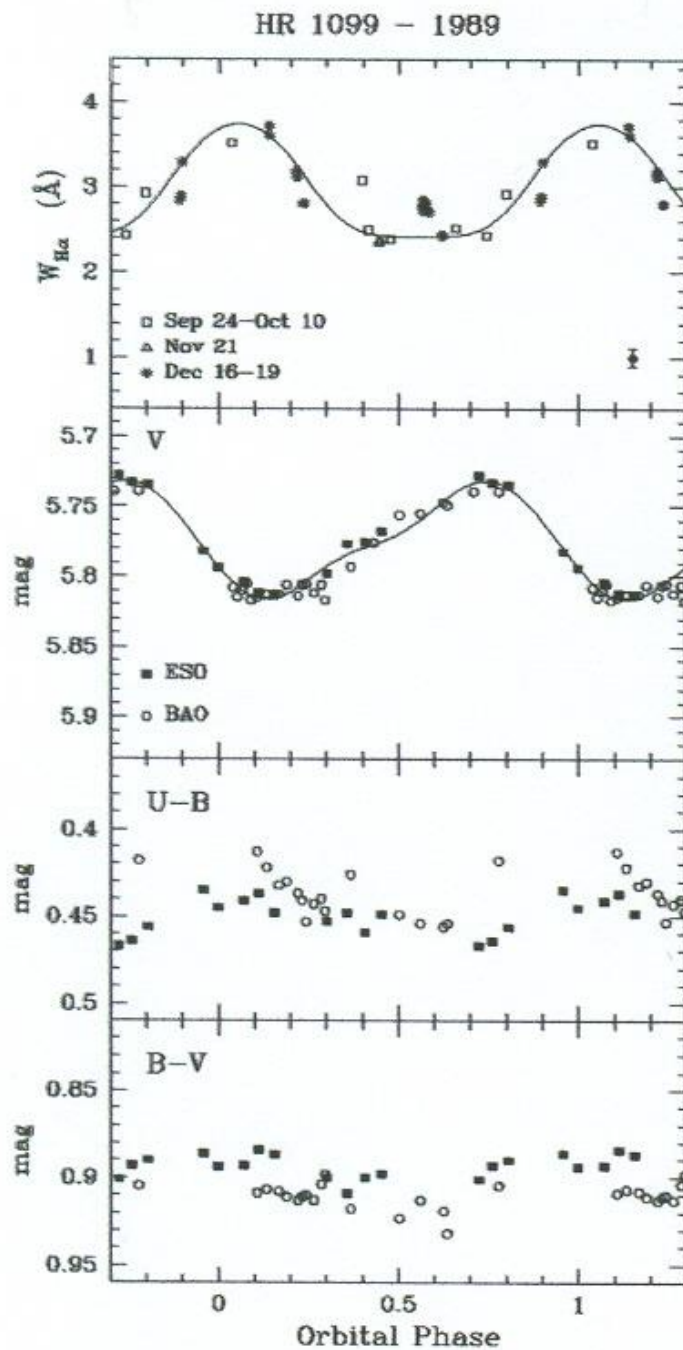
Leke ve Faküla



MM Her



V711 Tau
ve
UX Ari



Leke
ve
plage
model

HR 1099 - 1989



$$\phi = 0.15$$

HR 1099 - 1994



$$\phi = 0.40$$

UX Ari - 1994



$$\phi = 0.85$$

HK Lac - 1993



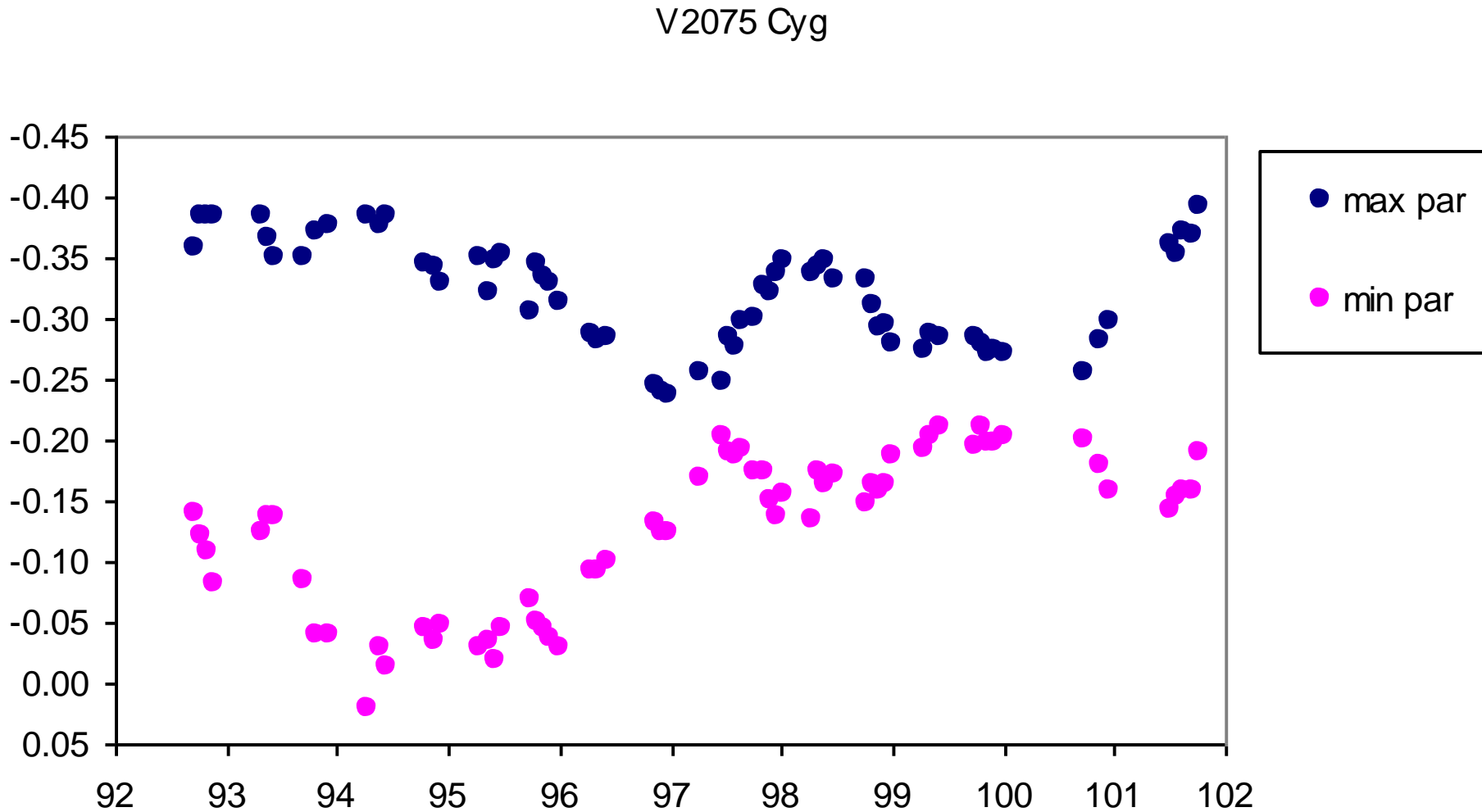
$$\phi = 0.10$$

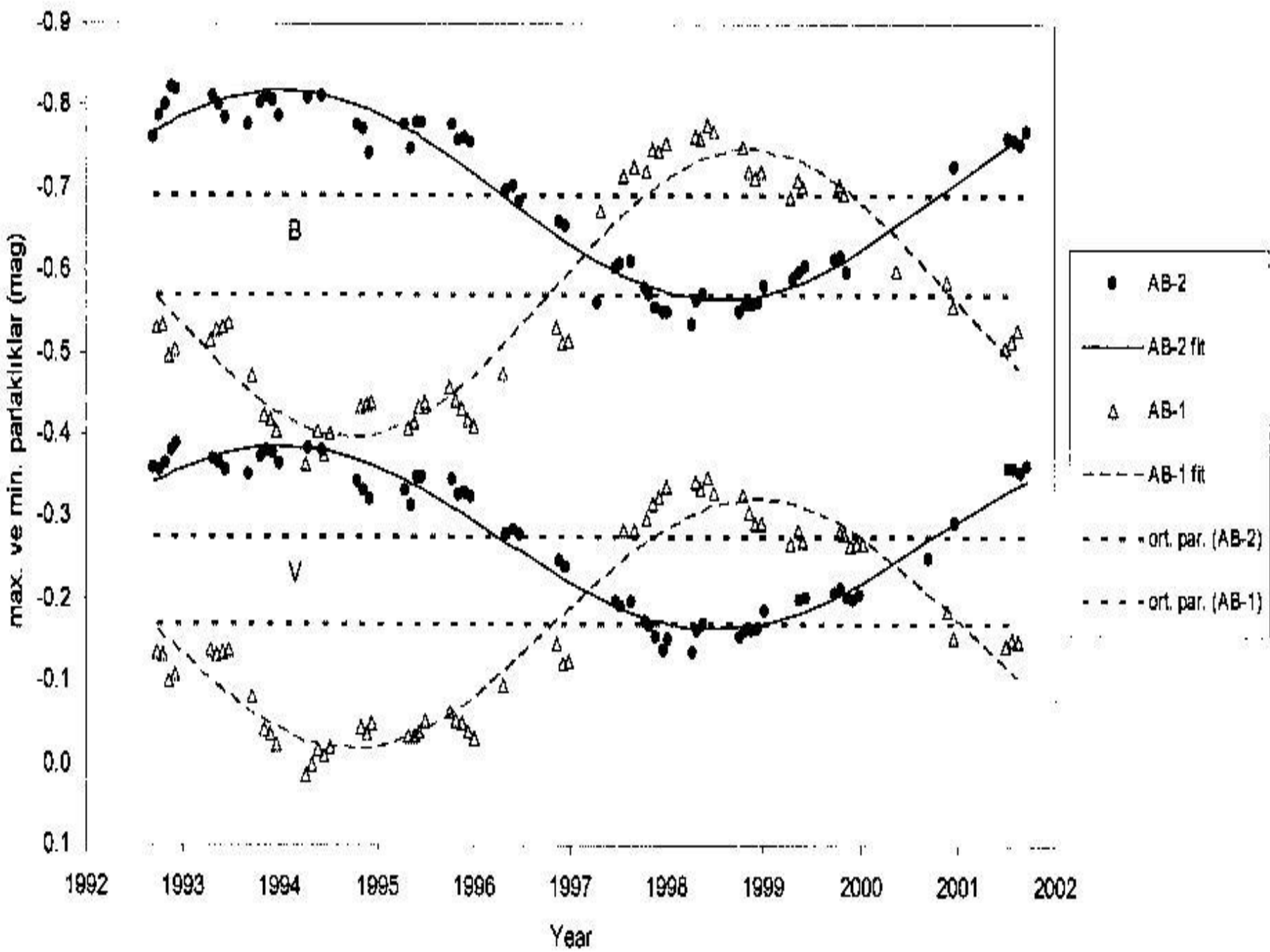
Aktif Boylamlar

- Tüm lekelerin ilk görüldüğü boylam
- Uzun ömürlü aktif boylamların varlığı, enerjik flarelerin görüldüğü yerlerden giderek belirlenmiştir.
(*Bai 1988*) (*Jetsu et al. 1997*)

- Bazı aktif yıldızlarda leke oluşumları 180° farklı boylamda görülmektedir.
- Aktif-aktif olmayan-aktif-aktif olmayan biçimde; Genişlikler 90° den küçük, 180° zıt. (*Henry et al. 1995*)

V2075 Cyg'nin aktif boylamları

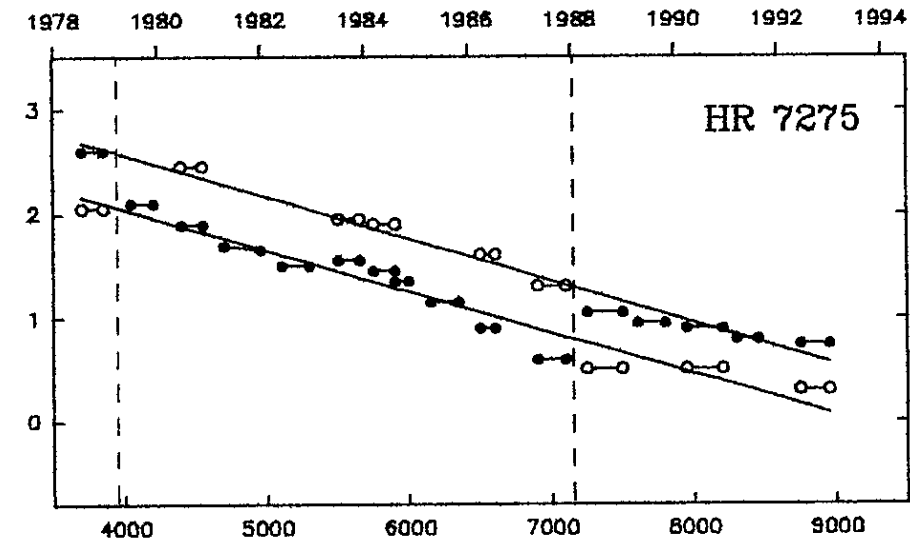
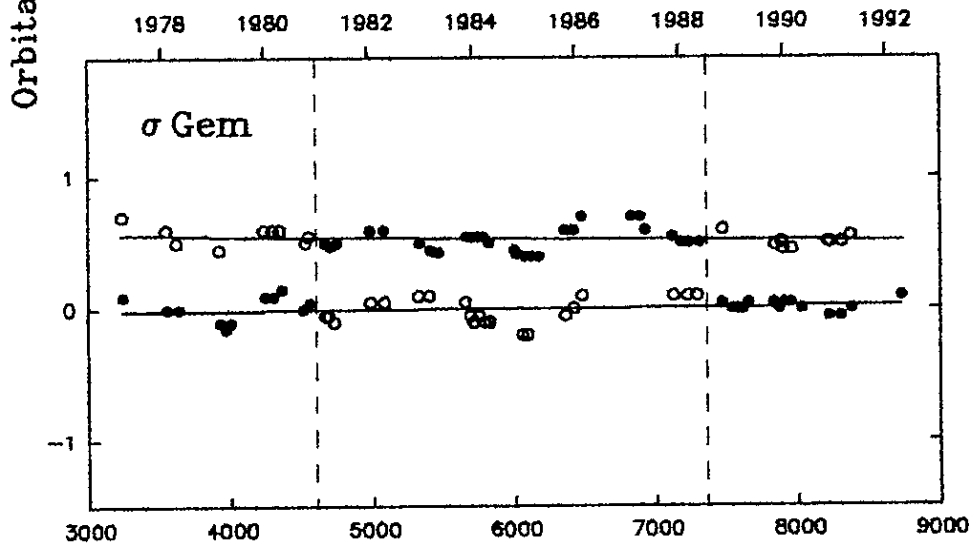
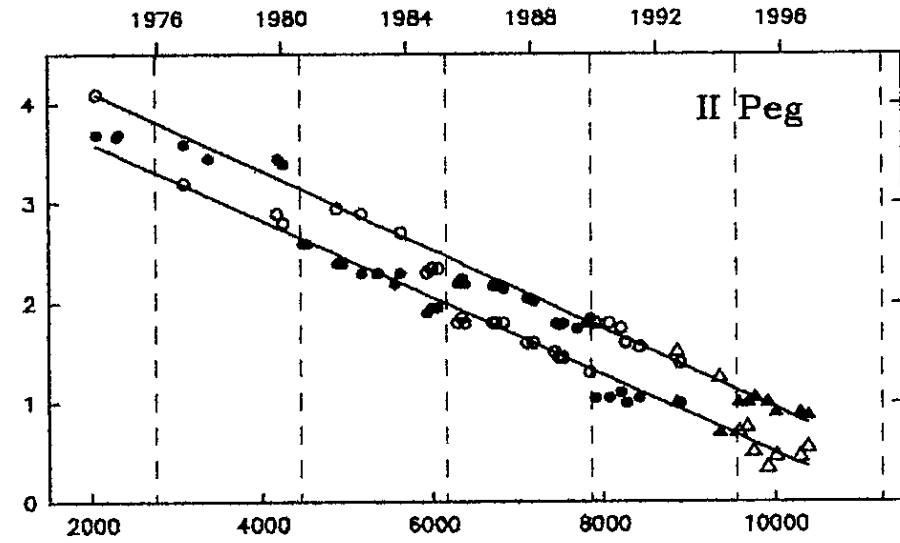
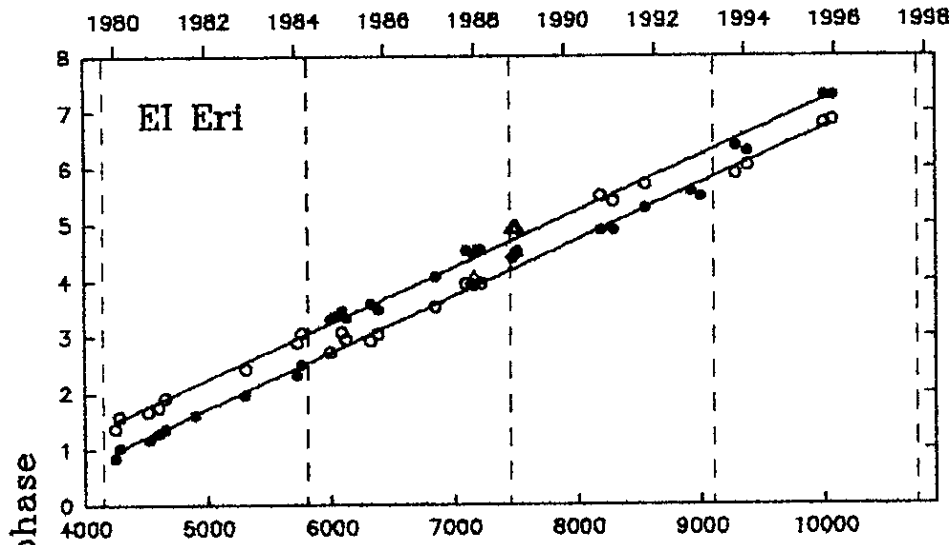




Flip-Flop

- Aktif boylamın kısa zamanda 180° zıt boylamda görünmesi, ***flip-flop etkisi***. (*Jetsu et al. 1991*)
- Aktif boylam uzun ömürlü. Lekeler kısa ömürlü ve yeni lekeler aynı aktif boylam içinde oluşur. (*Jetsu et al. 1993*)

Aktif Boylamlar ve Flip-Flop



JD 2440000+