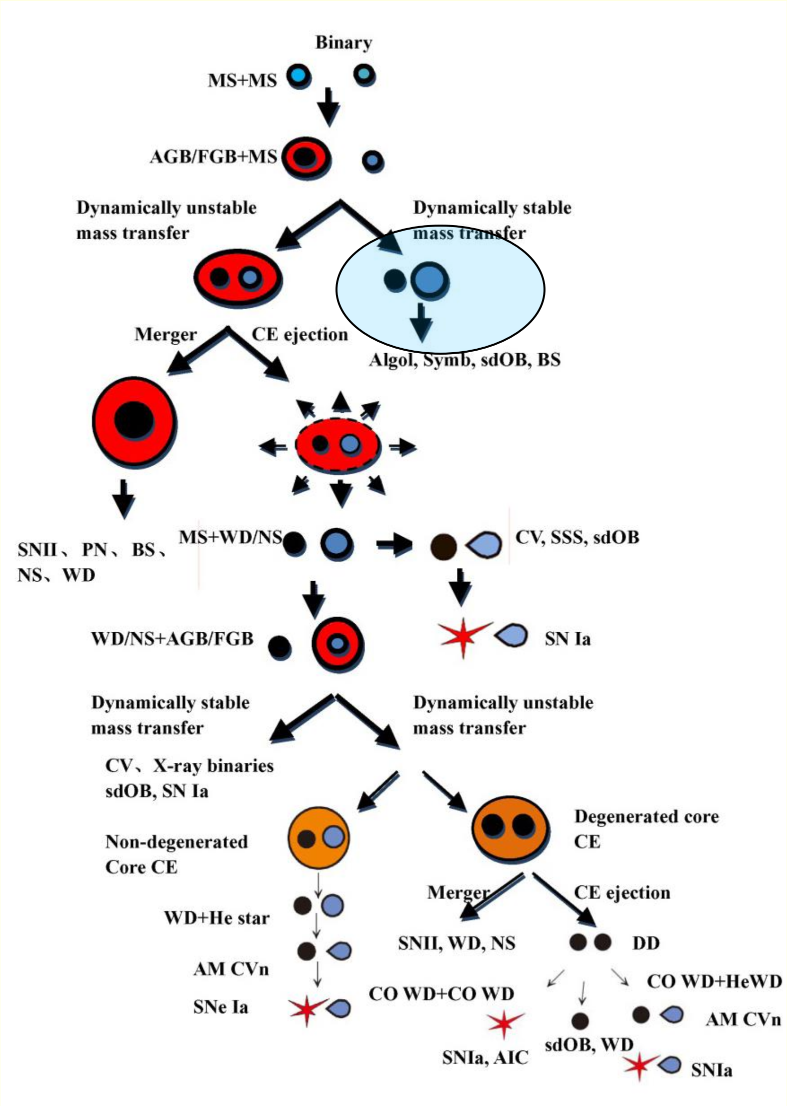
u Her sisteminin *CNO* çevrimi ile işlenmiş katmanlarının izleri

Ahmet Dervişoğlu
Erciyes Universitesi

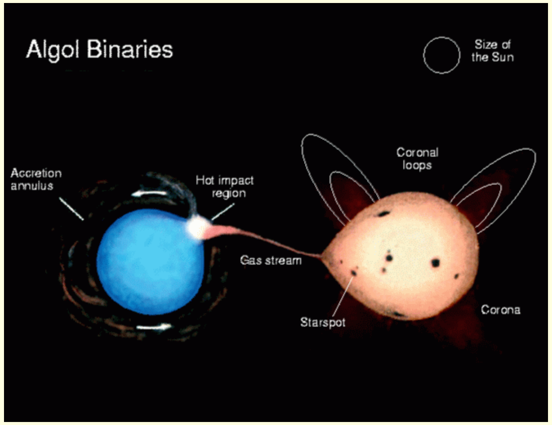
İçerik

- Çift yıldız evrim kanalları
- CNO çevrimi ile işlenmiş yıldız maddesi
- Tayfsal Ayırma
- Örnek aday Algoller
- u Her sistemi
- Evrimsel Analiz

Çift Yıldız Evrim Kanalları



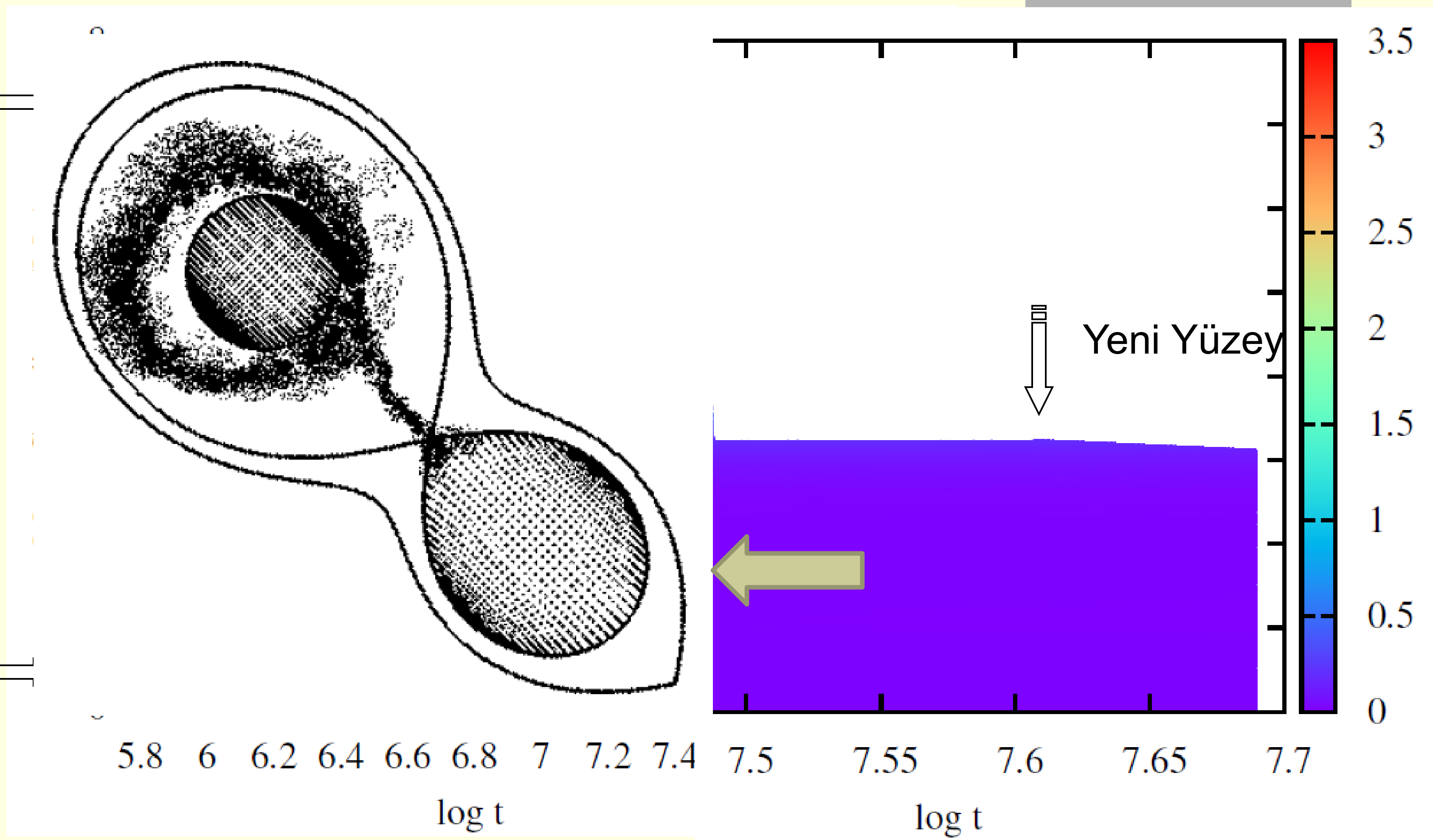
- Sayısız olasılık var.
- Modellemeler sınırlı parametrelerle
- Bilgi dejenerasyonu problemi!
  - Her bir kütle aktarımı yıldızların başlangıç parametrelerini karartıyor.
  - En iyi başlangıç noktalarından biri tek bir kütle aktarımı geçirdiği varsayılan yarı-ayrık Algoller.



CNO ile işlenmiş katmanlar!!

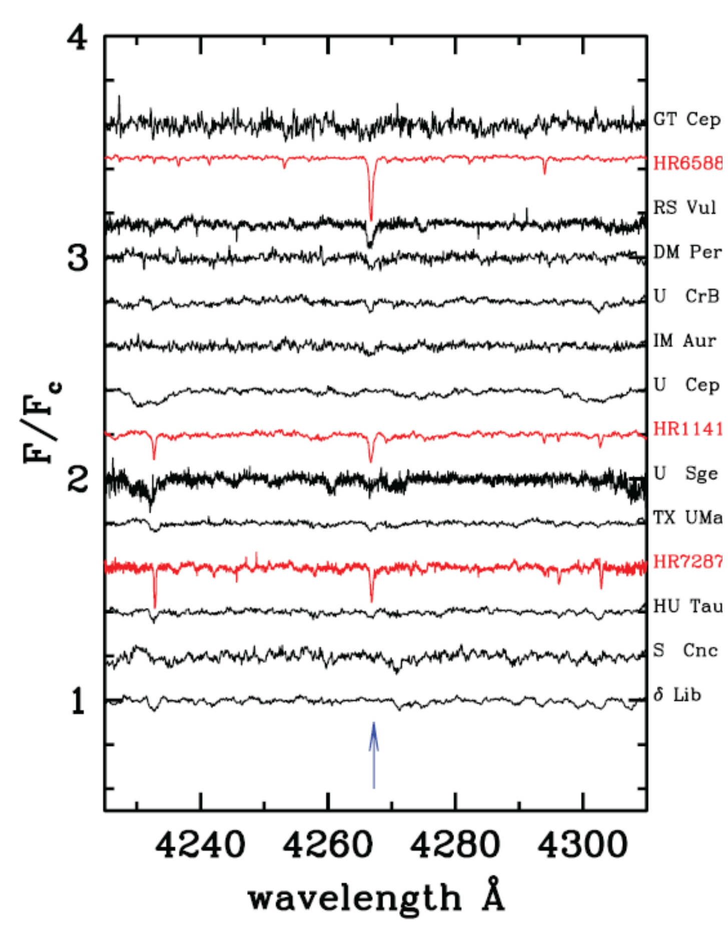
Yüzey

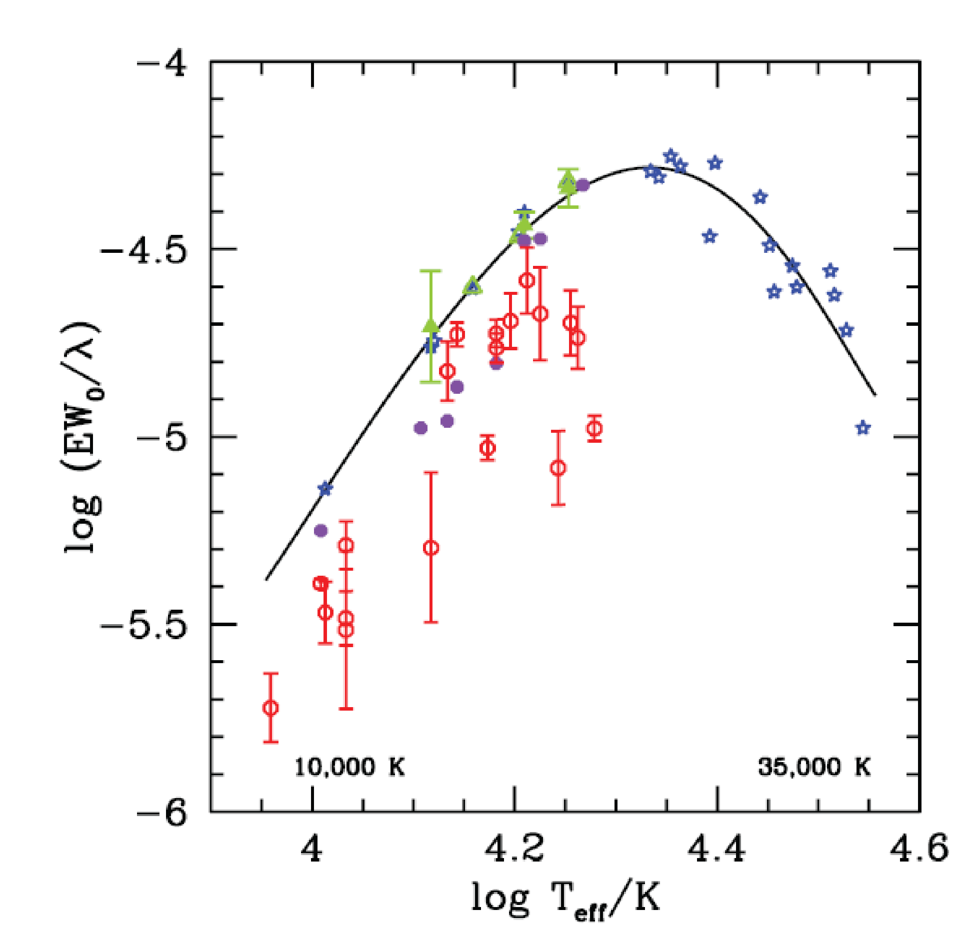
Merkez



7 M⊙ kütleli bir yıldızın merkezden yüzeye C/N profili.

Karbon Göreli Bolluğundaki Azalma

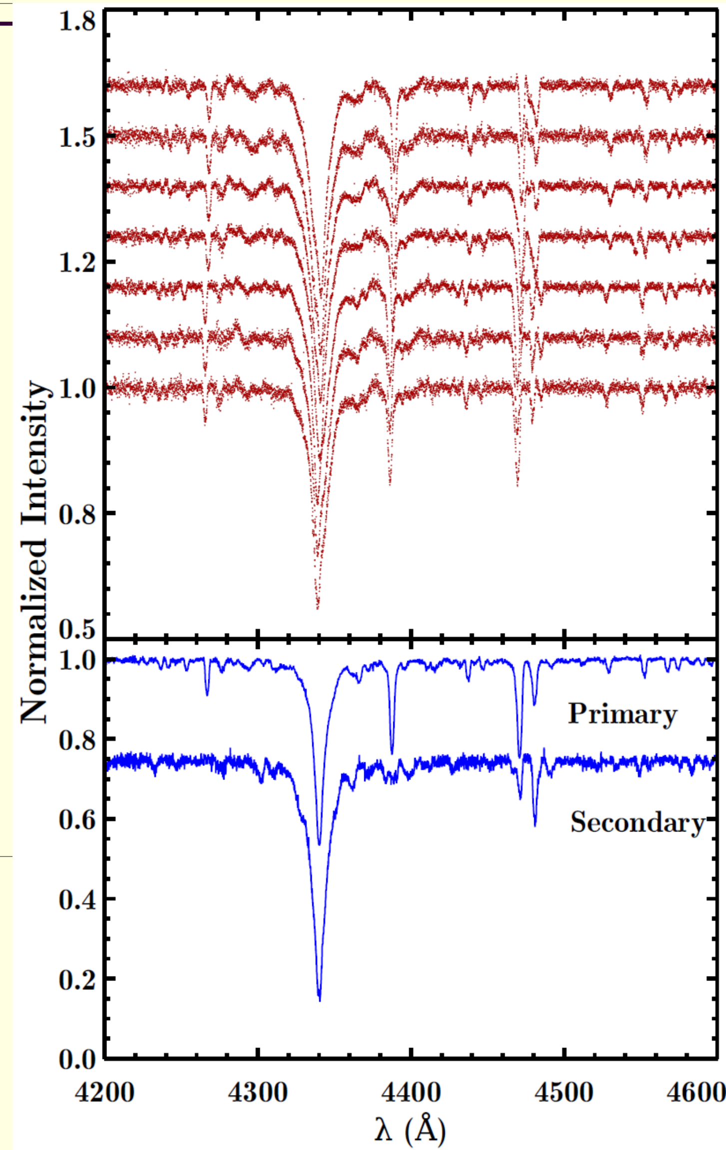




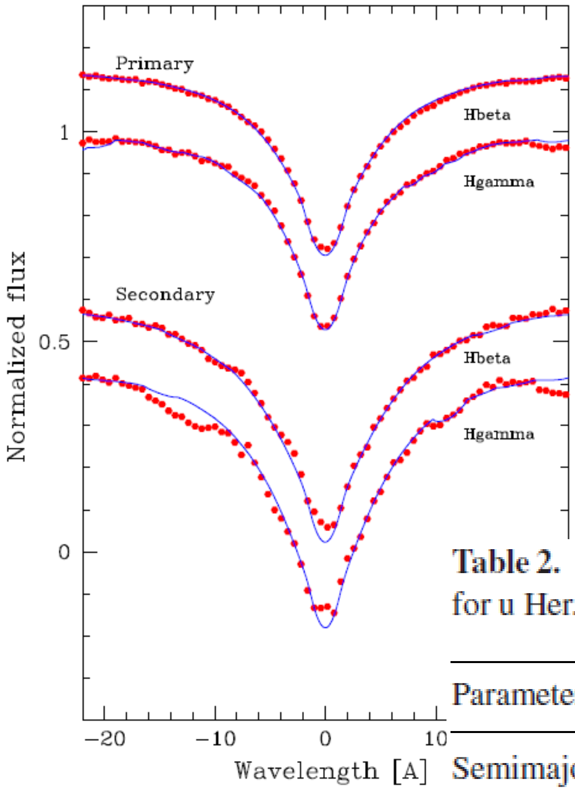
İbanoğlu ve ark., 2012 >> 18 Algol baş bileşeni

SPD – Tayfsal Ayırma

- Ardışık zaman aralıklarında alınmış çift yıldız tayflarının kullanılması ile yıldızların yörünge parametreleri dikine hız yöntemi ile uzun süredir elde edilmektedir.
- Temeli yine dopler kaymasına dayanan tayfsal ayırma yöntemi yörünge parametrelerinin yanı sıra bir biri üzerine düğümlenmiş bileşen tayflarını ayırmaktadır.
- Bu yöntem sayesinde elde edilen ayrılmış tayfların S/N oranları gözlenen her bir tayftan daha büyüktür.
- İyi evre dağılımına sahip böylesi bir gözlemden elde edilen sonuçlar tek yıldızların gözlemine kıyasla daha avantajlı hale gelmektedir.



u Her: Birleştirilmiş Çözüm



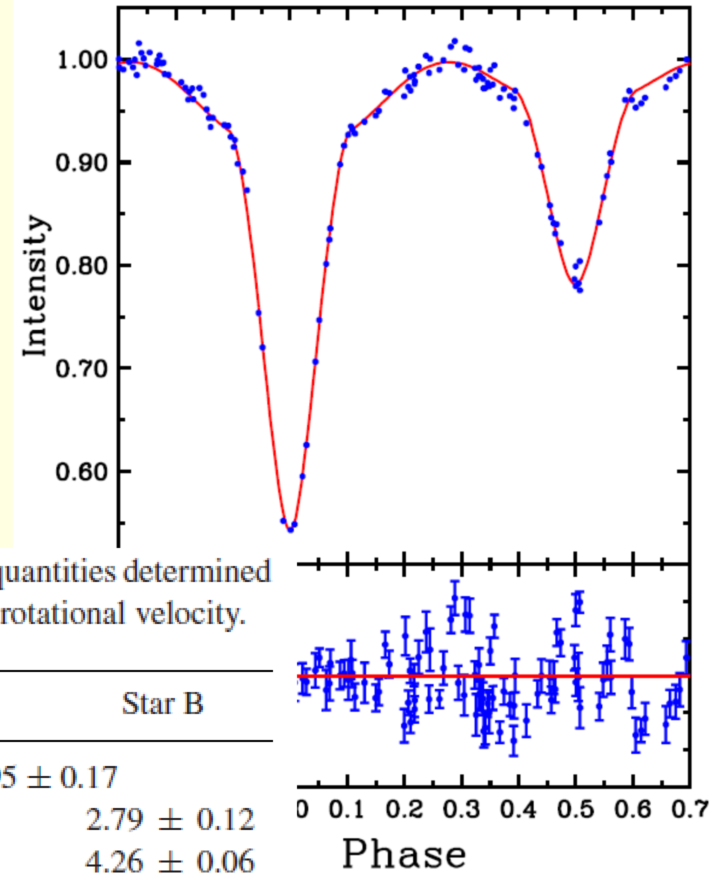
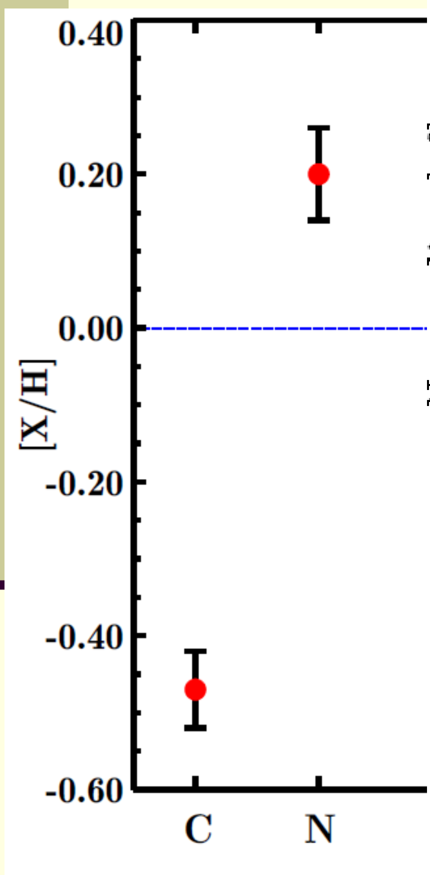
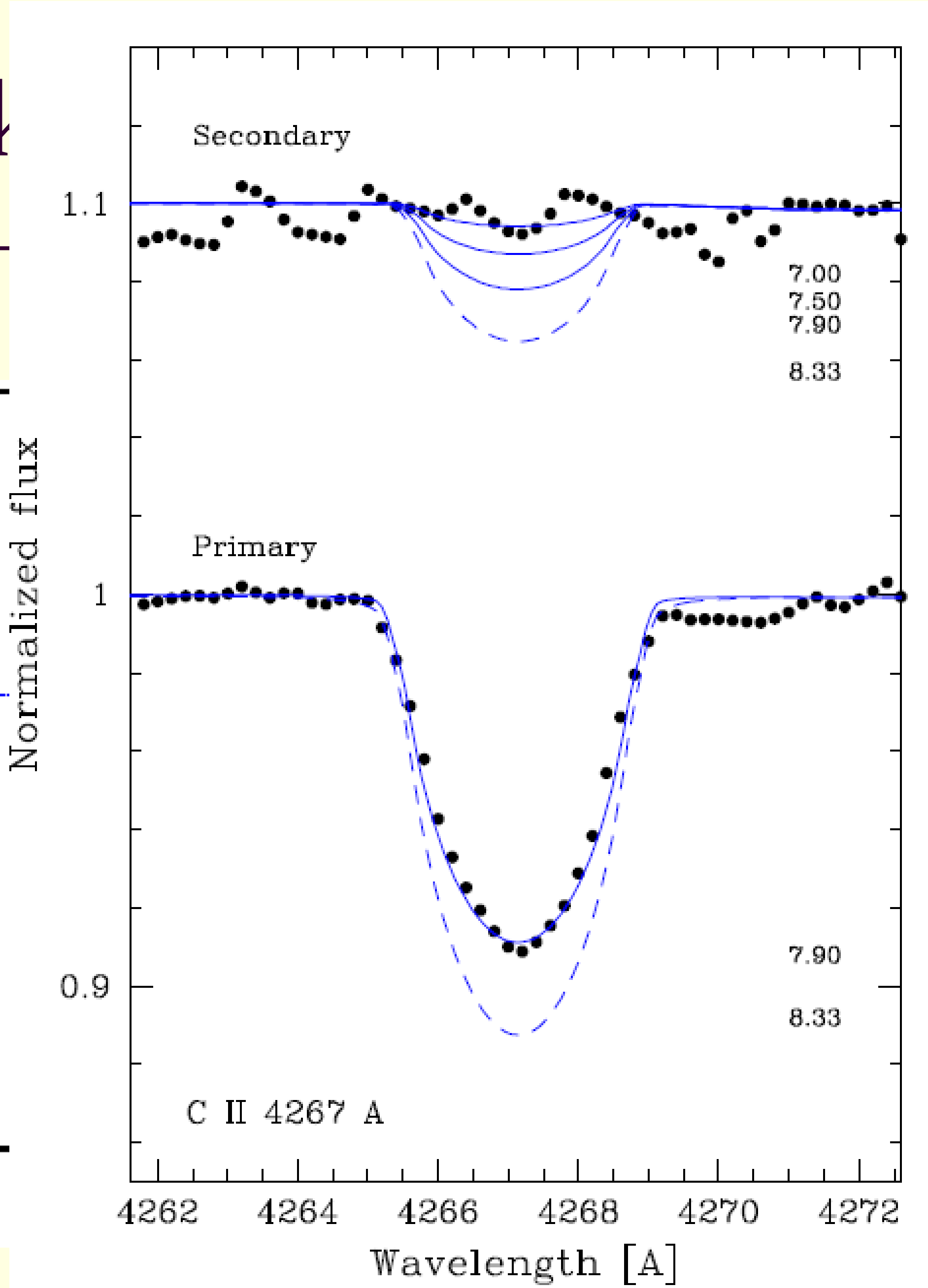


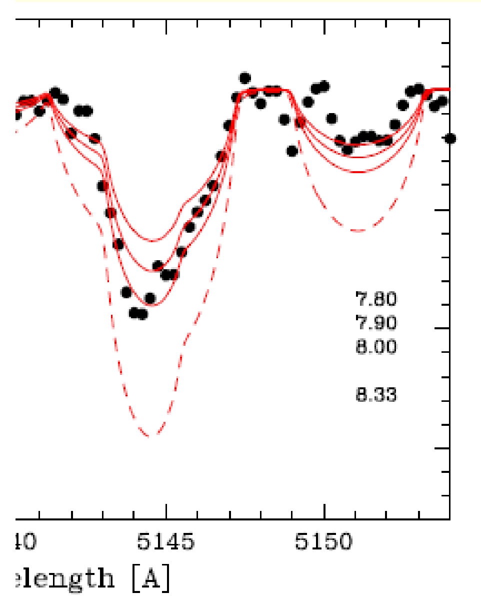
Table 2. The absolute dimensions and related quantities determined for u Her. V_{synch} is the calculated synchronous rotational velocity.

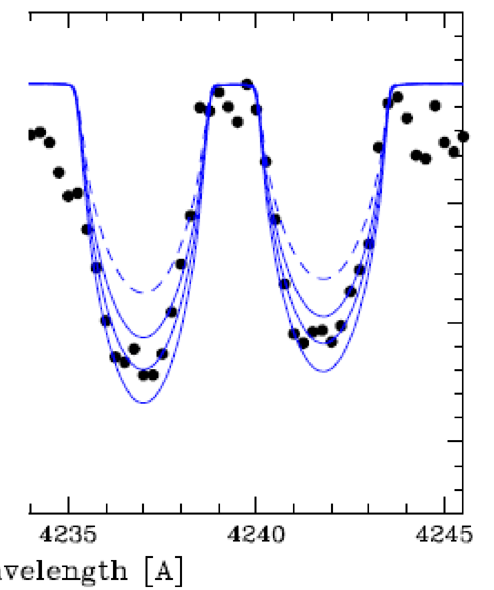
Parameter	Unit	Star A	Star B
Semimajor axis	$R_\odot$	14.95 ± 0.17	
Mass	$M_\odot$	7.88 ± 0.26	2.79 ± 0.12
Radius	$R_\odot$	4.93 ± 0.15	4.26 ± 0.06
$\log g$	cm s^{-2}	3.948 ± 0.024	3.625 ± 0.013
T_{eff}	K	21 600 ± 220	12 600 ± 550
$\log L$	$L_\odot$	3.68 ± 0.03	2.63 ± 0.08
$V_{eq} \sin i$	km s^{-1}	124.2 ± 1.8	107.0 ± 2.0
V_{synch}	km s^{-1}	121.7 ± 3.5	105.0 ± 1.5

Bolluk









NLTE (Buttler & Giddings, 1985)

Evrimsel Analiz

- Başlangıç parametreleri

$$\beta = 1 - |\frac{M_g}{\dot{M}_d}| \qquad 0 \leqslant \beta \leqslant 1$$

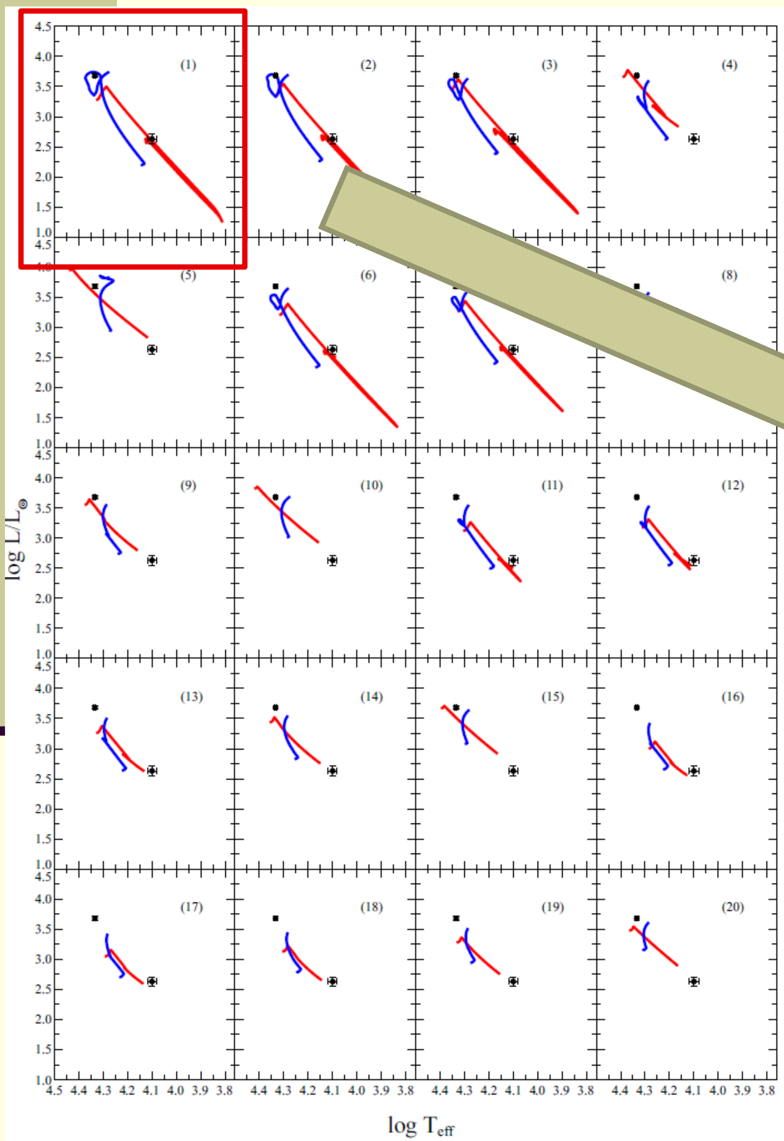
- Açısal momentum evrimi

$$\frac{M_t^i}{M_t^f} = \frac{(1+q^i)}{(1+q^f)} \frac{[1+q^f(1-\beta)]}{[1+q^i(1-\beta)]}$$

  - Kaçan madde oranı
  - Kaçan açısal momentum varsayımı

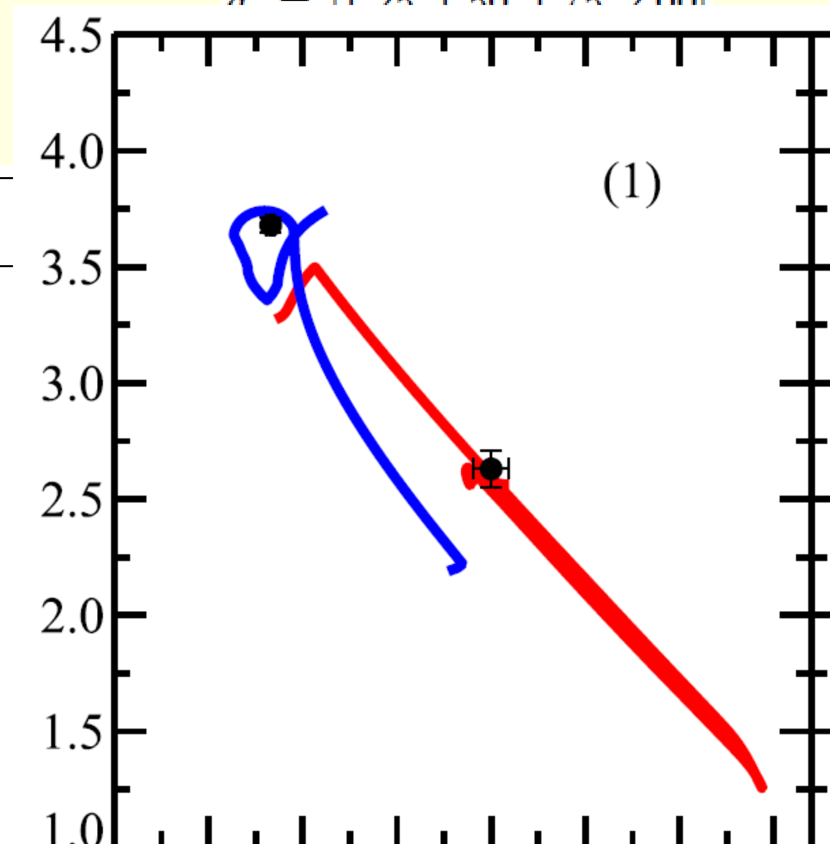
$$\frac{P^f}{P^i} = \left(\frac{M_d^i + M_g^i}{M_d^f + M_g^f}\right)^{1/2} \left(\frac{M_g^i}{M_g^i + (1-\beta)(M_d^i - M_d^f)}\right)^3 \left(\frac{M_g^i + M_d^i}{M_g^i + (1-\beta)M_d^i + \beta M_d^f}\right)^{-3/2} \left(\frac{M_d^i}{M_d^f}\right)^{3(1-\beta)}$$

Evrimsel analiz



$q^i = [1.25, 1.50, 1.75, 2.00]$

P^i d	M_d^f $M_\odot$								
[illegible]	[illegible]								
[illegible]	[illegible]								
[illegible]	[illegible]								
1.06	3.86								
0.91	3.16								
1.19	3.16								
1.15	3.31								
1.10	3.56								
1.00	4.03								
0.90	3.85								
1.07	3.46								
1.05	3.57								
1.01	3.80								
0.96	4.02								
0.91	4.12								
0.98	3.82								
0.97	3.93								
0.96	4.05								
0.95	4.18	7.24	1.36	2.77	4.16	0.59	3.30	4.29	0.70
0.95	4.31	7.56	1.58	2.91	4.17	0.64	3.60	4.29	0.75

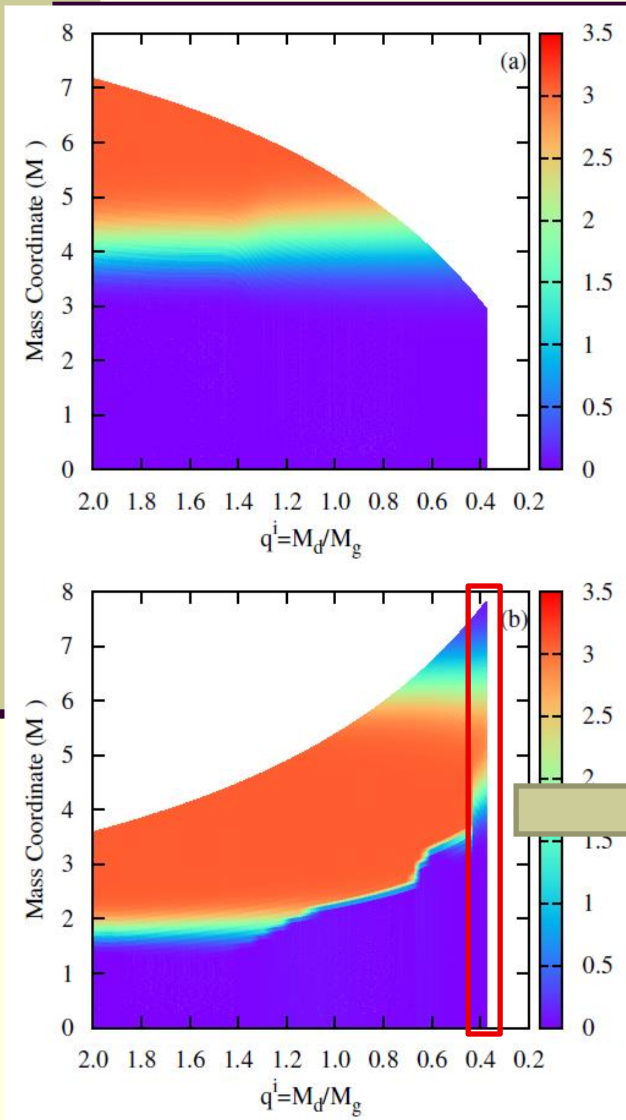


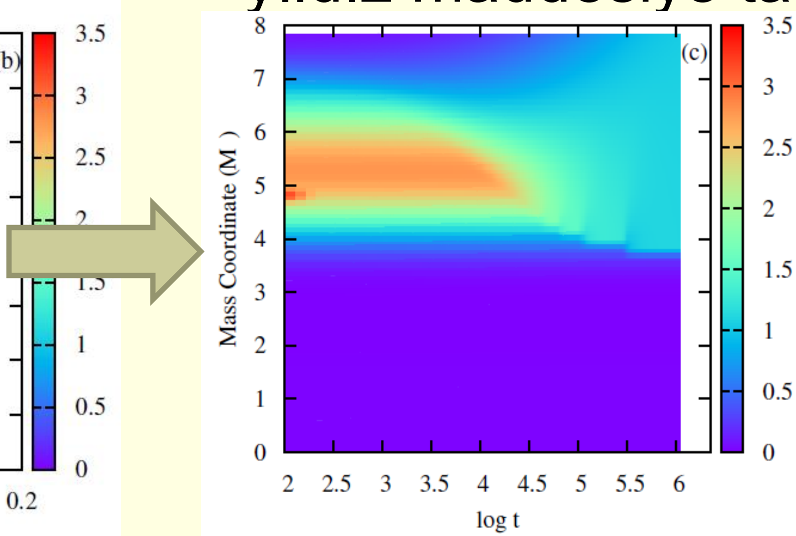
Evrimsel Analiz

- Sistemin muhtemel başlangıç parametreleri

  $M_d \sim 7.2\,M_\odot$ $M_g \sim 3.6\,M_\odot$ $P_i \sim 1.35\,d$

- Gözlenen C/N~0.9 oranı termohaline konveksiyonla karışmış yıldız maddesiye tam uyumlu!!





Tartışma

- Çift yıldızların yaşam öyküleri henüz tam değil.
- Algol sistemler bu öyküye iyi bir başlangıç olabilir.
- Tayfsal ayırma sayesinde bütün nimetlerini kullandığımız çift yıldızları aynı zamanda kimyasal bolluk çalışmaları için avantaja dönüştürebiliriz.
- u Her bir etüd çalışması
- Çok sayıda yüksek çözünürlüklü tayflardan elde edilecek yoldaş bileşenin kimyasal komposizyon analizi bu türden çalışmalara ışık tutacaktır.
- Aynı zamanda çift yıldız evrim modellerindeki belirsizliğe sınırlamalar getirecektir.

Teşekkürler

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS **444**, 3118–3129 (2014) doi:10.1093/mnras/stu1652

Tracing CNO exposed layers in the Algol-type binary system u Her

V. Kolbas,[1] A. Dervişoğlu,[2] K. Pavlovski[1]★ and J. Southworth[3]
[1] *Department of Physics, University of Zagreb, Bijenička cesta 32, 10000 Zagreb, Croatia*
[2] *Department of Astronomy & Space Sciences, Erciyes University, Kayseri, Turkey*
[3] *Astrophysics Group, Keele University, Staffordshire CV4 7AL, UK*

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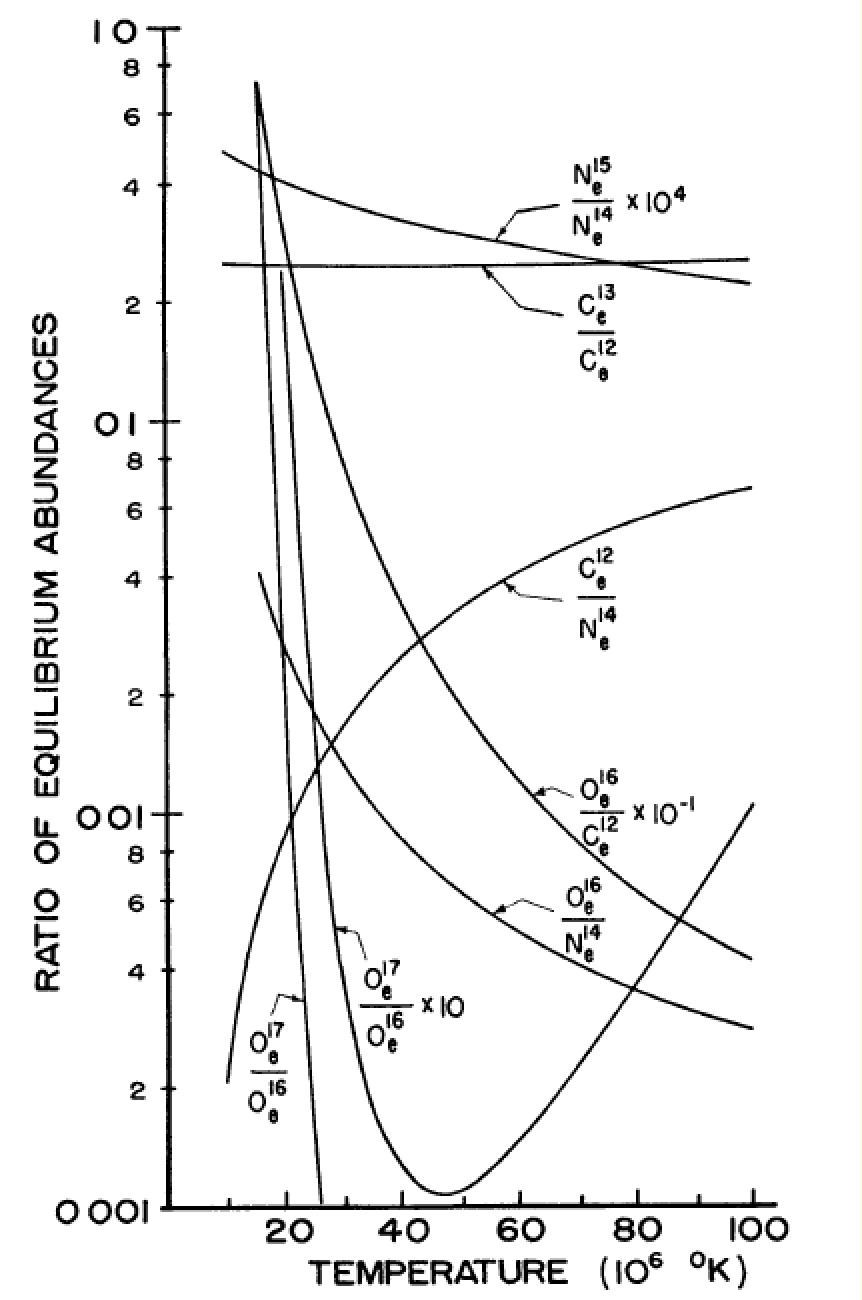
ABSTRACT
The chemical composition of stellar photospheres in mass-transferring binary systems is a precious diagnostic of the nucleosynthesis processes that occur deep within stars, and preserves information on the components' history. The binary system u Her belongs to a group of hot Algols with both components being B-stars. We have isolated the individual spectra of the two components by the technique of spectral disentangling of a new series of 43 high-resolution échelle spectra. Augmenting these with an analysis of the *Hipparcos* photometry of the systems yields revised stellar quantities for the components of u Her. For the primary component (the mass-gaining star) we find $M_{\rm A} = 7.88 \pm 0.26\,{\rm M}_\odot$, $R_{\rm A} = 4.93 \pm 0.15\,{\rm R}_\odot$ and $T_{\rm eff,A} = 21\,600 \pm 220\,{\rm K}$. For the secondary (the mass-losing star) we find $M_{\rm B} = 2.79 \pm 0.12\,{\rm M}_\odot$, $R_{\rm B} = 4.26 \pm 0.06\,{\rm R}_\odot$ and $T_{\rm eff,B} = 12\,600 \pm 550$ K. A non-LTE analysis of the primary star's atmosphere reveals deviations in the abundances of nitrogen and carbon from the standard cosmic abundance pattern in accord with theoretical expectations for CNO nucleosynthesis processing. From a grid of calculated evolutionary models the best match to the observed properties of the stars in u Her enabled tracing the initial properties and history of this binary system. We confirm that it has evolved according to case A mass transfer. A detailed abundance analysis of the primary (mass gaining) star gives $C/N = 0.9$, which supports the evolutionary calculations and indicates strong mixing in the early evolution of the secondary component, which was originally the more massive of the two. The composition of the secondary component would be a further important constraint on the initial properties of u Her system, but requires spectra of a higher signal to noise ratio.

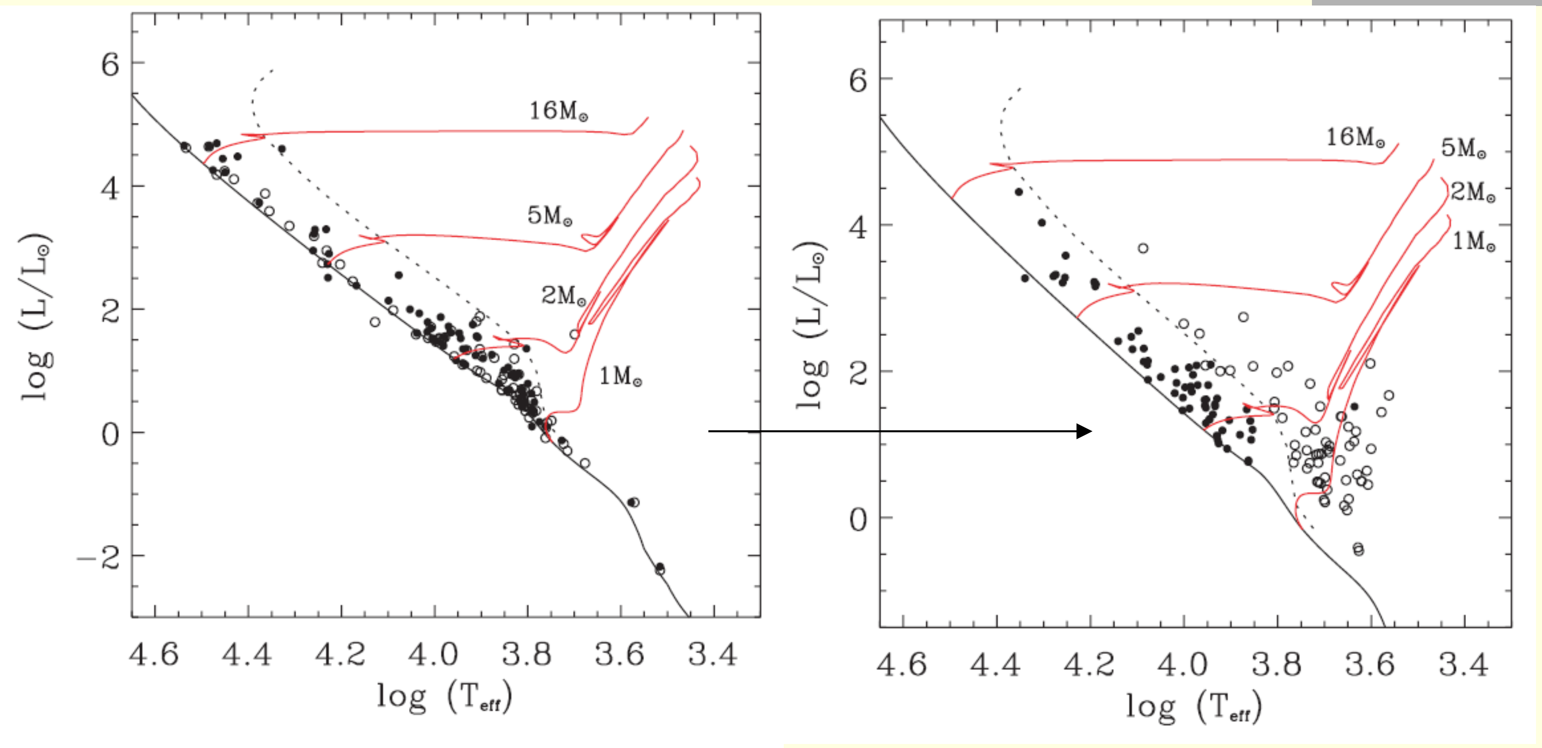
Key words: stars: fundamental parameters — stars: binaries: eclipsing — stars: binaries: spectroscopic — stars: individual: u Her

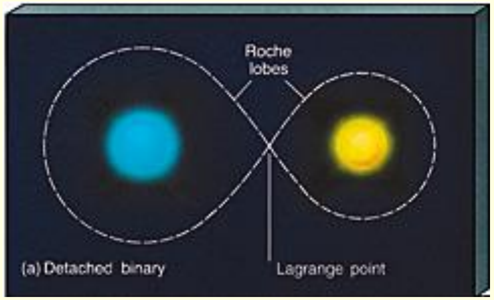
Bu çalışma 113F067 nolu TÜBİTAK projesince desteklenmektedir.

- Coughlan & Fowler, 1962

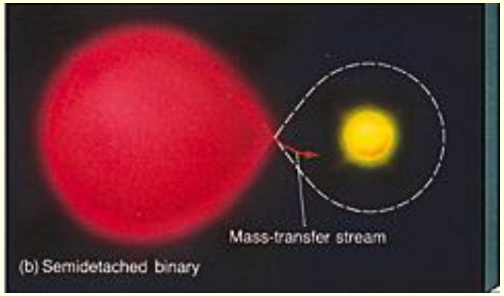


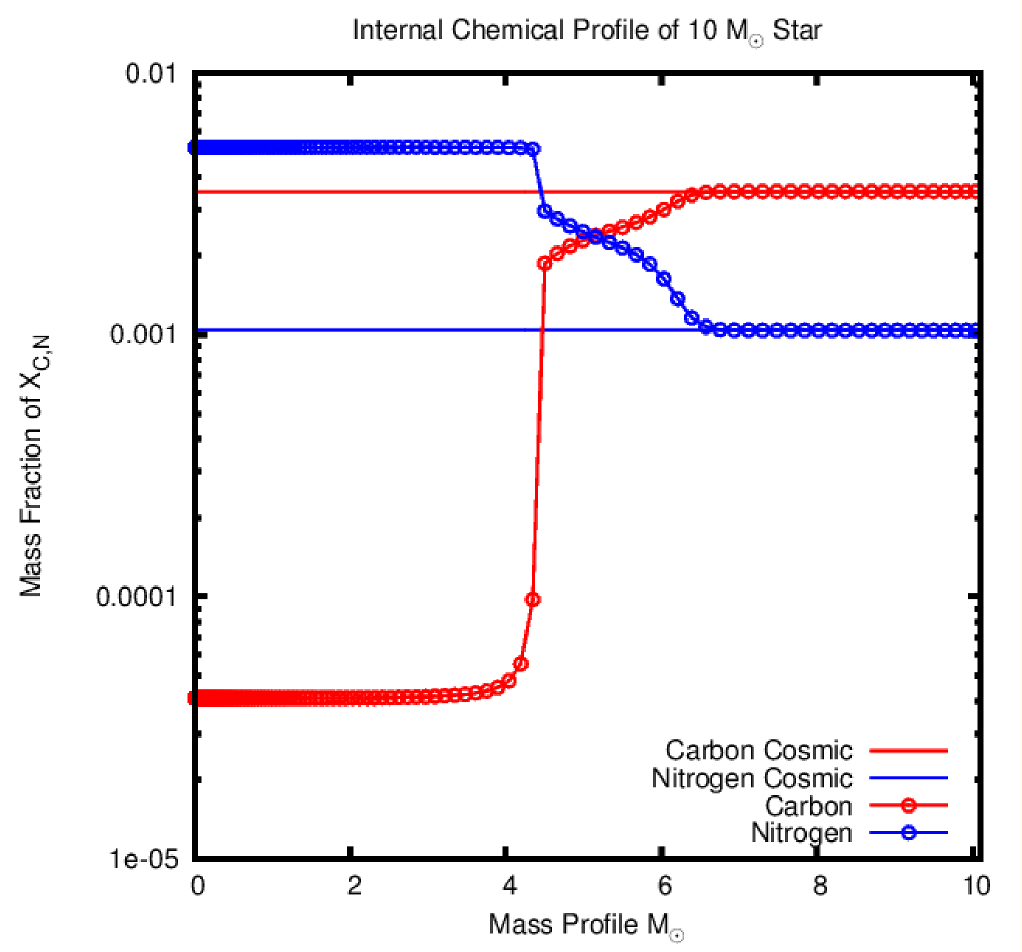
Detacheds / Semi-Detacheds



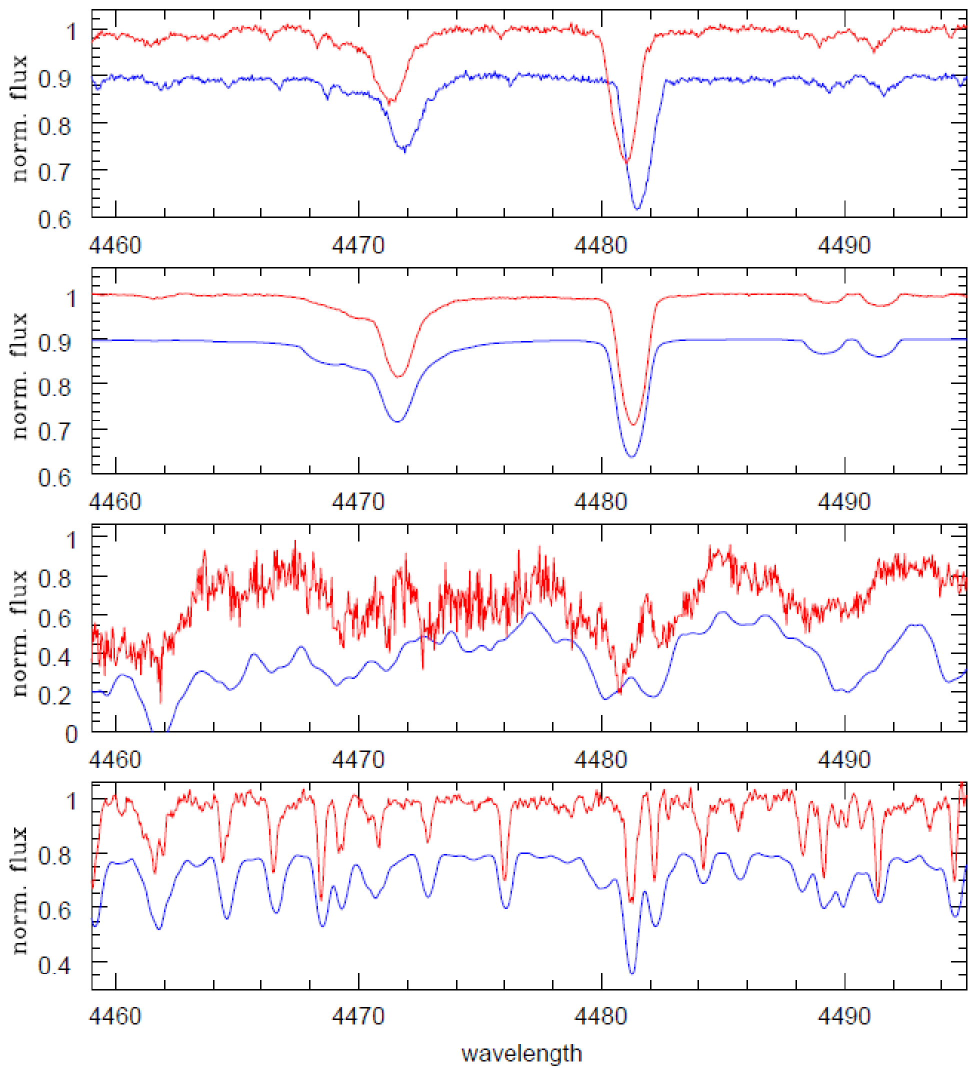


İbanoğlu et al., 2006




Internal Chemical Profile of 10 M☉ Star
0.01
0.001
0.0001
1e-05
Mass Fraction of $X_{C,N}$
0
2
4
6
8
10
Mass Profile M☉
Carbon Cosmic
Nitrogen Cosmic
Carbon
Nitrogen

SPD – Algol Binaries



- We have started initiation for observing well known Algols (Pavlovski, Dervisoglu, Kolbas, Southworth)
- We have compiled ~60 systems which error on their absolute parameters are less than %5!
- The first victim is Algol itself (Beta Per) which SPD successfully disentangle the three component even the one with only contributes %1 of total light!! (Kolbas & Pavlovski, 2012)

Table 4. Estimated photospheric abundances for different ions in the atmosphere of the primary component of u Her. Abundances are expressed relative to the abundance of hydrogen, $\log \epsilon(H) = 12.0$.

Line	$\log \epsilon(X)$	Line	$\log \epsilon(X)$	Line	$\log \epsilon(X)$
C II		O II		Mg II	
4267.00	7.90	4185.46	8.55	4481.13	7.50
5132.95	7.95	4189.79	8.70	5264.22	7.40
5137.26	7.97	4414.88	8.55	5401.54	7.50
5143.40	7.95	4416.97	8.62	Si II	
5151.08	7.85	4590.97	8.70	4128.05	7.55
N II		4596.20	8.68	4130.88	7.40
4227.75	8.00	4609.42	8.50	Si III	
4236.91	7.98	4661.63	8.62	4552.62	7.48
4241.80	7.95	4673.75	8.65	4567.82	7.37
4447.03	8.00	4676.23	8.65	4574.76	7.55
4507.56	8.00	4677.07	8.70	4716.65	7.70
4607.15	8.05	4698.48	8.60	4819.72	7.50
4613.86	8.00	4699.21	8.68	4828.96	7.35
4643.09	7.90	4703.18	8.48	Al III	
4803.27	8.05	4705.35	8.55	4149.92	6.30
4987.38	8.00	5206.64	8.50	4479.97	6.40
4994.36	8.02			4512.54	6.20
5001.47	7.95			4528.94	6.40
5007.31	7.83				
5010.62	7.90				
5045.09	7.93				
5495.65	8.03				
5666.63	7.85				