

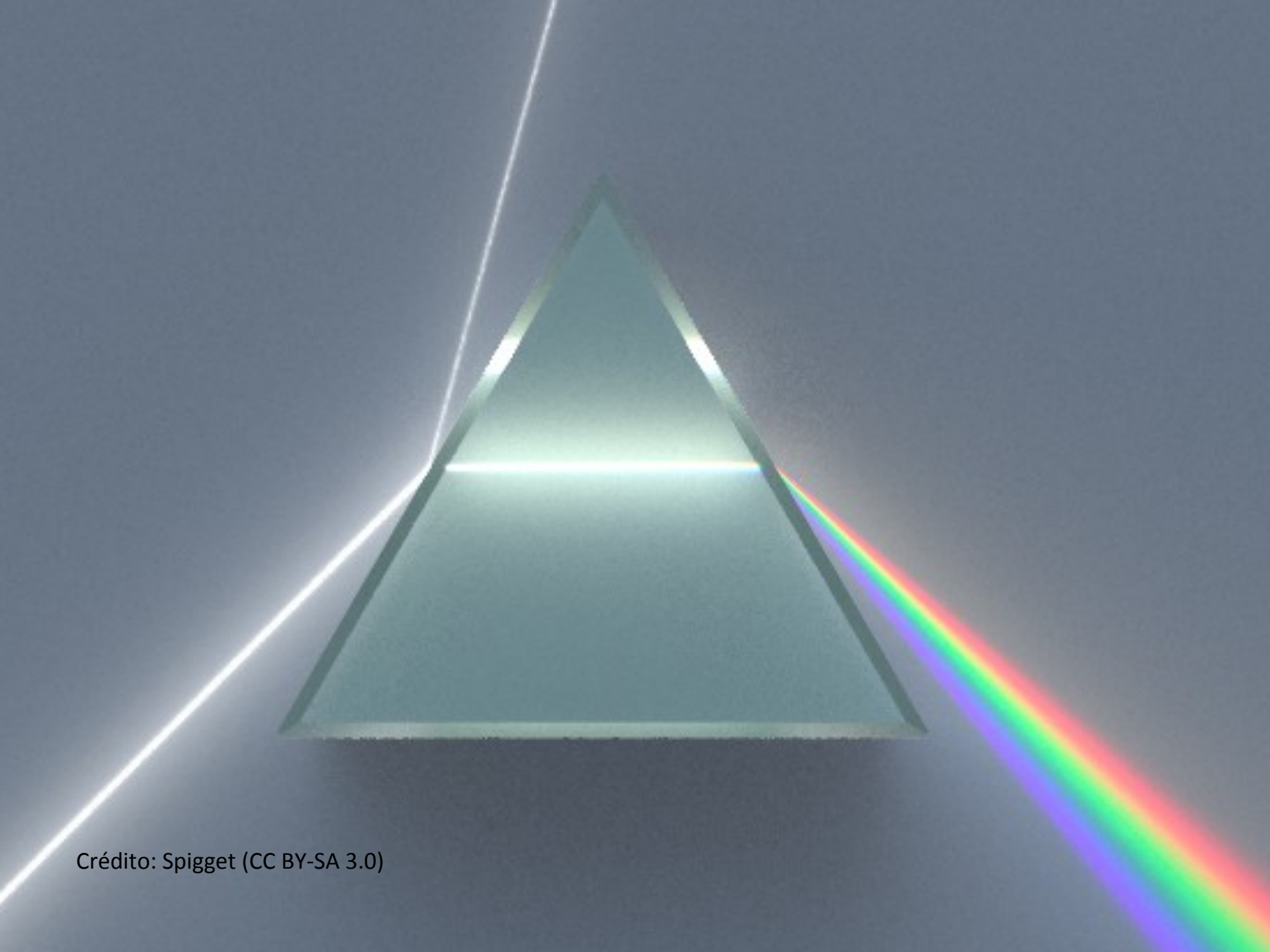
Espectroscopía

1.- Espectros

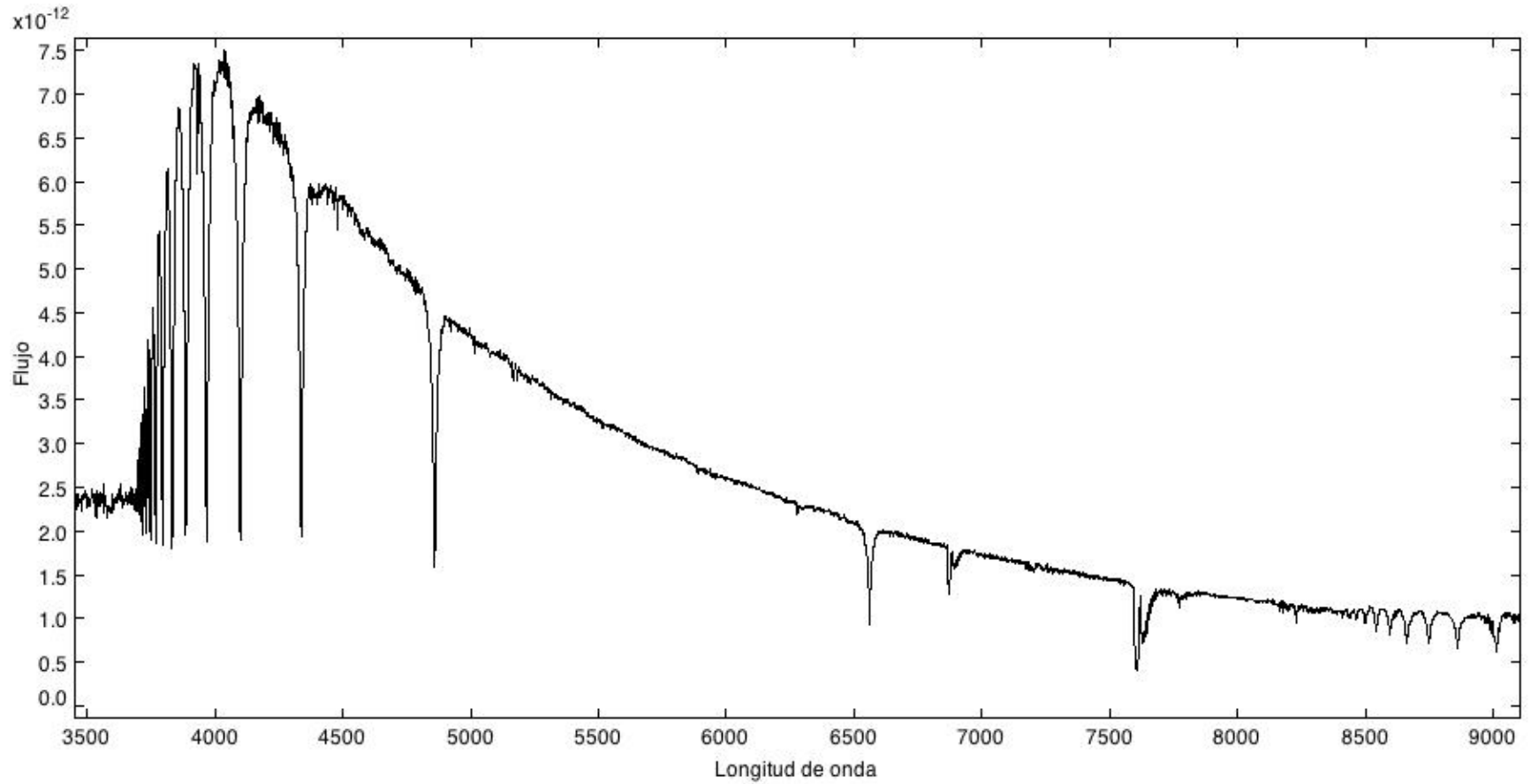
Juan Fabregat

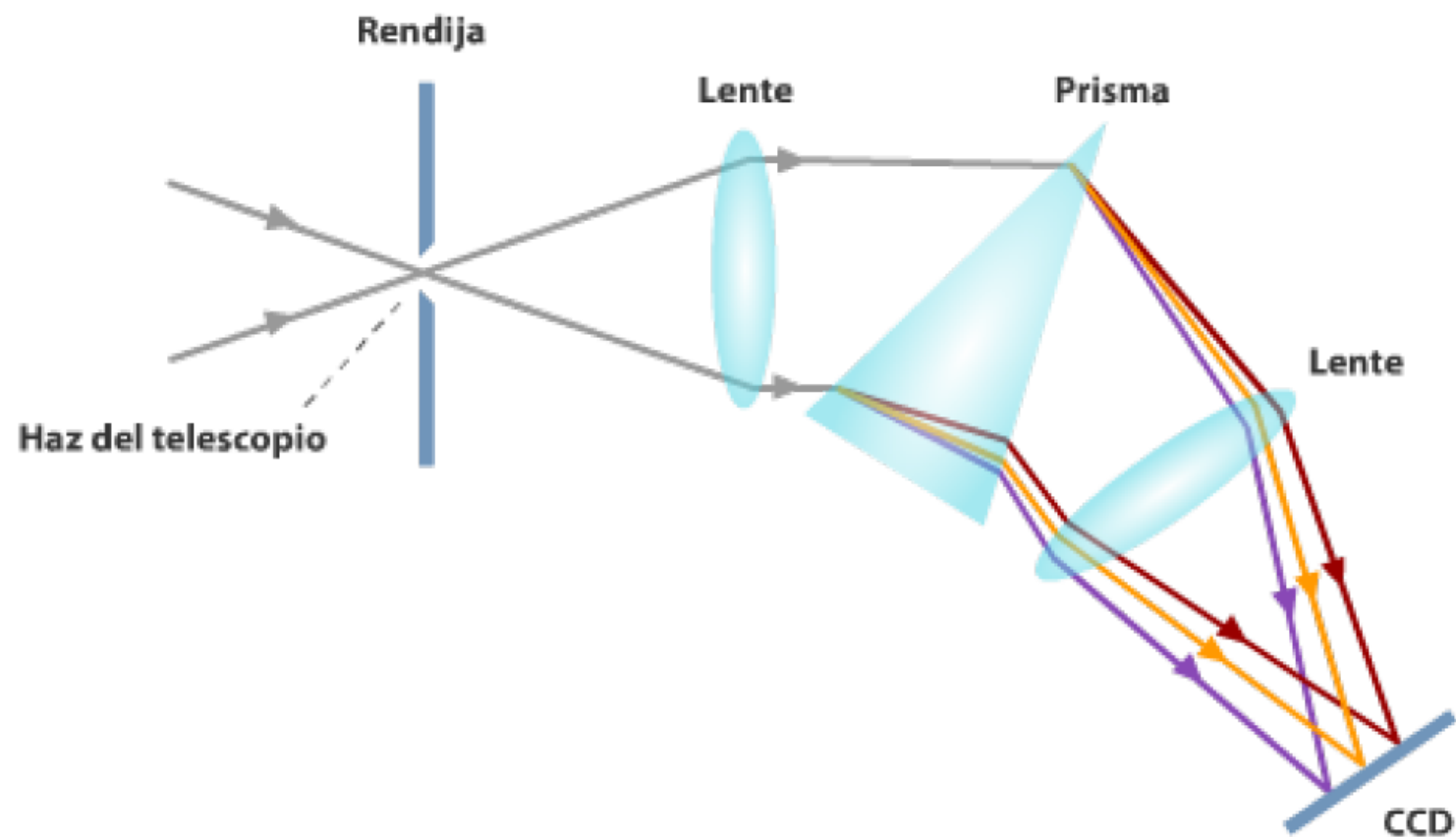
Universidad de Valencia

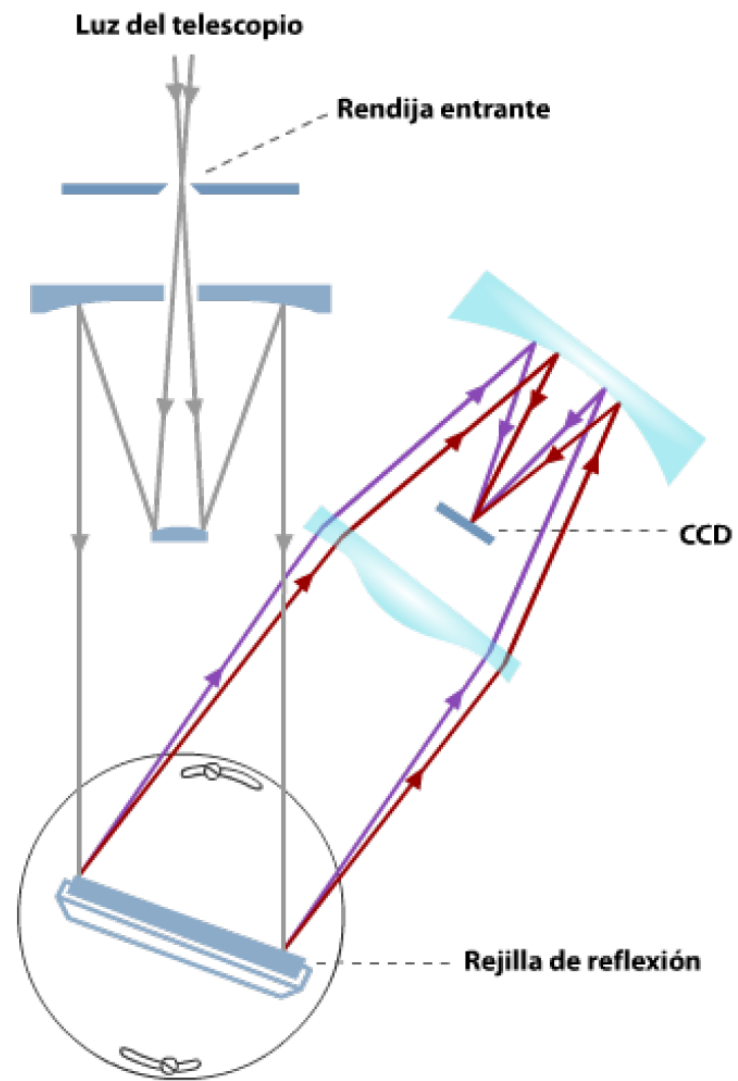


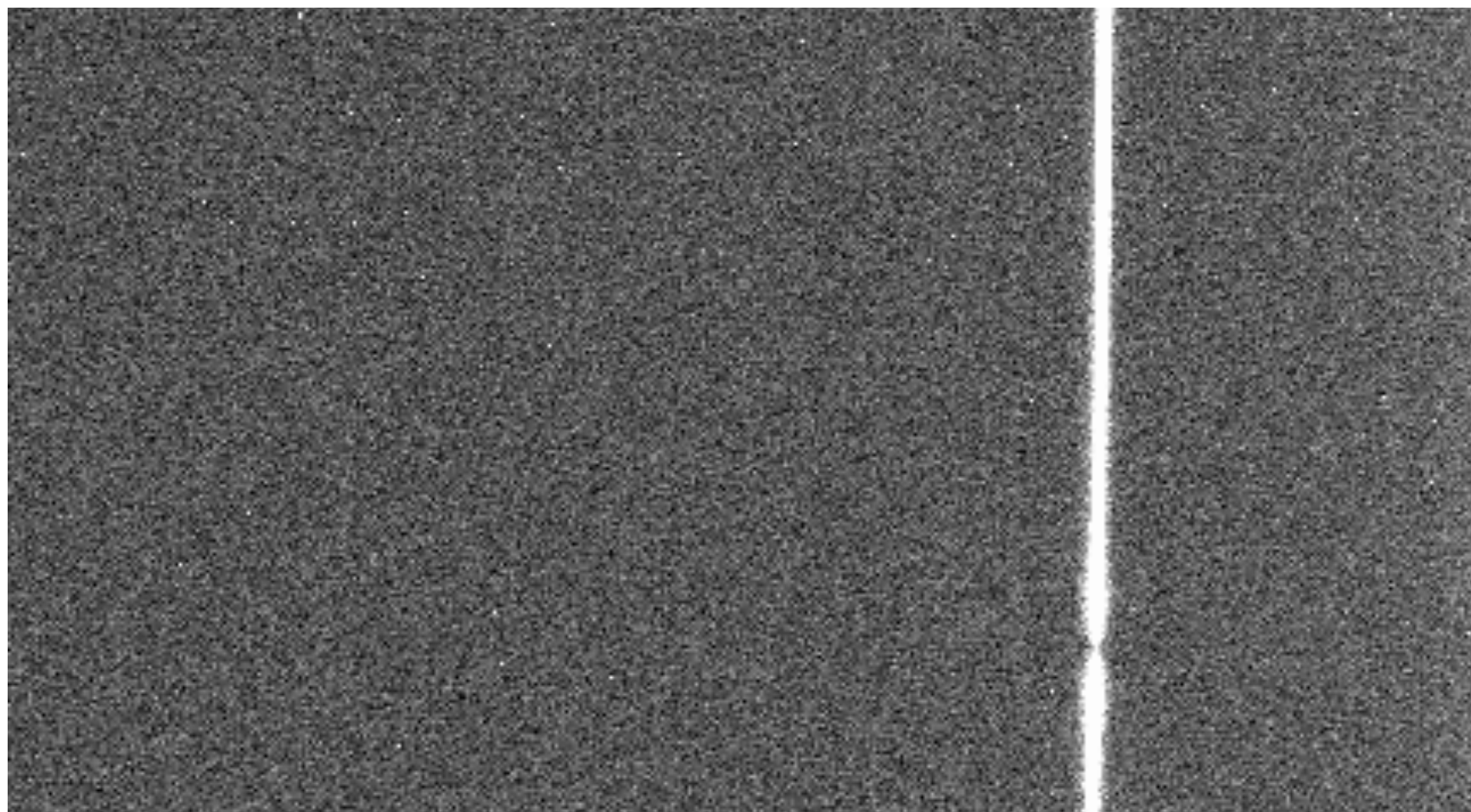


HD 109995 (A0V)



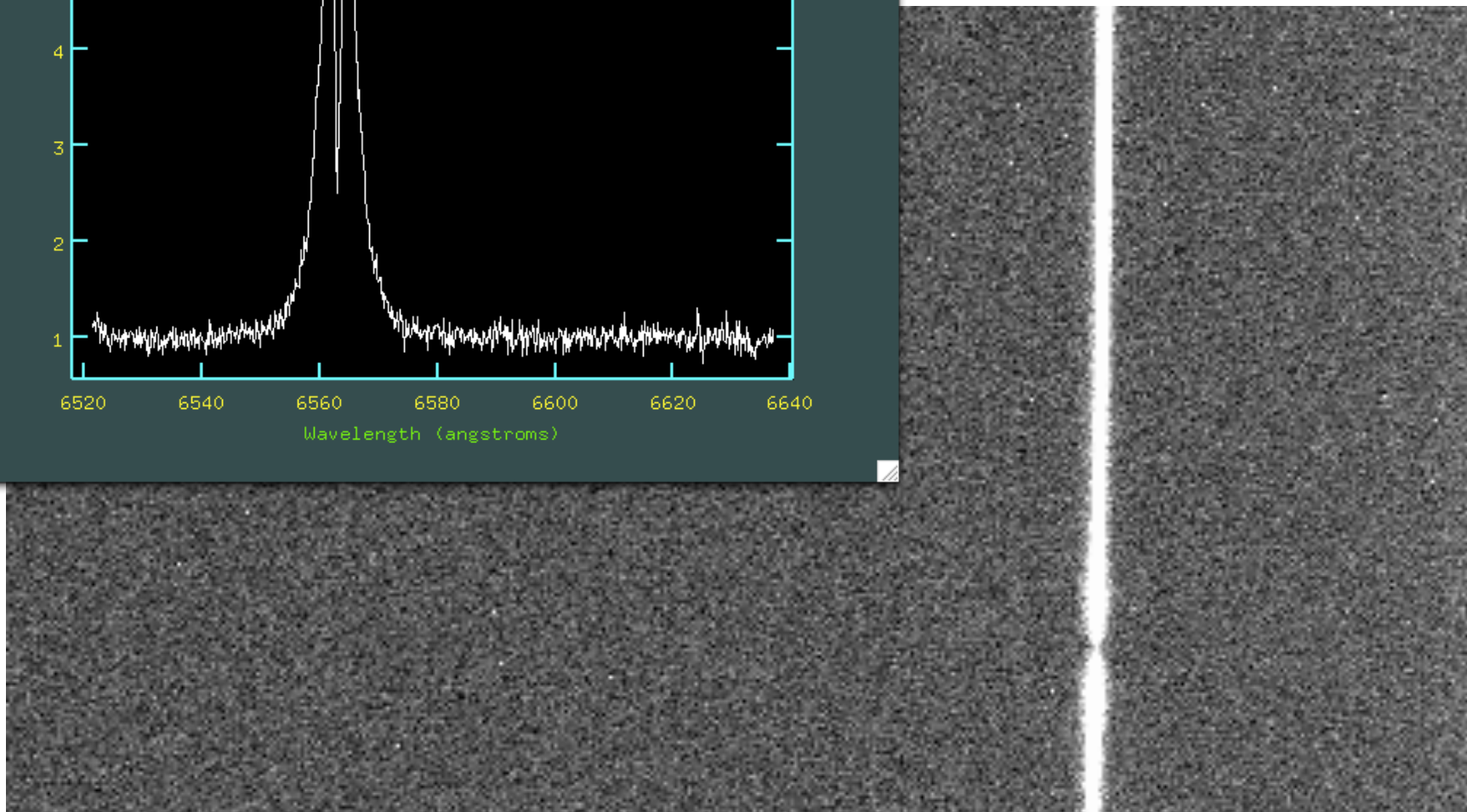
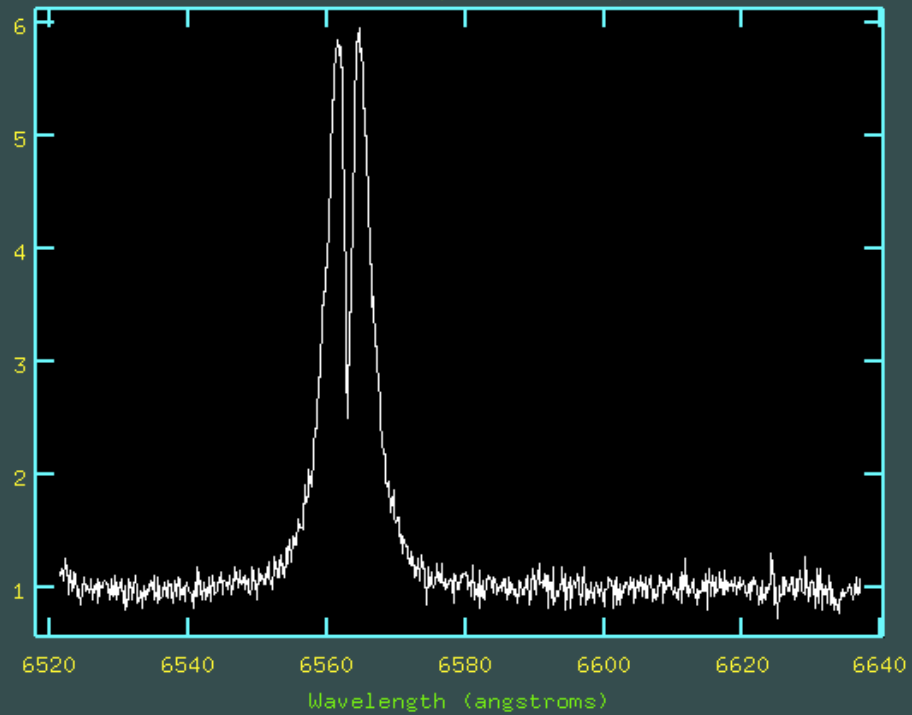




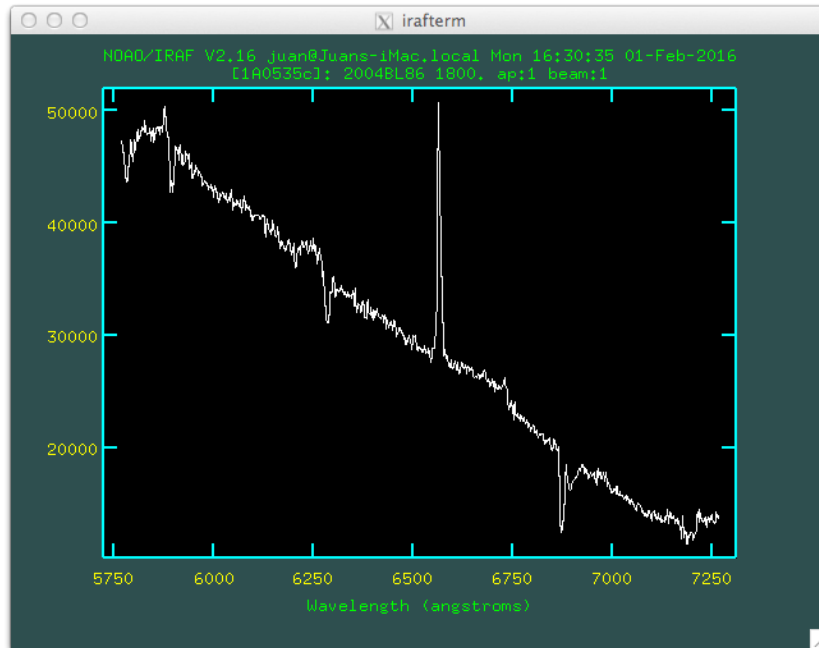


irafterm

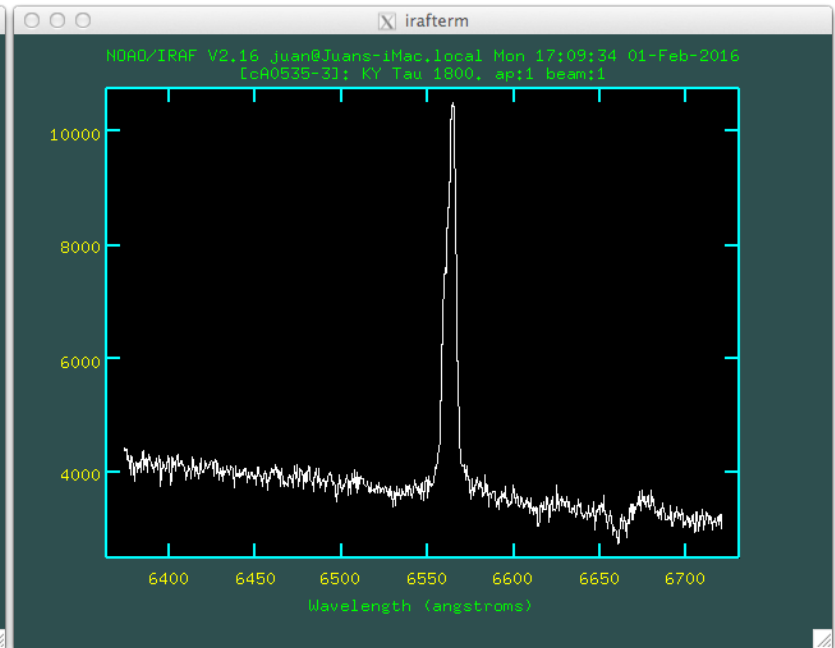
NOAO/IRAF V2.16 juan@Juans-MacBook-Air.local Fri 22:00:59 09-May-2014
[nHD22192.ms.fits]: phi Per 60. ap:1 beam:1



Rango espectral y dispersión

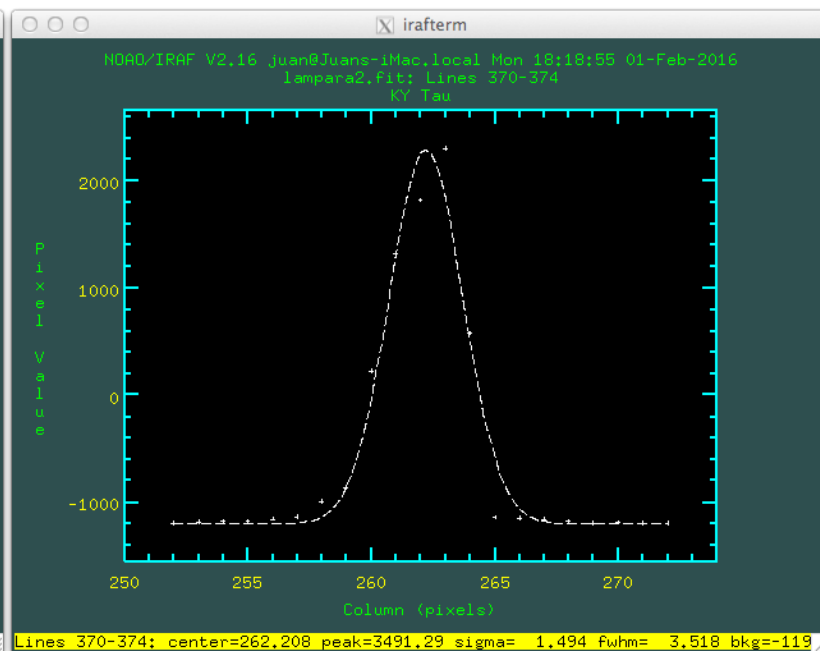
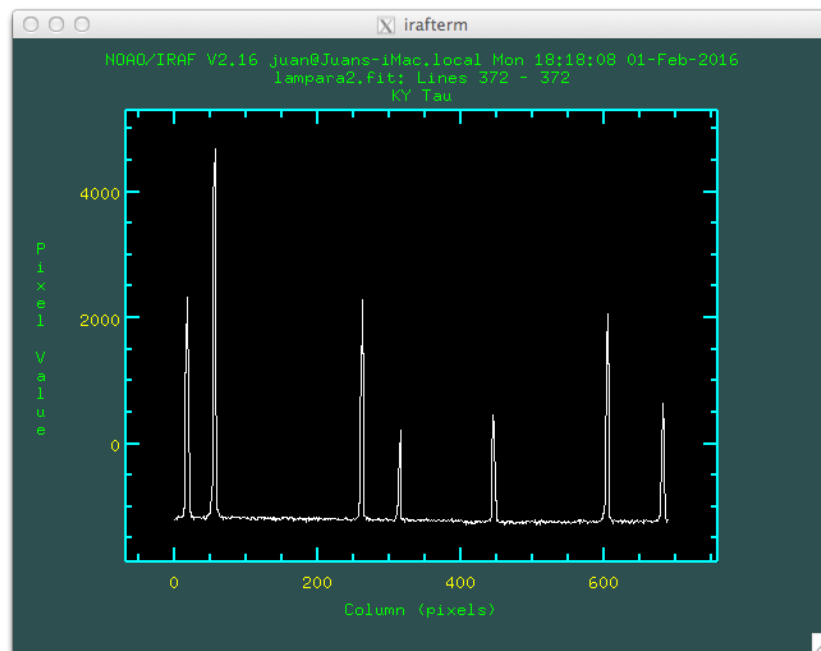


Rango: 5770 – 7265 (1495 Å)
Npix = 690 píxeles
Dispersión = 2.2 Å/píxel

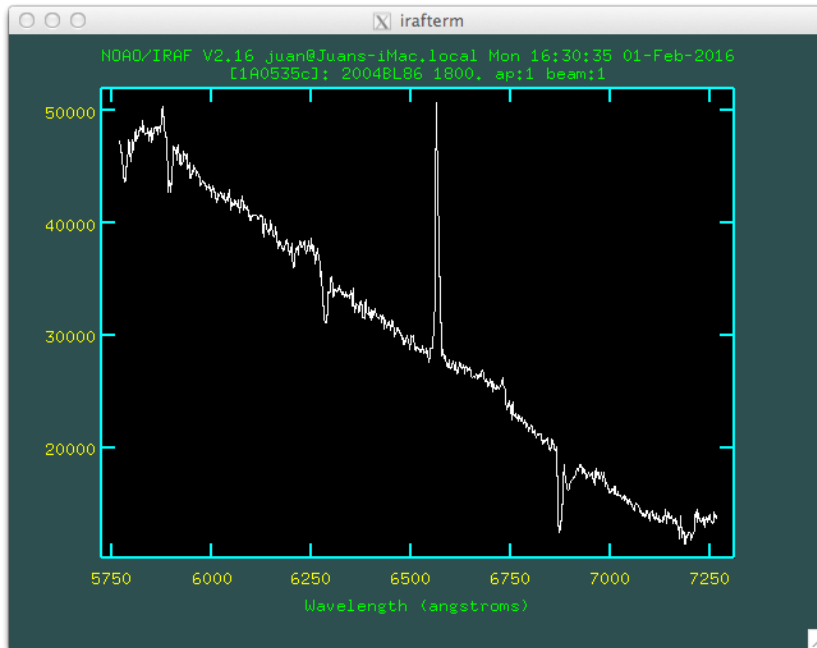


Rango: 6375 – 6720 (345 Å)
Npix = 690 píxeles
Dispersión = 0.5 Å/píxel

Resolución espectral



Rango espectral y resolución



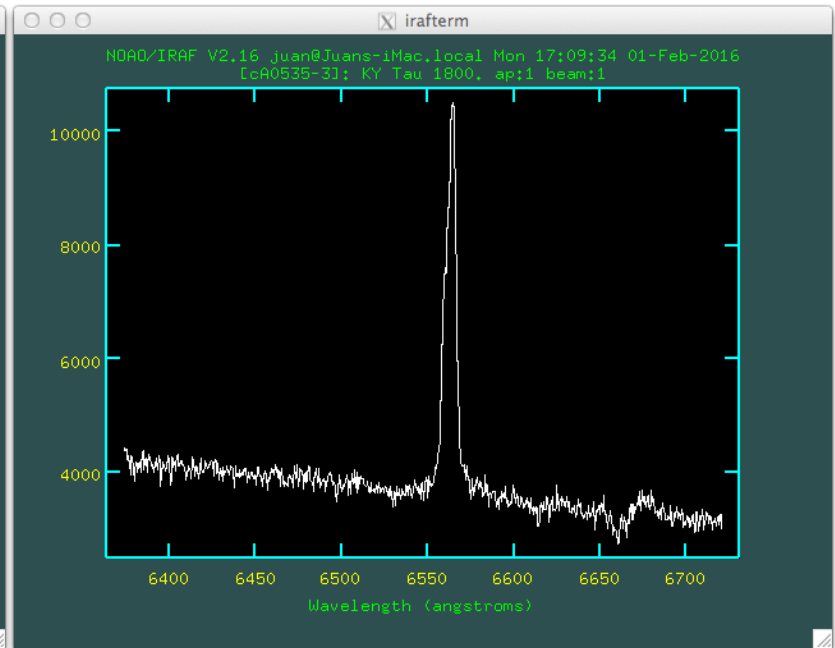
Rango: 5770 – 7265 (1495 Å)

Npix = 690 píxeles

Dispersión = 2.2 Å/píxel

Resolución = 8 Å

$R = \lambda/\Delta\lambda \approx 800$



Rango: 6375 – 6720 (345 Å)

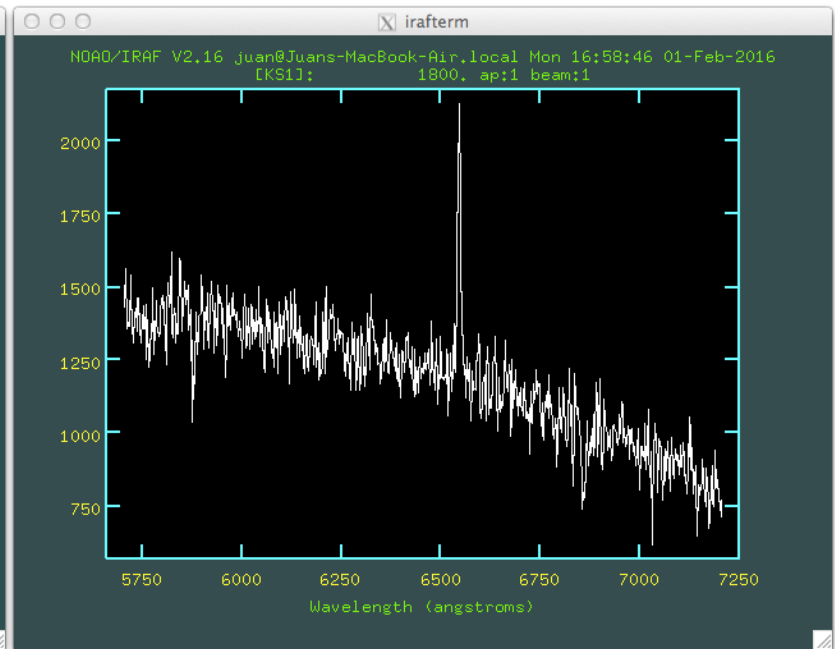
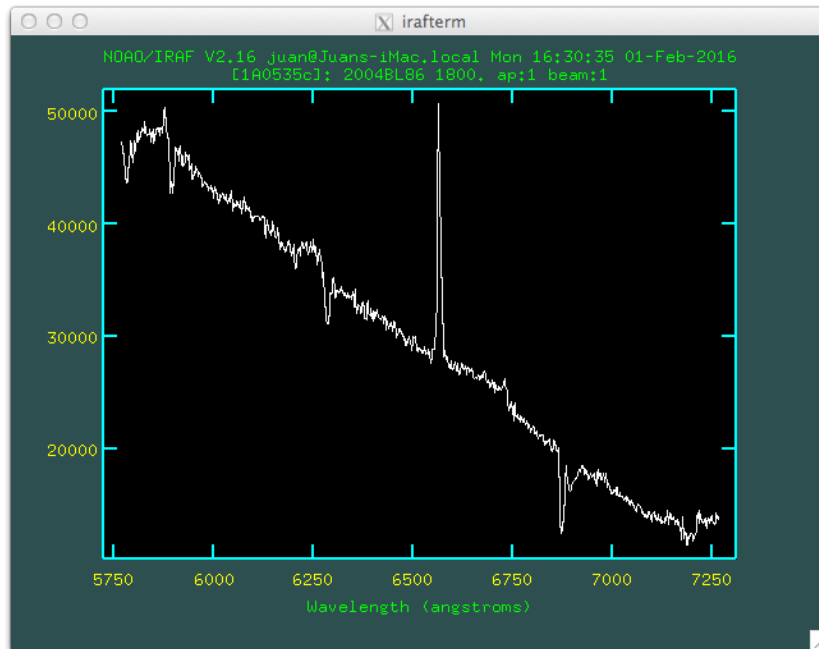
Npix = 690 píxeles

Dispersión = 0.5 Å/píxel

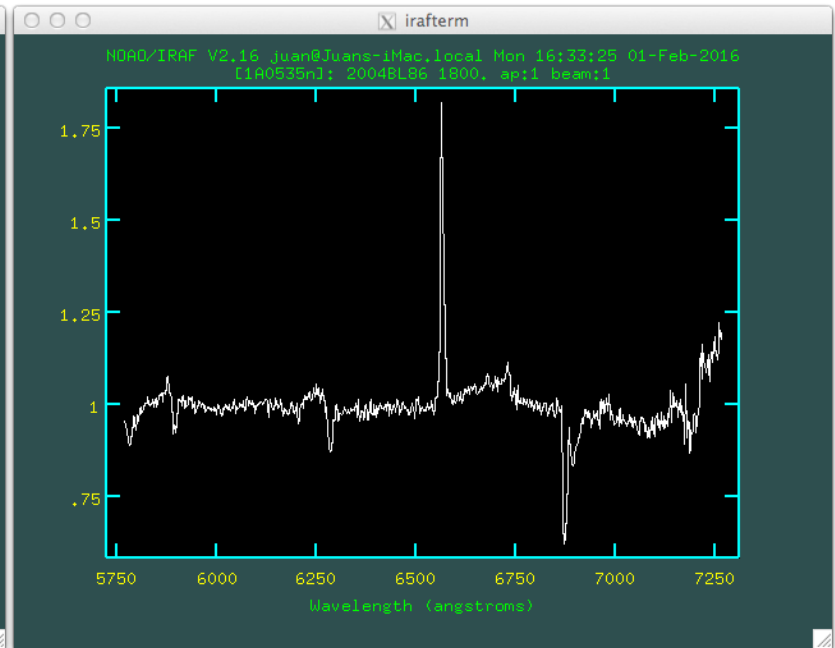
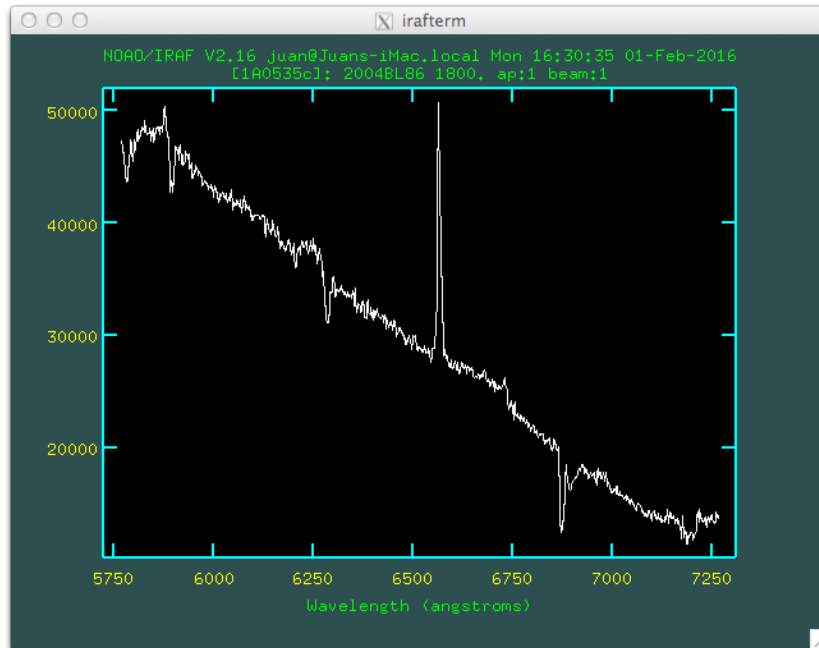
Resolución = 2 Å

$R \approx 3200$

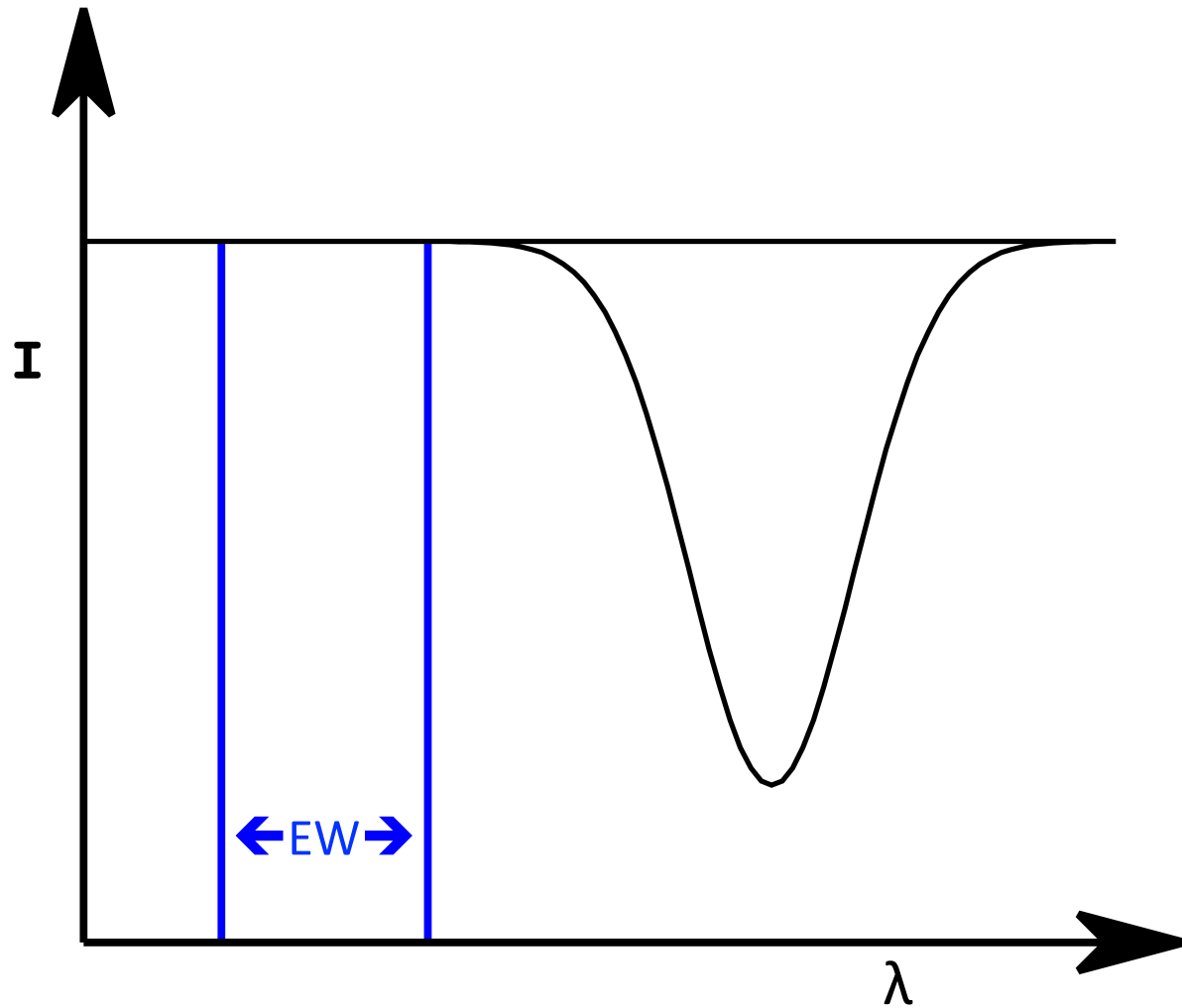
Relación señal ruido



Rectificación del espectro



Anchura equivalente



Créditos

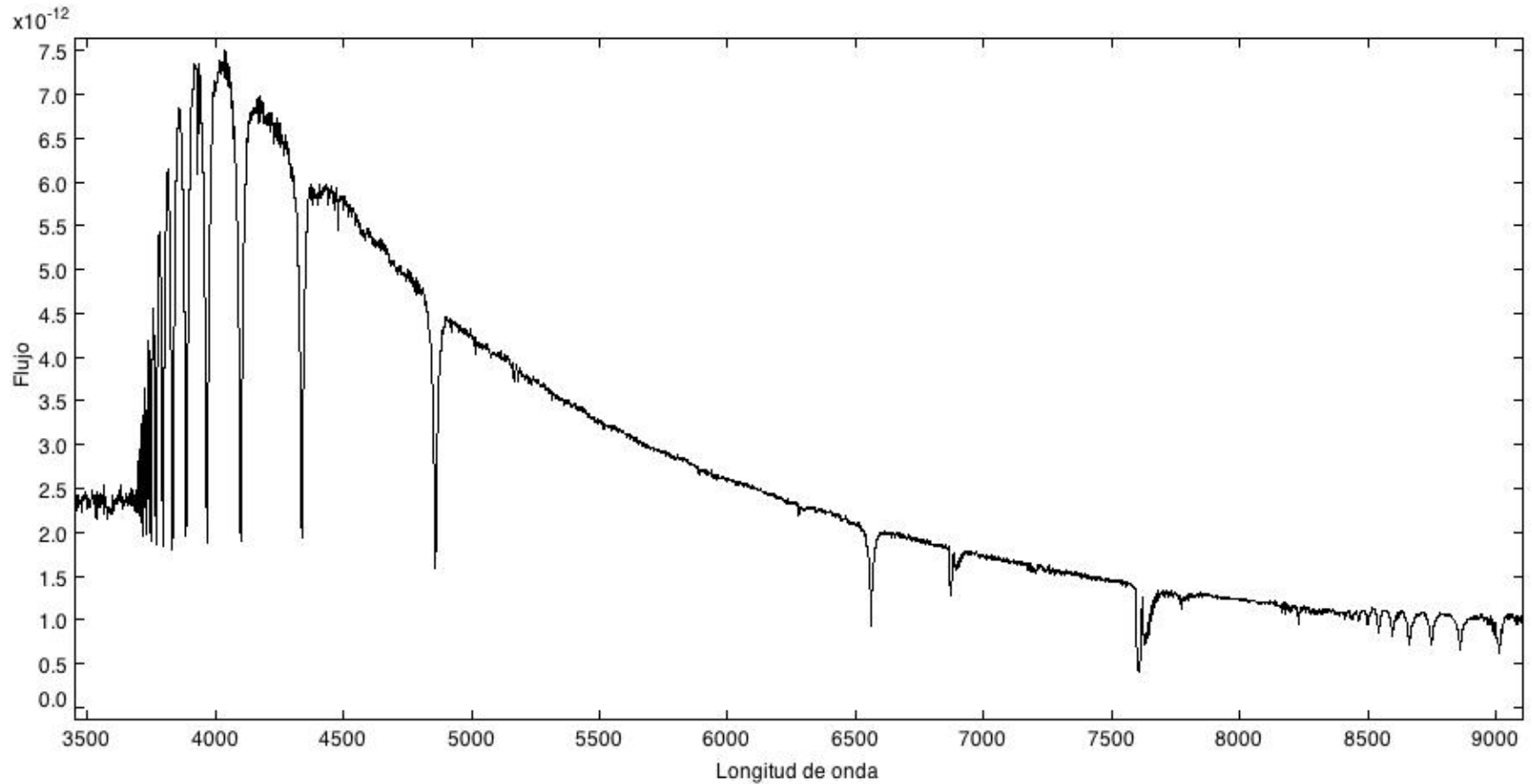
- Fig. 1: “Newton dispersing sunlight through a prism”, The Granger Collection, New York. (<http://kids.britannica.com/comptons/art-126632/A-19th-century-engraving-depicts-Isaac-Newton-dispersing-sunlight-through>), por Britannica Online for Kids.
- Fig. 2: “Dispersive prism illustration” (https://commons.wikimedia.org/wiki/File:Dispersive_Prism_Illustration.jpg), por Spigget (CC BY-SA 3.0)
- Fig. 3: “Espectro de HD 109995”. Datos de STELIB (<http://www.ast.obs-mip.fr/article181.html>)

Espectroscopía

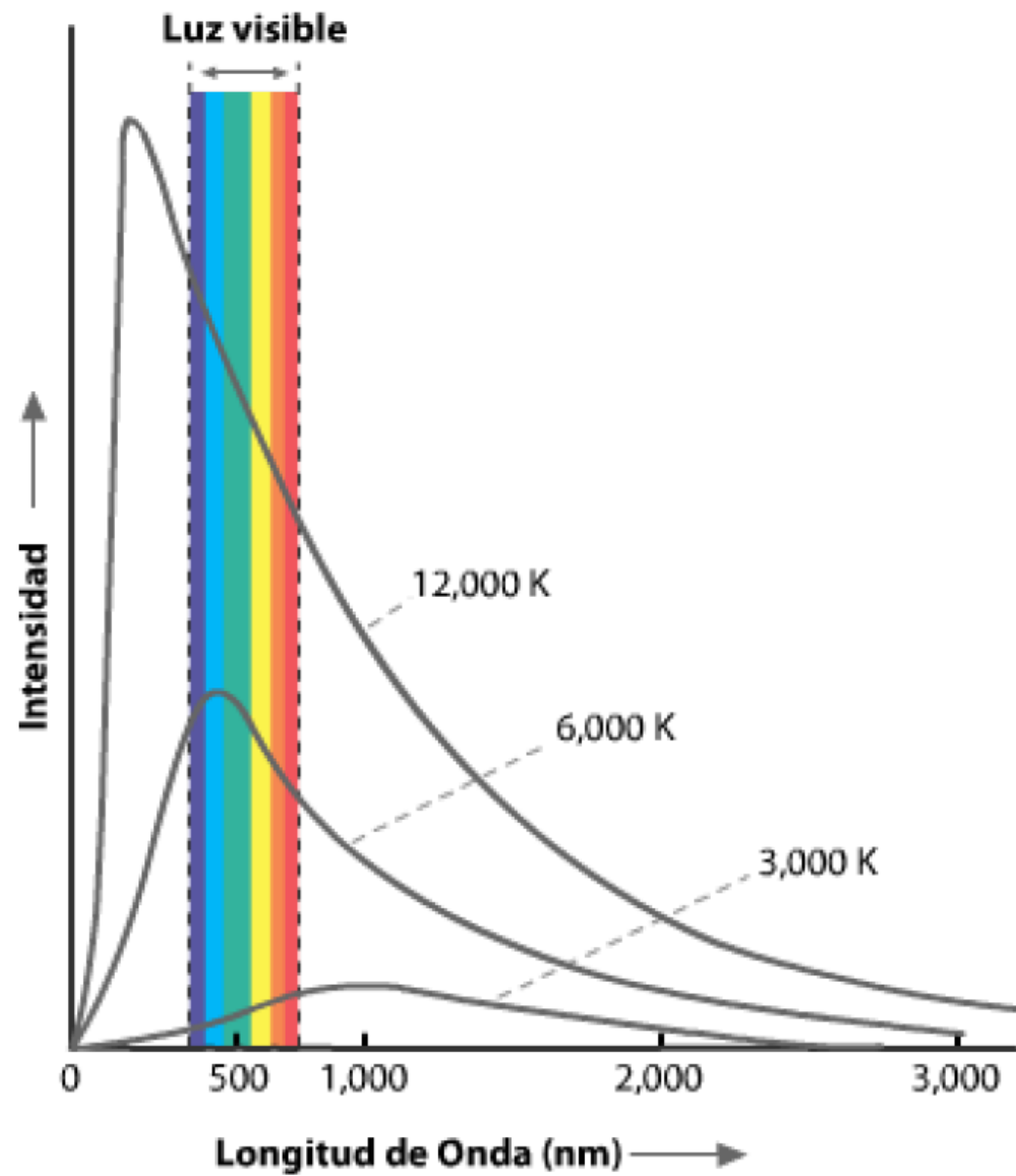
2.- Continuo y líneas espectrales

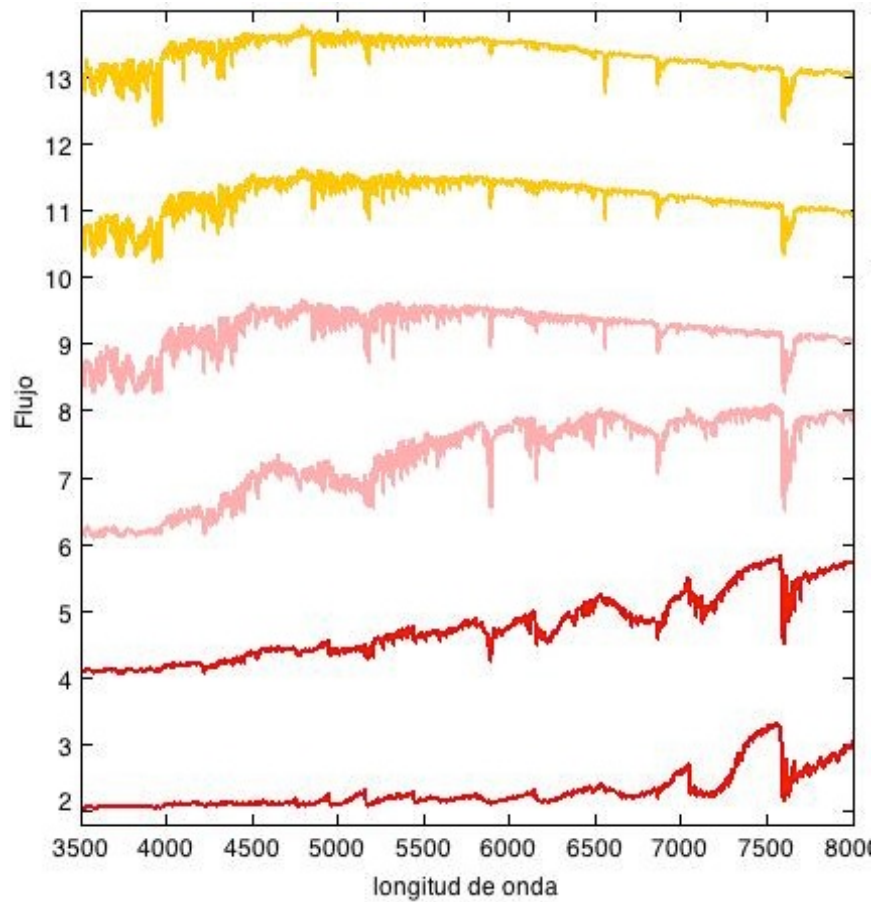
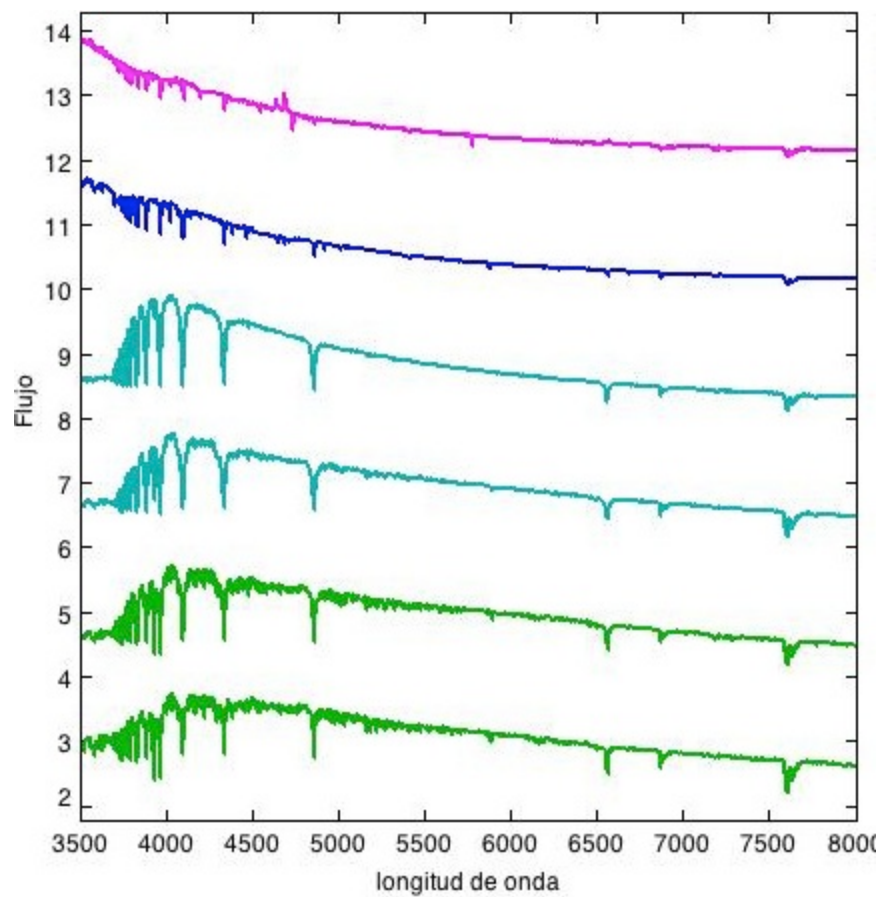
Juan Fabregat
Universidad de Valencia

HD 109995 (A0V)

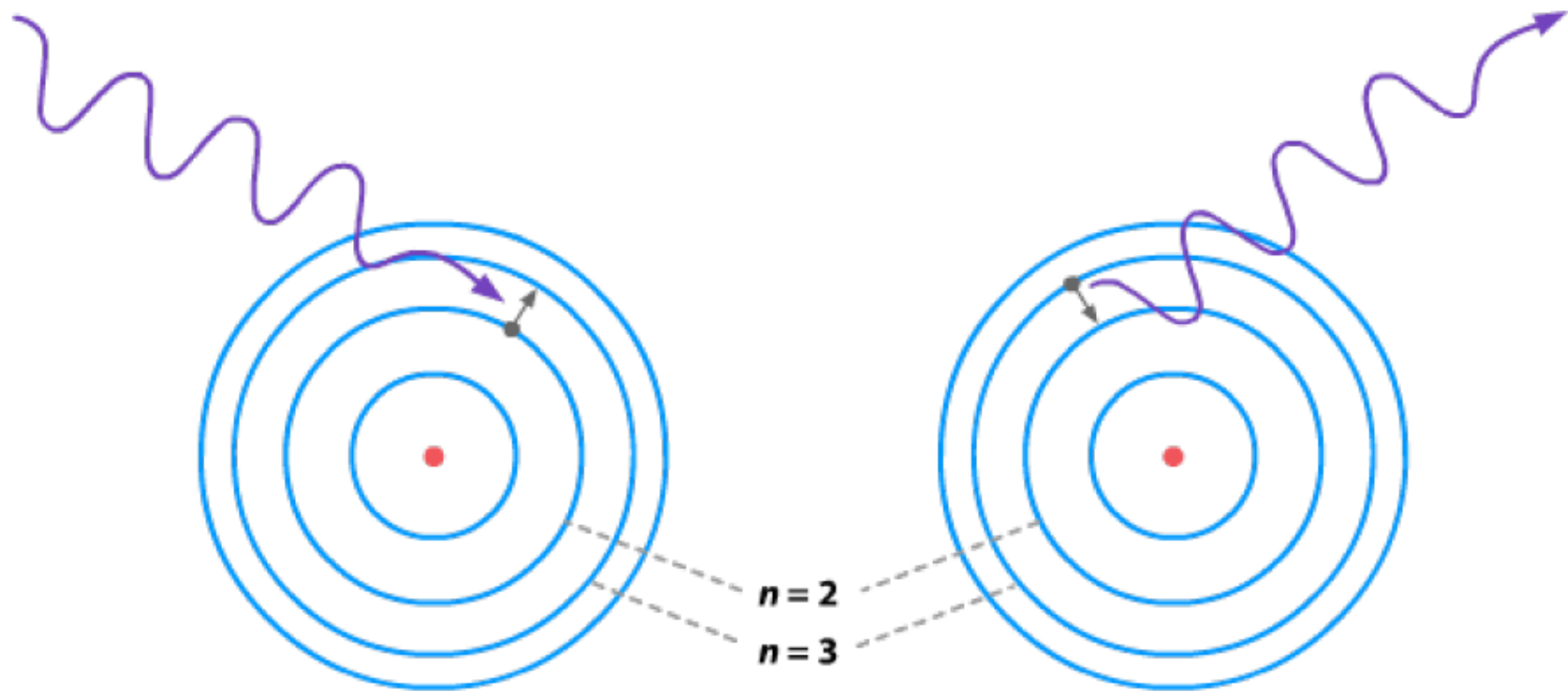


Crédito: STELIB





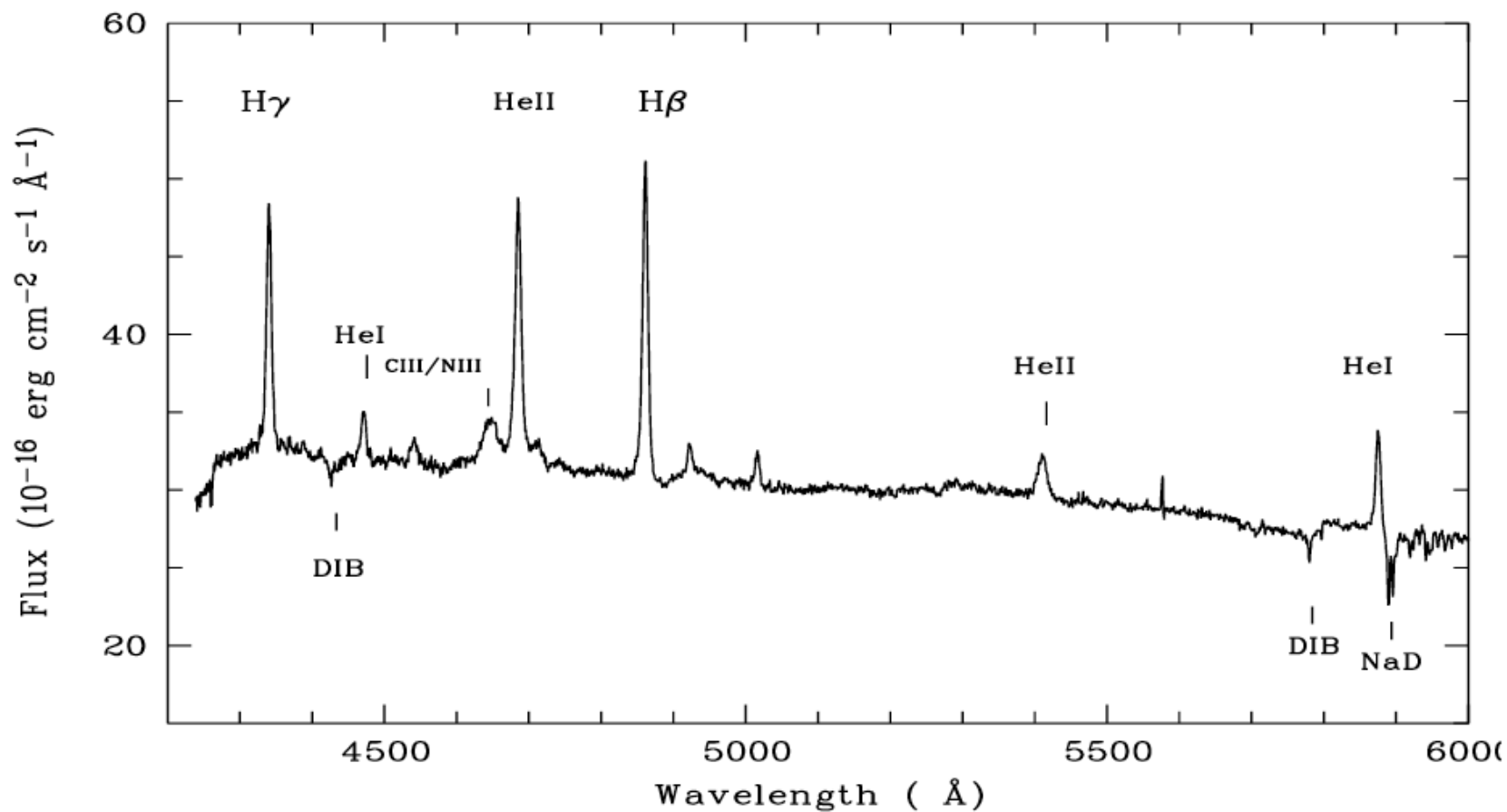
Crédito: STELIB



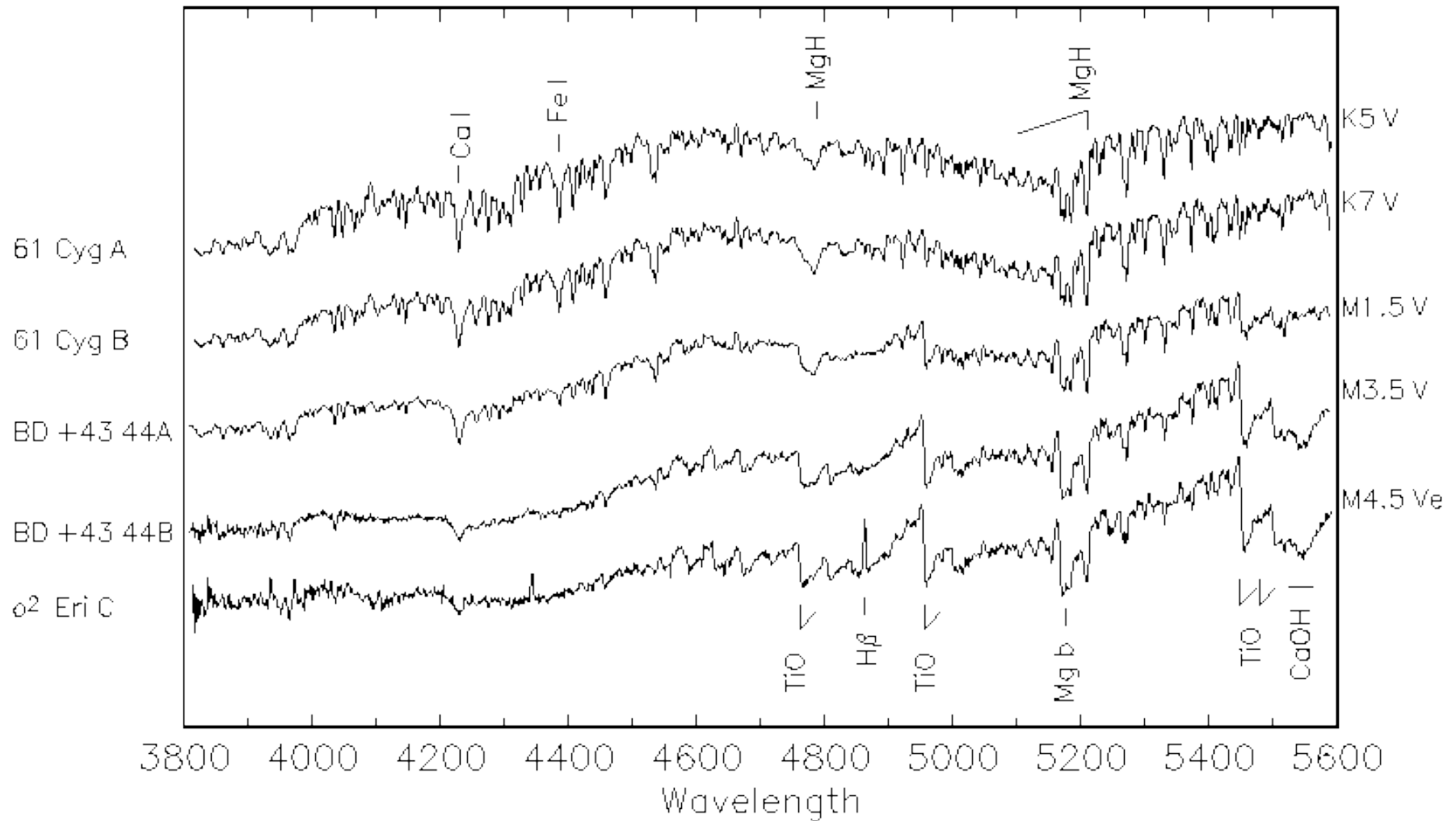
A ABSORCIÓN

B EMISIÓN

RX J2133.7+5107



Bandas moleculares



Crédito: R.O. Gray, Digital Spectral Classification Atlas

Créditos

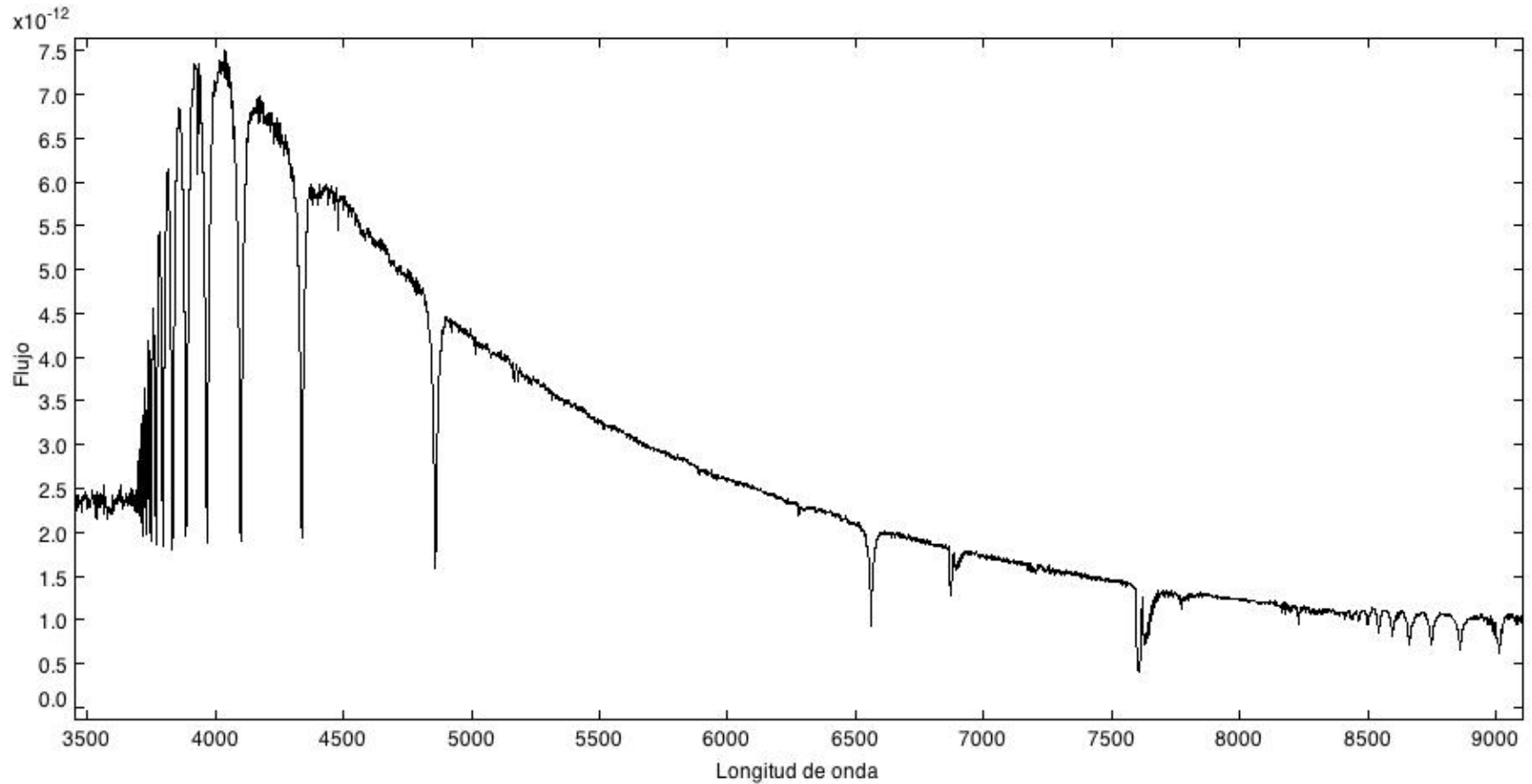
- Fig. 1: “Espectro de HD 109995”. Datos de STELIB (<http://www.ast.obs-mip.fr/article181.html>).
- Fig. 3: Datos de STELIB (<http://www.ast.obs-mip.fr/article181.html>).
- Fig 5: “RX J2133.7+5107: identification of a new long period Intermediate Polar”, por J.M. Bonnet-Bidadu et al., Astronomy & Astrophysics 445, 1037, 2006, figura 5 (<http://www.aanda.org/articles/aa/abs/2006/03/aa3303-05/aa3303-05.html>).
- Fig. 6: “A Digital Spectral Classification Atlas”, por R.O. Gray (<http://ned.ipac.caltech.edu/level5/Gray/frames.html>).

Espectroscopía

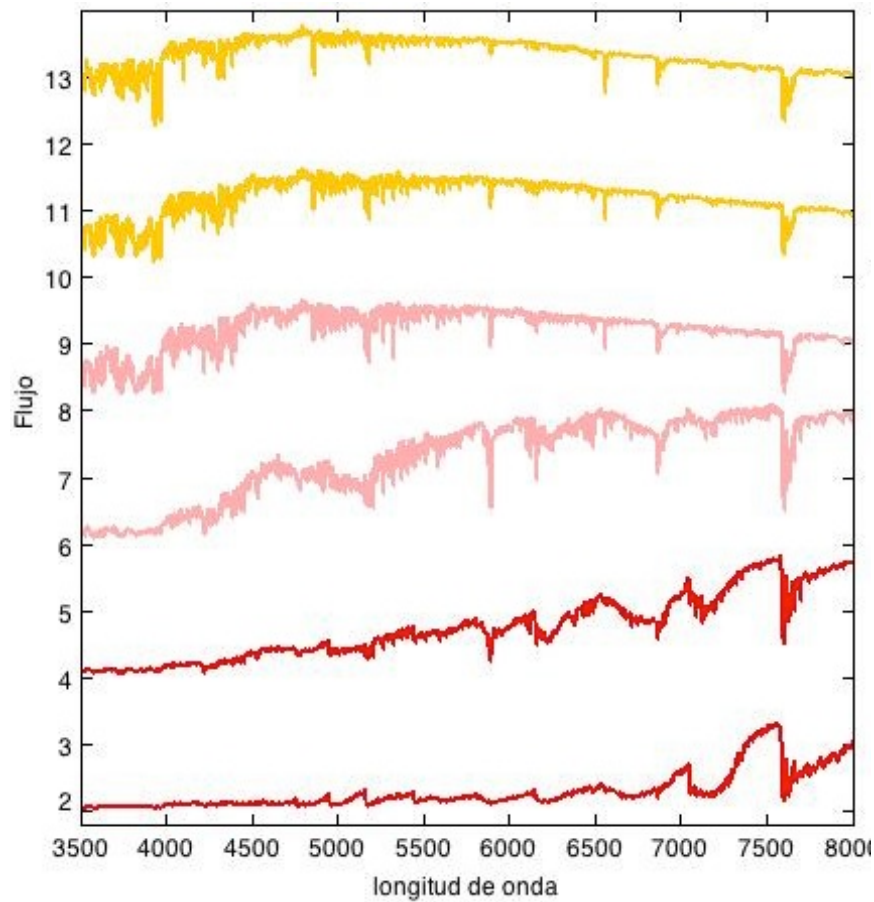
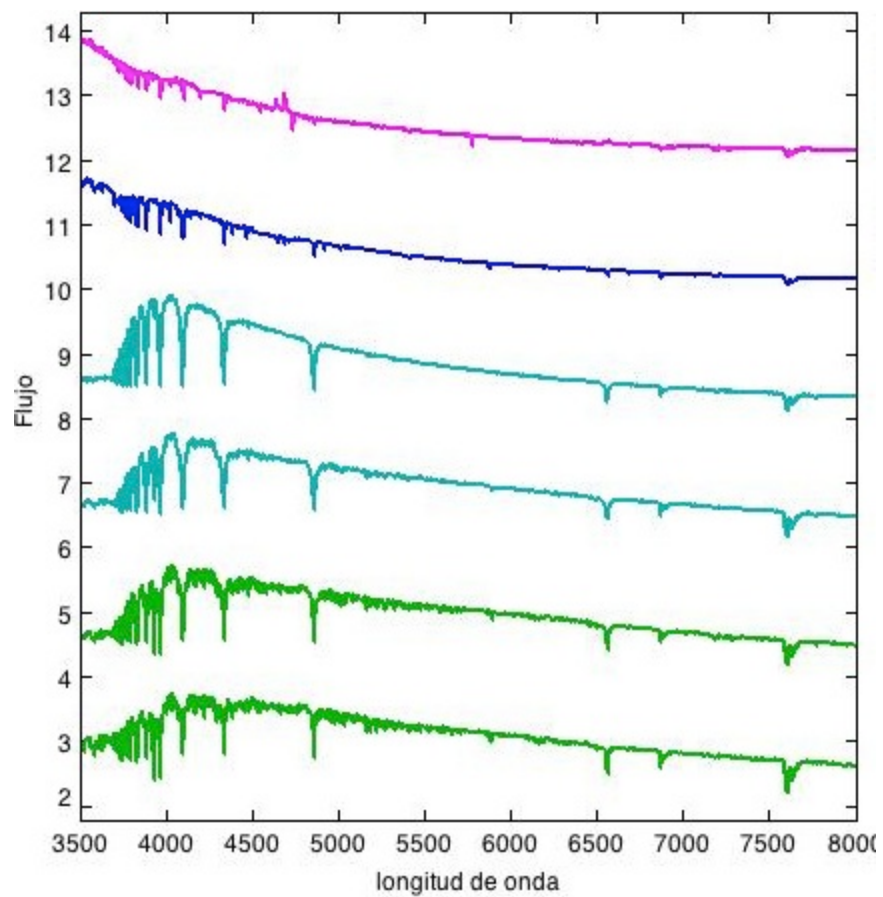
3.- Análisis espectral

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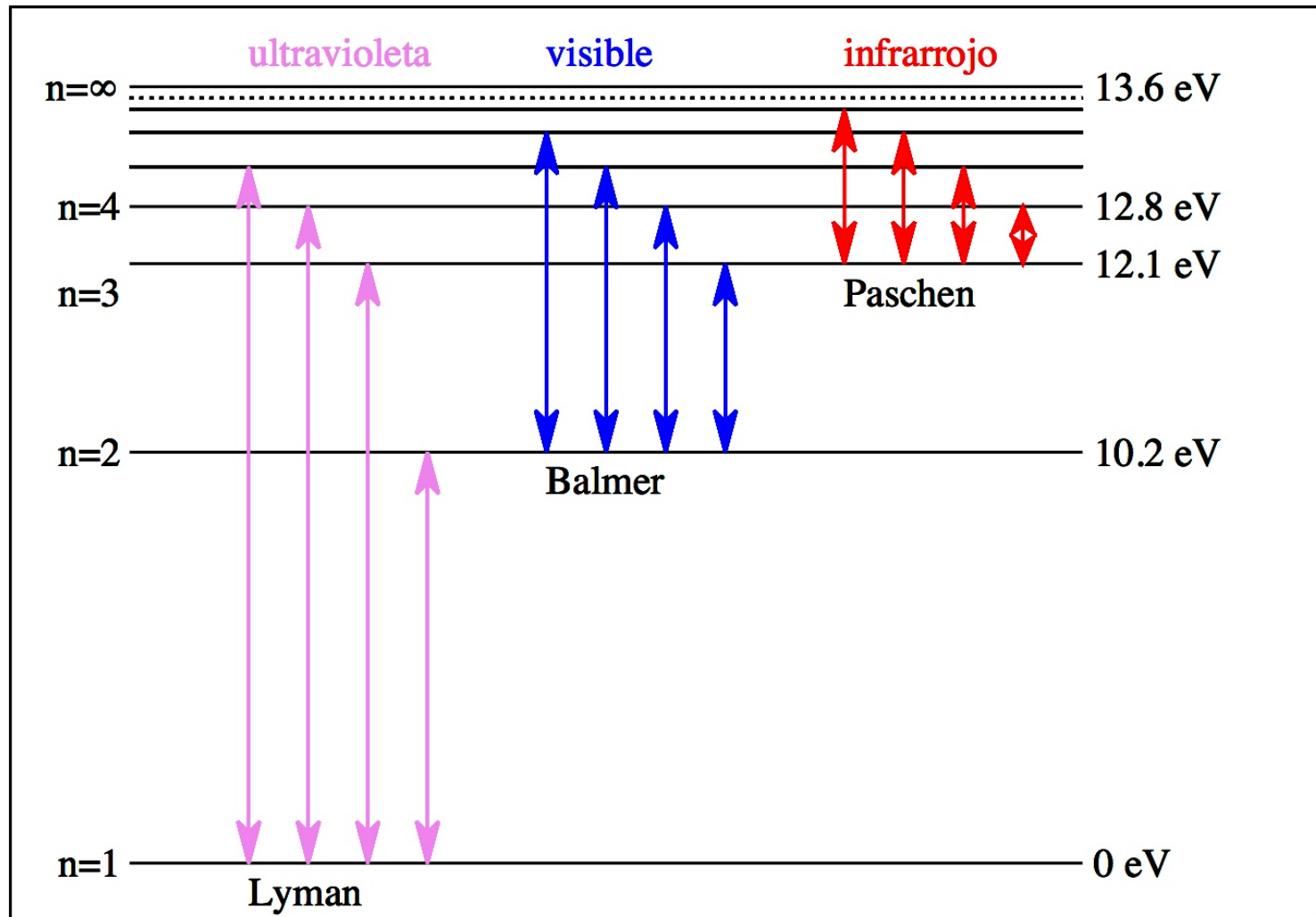
HD 109995 (A0V)

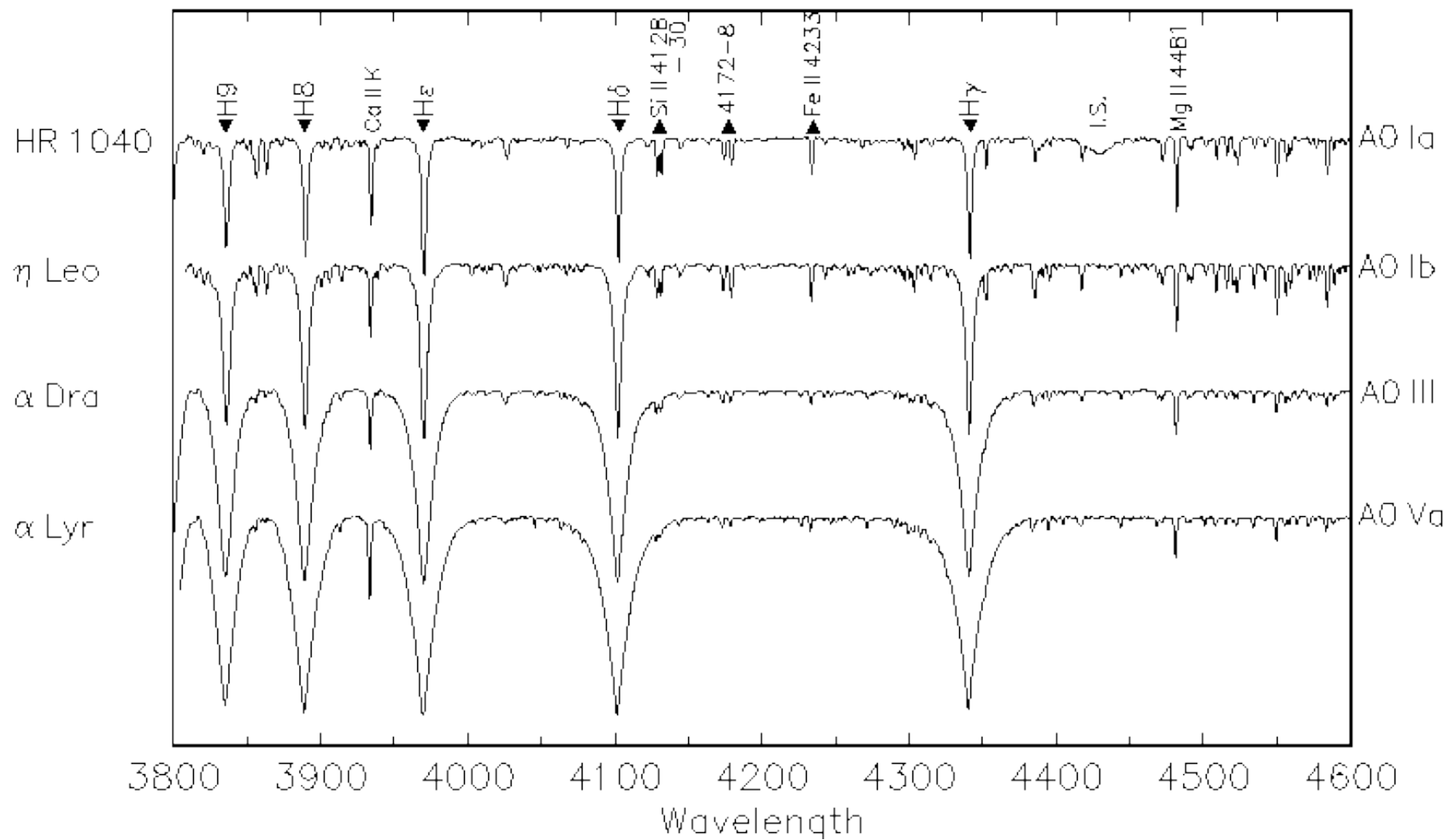


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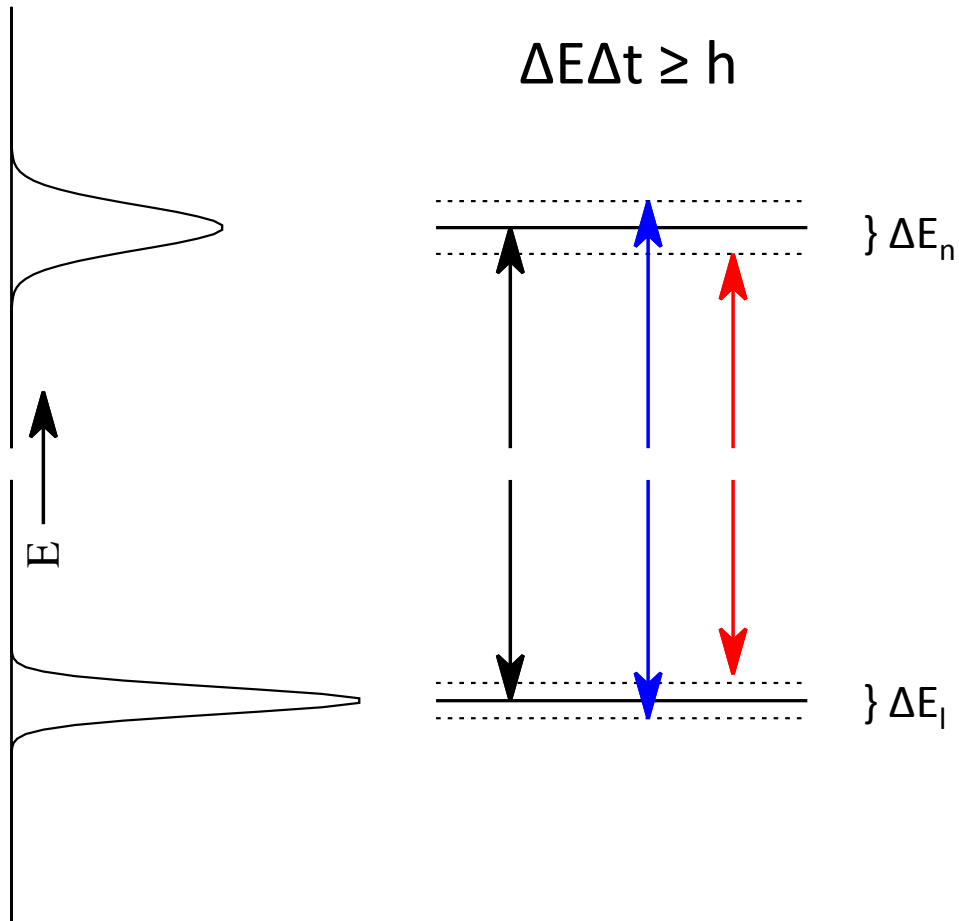
Crédito: STELIB



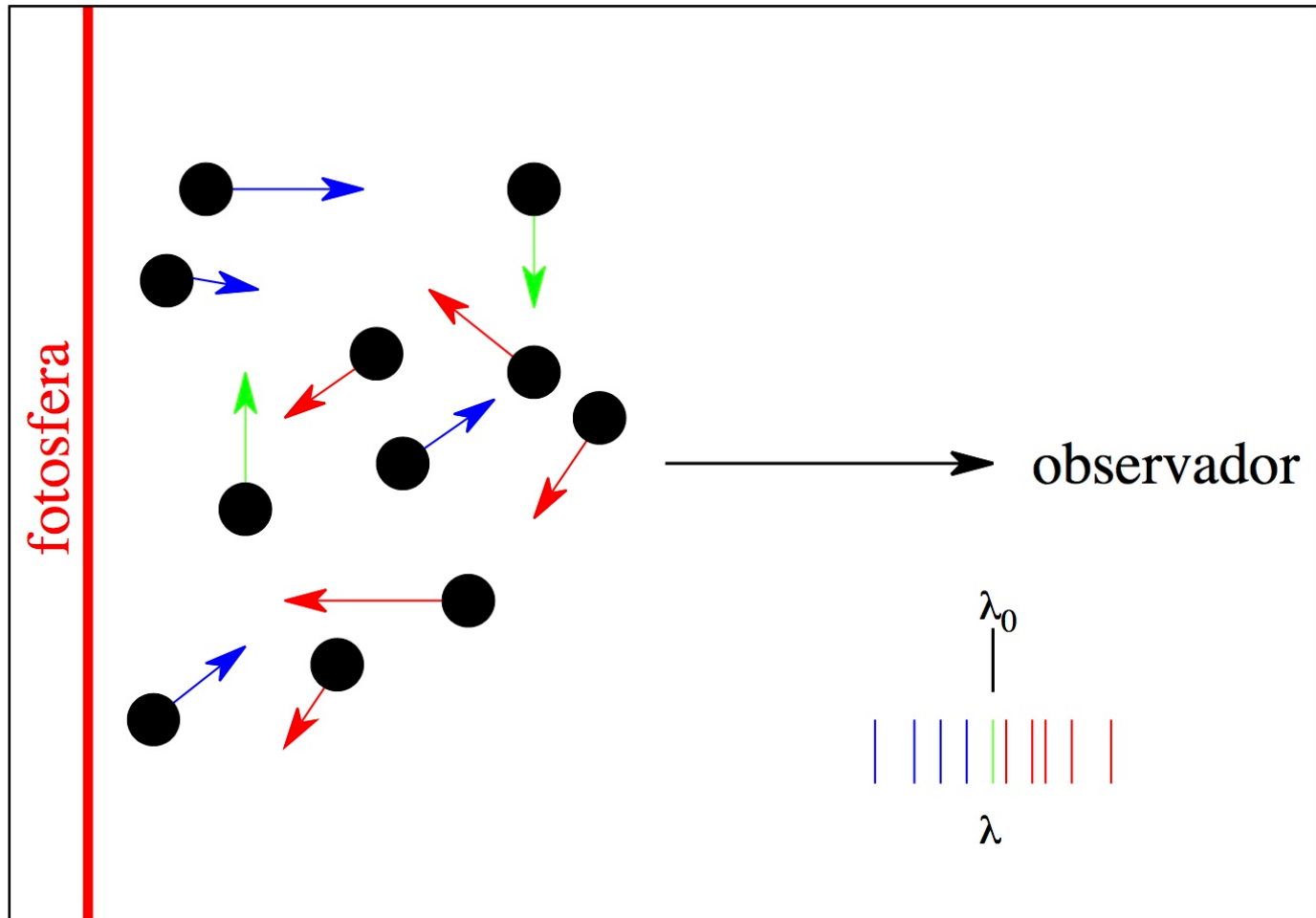


Crédito: R.O. Gray, Digital Spectral Classification Atlas

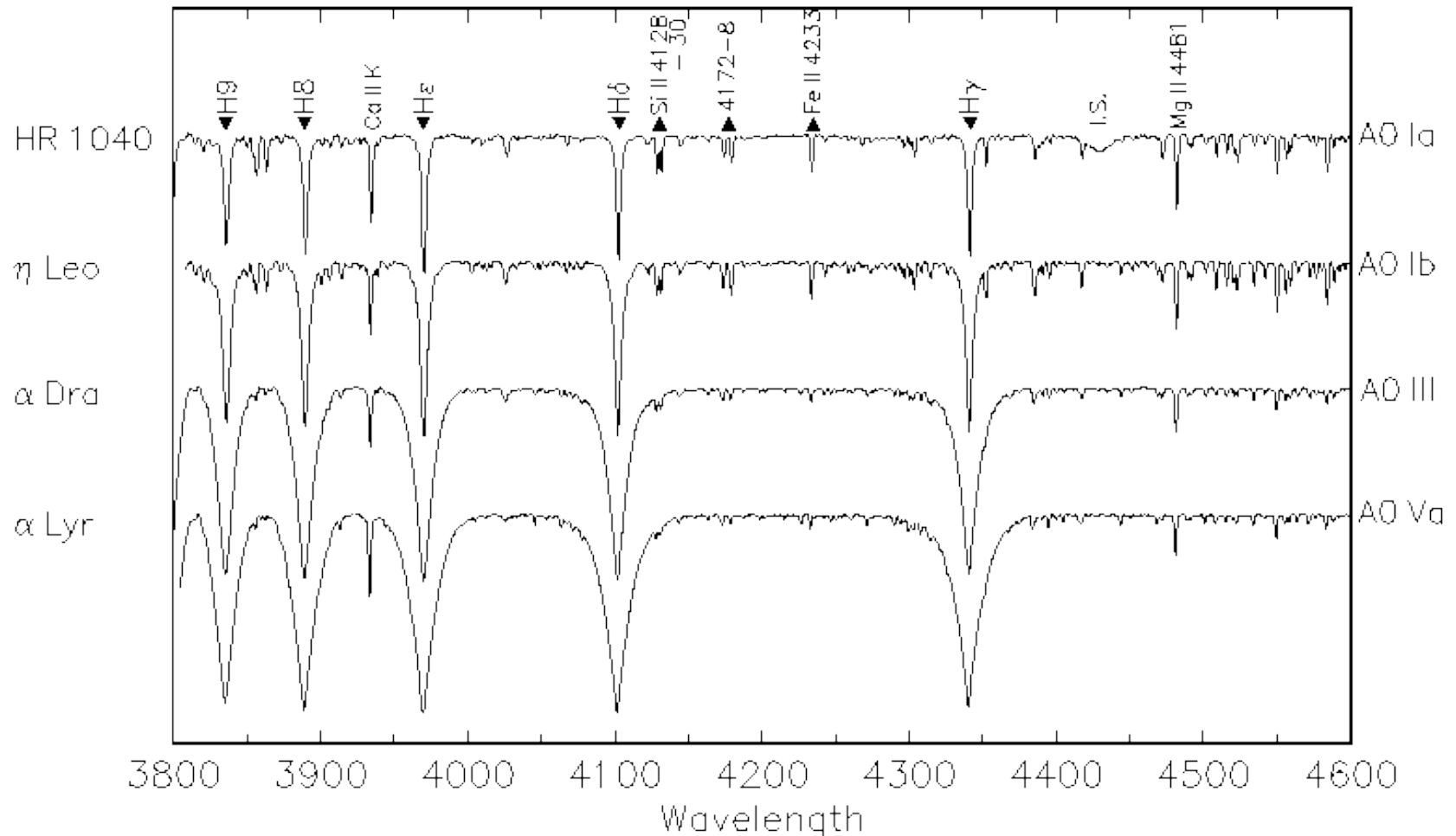
El ensanchamiento natural



El ensanchamiento térmico

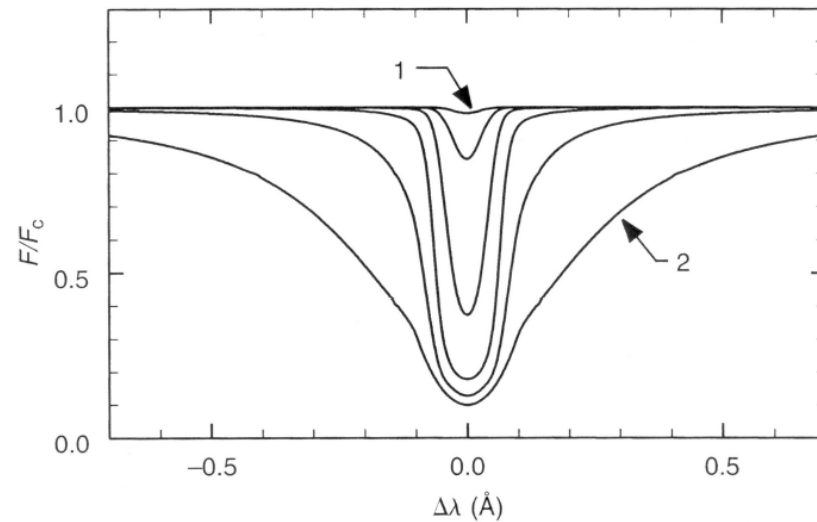
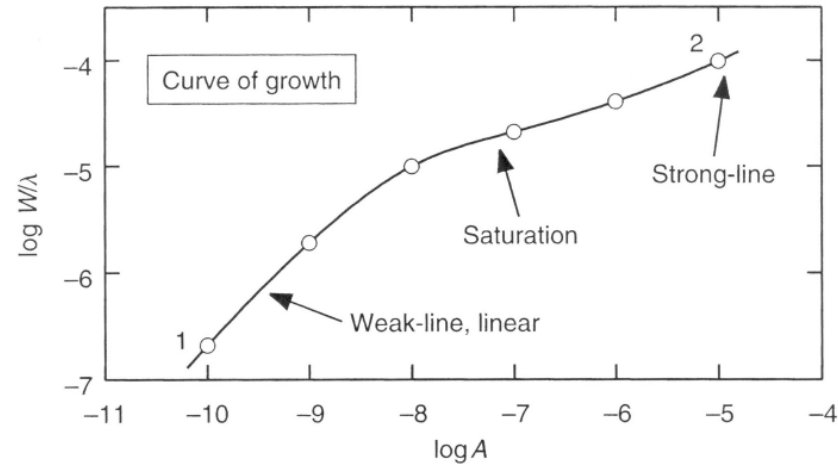


El ensanchamiento colisional

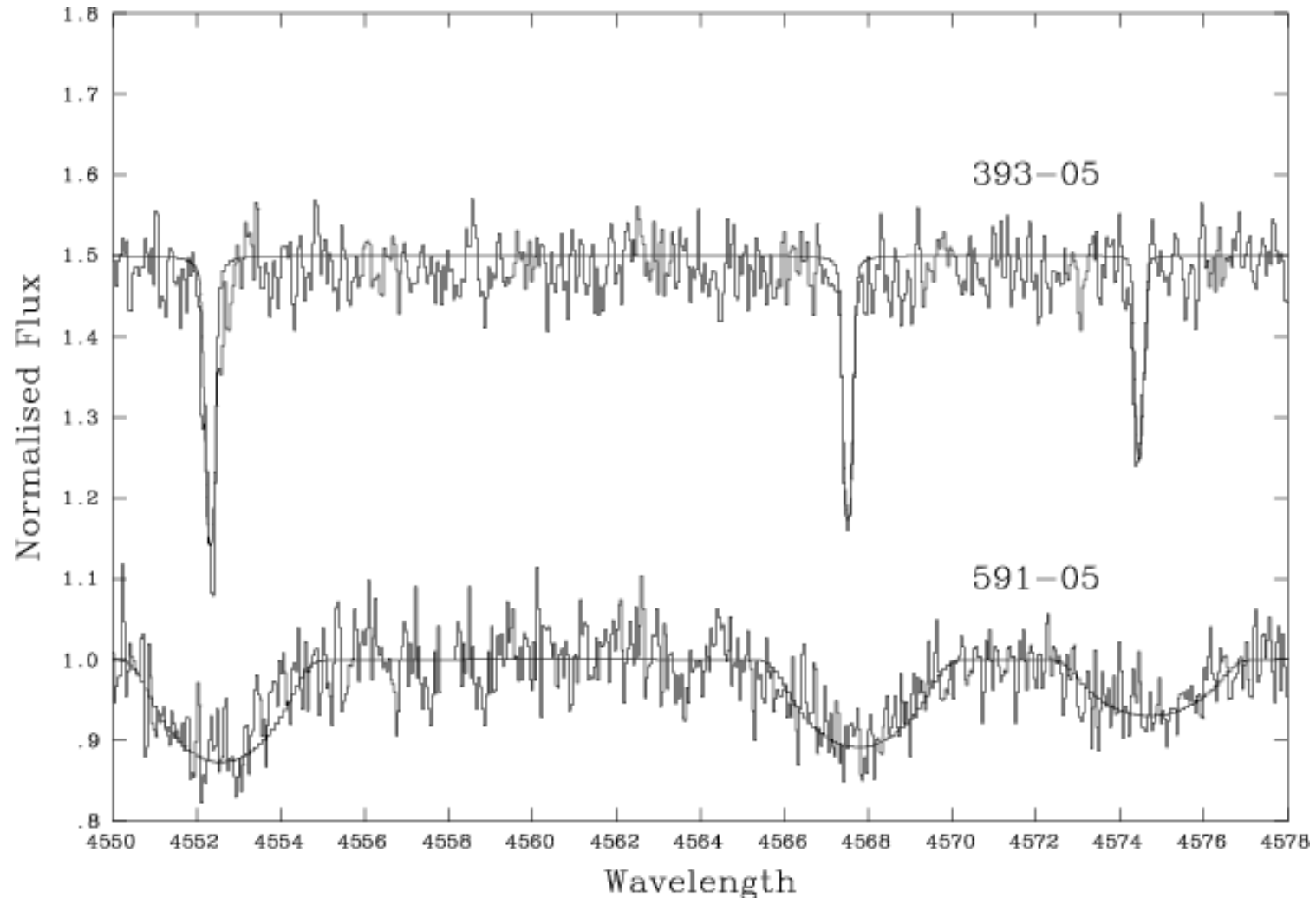


Crédito: R.O. Gray, Digital Spectral Classification Atlas

Abundancias químicas

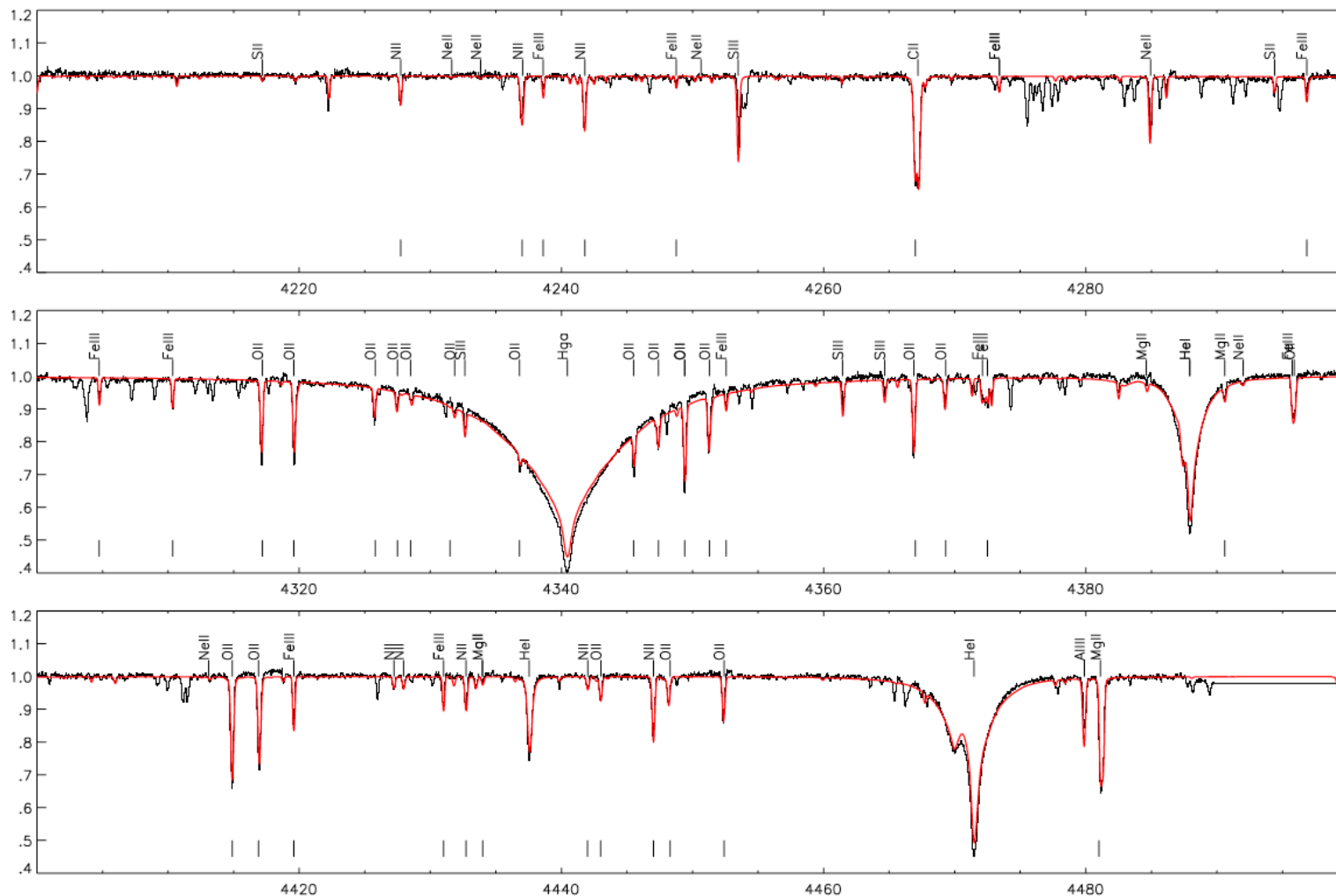


El ensanchamiento rotacional



Crédito: Munn et al., A&A 419, 713, 2004

Análisis espectral cuantitativo



Crédito: Nieva y Simón-Díaz, A&A 532, A2, 2011

Créditos

- Fig. 1: “Espectro de HD 109995”. Datos de STELIB (<http://www.ast.obs-mip.fr/article181.html>).
- Fig. 2: Datos de STELIB (<http://www.ast.obs-mip.fr/article181.html>).
- Figs. 4 y 7: “A Digital Spectral Classification Atlas”, por R.O. Gray (<http://ned.ipac.caltech.edu/level5/Gray/frames.html>).
- Fig. 8: “The Observation and Analysis of Stellar Photospheres”, por D.F. Gray, 3ª edición, Cambridge University Press 2005, figura 13.11.
- Fig 9: “A chemical analysis of five hot stars towards the Galactic centre”, por K.E. Munn et al., Astronomy & Astrophysics 419, 713, 2004, figura 5 (<http://www.aanda.org/component/article?access=bibcode&bibcode=&bibcode=2004A%2526A...419..713MFU>).
- Fig. 10: “The chemical composition of the Orion star forming region. III. C, N, Ne, Mg, and Fe abundances in B-type stars revisited”, por M.F. Nieva y S. Simón-Díaz, Astronomy and Astrophysics 532, A2, 2001, figura A1 (<http://www.aanda.org/articles/aa/abs/2011/08/aa16478-11/aa16478-11.html>).

Espectroscopía

4.- Clasificación espectral

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Espectros de Angelo Secchi

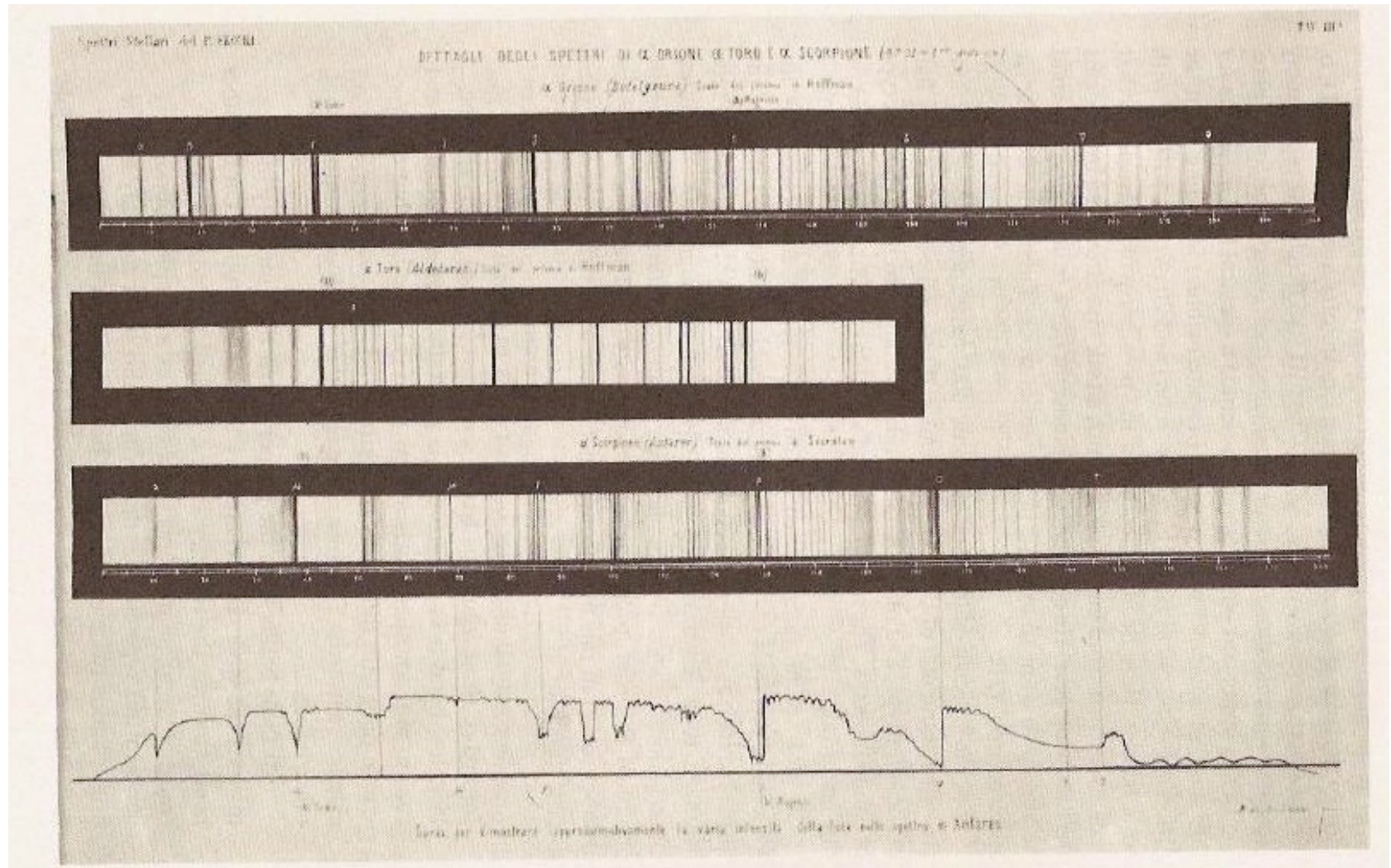


Fig. 1. (*1st type: Sirius, Vega, Altair, Regulus, etc.*)

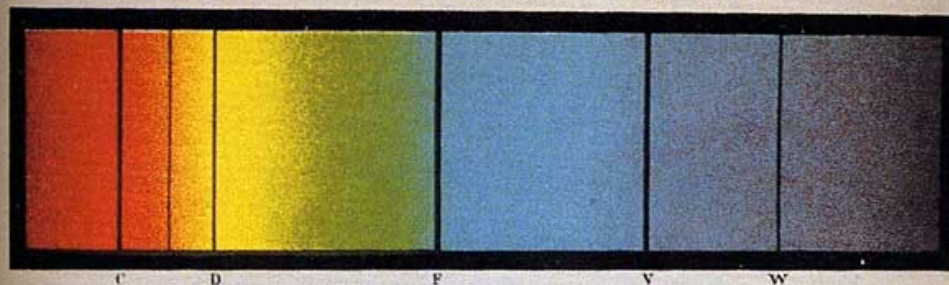


Fig. 2. (*2nd type: Sun, Pollux, Arcturus, Procyon, etc.*)

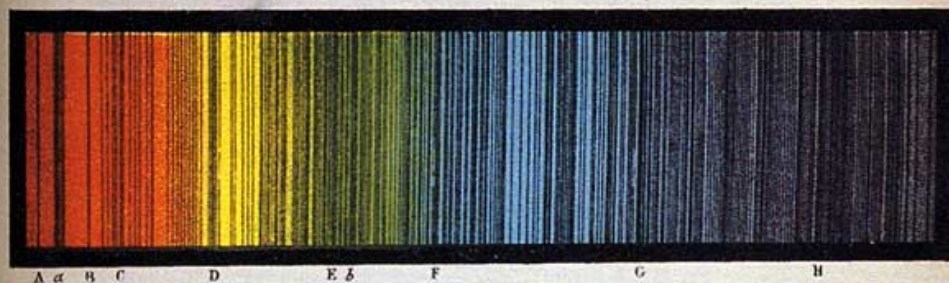


Fig. 3. (*3rd type: α Hercules, β Pegasus, α of Orion, Antares, etc.*)

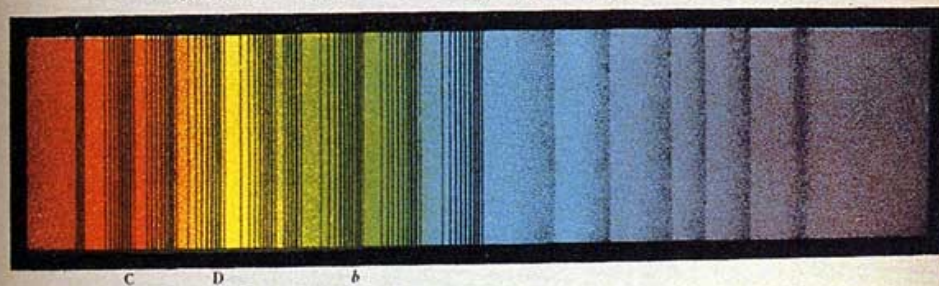
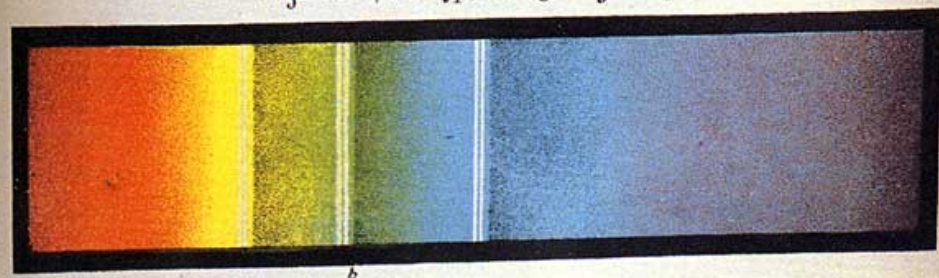


Fig. 4. (*4th type: 15^o of Schjellerup.*)



Clasificación espectral moderna

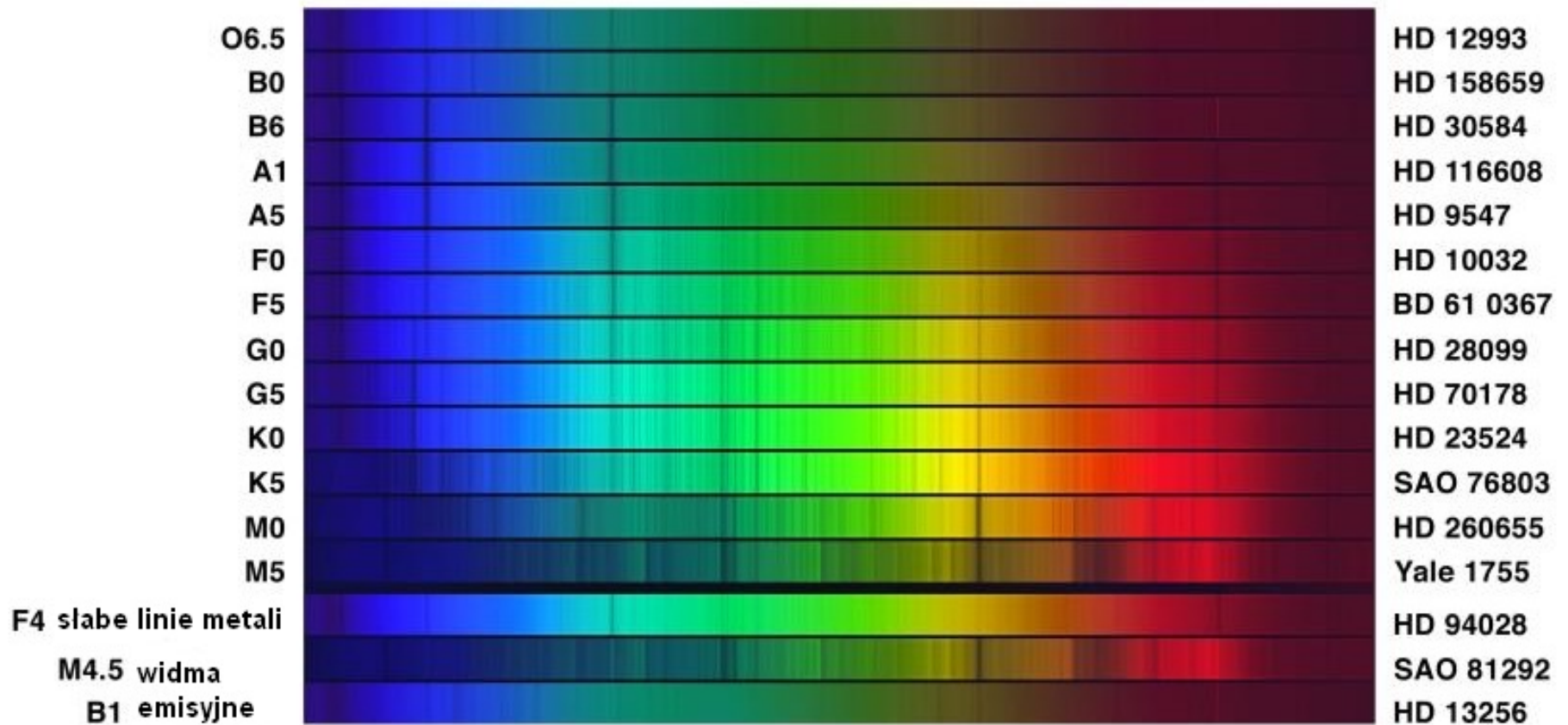


Diagrama de Hertzsprung-Russell

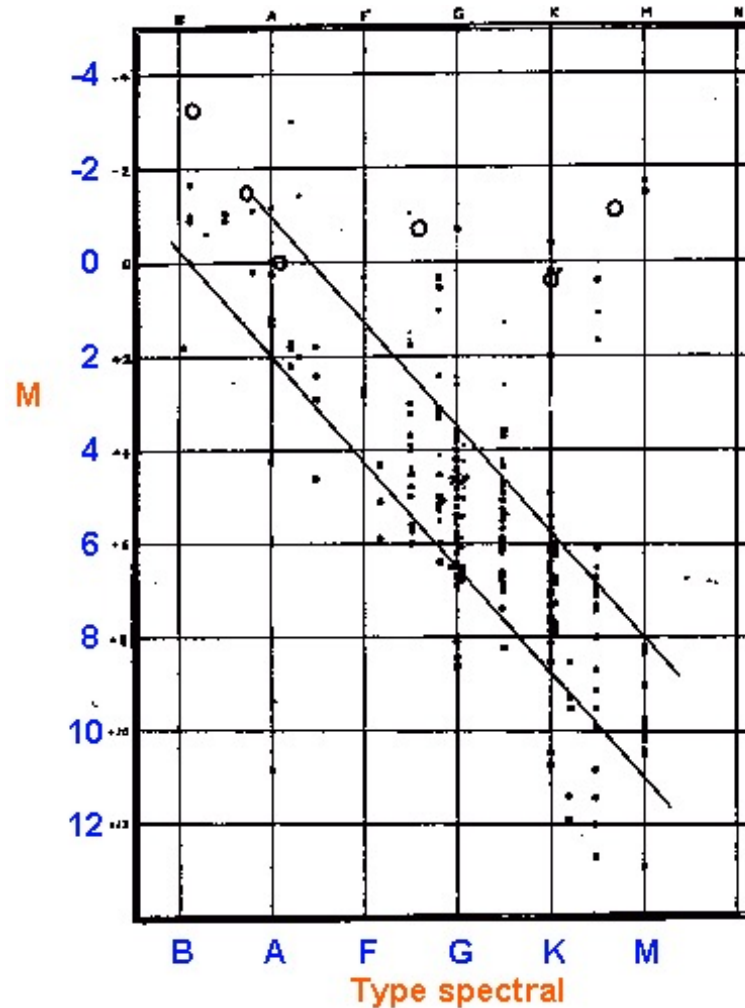
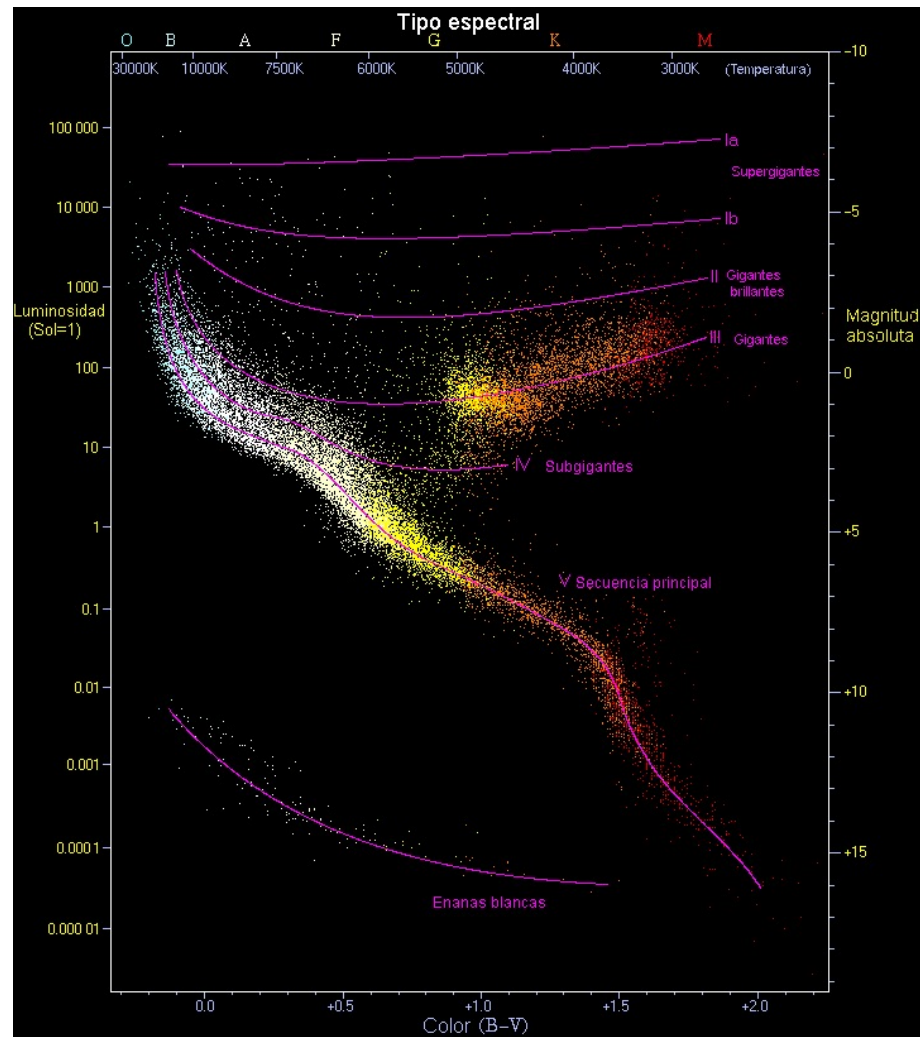


Diagrama de Hertzsprung-Russell

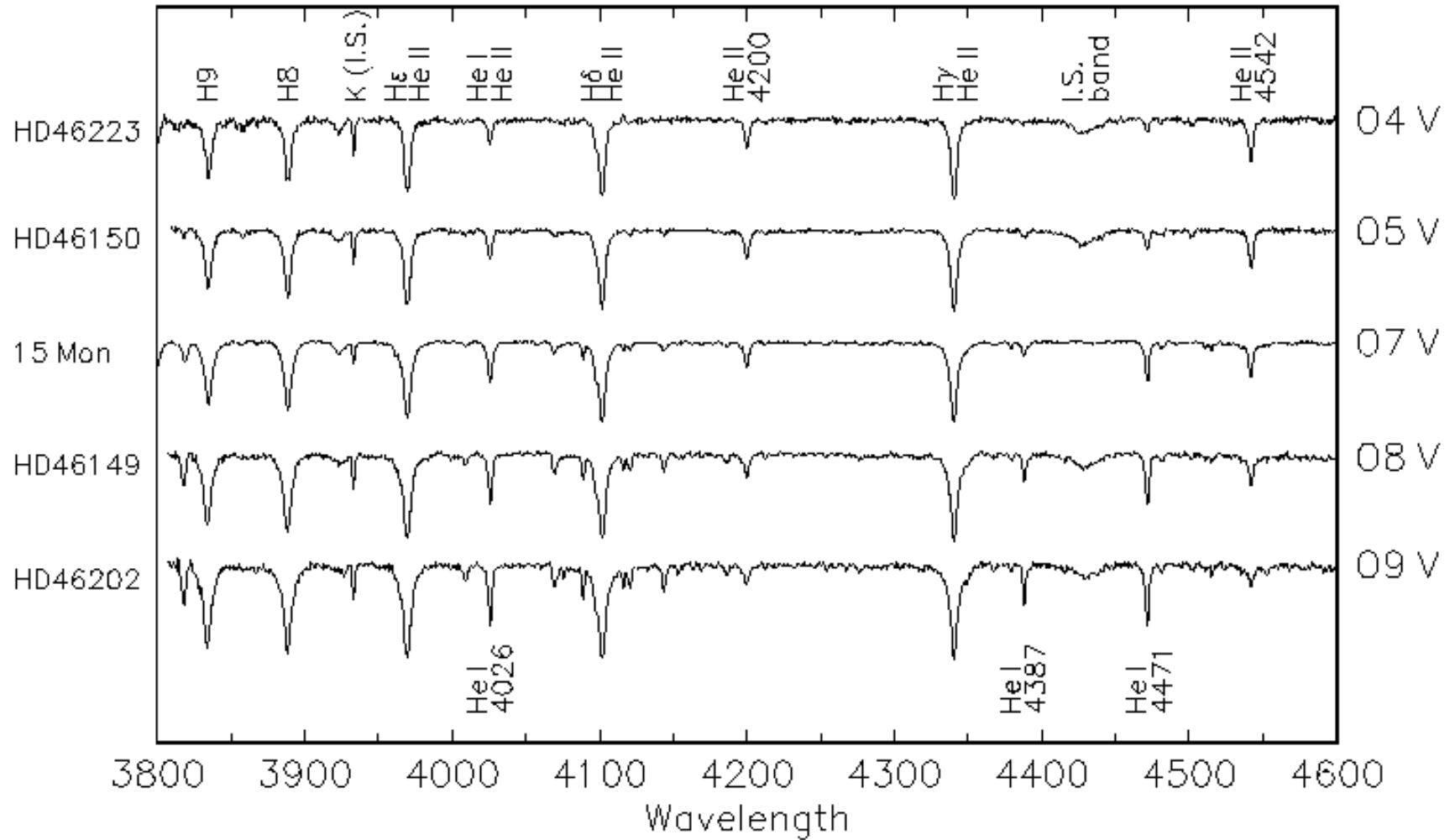


Crédito: Wikimedia Commons (CC BY-SA 3.0)

Tipos espectrales

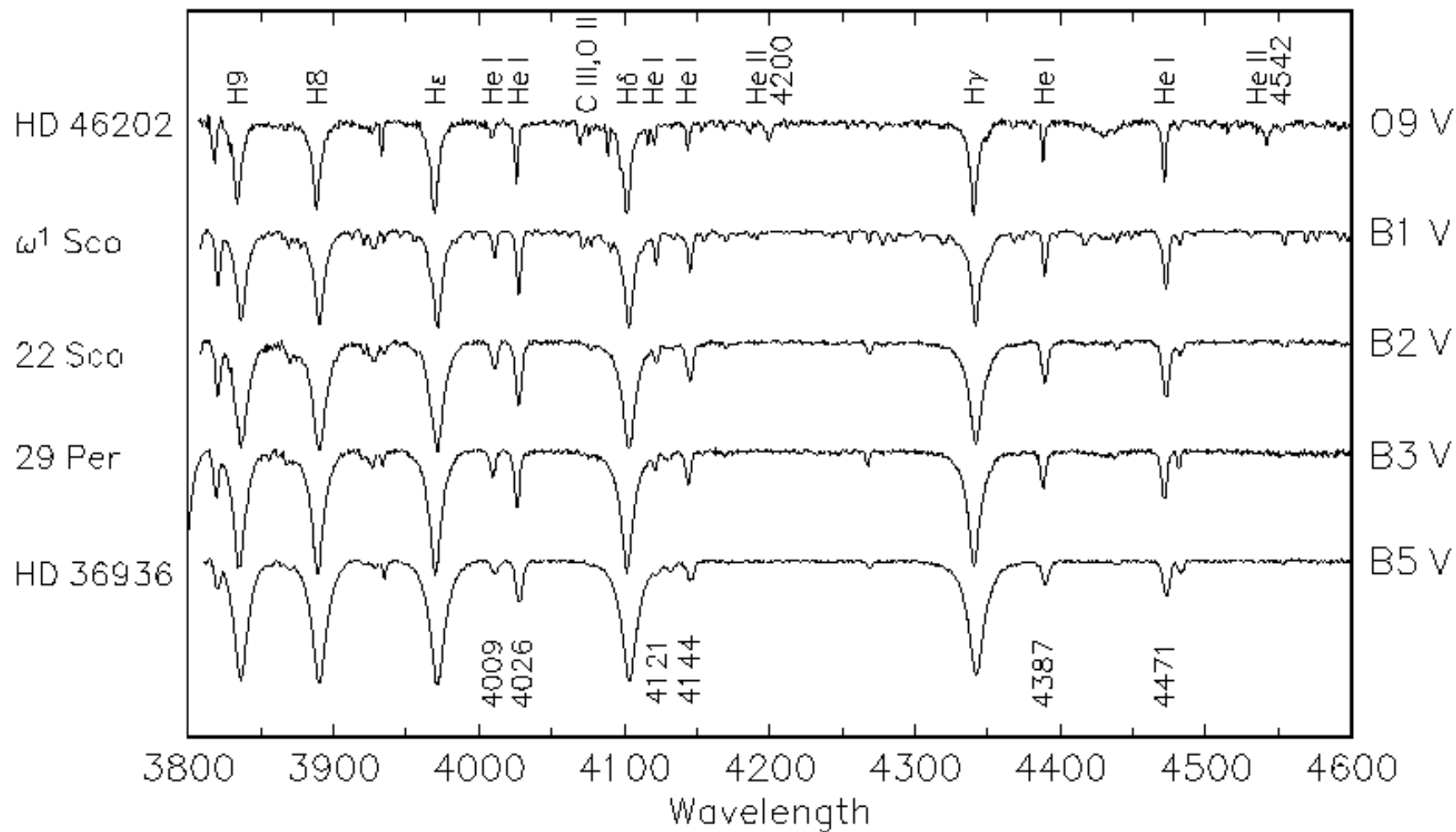
Tipo	Líneas espectrales	Temperatura efectiva
O	Líneas de absorción de HeII	35 000 - 25 000 K
B	Líneas de absorción de HeI	25 000 - 10 000 K
A	Líneas de absorción del HI	10 000 - 7 500 K
F	Líneas de metales ionizados	7 500 - 6 000 K
G	Líneas de metales neutros e ionizados	6 000 - 5 000 K
K	Líneas de metales neutros y óxido de Ti	5 000 - 3 500 K
M	Bandas moleculares de óxido de Ti	< 3 500 K

Main Sequence 04 – 09



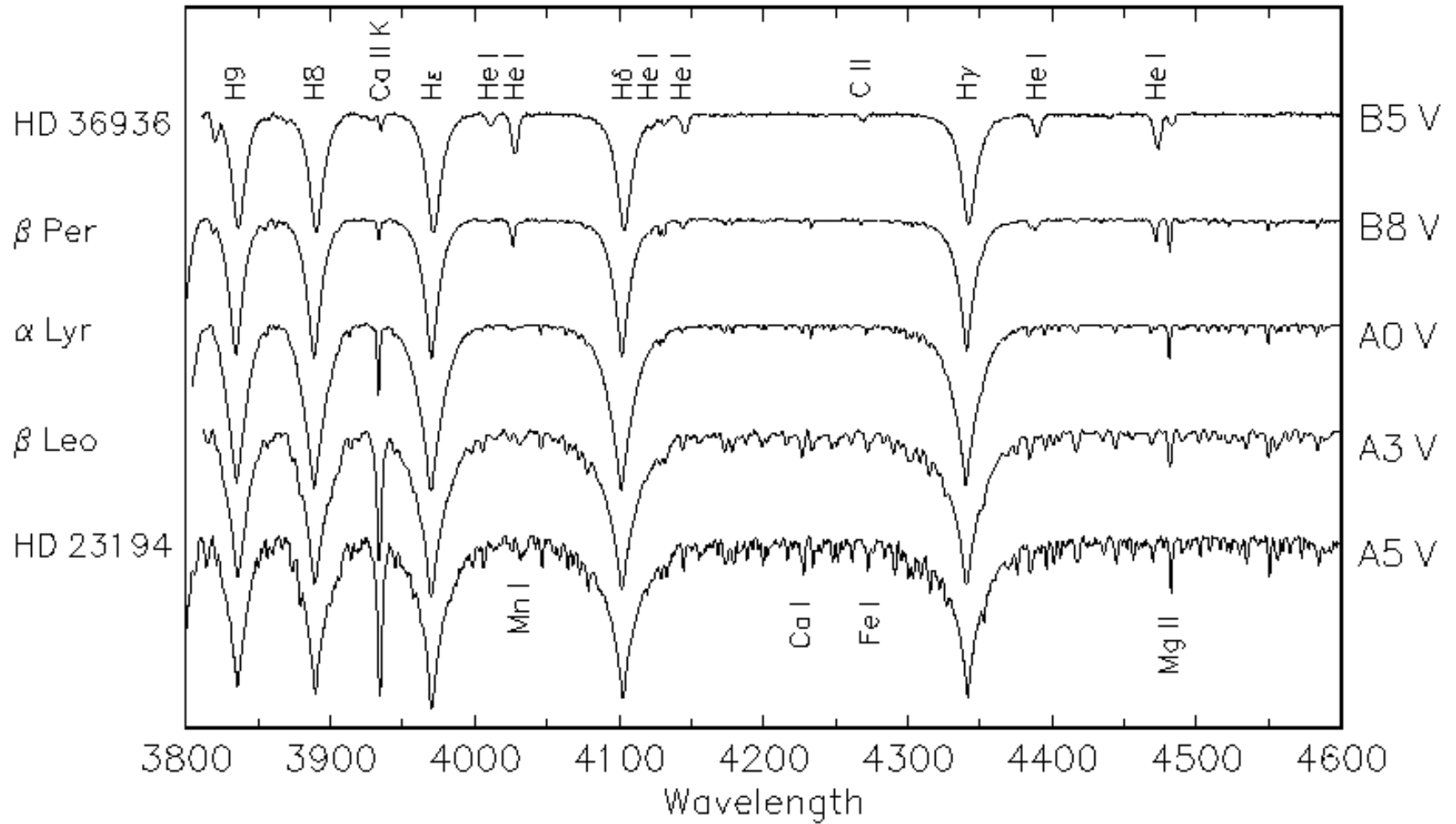
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Main Sequence O9 – B5



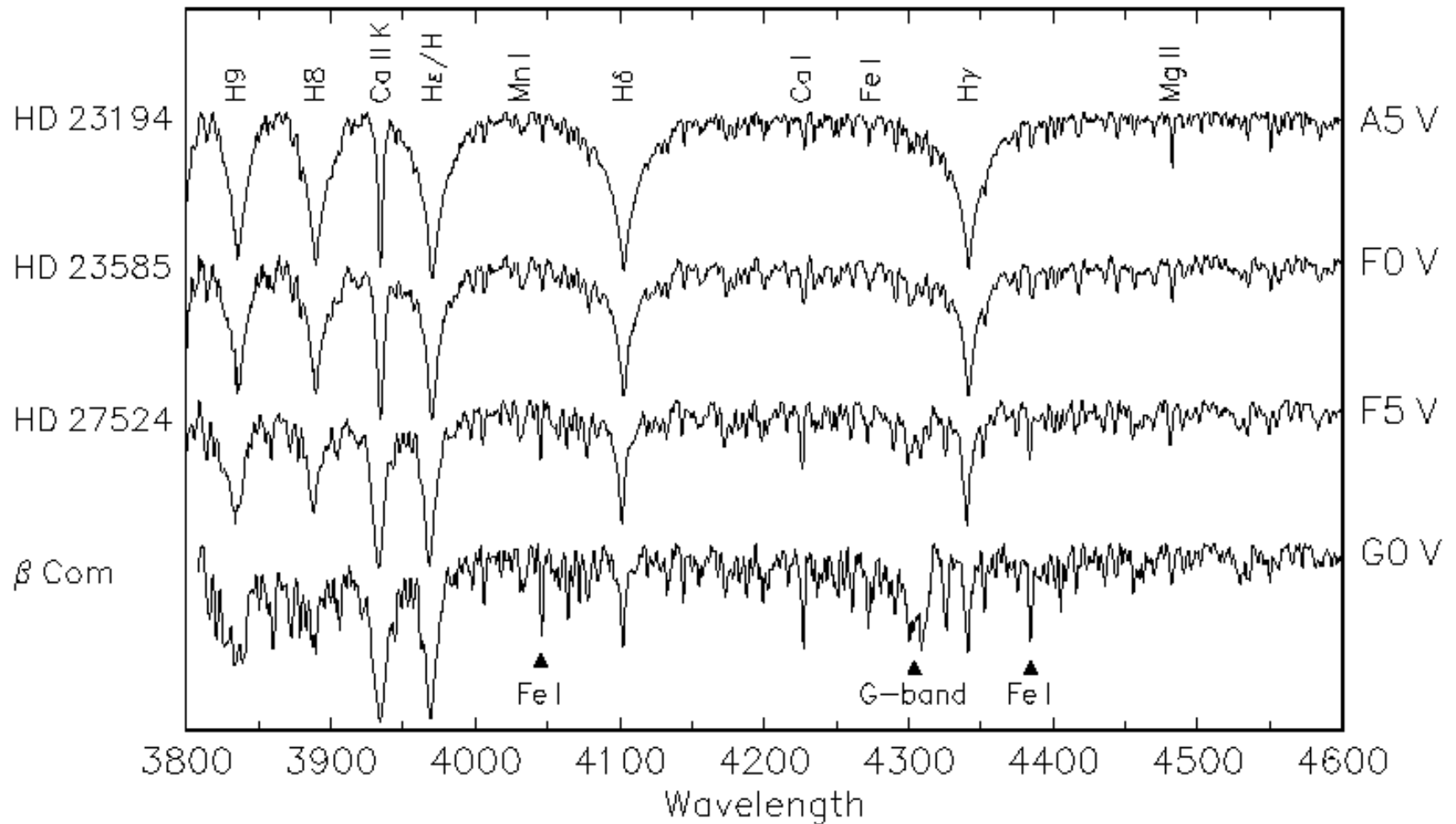
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Main Sequence B5 – A5



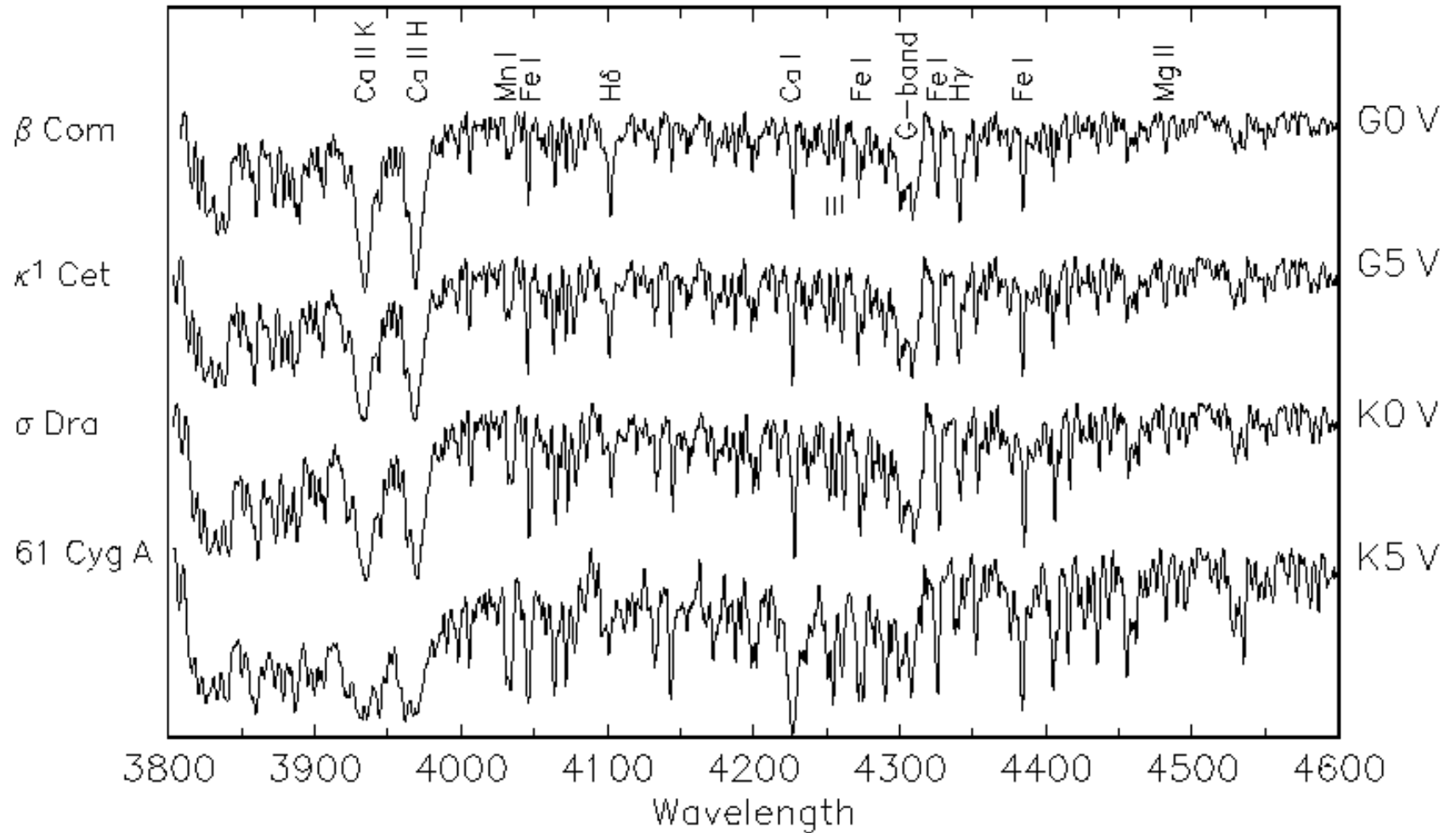
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Main Sequence A5 – G0



Crédito: R.O. Gray, Digital Spectral Classification Atlas

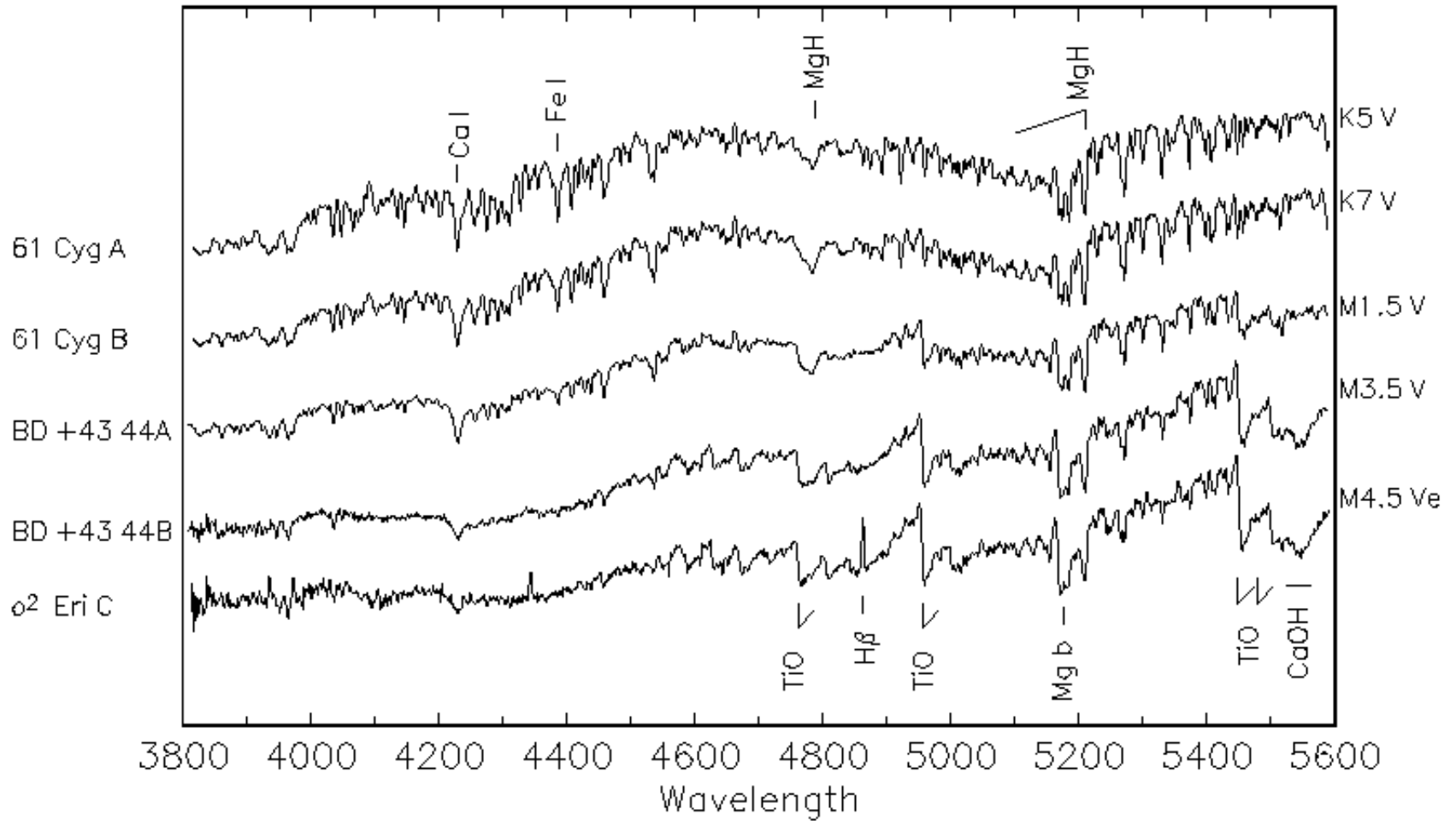
Main Sequence G0 – K5



Crédito: R.O. Gray, Digital Spectral Classification Atlas

Main Sequence K5 – M4.5

Normalized Flux

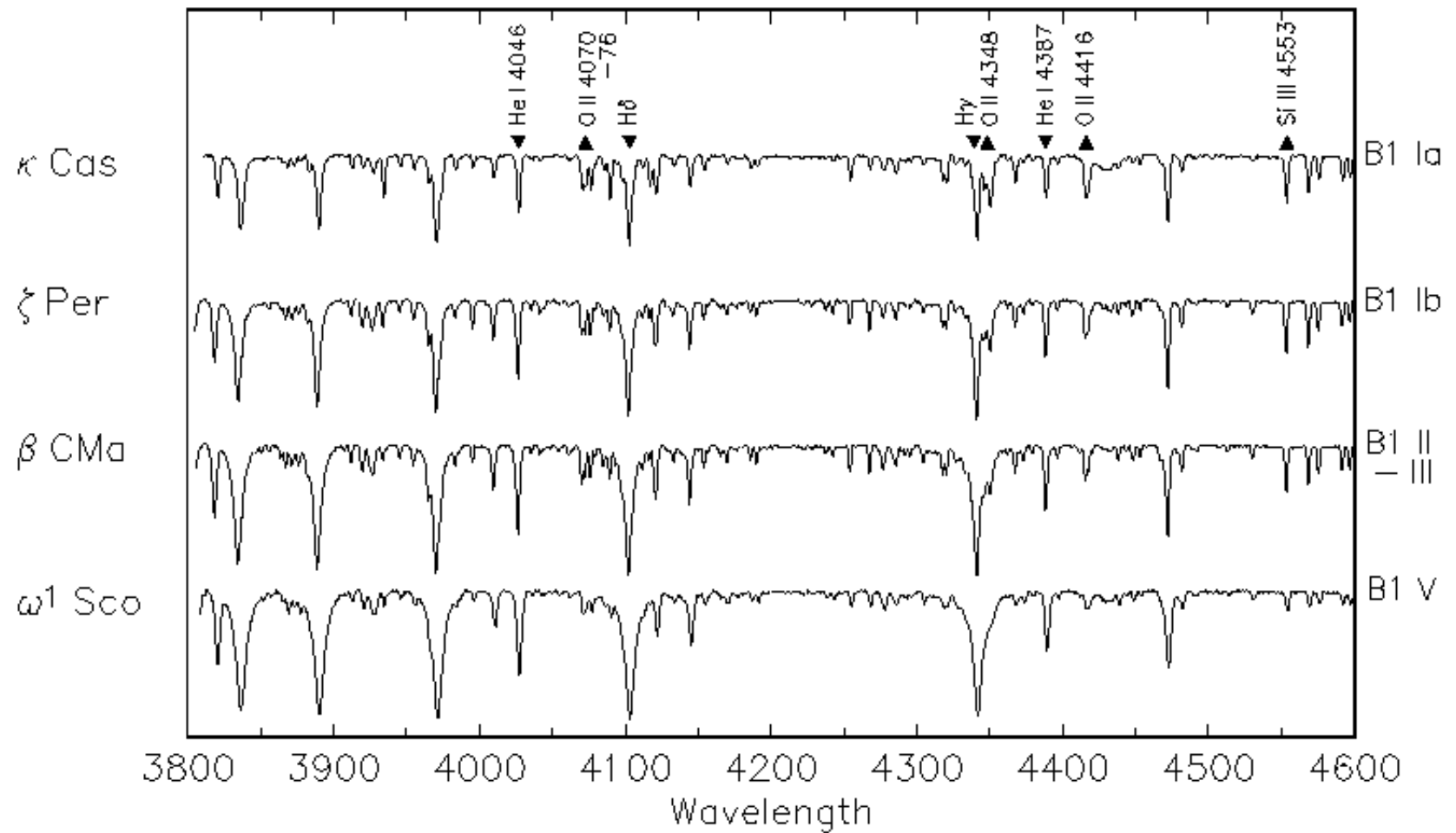


Crédito: R.O. Gray, Digital Spectral Classification Atlas

Clases de luminosidad

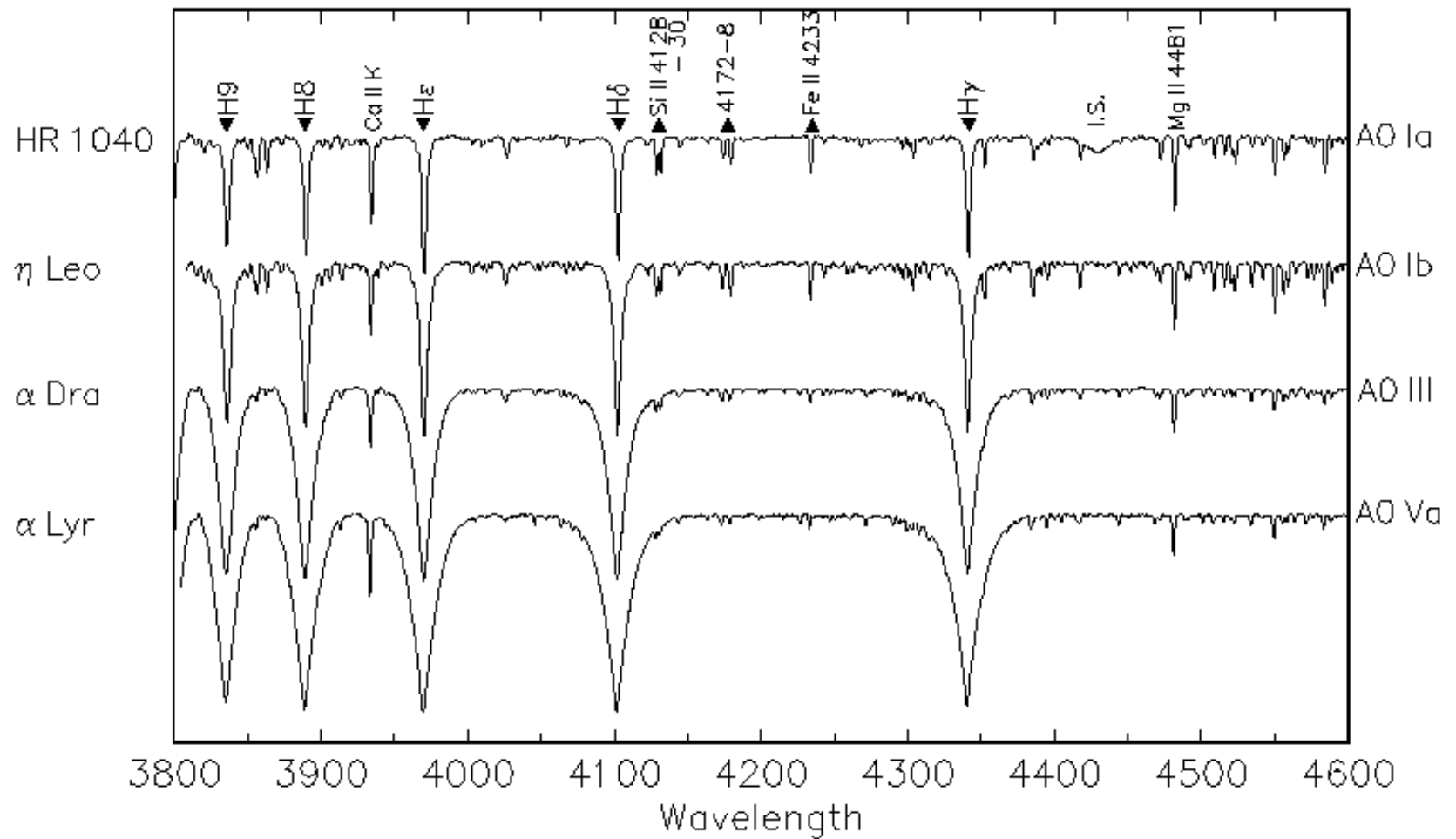
Clase	Tamaño	Estado evolutivo
V	$0.1 < R/R_o < 2$	Enana de la secuencia principal
IV	$2 < R/R_o < 10$	Subgigante
III	$10 < R/R_o < 100$	Gigante
II	$100 < R/R_o < 300$	Gigante brillante
I	$300 < R/R_o < 1000$	Supergigante

Luminosity Effects at B1



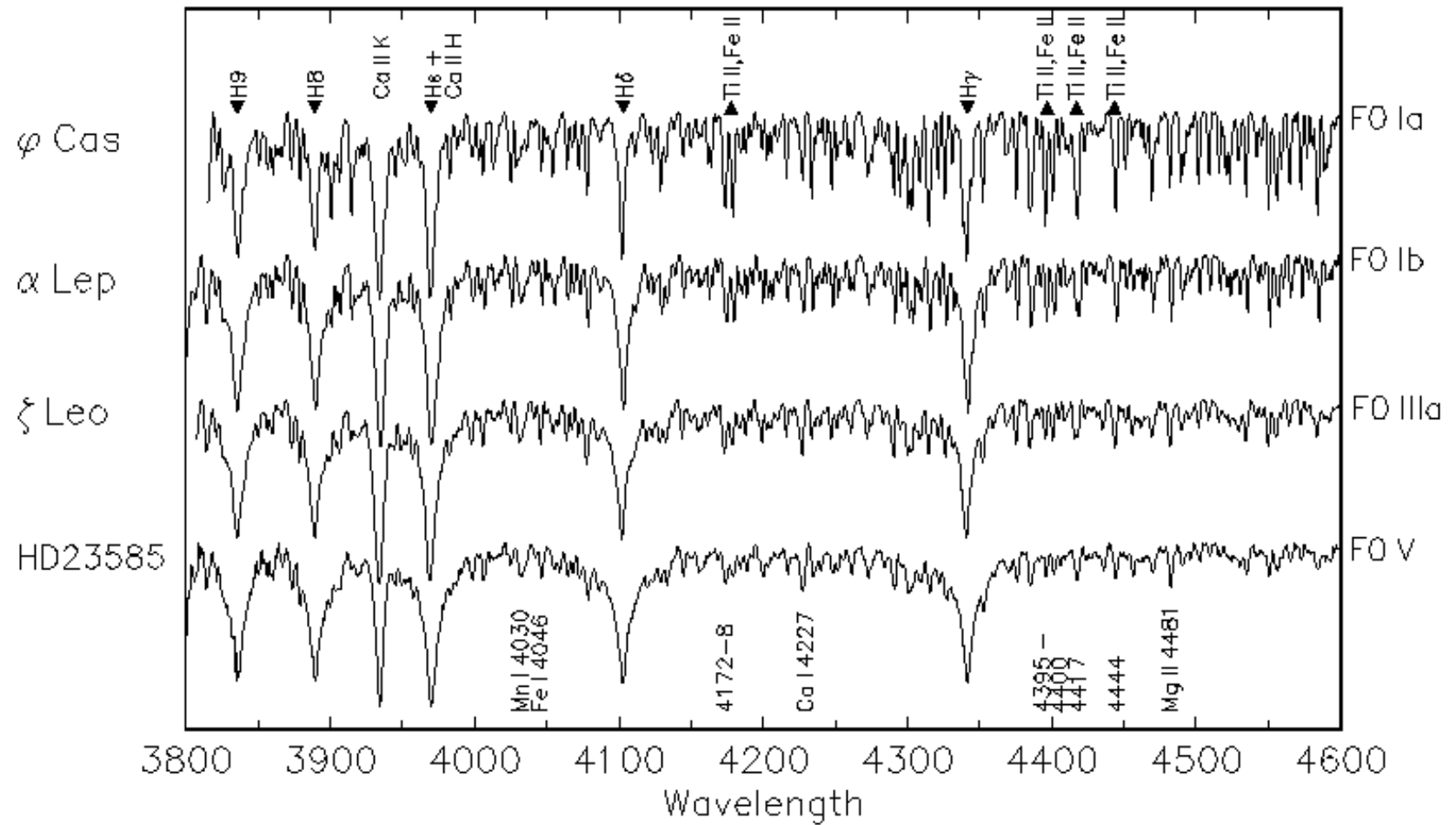
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Luminosity Effects at A0



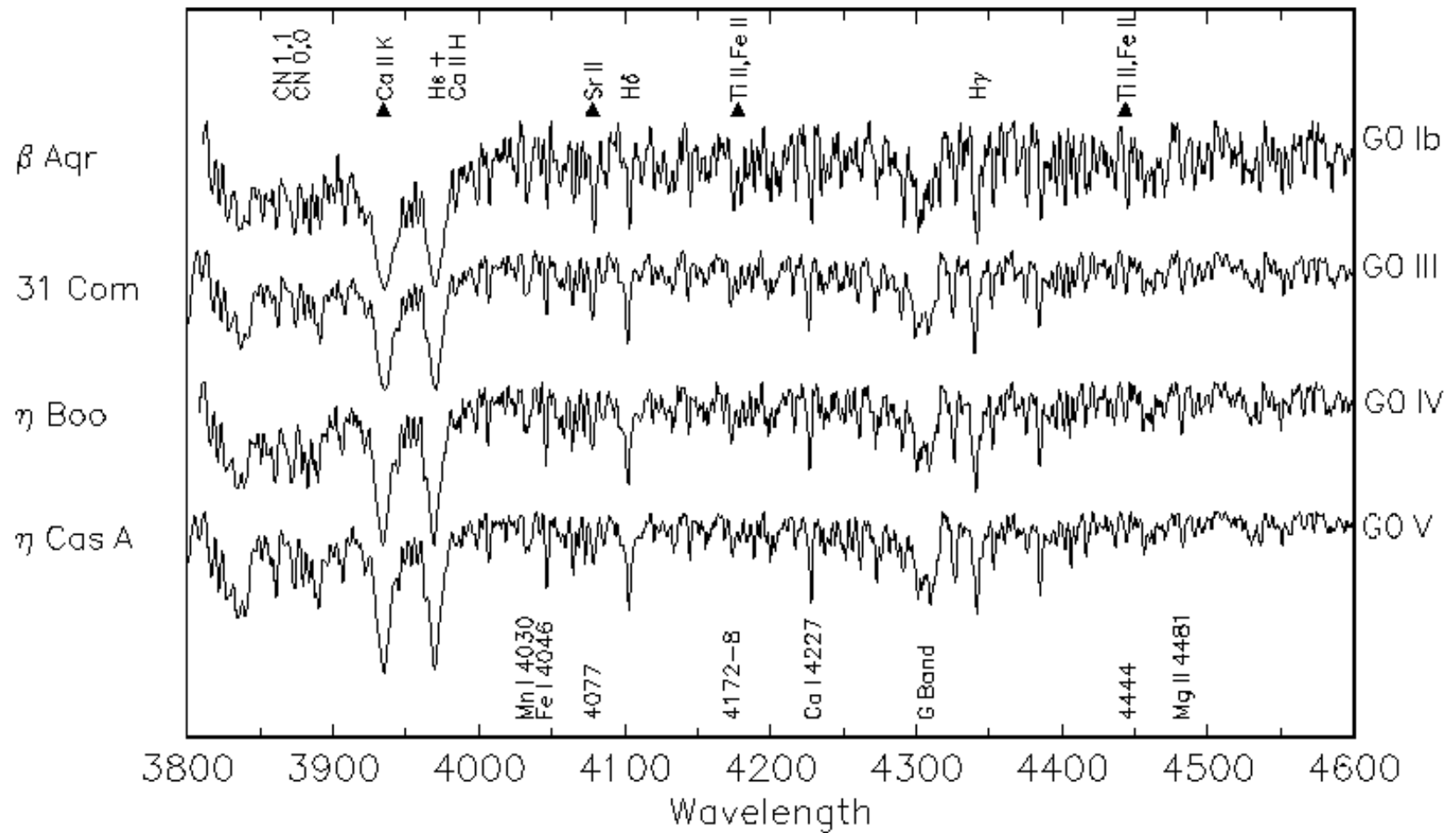
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Luminosity Effects at F0



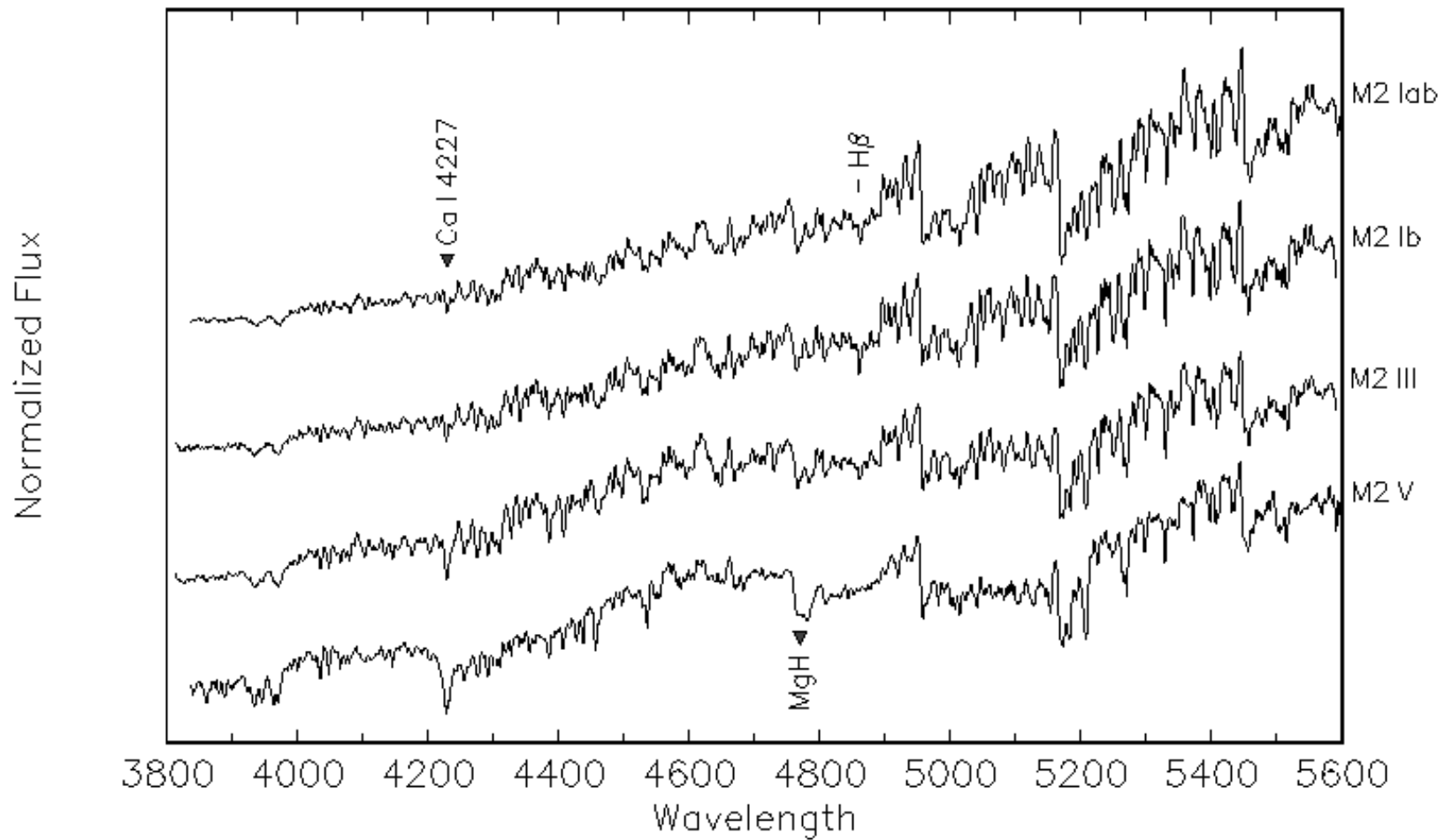
Crédito: R.O. Gray, Digital Spectral Classification Atlas

Luminosity Effects at G0



Crédito: R.O. Gray, Digital Spectral Classification Atlas

Luminosity Effects at M2



Crédito: R.O. Gray, Digital Spectral Classification Atlas

Calibración de los tipos espectrales

Tipo	M_V	$T_{eff}(K)$	$M(M_\odot)$	$R(R_\odot)$	$\log L(L_\odot)$	Tipo	M_V	$T_{eff}(K)$	$M(M_\odot)$	$R(R_\odot)$	$\log L(L_\odot)$
O5V	-5.5	41 000	40.0	17.8	5.7	G0III	0.6	5 800	2.5	6.3	1.5
B0V	-4.1	29 000	18.0	7.4	4.3	G5III	0.4	5 200	3.2	10.0	1.7
B5V	-1.1	15 000	6.5	3.8	2.9	K0III	0.2	4 810	4.0	16.0	1.9
A0V	1.4	9 800	3.2	2.5	1.9	K5III	-0.4	3 950	5.0	25.0	2.3
A5V	2.1	8 150	2.1	1.7	1.3	M0III	-0.7	3 850	6.3		2.6
F0V	2.6	7 250	1.7	1.3	0.8	M5III	-1.6	3 350			3.0
F5V	3.4	6 550	1.3	1.2	0.4						
G0V	4.4	5 900	1.1	1.0	0.1	B0Ia	-7.0	30 000	50.0	20.0	5.4
G5V	5.1	5 580	0.9	0.9	-0.1	A0Ia	-7.1	9 900	16.0	40.0	4.3
K0V	5.9	5 280	0.8	0.9	-0.4	F0Ia	-8.5	7 200	12.5	63.0	3.9
K5V	8.0	4 400	0.7	0.7	-0.8	G0Ia	-8.0	5 590	10.0	100.0	3.8
M0V	9.2	3 760	0.5	0.6	-1.2	G5Ia	-8.0	5 000	12.5	125.0	3.8
M5V	14.5	3 085	0.2	0.3	-2.1	K0Ia	-8.0	4 500	12.5	200.0	3.9
M8V	16.5	2 680	0.1	0.1	-3.1	K5Ia	-8.0	3 900	16.0	400.0	4.2
						M0Ia	-7.3	3 790	16.0	500.0	4.5

Créditos

- Fig. 4: “Diagrama de H.N. Russell”, Astrophysique sur Mesure, Observatorio de París/ U.F.E. (<http://media4.obspm.fr/public/VAU/temperatura/diagrama/hertzsprung-russel/historico-hr/OBSERVER.html>).
- Fig. 5: “HRDiagram-es” (<https://commons.wikimedia.org/wiki/File:HRDiagram-es.png>), por Alvaro qc (CC BY-SA 3.0).
- Figs. 6 a 16: “A Digital Spectral Classification Atlas”, por R.O. Gray (<http://ned.ipac.caltech.edu/level5/Gray/frames.html>).