

Fotometría Astronómica

Juan Fabregat

Observatorio Astronómico de la Universidad de Valencia

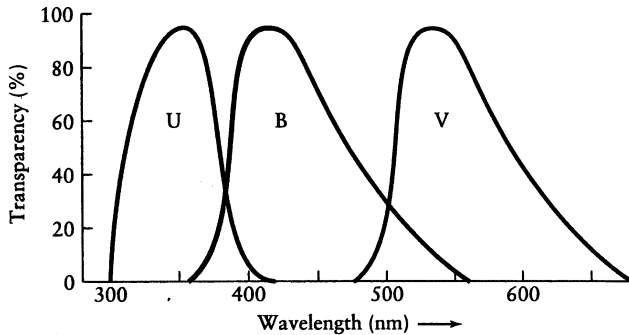
Astronomía observacional

$$F_{\lambda} = \alpha \int_{\lambda_1}^{\lambda_2} T_i(\lambda, d) T_a(\lambda, d) T_t(\lambda) T_f(\lambda) r(\lambda) f_{\lambda} d\lambda$$

- Conjunto de rangos espectrales
- Conjunto de magnitudes, colores e índices propios del sistema
- Lista de estrellas estándar con sus valores

- Magnitudes visuales m_v
- Magnitudes fotográficas m_{pg}
- Índice de color $CI = m_{pg} - m_v$

Sistema de Johnson



Sistema de Johnson

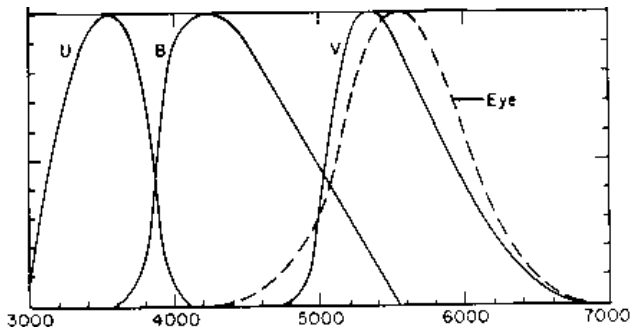
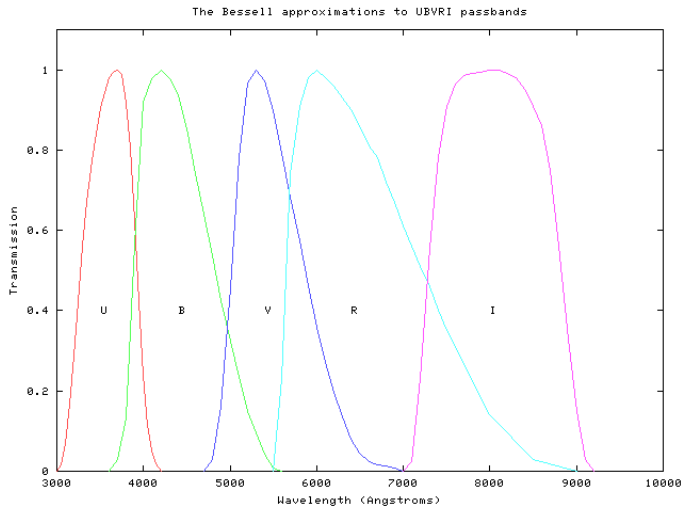
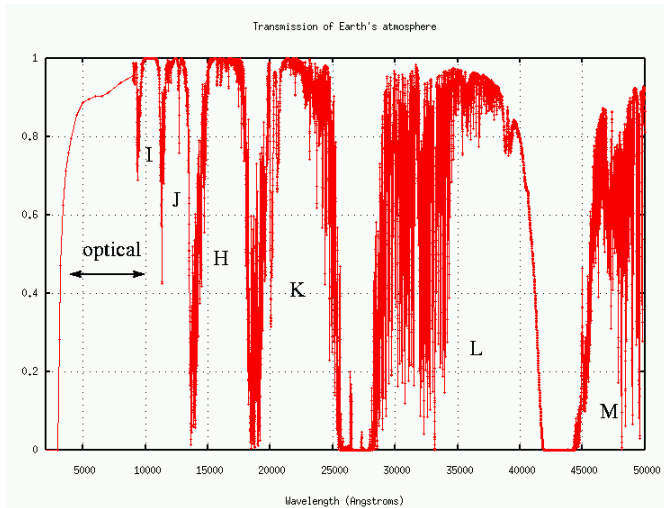


FIG. 1-4. SENSITIVITY CURVES OF THE EYE AND OF THE UBV PHOTOMETRIC SYSTEM

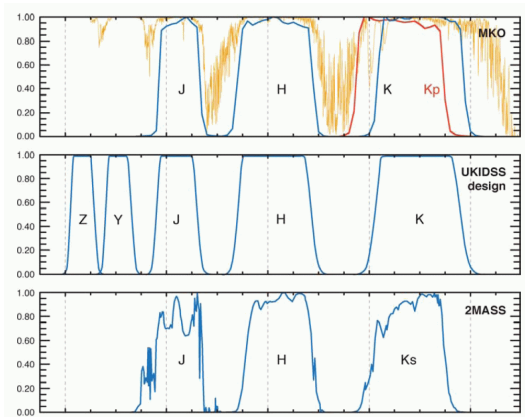
Sistema de Johnson-Cousins



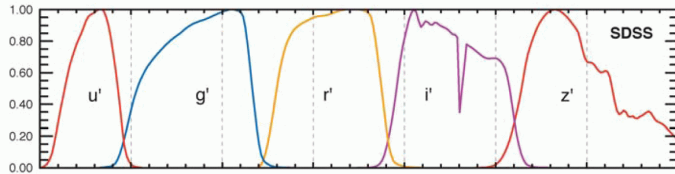
Transmisión de la atmósfera



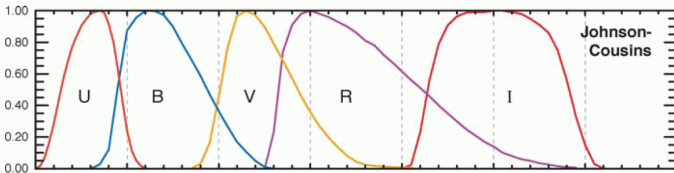
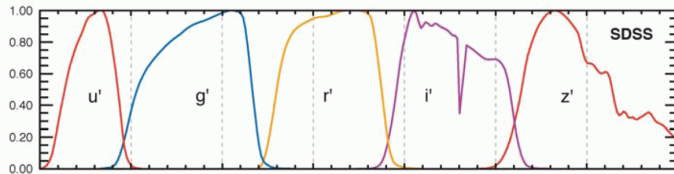
Sistema infrarrojo



Sistema de Sloan

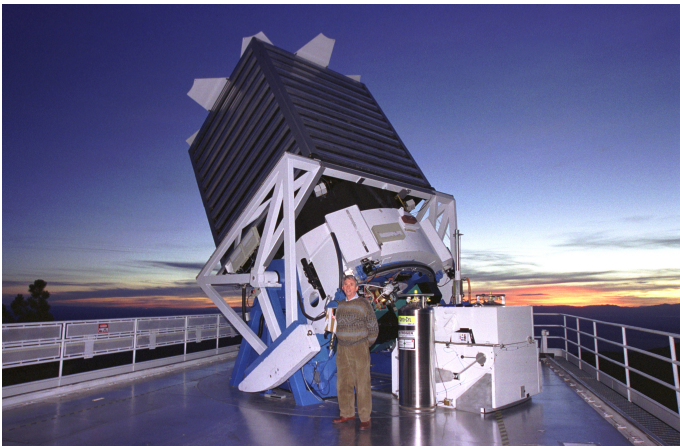


Sistema de Sloan



- Imágenes ópticas de más de un cuarto del cielo
- Mapa tridimensional de un millón de galaxias y cuasares
- Telescopio dedicado para fotometría y espectroscopía
- <http://www.sdss.org/>

Sistema de Sloan



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Sloan Digital Sky Survey

Mapping the Universe

What is the Sloan Digital Sky Survey?

Simply put, the Sloan Digital Sky Survey (SDSS) is the most ambitious astronomical survey ever undertaken. When completed, it will provide detailed optical images covering more than a quarter of the sky, and a 3-dimensional map of about a million galaxies and quasars. As the survey progresses, the data are released to the scientific community and the general public in annual increments.

The SDSS uses a dedicated, 2.5-meter telescope on Apache Point, NM, equipped with two powerful special-purpose instruments. The 120-megapixel camera can image 1.5 square degrees of sky at a time, about eight times the area of the full moon. A pair of spectrographs fed by optical fibers can measure spectra of (and hence distances to) more than 600 galaxies and quasars in a single observation. A custom-designed set of software pipelines keeps pace with the enormous data flow from the telescope.



The SDSS completed its first phase of operations — SDSS-I — in June, 2005. Over the course of five years, SDSS-I imaged more than 8,000 square degrees of the sky in five bandpasses, detecting nearly 200 million celestial objects, and it measured spectra of more than 675,000 galaxies, 90,000 quasars, and 185,000 stars. These data have supported studies ranging from asteroids and nearby stars to the large scale structure of the Universe.

The SDSS has entered a new phase, SDSS-II, continuing through June, 2008. With a consortium that now includes 25 institutions around the globe, SDSS-II will carry out three distinct surveys — the [Sloan Legacy Survey](#), SEGUE, and the [Sloan Supernova Survey](#) — to address fundamental questions about the nature of the Universe, the origin of galaxies and quasars, and the formation and evolution of our own Galaxy, the Milky Way.

Funding for the SDSS and SDSS-II has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Science Foundation, the U.S. Department of Energy, the National Aeronautics and Space Administration, the Japanese Monbukagakusho, the Max Planck Society, and the Higher Education Funding Council for England.

The SDSS is managed by the Astrophysical Research Consortium for the Participating Institutions. The Participating Institutions are the American Museum of Natural History, Astrophysical Institute Potsdam, University of Basel, Cambridge University, Case Western Reserve University, University of Chicago, Fiske University, Harvard-Smithsonian Center for Astrophysics, Johns Hopkins University, Lawrence Berkeley National Laboratory, MIT, New York University, Princeton University, Rice University, University of Rochester, University of Texas at Austin, University of Washington, Yale University, and the University of Arizona.

Image of the Week



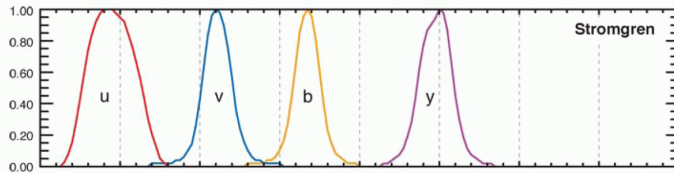
News

- Gravity helps SDSS-II reveal a brilliant jewel of the early universe
(November 7, 2006)
- How big is big? Probing the conditions of the universe on the largest scales
(May 15, 2006)

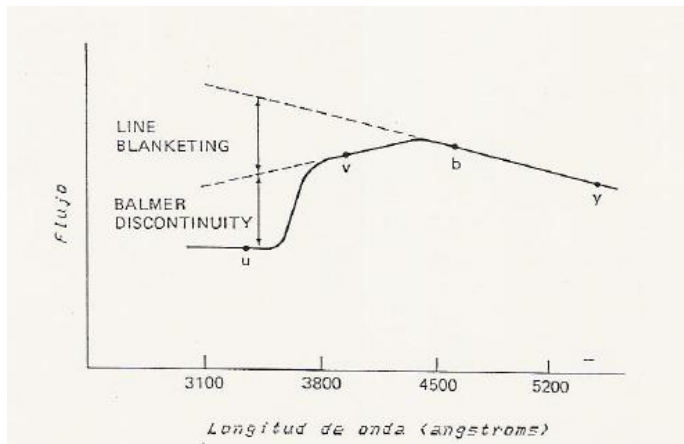
Events

- Data Release Five The fifth major data release provides images, imaging catalogs, spectra, and redshifts for download. (Data Release Four continues to be available.)
- Supernova Data Release One The first major data release from the SDSS-II supernova survey.

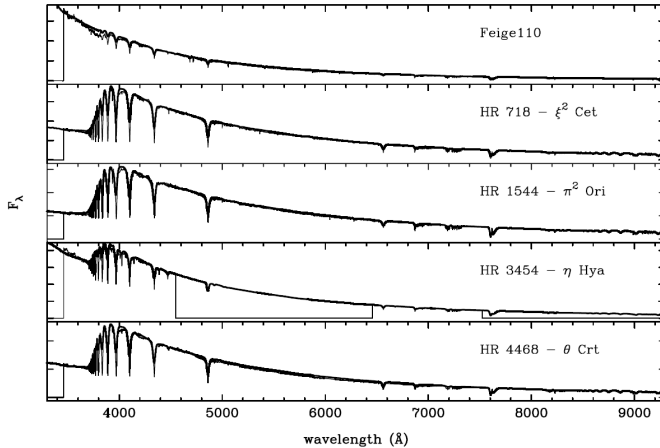
Sistema de Strömgren



Sistema de Strömgren

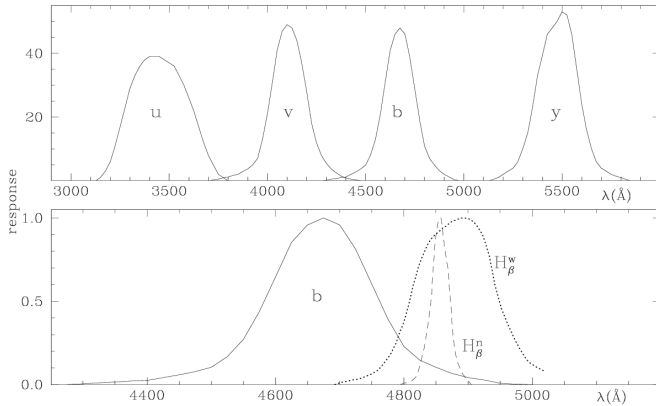


Sistema de Strömgren



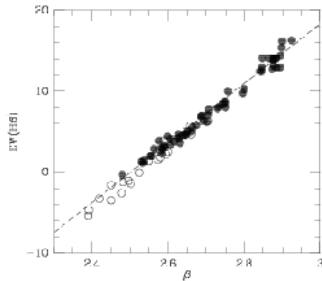
- $V \equiv V$ de Johnson
- $(b - y)$
- $m_1 = (v - b) - (b - y) = v - 2b + y$
- $c_1 = (u - v) - (v - b) = u - 2v + b$

Sistemas $H\beta$ de Crawford

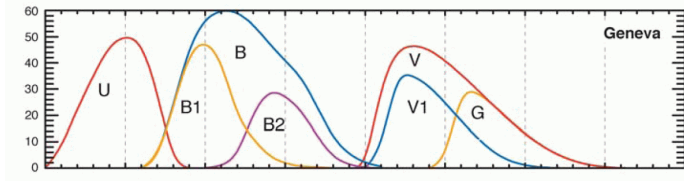


Sistemas H β de Crawford

$$\beta = \text{mag}(\beta_n) - \text{mag}(\beta_w)$$



Sistemas fotométricos



Extinción atmosférica

Un elemento de material absorbente o dispersor de espesor dx absorbe una una fracción τdx de un rayo de intensidad I . La cantidad dispersada es $I\tau dx$.

$$dI = -I\tau dx$$

Integrando a lo largo del recorrido x

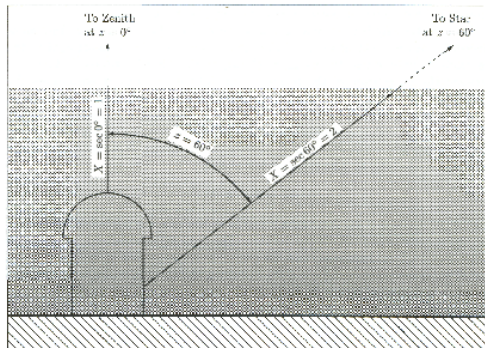
$$\log I = \log I_0 - \tau x$$

donde I e I_0 son las intensidades inicial y final. En magnitudes esto se convierte en:

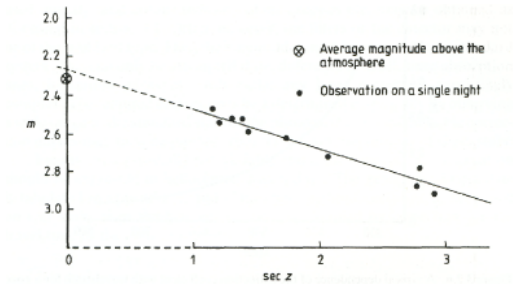
$$m_0 = m - 2.5\tau x$$

$$m_0 = m - kX$$

Extinción atmosférica



Extinción atmosférica



- Magnitudes instrumentales fuera de atmósfera:

$$m_0(\lambda) = m(\lambda) - k_\lambda X$$

- En el caso de bandas anchas:

$$m_0(\lambda) = m(\lambda) - (k_\lambda + k'_\lambda(B - V))X$$

Transformación estándar

Ecuaciones de transformación estándar del sistema UBV de Johnson:

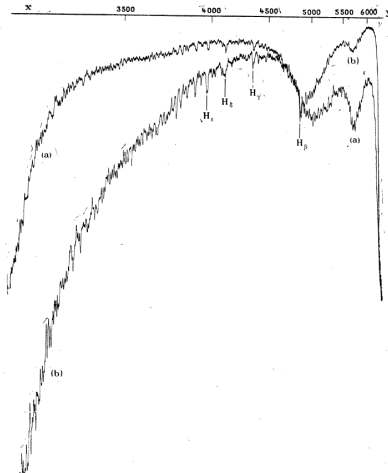
- $V = v_0 + \epsilon(B - V) + Z_v$
- $(B - V) = \mu(b - v)_0 + Z_{b-v}$
- $(U - B) = \psi(u - b)_0 + Z_{u-b}$

Transformación estándar

Ecuaciones de transformación estándar del sistema $uvby\beta$ de Strömgren-Crawf:

- $V = y + A + B(b - y)_{st}$
- $(b - y)_{st} = C + D(b - y)_{ins}$
- $m_{1(st)} = E + Fm_{1(ins)} + J(b - y)_{st}$
- $c_{1(st)} = G + Hc_{1(ins)} + I(b - y)_{st}$
- $\beta_{st} = a + b\beta_{ins}$

Extinción interestelar



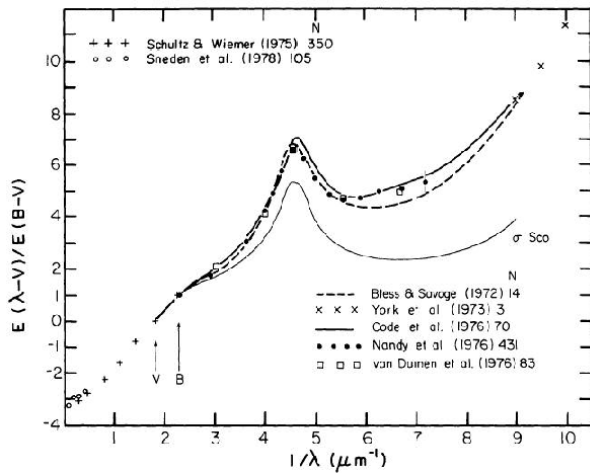
Índices intrínsecos. Absorción o extinción y exceso de color.

- Absorción: $A_M = M - M_0$
- Exceso: $E(C) = C - C_0$

Ejemplos:

- $V_0 = V - A_V$
- $(B - V)_0 = (B - V) - E(B - V)$
- $(b - y)_0 = (b - y) - E(b - y)$
- $c_0 = c_1 - E(c_1)$

Extinción interestelar



Extinción interestelar

INTERSTELLAR EXTINCTION LAW

λ	$E(\lambda - V)/E(B - V)$	A_λ/A_V	van de Hulst No. 15
<i>U</i>	1.64 ^a	1.531	1.555
<i>B</i>	1.00 ^b	1.324	1.329
<i>V</i>	0.0 ^b	1.000	1.000
<i>R</i>	-0.78 ^b	0.748	0.738
<i>I</i>	-1.60 ^b	0.482	0.469
<i>J</i>	-2.22 ± 0.02	0.282	0.246
<i>H</i>	-2.55 ± 0.03	0.175	0.155
<i>K</i>	-2.744 ± 0.024	0.112	0.0885
<i>L</i>	-2.91 ± 0.03	0.058	0.045
<i>M</i>	-3.02 ± 0.03	0.023	0.033
<i>N</i>	-2.93	0.052	0.013
8.0 μm	-3.03	0.020 ± 0.003	
8.5	-2.96	0.043 ± 0.006	
9.0	-2.87	0.074 ± 0.011	
9.5	-2.83	0.087 ± 0.013	
10.0	-2.86	0.083 ± 0.012	
10.5	-2.87	0.074 ± 0.011	
11.0	-2.91	0.060 ± 0.009	
11.5	-2.95	0.047 ± 0.007	
12.0	-2.98	0.037 ± 0.006	
12.5	-3.00	0.030 ± 0.005	
13.0	-3.01	0.027 ± 0.004	

Ejemplos:

- $A_V = 3.1E(B - V) = 4.3E(b - y)$
- $E(B - V)_0 = 1.35E(b - y)$
- $E(m_1) = -0.32E(b - y)$
- $E(c_1) = 0.2E(b - y)$

Colores o índices libres de extinción (reddening free)

$$I_L = I^1 - \frac{E(I^1)}{E(I^2)} I^2$$

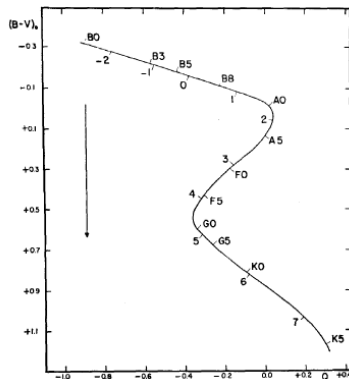
Demostración:

- $I_L = I_0^1 + E(I^1) - \frac{E(I^1)}{E(I^2)} (I_0^2 + E(I^2))$
- $I_L = I_0^1 + E(I^1) - \frac{E(I^1)}{E(I^2)} I_0^2 - \frac{E(I^1)}{E(I^2)} E(I^2)$
- $I_L = I_0^1 - \frac{E(I^1)}{E(I^2)} (I_0^2)$

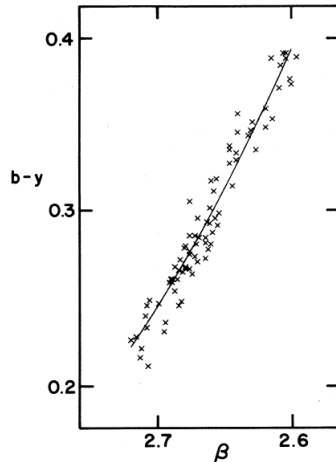
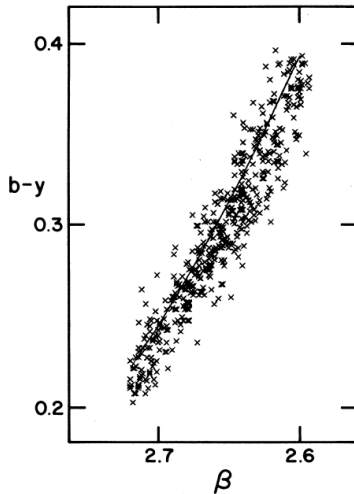
Extinción interestelar

Parameters Q , X and intrinsic indices of the UBV system

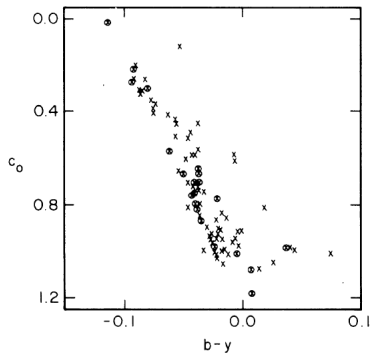
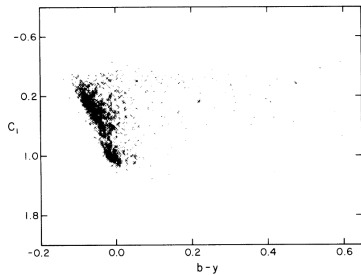
Sp V	X	Q	$(B-V)_0$	$(U-B)_0$
O5	0.72	-0.92	-0.32	-1.15
O6	0.72	-0.91	-0.32	-1.14
O7	0.72	-0.91	-0.32	-1.14
O8	0.72	-0.91	-0.31	-1.13
O9	0.72	-0.90	-0.31	-1.12
O9.5	0.72	-0.88	-0.30	-1.10
B0	0.70	-0.86	-0.30	-1.08
B0.5	0.69	-0.81	-0.28	-1.01
B1	0.69	-0.74	-0.26	-0.93
B2	0.67	-0.69	-0.24	-0.86
B3	0.65	-0.57	-0.20	-0.71
B5	0.62	-0.44	-0.16	-0.56
B6	0.62	-0.39	-0.14	-0.49
B7	0.62	-0.33	-0.12	-0.42
B8	0.62	-0.24	-0.09	-0.30
B9	0.63	-0.15	-0.06	-0.19
B9.5	0.63	-0.08	-0.03	-0.10
A0	0.65	0.00	0.00	0.00



Extinción interestelar



Extinción interestelar



Ley de Stefan-Boltzmann

$$F = \sigma T^4$$

Definición de Luminosidad

$$L = 4\pi R^2 F = 4\pi r^2 f$$

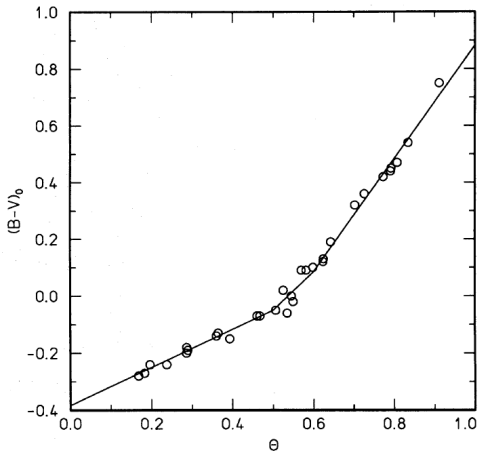
$$L = 4\pi \sigma R^2 T_{eff}^4$$

$$\Rightarrow f = \left(\frac{R}{r}\right)^2 \sigma T_{eff}^4$$

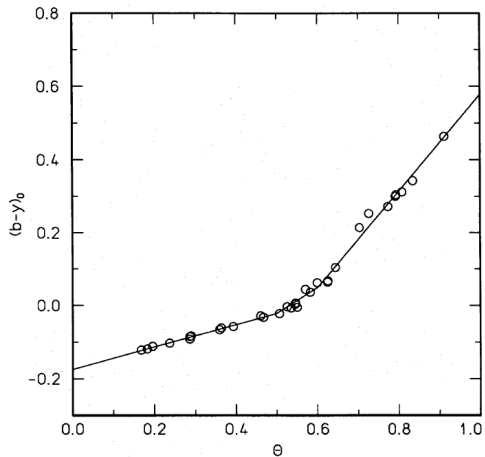
$$\Rightarrow f = \theta^2 \sigma T_{eff}^4$$

$$\Theta = \frac{5040K}{T_{eff}}$$

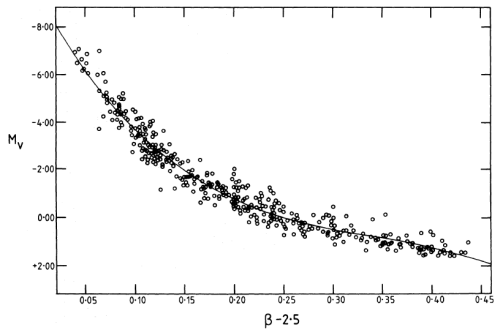
Temperatura efectiva



Temperatura efectiva



Luminosidad



Luminosidad

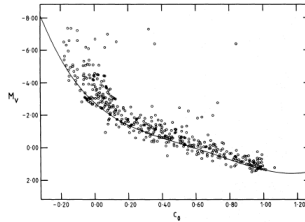


Figure 3. The H-R diagram using the distance moduli of the first calibration and showing the adopted ZAMS.

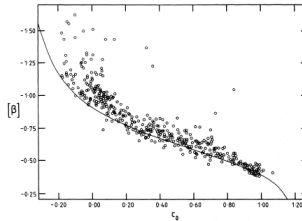
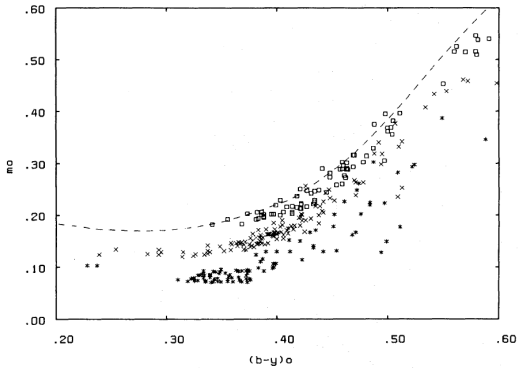
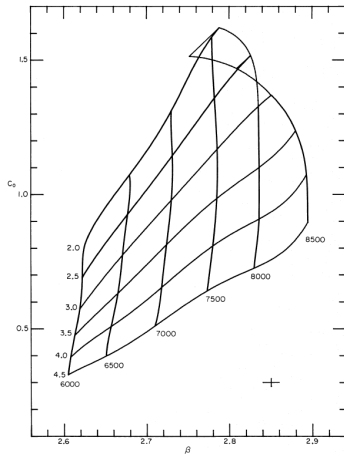


Figure 4. The H-R diagram obtained from the β index using the transformation $[\beta] = \log_{10}(\beta - 2.515)$. The adopted ZAMS is shown.

Metalicidad



Red de calibración



Red de calibración

