CARMENES target characterisation
Photometry of M dwarfs

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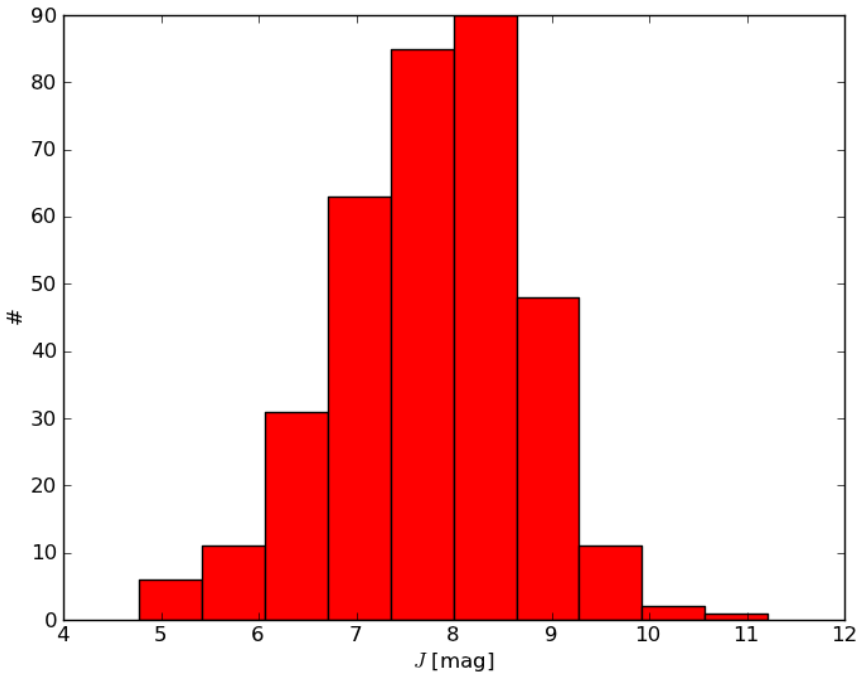
Introducción: CARMENES y CARMENCITA

Carmencita

Introducción: Muestra y estrellas M

T.esp.	M0V	M1V	M2V	M3V	M4V	M5V	M6V
$J_{\text{máx}}$[mag]	7.0	7.5	8.0	8.5	9.0	9.5	10.0

- Magnitud mínima
- Declinación $\delta \geq -23°$
- Separación $\rho > 5$ arcsec



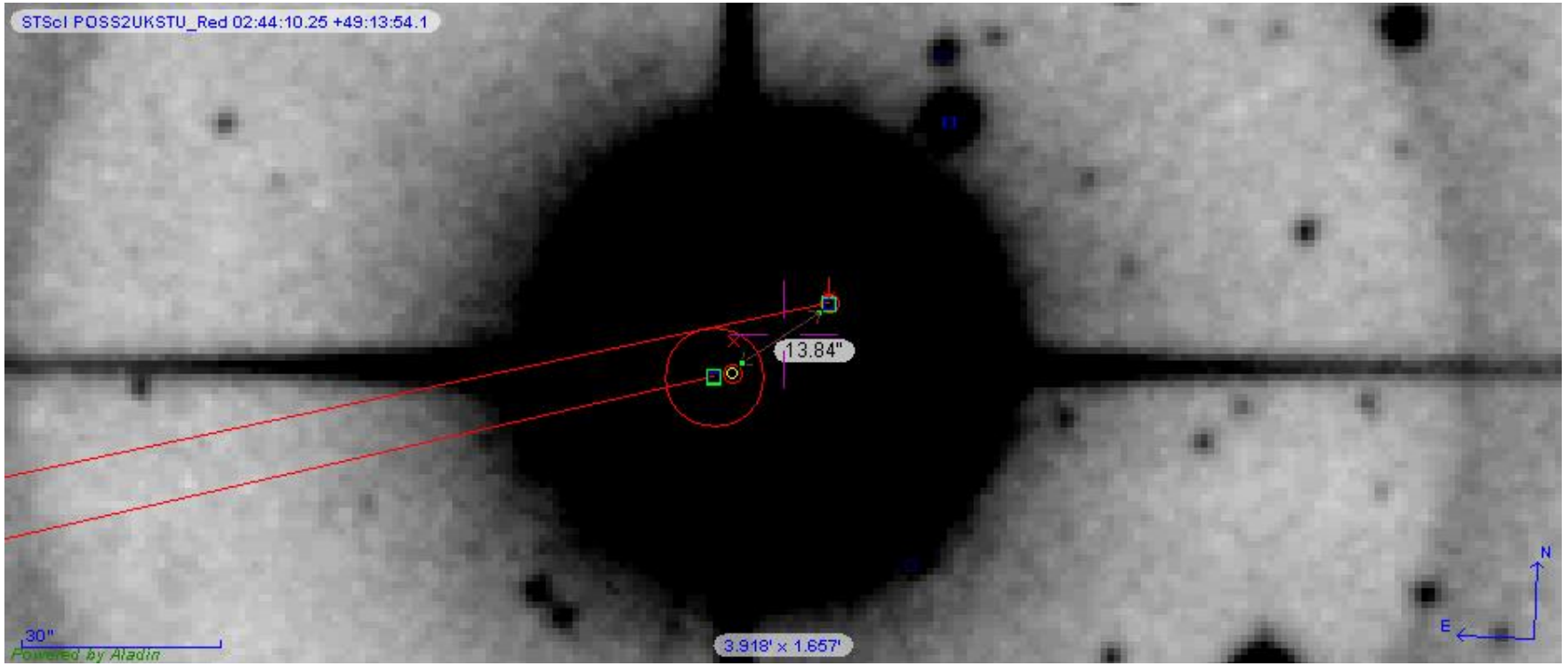
Análisis

- Se ha recopilado la información de 158 estrellas para todos los filtros, y los datos de *GALEX* de 377 estrellas.

Filtro	Sistema	λ_{eff}[Å]	F^0_λ[erg/cm^2/s/Å]	Magnitudes
FUV	*GALEX*	1542.26	$4{,}576 \times 10^{-8}$	AB
NUV	*GALEX*	2274.37	$2{,}104 \times 10^{-8}$	AB
u'	Sloan	3594.93	$8{,}423 \times 10^{-9}$	AB
B_T	Tycho-2	4280.00	$6{,}598 \times 10^{-9}$	Vega
B	Johnson	4378.12	$6{,}293 \times 10^{-9}$	Vega
g'	Sloan	4640.42	$5{,}055 \times 10^{-9}$	AB
V_T	Tycho-2	5340.00	$3{,}984 \times 10^{-9}$	Vega
V	Johnson	5466.11	$3{,}575 \times 10^{-9}$	Vega
r'	Sloan	6122.33	$2{,}904 \times 10^{-9}$	AB
i'	Sloan	7439.49	$1{,}967 \times 10^{-9}$	AB
J	2MASS	12350	$3{,}129 \times 10^{-10}$	Vega
H	2MASS	16620	$1{,}133 \times 10^{-10}$	Vega
Ks	2MASS	21590	$4{,}283 \times 10^{-11}$	Vega
W1	*WISE*	33526	$8{,}1787 \times 10^{-12}$	Vega
W2	*WISE*	46028	$2{,}415 \times 10^{-12}$	Vega
W3	*WISE*	115608	$6{,}5151 \times 10^{-14}$	Vega
W4	*WISE*	220883	$5{,}0901 \times 10^{-15}$	Vega

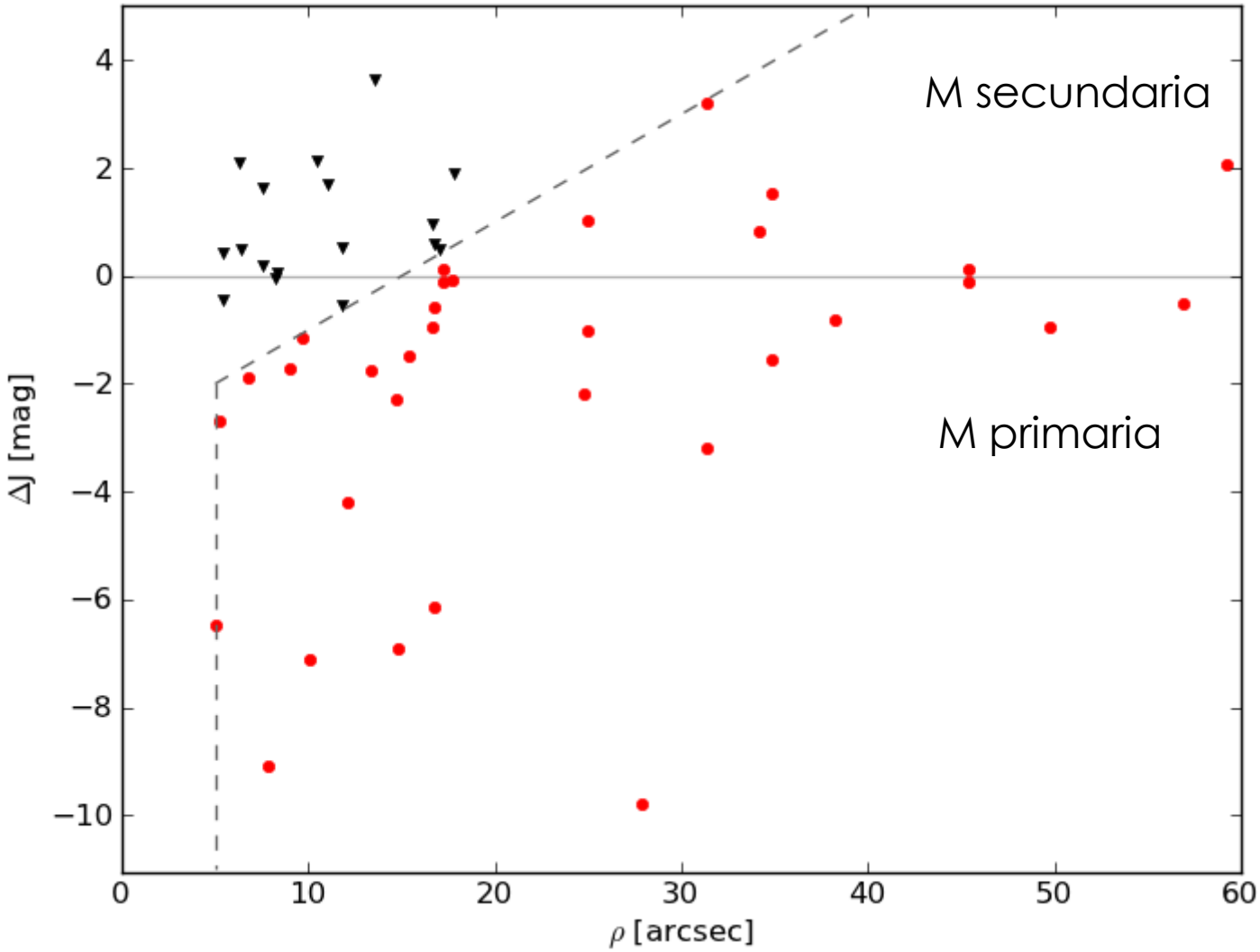
Datos obtenidos del SVO

Análisis: Separación-dif. magnitud

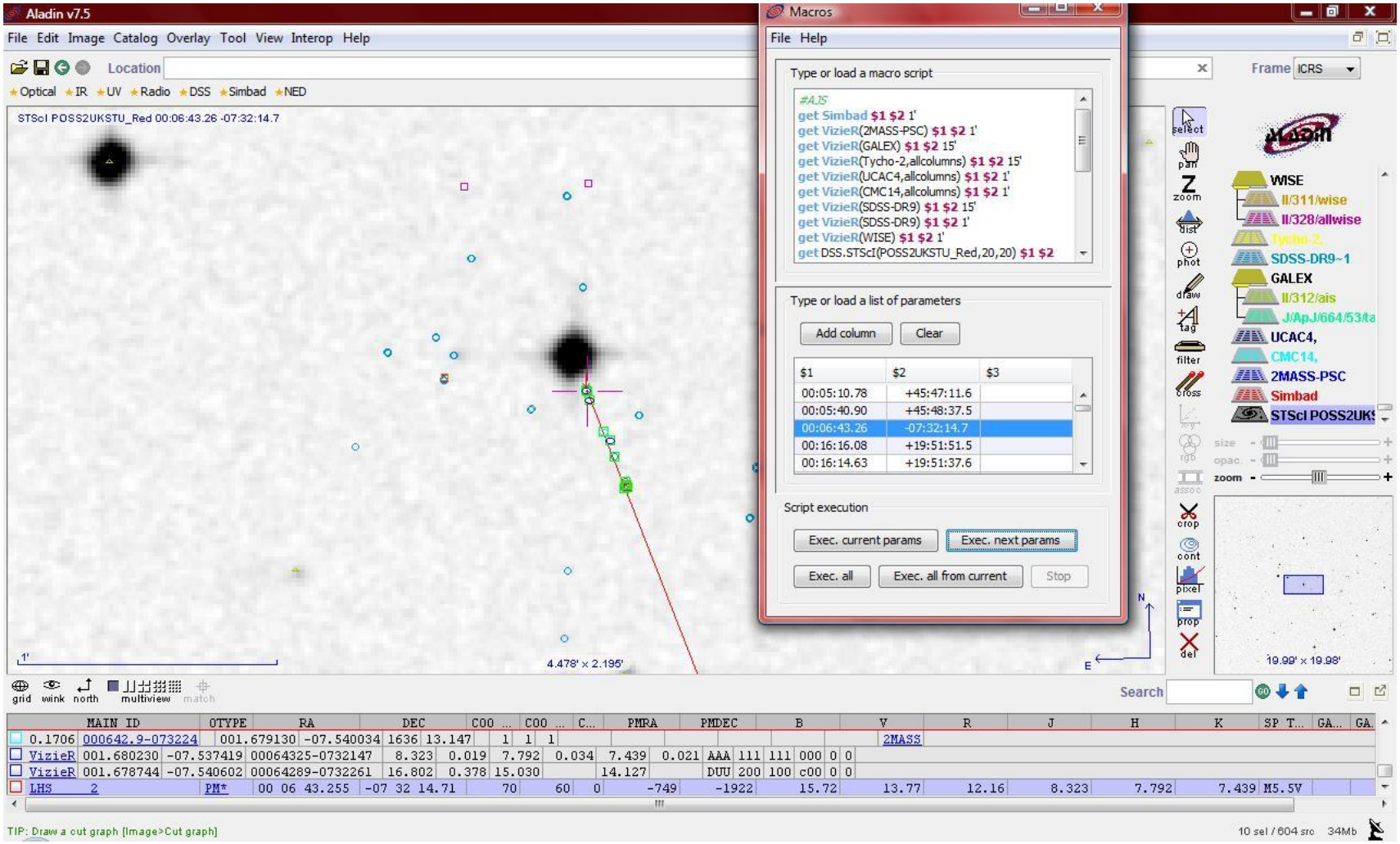


θ Persei AB: ρ =13.5 arcsec (>5 arcsec)
ΔJ = 3.657 mag

Análisis: Separación-dif. magnitud



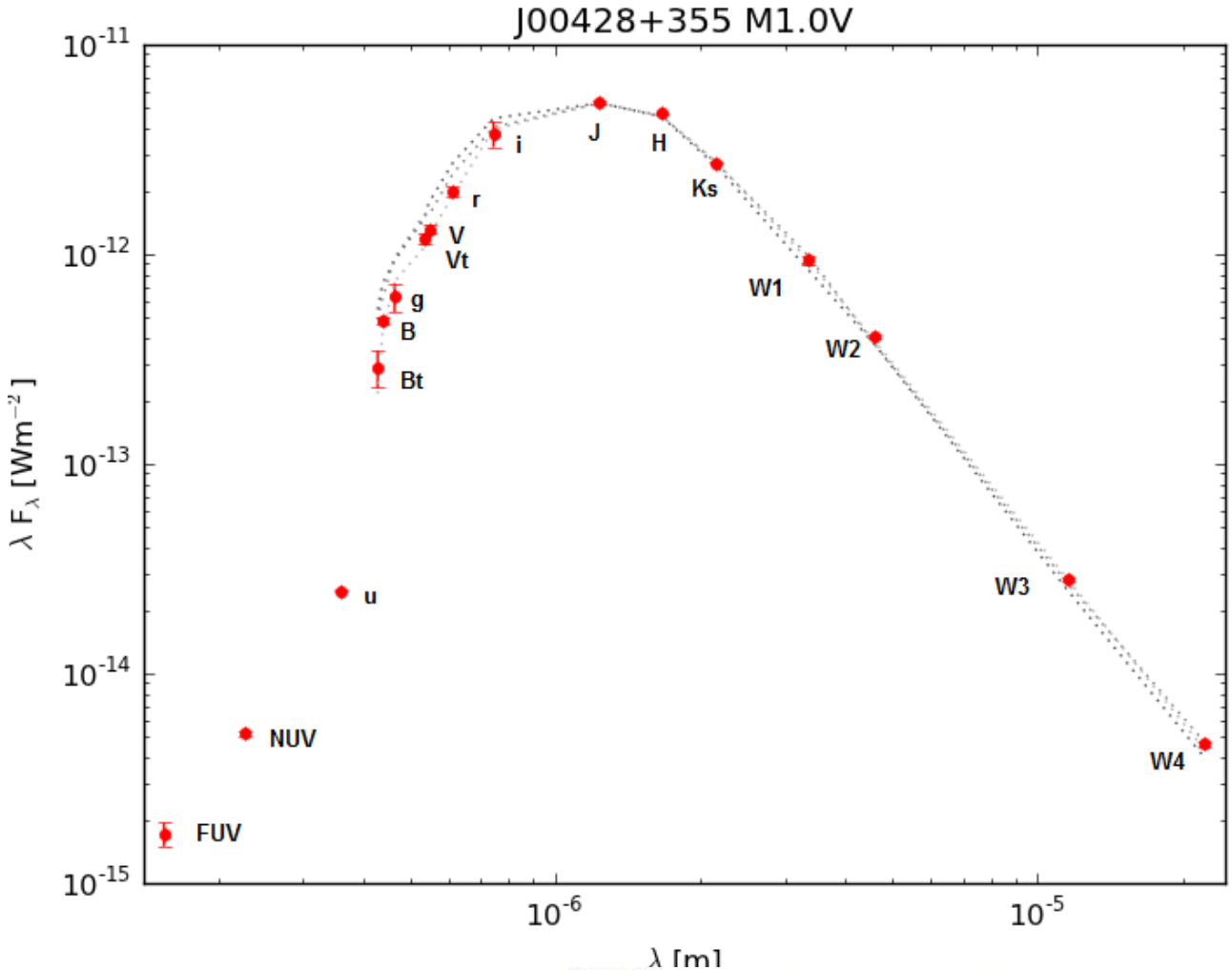
Análisis: Proceso de recopilación



Análisis: Proceso de recopilación

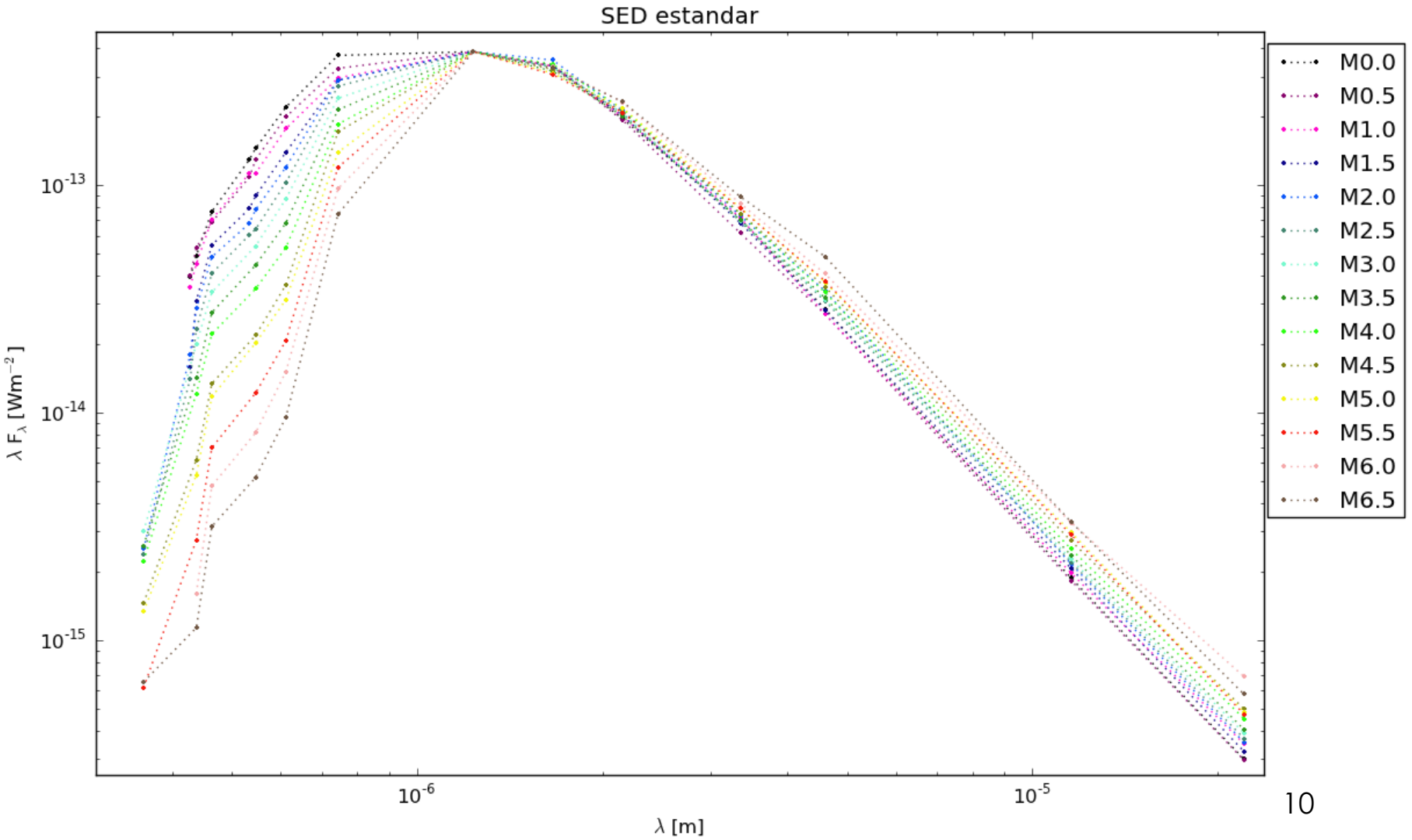
Filtro	Opción 1	Opción 2	Opción 3
FUV	*GALEX*	-	-
NUV	*GALEX*	-	-
u'	SDSS	-	-
B_T	Tycho-2	-	-
B	UCAC4	-	-
g'	SDSS	-	-
V_T	Tycho-2	-	-
V	UCAC4	-	-
r'	UCAC4	CMC14	SDSS
i'	UCAC4	SDSS	-
W1	*WISE*	-	-
W2	*WISE*	-	-
W3	*WISE*	-	-
W4	*WISE*	-	-

Análisis: SEDs Ejemplo de SED para FF And

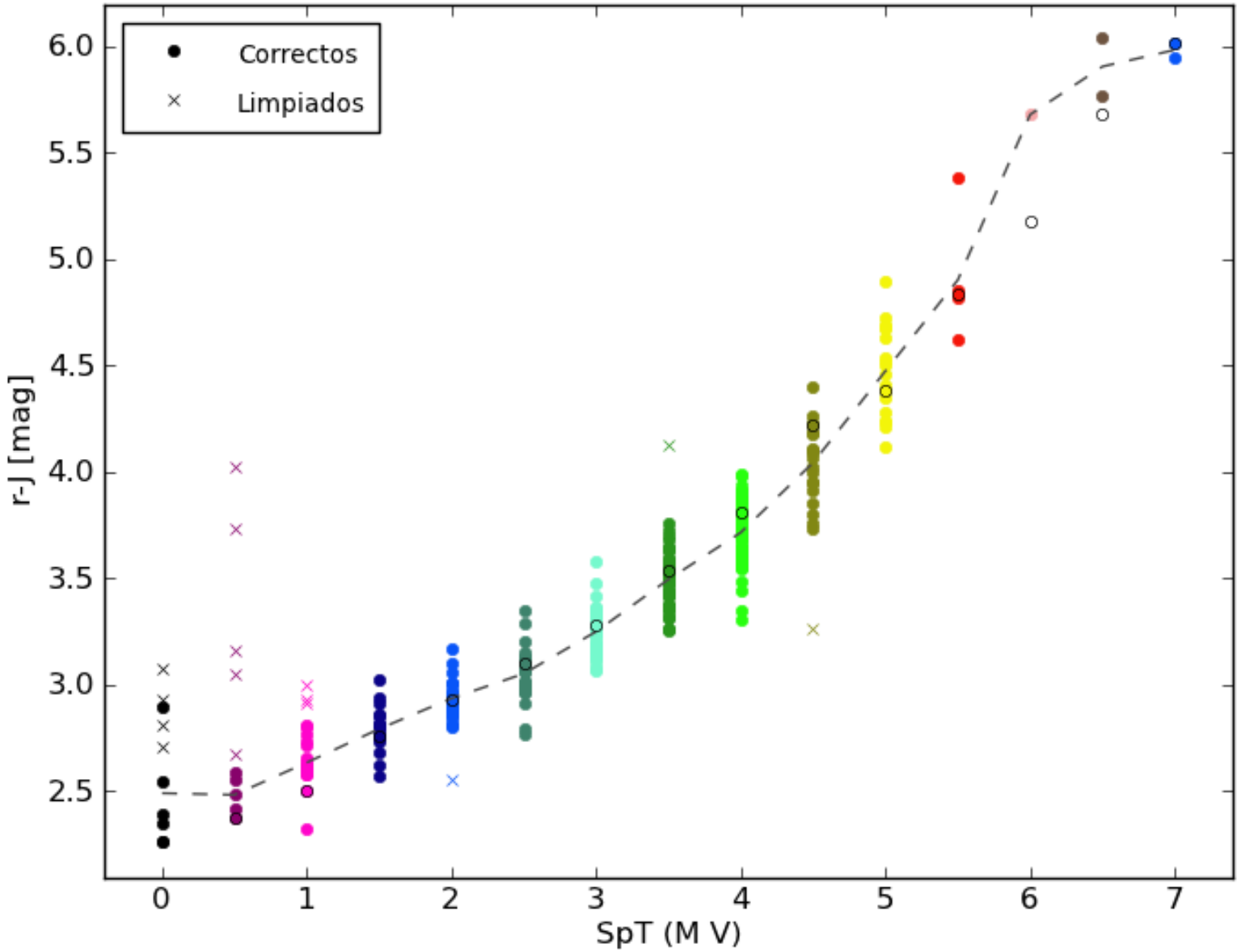


$$m_\lambda = -2{,}5 \log\left(\frac{F_\lambda}{F_\lambda^0}\right) \Longrightarrow F_\lambda = F_\lambda^0 \cdot 10^{-m_\lambda/2{,}5}$$

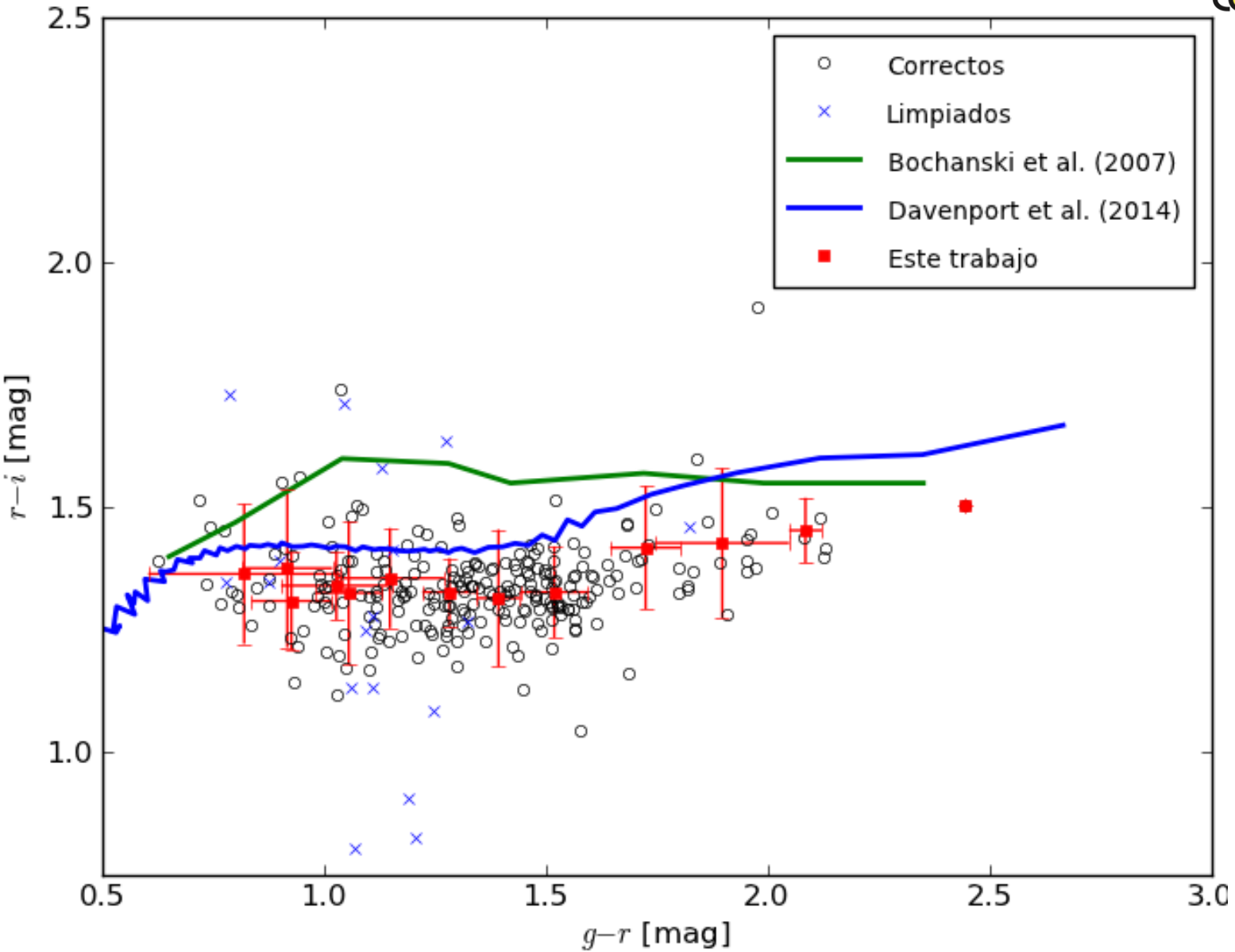
Análisis: Prototipos espectrales



Análisis: Diagramas color-tipo esp.

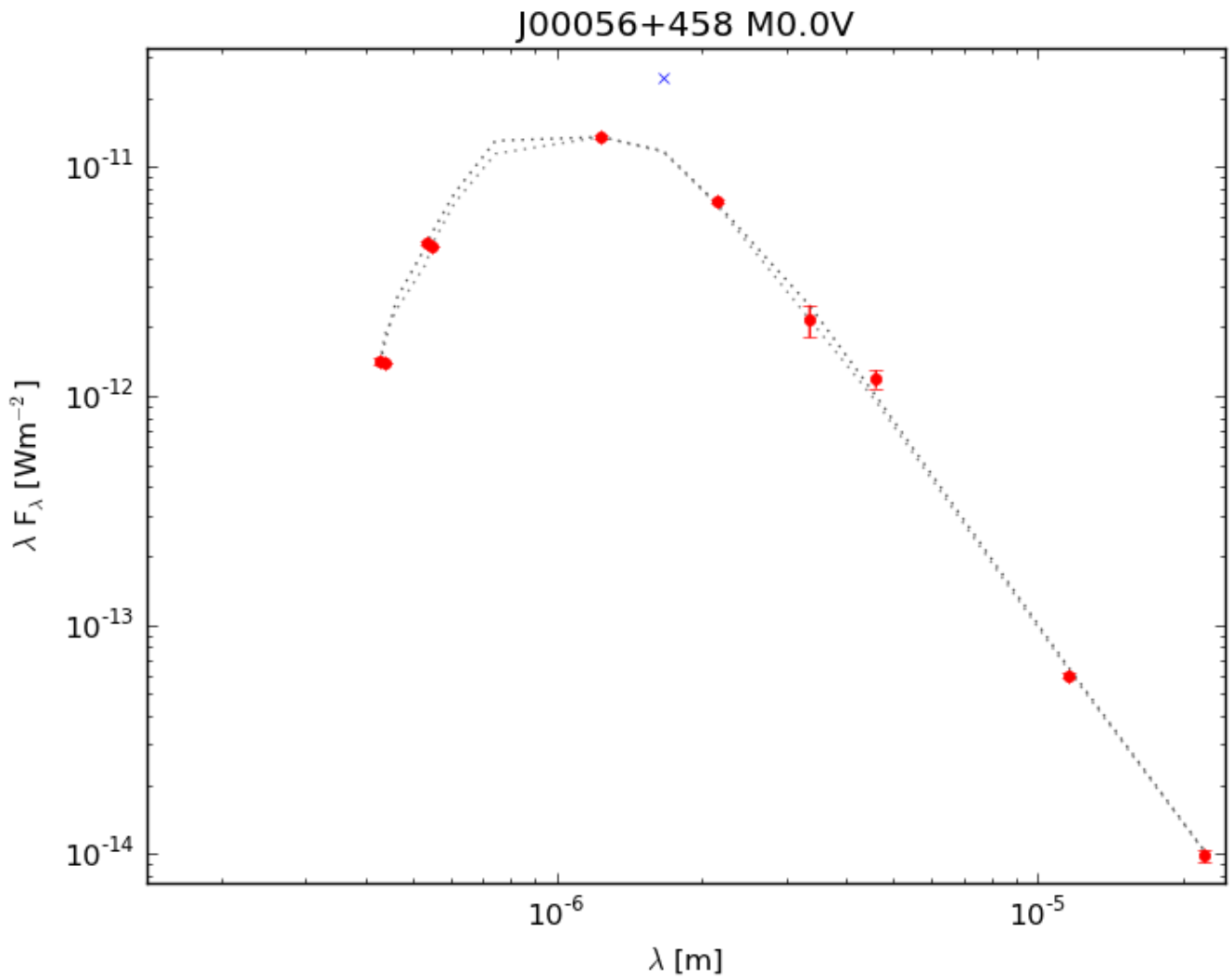


Análisis: Diagramas color-color



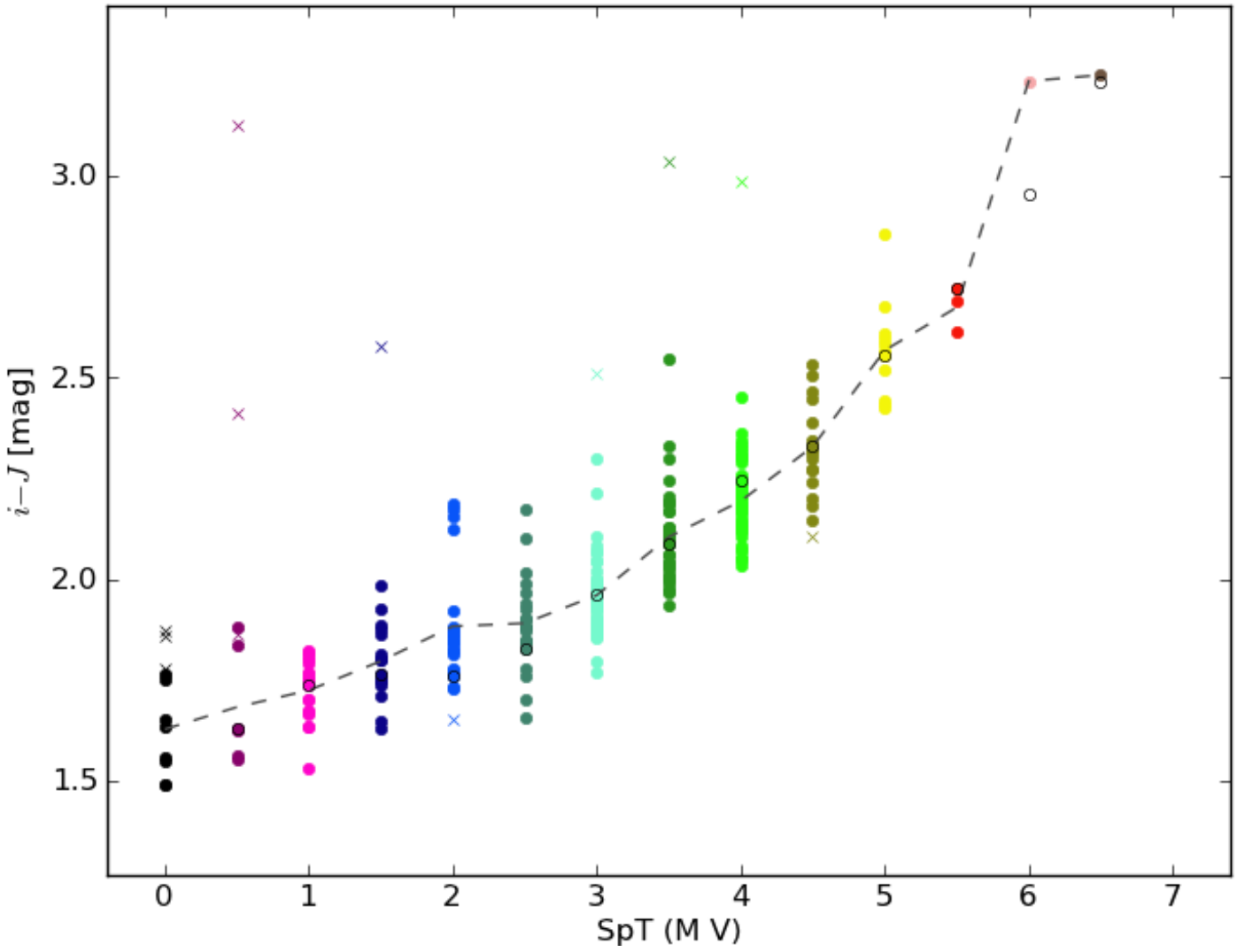
Análisis: Proceso de limpieza

Paso 1:



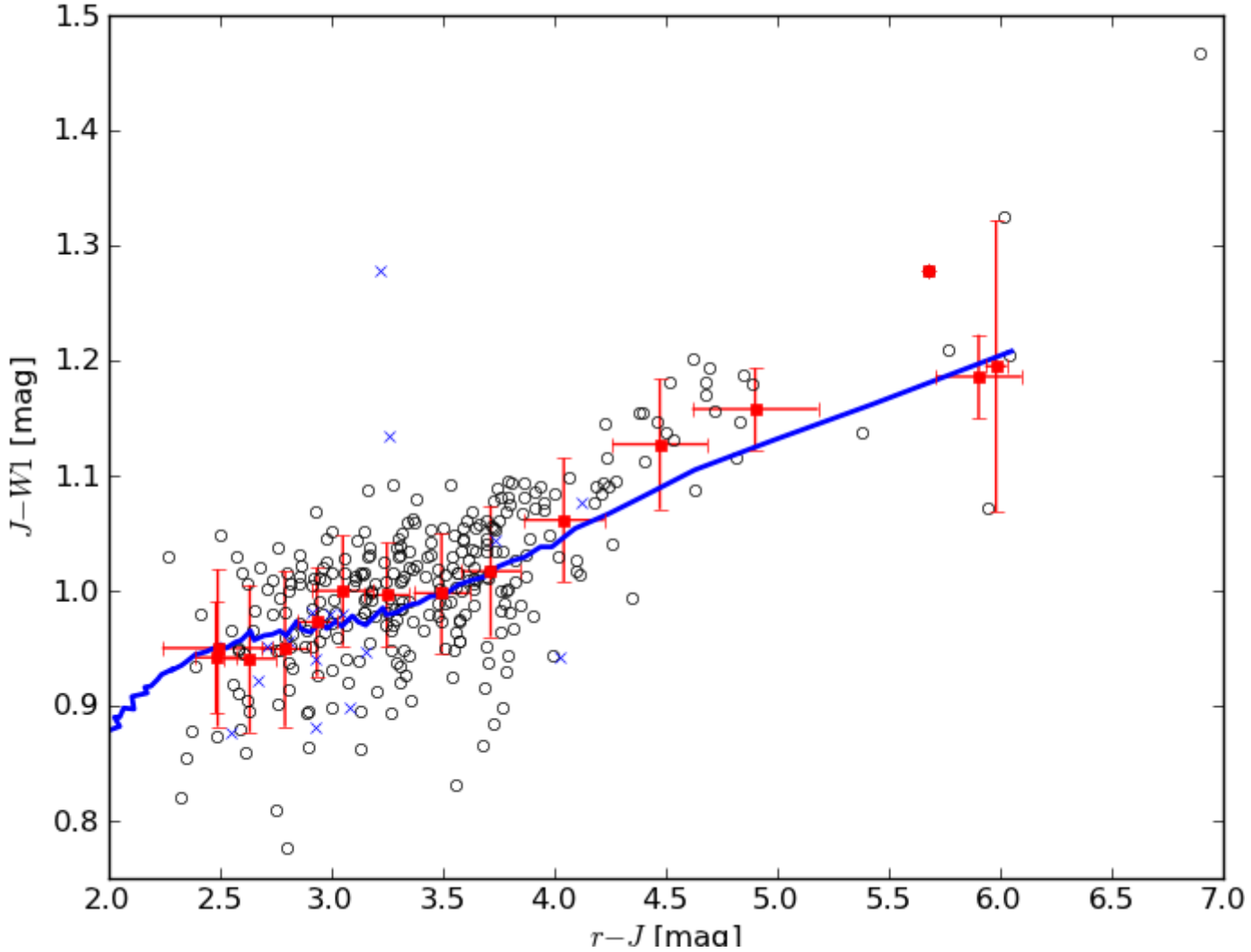
Análisis: Proceso de limpieza

Paso 2:



Análisis: Proceso de limpieza

Paso 3:



Análisis: Fichero ASCII

Karmn	Comp	Name	SpT	RA_J2000	DE_J2000	FUV_mag	eFUV_mag	NUV_mag	eNUV_mag	Ref08
J00051+457	C	GJ 2	M1.0 V	00:05:10.78	+45:47:11.6	...	...	...	...	GALEX
J00056+458	B	HD 38B	M0.0 V	00:05:40.90	+45:48:37.5	...	...	...	...	GALEX
J00077+603	-	G 217-032	M4.0 V	00:07:42.64	+60:22:54.3	...	...	...	...	GALEX
J00428+355	A	FF And	M1.0 V	00:42:48.21	+35:32:55.4	19.032	0.141	17.411	0.027	GALEX
J00570+450	-	G 172-030	M3.0 V	00:57:02.61	+45:05:09.0	...	...	...	...	GALEX
J01221+221	-	G 034-023	M4.5 V	01:22:10.28	+22:09:03.2	20.875	0.214	19.844	0.098	GALEX
J02026+105	A	RX J0202.4+1034	M4.5 V	02:02:28.24	+10:34:53.4	19.429	0.135	18.262	0.036	GALEX
J02070+496	-	G 173-037	M3.5 V	02:07:03.83	+49:38:44.1	21.665	0.435	20.302	0.141	GALEX
J02123+035	-	BD+02 348	M1.5 V	02:12:20.91	+03:34:31.1	...	...	19.736	0.069	GALEX
J02222+478	-	BD+47 612	M0.5 V	02:22:14.63	+47:52:48.1	...	...	...	...	GALEX
J02441+492	B	tet Per B	M1.5 V	02:44:10.25	+49:13:54.1	...	...	...	...	GALEX
J03133+047	-	CD Cet	M5.0 V	03:13:22.99	+04:46:29.4	...	...	21.970	0.388	GALEX
J03181+382	-	HD 275122	M1.5 V	03:18:07.42	+38:15:08.2	...	...	19.153	0.096	GALEX
J03463+262	-	HD 23453	M0.0 V	03:46:20.12	+26:12:56.0	21.392	0.388	18.292	0.051	GALEX
J03473-019	-	G 080-021	M3.5 V	03:47:23.33	-01:58:19.5	...	...	...	...	GALEX
J03480+686	-	BD+68 278B	M1.5 V	03:48:01.74	+68:40:38.9	...	...	...	...	GALEX
J03531+625	-	Ross 567	M3.0 V	03:53:10.42	+62:34:08.2	...	...	...	...	GALEX
J04225+105	-	LSPM J0422+1031	M3.5 V	04:22:31.99	+10:31:18.8	...	...	21.613	0.435	GALEX
J04376-110	-	BD-11 916	M1.5 V	04:37:41.88	-11:02:19.8	...	...	...	...	GALEX
J04429+214	-	2M J04425586+2128230	M3.5 V	04:42:55.86	+21:28:23.0	...	...	...	...	GALEX
J04488+100	-	1RXS J044847.6+100302	M3.0 V	04:48:47.39	+10:03:02.6	...	...	...	...	GALEX
J04588+498	-	BD+49 1280	M0.0 V	04:58:50.58	+49:50:57.3	...	...	18.279	0.045	GALEX
J05019+011	-	1RXS J050156.7+010845	M4.0 V	05:01:56.66	+01:08:42.9	...	...	...	...	GALEX
J05062+046	-	RX J0506.2+0439	M4.0 V	05:06:12.93	+04:39:27.2	...	...	...	...	GALEX
J05365+113	A	V2689 Ori	M0.0 V	05:36:30.99	+11:19:40.2	...	...	...	...	GALEX
J05366+112	B	2M J05363846+1117487	M4.0 V	05:36:38.47	+11:17:48.8	...	...	...	...	GALEX
J05415+534	B	HD 233153	M1.0 V	05:41:30.73	+53:29:23.9	20.605	0.226	18.391	0.024	GALEX
J05532+242	-	Ross 59	M1.5 V	05:53:14.04	+24:15:32.9	...	...	...	...	GALEX
J06371+175	-	HD 260655	M0.5 V	06:37:10.92	+17:33:52.7	...	...	...	...	GALEX
J00449-152	-	NLTT 2465	M4.5 V	00:44:59.31	-15:16:16.7	...	...	...	...	GALEX
J01048-181	-	GJ 1028	M5.0 V	01:04:53.69	-18:07:29.3	...	...	22.538	0.458	GALEX
J01125-169	-	YZ Cet	M4.5 V	01:12:30.53	-16:59:57.0	20.651	0.181	19.671	0.080	GALEX
J02033-212	-	G 272-145	M2.5 V	02:03:20.77	-21:13:42.7	...	...	...	...	GALEX
J03018-165S	B	BD-17 588 B	M3.5 V	03:01:51.43	-16:35:35.7	20.355	0.222	19.200	0.097	GALEX
J04352-161	-	LP 775-031	M7.0 V	04:35:16.13	-16:06:57.5	...	...	21.683	0.497	GALEX
J04538-177	-	GJ 180	M2.0 V	04:53:49.95	-17:46:23.5	...	...	...	...	GALEX
J05033-173	-	LP 779-046	M3.0 V	05:03:20.10	-17:22:24.5	...	...	...	...	GALEX
J05068-215E	A	BD-21 1074 A	M1.5 V	05:06:49.47	-21:35:03.8	...	...	...	...	GALEX
J06105-218	A	HD 42581 A	M0.5 V	06:10:34.62	-21:51:52.2	...	...	...	...	GALEX
J06574+740	-	2M J06572616+7405265	M4.0 V	06:57:26.16	+74:05:26.5	20.954	0.200	19.375	0.054	GALEX

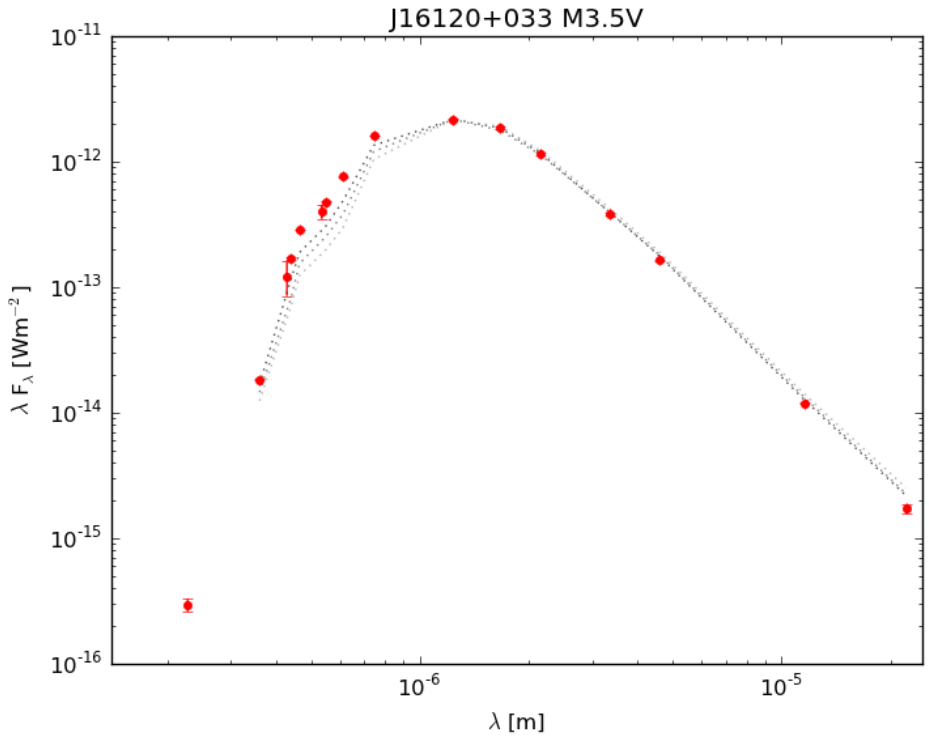
La elaboración de este fichero ha sido el objetivo y la tarea principal de este trabajo.

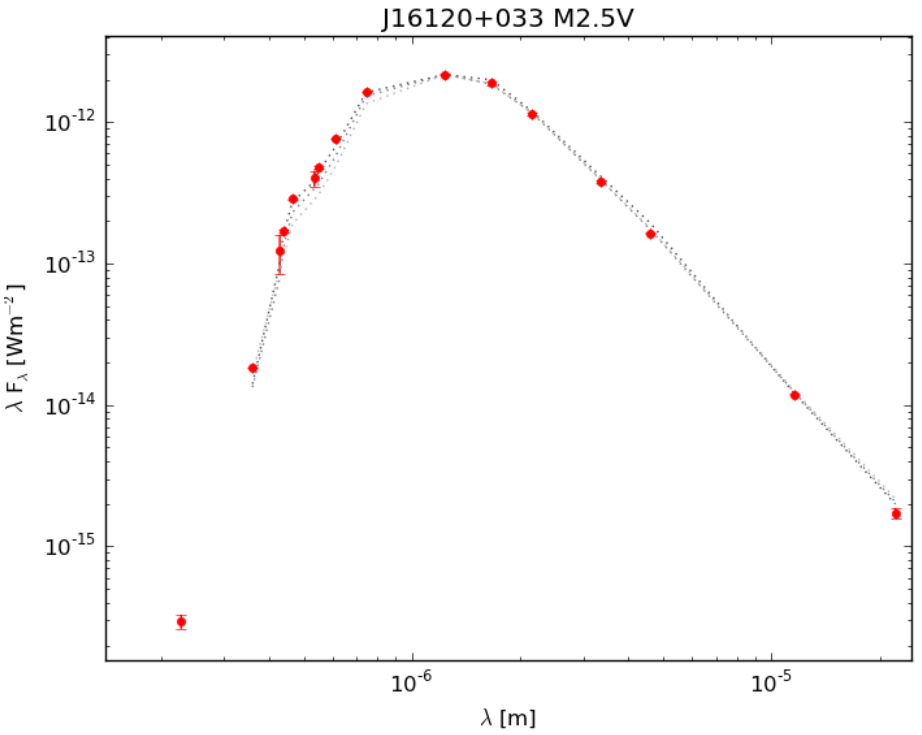
Análisis: Casos particulares y cambio de subtipo esp.

El proceso de limpieza individualizado ha permitido:

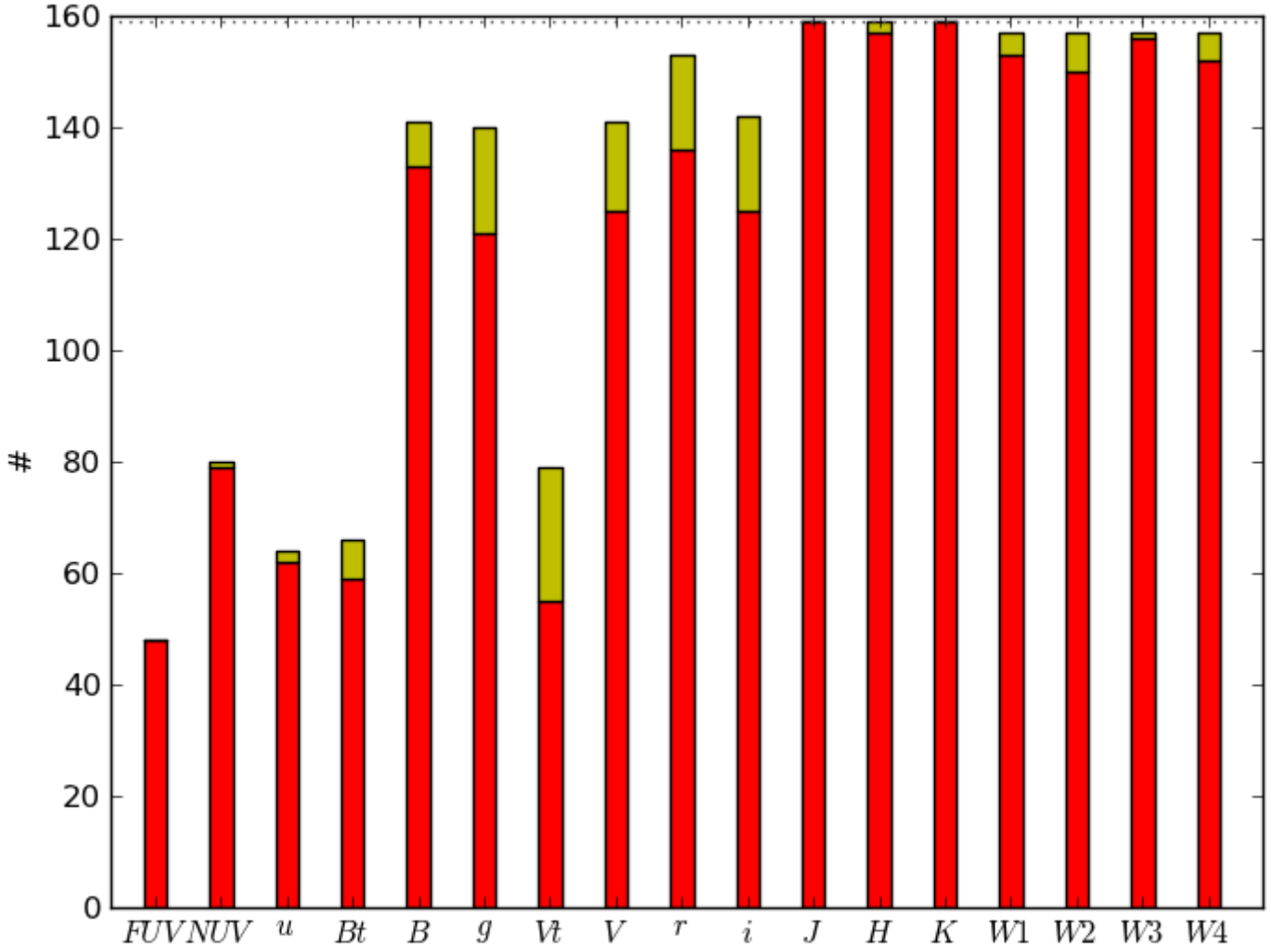
- Re-revisión de los datos
- Eliminar datos con avisos de mala calidad
- Posibles cambios espectrales, respecto al tipo espectral incluido en CARMENCITA

Análisis: TYC 371-1053-1

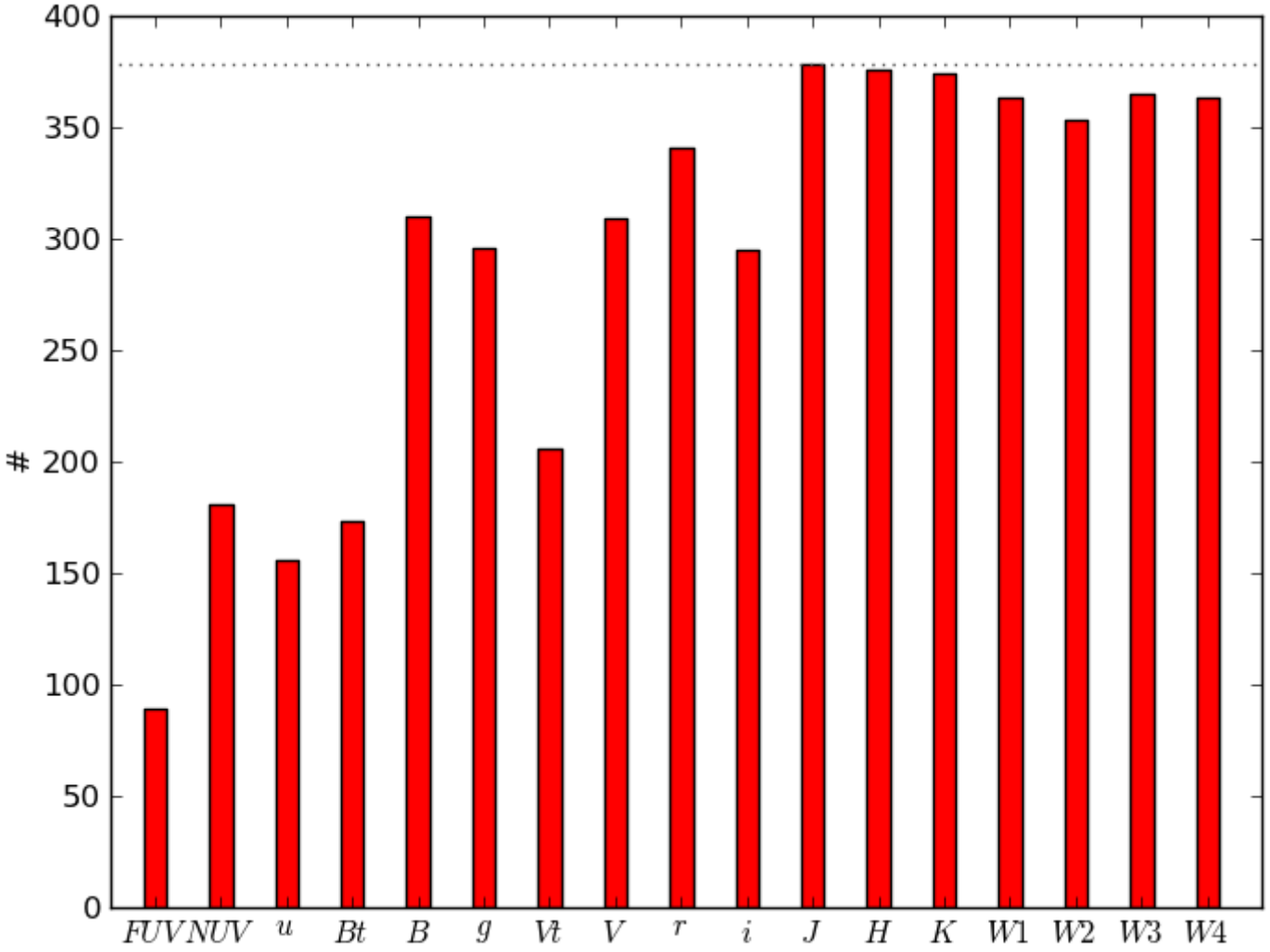




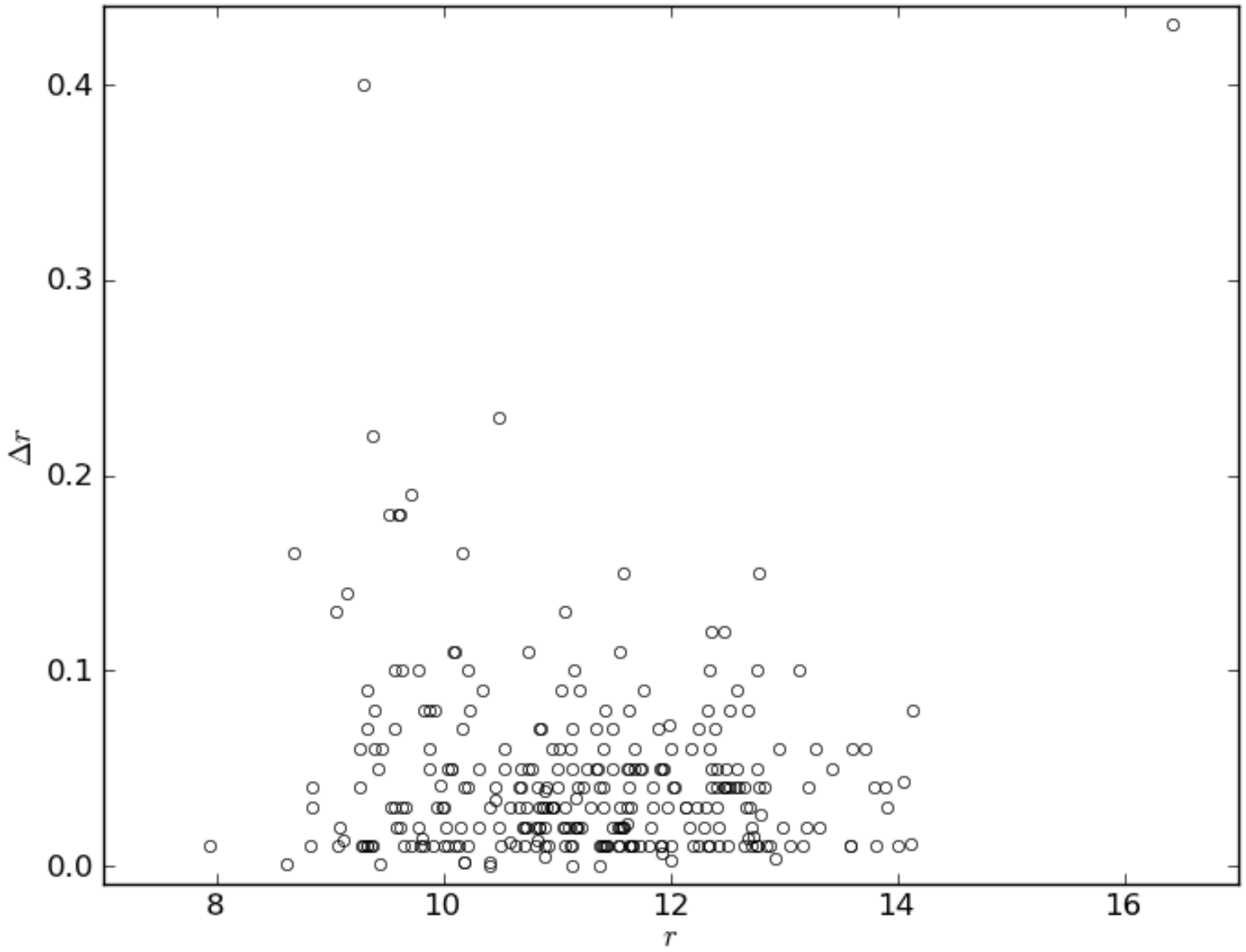
Resultados: Análisis de la limpieza



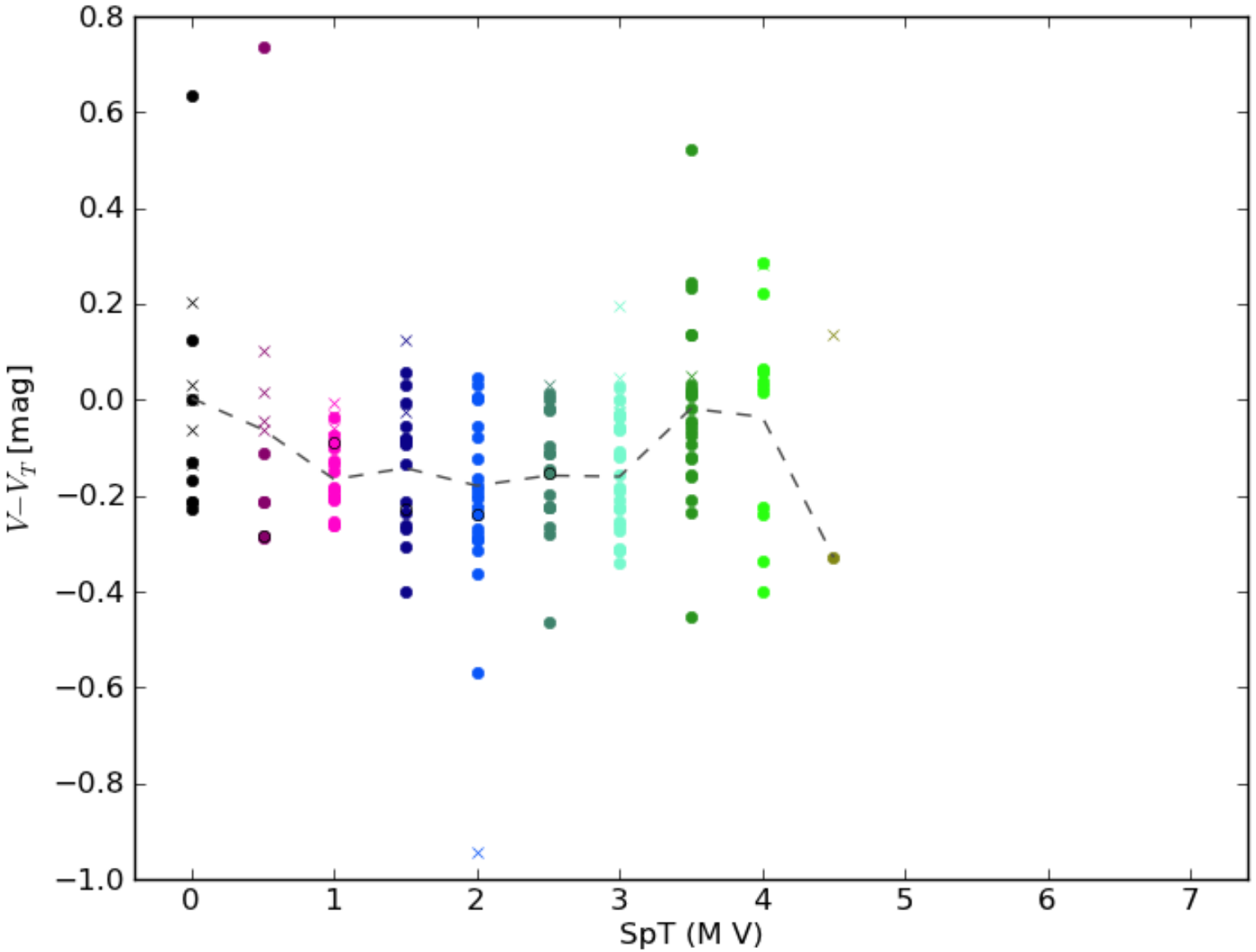
Resultados: Análisis de la limpieza



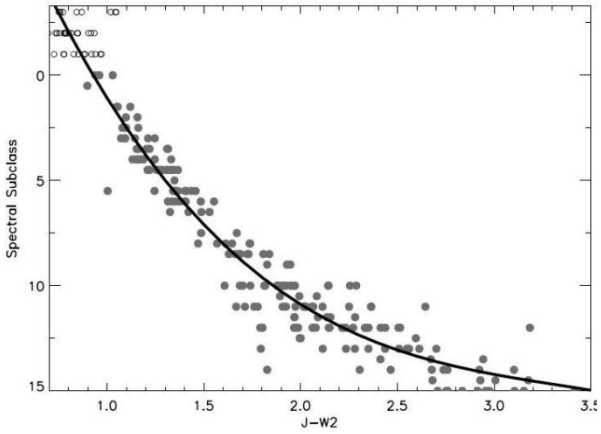
Resultados: Importancia de *r'*



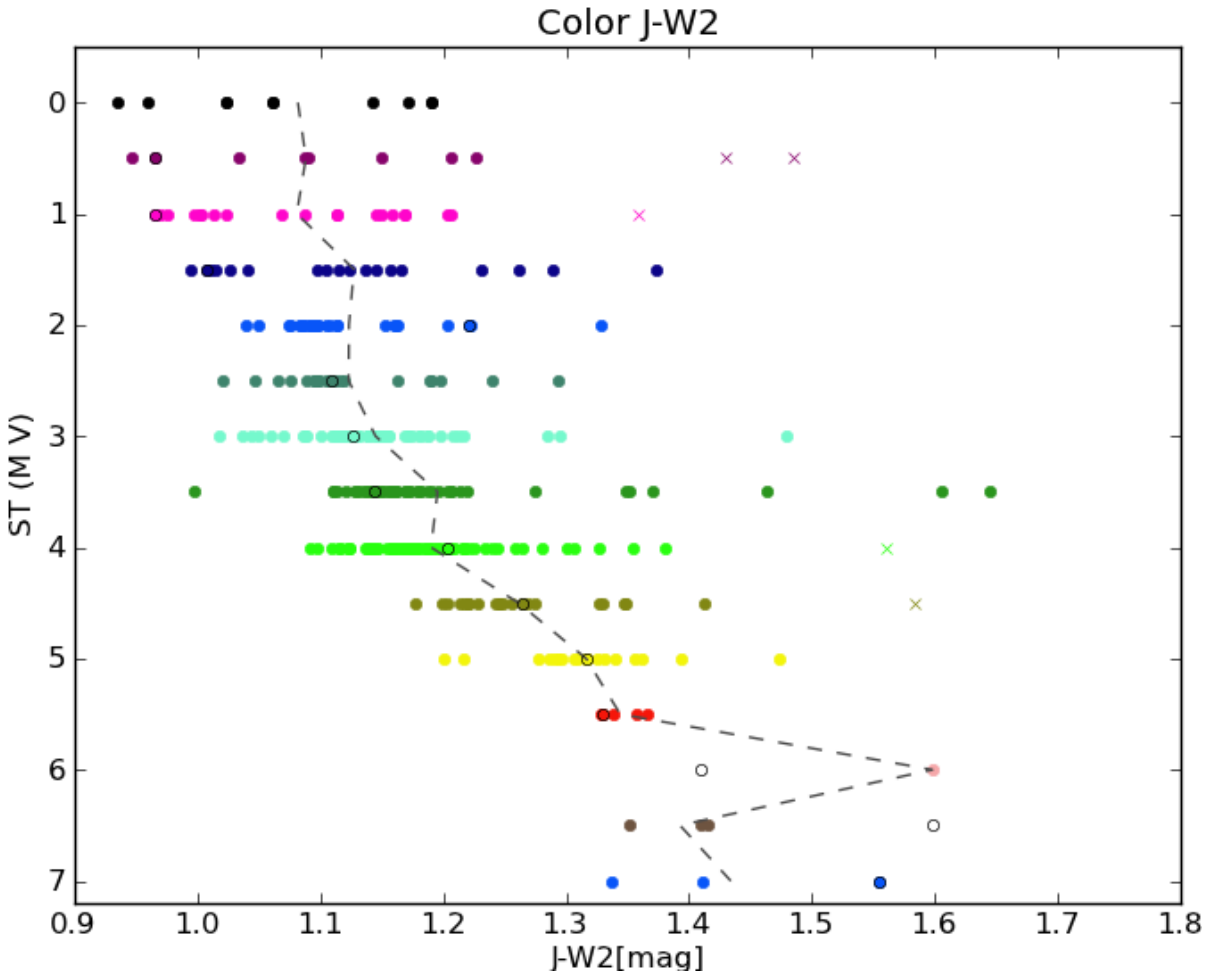
Resultados: Problemas con Tycho



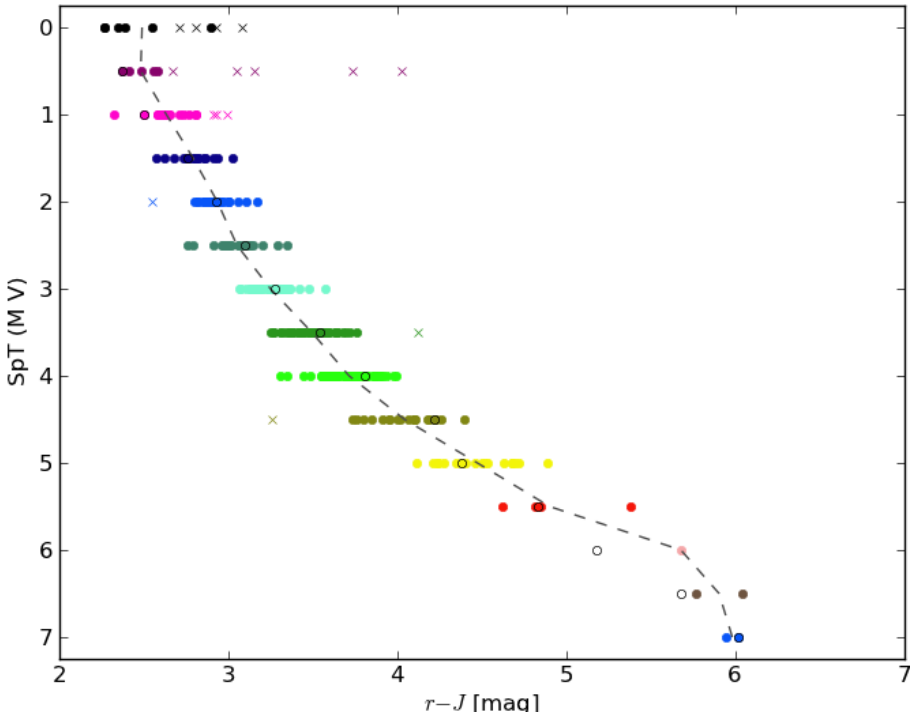
Resultados: Color como indicador espectral

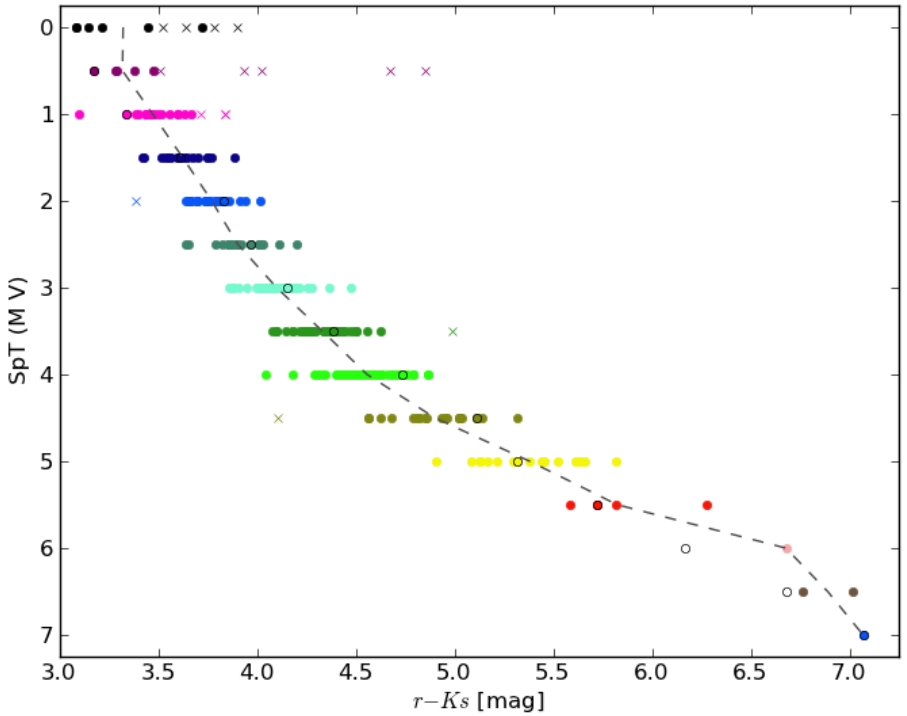


Kirkpatrick et al. (2011), los círculos representan estrellas K de Stauffer et al. (2010)



Resultados: Color como indicador espectral





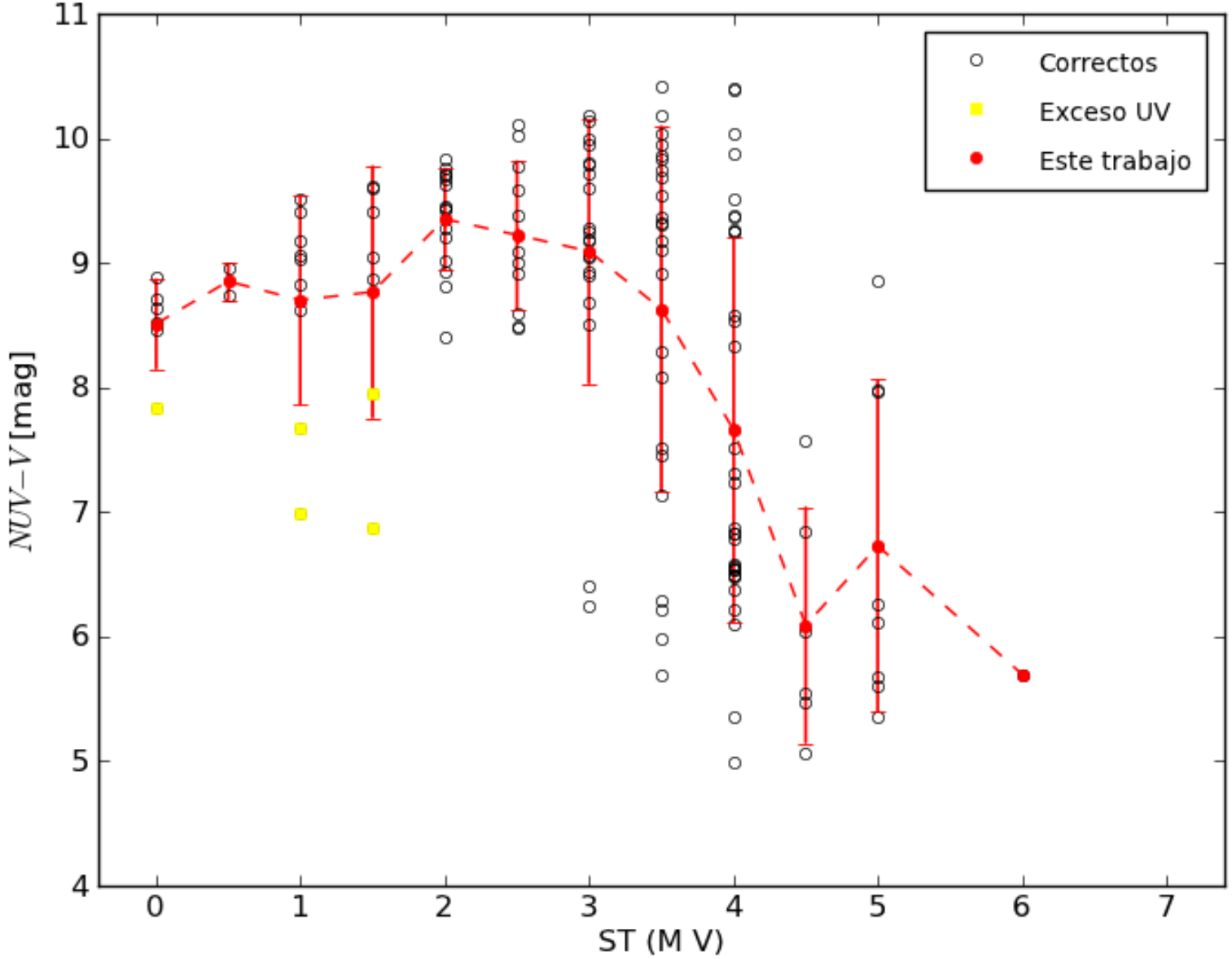
Resultados: Actividad, exceso UV

- Relación edad-actividad
  - Jóvenes → rápidas rotadoras → efecto dinamo → actividad

- Actividad → Emisión cromosférica en UV → FUV y NUV

- La actividad representa un inconveniente en las medidas de velocidad radial

Resultados: Actividad, exceso UV



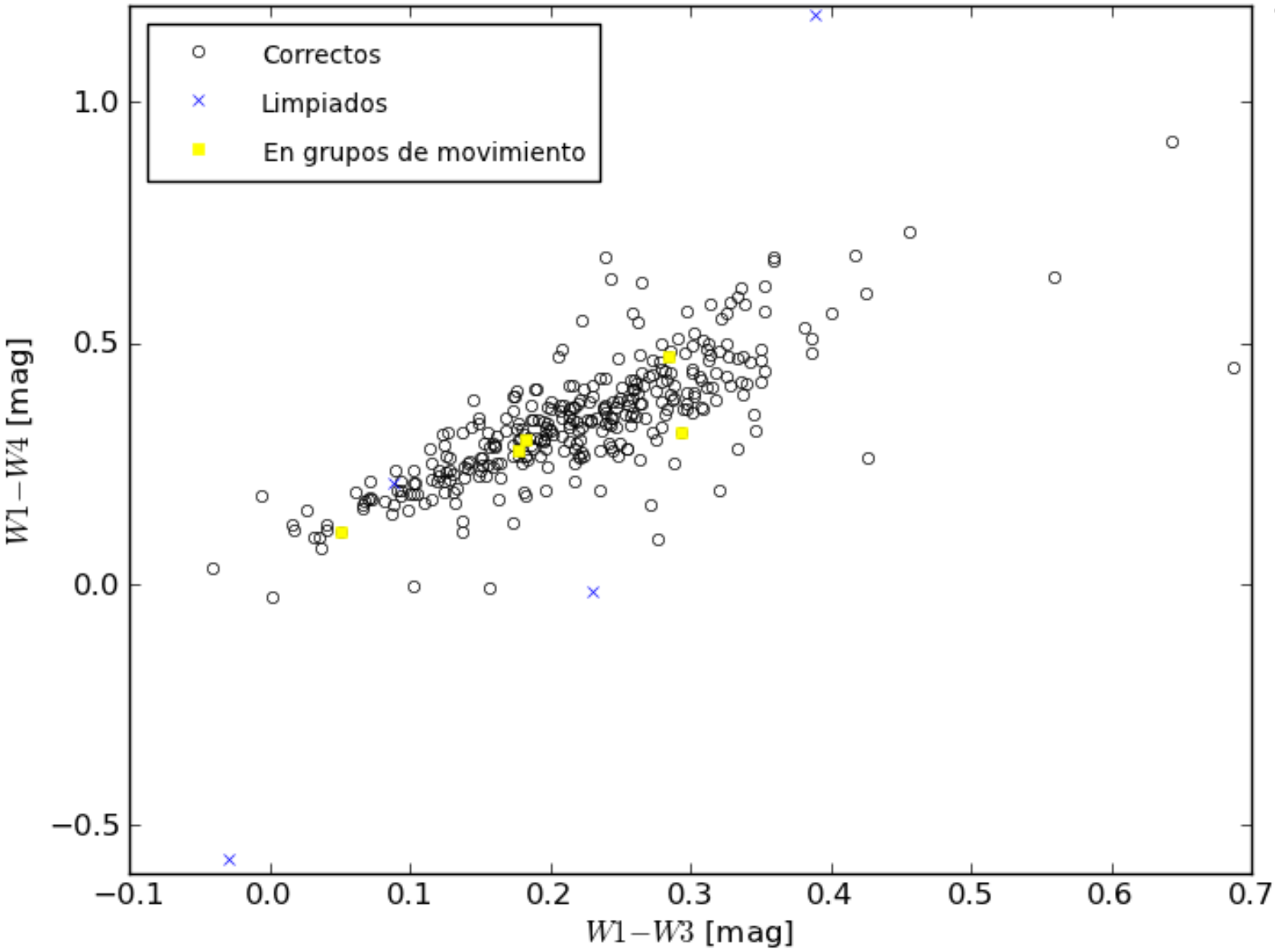
Resultados: Actividad, exceso UV

Estrellas con exceso UV → activas → ¿jóvenes?

Karmn	**Nombre**	**SpT** (MV)	$NUV - V$ [mag]	$pEW(\mathrm{H}\alpha)$ [Å]
J00428+355	FF And	1.0	6.983	-2.81
J09144+526	HD 79211	0.0	7.834	0
J09163-186	LP 787-52	1.5	7.957	0
J15218+209	OT Ser	1.5	6.873	-2.76
J21221+229	GSC 02187-00512	1.0	7.68	-0.43

Pseudo-anchura equivalente tabulada en CARMENCITA

Resultados: Exceso IR

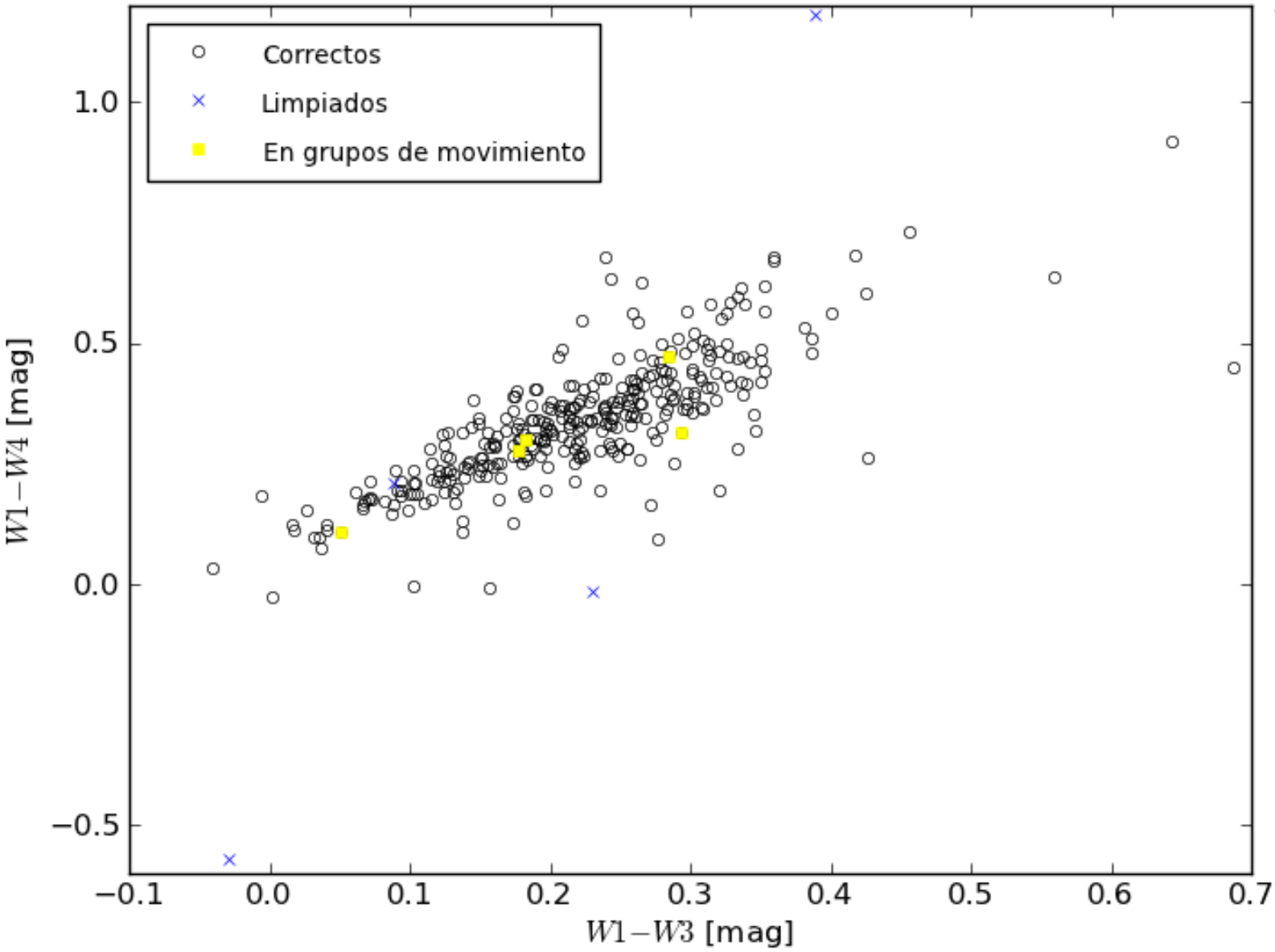


Resultados: Exceso IR

Estrellas en grupos de movimiento

Grupo de Movimiento Cúmulo	Karmn	Tipo esp.
TW Hydrae	J13196+333	M 1.5 V
	J13457+148	M 1.5 V
β Pictoris	J05019+011	M 4.0 V
	J21376+016	M 4.5 V
AB Doradus	J03473-019	M 3.5 V

Resultados: Exceso IR



Conclusiones

• Datos en *u'BB$_T$g'VV$_T$r'i'JHKsW1W2W3W4* para 158 estrellas tipo M y fotometría *FUV* y *NUV* de *GALEX* para 377 estrellas tipo M

• Limpieza individualizada de cada estrella y obtención de un fichero que se incluirá en CARMENCITA con datos muy completos, pero sobre todo precisos

• Un estudio de índices de color con una calidad única debida al tratamiento previo de los datos, ampliando y mejorando prácticamente todas las relaciones color-tipo espectral de enanas M publicadas hasta la fecha

• Identificación de posibles estrellas muy activas

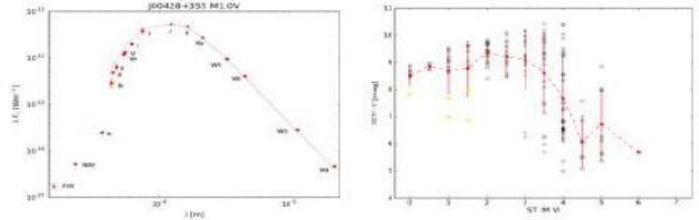
Preparation of the carmenes Input Catalogue

Mining public archives for stellar parameters and spectra of M dwarfs with master thesis students

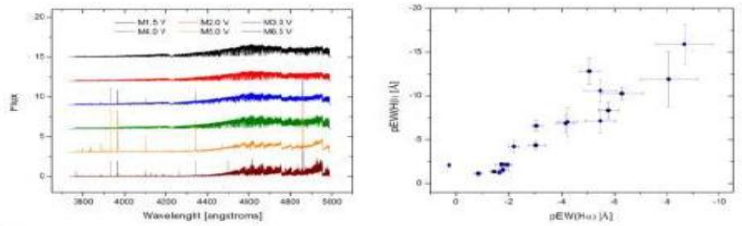
D. Montes[8], J. A. Caballero[10], F. J. Alonso-Floriano[8], M. Cortés-Contreras[8], E. González-Álvarez[8], D. Hidalgo[8], G. Holgado[8], H. Martínez-Rodríguez[8], J. Sanz-Forcada[10] and the CARMENES Consortium[1,2,3,4,5,6,7,8,9,10,11] (http://carmenes.caha.es/)

[1]Max-Planck-Institut für Astronomie • [2]Instituto de Astrofísica de Andalucía • [3]Landessternwarte Königstuhl • [4]Institut de Ciències de l'Espai • [5]Institut für Astrophysik Göttingen • [6]Instituto de Astrofísica de Canarias • [7]Thüringer Landessternwarte Tautenburg • [8]**Universidad Complutense de Madrid** • [9]Hamburger Sternwarte • [10]Centro de Astrobiología • [11]Centro Astronómico Hispano-Alemán – Calar Alto Observatory

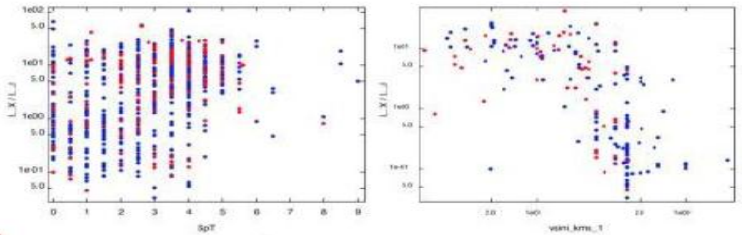
We are compiling the most comprehensive database of M dwarfs ever built, CARMENCITA, the **CARMENES Cool dwarf Information and daTa Archive**, which will be the CARMENES 'input catalogue'. In addition to the science preparation with low- and high-resolution spectrographs and lucky imagers (see the other posters at Cool Stars 18), we compile a huge pile of public data on over 2100 M dwarfs, and analyze them, mostly using virtual-observatory tools. Here we describe four specific actions carried out by *master students*. They mine public archives for additional high-resolution spectroscopy (UVES, FEROS and HARPS), multi-band photometry (*FUV-NUV-u-B-g-V-r-R-i-J-H-Ks-W1-W2-W3-W4*), X-ray data (*ROSAT*, *XMM-Newton* and *Chandra*), and periods, rotational velocities and Hα pseudo-equivalent widths. As described, there are many interdependences between all these data.



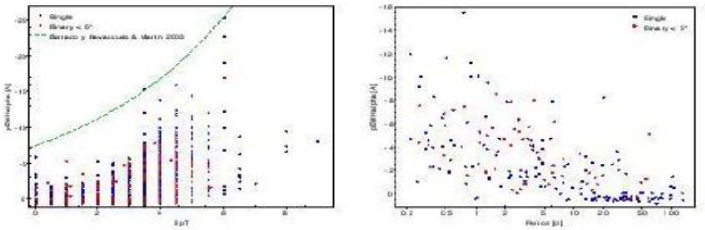
Photometry. *Holgado* compiled photometric data from *GALEX*, SDSS, Tycho-2, UCAC4, CMC14, 2MASS and *WISE* archives for constructing cleansed spectral energy distributions of 158 CARMENCITA stars (*left panel*: SED of FF And) and studying colour-colour relations of 361 bright, late-type, single M dwarfs that surpasses previous works. He also quantified the ultraviolet-excess emission and identified active early M dwarfs (*right panel*: *NUV-FUV* vs. spectral type).



High-resolution spectroscopy. *Martínez-Rodríguez* downloaded 128 UVES spectra of 61 CARMENCITA stars in eight channels (*left panel*: BLU437) and measured pseudo-equivalent widths of Hα–η, Ca II H&K, Na I D1&2 and He I D3. He measured *pEW*(Hα) of 27 M dwarfs for the first time and studied its relation to other lines in emission (right panel: *pEW*(Hβ) vs. *pEW*(Hα)). He also measured *vsini* of 24 stars (7 new) and identified wrong values published in the literature.



X-ray emission. *González-Álvarez* added new X-ray count-rate and hardness-ratio data of 188 M dwarfs to CARMENCITA. She calculated X-ray fluxes and luminosity ratios L_X/L_J for 770 stars in total and investigated its variation with spectral type (*left panel*) and rotational velocity (*right panel*). She corroborated with a large sample that close binaries (red dots) are more active than single stars and that X-ray saturation starts at *vsini* ≈ 5 km/s.



Rotation and activity. *Hidalgo* ransacked dozens of publications and compiled photometric periods for 217 CARMENCITA stars, rotational velocities for 420, pEW(Hα)s for 1766, and membership in young moving groups for 44. He studied the relation between spectral type, Hα activity (*left panel*), close multiplicity, periods (*right panel*) and *vsini*, from where he identified three stars with inclination angles *i* = 79.3 to 81.6 deg: DT Vir AB, BD-21 1074 A and FF And.

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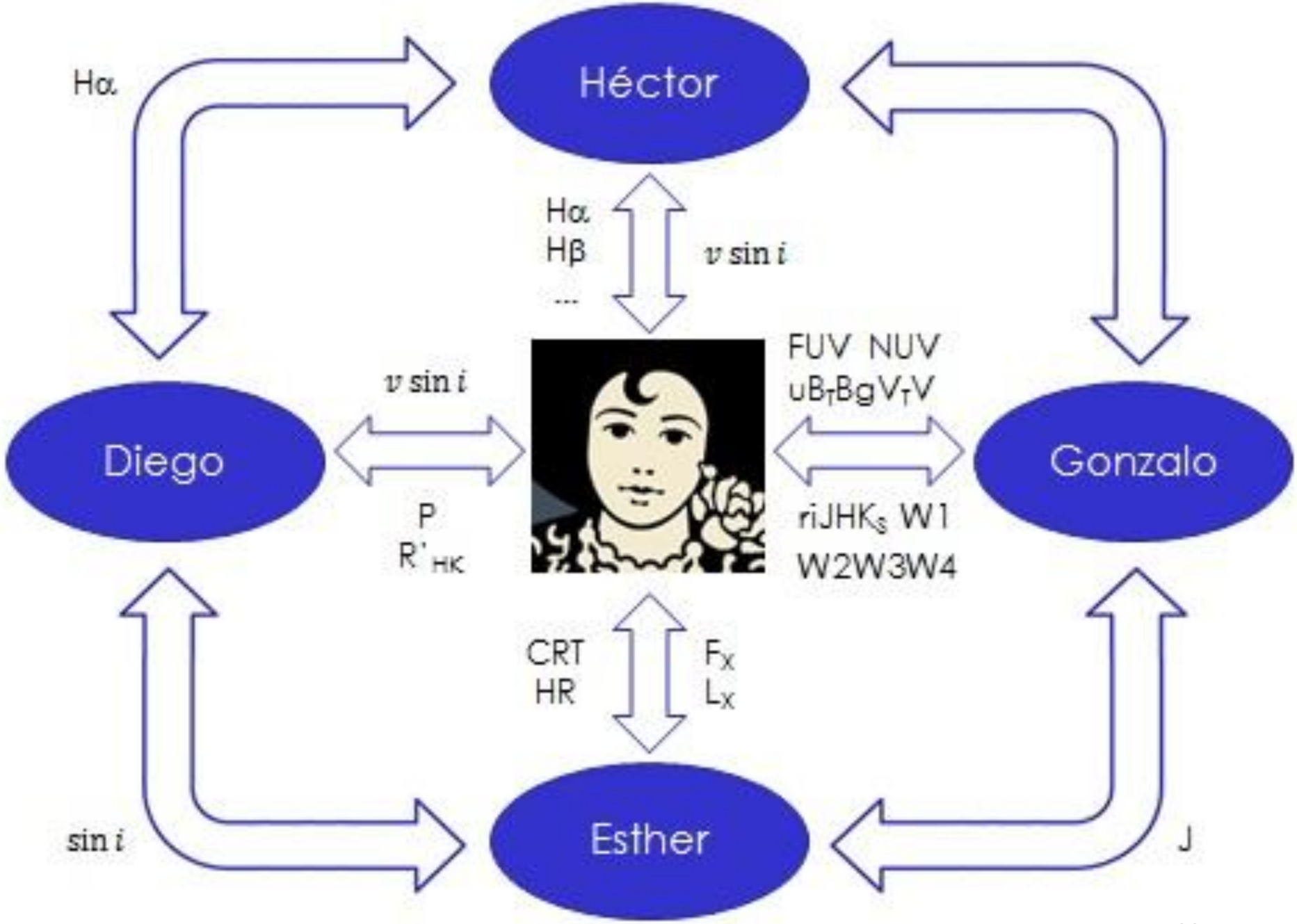
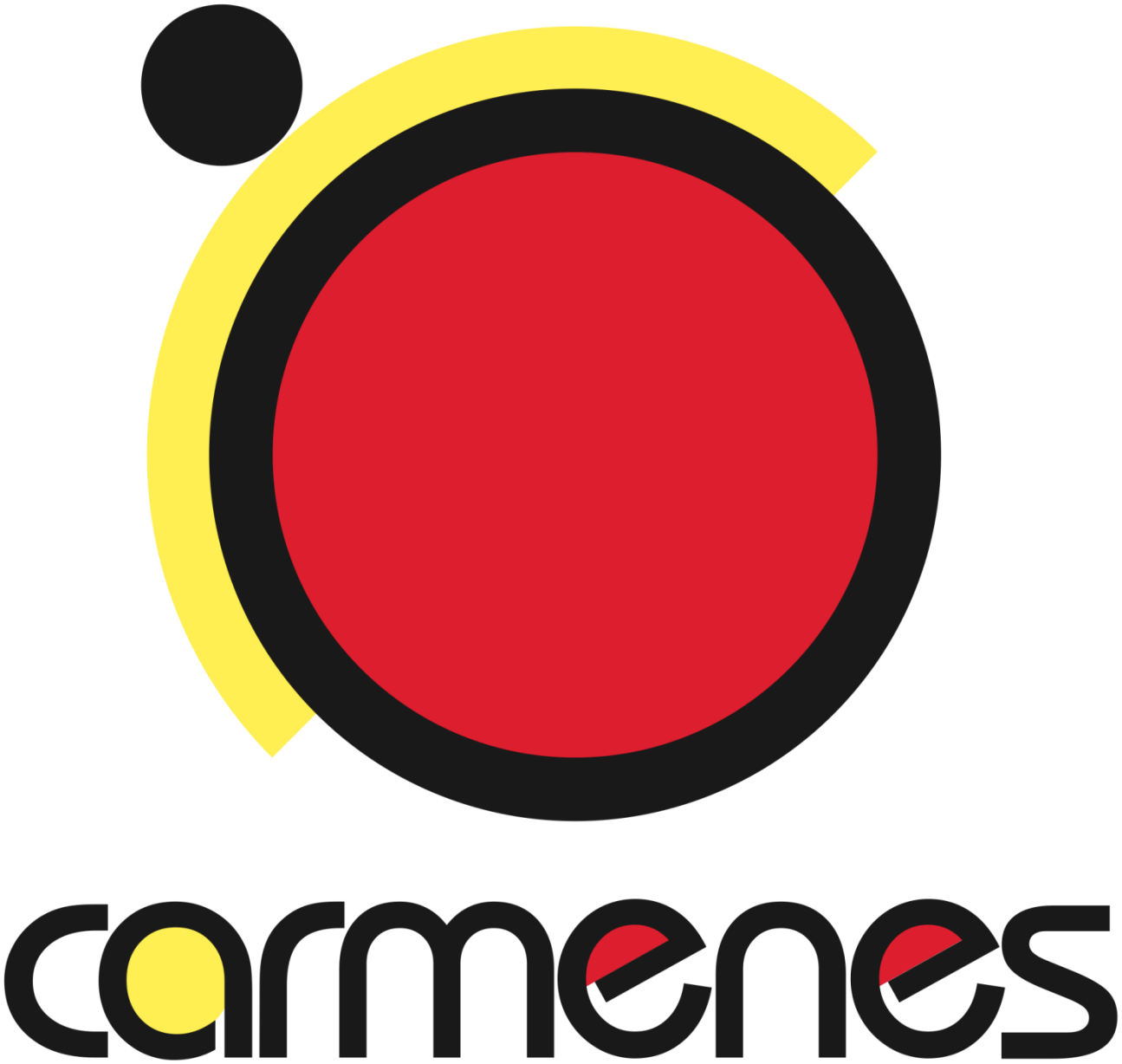
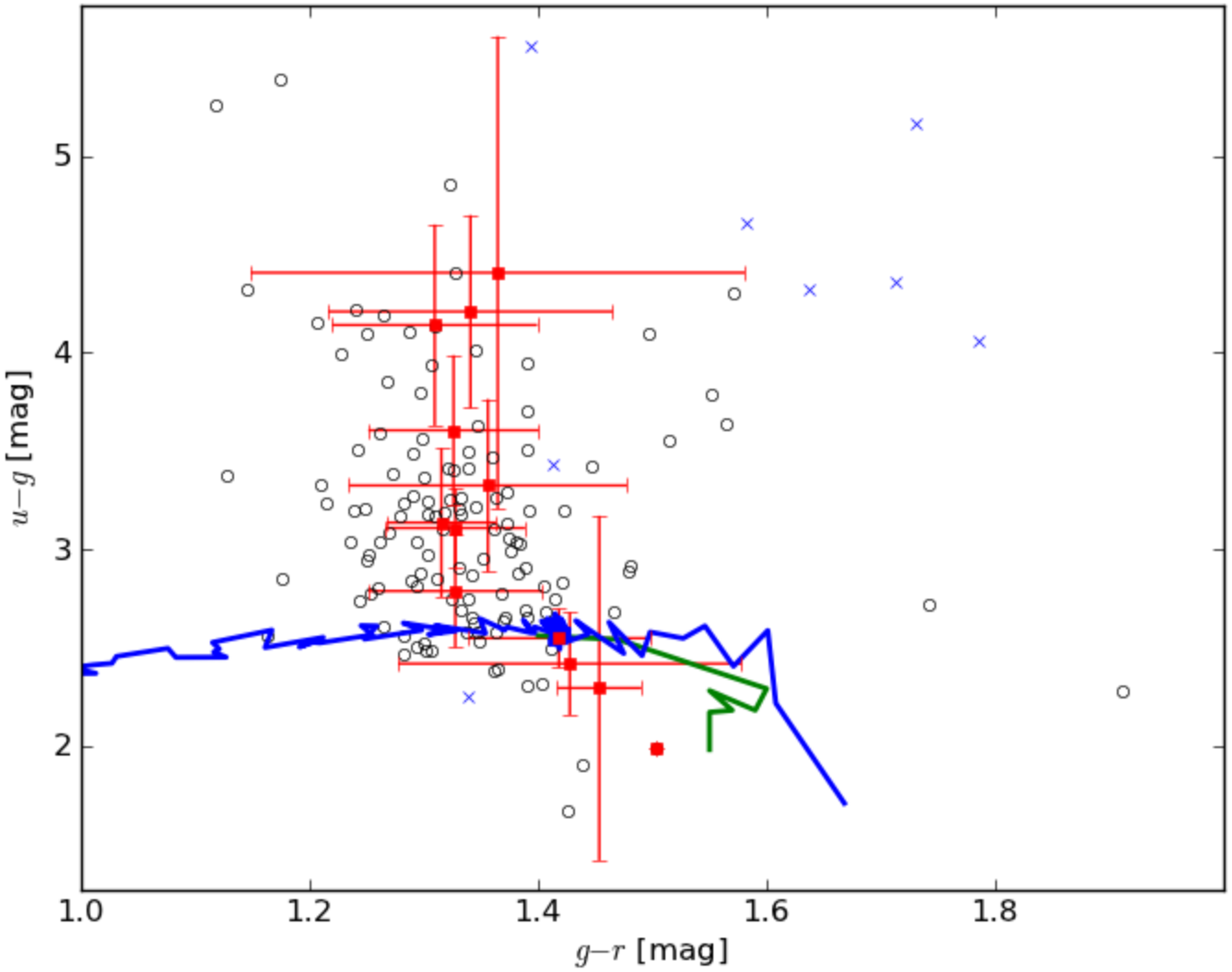
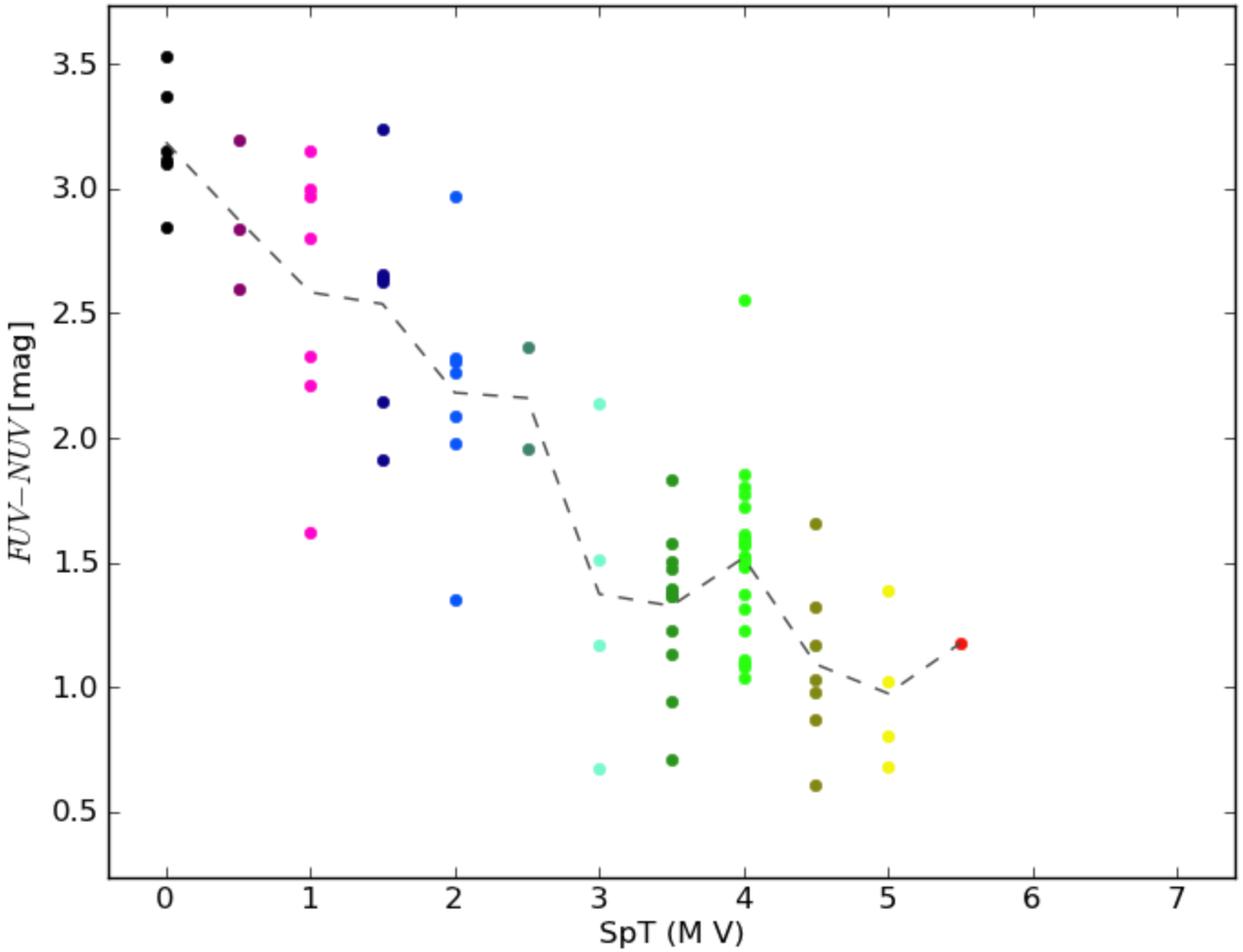
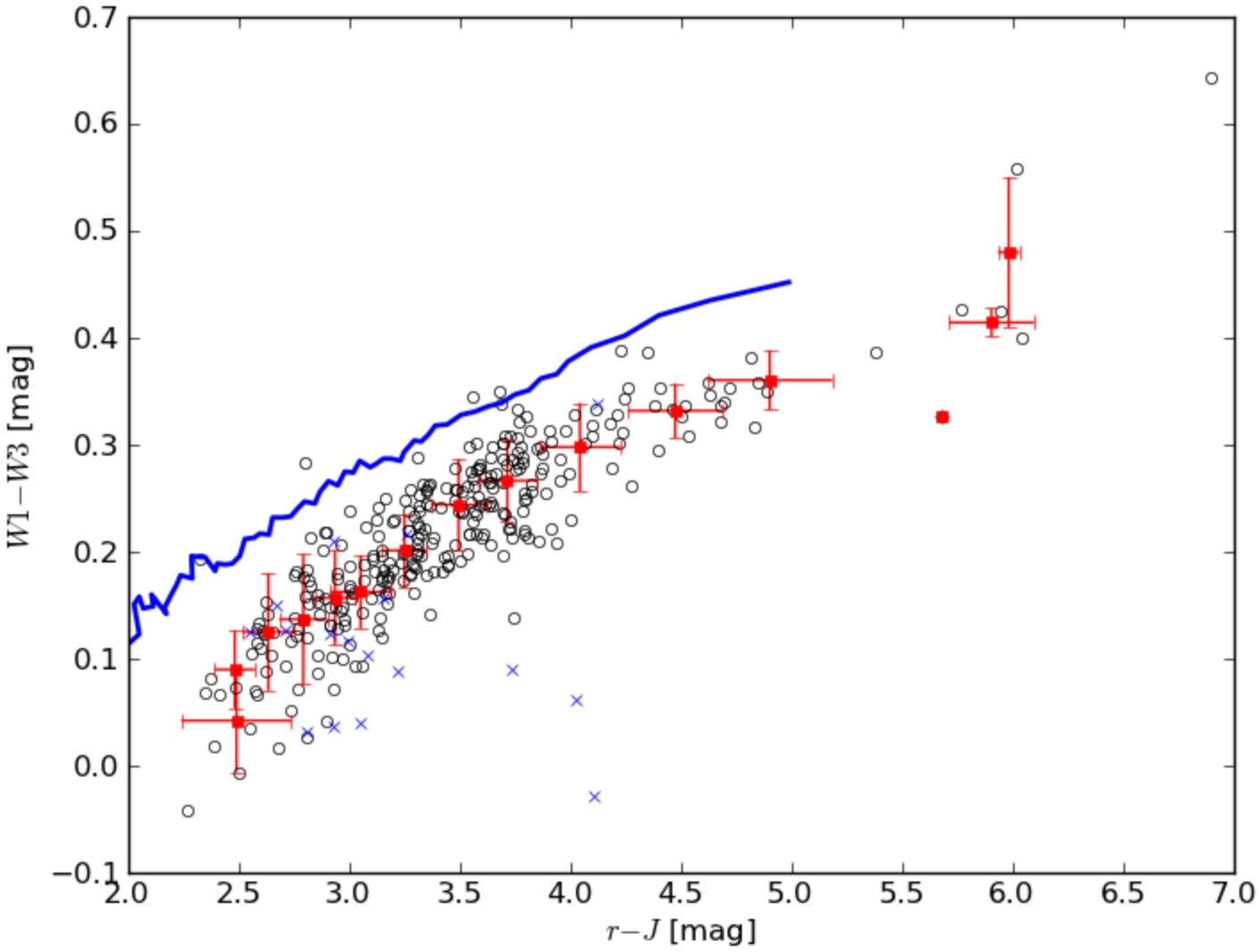
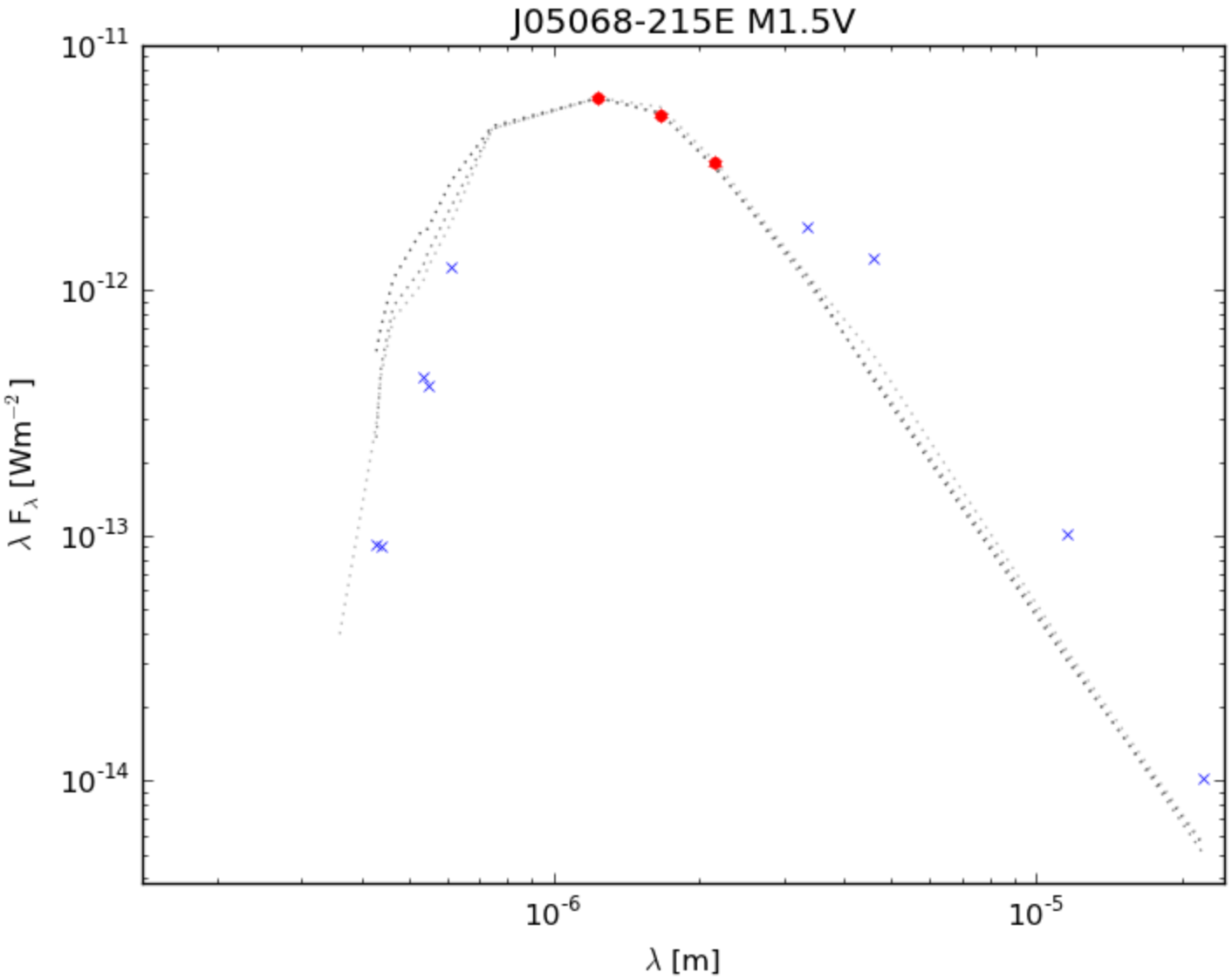

Héctor
Hα
Hα
Hβ
...
v sin i
FUV NUV
uBTBgVTV
v sin i
Diego
Gonzalo
P
R'HK
riJHKs W1
W2W3W4
CRT
HR
FX
LX
sin i
Esther
J
http://carmenes.cab.es/ext/armada/

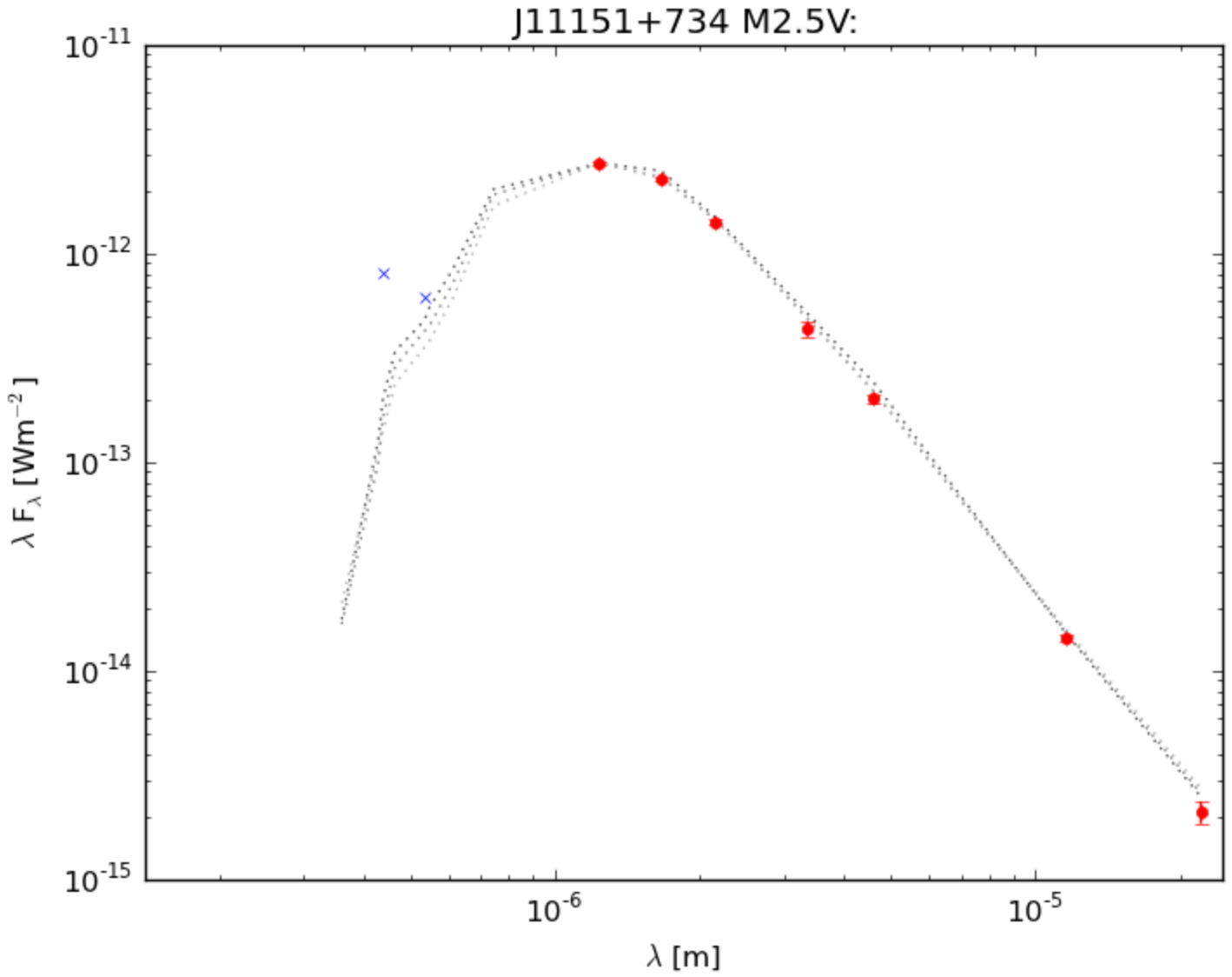

carmenes

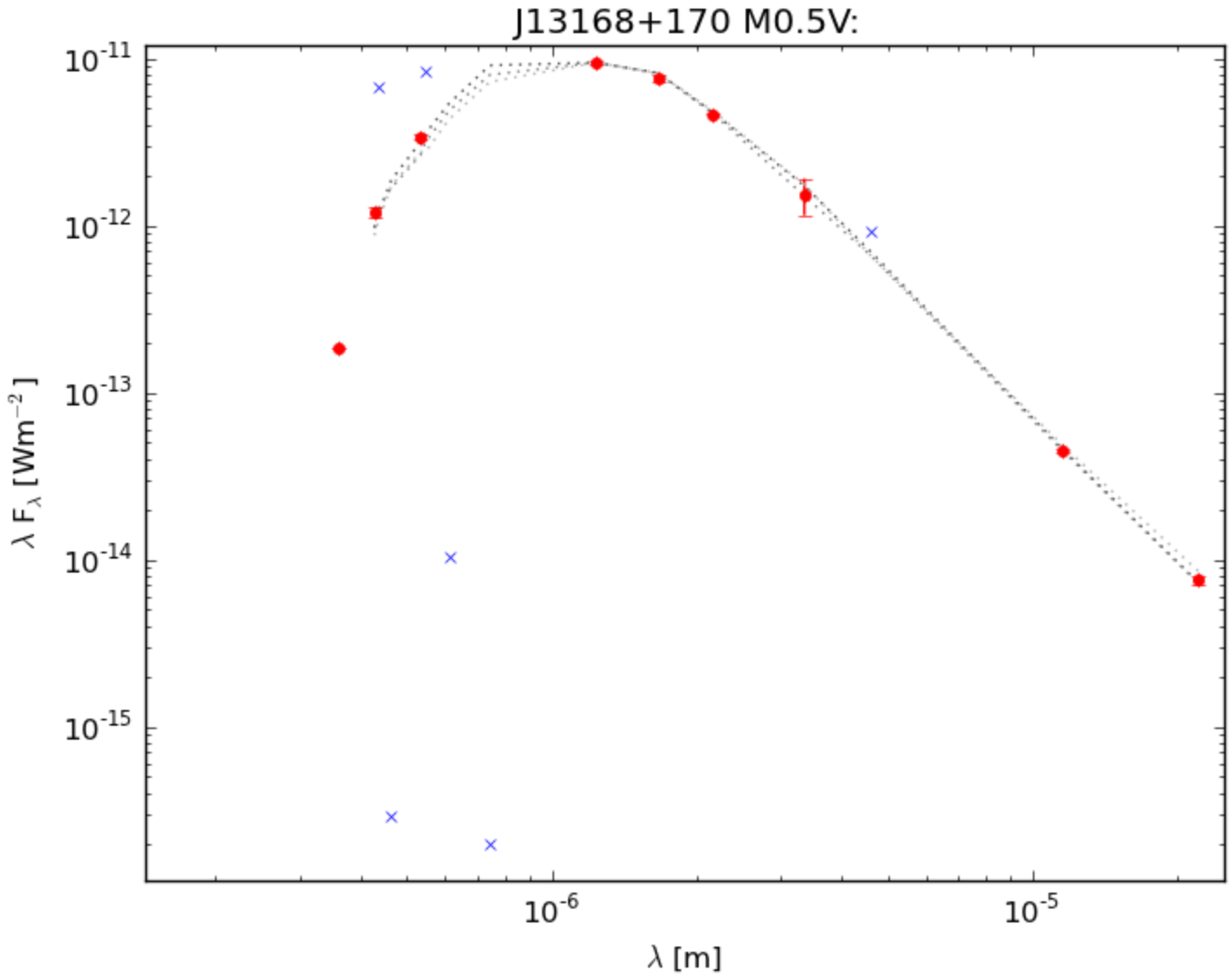

5
4
3
2
1.0
1.2
1.4
1.6
1.8
$u-g$ [mag]
$g-r$ [mag]

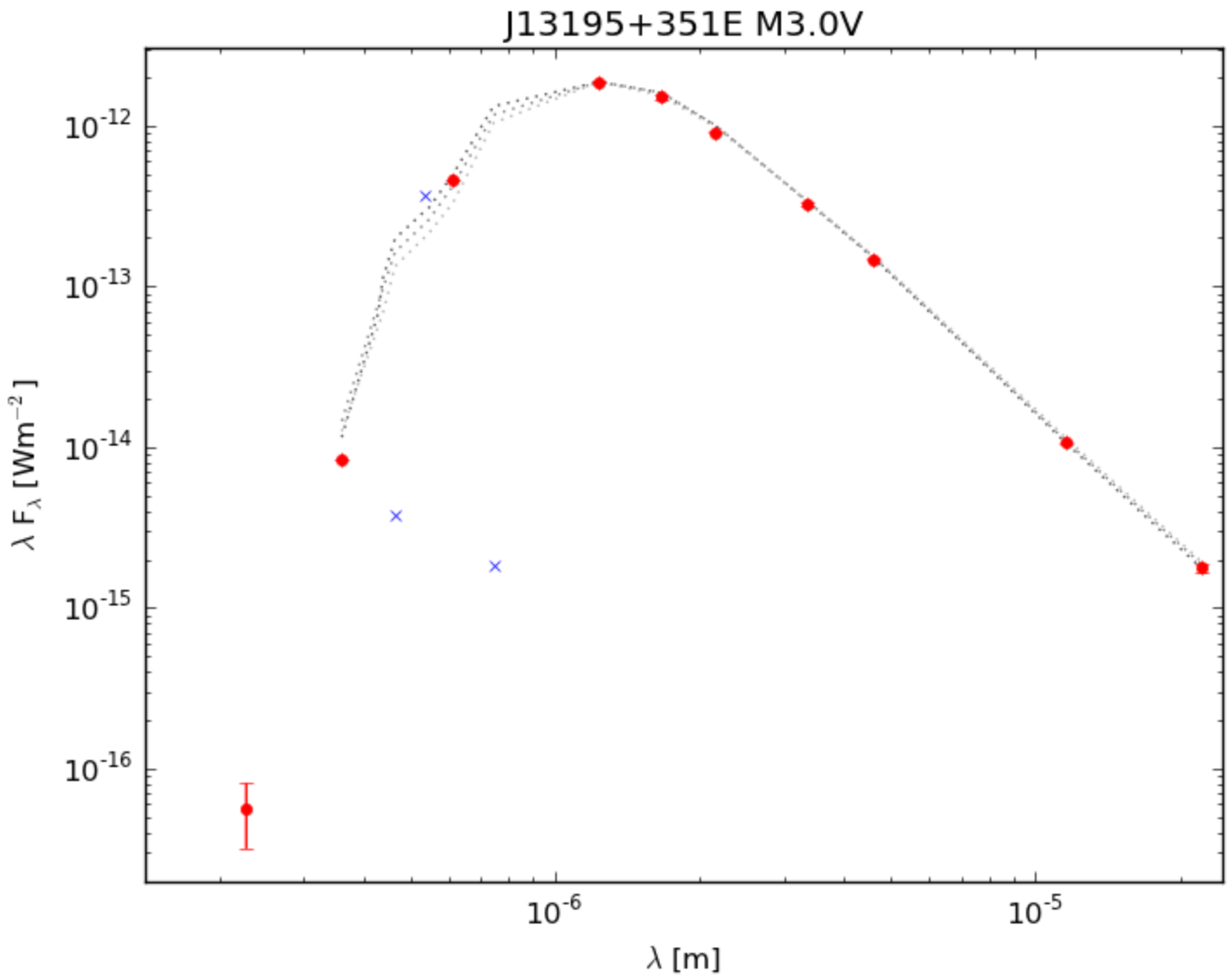

3.5
3.0
2.5
2.0
1.5
1.0
0.5
FUV−NUV [mag]
0
1
2
3
4
5
6
7
SpT (M V)


0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
$W1-W3$ [mag]
$r-J$ [mag]

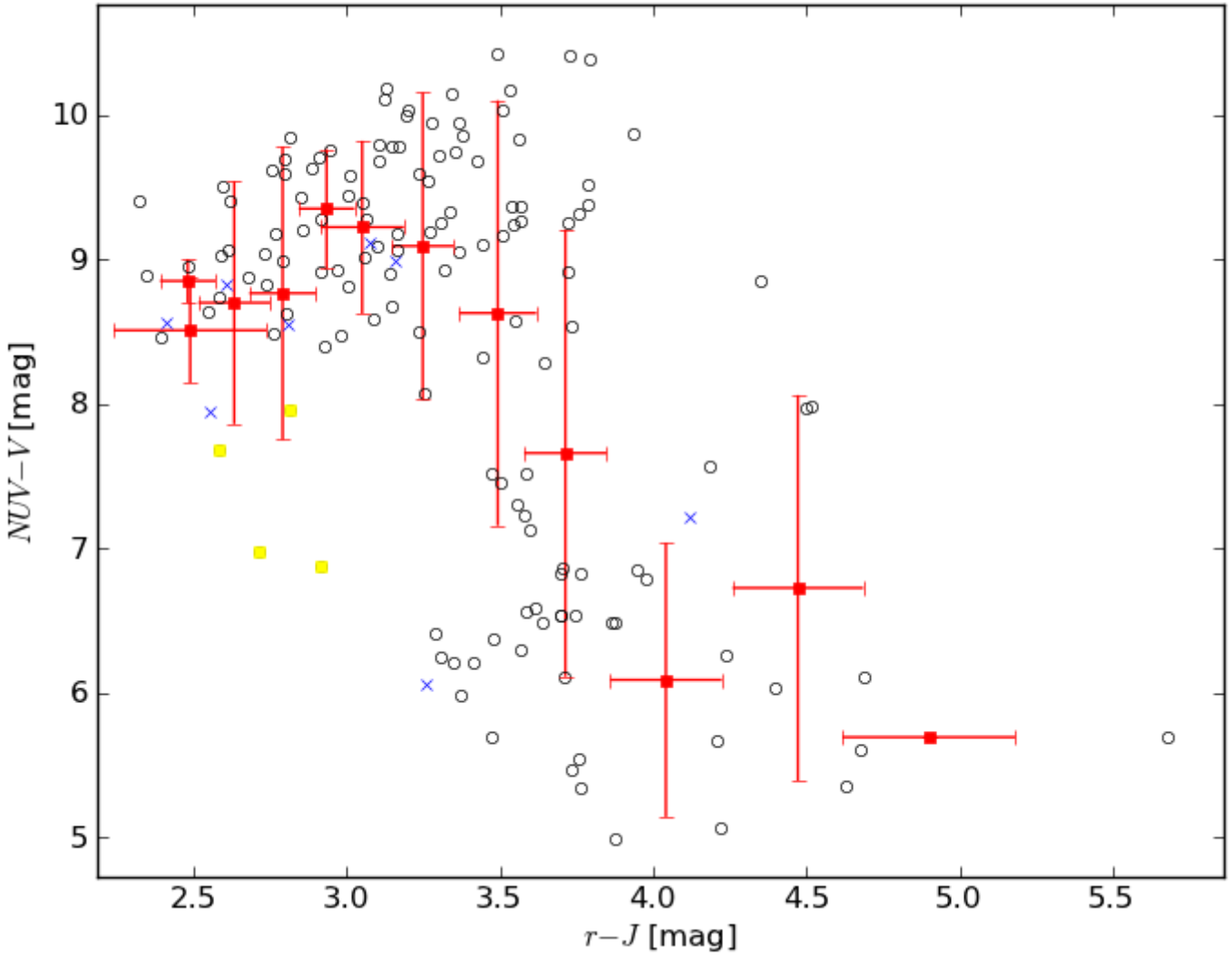

J05068-215E M1.5V
10^{-11}
10^{-12}
10^{-13}
10^{-14}
λF_λ [Wm^{-2}]
10^{-6}
10^{-5}
λ [m]

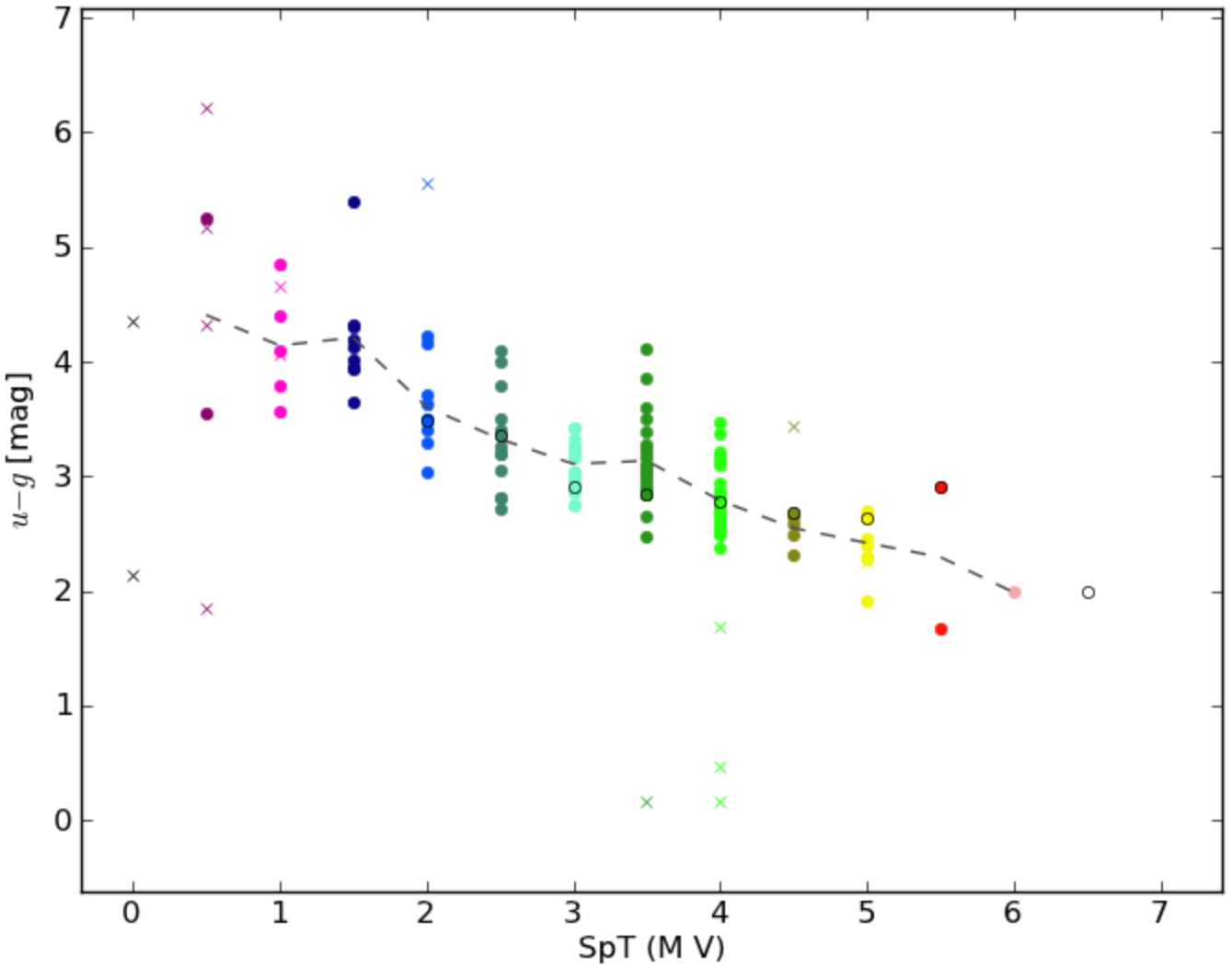

J11151+734 M2.5V:
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
λF_λ [Wm^{-2}]
10^{-6}
10^{-5}
λ [m]

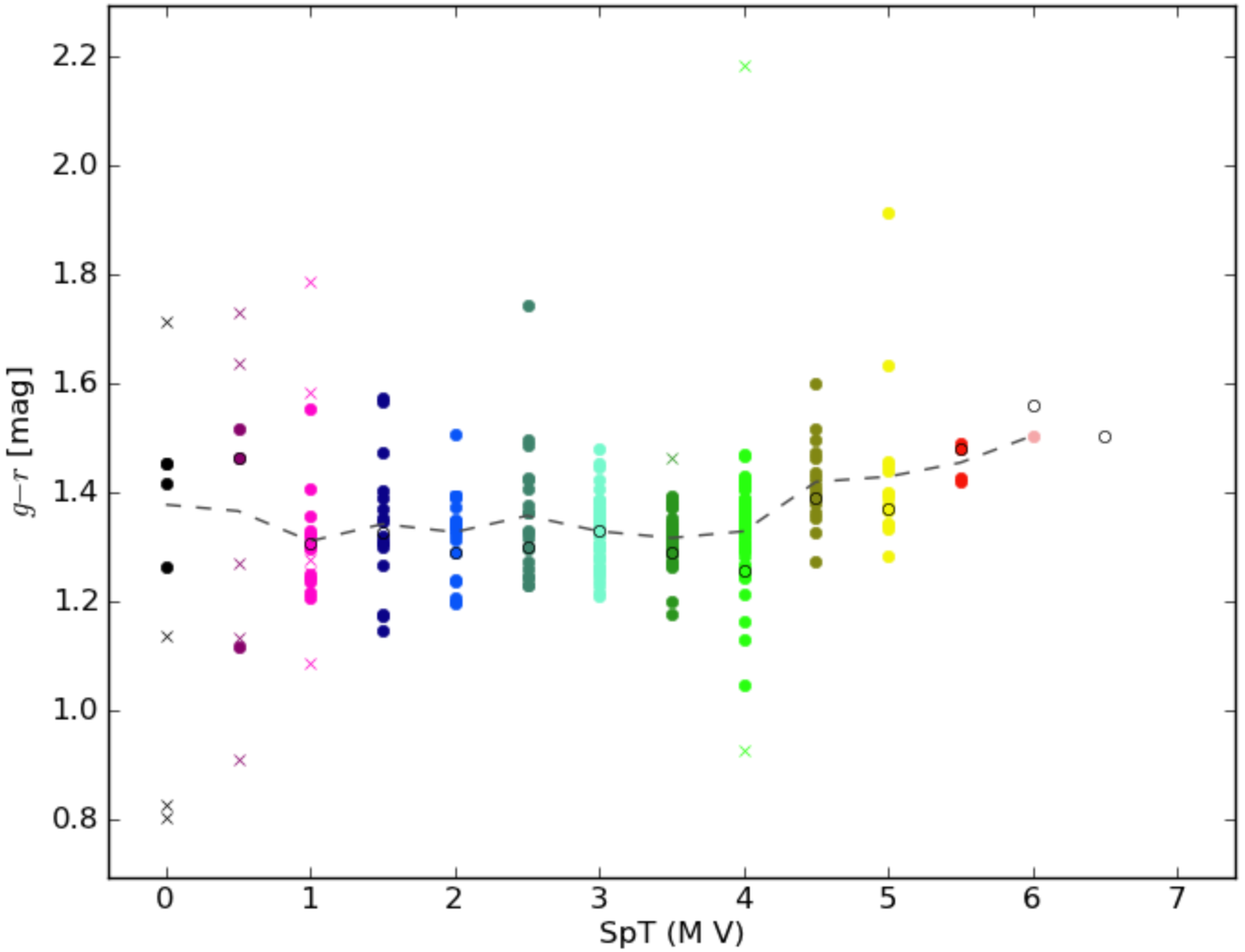

J13168+170 M0.5V:
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
λF_λ [Wm^{-2}]
10^{-6}
10^{-5}
λ [m]

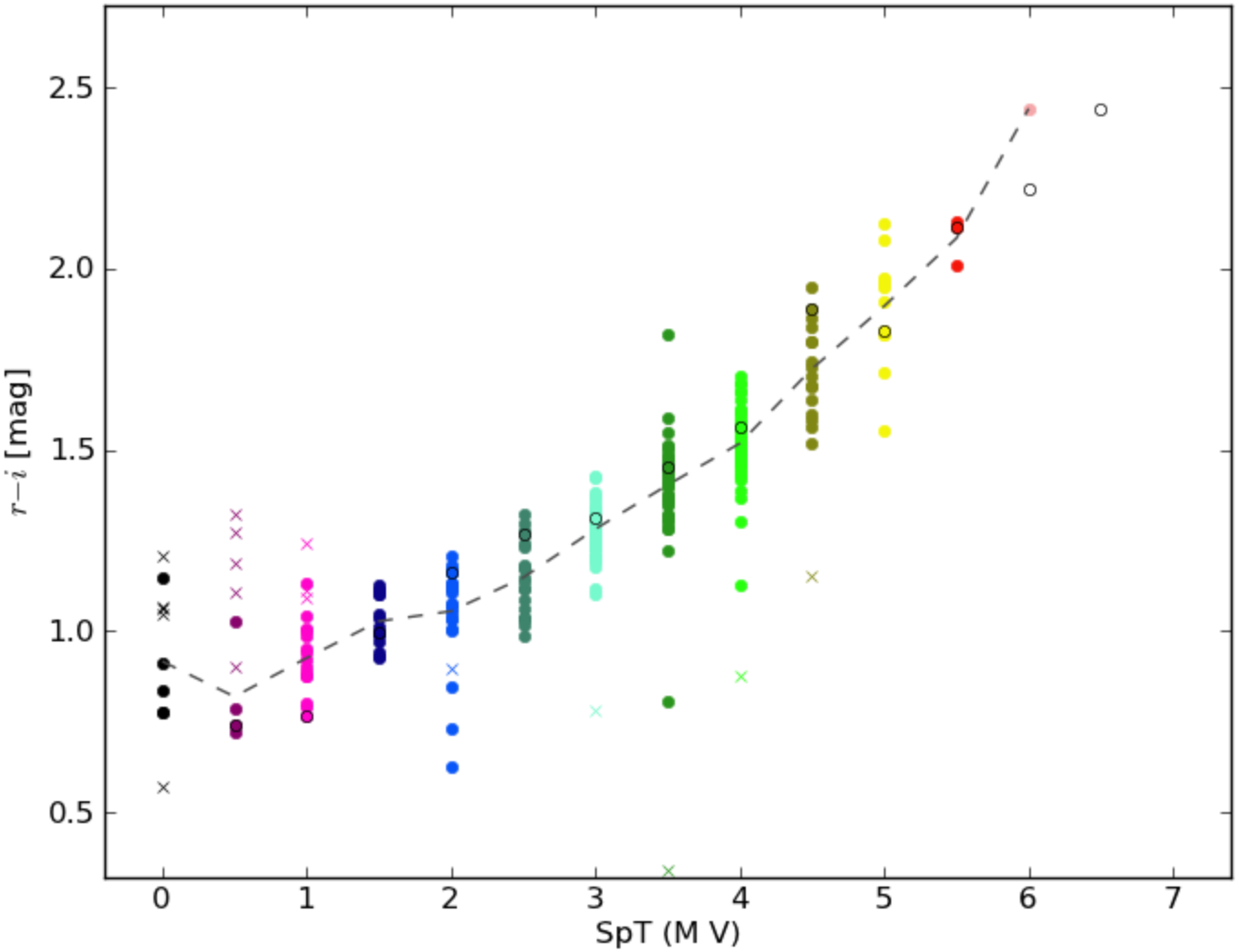

J13195+351E M3.0V
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
λF_λ [Wm^{-2}]
10^{-6}
10^{-5}
λ [m]

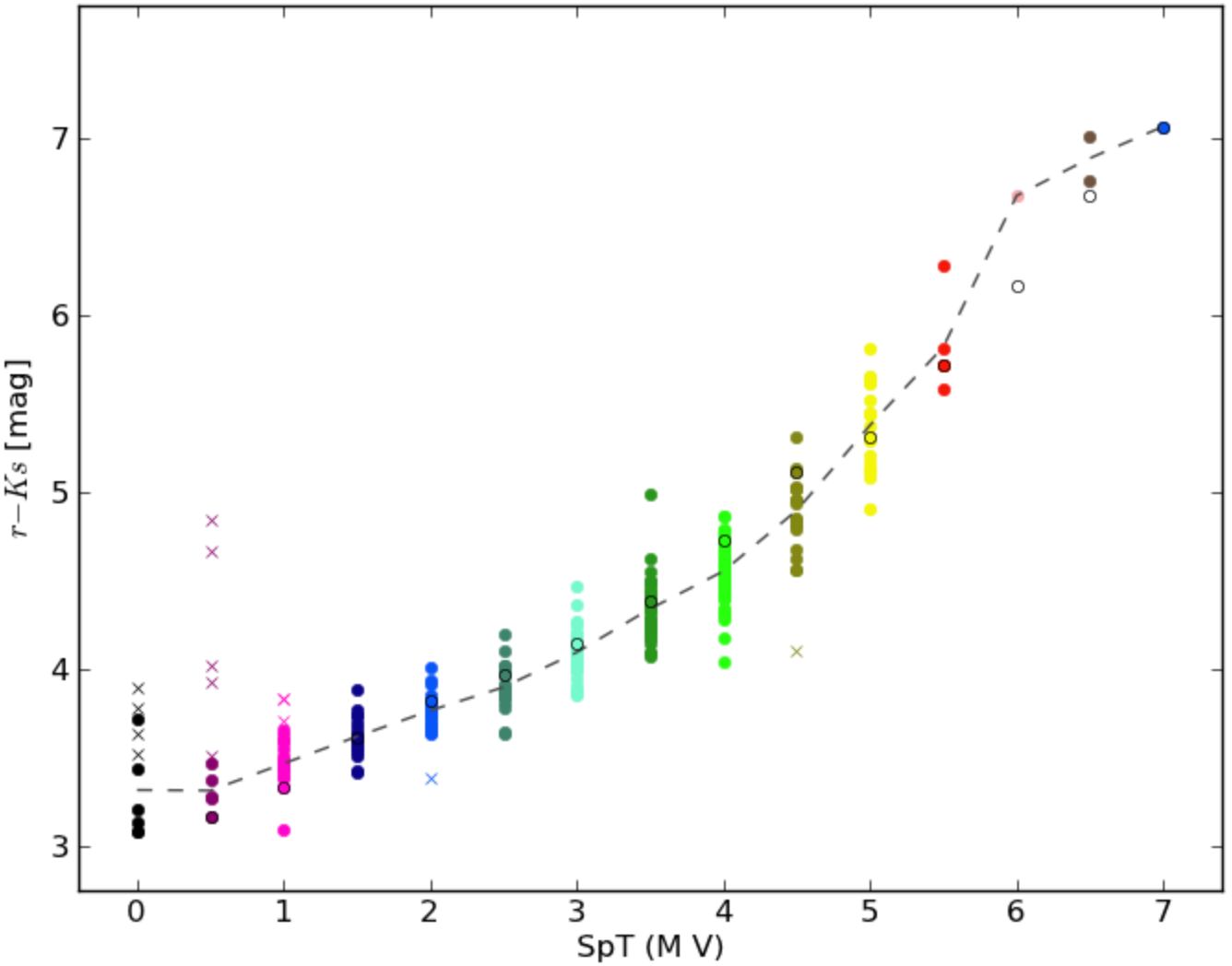
Resultados: Actividad, exceso UV

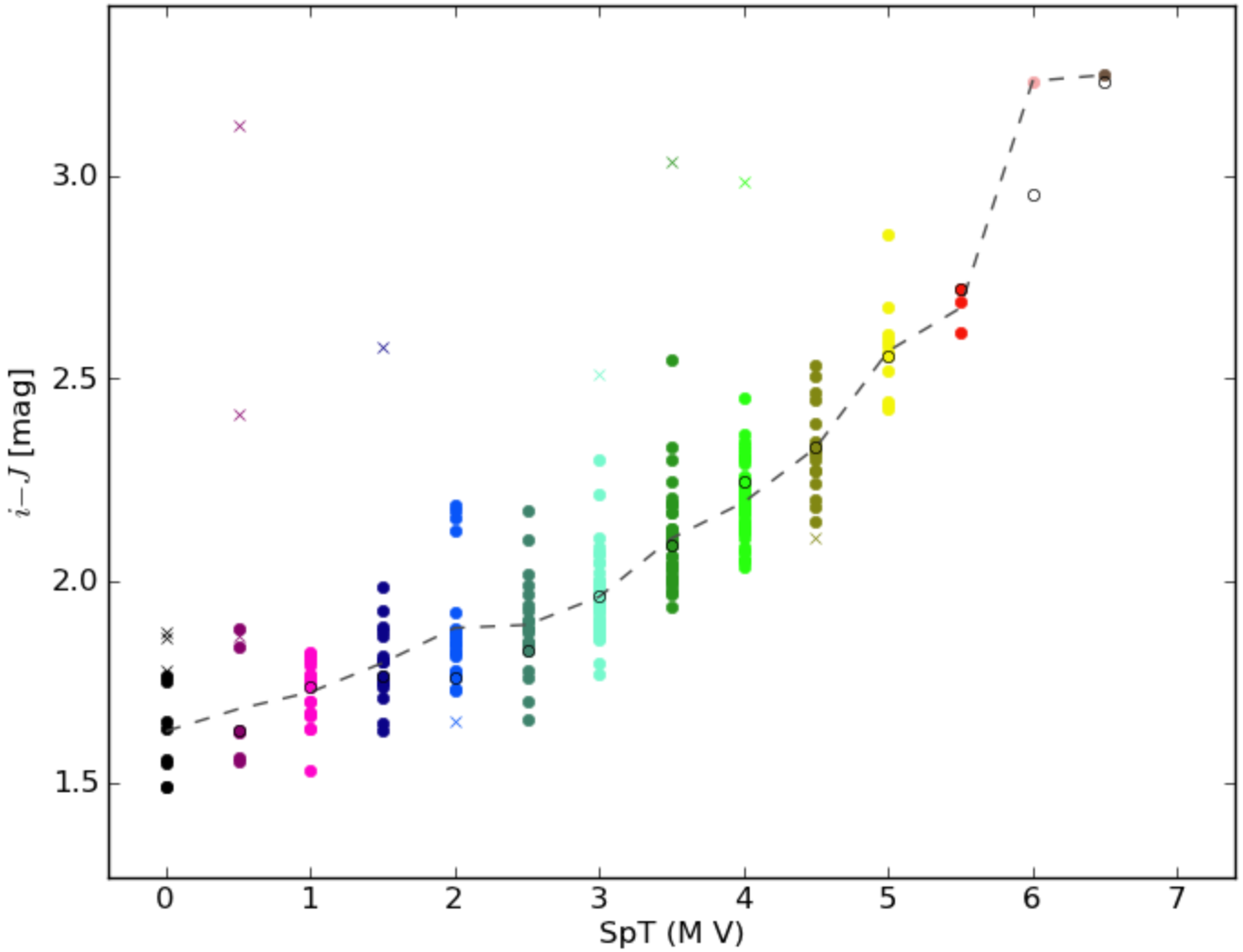


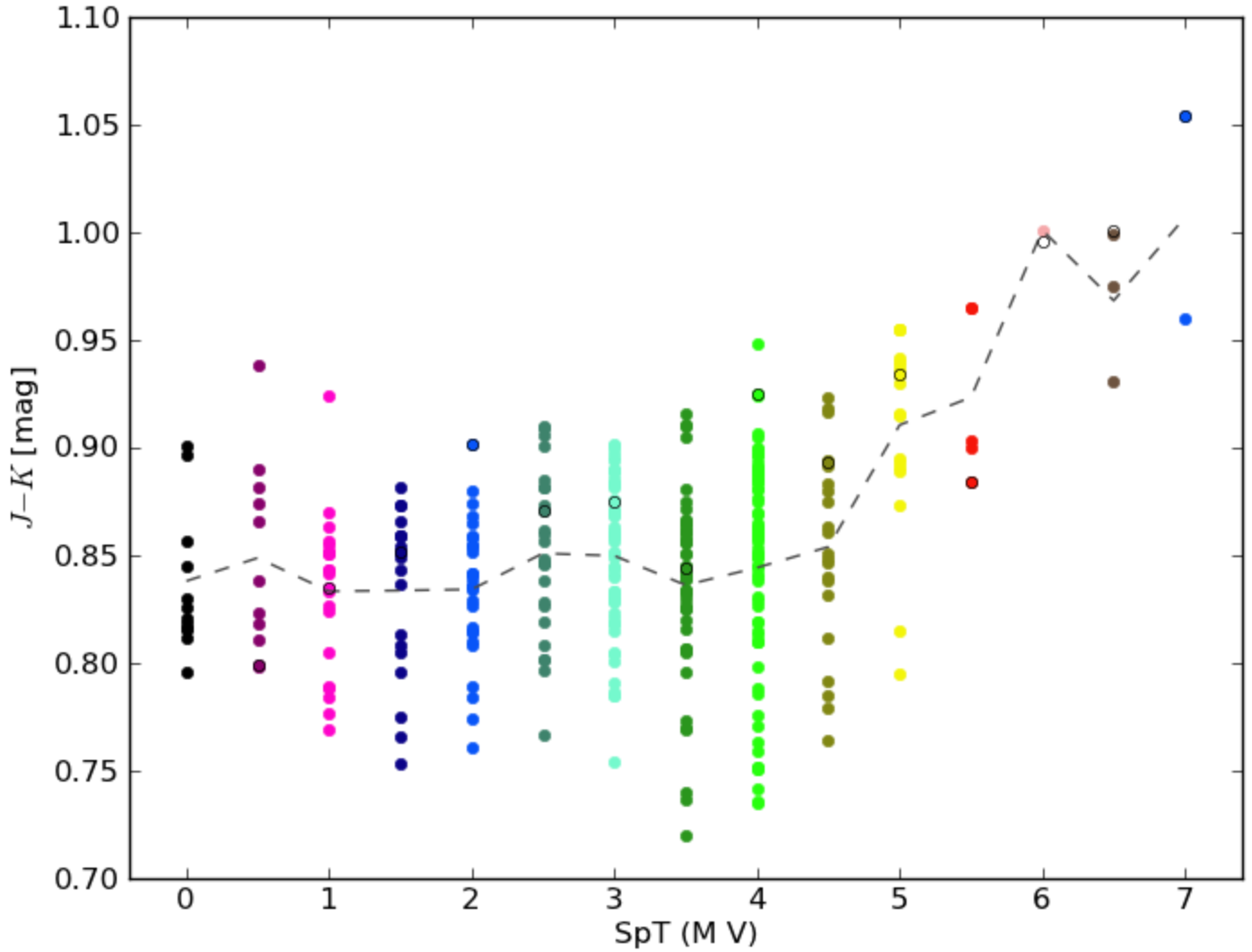

$u-g$ [mag]
SpT (M V)
0
1
2
3
4
5
6
7

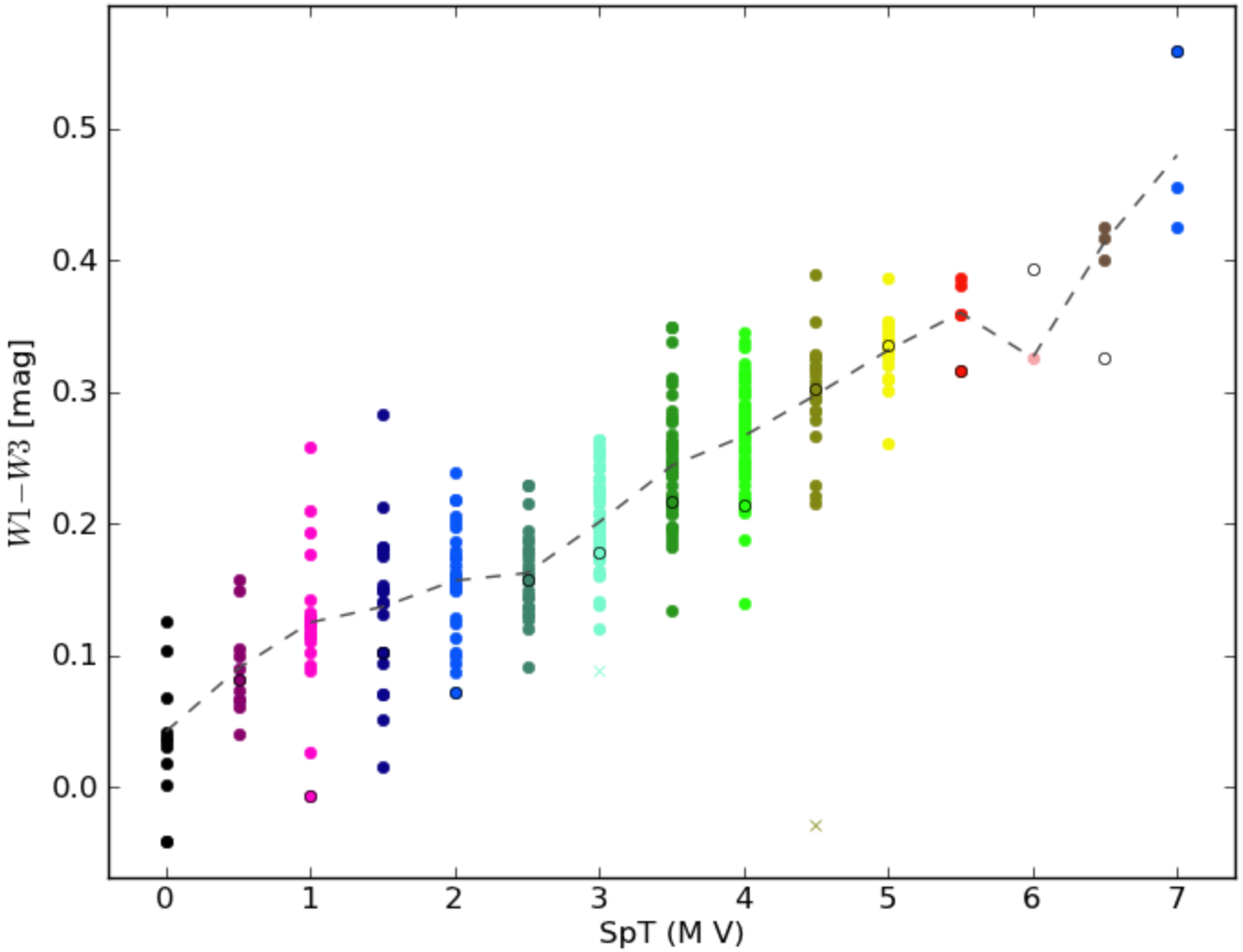

2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
$g-r$ [mag]
0
1
2
3
4
5
6
7
SpT (M V)

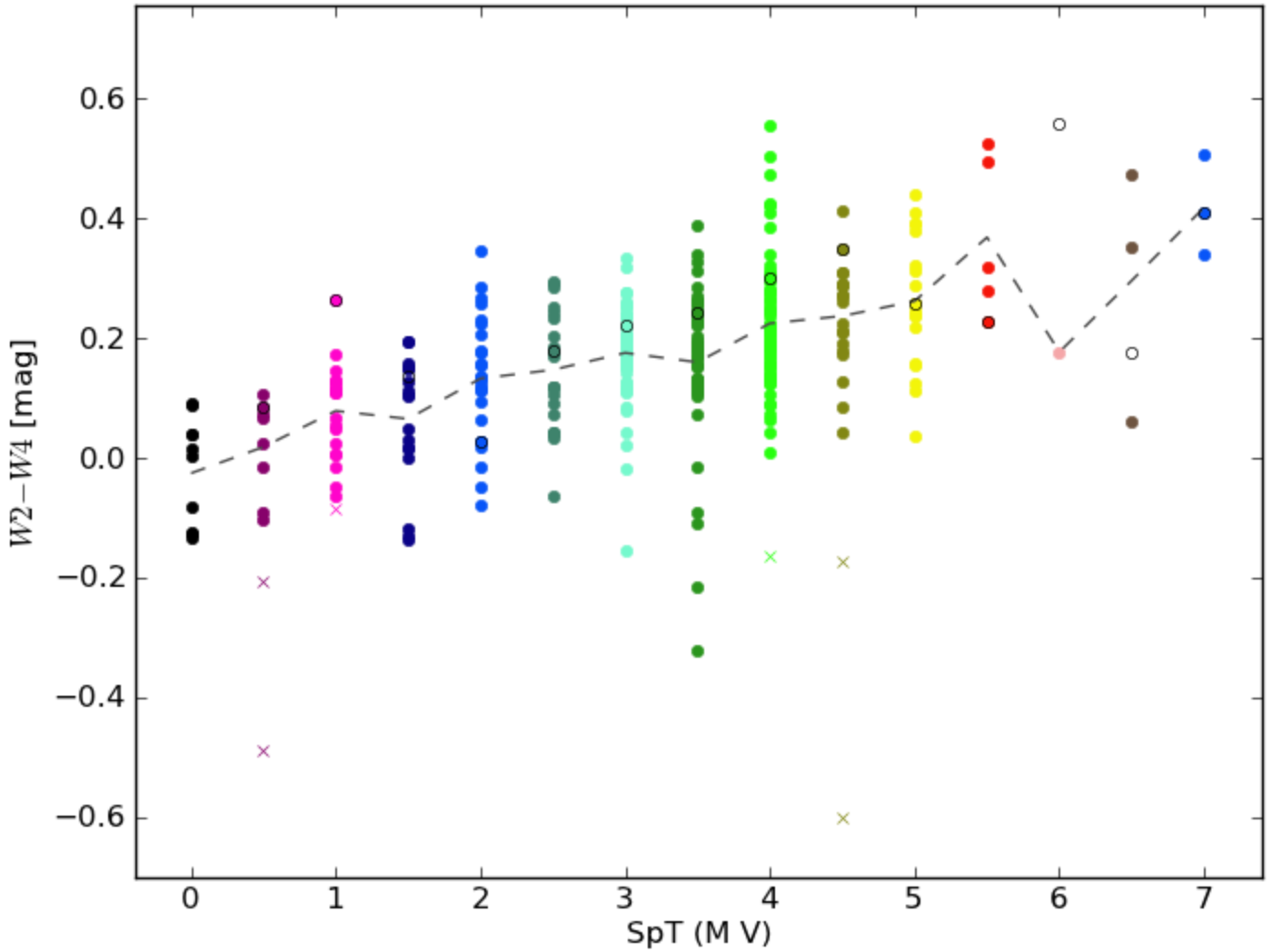

2.5
2.0
1.5
1.0
0.5
$r-i$ [mag]
0
1
2
3
4
5
6
7
SpT (M V)

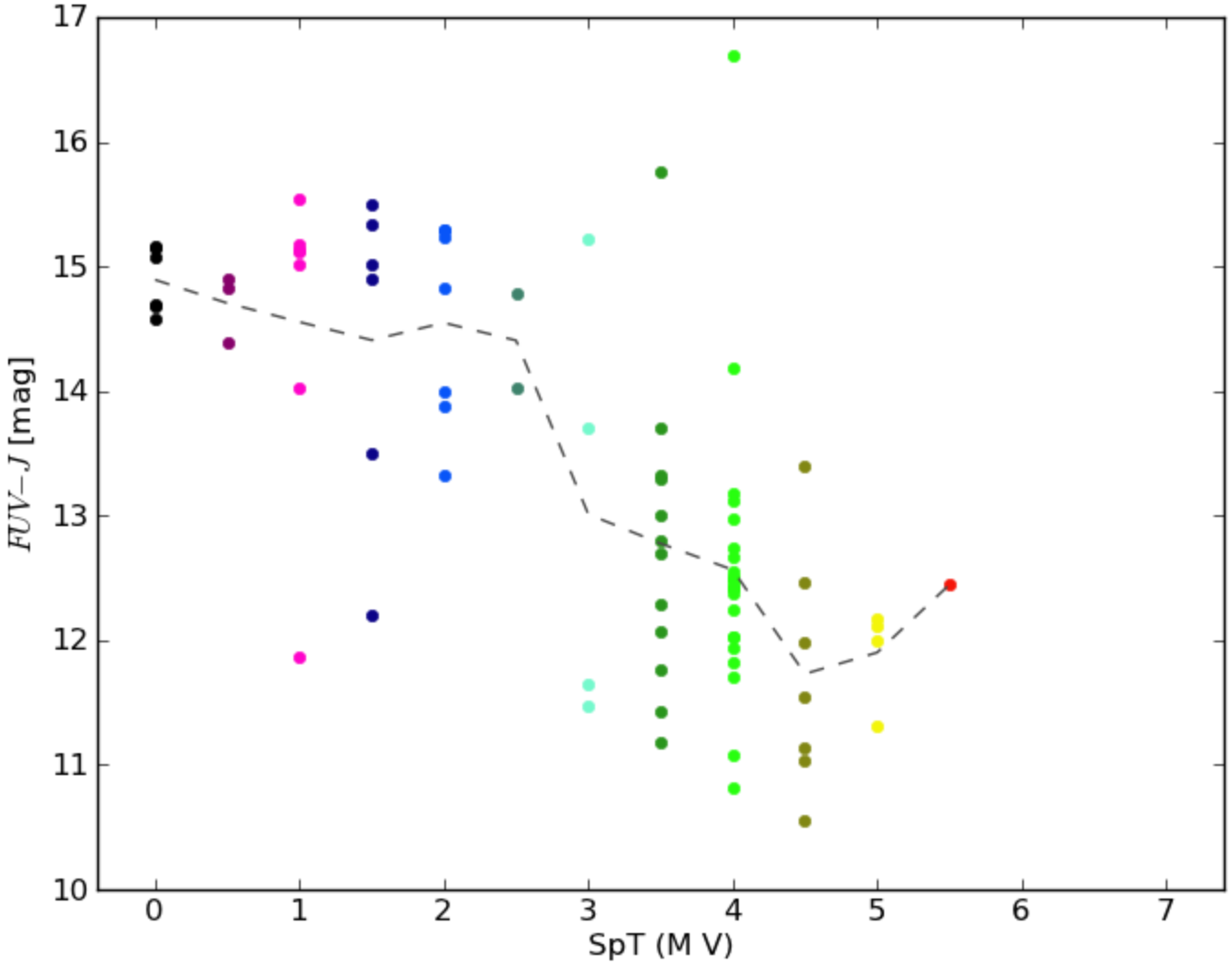

7
6
5
4
3
$r-Ks$ [mag]
0
1
2
3
4
5
6
7
SpT (M V)

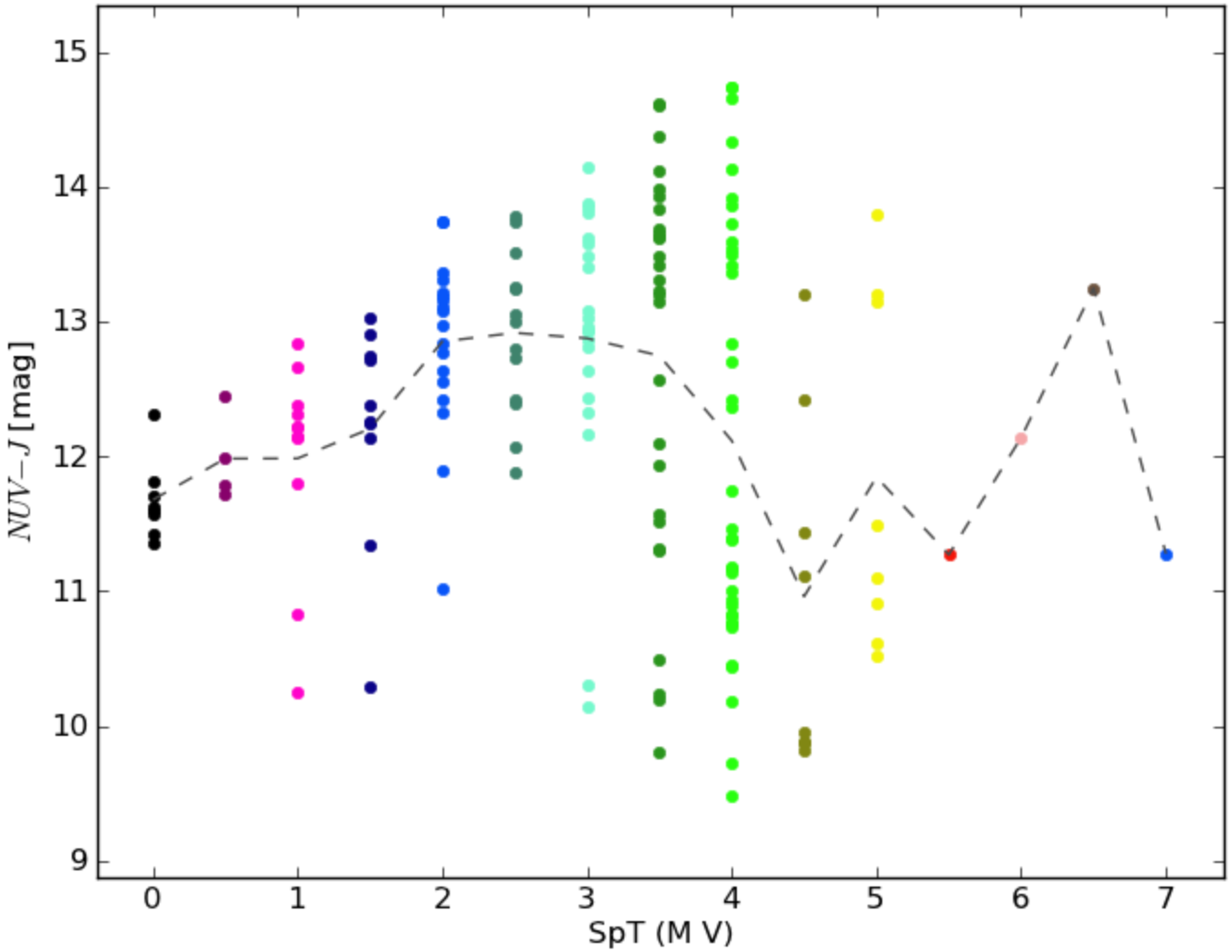

3.0
2.5
2.0
1.5
$i-J$ [mag]
0
1
2
3
4
5
6
7
SpT (M V)

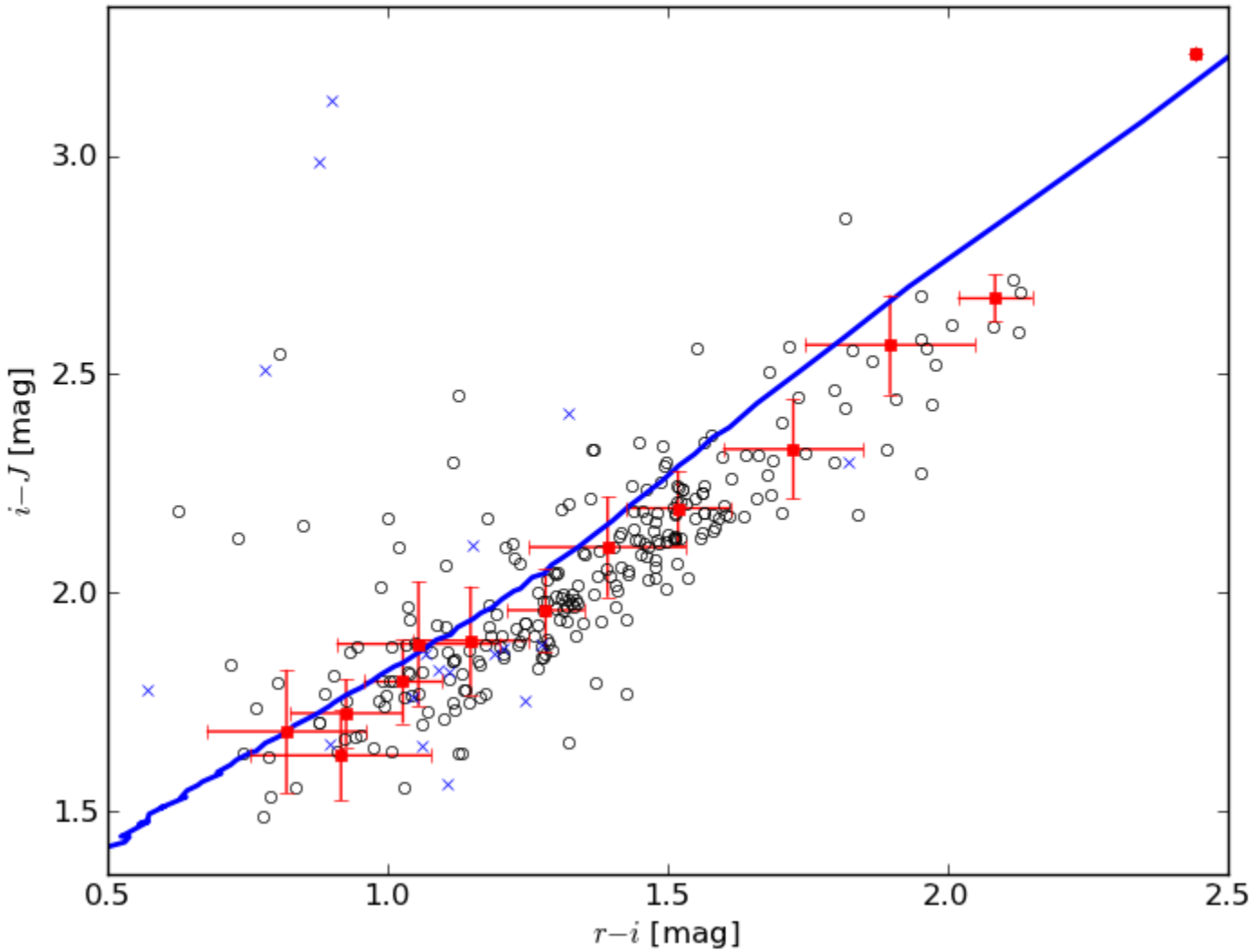

1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
J−K [mag]
0
1
2
3
4
5
6
7
SpT (M V)

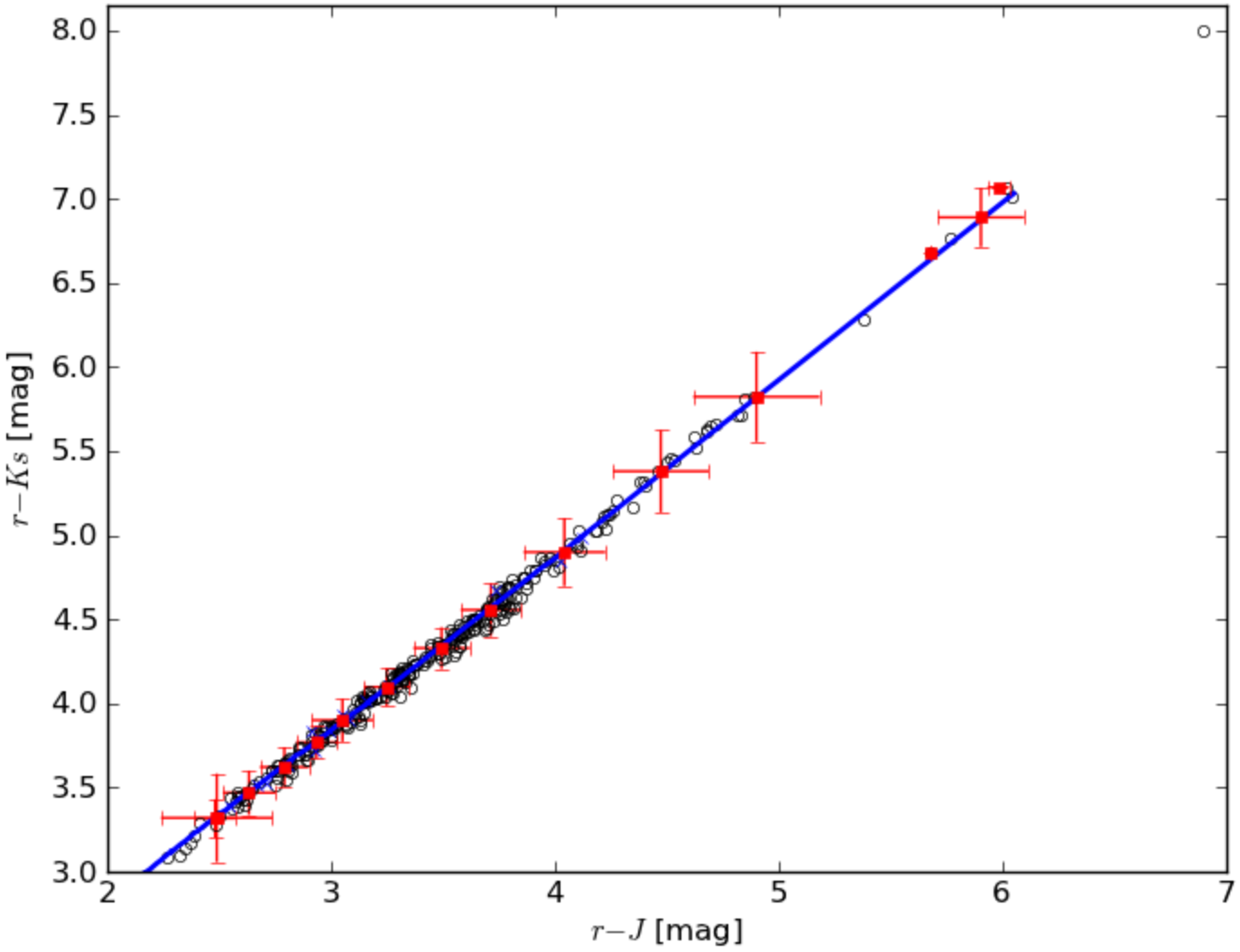

W1−W3 [mag]
0.0
0.1
0.2
0.3
0.4
0.5
0
1
2
3
4
5
6
7
SpT (M V)

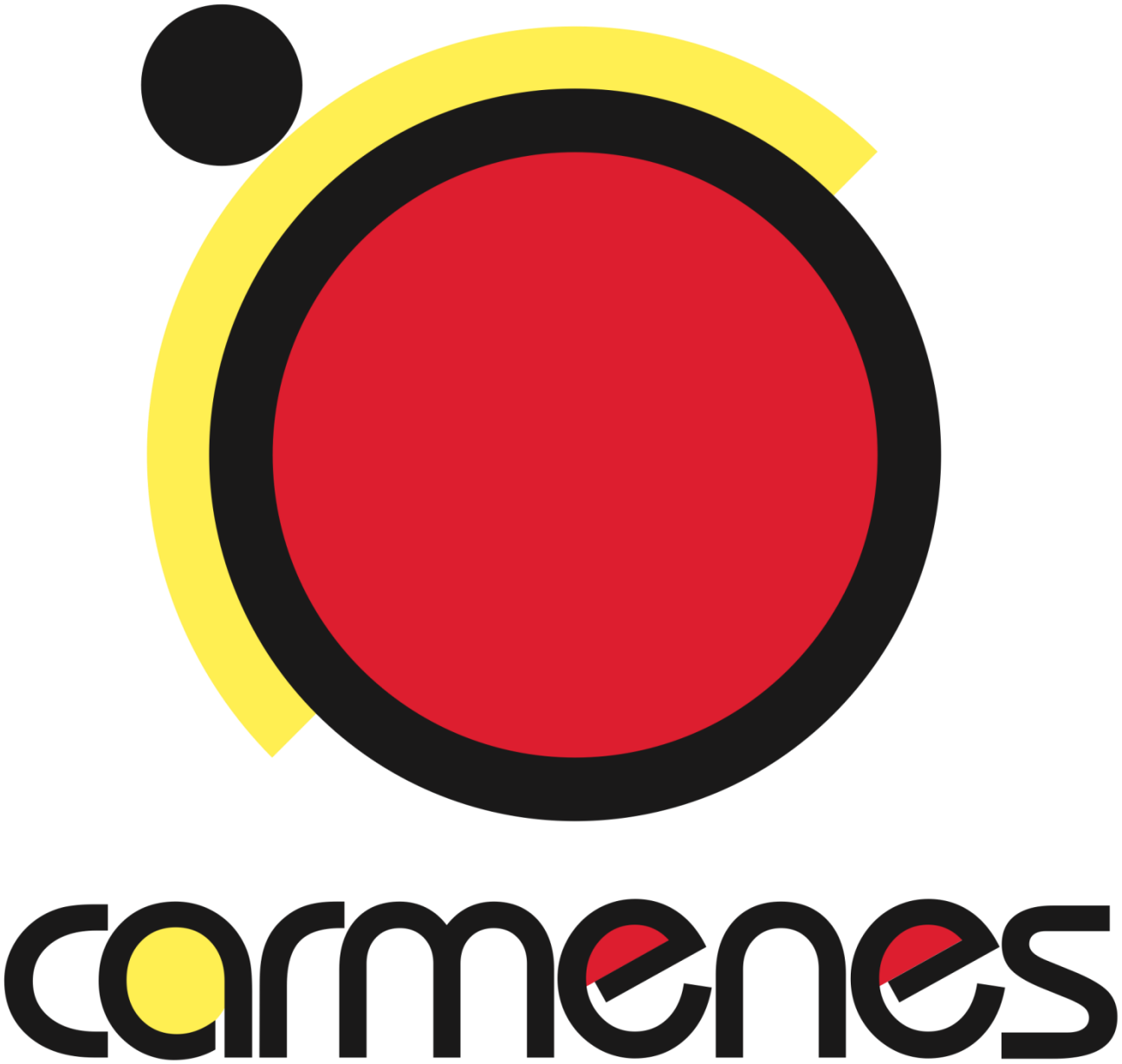

0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
W2−W4 [mag]
0
1
2
3
4
5
6
7
SpT (M V)


17
16
15
14
13
12
11
10
0
1
2
3
4
5
6
7
FUV−J [mag]
SpT (M V)


15
14
13
12
11
10
9
$NUV-J$ [mag]
0
1
2
3
4
5
6
7
SpT (M V)


3.0
2.5
2.0
1.5
$i-J$ [mag]
0.5
1.0
1.5
2.0
2.5
$r-i$ [mag]


8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2
3
4
5
6
7
$r-Ks$ [mag]
$r-J$ [mag]


carmenes