CARMENES catalogue of M dwarfs: luminosities, colours, and SEDs

Present and future science with CARMENES (RIA)
Granada, February 2019

Carlos Cifuentes
CAB (CSIC-INTA)

Sample

2470 late-type stars and brown dwarfs

2182 M

Carmencita.091

Carmencita

GTO

172 late-K

RECONS100

Kirkpatrick+11

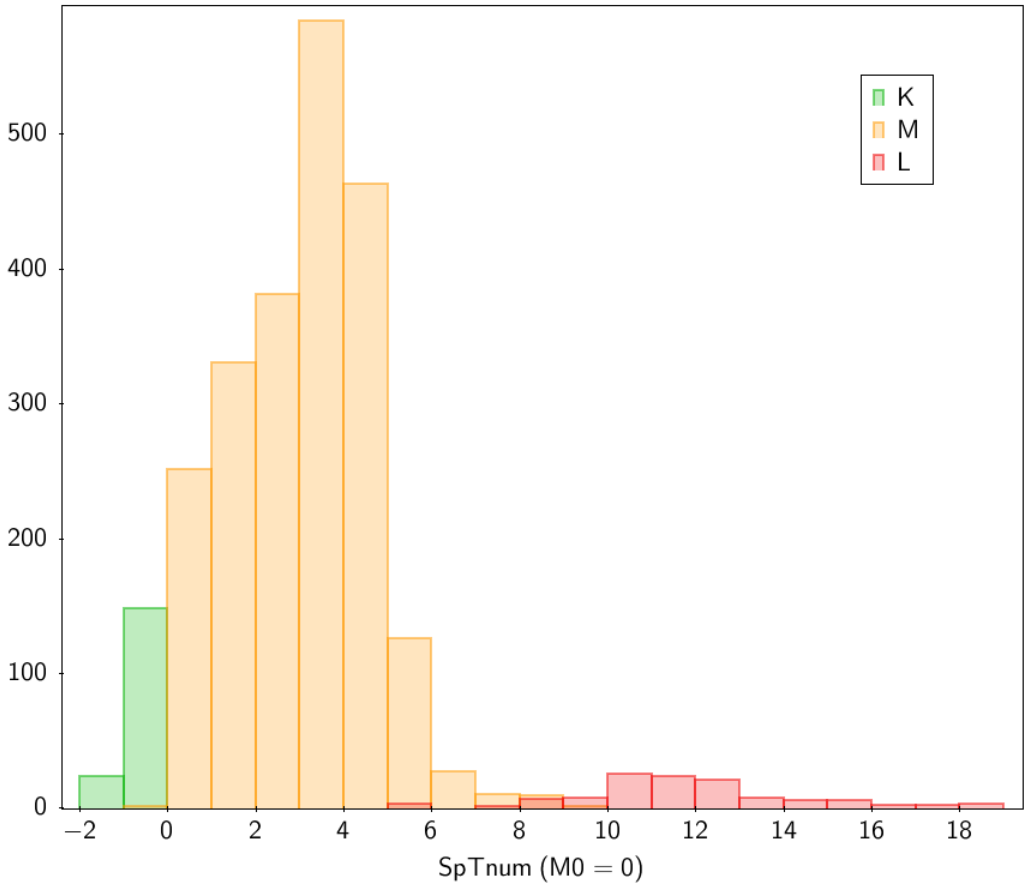
Lépine+13

Alonso-Floriano+15

116 late-M, L

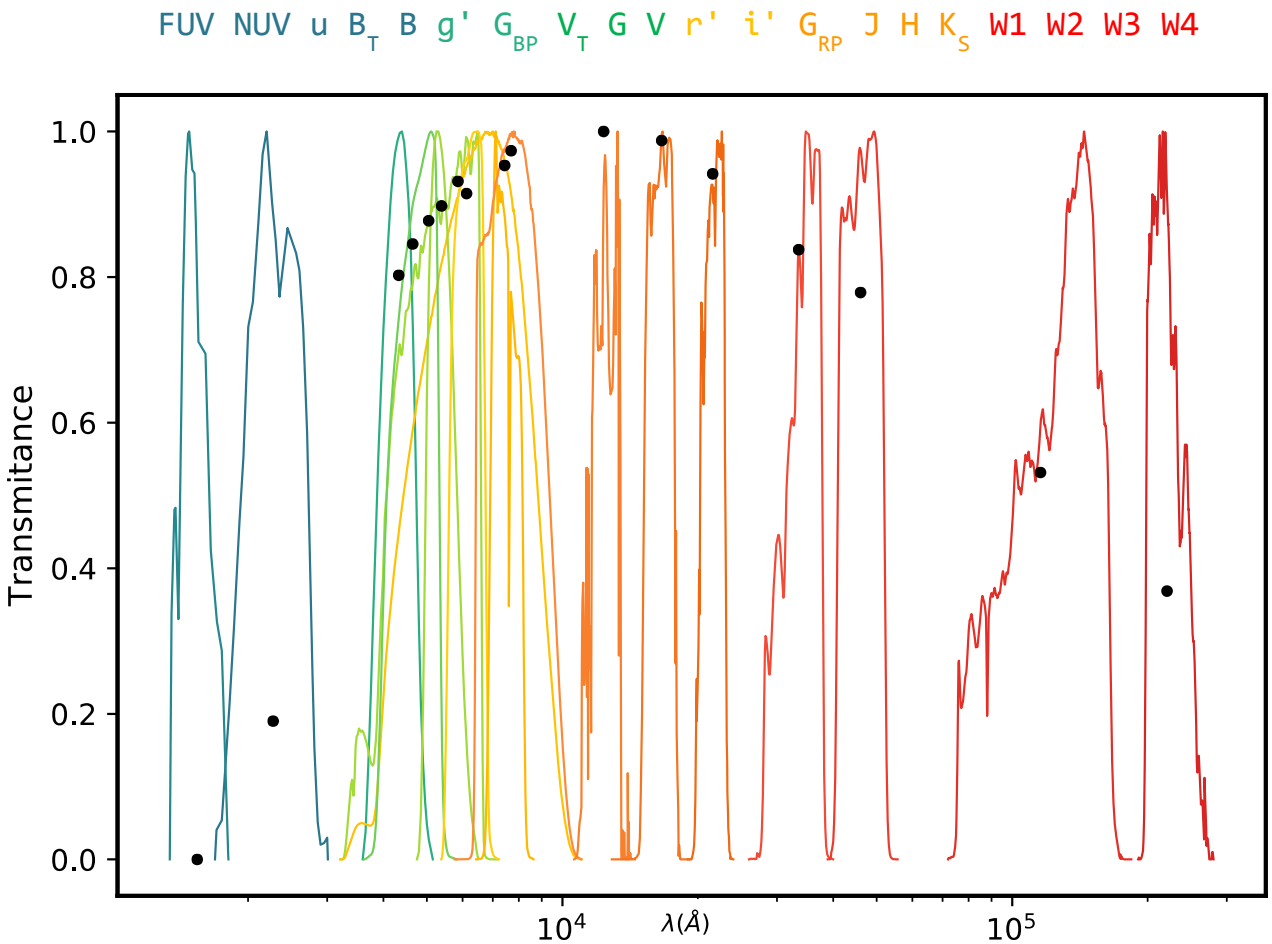
RECONS100

Smart+17



Photometry Filters

21 filters from **10** surveys



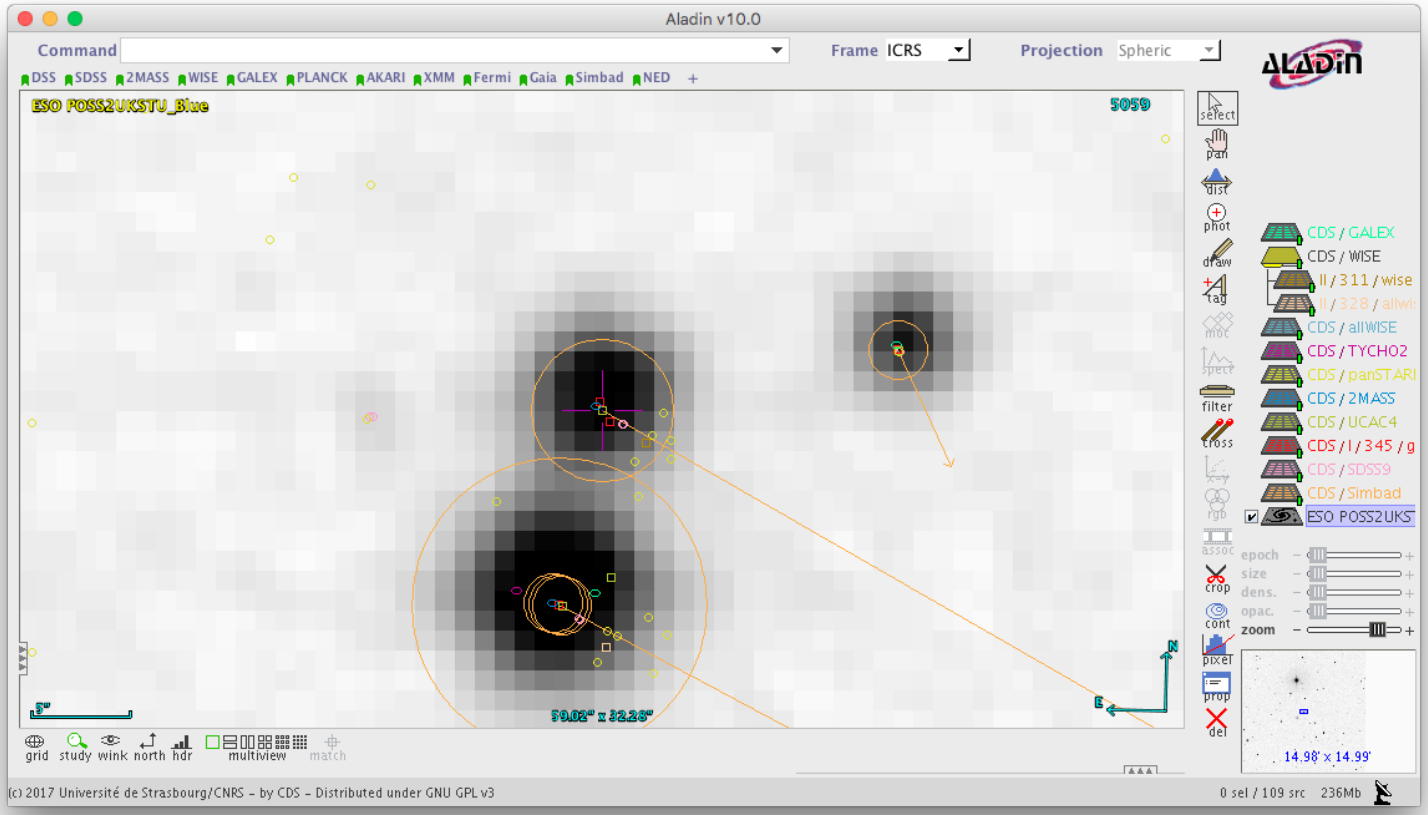
Photometry Completeness

Photometry completeness and source(s)		
FUV NUV	40 %	*GALEX* DR5
u'	45 %	SDSS9
B_T V_T	30 %	*Tycho-2*
B V	**>87%**	UCAC4, APASS9
B_P G R_P	**>97%**	*Gaia* DR2
g r i	**>99%**	UCAC4, SDSS9, PanSTARRS1
J H Ks	**~100%**	2MASS
W1 W2 W3 W4	**>99%**	allWISE

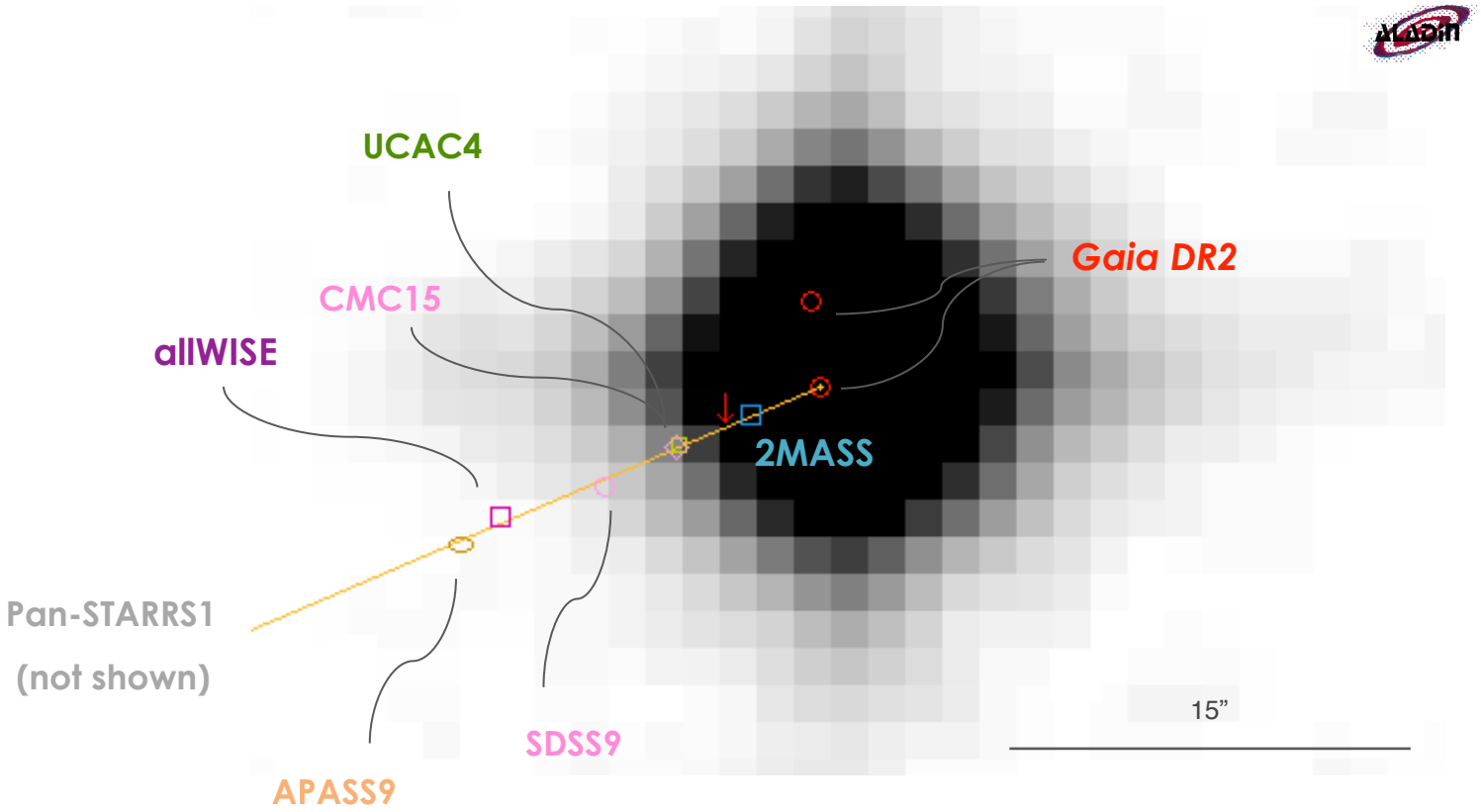
All Sample: *32,000+ individual magnitudes and uncertainties*

Photometry Filters

Tools: TopCat's CDS Upload X-Match (to VizieR) · ADQL · **Aladin**



Photometry Filters

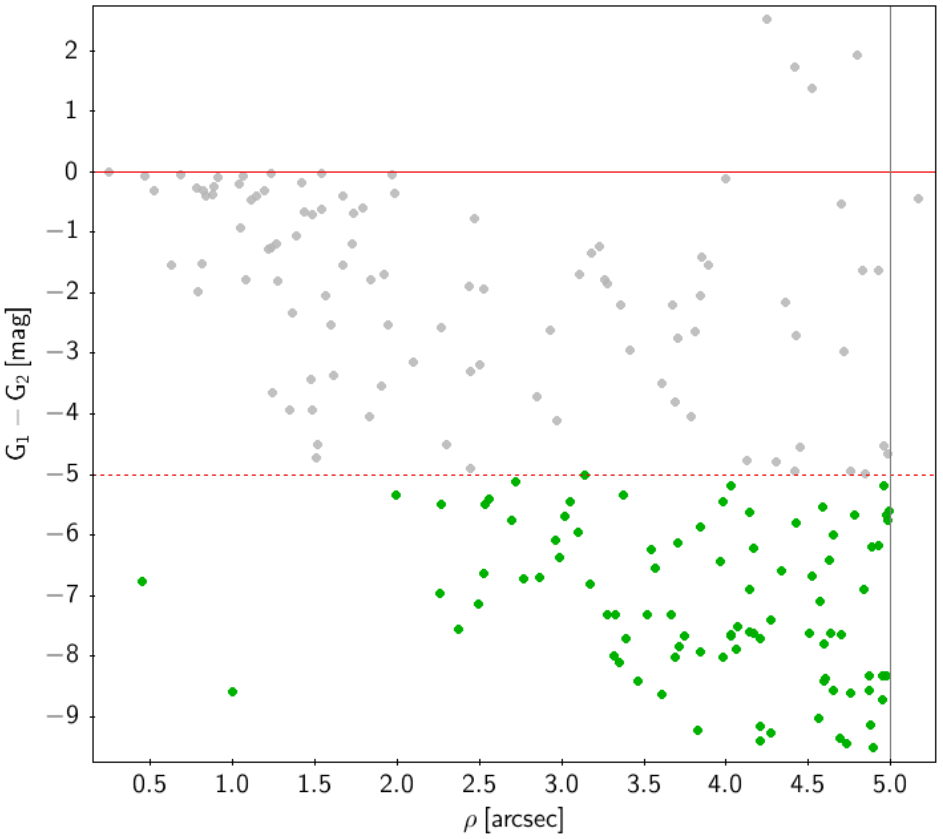


Sample Multiplicity

- Multiplicity rate M dwarfs ~30%
- Unresolved binaries increase F_{bol}
- Systematic bias of the radii

91 *new* binary systems
~26 identified (HiRes imaging)
~65 to be confirmed

- Resolved by *Gaia* DR2 at ρ ≤ 5 arcsec
- Not in WDS



Contaminated, *how much*?

$$\Delta m = -2.5 \log \frac{F_1}{F_2}$$

$$\Delta m = -5 \text{ mag}$$

$$\Longrightarrow F_2 = \frac{1}{100} F_1$$

Contaminated less than 1%.

Flux contaminated by **1%** implies a change in **5** mag.

Sample Quality

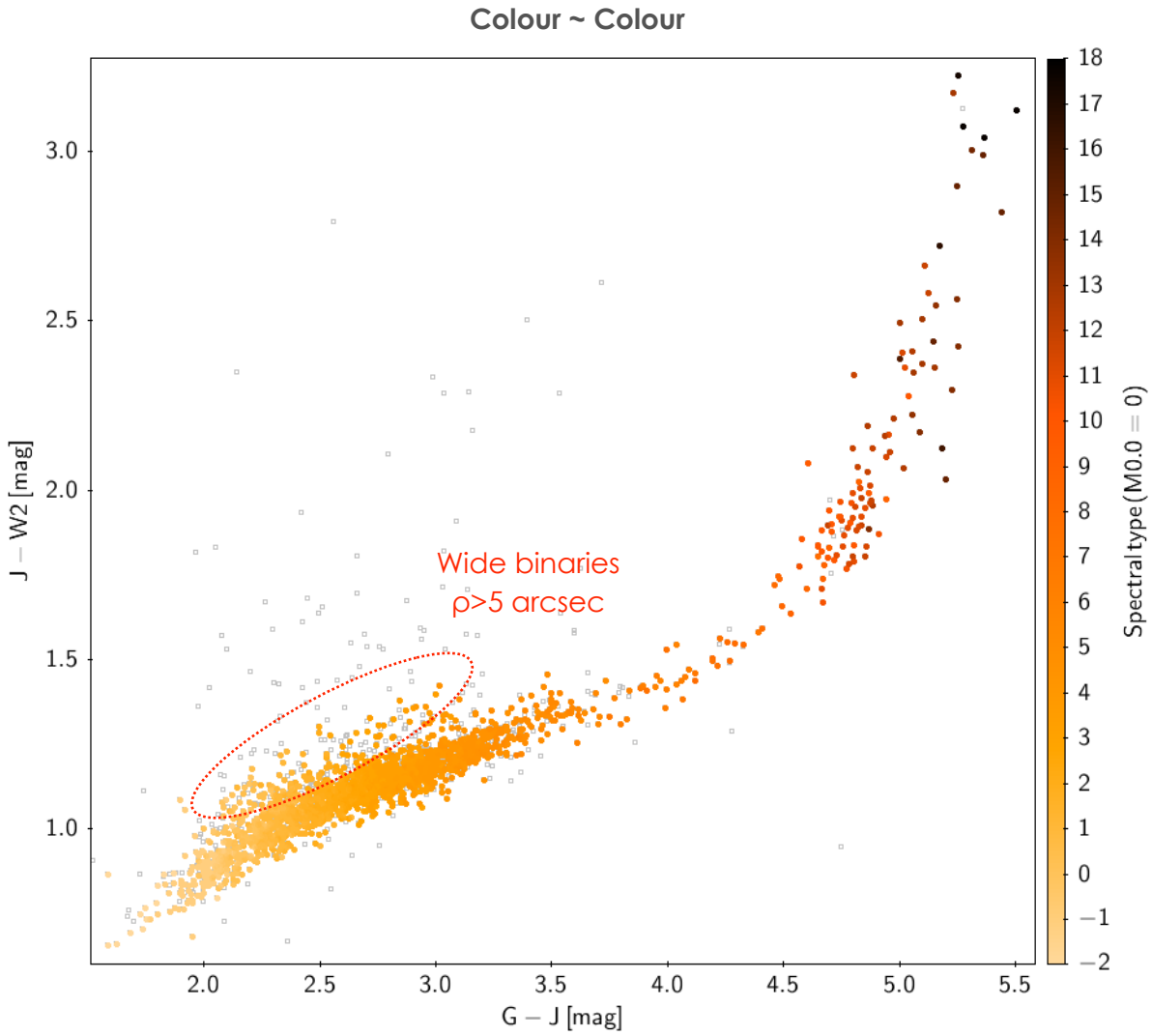
Main indicators

- ***Gaia* DR2** Astrometric goodnes-of-fit: UWE, RUWE (Lindergen et al. 2018)
- **2MASS** Photometric quality: Qflag = NNN
- **allWISE** Photometric quality: Qflag = NNNN

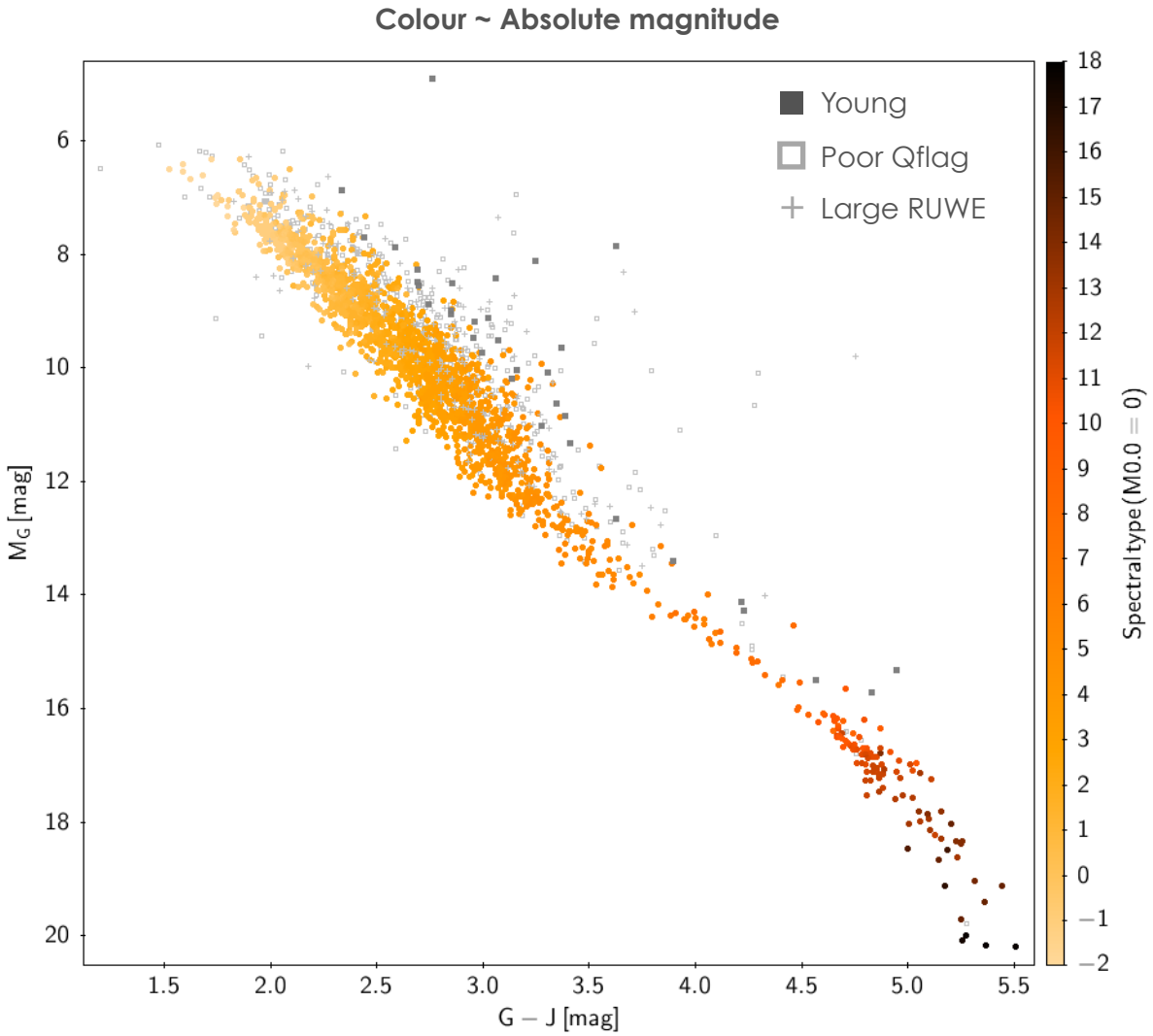
Excluding criteria:

- *Astrometric quality*: RUWE ≳1.5
- Photometric quality: Qflag ≠ A (or B)
- Multiplicity: Pairs at $\rho \leq 5$ arcsec contaminated more than 1%.
- Young: Beta Pictoris, Upper Sco, σ Orionis, Hyades, etc.

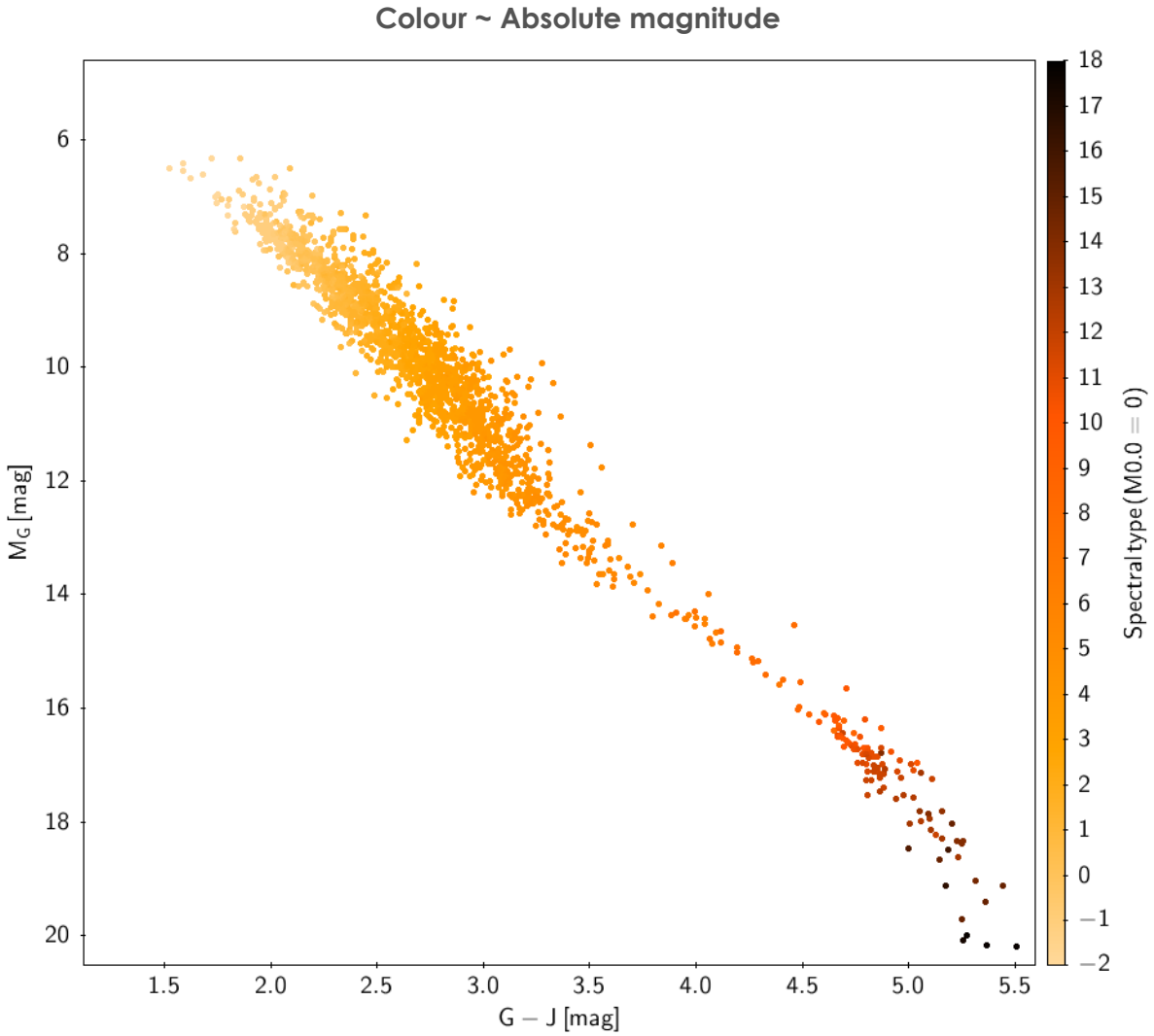
Photometry Diagrams



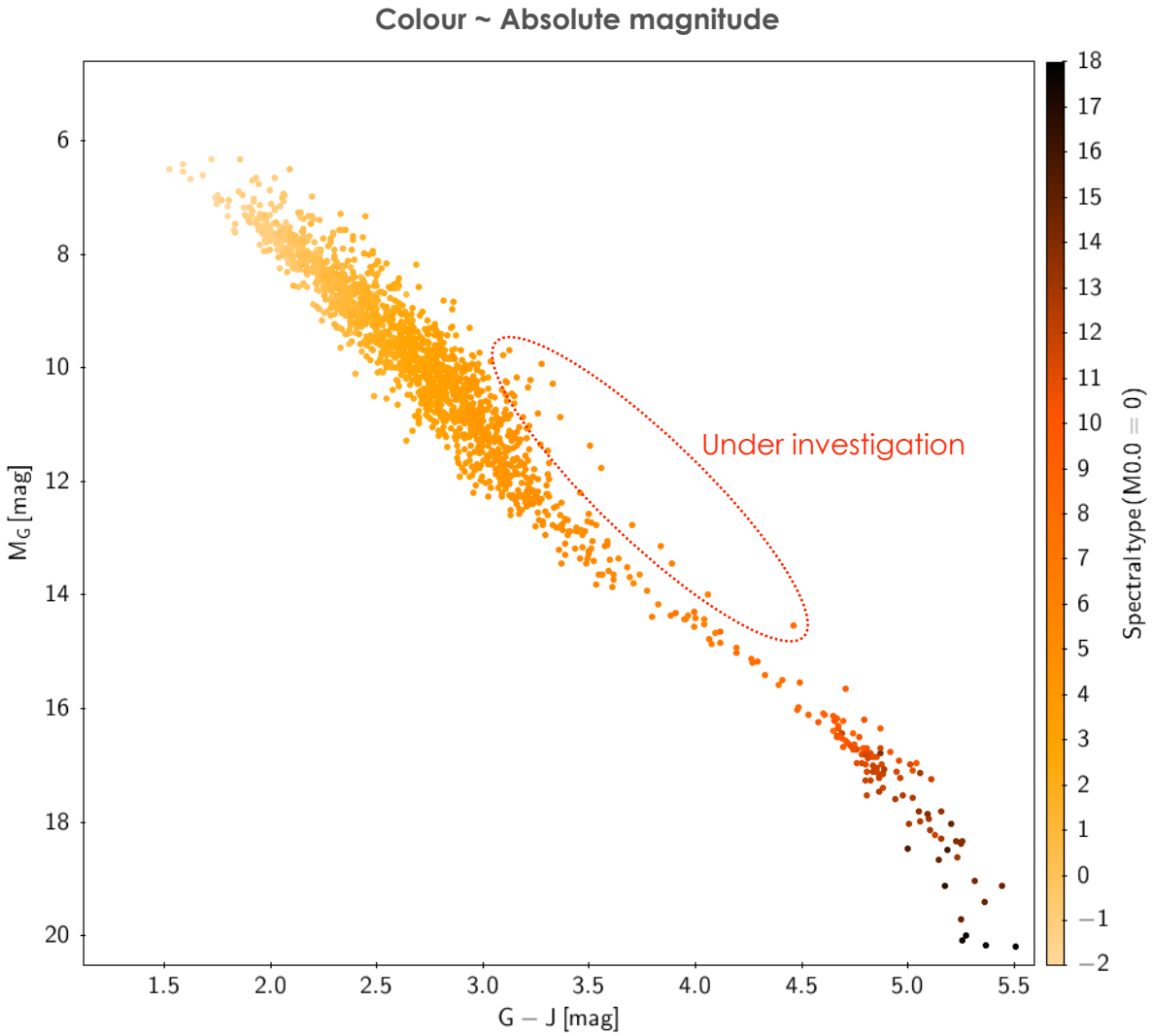
Photometry Diagrams



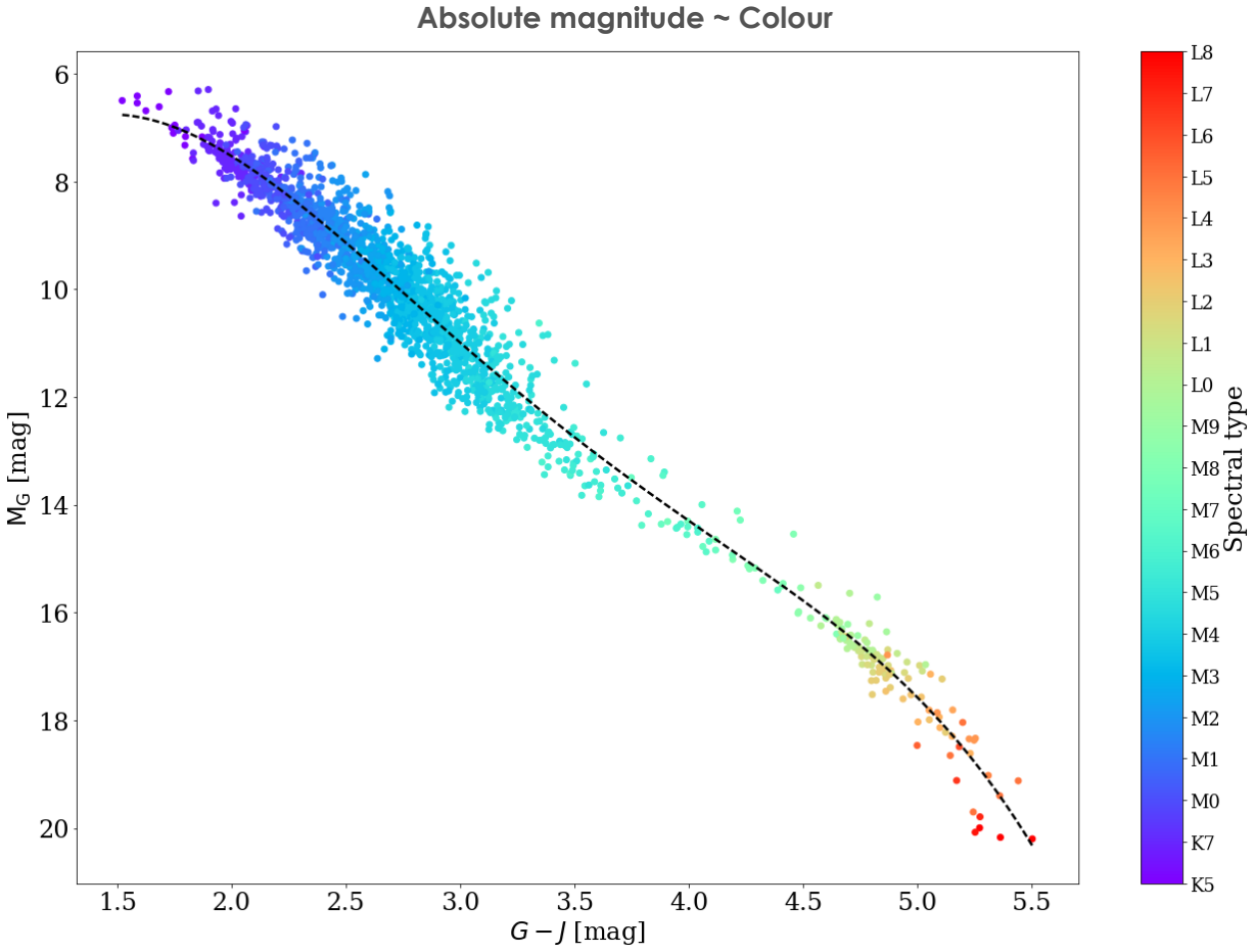
Photometry Diagrams



Photometry Diagrams



Photometry Diagrams

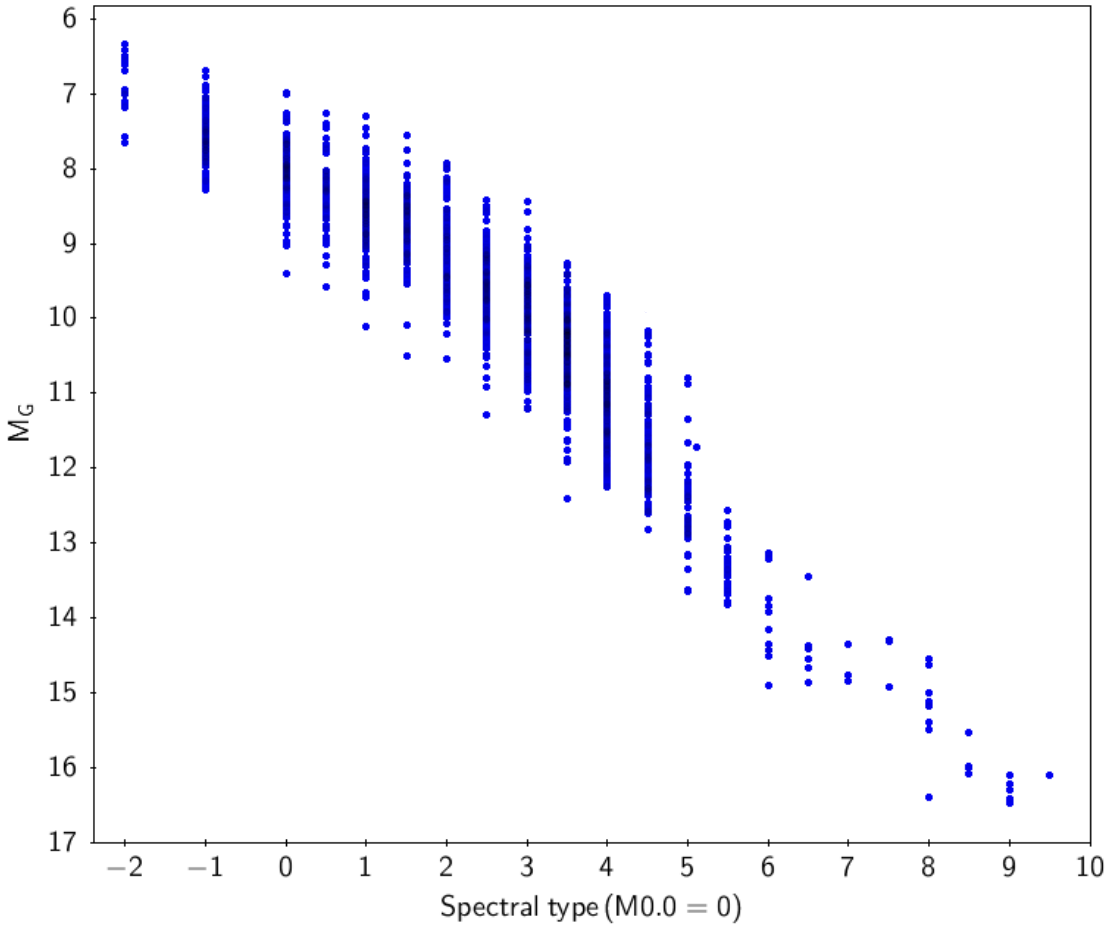


Photometric distance estimation

Applied to ~**70** stars without parallactic distances

Photometry Diagrams

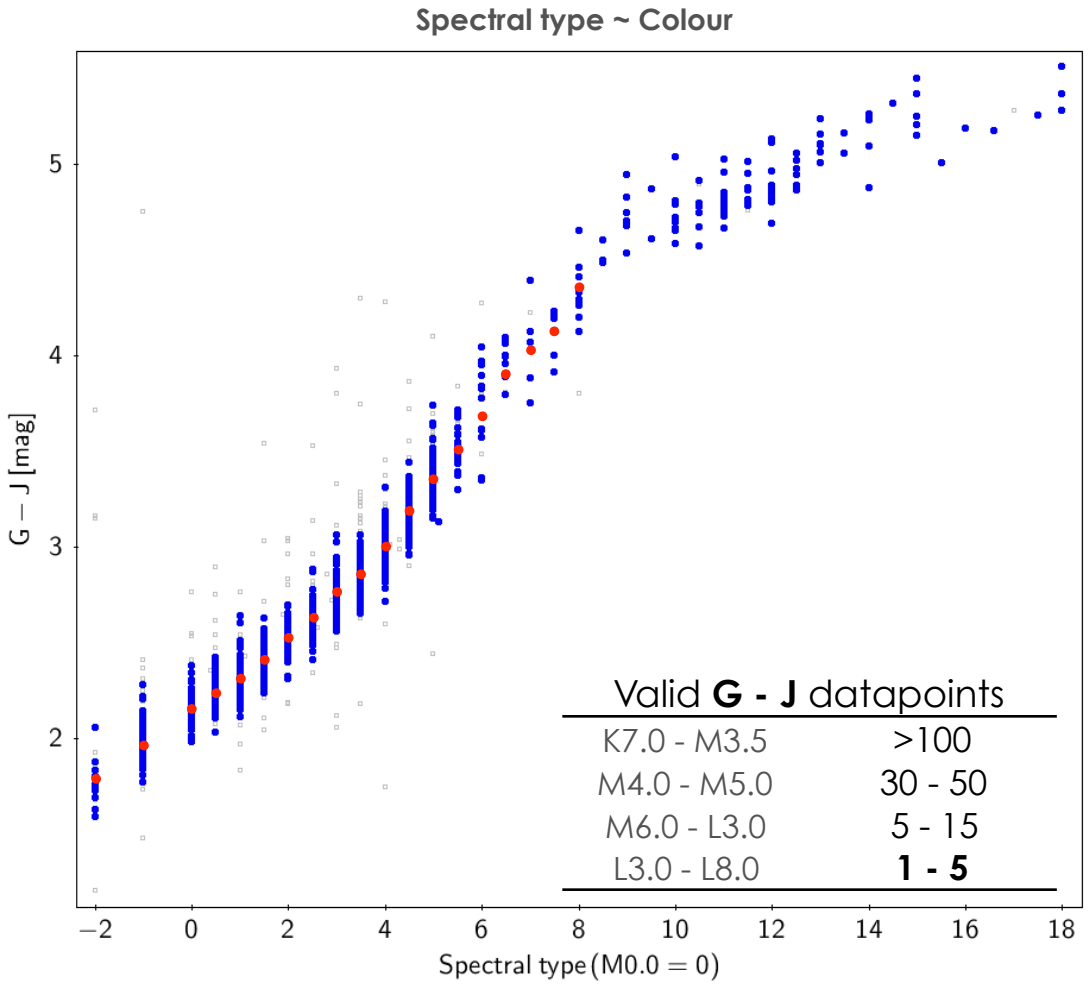
Abs. Magnitude ~ **Spectral type**



Photometric distance estimation

G magnitude instead 2MASS *J*

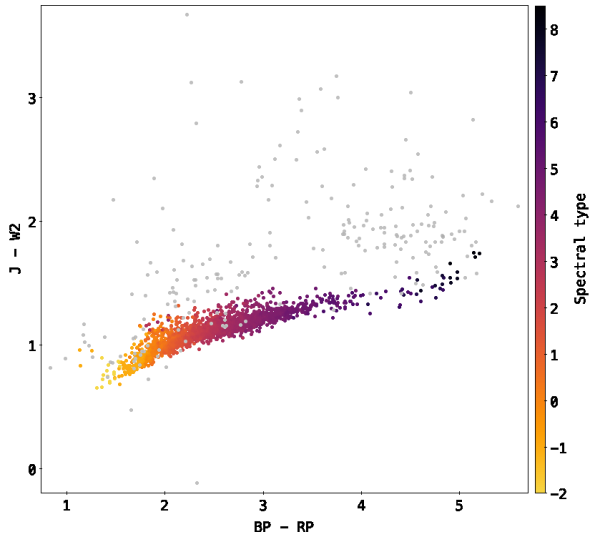
Photometry Diagrams

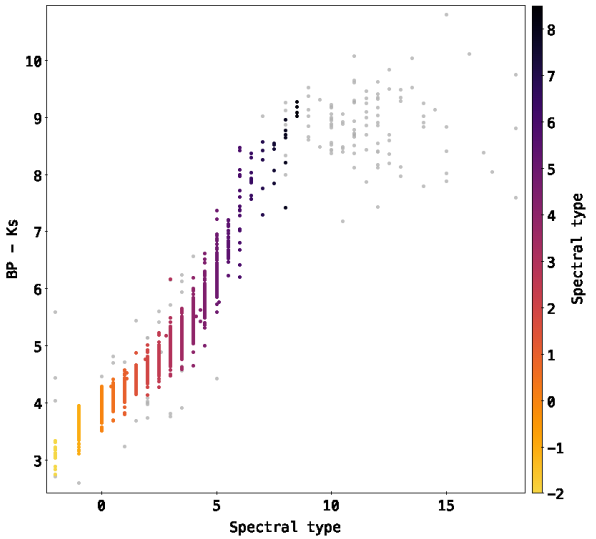


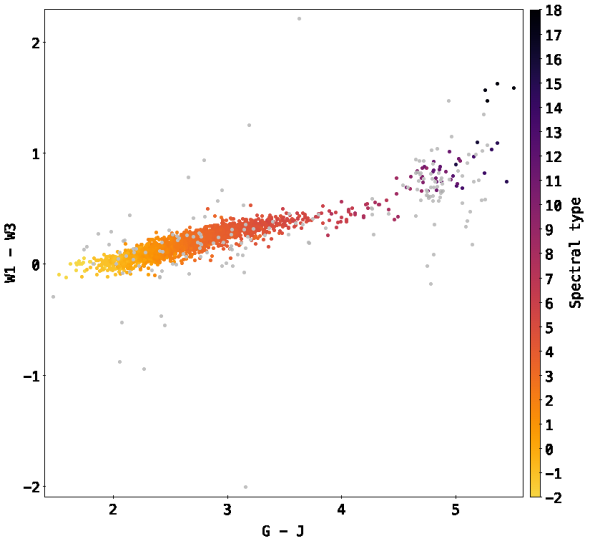
Spectral type estimation

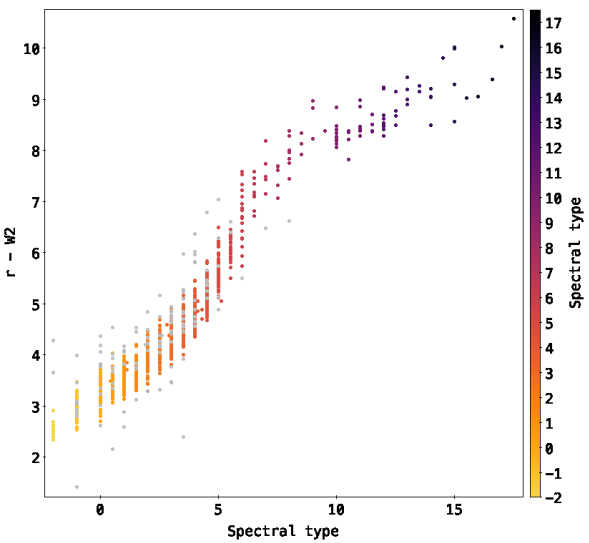
Average colours

Photometry Diagrams









Luminosities

VOSA

BT Settl-CIFIST model Baraffe et al. 2015

- T_{eff}**(K)** ∈ [1200, 4600] (L8 - K5)
- **log *g*** ∈ [4.5, 5.5] (Young?)
- **[Fe/H]** = 0 (except Luyten's star)
- A_V = 0 (d < 200 pc)

Distances

2412 parallactic:

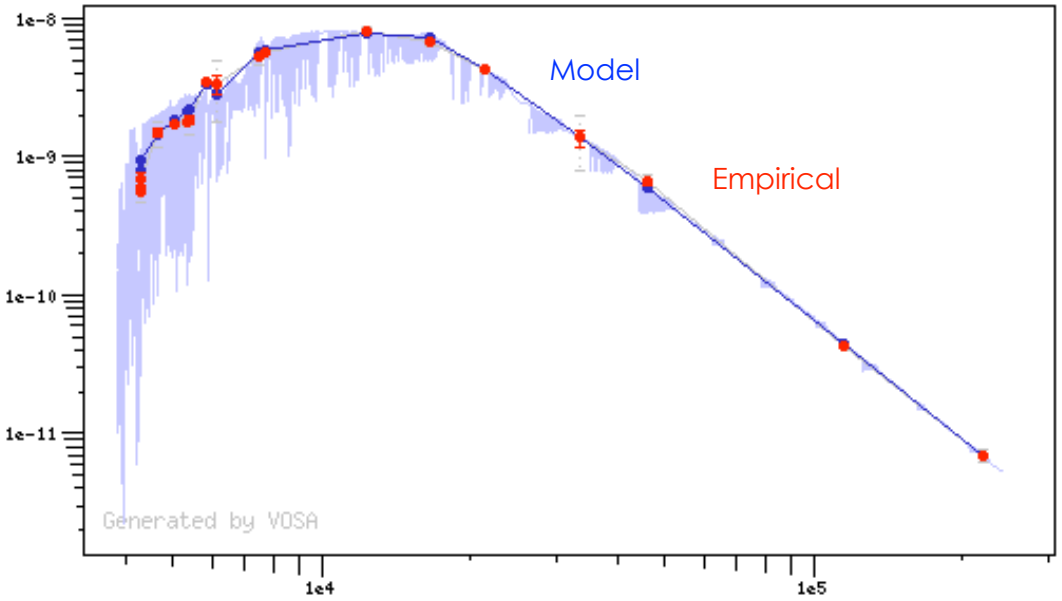
- 2292 Gaia DR2
- 108 Other (HIP2, vAl95…)

68 non-parallactic

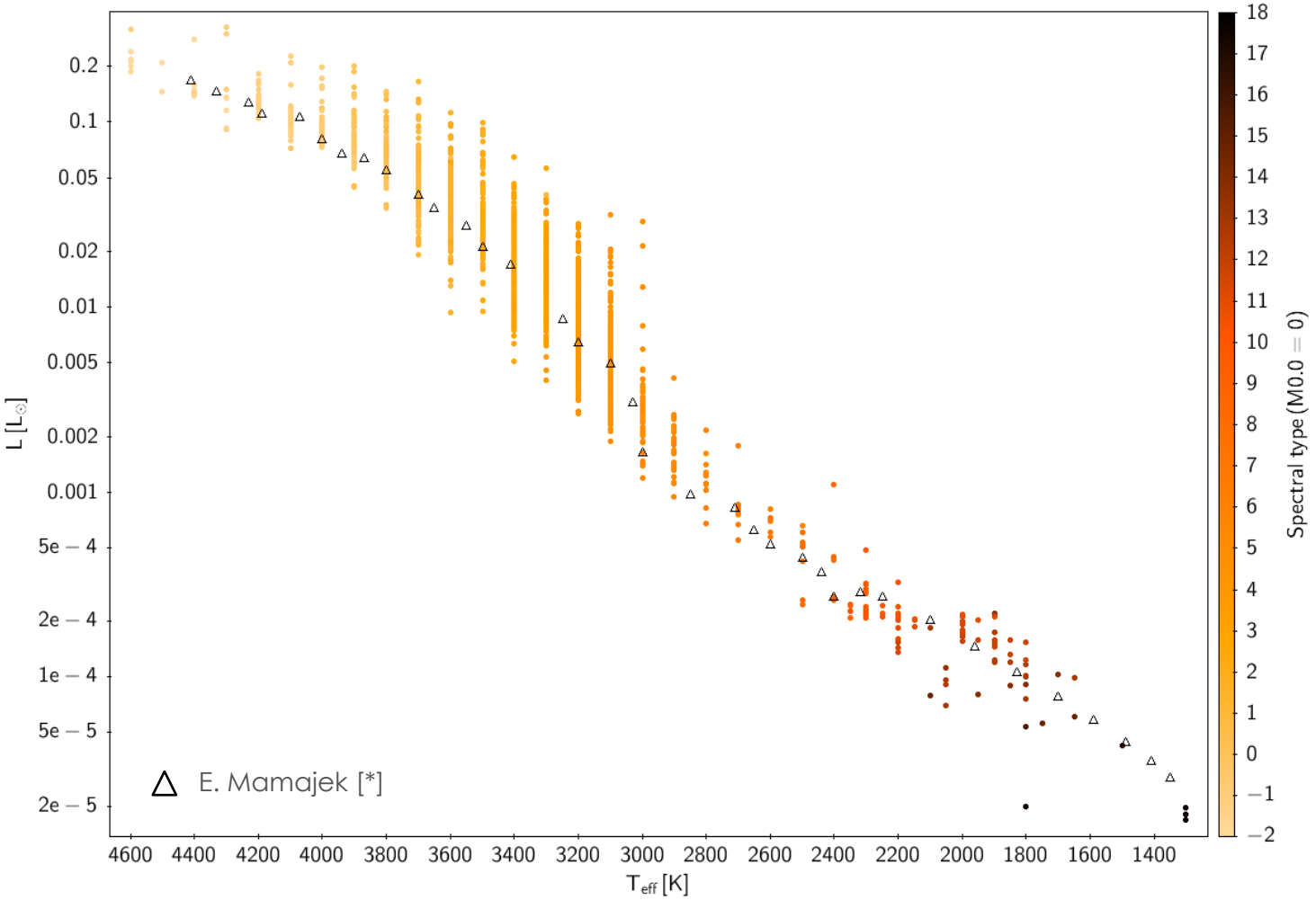
Photometry

FUV NUV u' not considered (Photospheric models)

VOSA Virtual Observatory SED Analyser (Bayo et al. 2008)

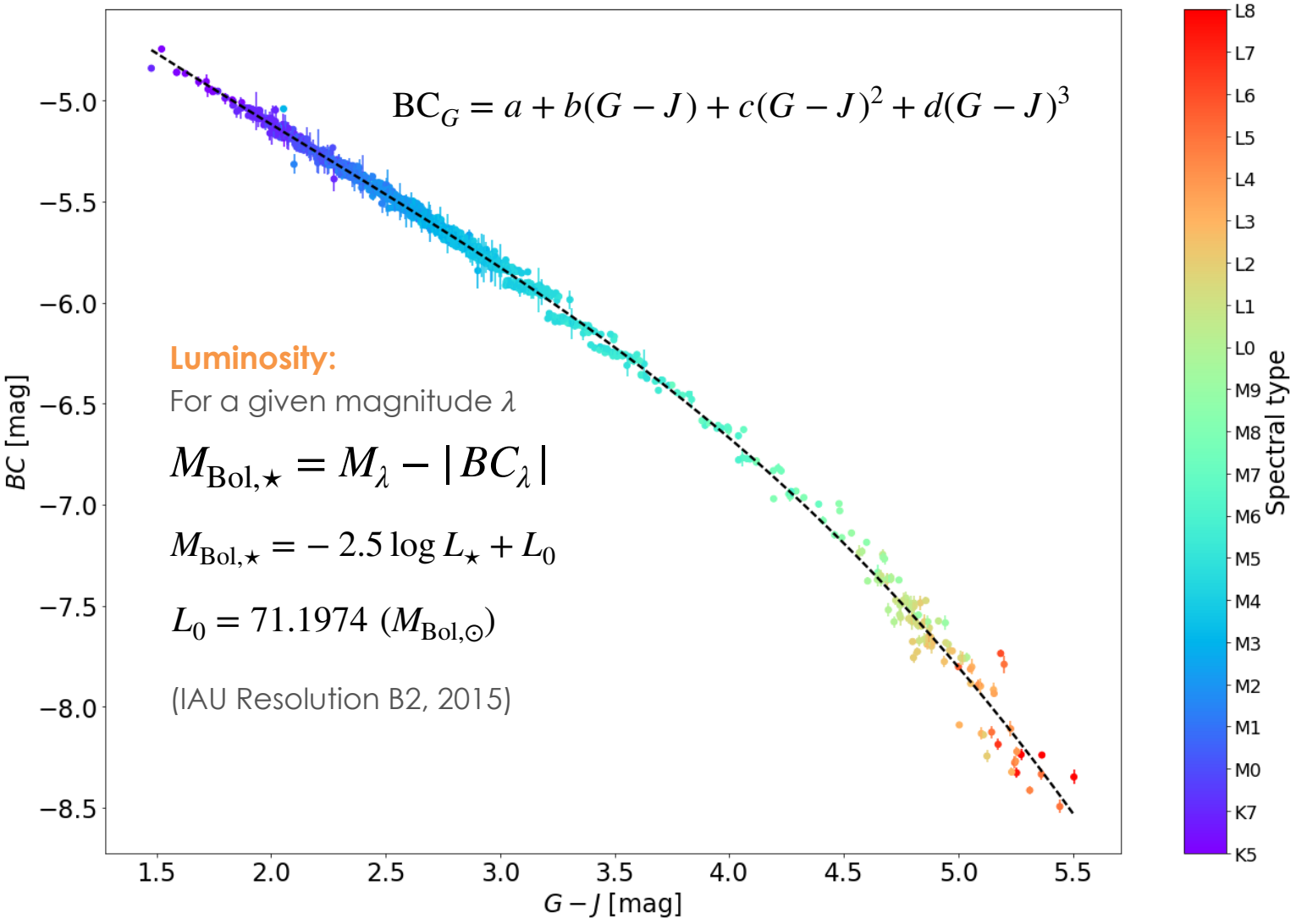


Luminosities



[*] *A Modern Mean Dwarf Stellar Color and Effective Temperature Sequence (2018)*

Bolometric corrections



In prep.

CARMENES input catalogue of M dwarfs

V. Luminosities, colours, and spectral energy distributions

C. Cifuentes[1,2], J. A. Caballero[1], M. Cortés-Contreras[1], A. Schweitzer[3], V. M. Passeger[3], D. Montes[2], F. J. Abellán de Paco[2,11], R. Dorda[2], G. Holgado[2,12], J. C. Morales[4,5], E. Solano[1], I. Ribas[4,5], A. Reiners[6], A. Quirrenbach[7], P. J. Amado[8], and et al.

- Mass estimation
- Empirical relations:
  - Radius - Abs. Magnitude
  - Radius - Temperature
  - Colour - Temperature
- …and more

Thank you