# II. Science case and M-dwarf sample

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**Abstract.** CARMENES (*Calar Alto high-Resolution search for M dwarfs with Exoplanets with Near-infrared and optical Echelle Spectrographs*, see poster CARMENES I by Amado et al.) is an instrument being built for the 3.5m telescope of the Calar Alto Observatory. It will consist of two separate spectrographs (R~82000) covering the near-infrared and optical bands from 0.5 to 1.7 μm. It will achieve a radial velocity precision of 1 m s$^{-1}$ and will monitor about 300 stars during five years. The main goal of the survey is the discovery of Earth-like planets in the habitable zone of late-type stars. To achieve this goal, we are compiling a comprehensive list of M dwarfs from available catalogs as well as using Virtual Observatory techniques. However, in order to select the best targets, key properties such as the spectral type and the activity level are needed. Therefore, observations of those targets with poor data are being taken to completely characterize our sample.

## Science case

The main objective of CARMENES is to carry out a survey of late-type main-sequence stars with the goal of detecting **rocky planets** in their habitable zones. With a radial velocity precision of 1 m s$^{-1}$, super-Earths of 5 $M_\oplus$ masses can be detected **around M4 stars and later** (see Fig. 1), a range of host stars that is still almost unexplored due to their intrinsic faintness in the visual bands.

One of the challenges that poses the spectroscopic follow-up of late-type stars is the effect of **chromospheric activity**. Low-mass stars are known to be more active than Sun-like stars (see Fig. 2) and this can mimic or mask the effect of exoplanets. For this reason, especial attention to the properties of the targets (including activity) has to be taken, and simultaneous follow-up in the visual bands will be very useful. As a by-product, the survey will provide a large catalog of very well characterized M dwarfs.

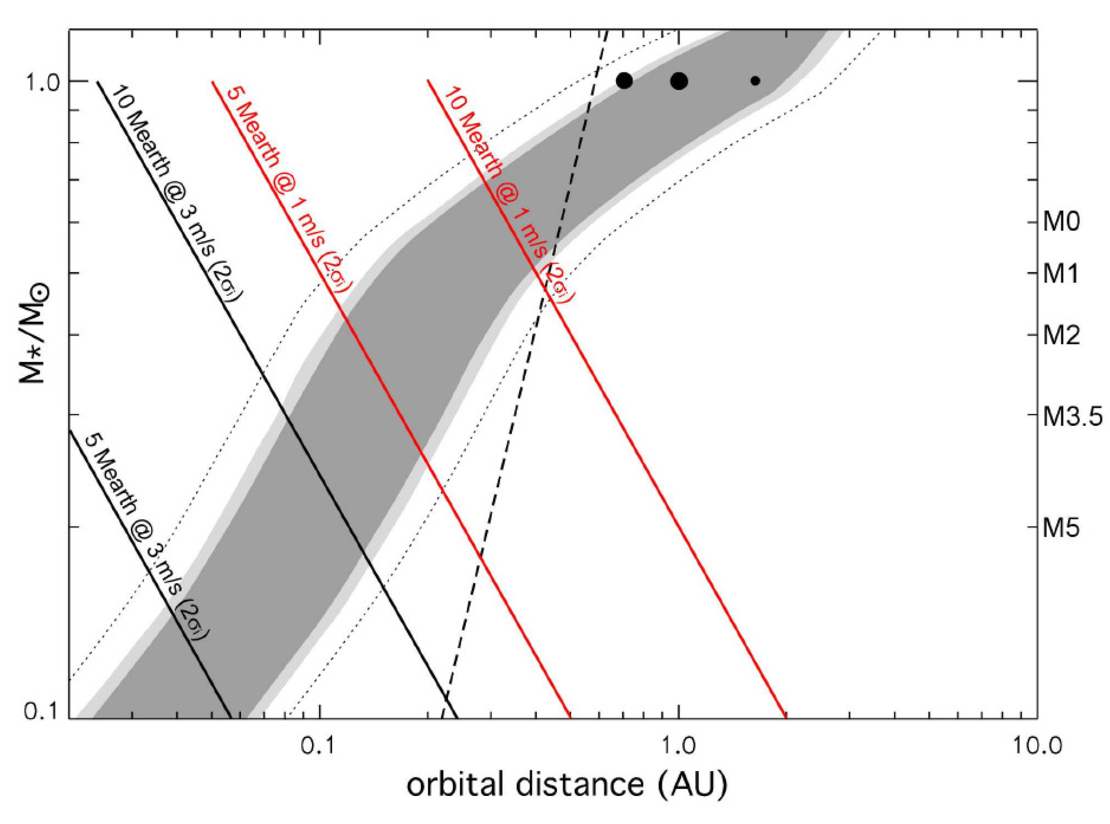


**Fig. 1.** Habitable zone as a function of stellar mass and orbital separation. The dashed line indicates the tidal locking distance. Solid lines illustrate the detection limits of super-Earth type planets at different radial velocity precisions.

**References**

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## M-dwarf sample

In order to select the best M-dwarf candidates for the survey, we are compiling and exhaustive list of M-type stars in the CARMENCITA database (see poster CARMENES III by Caballero et al.).

Most of the stars come from the **Palomar /Michigan State University spectroscopic survey** (PMSU; Reid et al. 1995; Hawley et al. 1996). This catalog lists spectral types, magnitudes, parallaxes, Hα equivalent widths, and kinematics for more than 2000 late-type stars.

**Selection criteria:**
- **declination δ > -23º**: observability
- ***J* mag**: it limits the radial velocity precision (see Table 1)
- **single stars**: stars with close companions with separations ρ<5 arcsec are discarded (see poster CARMENES V by Cortés-Contreras et al.)

**Rotation velocity** represents an additional limitation because larger values of ***v*sin*i*** reduce the precision of the radial velocity measurements. For this reason, high-resolution spectroscopic observations are being taken to measure the rotation velocity of each target.

## Additional targets

We also included in our sample few more M dwarfs coming from databases such as **RECONS** (http://www.recons.org/) and **DwarfArchives** (http://www.dwarfarchives.org); other surveys (Bochanski et al. 2005; Boyd et al. 2011; Irwin et al. 2011), and virtual observatory techniques.

But the major improvement comes from the recent catalog of bright M dwarfs by **Lépine & Gaidos (2011,** 2012; hereafter **LG2011)**. This catalog lists about 9000 M-type stars that significantly increase the number of targets in our sample (see Table 1).

However, the properties of these stars are derived from photometric calibrations that do not provide accurate spectral types, particularly for very-late M-dwarfs (see Fig. 3). For these reason, we are currently carrying out **low-resolution spectroscopic observations** of these stars with the aim of deriving accurate spectral types (see poster CARMENES IV by Alonso-Floriano et al.).

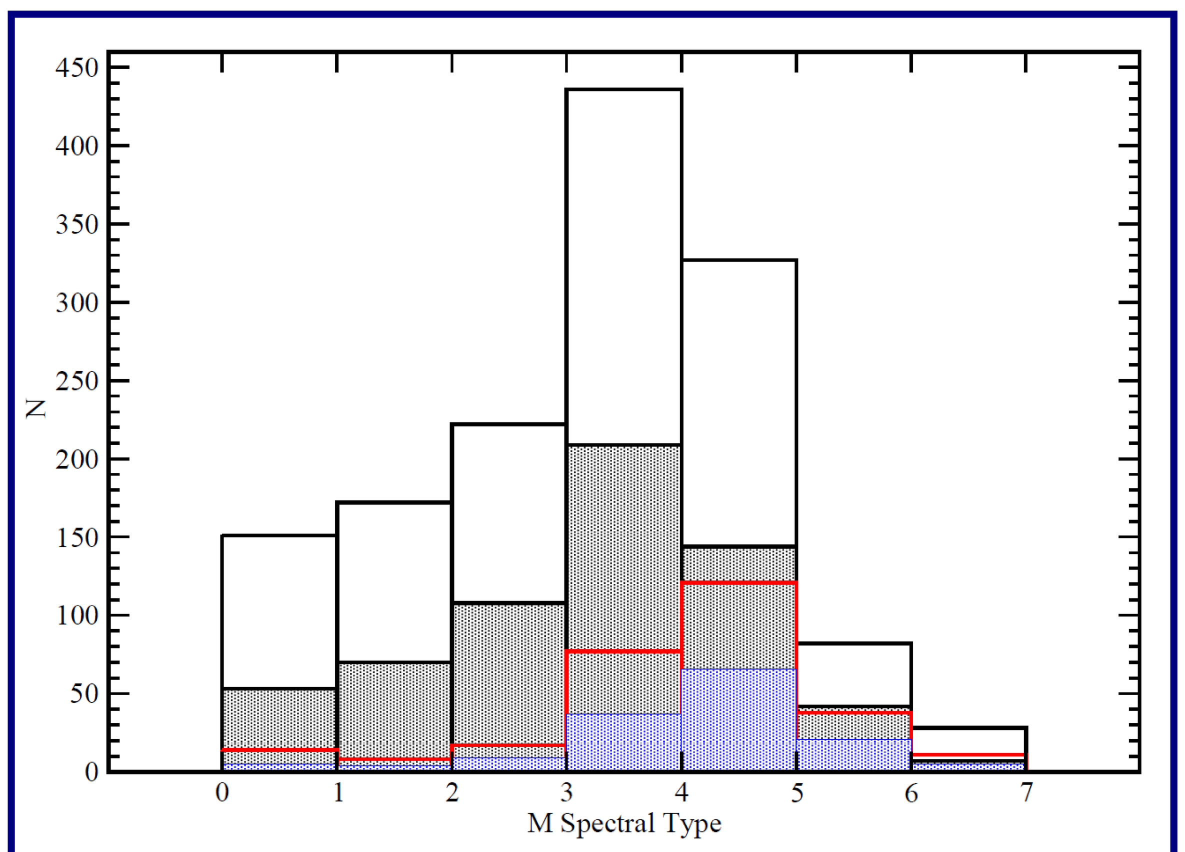


**Fig. 2.** Number of stars in the PMSU survey as a function of the spectral type (black). The number of active stars is also shown in red. Filled bars represent the number of stars that fulfill the CARMENES requirements, and the number of such stars that are active are shown in blue.

**Table 1.** J-band threshold for each spectral type, number of stars in PMSU and number of new targets from LG2011 that can be added to our sample.

| SpT | *J* (mag) | N (PMSU) | ΔN (LG2011) |
|---|---|---|---|
| M0 | <7.5 | 53 | 14 |
| M1 | <8.0 | 70 | 15 |
| M2 | <8.5 | 108 | 36 |
| M3 | <9.0 | 209 | 96 |
| M4 | <9.5 | 144 | 240 |
| M5 | <10.0 | 42 | 169 |
| ≥M6 | <10.5 | 7 | 51 |

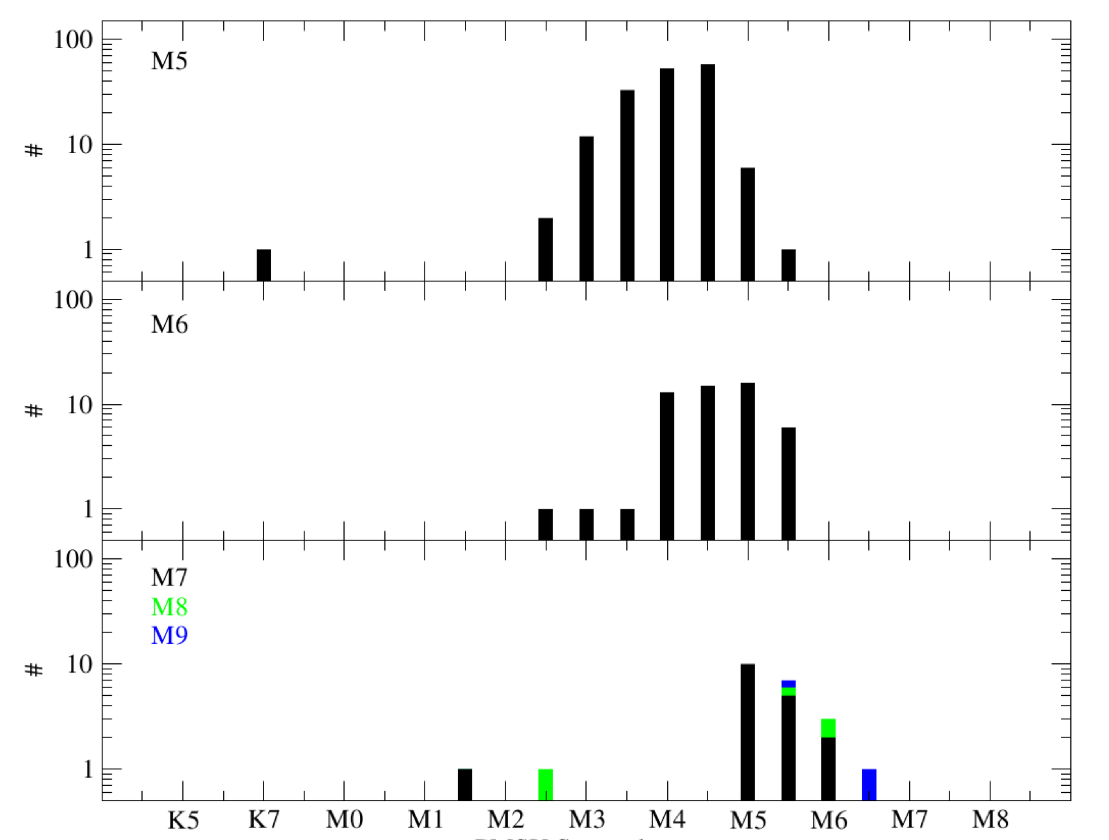


**Figure 3.** Comparison of the spectral types given by LG2011 (labeled in each panel) and those in the PMSU catalog for the stars present in both catalogs.

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