Astrophysical parameters of M dwarfs with exoplanets

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Calar **A**lto high-**R**esolution search for **M** dwarfs with **E**xo-Earths with **N**ear-Infrared and optical **E**chelle **S**pectrographs

The Consortium

carmenes is a key project that involves eleven Spanish and German institutions. From January 1st, 2016 is monitoring **325** M dwarfs. So far, **7** planet candidates have been reported, including **Barnard's Star b**, the nearest planet to the Sun hosted by a single star.

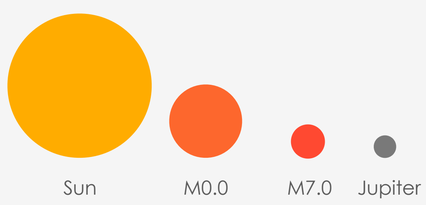
The Instrument

carmenes is a pair of very high resolution spectrographs working in the visible and in the IR. It is optimised for the search of Earth-mass planets around M dwarfs using the radial velocity method. It is mounted on the 3.5m telescope in Calar Alto, Almería.

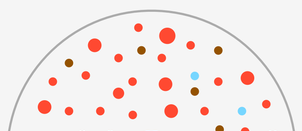
The Stars

Carmencita is the carmenes catalogue of M dwarfs. They are by far the most numerous stars and the most suitable for radial velocity investigations. Studying their properties is an essential step to characterise their planetary companions.

M dwarfs

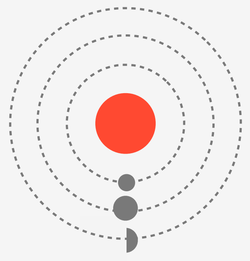


M dwarfs have:
8 - 60 % solar mass
1.5 - 7.2 x10^{-2} solar luminosity
2300 - 3800 K

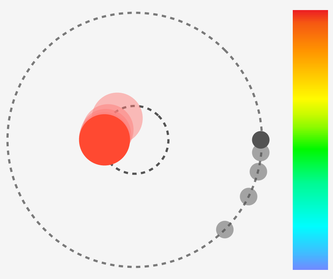


M dwarfs in the **Solar neighbourhood** at less than 5 pc
(Not to scale)

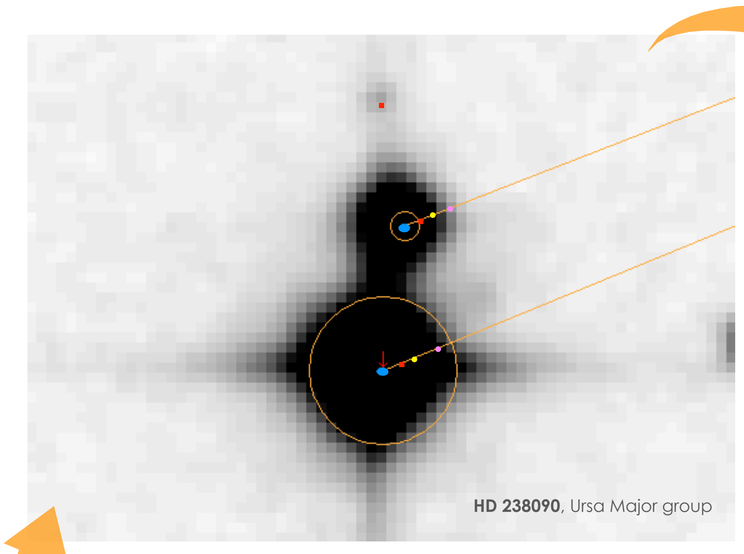
50 out of **64** are M dwarfs!



Planet occurrence
2.5 planets per M dwarf
From **1** to **4** Earth radii
~16% are Earth-size planets

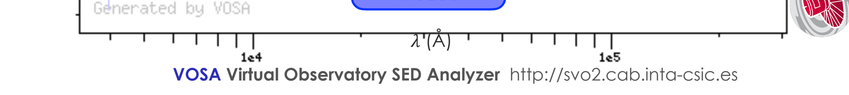


Radial velocity method
is based on the
Doppler effect
Other phenomena can mimic radial velocity signals from a planet!



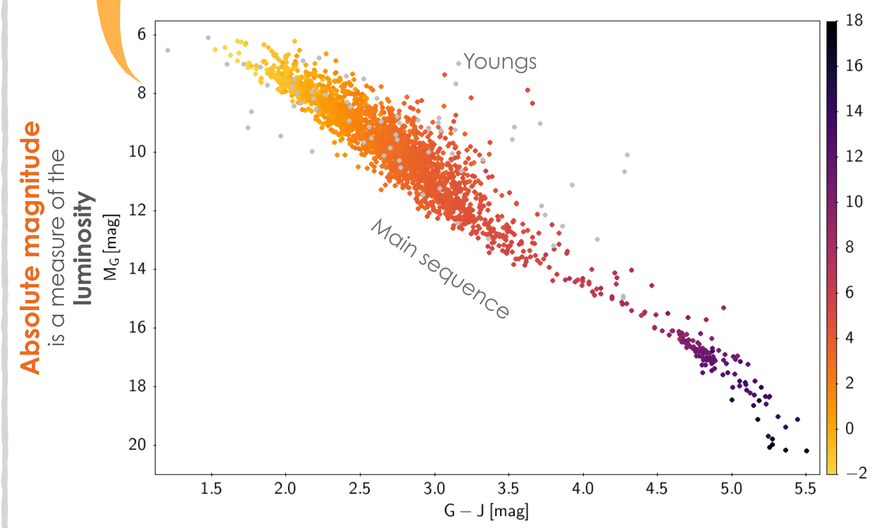
Observation

Different ground- and space-based missions have observed **Carmencita** stars using multiple filters. Studying the presence of close stellar companions is also fundamental.



Photometry

The photometric data collected covers all the spectral range from UV to nIR. It contains information about the fluxes in individual filters, and the total flux or luminosity.



Colour
is a good indicator of the
effective temperature

VOSA **Virtual Observatory SED Analyzer** http://svo2.cab.inta-csic.es

SED

Using this photometry we can build the **Spectral Energy Distribution**. Fitting the empirical data to spectra models using **VOSA** it is possible to compute the luminosity and the effective temperature, and to draw important conclusions.

carmenes VIS Spectra → log g [Fe/H] → L, T_{eff} → R → M

Astrophysical parameters determine the emergence and evolution of planetary companions. They also play a fundamental role on their conditions for habitability.

Habitable zone

The **luminosity** of a star defines a circumstellar habitable zone where water can be in liquid form. It is much more difficult for a planet outside this orbit to support life.

Activity

M dwarfs are extremely active stars, specially in their youth. This manifests as a **flux excess** in the ultraviolet and has severe implications on the orbiting planets' habitability.

Tidal locking

In close orbits, **gravitational** influence, leads to synchronous rotation. One hemisphere always faces the star and lacking rotation prevents from developing a magnetic field.

Exomoons

In a planet that is locked to its star, a **moon** can represent a chance for habitability. Still, it would face its own difficulties, such as tidal heating and the effect of eclipses.