CARMENES-Gaia synergies

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What does CARMENES mean?

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

CARMENES main facts

- Two-channel spectrograph (VIS, NIR: $\Delta\lambda$ = 0.5-1.7 μm)
- Final Design Review in Feb 2013 (docs on next Friday)
- 1 m/s radial-velocity accuracy
- First light in mid 2014 (VIS)
- 600-750 guaranteed nights for core programme
- Exoplanets around M dwarfs
- Around 300 targets carefully selected
- Essentially, the brightest, latest M dwarfs in the solar neighbourhood

carmenes

carmenes.caha.es Monthly Planet January 2013, No. 1

The CARMENES Final Design Review gets close

The review will be on 19-20 February 2013 at the Instituto de Astrofisica de Andalucia

Granada. By the end of February, the CARMENES project will be reviewed by an external panel of international experts in astronomical instrumentation. Representatives of the major funding bodies will also participate in the review. The FDR documentation set, with over 2000 pages, contains all the information for building the spectrograph, from the detectors, through the calibration units, to the pipeline computers.

Receipt of the engineering-grade NIR detector at MPIA

Heidelberg. As illustrated by the figure above, the engineering grade Hawaii-2RG from Teledyne arrived in Heidelberg in good order and is ready to start being tested.

Improvements of the Fabry-Pérot wavemeters

Gottingen. Mathias Zechmeister presented the first synthetic spectra of the IAG Fabry-Pérot etalon and a Phoenix Cond model of a star with T_{eff}=3000 K, logg = 5.0 and Z=0.0.

Order of VIS camera

Almeria/St. Gallen. The VIS camera order was recently put in place. After a visit by Walter Seifert and Wenli Xu, the Swiss company Fisba Optik AG was chosen for the manufacture.

SPIE paper published

Amsterdam. *CARMENES. I: instrument and survey overview*, by Quirrenbach, Amado, Seifert et al. (2012, SPIE, 8446, E0R), eventually appeared in the ADS. It includes all the consortium members as co-authors.

http://**carmenes.caha.es**

CARMENCITA: 1500+ stars

Karmn | Comp | Class | Flags | Name | GJ | SpT | Ref01 | RA_J2000 | DE_J2000 | Ref02 | Ra_mag | Ref03 | IN_mag | Ref04 | J_mag | eJ_mag | H_mag | eH_mag | Ks_mag | eKs_mag | QFlag | Ref05 | WideCompanion | WideWDS | Widerho_arcsec | eWiderho_arcsec | Ref06 | WideCompanionSpT | WideCompanionJ_mag | WideCompanionFeH | Ref07 | CloseMultiplicity | CloseWDS | Closerho_arcsec | eCloserho_arcsec | Ref08 | **pi_mas** | **epi_mas** | **Ref09** | **d_pc** | **ed_pc** | **Ref10** | pEWHalpha_A | Ref11 | 1RXS | CRT_s-1 | eCRT_s-1 | HR1 | eHR1 | HR2 | eHR2 | Ref12 | vsini_kms-1 | evsini_kms-1 | Ref13 | Vr_kms-1 | eVr_kms-1 | Ref14 | TiO5 | CaH2 | Ref15 | OtherActivityIndicators | Flare | Ref16 | P_d | Ref17 | **muRA_masa-1** | **emuRA_masa-1** | **muDE_masa-1** | emuDE_masa-1 | Ref18 | MV_mag | Ref19 | U_kms-1 | eU_kms-1 | V_kms-1 | eV_kms-1 | W_kms-1 | eW_kms-1 | Ref20 | RV | Planet | Ref21 | Origin | Notes

CARMENCITA: 1500+ stars

Carmencita

carmenes

- **Public**
- **Private**
- Carmencita
- Database
- Search
- **Referees**

CARMENCITA

Database

More data • Ascii file • XML file

recno	Karmn	Class	Name	SpT	RA_J2000	DE_J2000	J_mag	vsini_kms_1
1	J00051+457	Alpha	GJ 2	M1.0 V	00:05:10.78	+45:47:11.6	6.704	...
2	J00056+458	Alpha	HD 38B	M0.0 V	00:05:40.90	+45:48:37.5	6.142	...
3	J00067-075	Alpha	GJ 1002	M5.5 V	00:06:43.26	-07:32:14.7	8.323	<12
4	J00079+080	Beta	LHS 1022	M3.0 V	00:07:59.09	+08:00:19.1	9.392	...
5	J00084+174	Beta	[RHG95] 23	M0.0 V	00:08:27.30	+17:25:27.5	7.807	...
6	J00088+208	Alpha	LP 404-033	M4.5 V	00:08:53.92	+20:50:25.2	8.870	...
7	J00115+591	Alpha	LSR J0011+5908	M6.0 V	00:11:31.82	+59:08:40.0	9.945	...

BajaMasa RecGaia
Líneas de investigación

- **EXOS:** sistemas exoplanetarios
  - EXOS-1: astrometría de sistemas conocidos
  - EXOS-2: velocidad radial de nuevos sistemas
  - EXOS-3: caracterización detallada (astrosismología)
- **MLT:** enanas ultrafrías
  - MLT-1: M tardías (diagrama H-R, cinemática…)
  - MLT-2: L y T (aisladas o como compañeras)
- **YBD:** enanas marrones jóvenes
  - Parte baja de (I)MF en cúmulos estelares y asociaciones

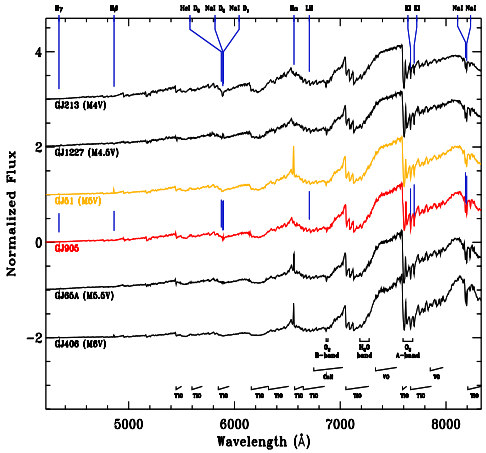
Synergies I

- **CARMENES → *Gaia*:**
  - Accurate radial velocities of M dwarfs (*Vr*: *G* > 13 mag)
  - Rotational velocities (*vsini*: *G* > 17 mag)
  - Spectral types (science preparation)
  - Reliable abundances (*G* > 12 mag)
  - Activity indicators (and Ca IRT at much higher resolution)

CARMENCITA: low-res spec.

CAFOS @ 2.2m

Least square minimitation



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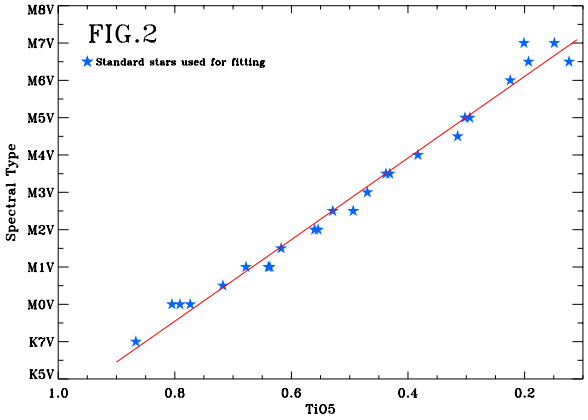
SpT vs Spectral indices



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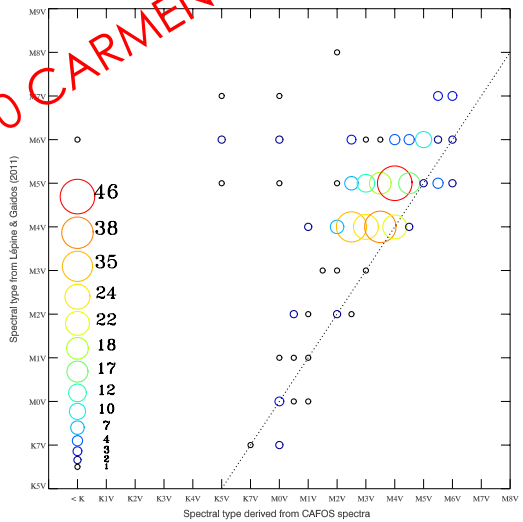
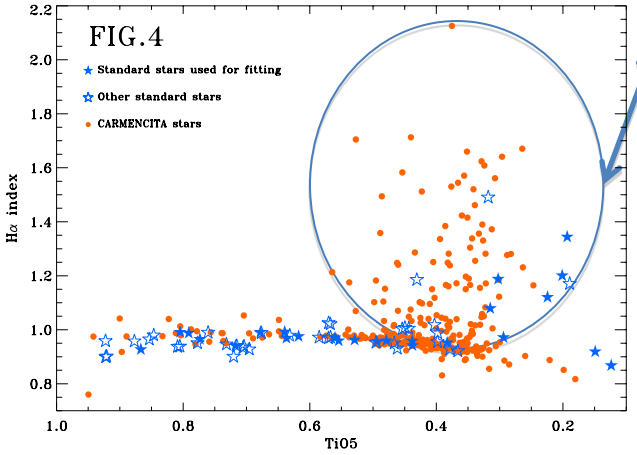
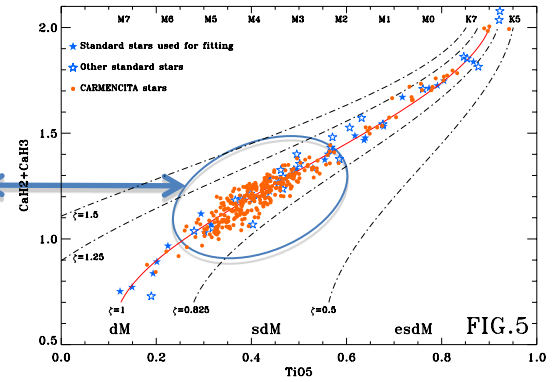
>450 CARMENCITA





Stellar Activity
Ha index

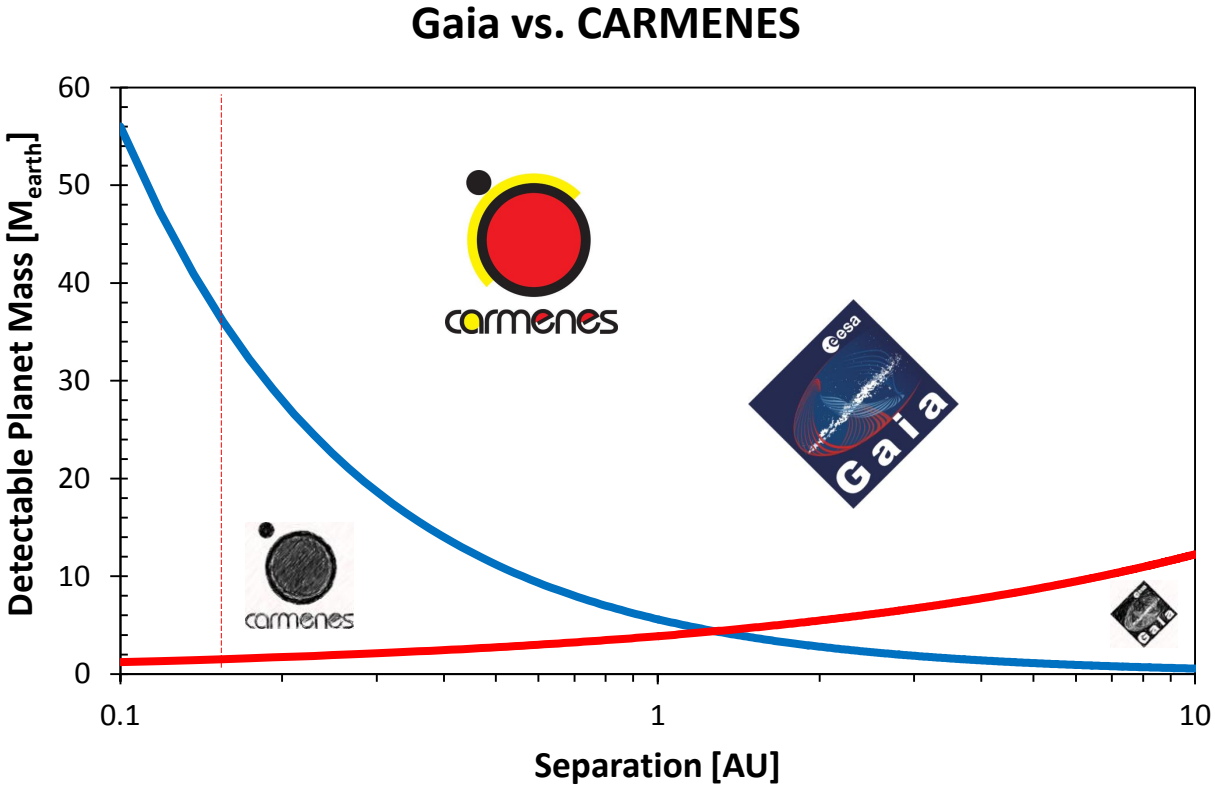
Relative Metallicities



Synergies II


- ***Gaia* → CARMENES:**
  - Accurate parallactic distances to *all* targets (→ absolute magnitudes, luminosities, radii…)
  - Very accurate proper motions (→ galactic space velocities, stellar kinematic groups, wide multiplicity…)
  - Unresolved multiplicity ($\rho < 0.2$ arcsec)
  - Astrometric upper limits to radial-velocity companion mass (or even *determination of real masses!*)

Synergies example



- Typical distance
  $d = 20\ pc$
- Typical star mass
  $M_\star = 0.12\ M_\odot$
- $\alpha = 7$ μas
- Vr = 1 m/s

$$\alpha[\mu as] = 3\,\frac{M_p[M_{earth}]\,a[AU]}{M_*[M_\odot]\,d[pc]}$$

$$Vr[m/s] = 0.089\,\frac{M_P[M_{earth}]\sin i}{\sqrt{a[AU]M_*[M_\odot]}}$$

Conclusions

- CARMENES provides interesting data to Gaia

Radial and Rotational velocities, Spectral types, Abundances, Activity indicators …

- Gaia provides interesting data to CARMENES

Parallactic distances, Proper motions, Multiplicity …

- Many exoplanets around M stars could be detected by GAIA & CARMENENES

d pc	Msol	a		
10	0.5	0.35	1	2
muas	100	476	167	83
	12	57	20	10
	7	33	12	6

d pc	Msol				
20	0.25	0.1	0.5	1	2
	100	1667	333	167	83
	12	200	40	20	10
	7	117	23	12	6

d pc	Msol	a		
20	0.5	0.35	1	2
muas	100	952	333	167
	12	114	40	20
	7	67	23	12

d pc	Msol				
20	0.12	0.1	0.5	1	2
	100	800	160	80	40
	12	96	19	10	5
	7	56	11	6	3

Msol	Lsol	ZH	0.95	1.15
0.25	0.015625	0.125	0.11875	0.14375
0.12	0.001728	0.04156922	0.00493634	0.00597558