# Evolved stars The metallicity - giant planet connection

## Annelies Mortier

Nuno C. Santos, S. Sousa, V. Adibekyan, E. Delgado Mena, M. Tsantaki, G. Israelian, M. Mayor

> XXIII ENAA 18 July 2013

Lisboa, Portugal







# Outline

## Introduction

2 Metallicity connection for dwarf stars

#### Giant stars and metallicities

- Sample
- Deriving stellar parameters
- Possible bias
- Metallicity enhancement?

### 4 SWEETCat

## 5 Conclusions

- Around 900 planets discovered
- Several detection methods:

Direct imaging, **Photometry (transits), Radial Velocity**, Astrometry, Microlensing, Pulsar timing



- Around 900 planets discovered
- Several detection methods:

Direct imaging, **Photometry (transits), Radial Velocity**, Astrometry, Microlensing, Pulsar timing

 $\bullet\,$  Most hosts are dwarf stars, but  $\sim 20\%$  (sub)giants



- Around 900 planets discovered
- Several detection methods:

Direct imaging, **Photometry (transits), Radial Velocity**, Astrometry, Microlensing, Pulsar timing

- $\bullet\,$  Most hosts are dwarf stars, but  $\sim 20\%$  (sub)giants
- Theory of planet formation and evolution still under debate (Pollack et al. 1996, Mayer et al. 2002, Mordasini et al. 2009)
  Core accretion
  Gravitational instability

## Introduction



H. Levin 2005



Quinn et al. 2002

- Around 900 planets discovered
- Several detection methods:

Direct imaging, **Photometry (transits), Radial Velocity**, Astrometry, Microlensing, Pulsar timing

- Most hosts are dwarf stars, but  $\sim 20\%$  (sub)giants
- Theory of planet formation and evolution still under debate (Pollack et al. 1996, Mayer et al. 2002, Mordasini et al. 2009)
  Core accretion Gravitational instability
- Stellar mass, metallicity, disk composition, ... influence planet formation processes

## Giant planet frequency - dwarf stars



(Udry & Santos 2007)

(Johnson et al. 2010)

#### Increasing function of metallicity

Annelies Mortier (CAUP)



<sup>(</sup>Mortier et al. 2013)

No statistical difference between flat or exponential tail

Annelies Mortier (CAUP)

## Evolved planet hosts in literature



HM07: same metallicity enhancement as for dwarfs

## Evolved planet hosts in literature



Mal13: no for giants, yes for subgiants



71 evolved planet hosts;  $\log q < 4.0$ ; high resolution spectra

Annelies Mortier (CAUP)

#### • High resolution spectroscopy

- Equivalent widths of Fel and Fell lines with ARES
- Imposing excitation and ionization equilibrium assuming LTE, using the MOOG code

• Stellar evolutionary models from the **Padova** group through their webinterface  $\Rightarrow M_{\odot}$ 

#### Two different line list sets

- Hekker & Melendez 2007
- Sousa et al. 2008 + Tsantaki et al. 2013

 $\Rightarrow T_{eff}$ , [Fe/H]

 $\log g, \xi_t$ 



(Tsantaki et al. 2013)

#### TS13 better for cool stars than SO08

## Comparing different linelists



(Mortier et al. 2013b)

#### Results agree well $\rightarrow$ SO08 + TS13 adopted

Annelies Mortier (CAUP)

## Comparing with literature



(Mortier et al. 2013b)

#### Good agreement with different literature works

Annelies Mortier (CAUP)

## Dwarfs versus giants



(Mortier et al. 2013b)

Dwarf planet hosts more metal-rich than giant stars with planets

Annelies Mortier (CAUP)

## Bias in search samples



(Mortier et al. 2013b)

### Planet search samples of (sub)giant stars have a metallicity bias due to B-V colour cut



(Mortier et al. 2013b)

#### We find no metallicity enhancement for giant stars with planets

Annelies Mortier (CAUP)

# SWEETCat

#### Parameters from this sample added to homogeneous planet host catalogue

#### SWEET-Cat: a catalog of stellar parameters for stars with planets

ownload Data

Name	HD number	RA	Dec	Vmag	o(Vmag)	π	σ(π)	Source of $\pi$	Teff	o(Teff)	logg	σ(logg)	LC logg	σ(LC logg)	Vt	o(Vt)	[Fe/H]	o([Fe/H])	Mass	σ(I
11 Com	107383	12 20 43.02	+17 47 34.33	4.74	0.02	11.25	0.22	Simbad	4830	79	2.61	0.13			1.70	0.10	-0.34	0.06	2.00	0.2
11 UMi	136726	15 17 05.88	+71 49 26.04	5.02		8.19	0.19	Simbad	4340	70	1.60	0.15			1.60	0.80	0.04	0.04	1.80	0.2
14 And	221345	23 31 17.41	+39 14 10.30	5.22		12.63	0.27	Simbad	4773	100	2.53	0.10			1.64	0.30	-0.26	0.11	1.45	
<u>14 Her</u>	145675	16 10 24.31	+43 49 03.52	6.67		56.91	0.34	Simbad	5311	87	4.42	0.18			0.92	0.10	0.43	0.08	0.95	0.0
16 Cyg B	186427	19 41 51.97	+50 31 03.08	6.20		47.14	0.27	Simbad	5772	25	4.40	0.07			1.07	0.04	0.08	0.04	1.00	0.0
18 Del	199665	20 58 25.93	+10 50 21.42	5.52		13.28	0.31	Simbad	5076	38	3.08	0.10			1.32	0.04	0.00	0.03	2.33	0.0
24 Sex	90043	10 23 28.37	-00 54 08.09	6.44	0.01	12.91	0.38	Simbad	5069	62	3.40	0.13			1.27	0.07	-0.01	0.05	1.81	0.0
<u>30 Ari B</u>	16232	02 36 57.74	+24 38 53.02	7.09		24.52	\$.68	Simbad	6377	170	4.49	0.05			~		0.14	0.18	1.16	0.0
4 Uma	73108	08 40 12.81	+64 19 40.57	4.60		12.74	0.26	Simbad	4564	100	2.28	0.10			1.69	0.30	-0.16	0.13	1.48	
42 Dra	170693	18 25 59.13	+65 33 48.52	4.83		10.36	0.20	Simbad	4513	100	2.24	0.10			1.59	0.30	-0.39	0.12	1.74	
<u>47 Uma</u>	95128	10 59 27.97	+40 25 48.92	5.04	0.05	71.11	0.25	Simbad	5954	25	4.44	0.10			1.30	0.04	0.06	0.03	1.04	0.0
51 Peg	217014	22 57 27.98	+20 46 07.79	5.46	0.05	64.07	0.38	Simbad	5804	36	4.42	0.07			1.20	0.05	0.20	0.05	1.04	0.0
55 Cnc	75732	08 52 35.81	+28 19 50.95	5.95	0.05	81.03	0.75	Simbad	5279	62	4.37	0.18			0.98	0.07	0.33	0.07	0.93	0.0
6 Lyn	45410	06 30 47.10	+58 09 45.48	5.88		17.92	0.47	Simbad	4978	18	3.16	0.05			1.10	0.07	-0.13	0.02	1.70	0.3
																	(San	tos et	al. 2	013

# Already analysed 70% of all FGKM planet hosts and 96% of all RV detected dwarf hosts

Annelies Mortier (CAUP)

- Analyse giant stars with linelists of Sousa et al. 2008 (T $_{eff}>5200\,{\rm K})$  and Tsantaki et al. 2013 (T $_{eff}<5200\,{\rm K})$
- Comparing dwarf stars with giant stars suffers from sample biases in metallicity
- We find no metallicity enhancement for giant stars with planets, as we do for dwarfs
- Sample is added to the homogeneous catalogue SWEET-Cat

- Analyse giant stars with linelists of Sousa et al. 2008 (T $_{eff}>5200\,{\rm K})$  and Tsantaki et al. 2013 (T $_{eff}<5200\,{\rm K})$
- Comparing dwarf stars with giant stars suffers from sample biases in metallicity
- We find no metallicity enhancement for giant stars with planets, as we do for dwarfs
- Sample is added to the homogeneous catalogue SWEET-Cat

# Stay tuned!