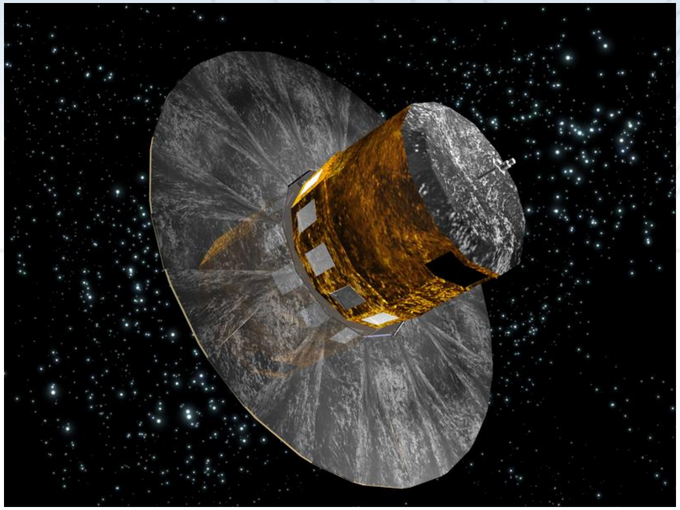


Plato WP127 workshop
25 June2016

Galactic physics
Gaia-Plato synergy

D. Katz (on behalf of the Gaia people)

l'Observatoire de Paris
GEPI
Galaxies Étoiles Physique et Instrumentation

Milky-Way science case

	Gaia	Plato
Galactic structure • Density profiles • Disc warp and flare • Etc…	α, δ, π	
Galactic kinematics & dynamics • Velocity distribution functions • Gravitational instabilities • Resonances • Radial migration	μ_α, μ_δ, V_R	
Gas, dust & stellar phases • Gas and dust distribution • Gas infall and outflow • Star formation, IMF, yields • Chemistry: iron, alpha elements, r and s processes	Av, E_{B-V} Teff, logg, [Fe/H], [X/Fe] multiplicity (mass) variability	Teff, logg Evolutionary stage (e.g. RGB vs RC) variability
Milky-Way formation/evolution • Age/Kinematic, Age/Metallicity, Age/abundances relation • Star Formation Rate, mass assembly history	Age (from "isochrones")	**Age**

Parallaxes: precisions

	B1V	G2V	M6V
V-Ic [mag]	-0.22	0.75	3.85
Bright stars	5-14 µas	5-14 µas	5-14 µas
V=15 mag	26 µas	24 µas	9 µas
V=20 mag	330 µas	290 µas	100 µas

α, δ, π

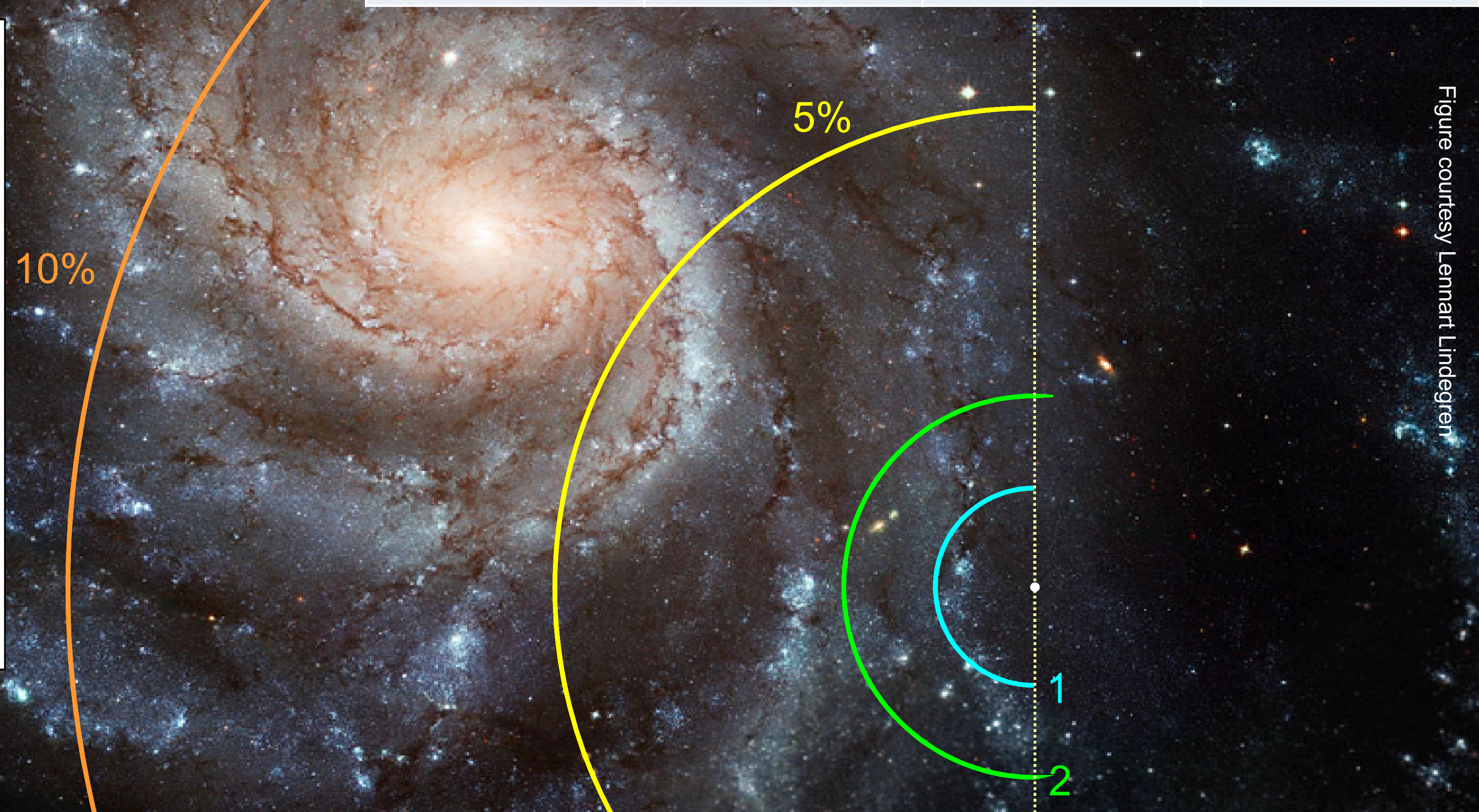
μ_α, μ_δ, V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



10 µas ↔ 10% on distances at 10kpc

Parallaxes: e.g., Mapping the Milky-Way

William Herschel (1785)

α, δ, π

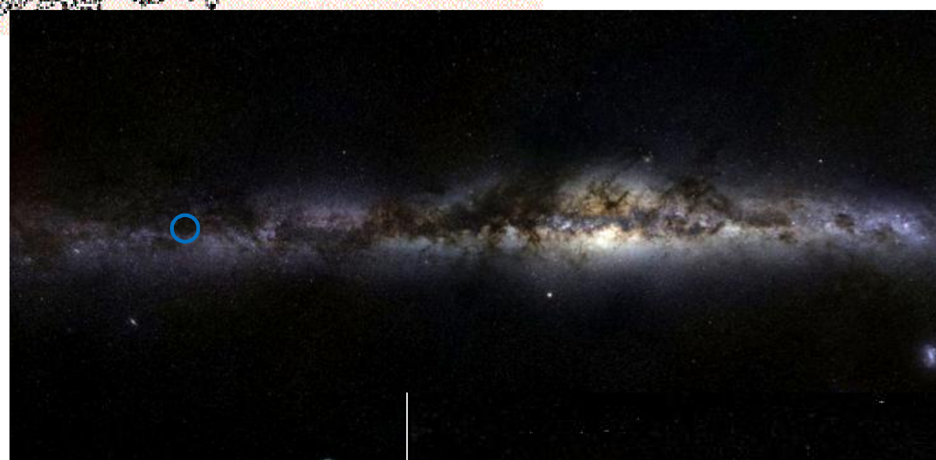
μ_{α}, μ_{δ}, V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

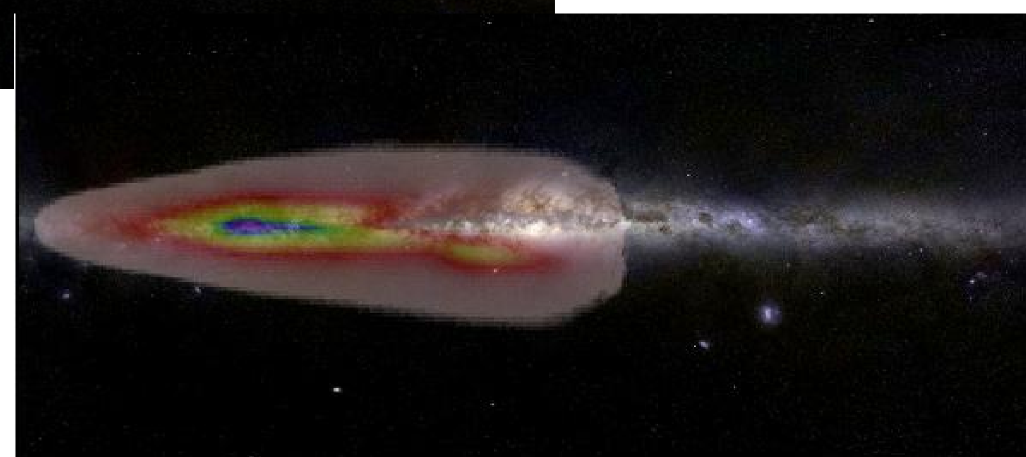
variability

Age



Hipparcos (1993)
30 000 distances
with 10% precision

Gaia
150 millions distances
with 10% precision



Radial velocity: K giant spectrum

HIP 86564 K5 V = 6.64

α, δ, π

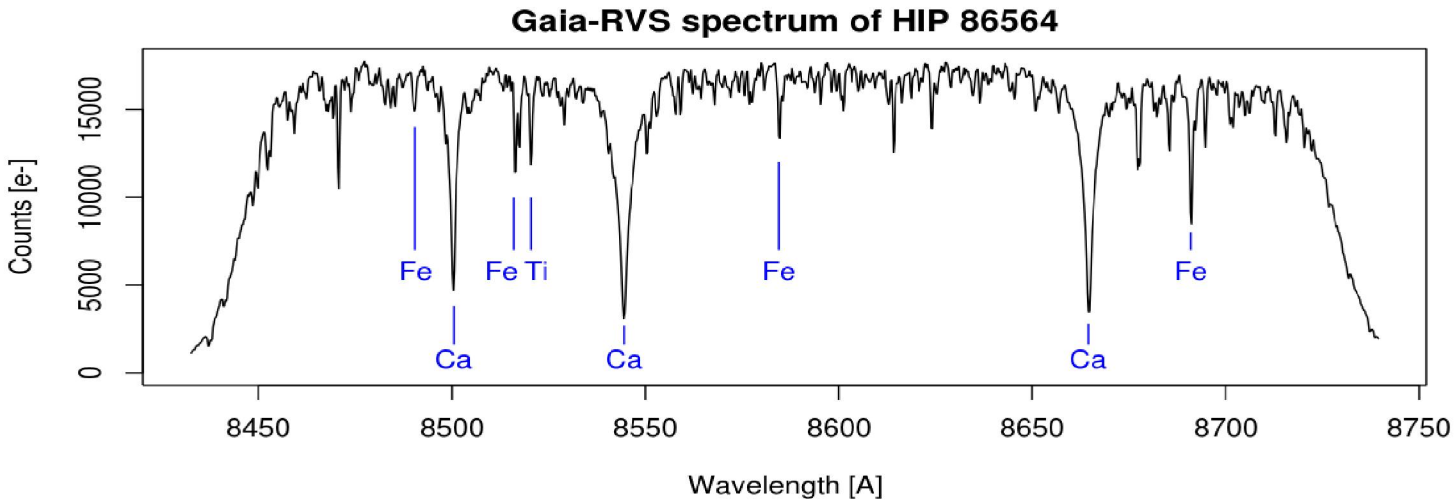
μ_α, μ_δ, V_R

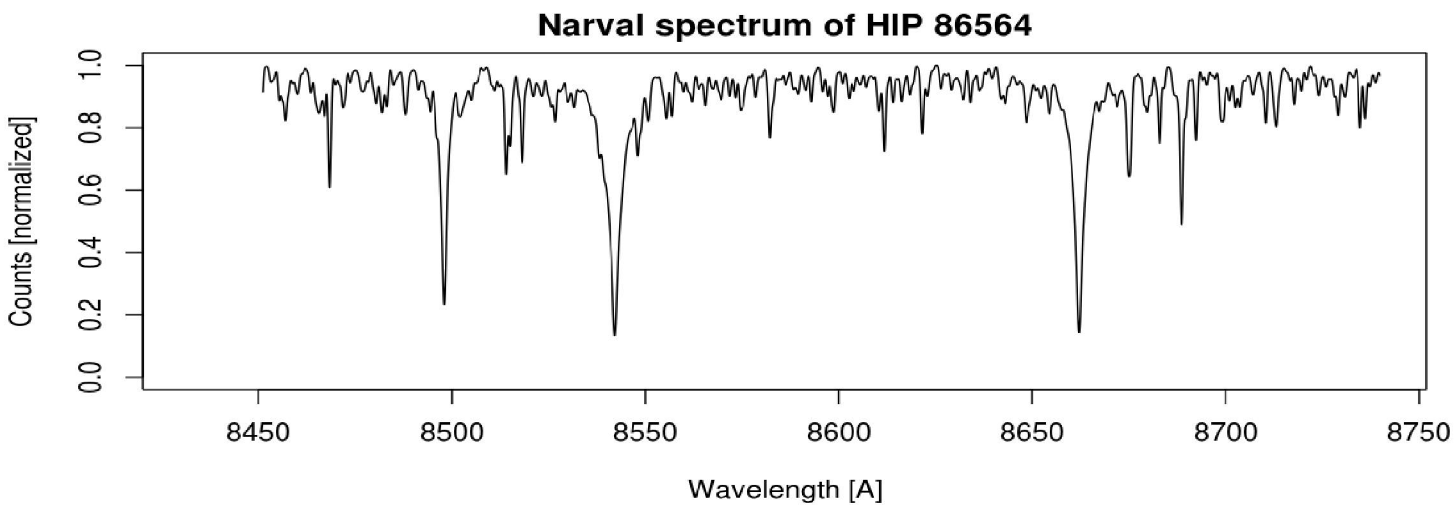
Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age





http://www.cosmos.esa.int/web/gaia

Credits: ESA/Gaia/DPAC/Airbus-DS/
David Katz, Olivier Marchal and Caroline Soubiran

Radial velocity: precisions

α, δ, π

μ_{α}, μ_{δ},

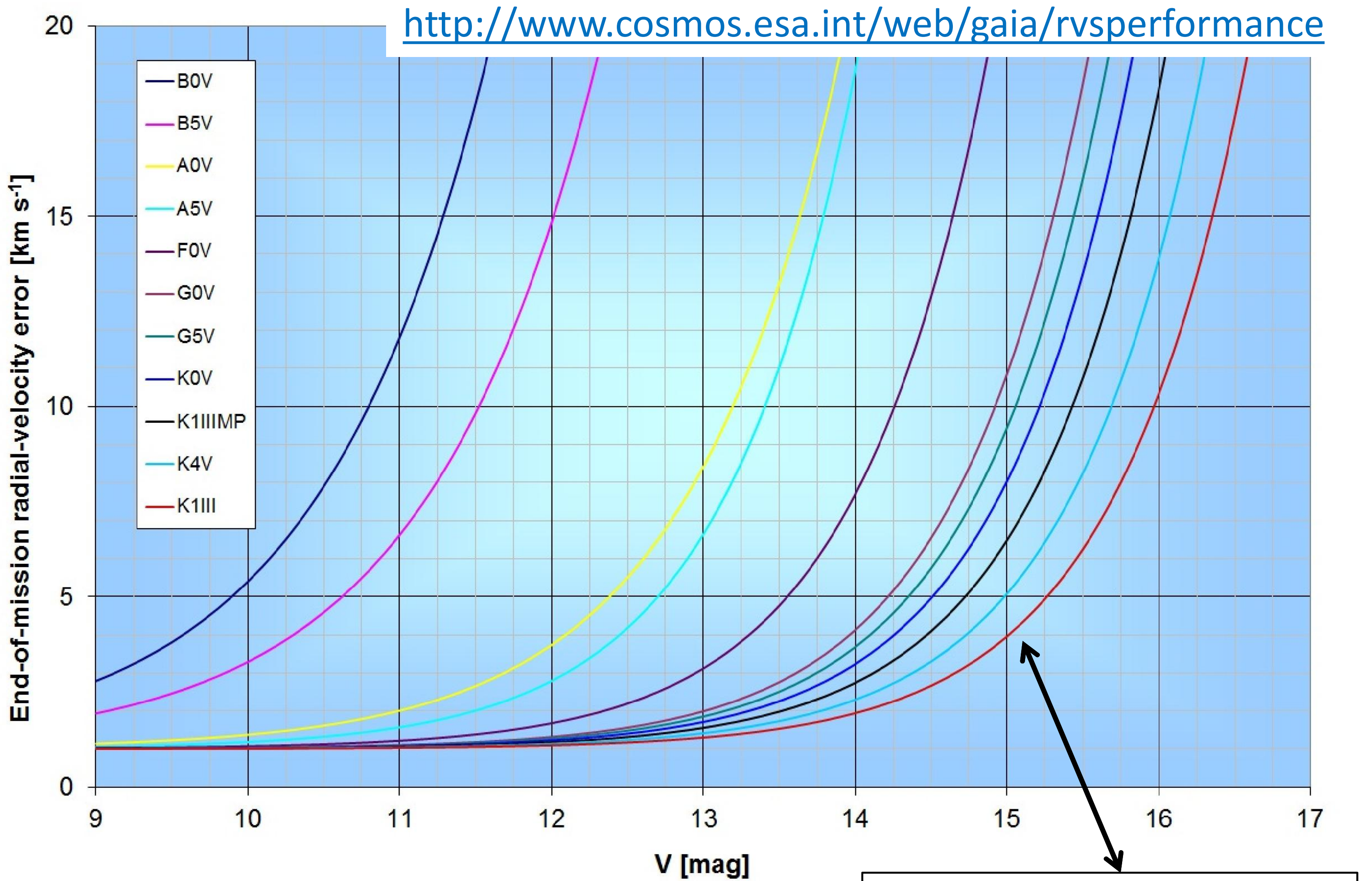
V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



K giant (solar metallicity)

- 1 kpc → $\sigma V_R \leq$ 1 km/s
- 10 kpc → $\sigma V_R \approx$ 4 km/s
- 15 kpc → $\sigma V_R \approx$ 10 km/s

A_V, E_{B-V}: BP-RP, RVS

credits: ESA/Gaia/DPAC/CU6/Observatoire de Paris-Meudon/Olivier Marchal, Carine Babusiaux & David Katz

α, δ, π

μ_α, μ_δ, V_R

Av,

E_{B-V}

Teff, logg

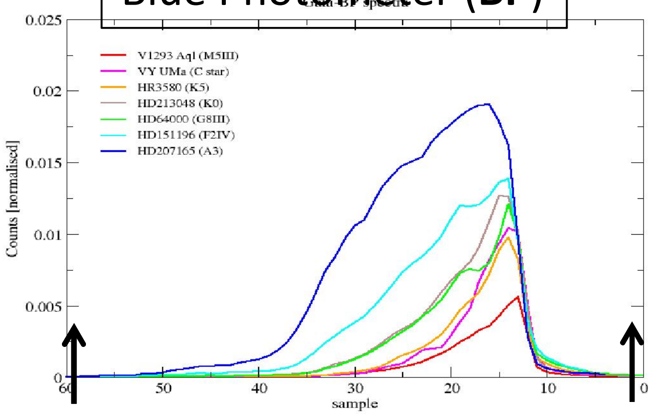
[Fe/H]

[X/Fe]

variability

Age

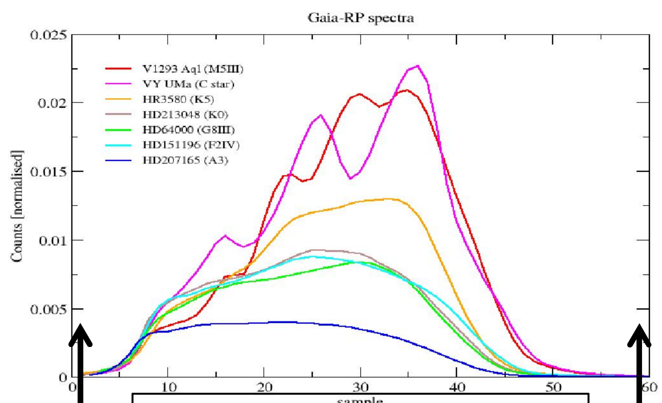
Blue Photometer (**BP**)



330 nm

680 nm

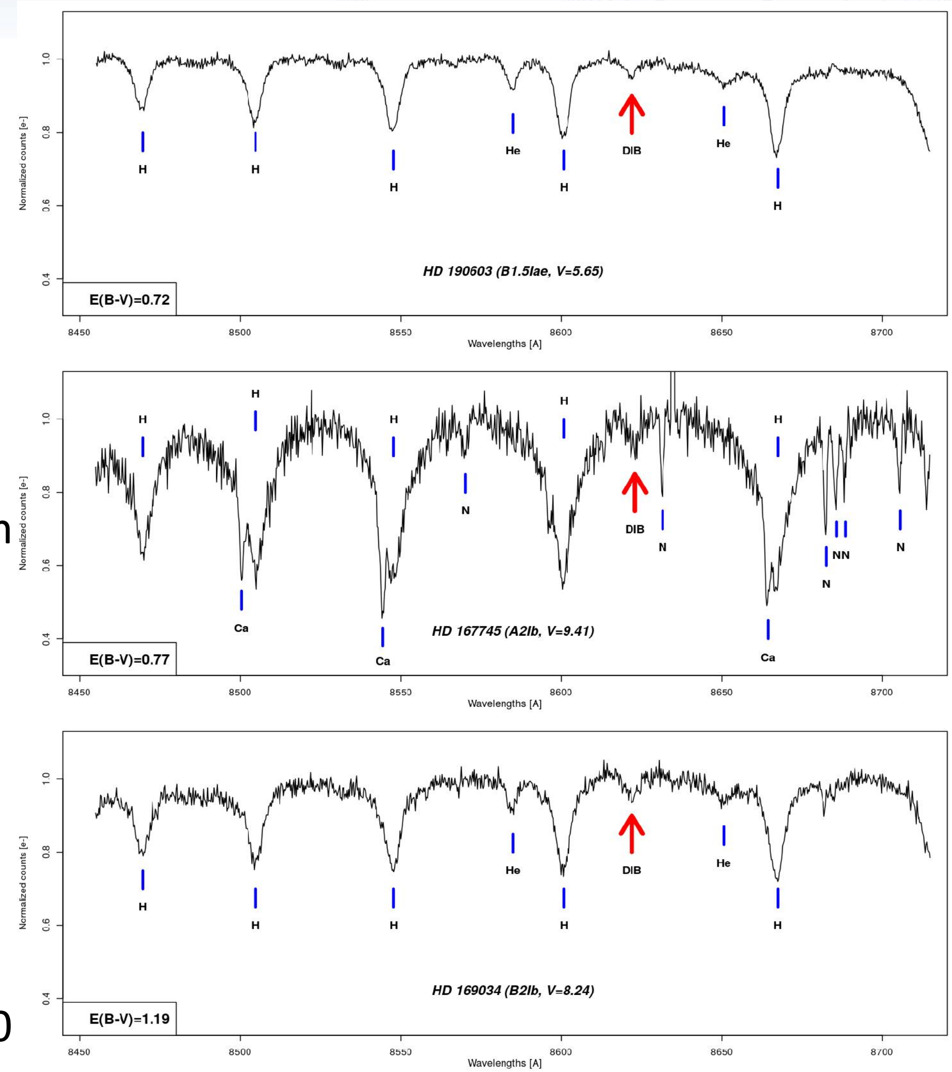
Credits: ESA/Gaia/DPAC/Airbus-DS/ Carme Jordi, J.M. Carrasco



640 nm

1050

Red Photometer (**RP**)



Bailer-Jones, Andrae, Arcay et al.,2013, A&A, 559, A74

G=15 → σA_0 = 0.1 mag

Diffuse Interstellar Band(DIB): 8620 A

E(B-V): E(B-V) = 2.72 × EW (Ang)

Munari, Tomasella, Fiorucci et al., 2008, A&A, 488, 969

Teff, logg, [Fe/H], [α/Fe]: Bp-Rp

α, δ, π

μ_α, μ_δ, V_R

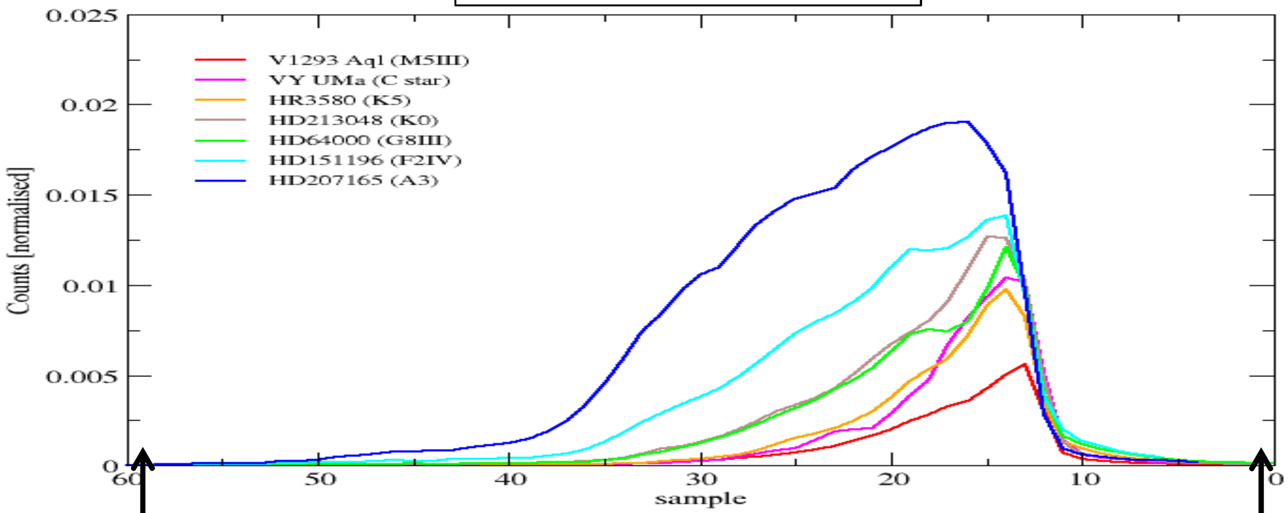
Av, E_{B-V}

Teff,
logg
[Fe/H]
[X/Fe]

variability

Age

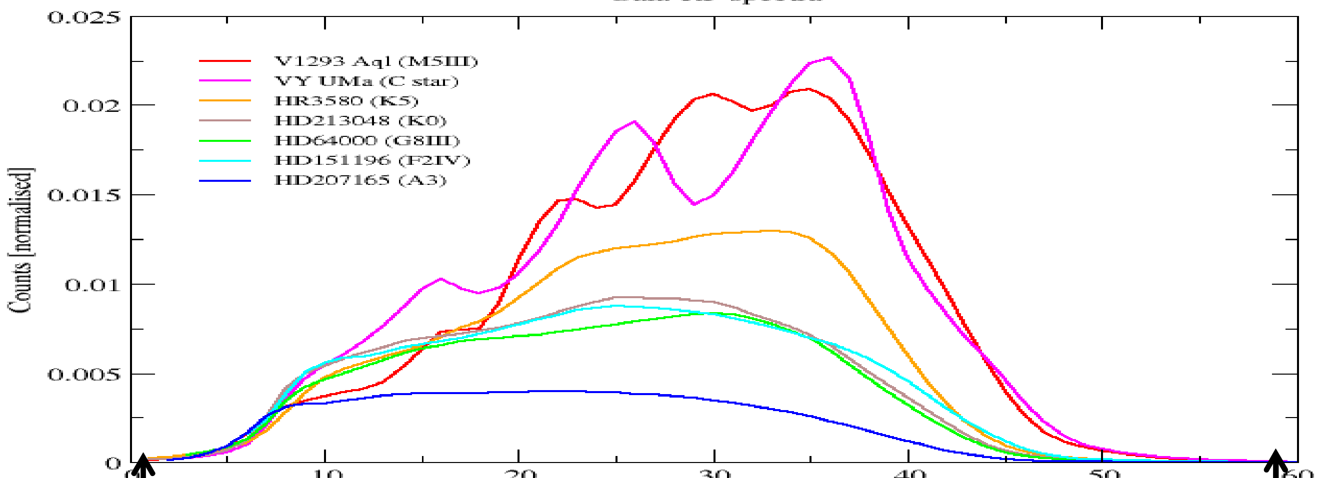
Blue Photometer (**BP**)



330 nm

680 nm

Gaia-RP spectra



640 nm

Red Photometer (**RP**)

1050 nm

Credits: ESA/Gaia/DPAC/Airbus-DS/
Carme Jordi, J.M. Carrasco

Teff, logg, [Fe/H], [α/Fe]: RVS

α, δ, π

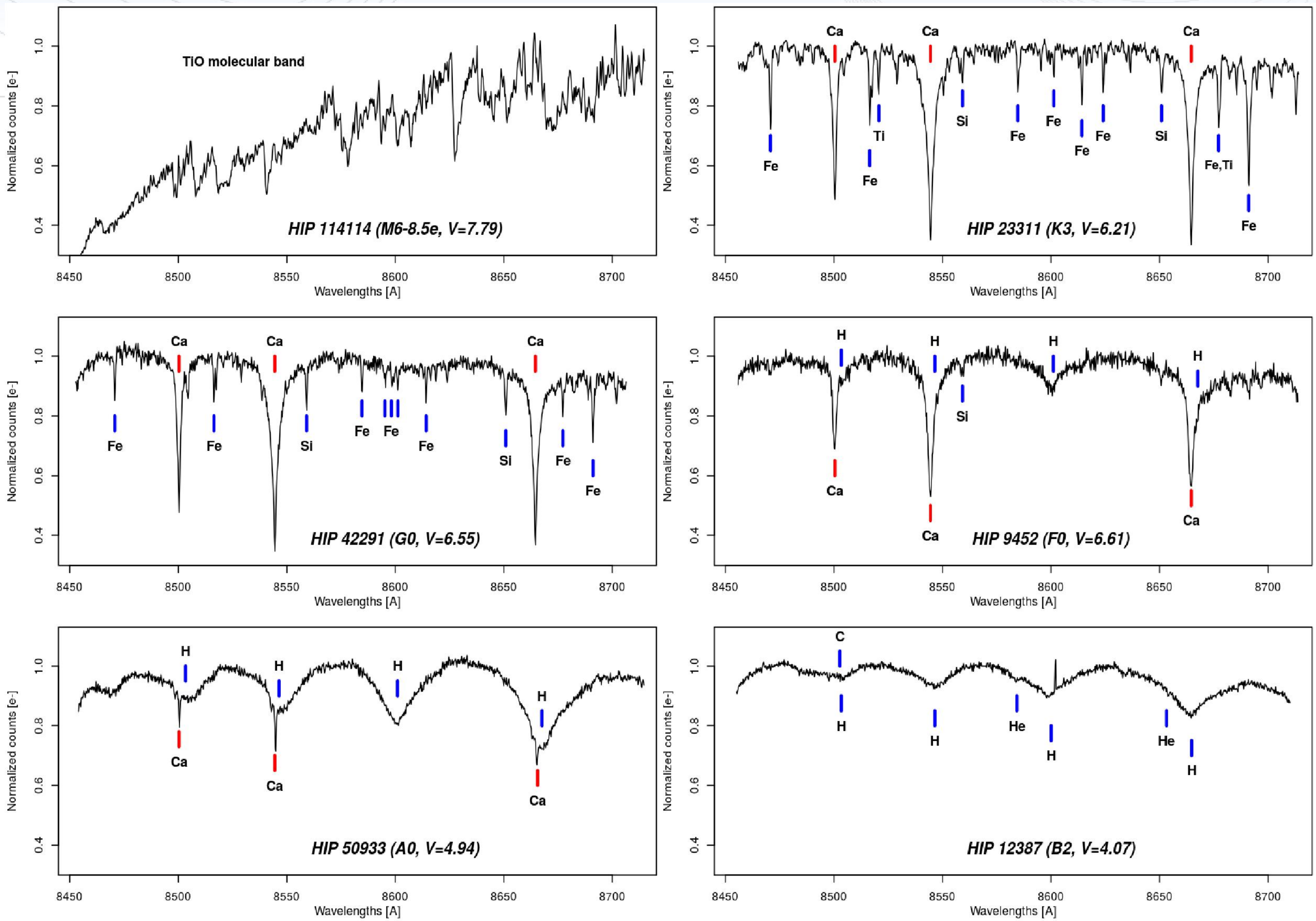
μ_{α}, μ_{δ}, V_R

Av, E_{B-V}

Teff, logg [Fe/H] [X/Fe]

variability

Age



http://www.cosmos.esa.int/web/gaia

Credits: ESA/Gaia/DPAC/
Olivier Marchal , David Katz

Teff, logg, [Fe/H], [α/Fe]: precisions

α, δ, π

μ_α, μ_δ, V_R

Av, E_{B-V}

Teff,
logg
[Fe/H]
[X/Fe]

variability

Age

The Gaia astrophysical parameters inference system (Apsis)
Bailer-Jones, Andrae, Arcay et al., 2013, A&A, 559, A74
BP/RP internal precision, **G=15**

σTeff = 100 K
σlogg = 0.25
σ[Fe/H] = 0.2 dex

*Stellar parametrization from Gaia **RVS** spectra*
Recio-Blanco, de Laverny, Allende-Prieto et al., 2016, A&A, 585, A93
Estimated end-of-mission internal precision (extract from Table 5):

	σTeff		σlogg		σ[Fe/H]		σ[α/Fe]	
Grvs	10.3	12.6	10.3	12.6	10.3	12.6	10.3	12.6
K-giant (solar met.)	21	147	0.06	0.29	0.02	0.12	0.02	0.10
K-giant (metal-poor)	65	289	0.13	0.34	0.07	0.25	0.05	0.19

Plato
Teff & Log g seismic

σlogg = 0.015 dex

(R. Peralta PhD thesis – Corot/Kepler data)

Variability

Credits: ESA/Gaia/DPAC/CU5/DPCI/CU7/INAF-OABo/INAF-OACn Gisella Clementini, Vincenzo Ripepi, Silvio Leccia, Laurent eyer, Lorenzo Rimoldini, Isabelle Lecoeur-Taibi, Nami Mowlavi, Dafydd Eavns, Geneva CU7/DPCG and the whole CU7 team.

α, δ, π

μ_α, μ_δ, V_R

Av, E_{B-V}

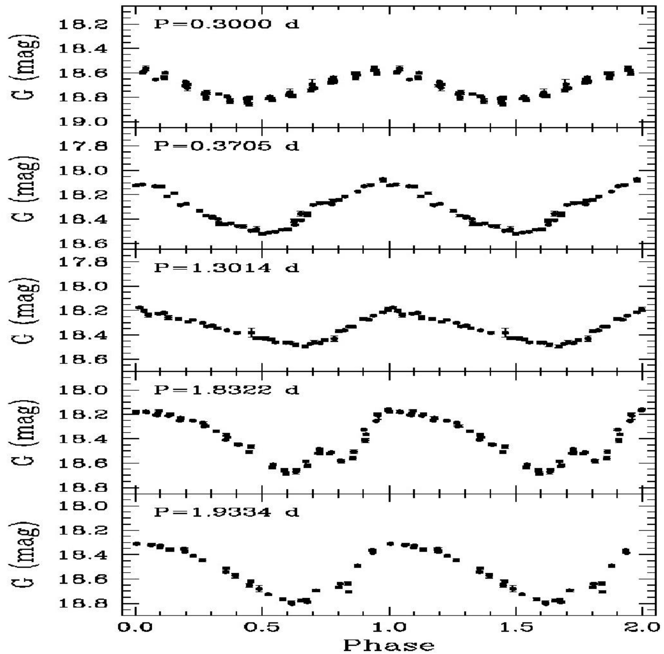
Teff, logg

[Fe/H]

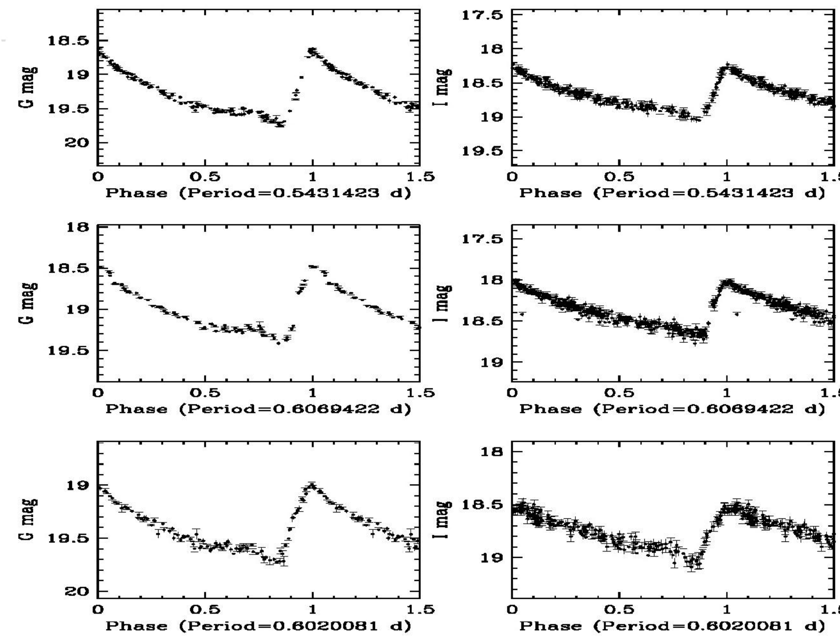
[X/Fe]

variability

Age



Cepheids in the
Large Magellanic Cloud



Gaia

Ogle IV

RR-Lyrae in the
Large Magellanic Cloud

Bp/Rp Preliminary processing/calibrations:

- 10-15 mmag per measurement
- 70 epochs (on average in 5 years) + Ecliptic poles

Plato

- Much finer time sampling → very detailed oscillation spectra
- Evolutionary stage: separation Red Giant Branch / Red Clump

Age: Milky-way mass assembly & chemical history

α, δ, π

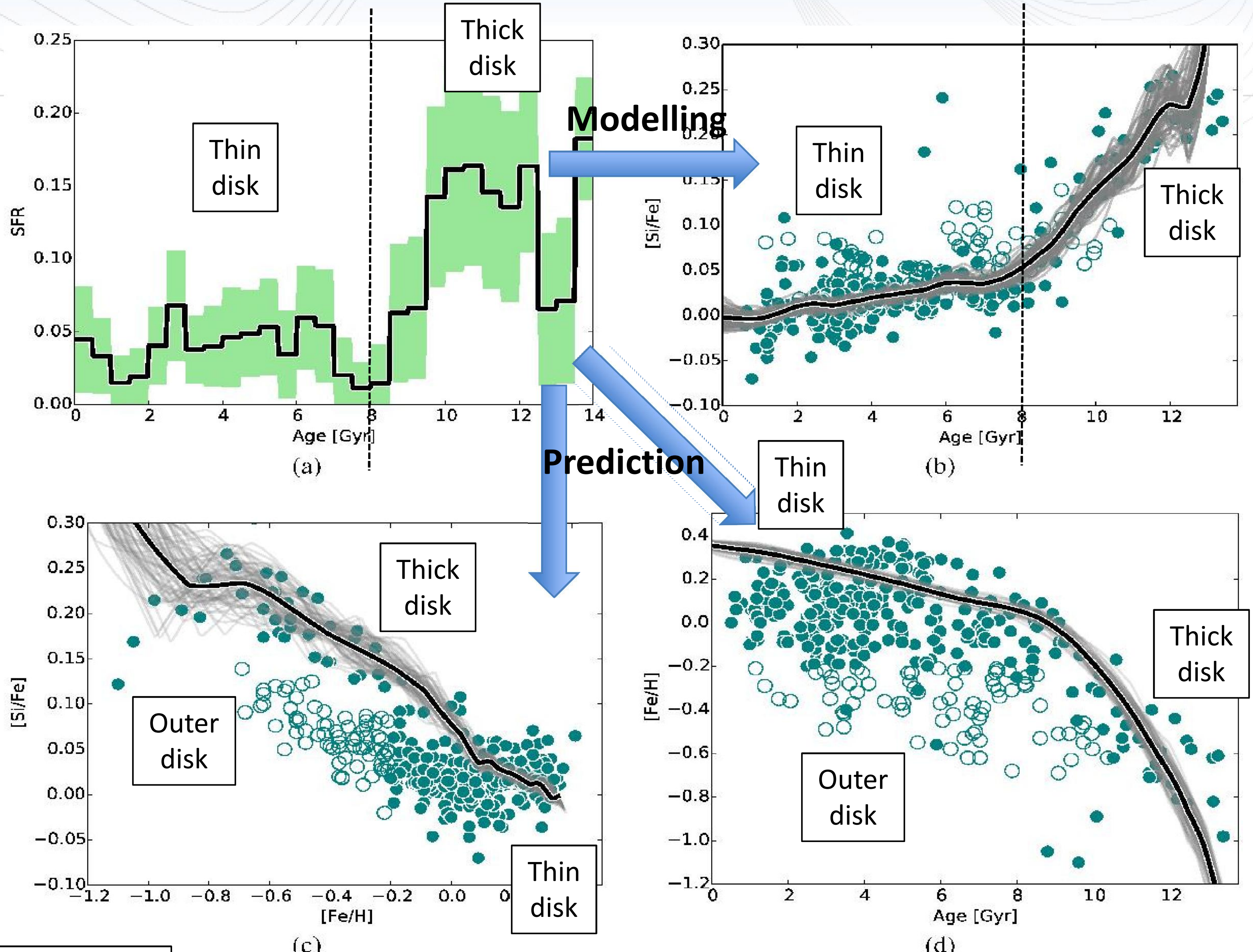
μ_α, μ_δ, V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



Snaith, Haywood, Di Matteo et al., 2015, A&A, 578, A87

Ages from isochrones

α, δ, π

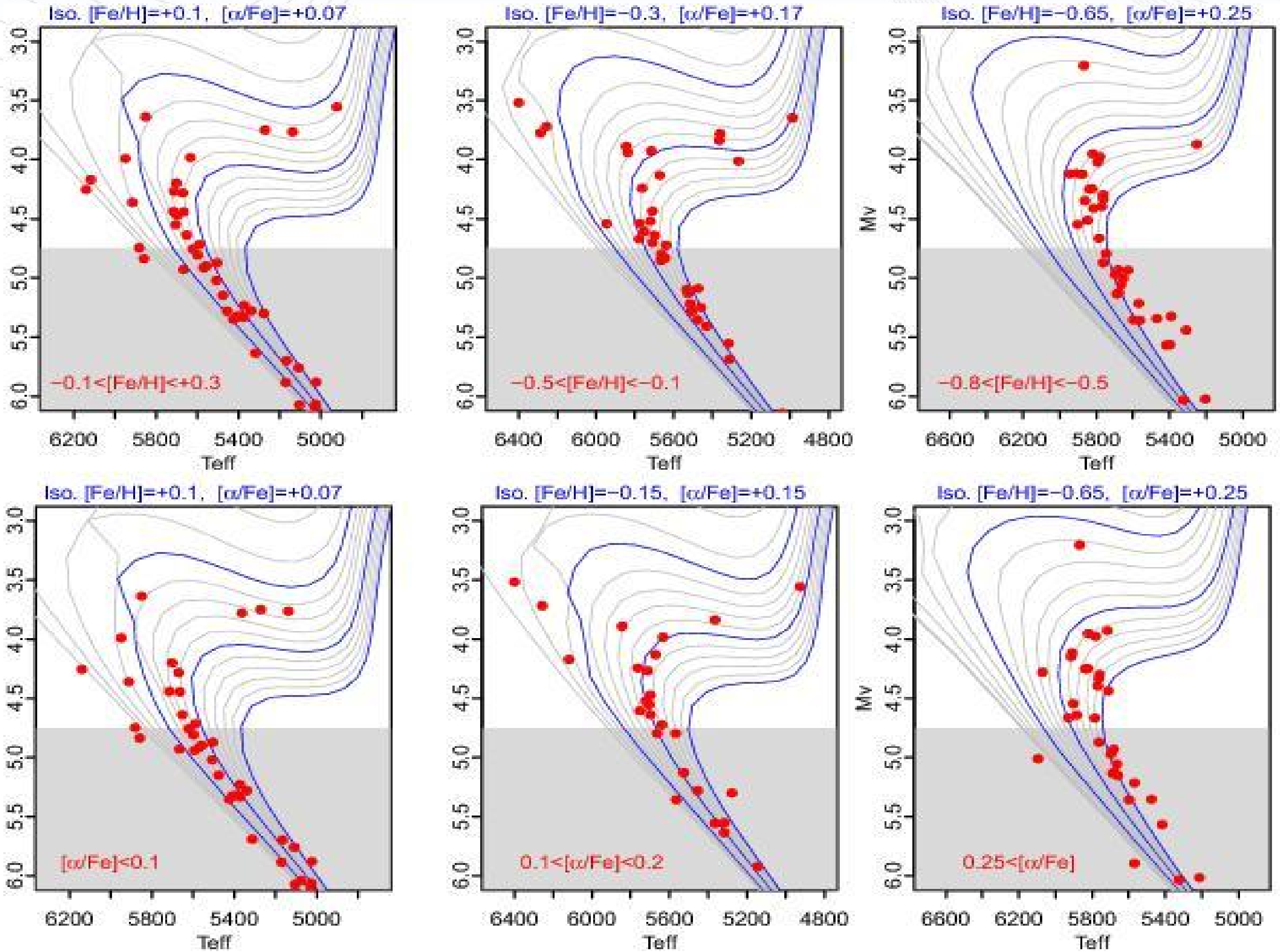
μ_α, μ_δ, V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



- Turn-off/sub-giants: **σAge ≈ 30%**
- Cool main-sequence / giants: isochrones closely packed

Haywood, Di Matteo, Lehnert et al., 2013, A&A, 560, A109

Ages with Plato

α, δ, π

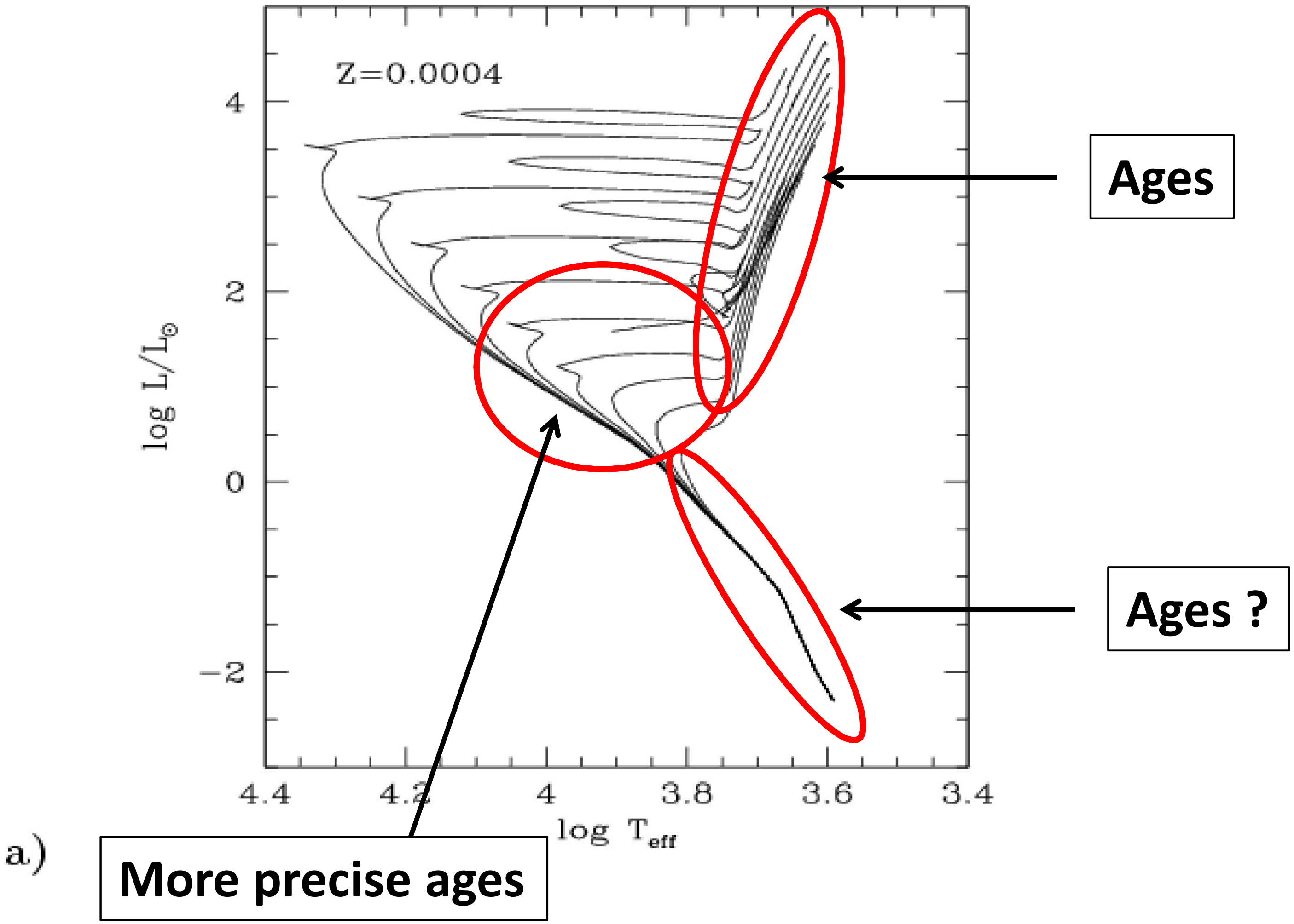
μ_α, μ_δ, V_R

Av, E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



Radial velocity: e.g. dynamics of accreted satellite

Credits: R. Wyse

α, δ, π

μ_α, μ_δ,

V_R

Av, E_{B-V}

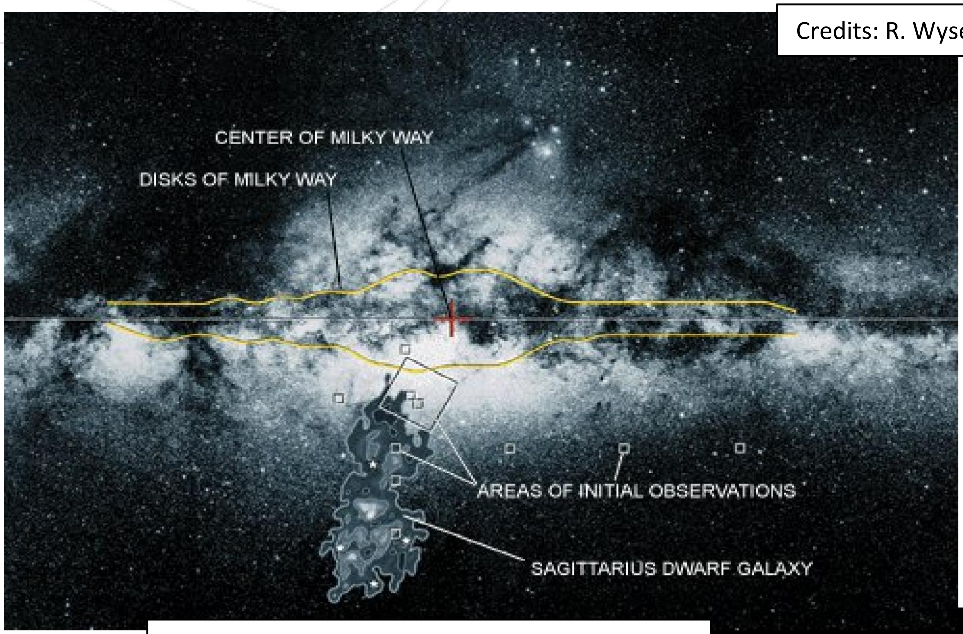
Teff, logg

[Fe/H]

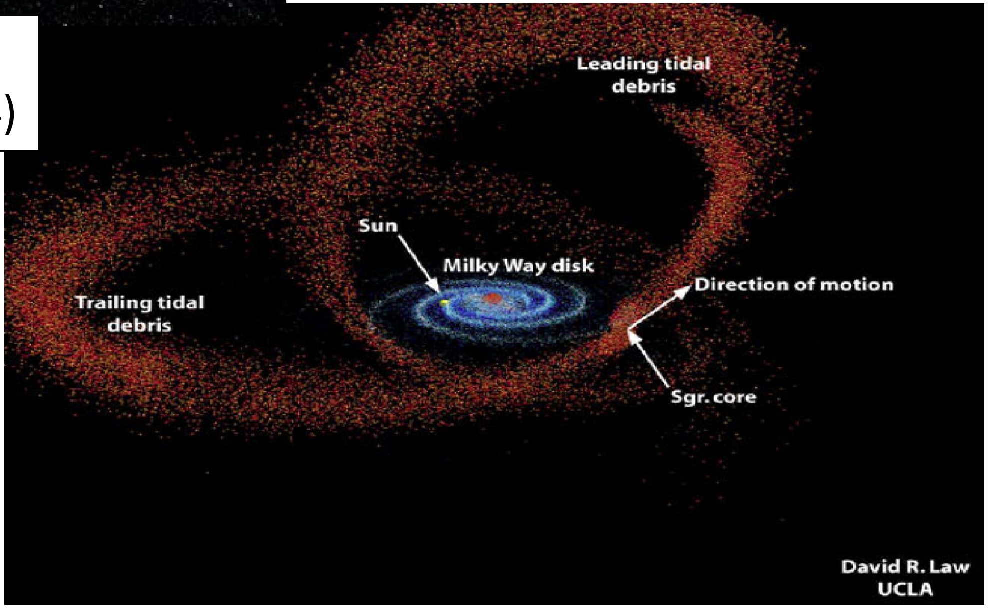
[X/Fe]

variability

Age



Sagittarius dwarf galaxy
(discovered: R. Ibata 1994)



Av, E_{B-V}: e.g., 3D view of the interstellar medium

α, δ, π

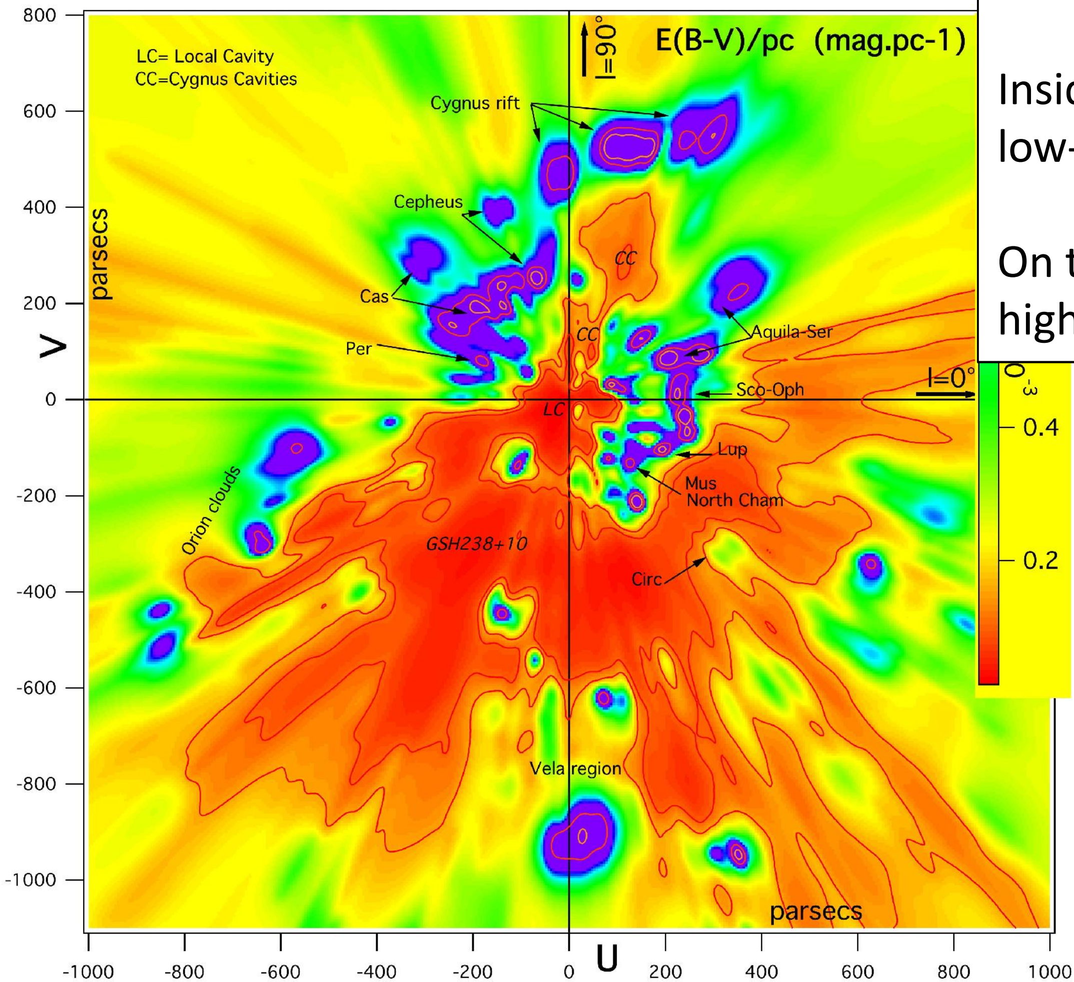
μ_α, μ_δ, V_R

Av,
E_{B-V}

Teff, logg
[Fe/H]
[X/Fe]

variability

Age



The interstellar medium absorbs the light of the stars → of known distances (Hipparcos)

Inside the local cavity
low-density hot gas (T ~10^6 K)

On the edges of the local cavity
high density cold gas (T~10^3 K)

Lallement, Vergely, Valette et al., 2013, A&A, 561, A91