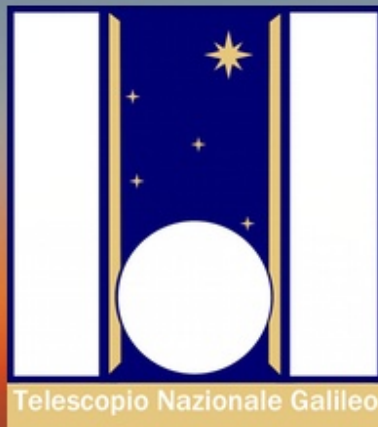


Gaia FOLLOW-UP : HARPS/GIANO SPECTRA OF BRIGHT STARS IN OPEN CLUSTERS

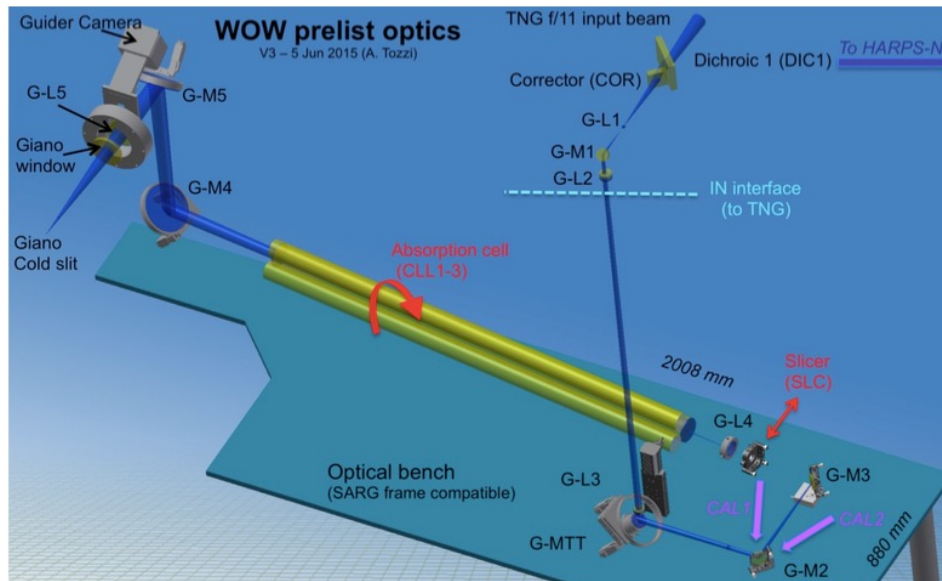
Angela Bragaglia
INAF-OA Bologna

La missione e le prospettive scientifiche di TNG nell'astrofisica
del 2020



◆ INAF
ISTITUTO NAZIONALE
DI ASTROFISICA
NATIONAL INSTITUTE
FOR ASTROPHYSICS

GIARPS & OCs : who? what? where? when? why?



: Scheme of the GIARPS optics necessary to feed GIANO and use it simultaneously with HARPS – N (AD1).



GLARPS & OCs : who? what? where? when? why?

First contact with :

Experts in high-res spectroscopy :

Carretta, D'Orazi, Lucatello, Magrini, Mucciarelli, Vallenari
(*mainly* old clusters)

Frasca, Lanzafame, Prisinzano, Randich
(*mainly* young clusters)

Experts in stellar/chemical evolution models:

Cassisi, Romano, Straniero, Tosi

additional co-I's welcome !

GLARPS & OCs : who? what? where? when? why?

Bright stars ($V \leq 12$; $H \leq 10$) to get $\text{SNR} > 50$ in 1 hour in :

- open clusters
- associations
- moving groups
- star forming regions

KNOWN AND NEW DISCOVERIES BY GALA

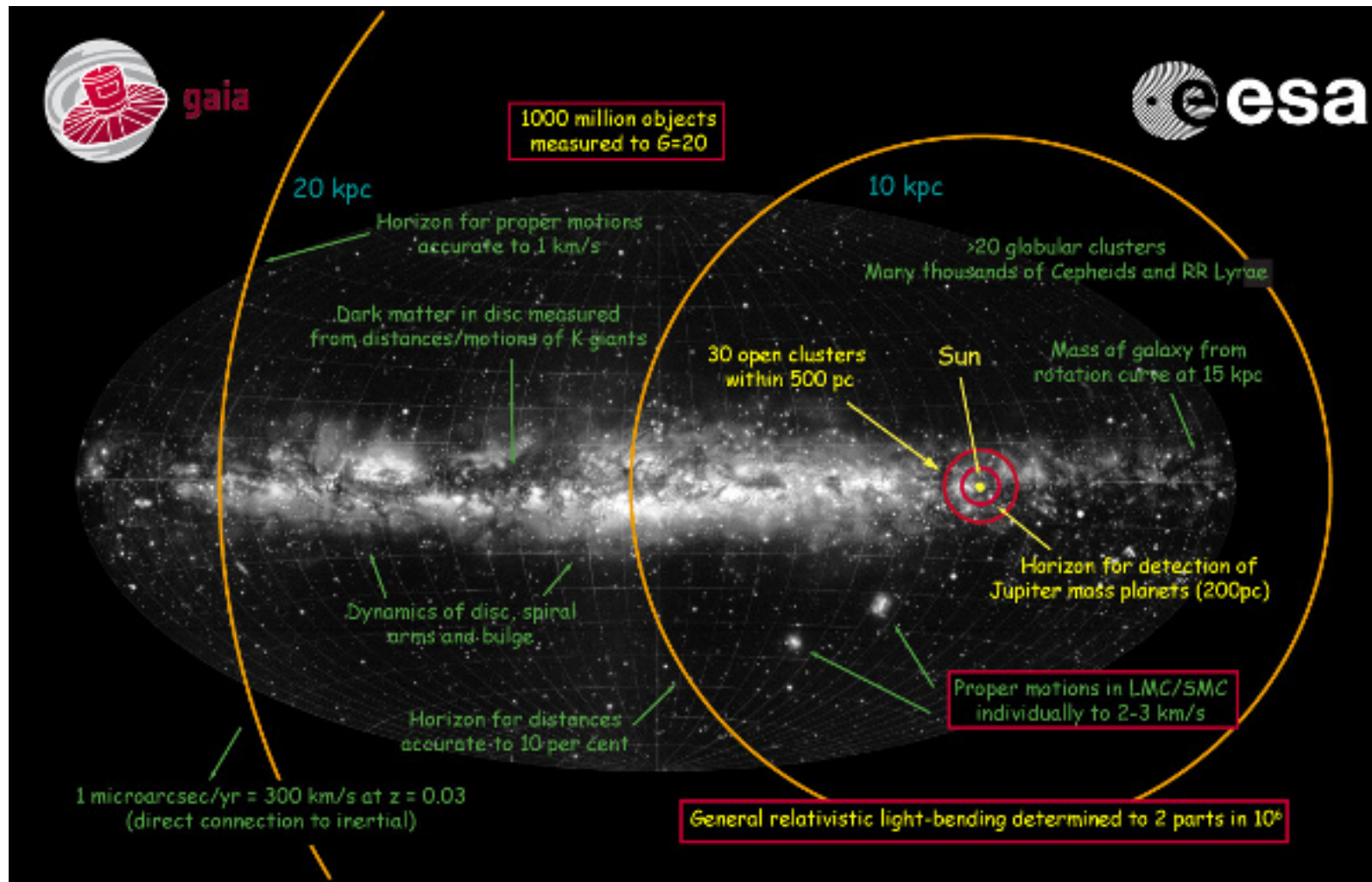
Note:

for red clump stars $V < 12$, $H < 10$ means $D_{\odot} < 1 \text{ kpc}$ (... about ...)

GLARPS & OCs : who? what? where? when? why?

- TNG : HARPS-N + GIANO
- To be decided

GLARPS & OCs : who? what? where? when? why?



Kharchenko
et al. 2013:

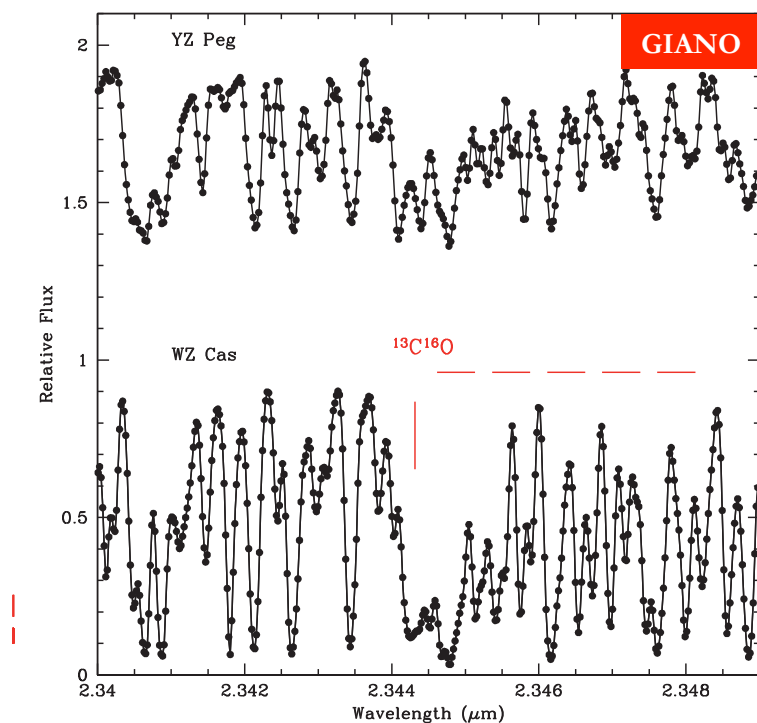
~200 OCs
 $D_{\odot} < 1000$ pc
 $\text{Dec} > -20$

Credits: ESA/Lund Obs.

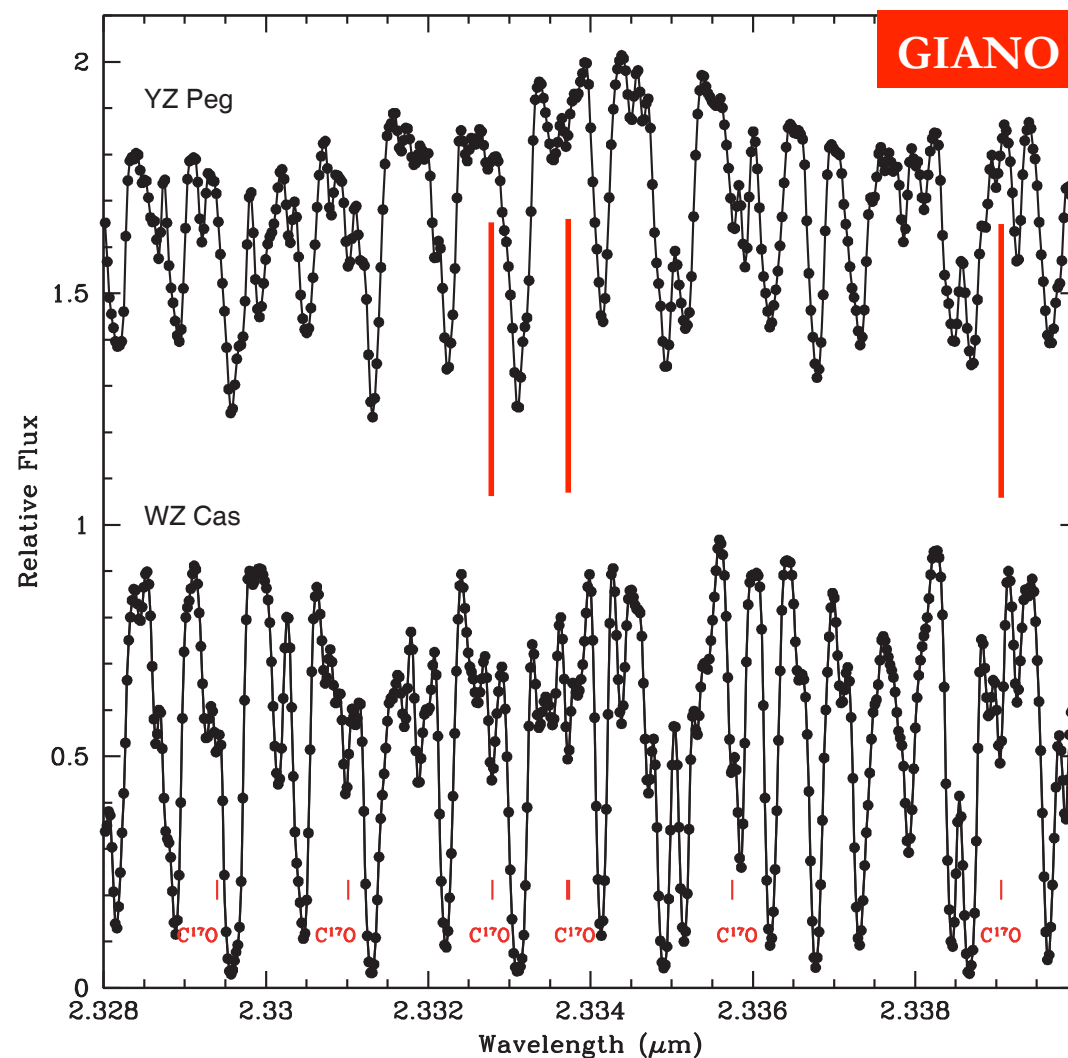
It's the chemistry, baby

- Complete chemical characterization, homogeneous analysis
(cluster : homogenous sample – beat down errors)
- Elements of all nucleosynthetic chains (GIARPS)
e.g. : neutron-capture elements : best in blue part of spectra
isotopic ratios : $^{24}\text{Mg} : ^{25}\text{Mg} : ^{26}\text{Mg}$ from MgH at 5140 Å
C,N & $^{12}\text{C} / ^{13}\text{C}$: best from IR
F : only from FH in K-band
from different WL range : comparison of scales (e.g. O, C,N)
- Analysis possible for cool / reddened stars (GIANO)
- Benchmarks / calibrators for surveys

It's the chemistry, baby : O isotopes

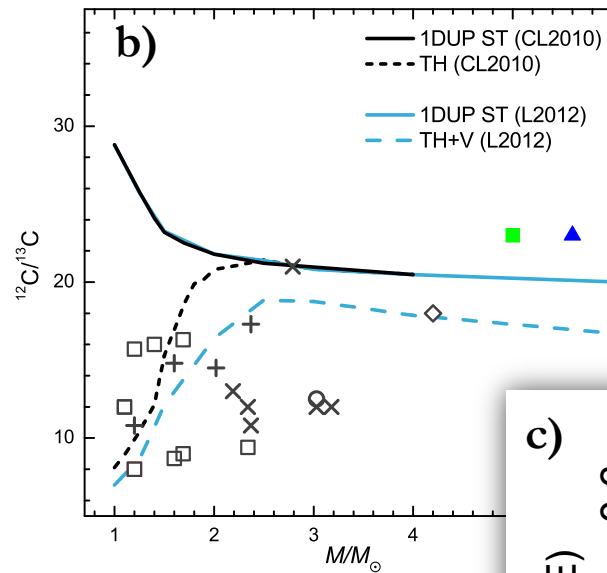
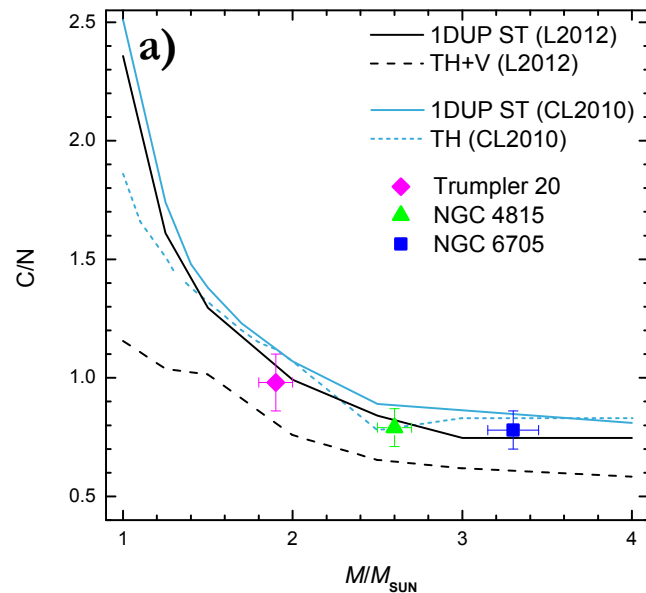


GIANO pre-refurbishment



Courtesy : Oscar Straniero

To mix or not to mix, this is the question



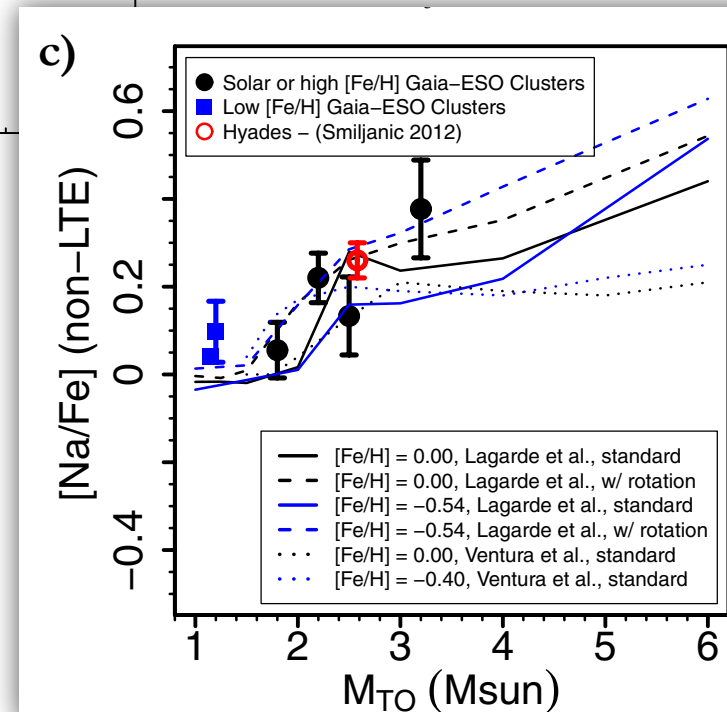
better : HOW to mix

Giants in OCs

a) C/N

b) $^{12}\text{C}/^{13}\text{C}$ (note: GIANO - also N, O isotopes)

c) Na

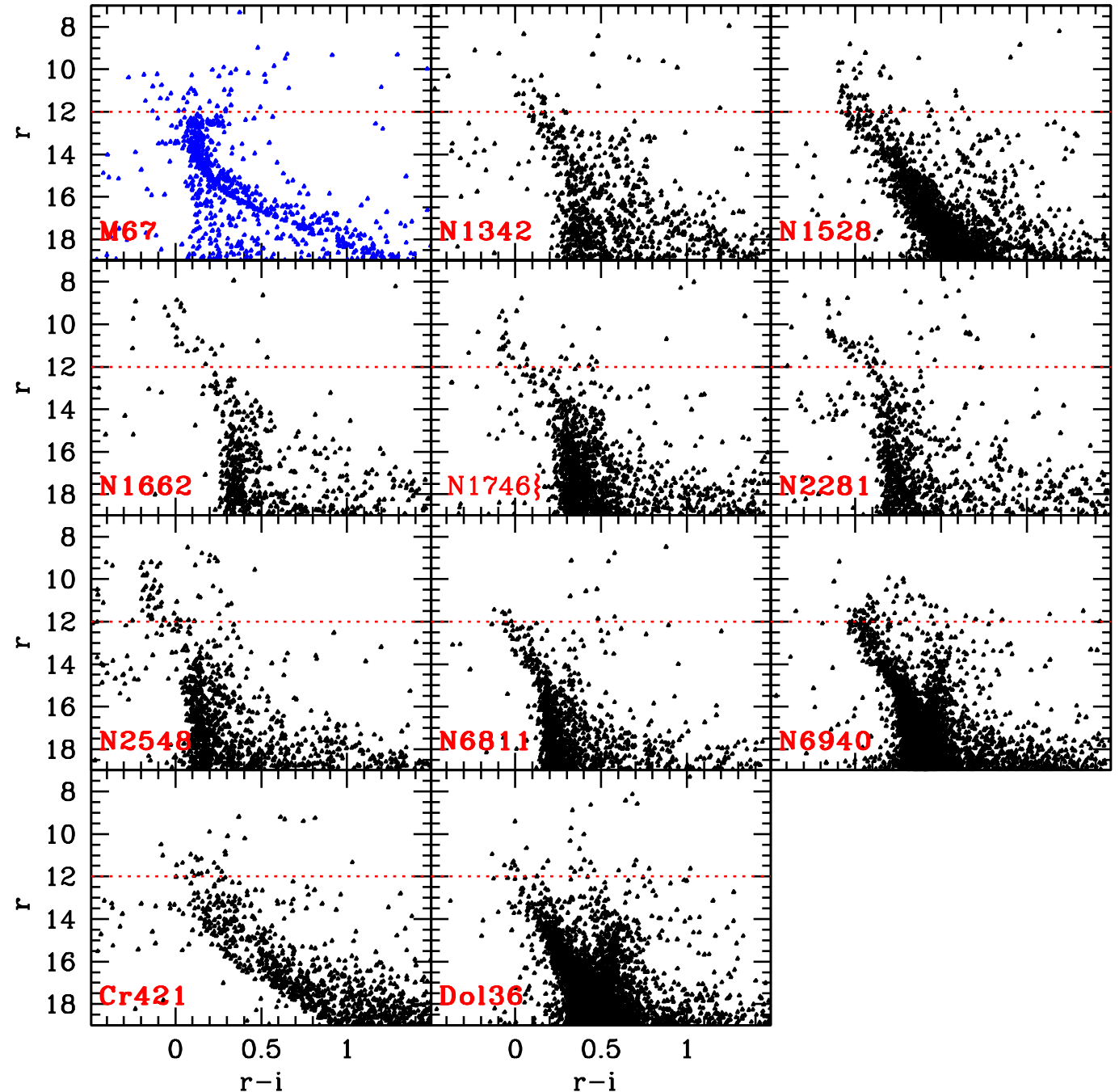


PanSTARRS1

radius=10'

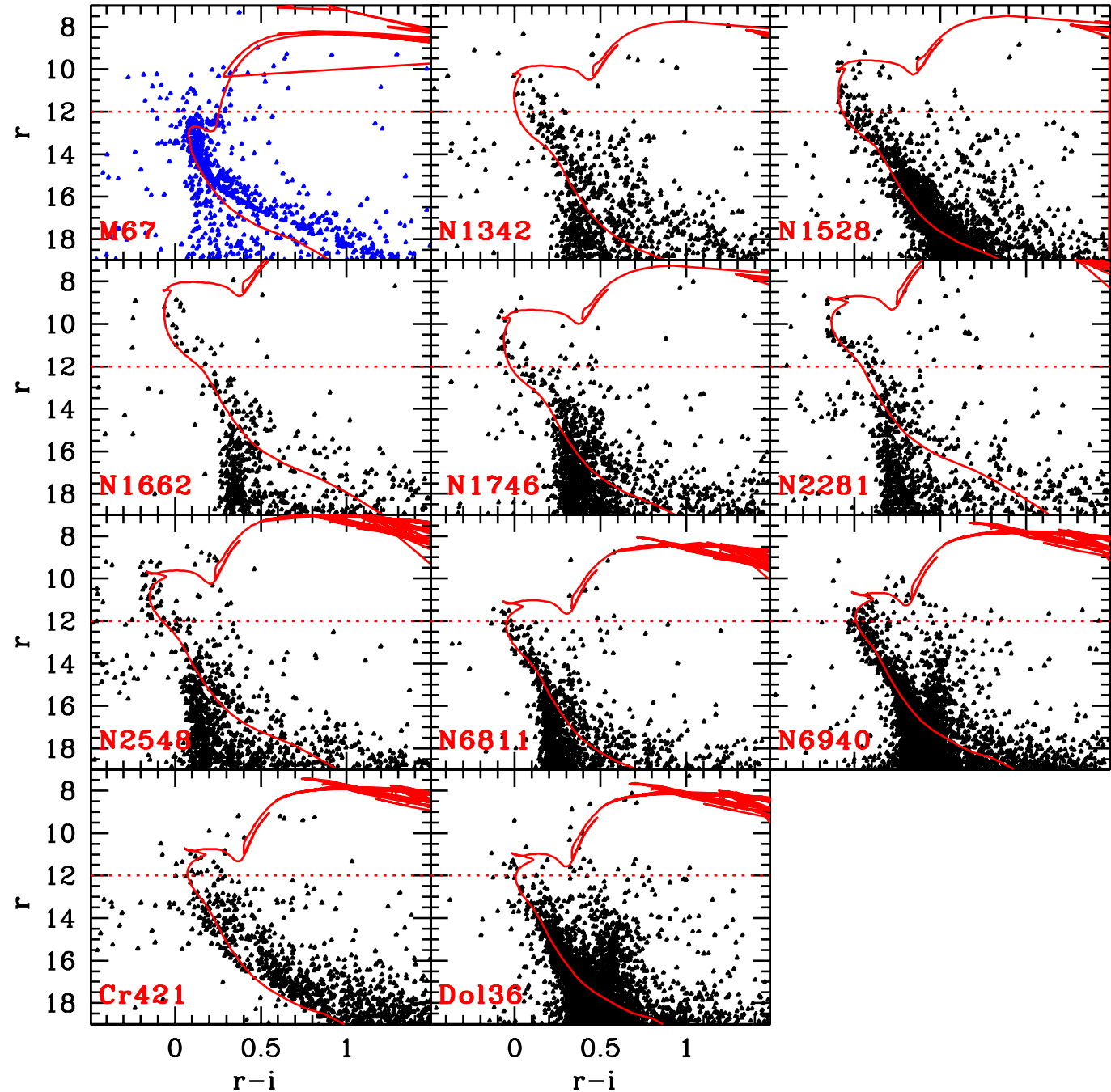
Dec > -20°

	Age (Gyr)	Dist _⊙ (pc)
M67	4	890
NGC1342	0.4	660
NGC1528	0.4	950
NGC1662	0.5	440
NGC1746	0.5	800
NGC2281	0.5	500
NGC2548	0.5	800
NGC6811	0.6	1200
NGC6940	0.6	850
Collinder421	1	760
Dolidze36	1	970



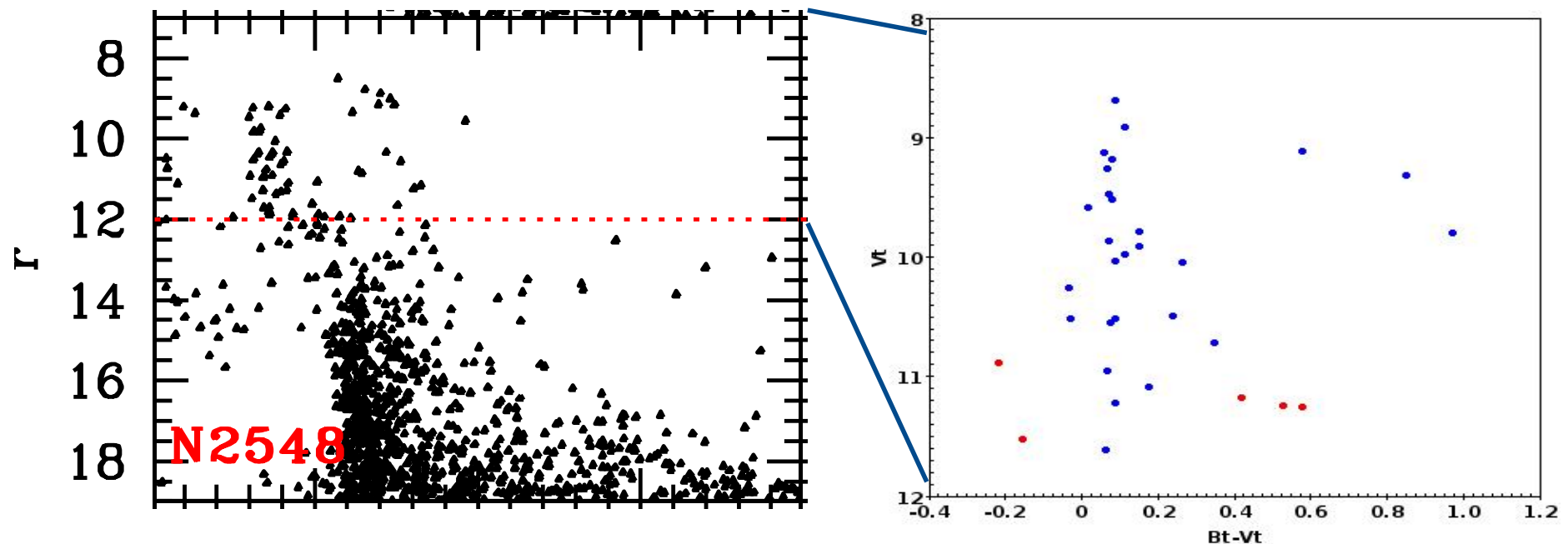
PanSTARRS1 + PARSEC isochrones

	Age (Gyr)	Dist _⊙ (pc)
M67	4	890
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Collinder421	1	760
Dolidze36	1	970



TGAS data can be used, but Gaia DR2 will

- be more precise
- reach fainter (and brighter) limits



Ruprecht 147 : the beginning of a beautiful friendship

ASTRONOMICAL JOURNAL, 145:134 (26pp), 2013 May

doi:[10.1088/0004-6256/14](https://doi.org/10.1088/0004-6256/145/1/134)

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RUPRECHT 147: THE OLDEST NEARBY OPEN CLUSTER AS A NEW BENCHMARK FOR STELLAR ASTROPHYSICS

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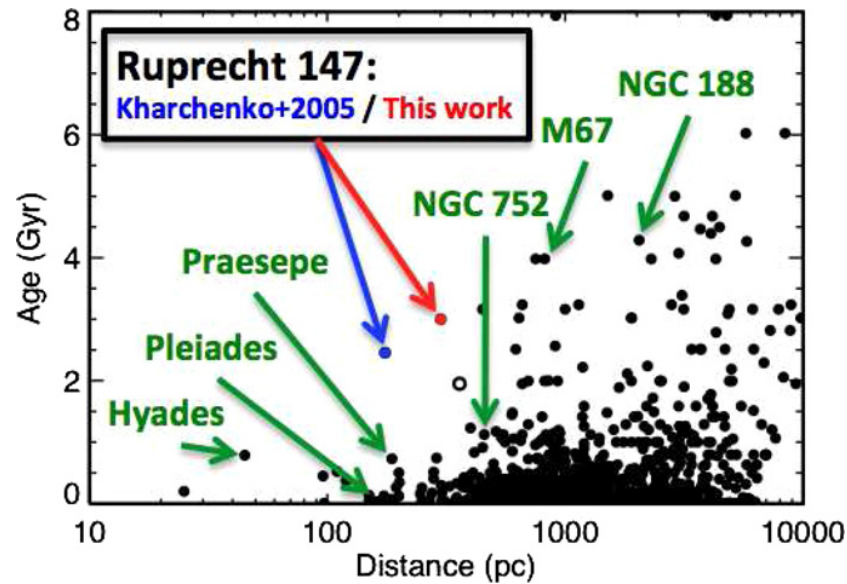
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Received 2012 May 26; accepted 2012 December 7; published 2013 April 4

ABSTRACT

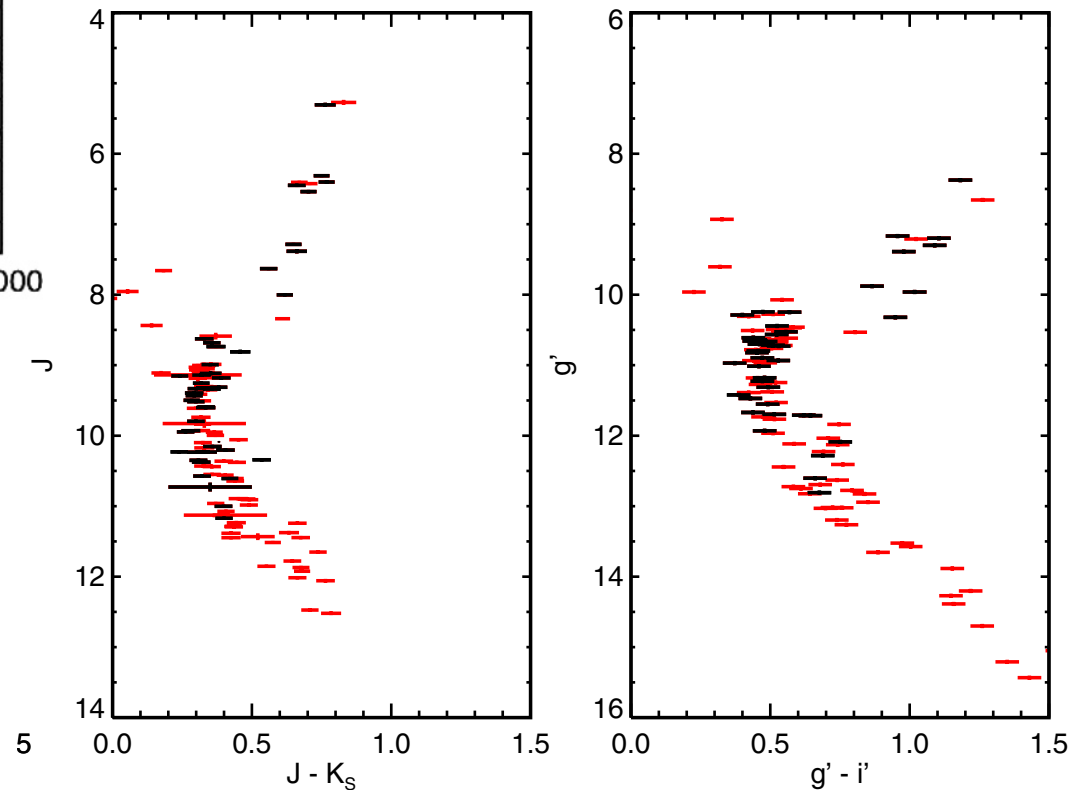
Ruprecht 147 is a hitherto unappreciated open cluster that holds great promise as a standard in fundamental stellar astrophysics. We have conducted a radial velocity survey of astrometric candidates with Lick, Palomar, and MMT observatories and have identified over 100 members, including 5 blue stragglers, 11 red giants, and 5 double-lined spectroscopic binaries (SB2s). We estimate the cluster metallicity from spectroscopic analysis, using Spectroscopy Made Easy (SME), and find it to be $[M/H] = +0.07 \pm 0.03$. We have obtained deep CFHT/MegaCam $g'r'i'z'$ photometry and fit Padova isochrones to the $(g' - i')$ and Two Micron All Sky Survey ($J - K_s$) color–magnitude diagrams, using the τ^2 maximum-likelihood procedure of Naylor, and an alternative method using two-dimensional cross-correlations developed in this work. We find best fits for Padova isochrones at age $t = 2.5 \pm 0.25$ Gyr, $m - M = 7.35 \pm 0.1$, and $A_V = 0.25 \pm 0.05$, with additional uncertainty from the unresolved binary population and possibility of differential extinction across this large cluster. The inferred age is heavily dependent on our choice of stellar evolution model: fitting Dartmouth and PARSEC models yield age parameters of 3 Gyr and 3.25 Gyr, respectively. **At ~ 300 pc and ~ 3 Gyr, Ruprecht 147 is by far the oldest nearby star cluster.**

Ruprecht 147 : the oldest nearby OC

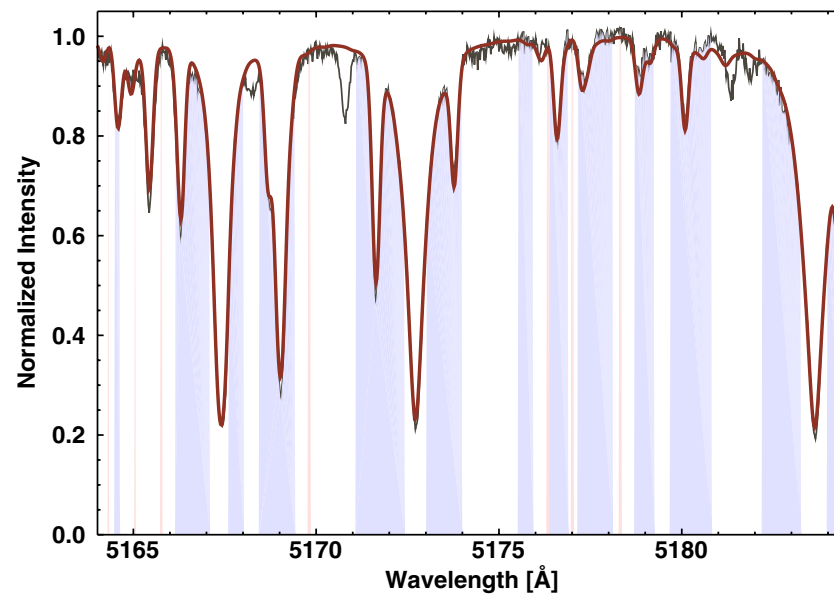
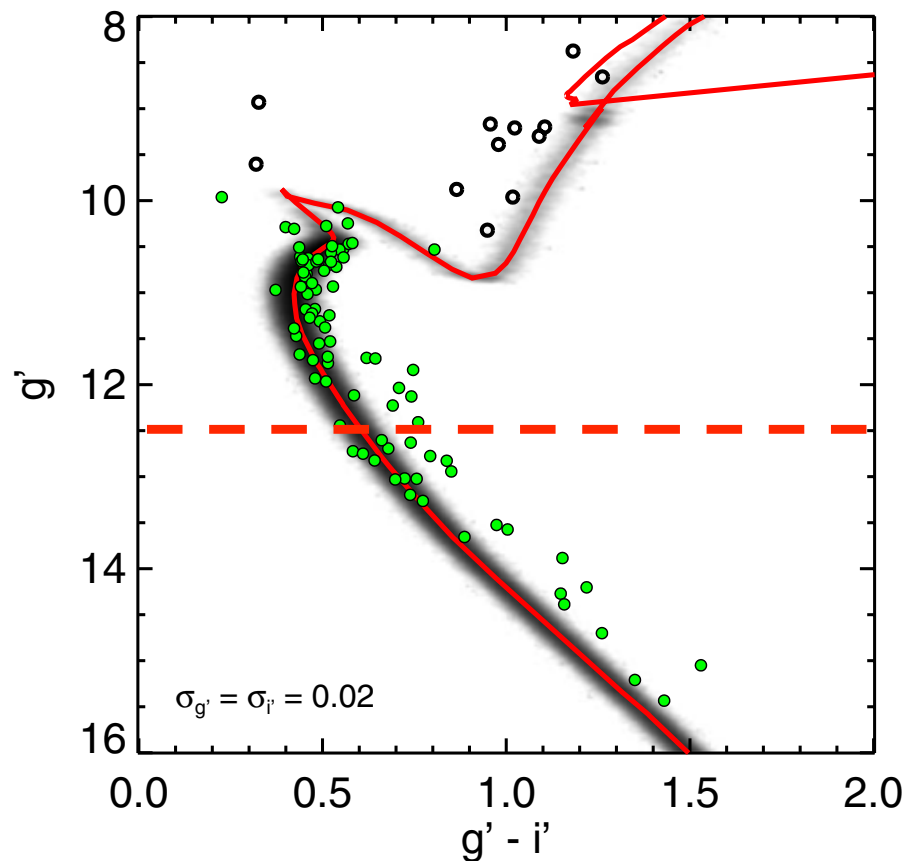


WEBDA data

2MASS JKs & g',i'



Ruprecht 147 : the oldest nearby OC

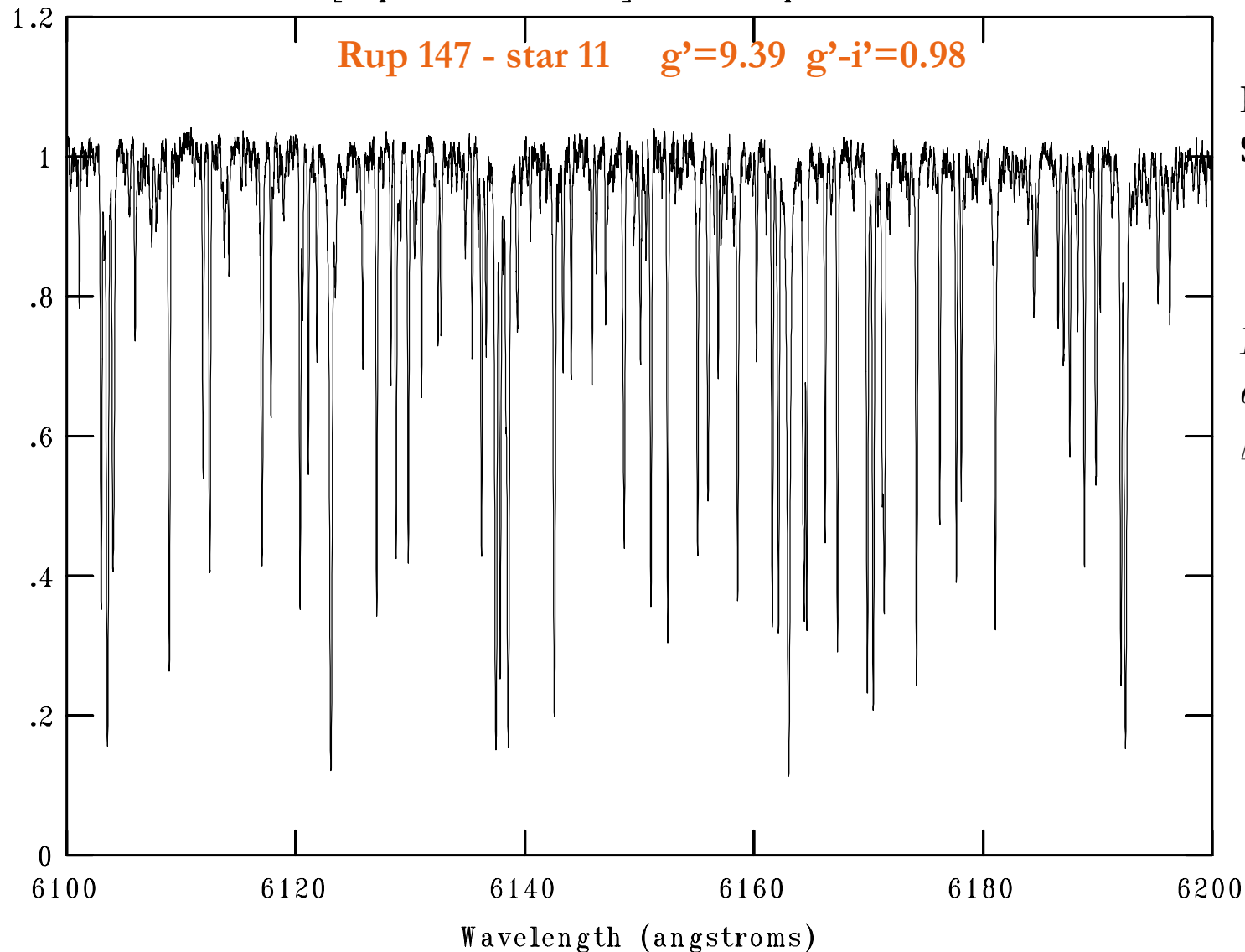


Keck HIRES spectrum

CFHT Megacam photometry

Ruprecht 147 : the oldest nearby OC

[rup147_star11.fits]: 1200. ap:1 beam:1



HARPS-N 1200s
SNR~ 80 @450nm
>120 @610nm

*First pass analysis of
6 stars:
[Fe/H]=+0.1 dex
(rms 0.05)*

*Bragaglia,
Andreuzzi,
Donati*

The young lions

... and furthermore, thanks to GIARPS
(an unicum, for resolution and spectral coverage)

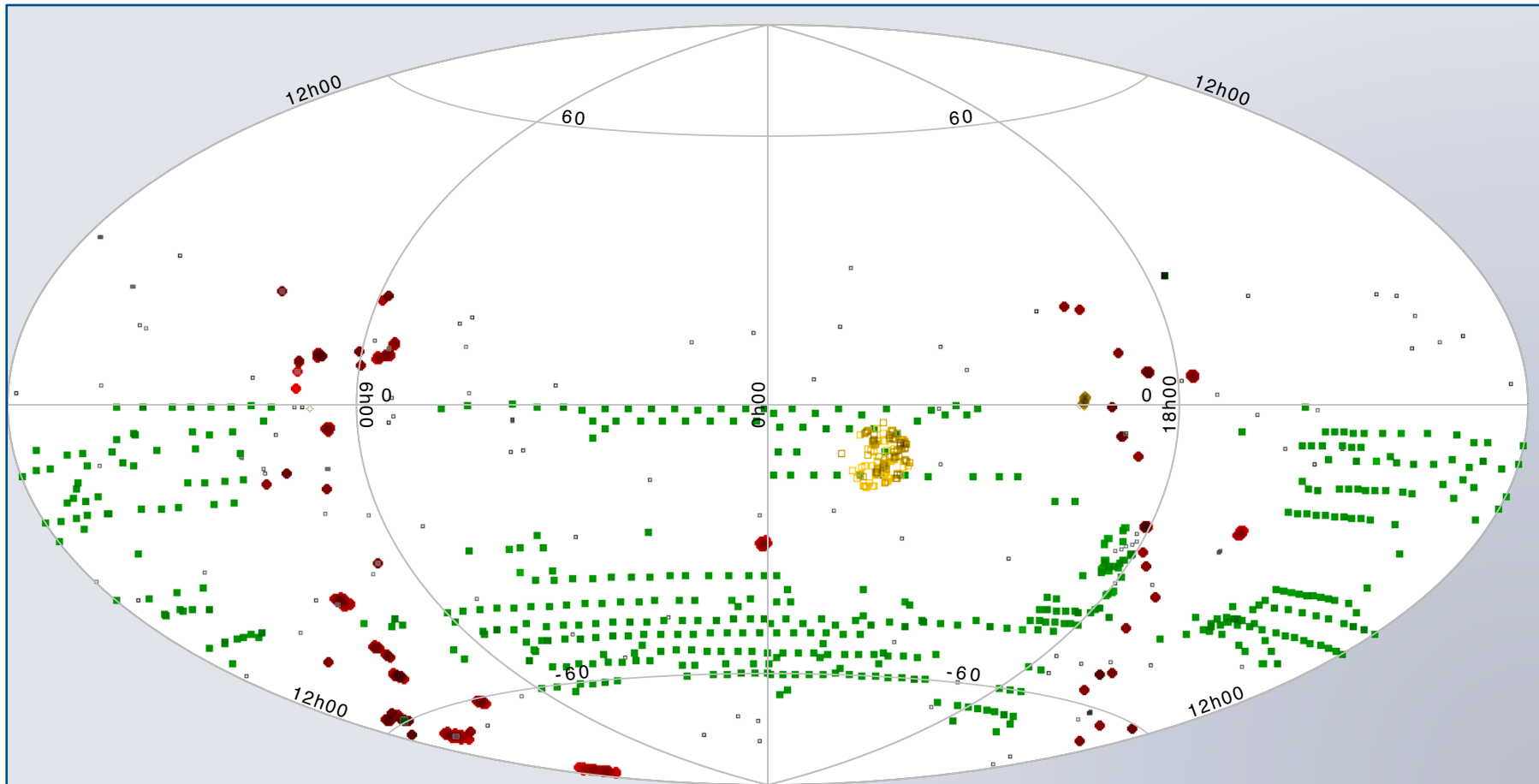
observe [especially with GIANO] and obtain complete
chemical characterization of :

- young clusters and low-obscuration SFR
(combining Gaia with IPHAS/VPHAS+ covering from u to H_α)
- very young stars in SFR [partially] embedded
(IR only)



Gaia-ESO : South by Southwest

R~20000, HR15/09 (~tens of thousand) ; R=47000, U580 (~thousand)



Open cluster MW field Kepler/CoRoT Standard (GBS/cluster)



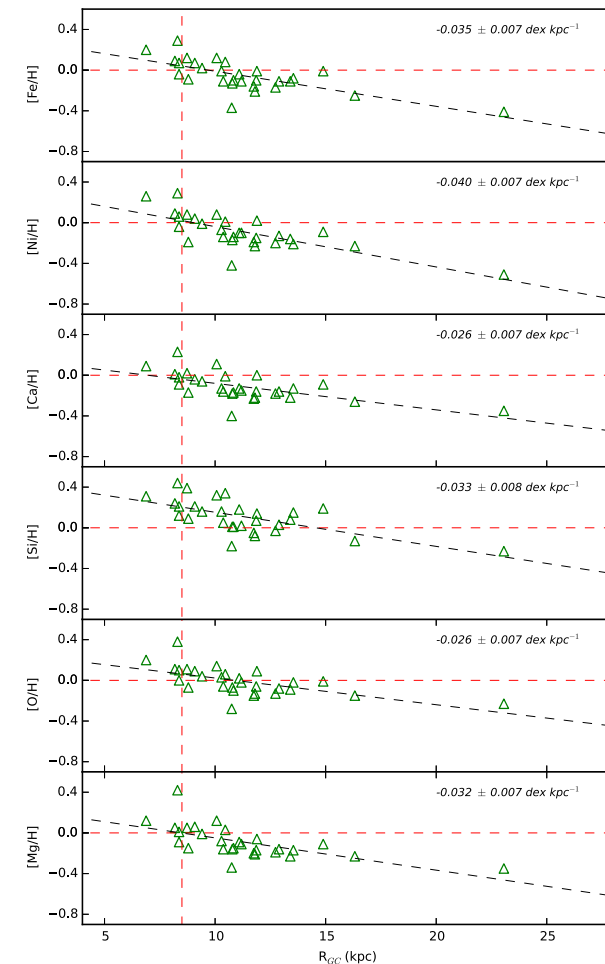
APOGEE : meet the IR

H-band, $R=20000$; (almost) only giants ; a few-a few tens per clusters

OCCAM

(Open Cluster Chemical Analysis and Mapping) :

29 open clusters,
304 giant stars

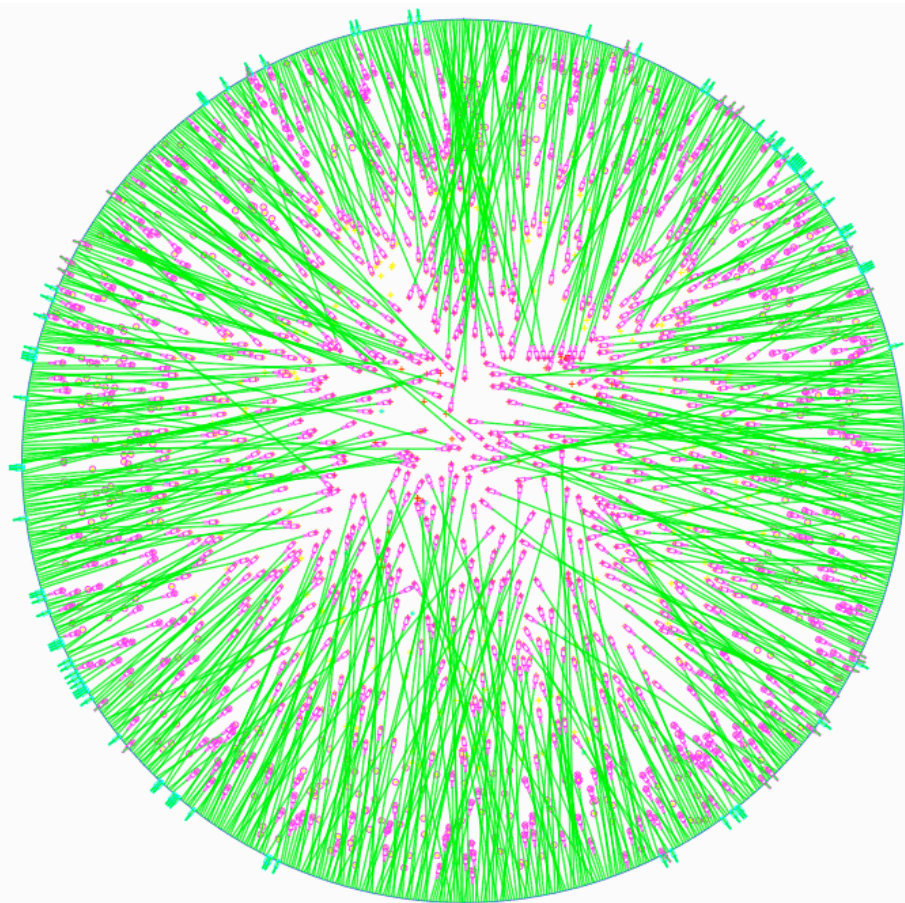


Frinchaboy et al. 2013, Cunha et al. 2016



WEAVE is coming to a telescope near you

WEAVE = WHT Enhanced Area Velocity Explorer



@ 4.2m WHT, La Palma

2° diameter

960 (plate A)/940 (plate B) fibers

1.3" fiber diameter

mIFUs, LIFUs

LR (R~5000) : 366-959 nm

HR (R~20000) :

404-465/473-545 + 595-685nm

➤ **“not-so-high-resolution”**

➤ **DeltaWL~150 nm**

