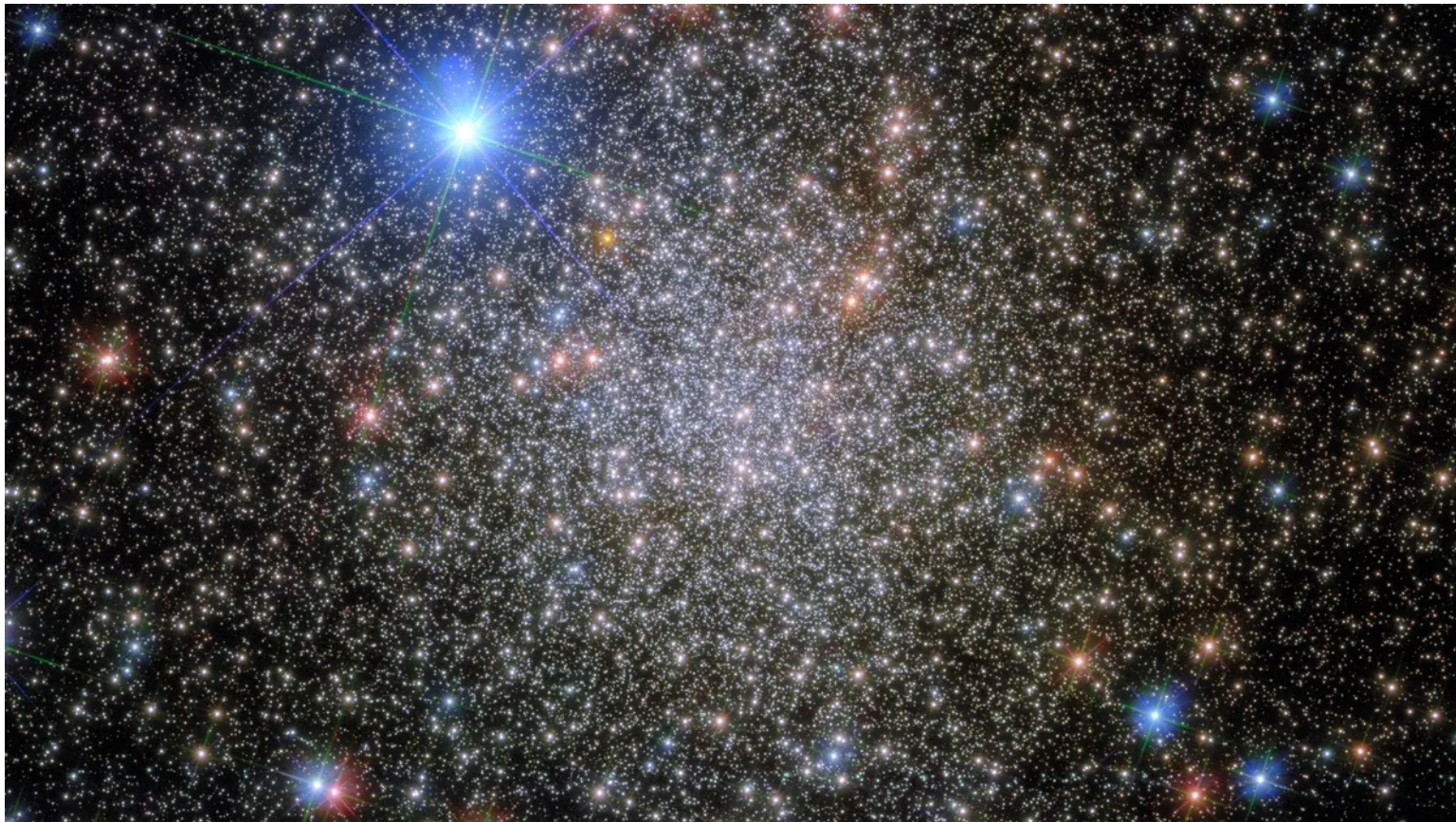


STARS AND STELLAR POPULATIONS WITH ANDES

Alessio Mucciarelli - University of Bologna
(on behalf of Science Team Working Group 2)



Meeting della strumentazione ELT a guida italiana (MORFEO e ANDES) - Napoli, May 14 2026

WG2 white paper

The discovery space of ELT-ANDES. Stars and stellar populations

Ian U. Roederer^{IUR1,IUR2*}, Julián D. Alvarado-Gómez^{JAG},
Carlos Allende Prieto^{CAP1,CAP2}, Vardan Adibekyan^{VA},
David Aguado^{DA1,DA2}, Pedro J. Amado^{PJA},
Eliana M. Amazo-Gómez^{EMAG}, Martina Baratella^{MBA1,MBA2},
Sydney A. Barnes^{SAB}, Thomas Bensby^{TB}, Lionel Bigot^{LB},
Andrea Chiavassa^{AC}, Armando Domiciano de Souza^{AD},
Camilla Juul Hansen^{CJH}, Silva P. Järvinen^{SPJ},
Andreas J. Korn^{AJK}, Sara Lucatello^{SL}, Laura Magrini^{LM},
Roberto Maiolino^{RM}, Paolo Di Marcantonio^{PM},
Alessandro Marconi^{AMa}, José R. De Medeiros^{JRM},
Alessio Mucciarelli^{AM1,AM2}, Nicolas Nardetto^{NNa}, Livia Origlia^{LO},
Celine Peroux^{CP}, Katja Poppenhäger^{KP1, KP2},
Cristina Rodríguez-López^{CRL}, Donatella Romano^{DR},
Stefania Salvadori^{SN}, Patrick Tisserand^{PT}, Kim Venn^{KV1},
Gregg Wade^{GAW}, Alessio Zanutta^{AZ}

Science cases in 3 key areas



PHYSICS OF STELLAR ATMOSPHERES,
STRUCTURE AND EVOLUTION

STARS OF THE MILKY WAY AND
LOCAL GROUP GALAXIES

THE STAR-PLANET CONNECTION

PHYSICS OF STELLAR ATMOSPHERES, STRUCTURE AND EVOLUTION

- Stellar activity and magnetism (blue, optical, NIR)
- Gravity darkening and stellar rotation (optical, NIR)
- Lithium in stars and the primordial lithium abundance (optical)
- The Initial Mass Function (NIR)
- Atomic diffusion in low-mass stars (optical)
- Nucleosynthesis of the rapid neutron-capture elements (blue, optical)

STARS OF THE MILKY WAY AND LOCAL GROUP GALAXIES

- The first stars (*blue*, *optical*)
- Stellar populations in the *Galactic Bulge* (*optical*, *NIR*)
- Dwarf galaxies in the *Local Group* (*blue*, *optical*, *NIR*)
- The edge of the *Galactic disk* with open clusters (*optical*)

THE STAR-PLANET CONNECTION

- Stellar chemical composition as a driver of exoplanet formation (optical, NIR)
- Star-planet interactions (optical, NIR)

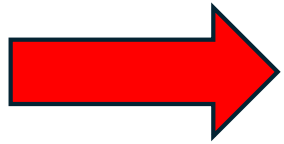
Some examples of the use of ANDES for stellar science cases

(1) ATOMIC DIFFUSION IN LOW-MASS STARS

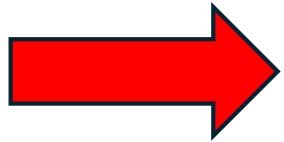


Atomic diffusion:

a slow transport mechanism of chemicals due to pressure/temperature/chemical gradients in stellar radiative layers



It modifies the surface chemical composition in particular for metal-poor stars

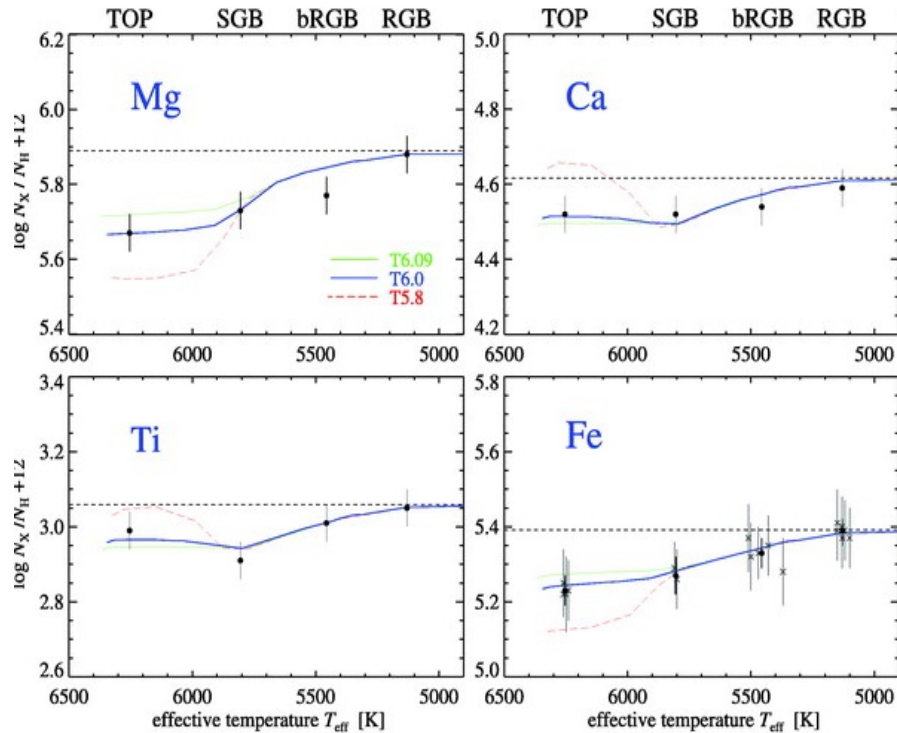


The original chemical composition is restored when the stars evolve as giant stars.

In globular clusters, the abundance differences between dwarf and giant stars are smaller than that expected ... **this physical mechanism is not well constrained**

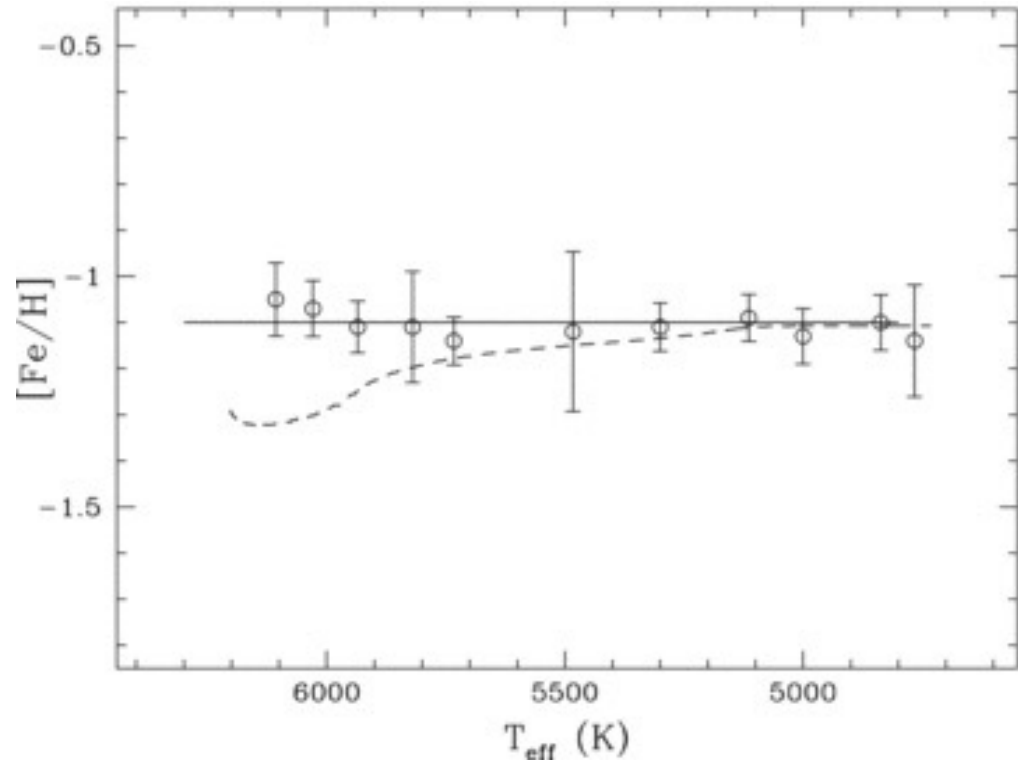
NGC 6397

Korn+06



M4

Mucciarelli+11



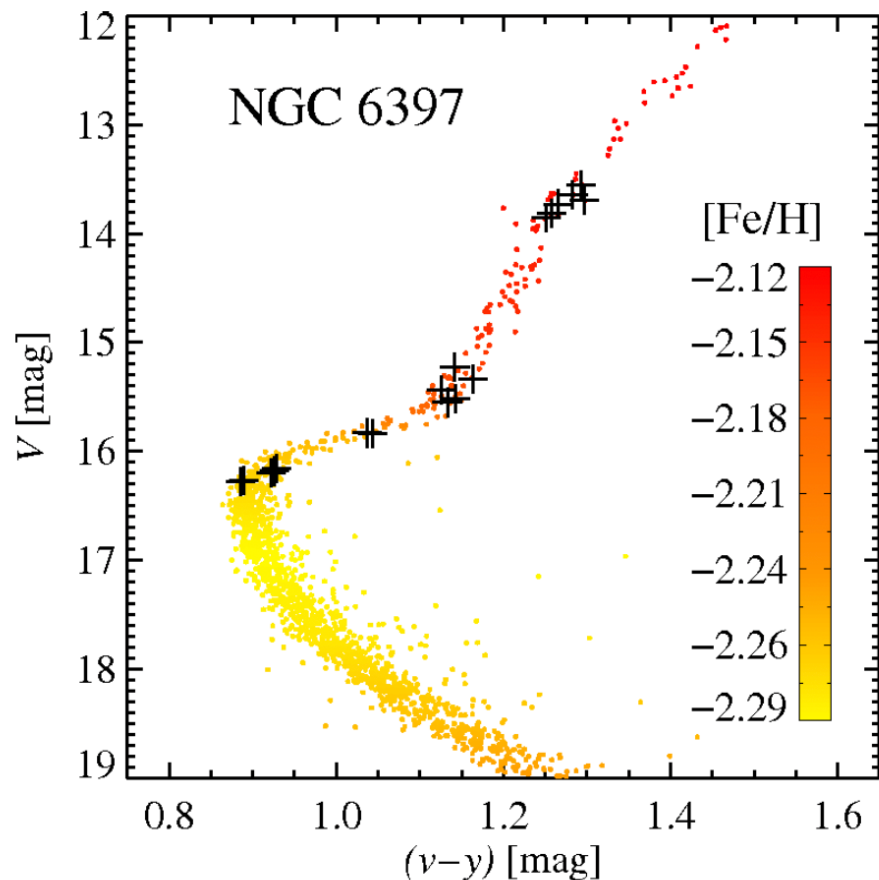
Main-Sequence stars
in globular clusters:
 $G \sim 16.5 - 19$



Too faint to obtain high-res
spectra with high SNR
(reaching low-mass stars)

How is really efficient the atomic diffusion in unevolved low-mass stars?

- Metallic abundances in evolved and unevolved stars in globular clusters
- Only with ANDES we can reach masses as low as $0.6 M_{\odot}$

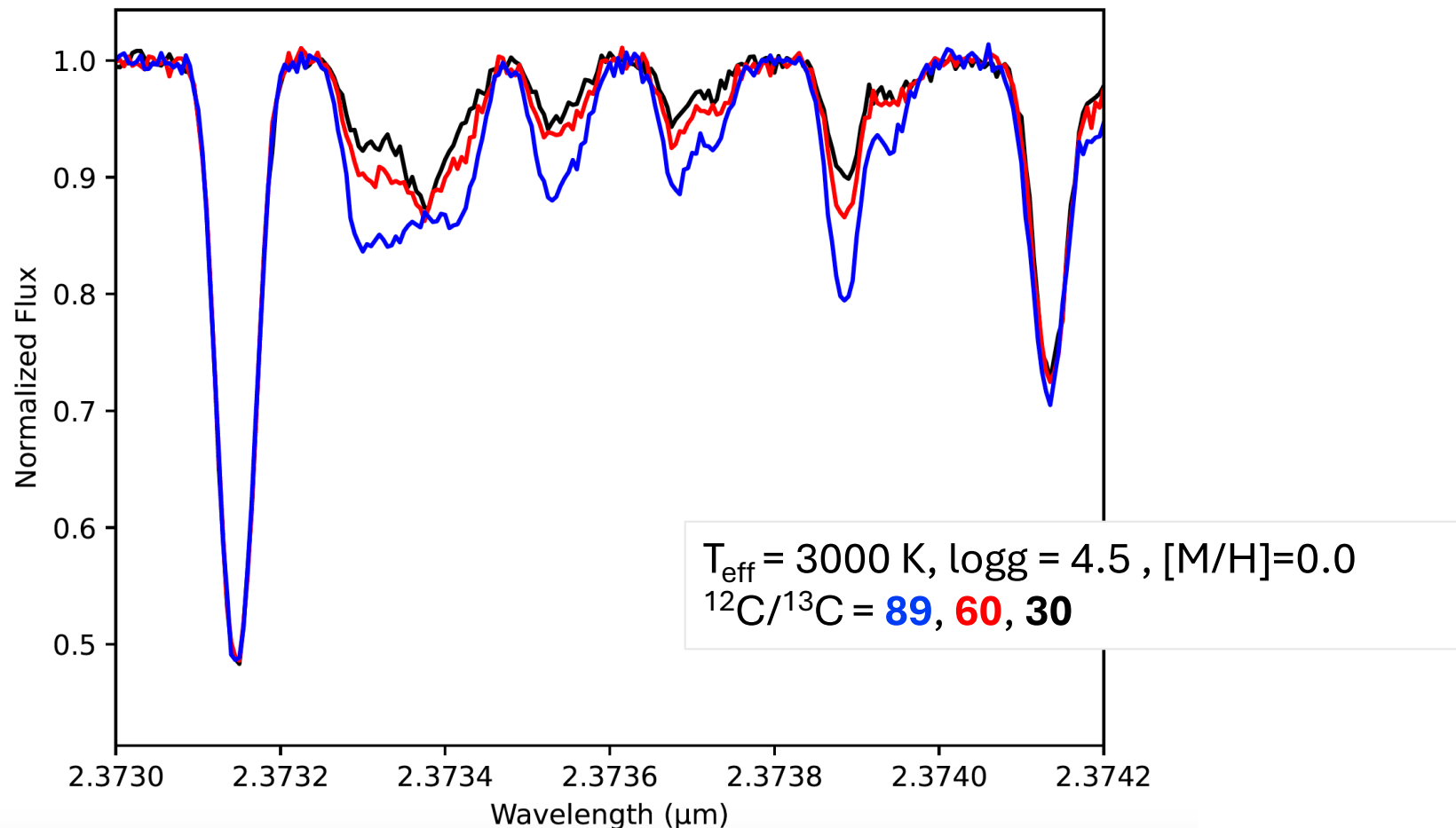


Mass	S/N@550, $t_{\text{exp}} = 3$ hrs	
	ANDES	UVES
0.77 $M_{\odot}$	230	50
0.70 $M_{\odot}$	110	22
0.65 $M_{\odot}$	80	14
0.60 $M_{\odot}$	50	10

(2) CONSTRAINING THE IMF WITH $^{12}\text{C}/^{13}\text{C}$ ISOTOPIC RATIO



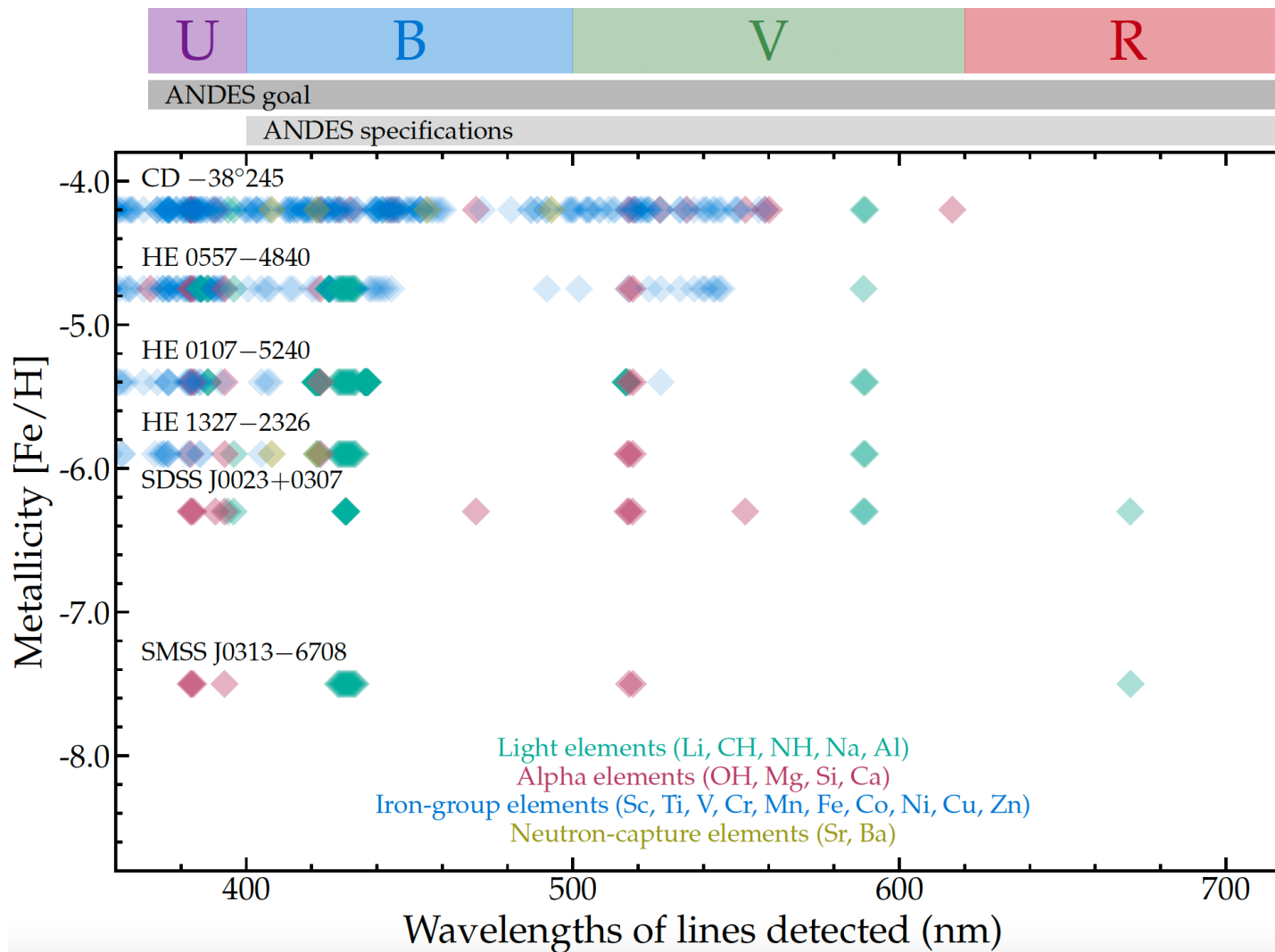
- To constrain the shape of the IMF and the role played by the physical conditions of the medium from which the stars form
- $^{12}\text{C}/^{13}\text{C}$ in unevolved stars
- ANDES (K-band) allows to measure $^{12}\text{C}/^{13}\text{C}$ in M-dwarfs
- M-dwarfs up to ~ 300 kpc (with CRIRES+ up to ~ 50 kpc)



(3) THE FIRST STARS

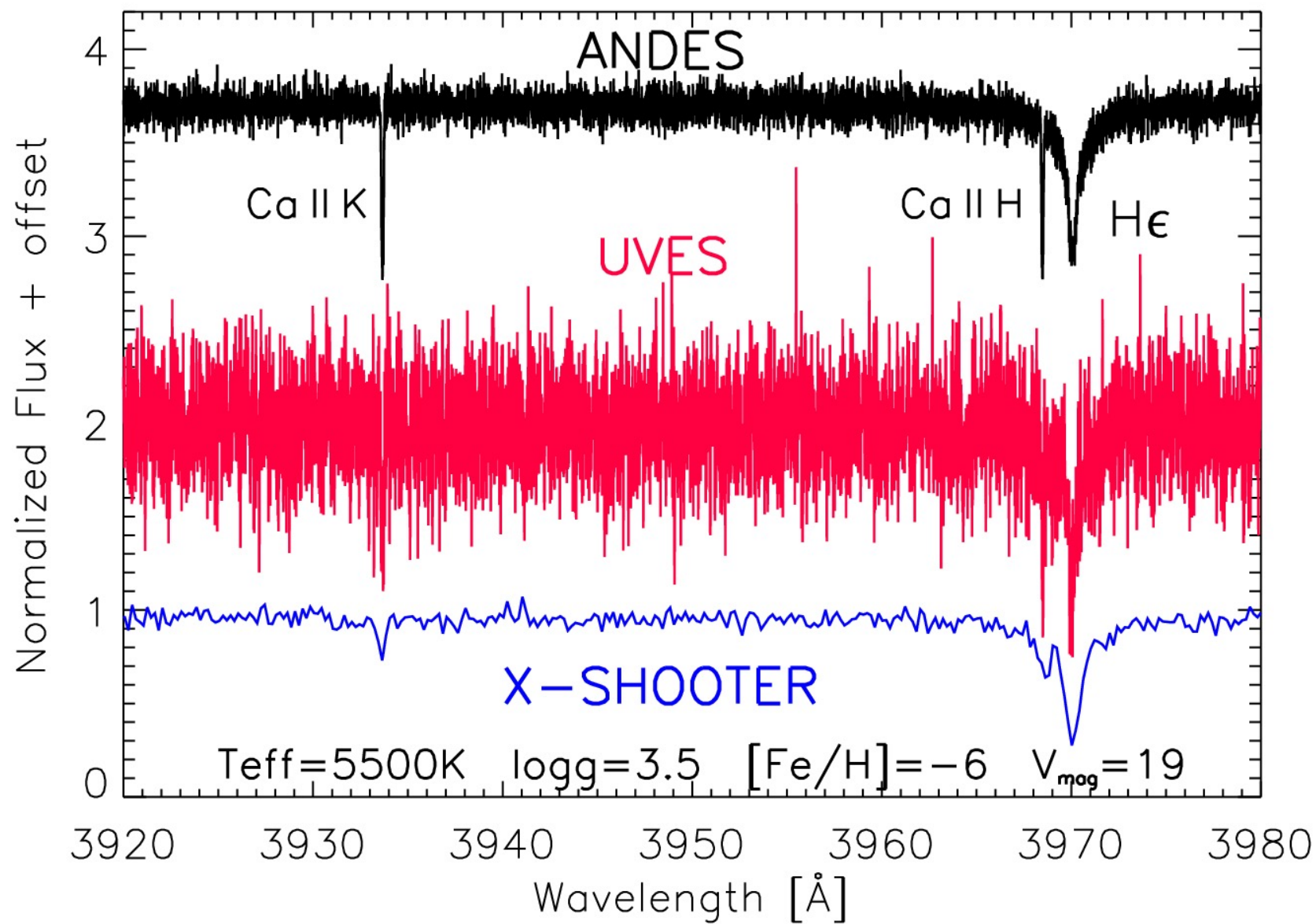


- Search for Population III stars and their descendants (very metal-poor stars)
- Optical and blue lines
- Faint stars ($G > 18-19$)



Lines detected
at $[\text{Fe}/\text{H}] < -4$



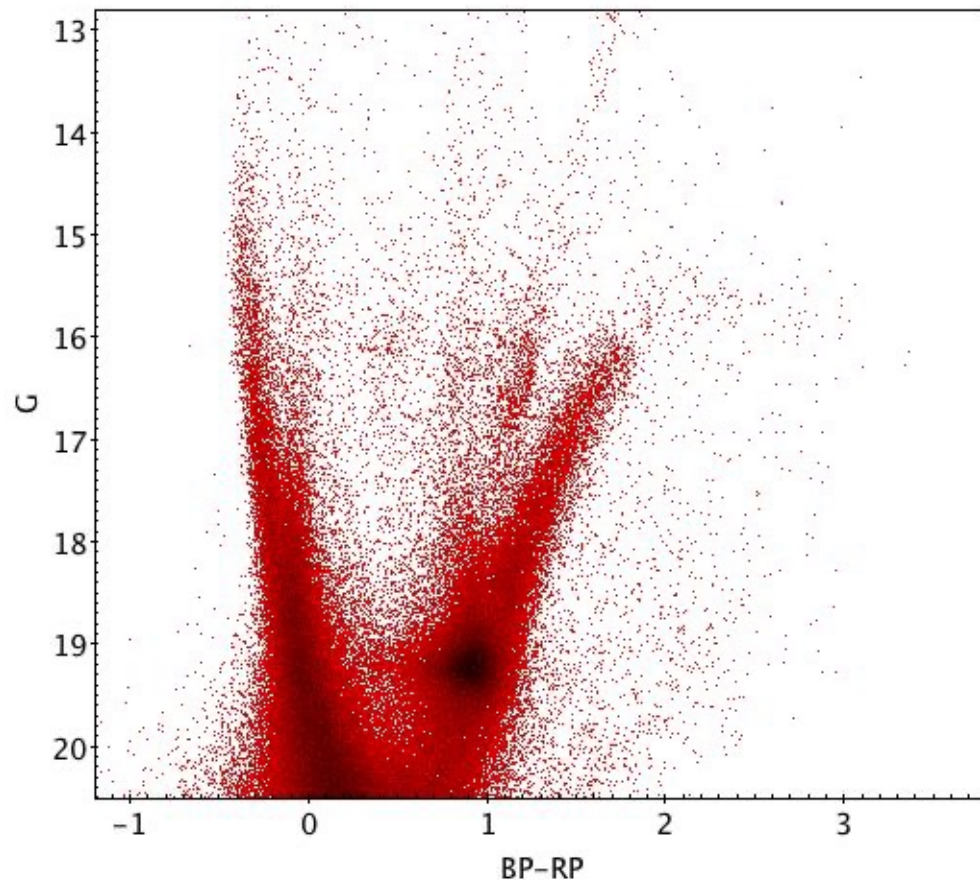


(4) DWARF GALAXIES IN THE LOCAL GROUP

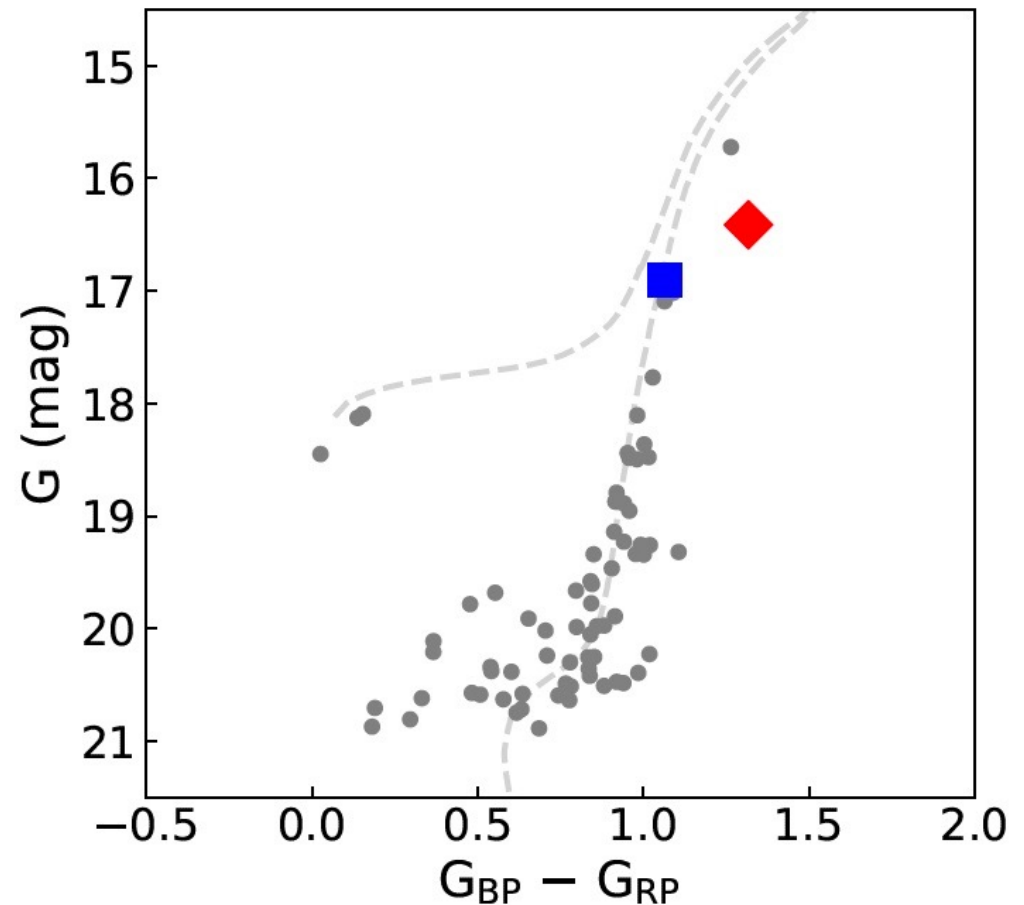


- Faint stars (giants in dwarf galaxies, $G > 16-17$)
- Ultra-faint dwarfs, $G > 18-19$
- High-resolution follow-up of peculiar stars in external galaxies that will be discovered with 4MOST, MOONS etc ...

LMC



Reticulum II



ANDES



Its unique combination of

- ELT aperture
- Very high spectral resolution
- Large spectral coverage

will allow to enlarge the discovery space of the stellar astrophysics.

A continuous effort
by our community
is necessary.