



Leibniz-Institut für
Astrophysik Potsdam

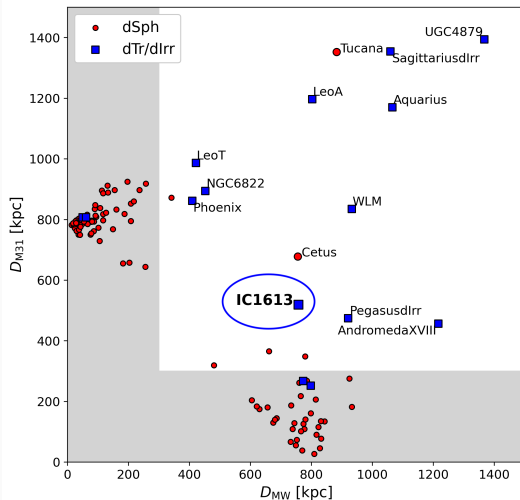
From gas to stars: MUSEings on the internal evolution of IC 1613

Salvatore Taibi

with: G. Battaglia, M. Roth, S. Kamann, G. Iorio, C. Gallart, R. Leaman,
E. Skillman, N. Kacharov, M. Beasley, P. Mancera Piña, and G. van de Ven

A decade of discoveries with MUSE and beyond. ESO, Garching, 18-22 November 2024

Spectroscopy of an isolated dwarf galaxy



(McConnachie 2012 – Jan 2021 compilation)

Isolated Local Group dwarf galaxies

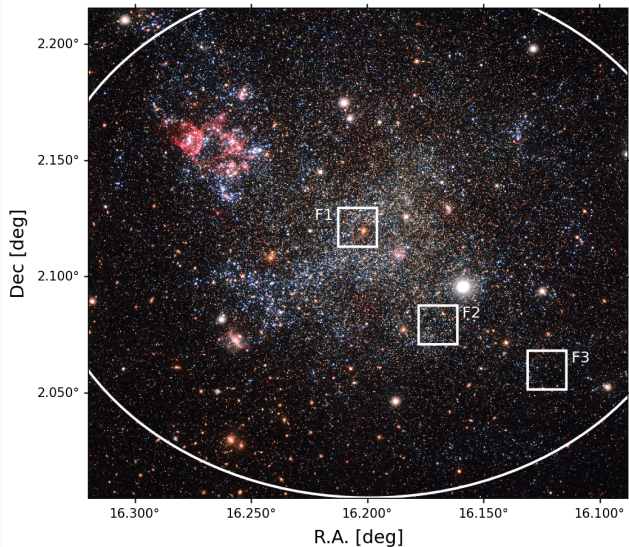
⇒ a window onto the intrinsic properties of low-mass galaxies

Our goal

Study a *gas-rich* system to reconstruct the evolution of stellar kinematics over time and its link to the neutral gas

⇒ **MUSE observations of IC 1613**

The dwarf irregular IC 1613



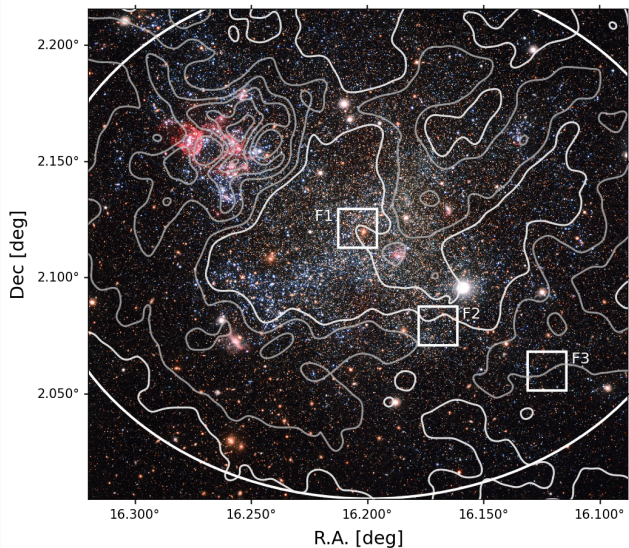
An $M_* \sim 10^8 M_\odot$ dwarf galaxy

VLT/MUSE

- 3 pointings out to $\sim R_e$
- Total $t_{\text{exp}} \sim 9$ hrs
- Source extraction with PampelMUSE
Kamann et al. (2013)
- 10^3 sources at $S/N > 5$

Taibi et al. (2024); A&A, 689, A88

The dwarf irregular IC 1613



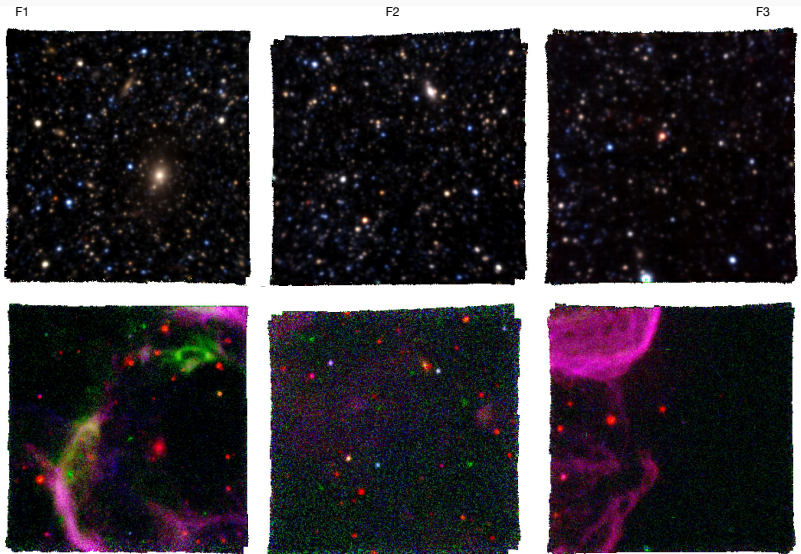
An $M_* \sim 10^8 M_\odot$ dwarf galaxy

VLT/MUSE

- 3 pointings out to $\sim R_e$
- Total $t_{\text{exp}} \sim 9$ hrs
- Source extraction with PampelMUSE
Kamann et al. (2013)
- 10^3 sources at $S/N > 5$

Taibi et al. (2024); A&A, 689, A88

Pointings

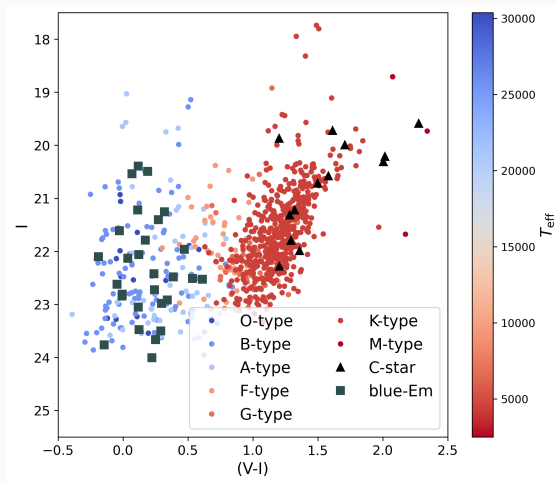


Spectral classification

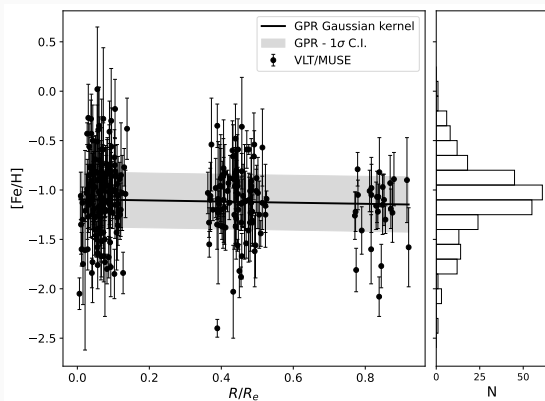
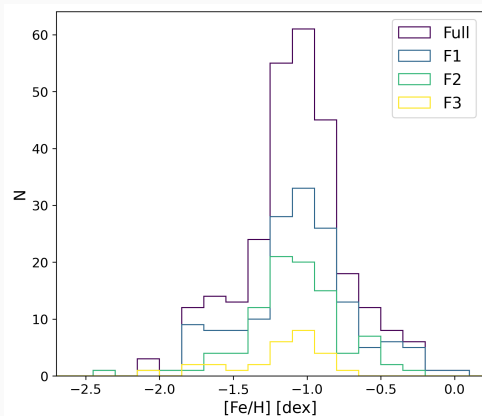
Semi-automatic procedure (following Roth et al. 2018)

- ~ 800 stars classified with $\delta(T_{\text{eff}}) < 500$ K
- Major component of K-types
- ~ 100 young Main Sequence
- Incl. 24 Be stars ($f_{OB}=18\%$) and 14 C-stars

→ main sample for chemical and kinematic analysis



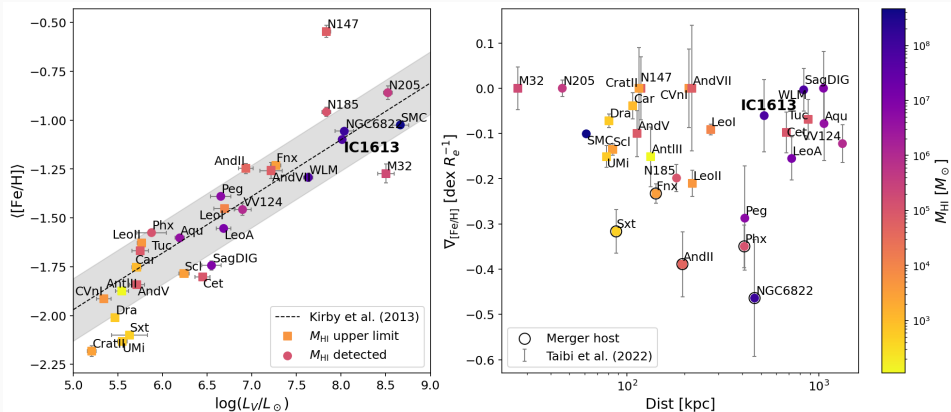
Chemical analysis



Metallicity estimation for ~ 300 red giant stars from Ca II triplet lines

Comparable distributions among field and absence of a radial gradient

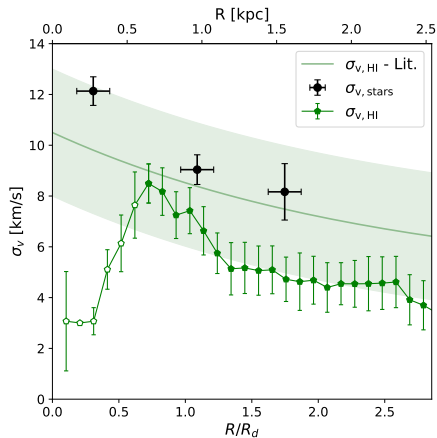
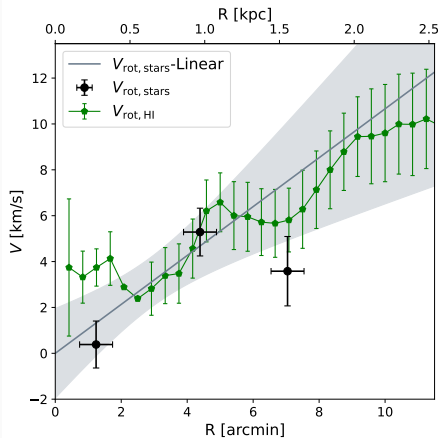
Chemical analysis



IC 1613 follows $L_V - [Fe/H]$ relation and general $\nabla_{[Fe/H]}$ trends

Results in agreement with literature (Kirby et al. 2013, Taibi et al. 2022)

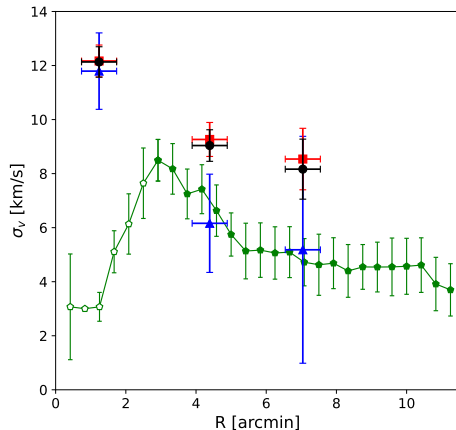
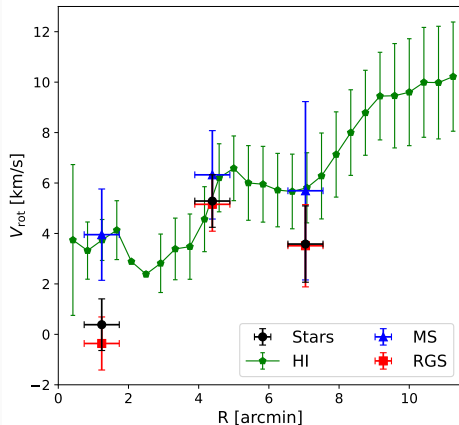
Kinematic analysis



Probability-weighted Bayesian analysis

Rotation signal detected with high significance → **First time!**

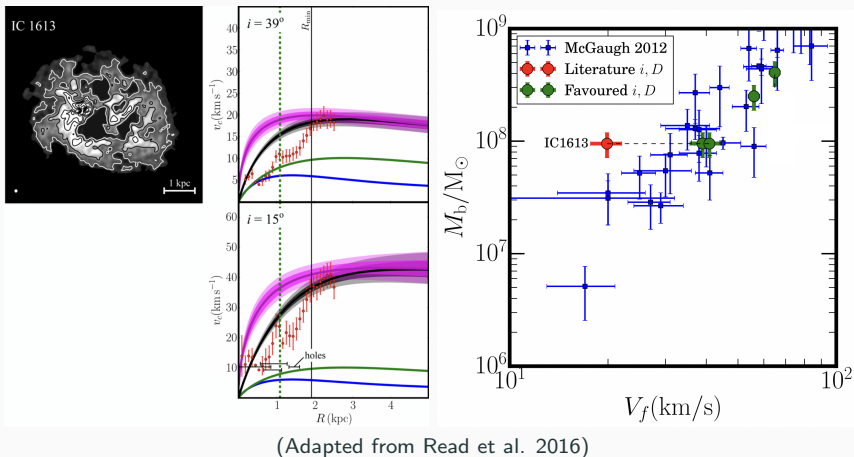
Kinematic analysis by stellar population



Stellar rotation dominated by RGS and mostly decoupled from HI

Kinematics of the young MS stars more uncertain but closer to the neutral gas

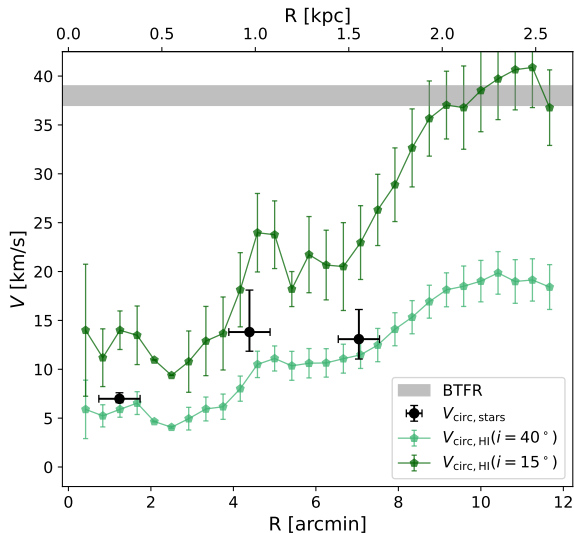
Debate over the inclination angle



A low inclination angle allows for a better dynamical modelling

It would also bring IC 1613 in agreement with the BTFR

Dynamical mass estimation



Role of inclination

$$\text{Stellar } i = 32^\circ \pm 11^\circ$$

Using MS and RGS as tracers

More data needed at larger R

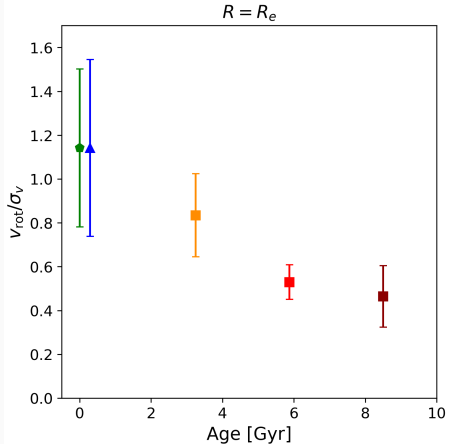
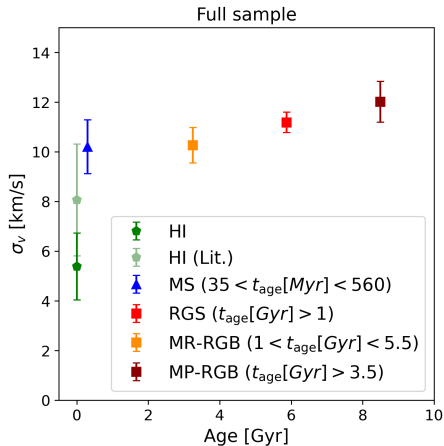
Dynamical mass at $R_{1/2}$

$$V_{\text{circ}} = 14_{-2}^{+4} \text{ km/s}$$

$$M_{\text{dyn}} = 0.7_{-0.2}^{+0.4} \times 10^8 M_\odot$$

$$M_{\text{dyn}}/L_V \sim 2$$

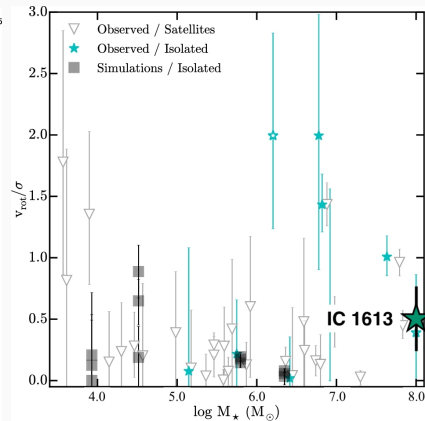
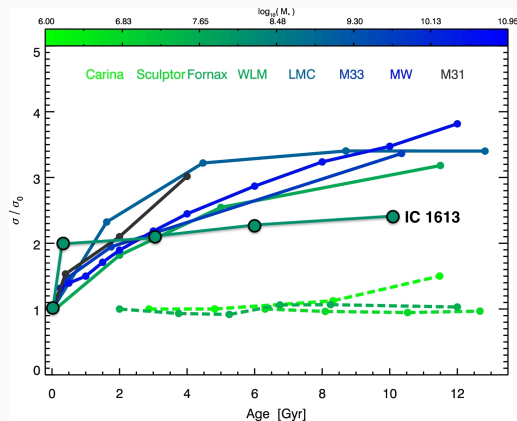
Age-kinematic trends



Velocity dispersion increases while rotation support decreases with ages

Support scenario in which stars are born from ISM less turbulent with time

Age-kinematic trends



(Adapted from Leaman et al. 2017 and Wheeler et al. 2017)

Age-velocity dispersion relation for LG galaxies

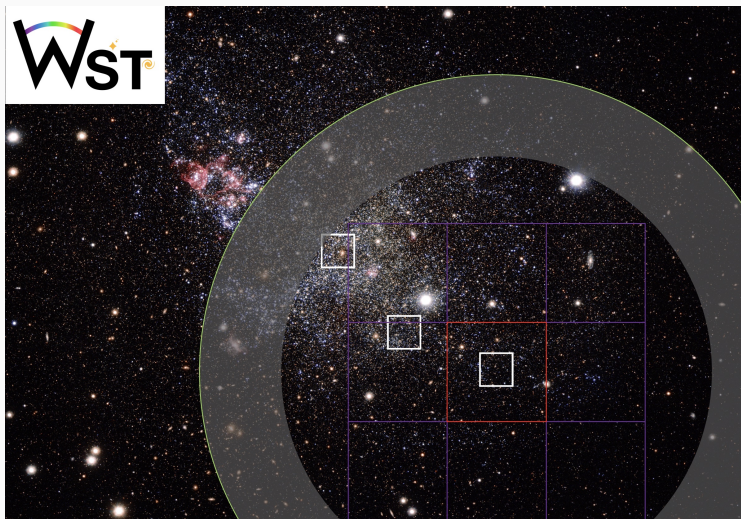
LG galaxies are not fast rotators in their evolved component: born as puffy systems

IC 1613 with MUSE:

- Rotation signal detected with high significance → First time!
- New estimation of the inclination angle using only independent stellar tracers
- Velocity dispersion increases, while the rotation-support decreases with age
⇒ support scenario in which stars are born from a less turbulent gas over time

IC 1613 in the future:

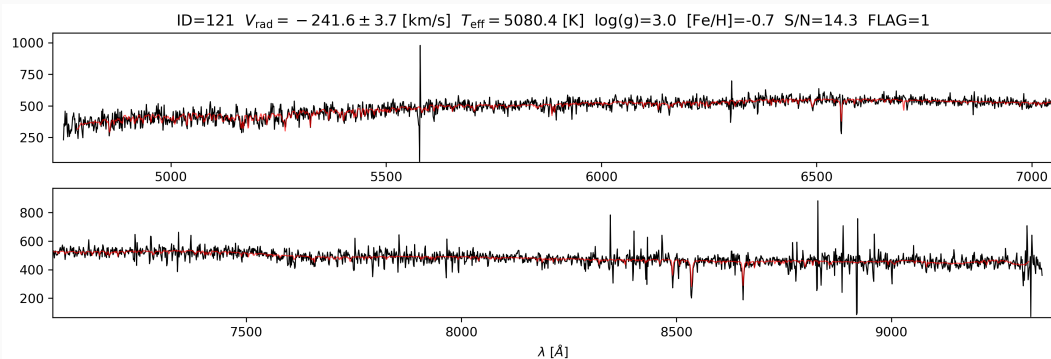




(Mainieri et al. 2024)

Back-up

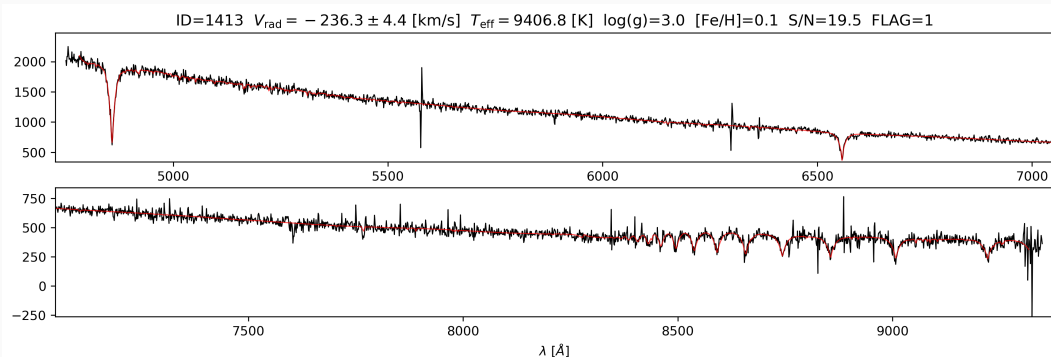
Radial velocity determination



Using spexxy with PHOENIX synthetic spectral library (Husser et al. 2013)

Measured ~ 1000 stars with accurate $\delta(V_{\text{rad}}) < 20 \text{ km s}^{-1}$ for $S/N > 3.5$

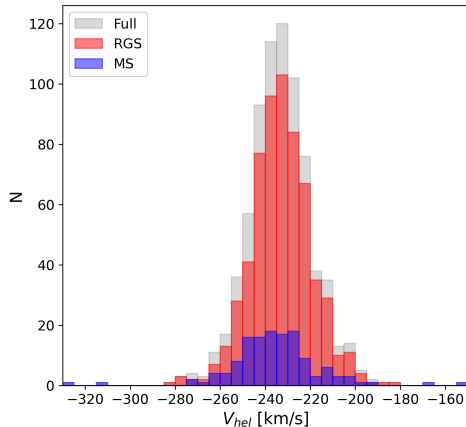
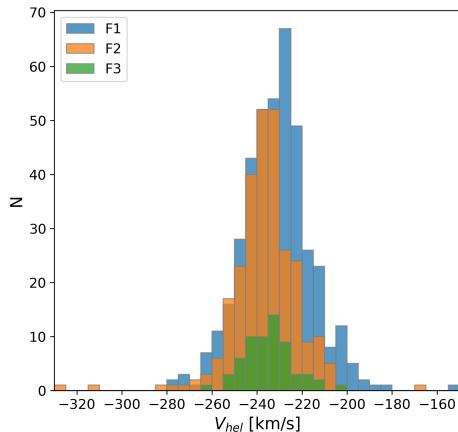
Radial velocity determination



Using **spexxy** with **PHOENIX** synthetic spectral library (Husser et al. 2013)

Measured ~ 1000 stars with accurate $\delta(V_{\text{rad}}) < 20 \text{ km s}^{-1}$ for $S/N > 3.5$

Inspection of velocity distributions



Velocity distributions highlighted per field and stellar population

Contaminants removed with Gaia-eDR3, photometry and spectral classification