# Twinkle twinkle little star, can I know how old you are?

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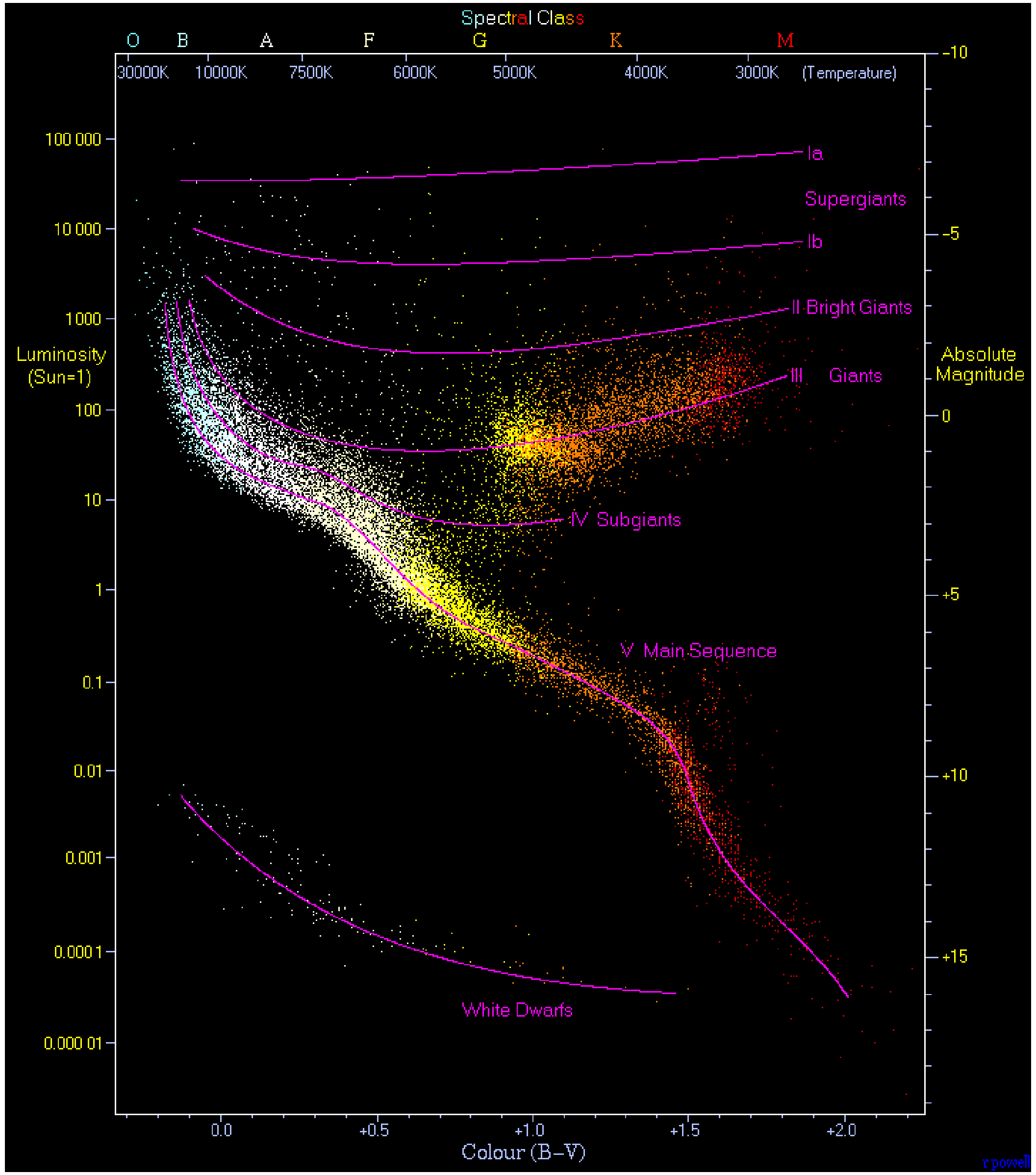
# Stellar evolution

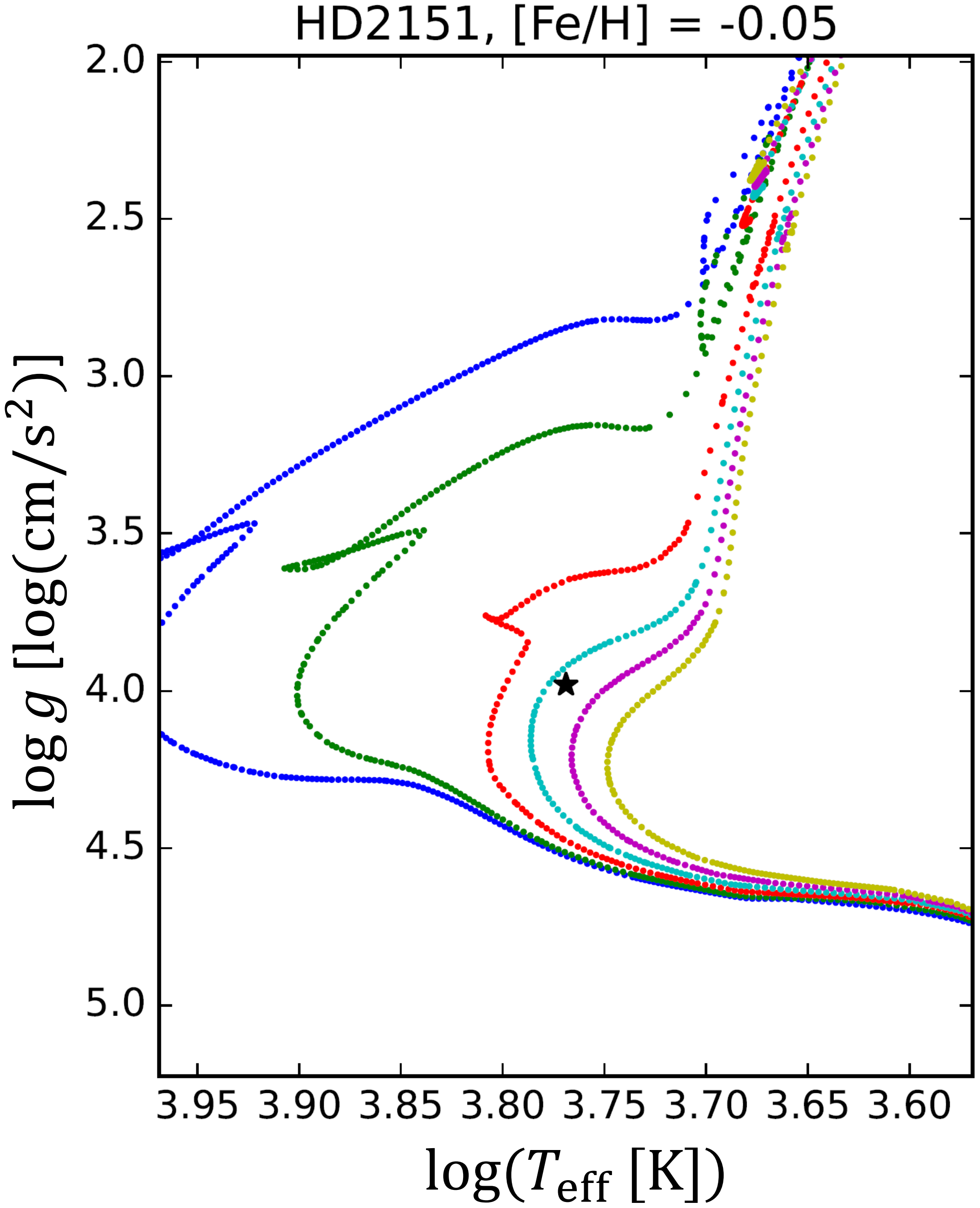
- HRD: One way to observe stellar evolution
- Turn-off & Subgiant stars:
  →Observable stellar properties vary more between stars with different ages
- Why care about ages?
  →**Timelines** for astronomical processes
  →**Galactic archaeology**




Credit: By Richard Powell - The Hertzsprung Russell Diagram, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=1736396

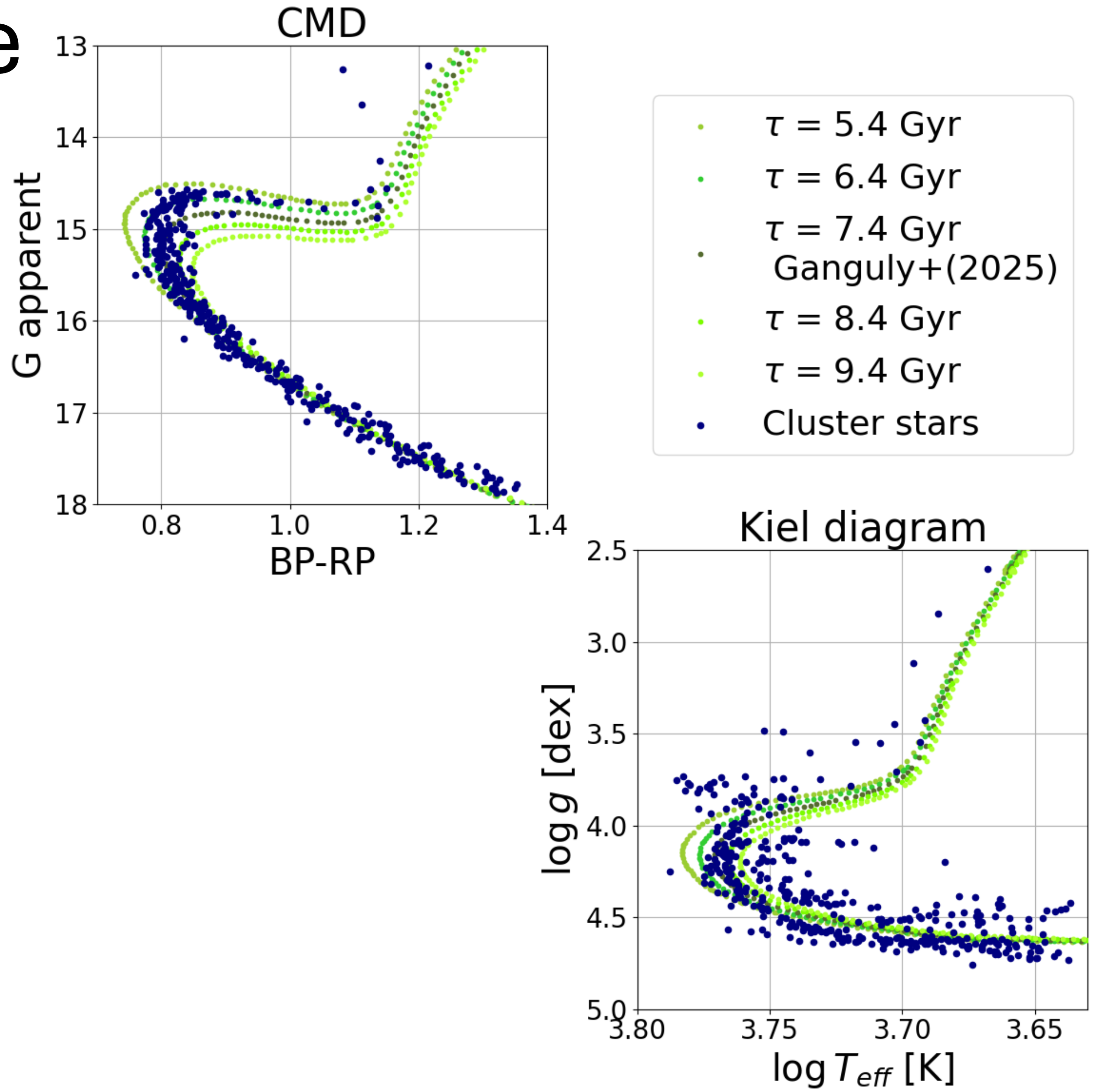
# Isochrone matching

- Isochrone: Stellar evolution model
  - →**Same**: Age, Z (composition)
  - →**Varying**: Mass
- Finds **isochrone closest** to the star
- Expected to work best for **subgiants**
  - →Masses: $\sim 1 - 2\ \mathrm{M}_{\odot}$
  - →Ages: $\sim 1 - 10$ Gyr



# The age estimation code

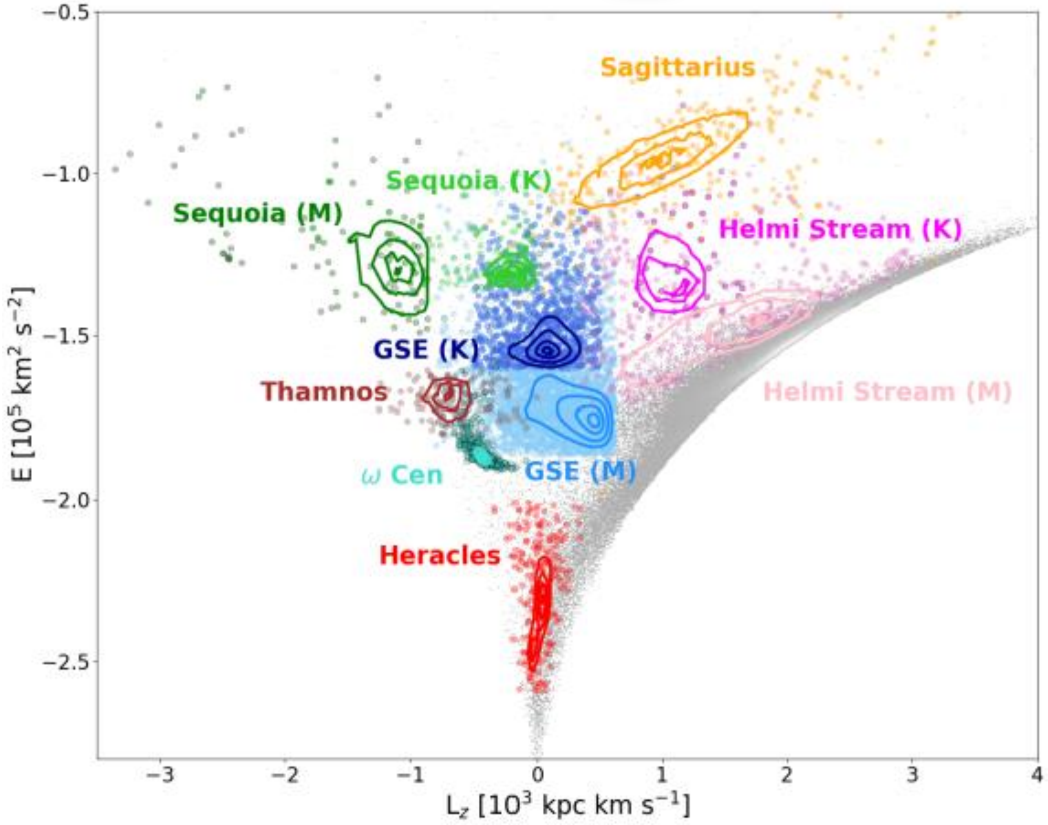
- From Sahlholdt & Lindegren (2021)
- **Bayesian statistical comparison**
- Calculates PDF for [Fe/H] and age
- Has been:
  - →**developed** on synthetic populations Sahlholdt & Lindegren (2021)
  - →**applied to** MW disc subgiant stars in Sahlholdt et al. (2022)



# Goals

- Spectroscopic data is **limited**, photometric data from Gaia is more **abundant**
  - →Want to test code's **applicability** to Gaia **photometric data**

- Want to apply to:
  - →MW **halo stars**
  - →MW neighbourhood **dwarf galaxies**

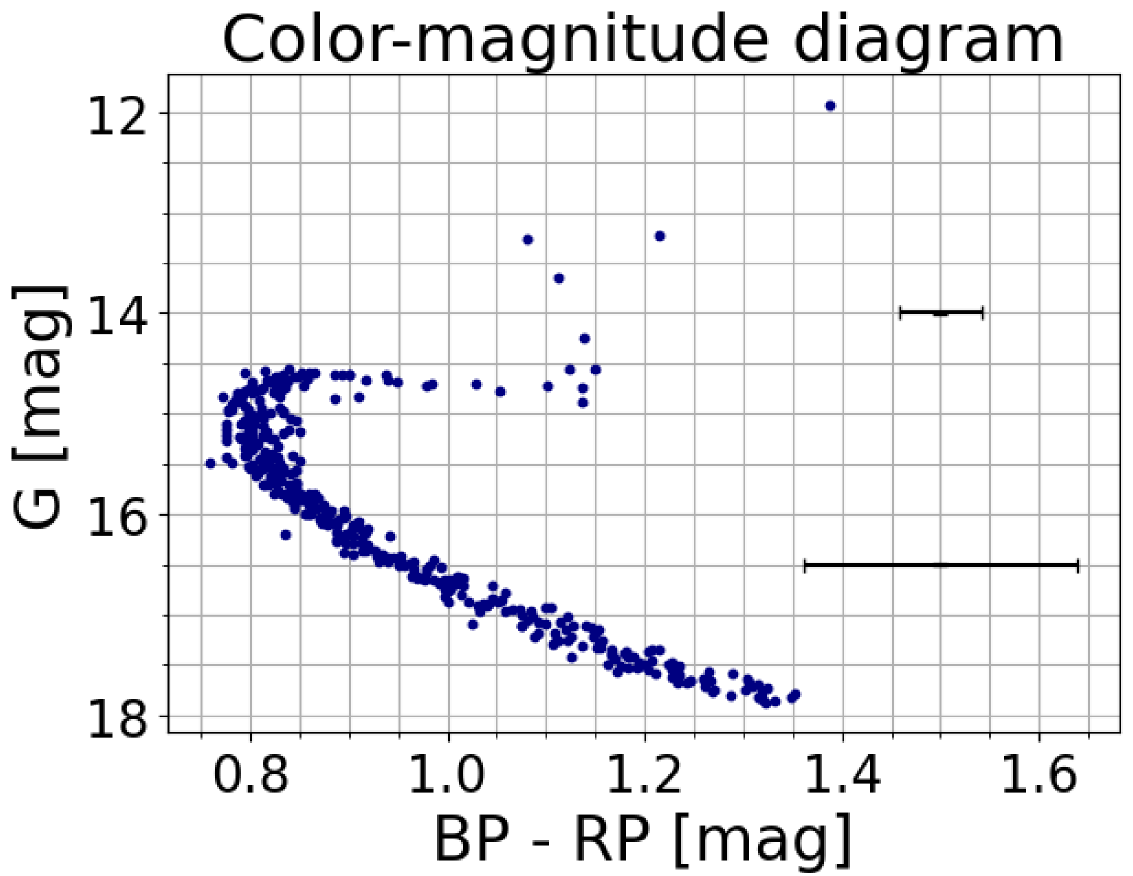



Mori et al. (2025)

# NGC188

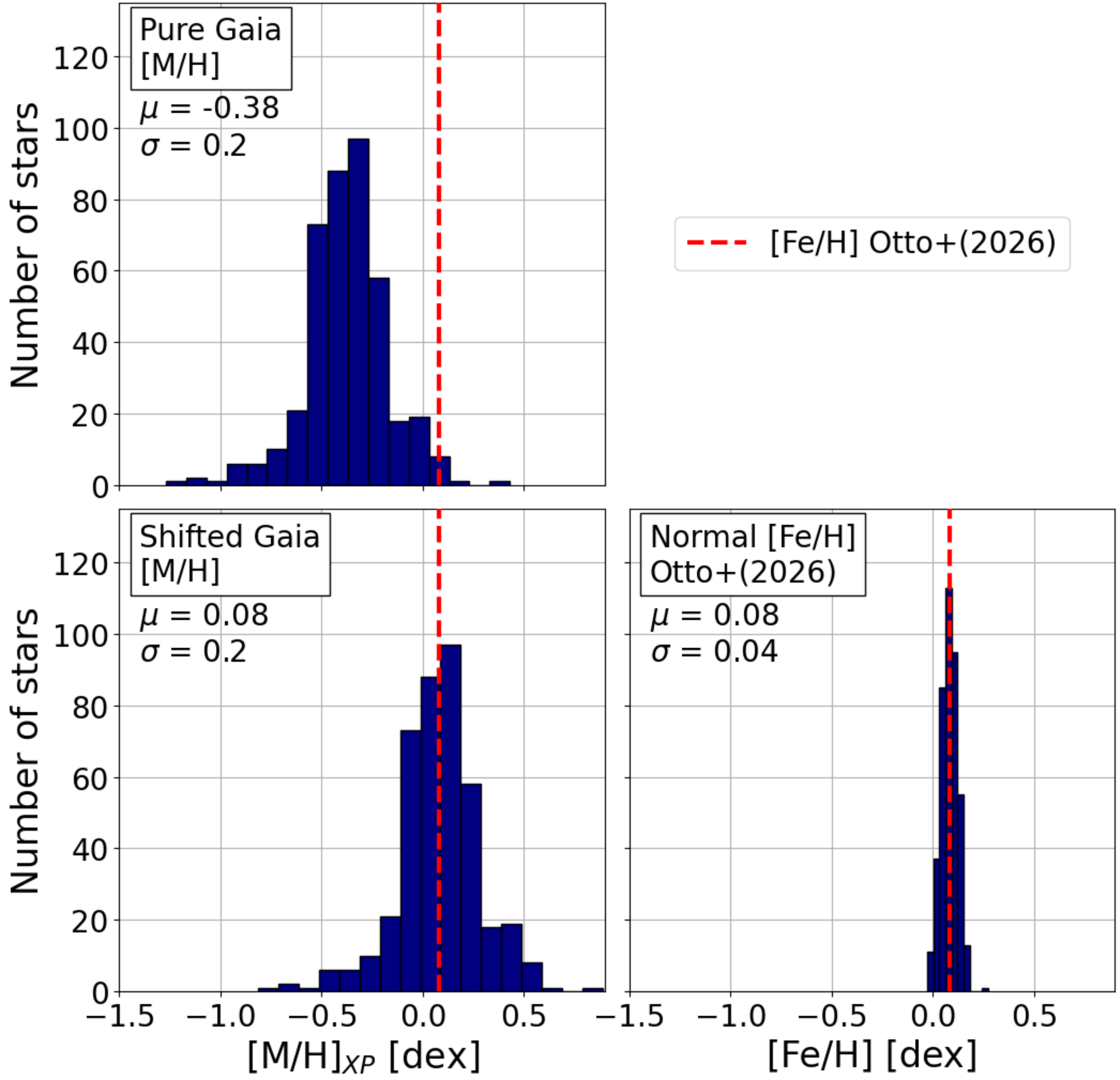
- Important parameters (Ganguly, 2025; Otto, 2026)
  - →Age: ~7.4 $\pm$ 1 Gyr
  - →[Fe/H]: ~0.08 dex
  - →Distance: ~1.7 kpc
  - →Extinction: 0.46 mag

- Data:
  - →Gaia
    - G, BP, RP, parallax
    - XP spectra: [M/H], $T_{\text{eff}}$, $\log g$
  - →Otto et al. (2026) from SDSS DR19
    - Average cluster [Fe/H]



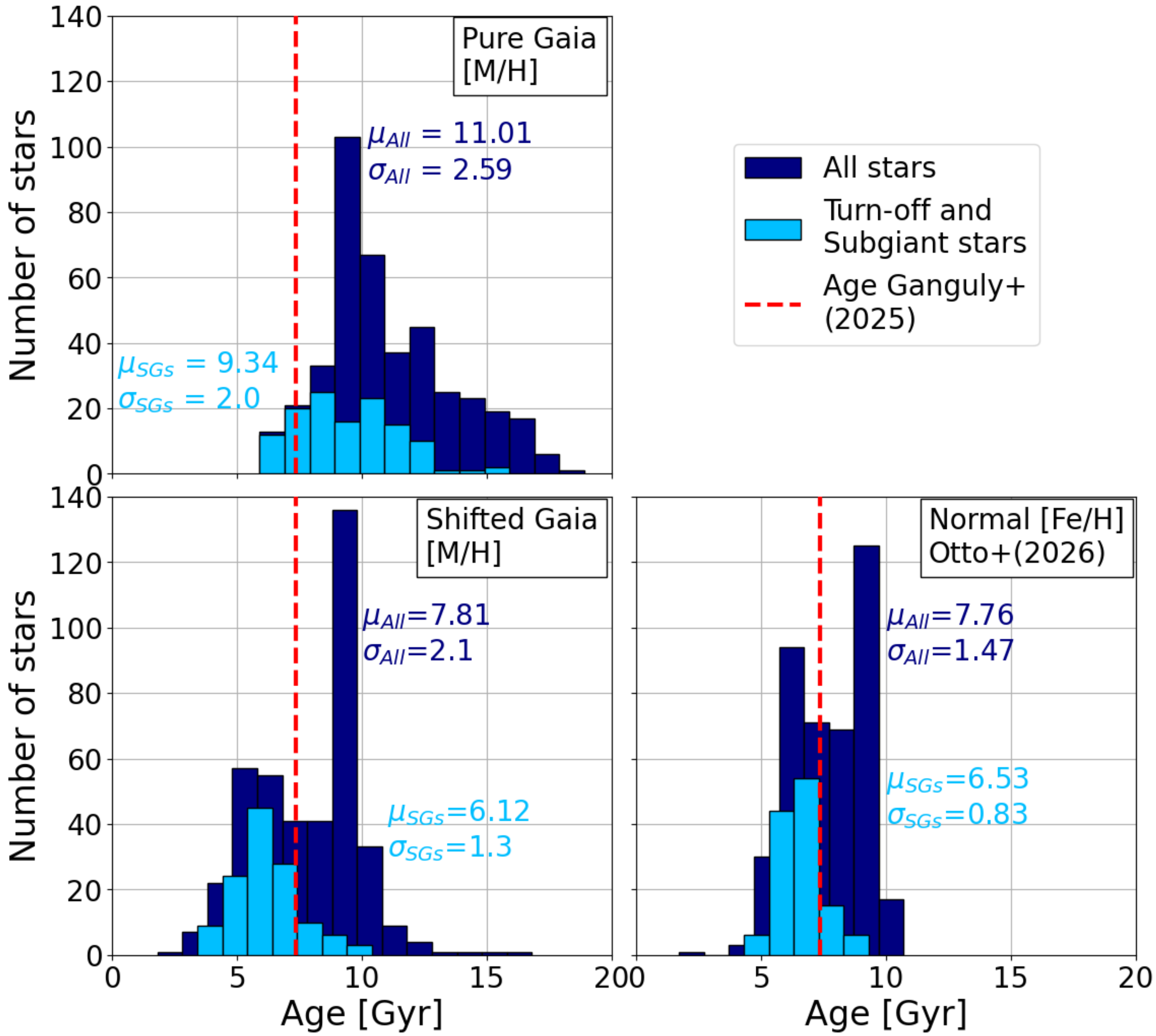
# Tests done so far

- All:
  - →CMD fits ⇒ Gaia G, BP-RP, parallax
  - →PARSEC isochrones
- "Pure Gaia [M/H]"
  - →**Gaia XP** [M/H] values
- "Shifted Gaia [M/H]"
  - →Gaia XP [M/H] **values shifted** to mean SIMBAD value
- "Normal [Fe/H] Otto+(2026)"
  - →**Normal distribution** drawn from SDSS DR19 cluster [Fe/H] value



# Results

- Pure Gaia [M/H]
  - →**Large** dispersion
  - →Mean age **far** from lit. age
- Shifted Gaia [M/H]
  - →**Slightly narrower** dispersion
  - →Mean age **closer** to lit. age
- Normal [Fe/H] Otto+(2026)
  - →**Narrower** dispersion
  - →Mean age **close** to lit. age



# Conclusions and future plan

- [Fe/H] data used in method heavily affects the results
  - →Mean [Fe/H] close to literature value gives **ages closer to literature value**
  - →Narrow [Fe/H] dispersion gives **narrower age dispersion** and **ages closer to literature value**

- Upcoming steps:
  - →Sample Age Metallicity Distribution
  - →Testing different isochrones
  - →More detailed extinctions from dust maps
  - →Test on more clusters