# NGC 3201

Globular Cluster

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Aim is to calculate the Distance and Age of NGC 3201

# Distance

Table 1: Estimates of apparent visual distance modulus, reddening and distance from the literature.

| **Apparent visual distance modulus $(m-M)_V$ [mag]** | **Reddening E(B-V) [mag]** | **Distance [kpc]** | **Source** |
|---|---|---|---|
| 14.08 ± 0.06 ± 0.1 | N/A | N/A | Mazur et al. 2003, https://arxiv.org/abs/astro-ph/0304359 |
| 14.10 | 0.14 | 5.4 | Alcaino 1976, https://ui.adsabs.harvard.edu/abs/1976A%26AS...26..251A/abstract |
| 14.20 | 0.24 | 4.9 | Harris 2010, https://arxiv.org/abs/1012.3224, the catalog: http://physwww.mcmaster.ca/~harris/mwgc.dat |
| 14.2 | 0.21± 0.02 | 5.2 | Lee 1977, https://ui.adsabs.harvard.edu/abs/1977A%26AS...28..409L/abstract |
| N/A | 0.25 ± 0.02 | 4.67 ± 0.24 | Layden et al. 2003, https://ui.adsabs.harvard.edu/abs/2003AJ....125..208L/abstract |
| N/A | 0.25 ± 0.01 | 5.1 ± 0.1 kpc | Monty et al. 2018, https://arxiv.org/abs/1808.05271 |

## Notes about distance modulus

Literature usually gives *apparent visual distance modulus* $(m\text{-}M)_V$ (Table 1.) To calculate the distance, we first need to calculate the *true distance modulus* $(m\text{-}M)_0$, which is the apparent distance modulus minus the light extinction term $A_V = R_V E(B - V)$:

$$(m\text{-}M)_0 = (m\text{-}M)_V - R_V E(B - V),$$

where

- $R_V = 3$ is optical total-to-selective extinction ratio value that is dependent upon the density of the interstellar medium. I don't know where this number 3 comes from, but they all use it.
- $E(B - V)$ is the extinction correction value (aka "reddening") of the (B-V) colour (given by Table 1).

Once we calculate $(m\text{-}M)_0$, we can find distance d (in pc) from equation:

$$(m\text{-}M)_0 = 5 \log_{10}[d/(10\ pc)].$$

# Age

The method we will use to determine the age of NGC 3201 is through a comparison with theoretical isochrones. The isochrones that we generate are plotted on a Colour Magnitude Diagram (CMD), where absolute magnitude in the UBVRI filter is plotted against colour. In the literature, these isochrones are presented as trendlines indicating where the globular cluster data will lie, thus giving an approximate age estimate determined by fitting isochrones to the CMD of the cluster.

Table 2: Ages for NGC 3201 found through Isochrone Fitting from literature

| **Age (Gyr)** | **Source** |
|---|---|
| 13.4 ± 0.5 | Layden et al. 2003 https://ui.adsabs.harvard.edu/abs/2003AJ....125..208L/abstract |
| 12.2 ± 0.5 | Monty et al. 2018 https://ui.adsabs.harvard.edu/abs/2018ApJ...865..160M/abstract |
| 12.00 ± 0.75 | Dotter et al. 2010 https://arxiv.org/abs/0911.2469 |

| | |
|---|---|
| 11.4 | Munoz et al. 2013<br>https://arxiv.org/abs/astro-ph/0109433 |
| 12 ± 1 | Calamida et al. 2008<br>https://ui.adsabs.harvard.edu/abs/2009IAUS..258..189C/abstract |

An example result of calculating the age of NGC 3201:

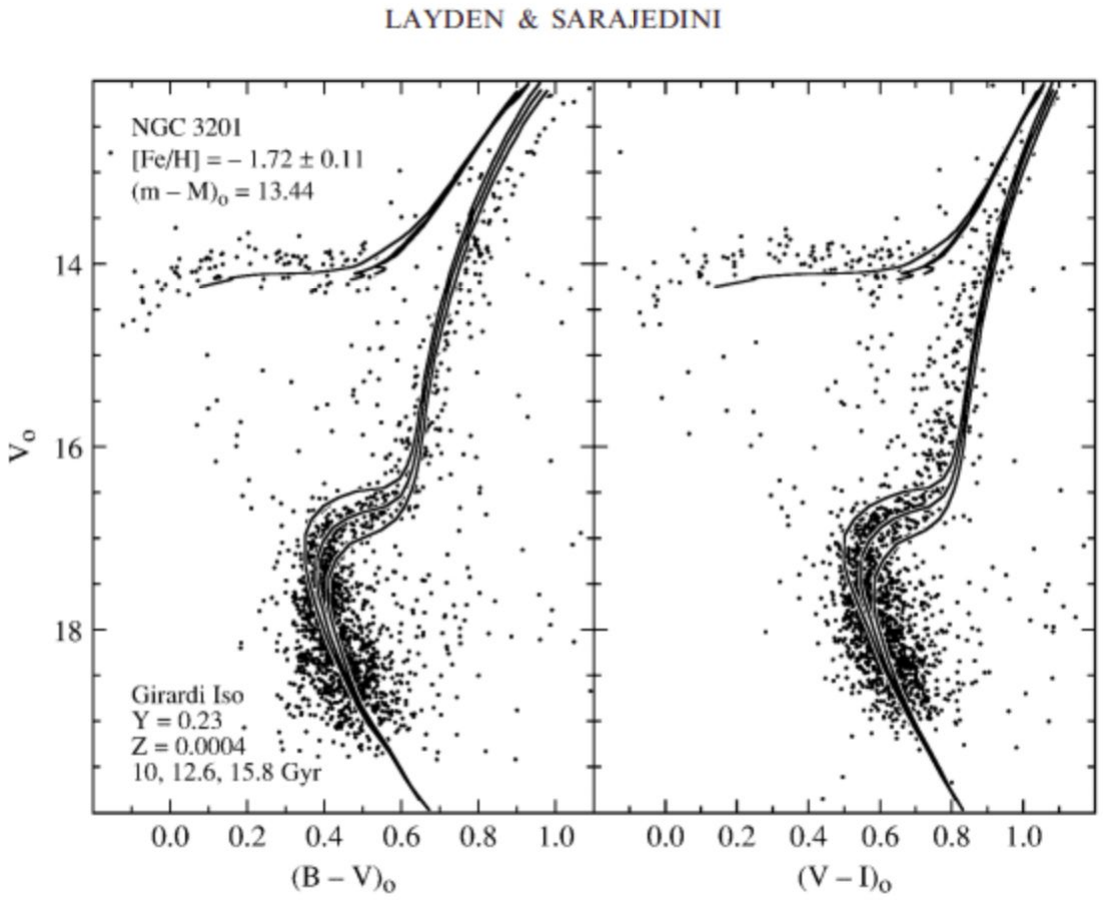


Figure 1. NGC 3201 against V-band as a function of (B - V) colour on the left side, right side, V band is a function of (V - I) colour. The curves mark the isochrones, where we have ages 10.0, 12.6 and 15.8 Gyrs. (Layden et al. 2003)

Therefore, Layden et al. suggests from the isochrone fitting that NGC 3201 has an age of 13.4 ± 0.5.