Analyzing NGC 2287 in Three Dimensions with StargateVR

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Introducing NGC 2287

Messier 41 The Little Beehive Cluster CHI-1 2h40 | Telescope Live

NGC 2287 also known as the Little Beehive Cluster

- Bright open star cluster
- Located in the constellation Canis Major
- Roughly the size of the full moon in the night sky

Physical parameters

- Lies 705±9 pc from Earth [2]
- 100 or more stars [1]
- Metallicity: [Fe/H] = -0.11 [2]

Project Tools

01

Gaia

Locating the cluster in Gaia cone search

02

StarGateVR

3D Gaia data sorting to find grouped stars

03

Python and MIST

Determining cluster members, age, and distance

04

Chandra

X-ray data for determining lower mass cluster members

Gaia and StarGateVR

Data comes from Gaia Data Release 3

- Using search feature for preset right ascension and declination
- 16,467 stars and we only want around 100

StarGateVR Interface

- Left hand - gating and control panel
- Right hand - movement and panel interaction
- XYZ is scaled in units of parsec and UVW is in km/s
- U is in the direction of galactic center, V is in the direction of the sun's motion perpendicular to the center, and W is out of the galactic plane

```
SELECT TOP 2000000 gaiadr3.gaia_source.source_id as source_id, gaiadr3.astrophysical_parameters.source_id as source_id2,
gaiadr3.gaia_source.ra as ra, gaiadr3.gaia_source.dec as dec, (1 / gaiadr3.gaia_source.parallax)*1000 as dist, gaiadr3.gaia_source.parallax as parallax,
gaiadr3.gaia_source.parallax_error as parallax_error, gaiadr3.gaia_source.l, gaiadr3.gaia_source.b, gaiadr3.gaia_source.pmra as pmra,
gaiadr3.gaia_source.pmdec as pmdec, gaiadr3.gaia_source.radial_velocity as rv, gaiadr3.gaia_source.phot_g_mean_mag as photo_g_mean_mag,
gaiadr3.gaia_source.bp_rp as bp_rp, 0 as X, 0 as Y, 0 as Z, 0 as U, 0 as V, 0 as W, 0 as absMag, 0 as revAbsMag, 0 as revbp_rp, 0 as zero, 1 as one,
gaiadr3.astrophysical_parameters.teff_gspspec as teff, gaiadr3.astrophysical_parameters.teff_gspspec_upper as teff_up,
gaiadr3.astrophysical_parameters.teff_gspspec_lower as teff_lo, gaiadr3.astrophysical_parameters.logg_gspspec as logg,
gaiadr3.astrophysical_parameters.logg_gspspec_upper as logg_up, gaiadr3.astrophysical_parameters.logg_gspspec_lower as logg_lo,
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gaiadr3.astrophysical_parameters.classprob_dsc_combmod_star as prob_star,
gaiadr3.astrophysical_parameters.classprob_dsc_combmod_binarystar as prob_bistar, gaiadr3.gaia_source.phot_rp_mean_mag as
photo_rp_mean_mag, gaiadr3.gaia_source.phot_bp_mean_mag as photo_bp_mean_mag, gaiadr3.gaia_source.g_rp as g_rp,
gaiadr3.gaia_source.bp_g as bp_g FROM gaiadr3.gaia_source, gaiadr3.astrophysical_parameters WHERE CONTAINS(
POINT('ICRS',gaiadr3.gaia_source.ra,gaiadr3.gaia_source.dec), CIRCLE( 'ICRS',
COORD1(EPOCH_PROP_POS(101.499,-20.716,1.3600,-4.3390,-1.3810,23.5200,2000,2016.0)),
COORD2(EPOCH_PROP_POS(101.499,-20.716,1.3600,-4.3390,-1.3810,23.5200,2000,2016.0)), 0.83333333333333334) )=1 AND
(gaiadr3.gaia_source.parallax_over_error>=5 AND gaiadr3.gaia_source.astrometric_excess_noise<=2 AND
gaiadr3.astrophysical_parameters.source_id=gaiadr3.gaia_source.source_id)
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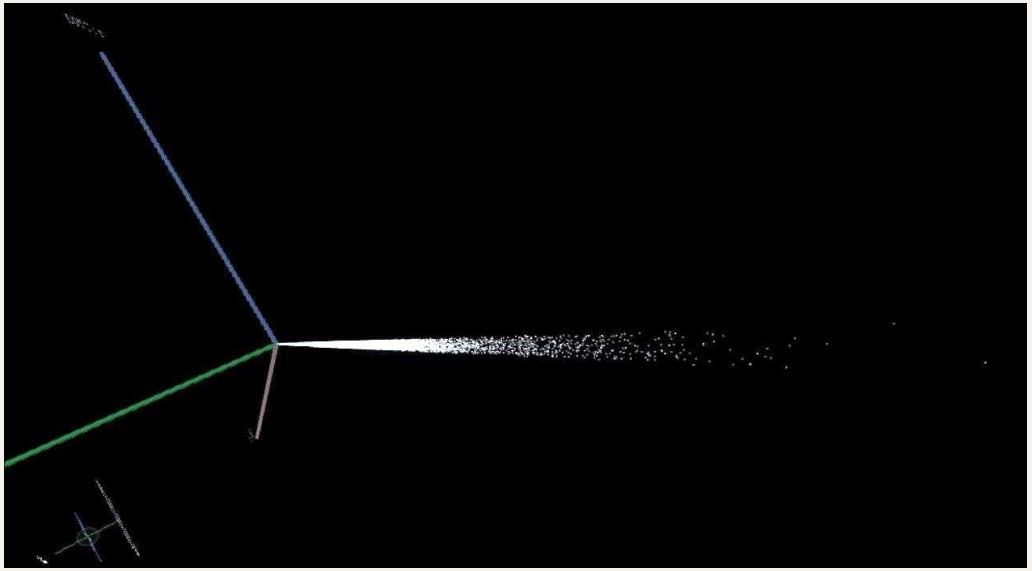
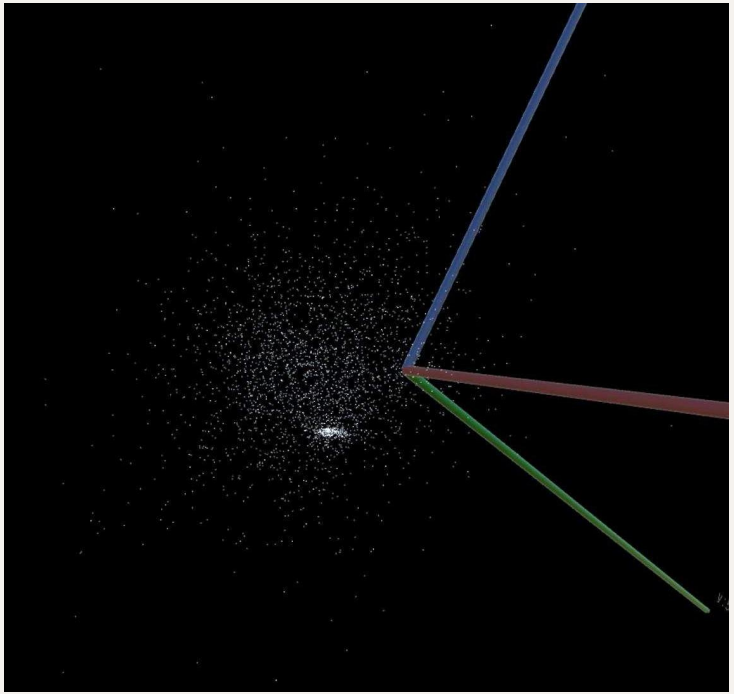
Output 16,467 stars

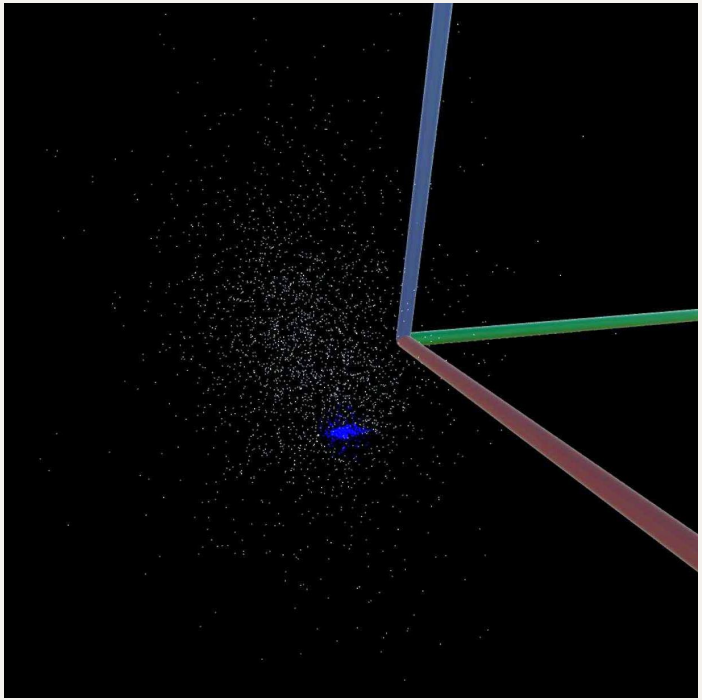
Data Sorting and Analysis

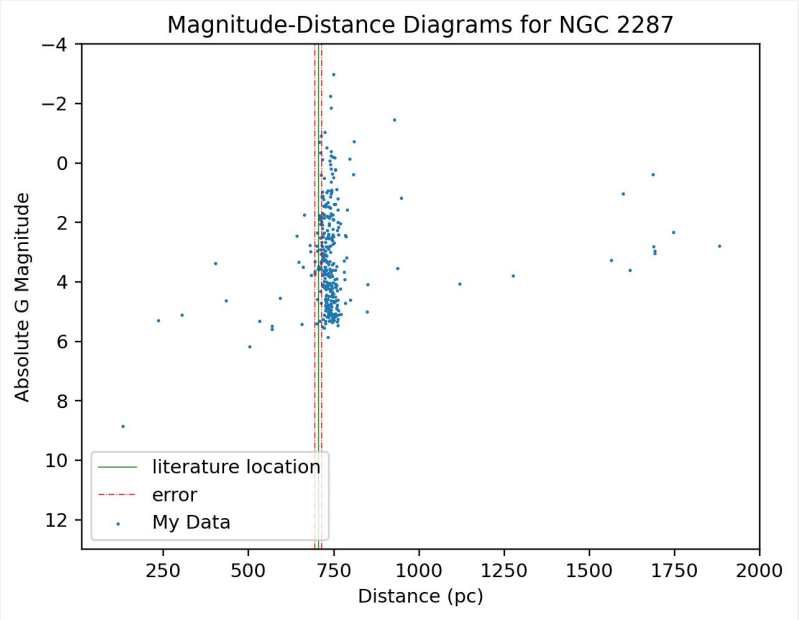




Cone search in XYZ and UVW in StarGateVR

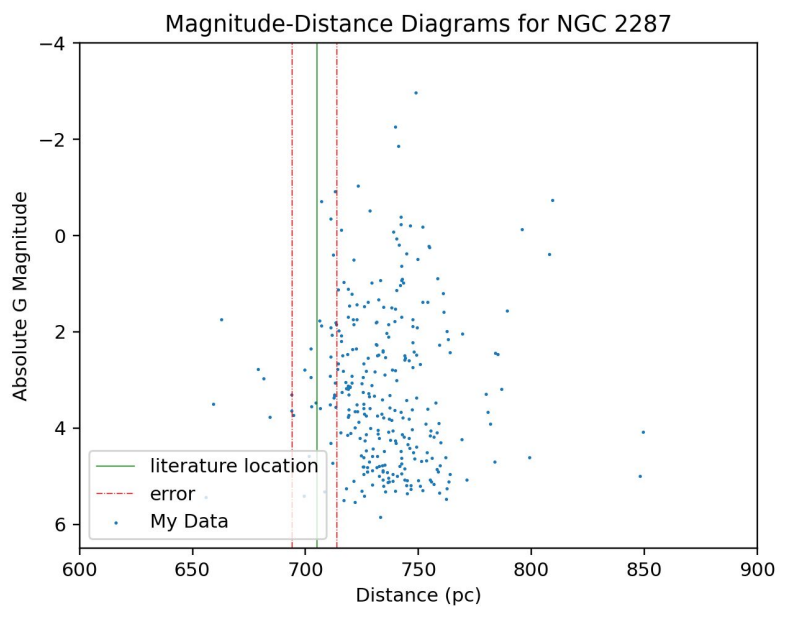
Cluster Determination

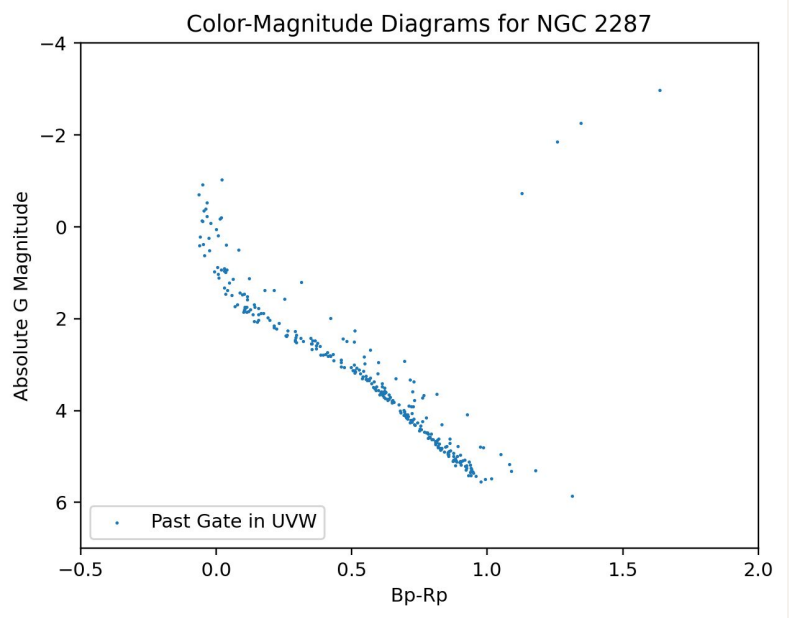




Gated stars with similar velocities produce a tight grouping in distance from us ⇨ 330 stars

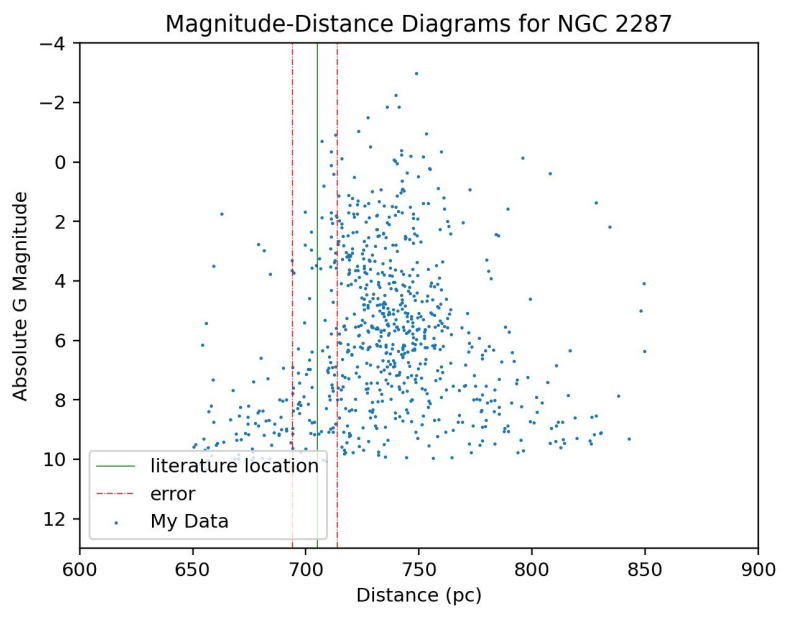
CMD of UVW Gate

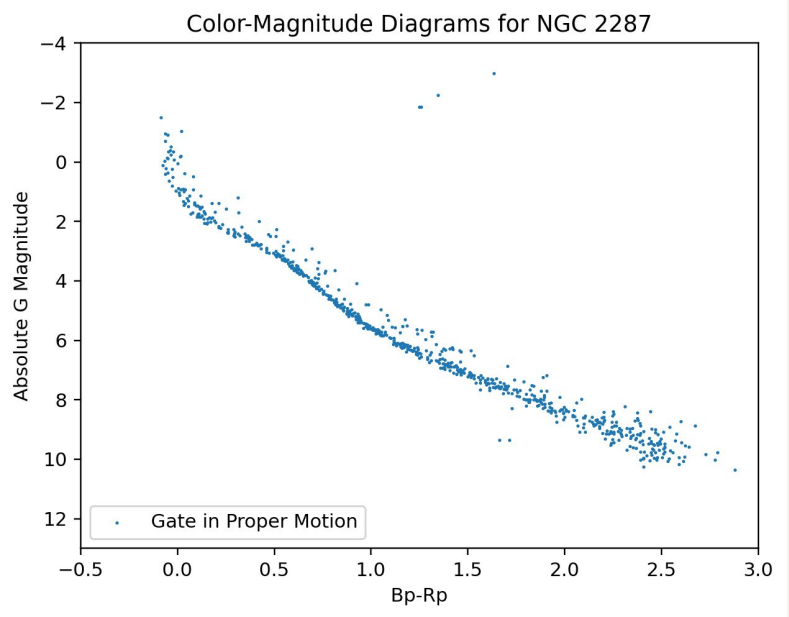




Sorting by distance [650-850pc] allows for a tight main sequence ⇨ 301

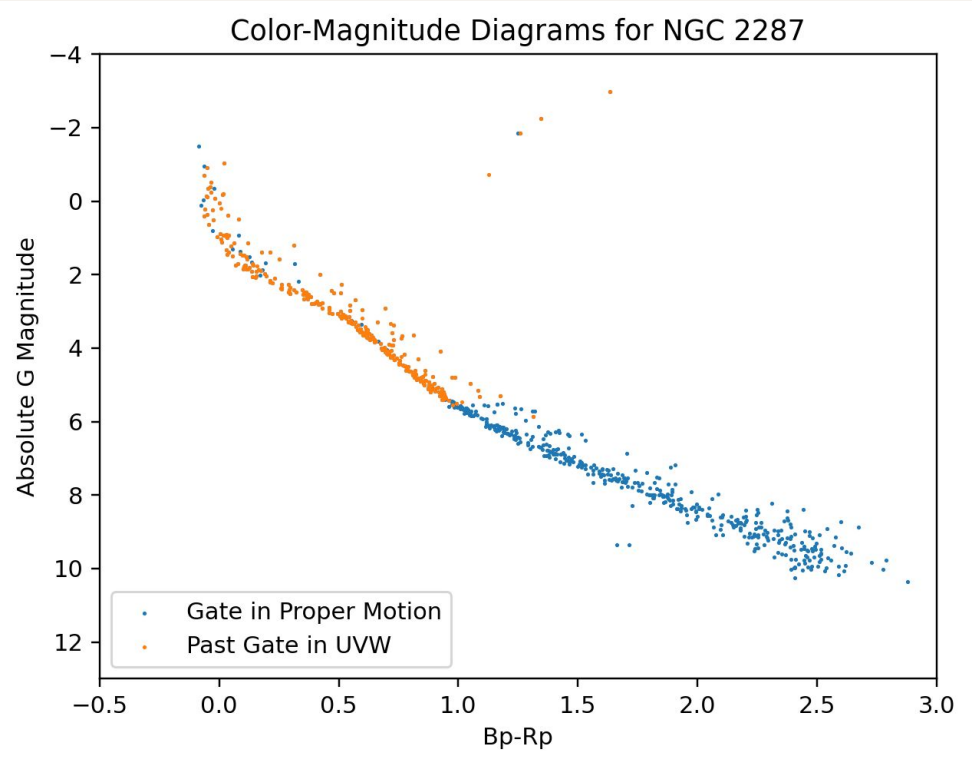
CMD of Proper Motion Gate



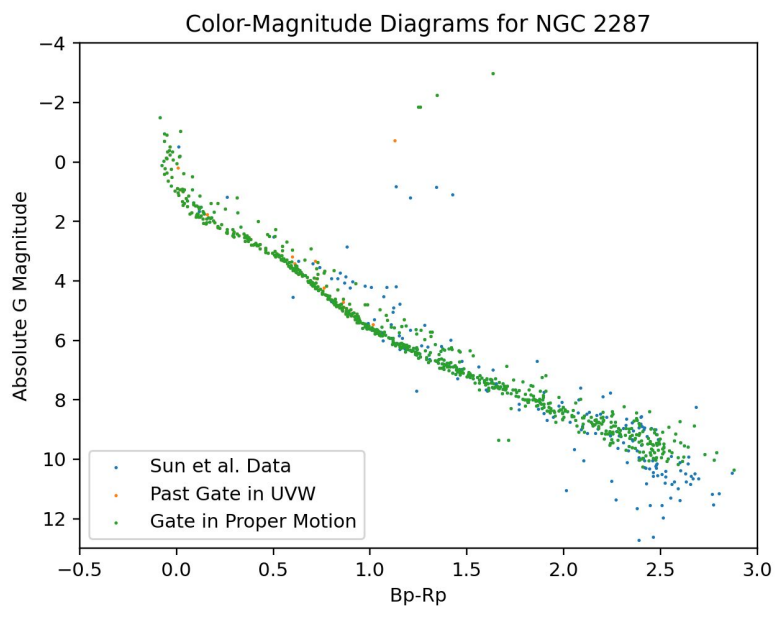


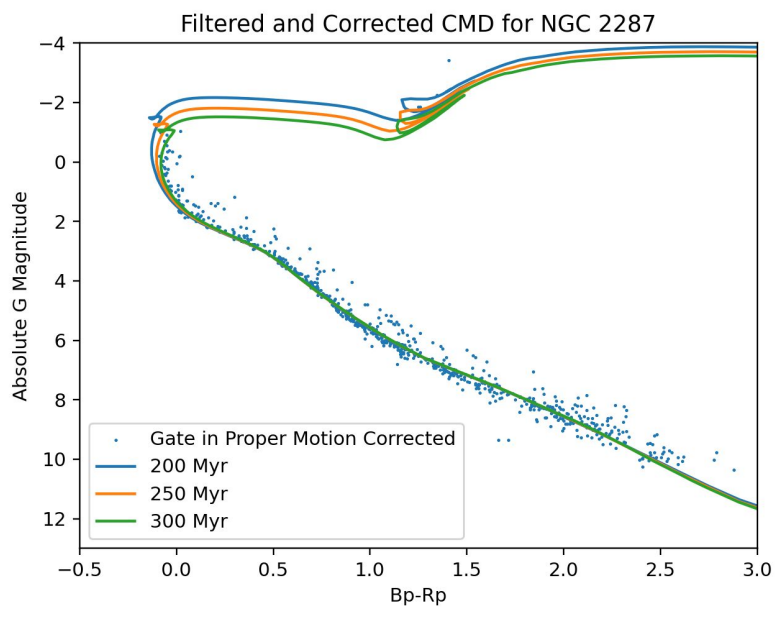
Sorting by distance [650-850pc] and proper motion allows for a tight main sequence with the dimmer stars ⇨ 765

Proper Motion Membership Gains



Comparison with Published Results and Isochrones





Conclusions and Future Work

We determine the membership to be more than double the current accepted value.

- Multiple ways to separate cluster stars from surroundings
- UVW gating
- XYZ gating
- Proper motion gating

Future Work

- Crossmatching multiple methods to determine the similar members between methods
- Better extinction and reddening correction
- Potential Chandra data for studying the lower main sequence we cannot study using UVW gating

Thanks

Questions?

Works Cited

[1] “Messier 41.” Messier Objects, September 9, 2022.

https://www.messier-objects.com/messier-41/.

[2] “M41.” SIMBAD Astronomical Database - CDS (Strasbourg). Accessed December 1, 2022.

http://simbad.u-strasbg.fr/simbad/sim-id?Ident=M41.

[3] “Infrared Science Archive.” IPAC. Accessed December 1, 2022.

https://www.ipac.caltech.edu/project/irsa.

[4] Gaia archive. Accessed December 1, 2022. https://gea.esac.esa.int/archive/.

Credit to those who are working on StarGateVR

[5] Sun, Weijia, Chengyuan Li, Licai Deng, and Richard de Grijs. “Tidal-Locking-Induced Stellar Rotation Dichotomy in the Open Cluster

NGC 2287?” *The Astrophysical Journal* 883, no. 2 (2019): 182. https://doi.org/10.3847/1538-4357/ab3cd0.