

Background

- Virtual Reality (VR) is an emergent technology with relatively untapped potential for scientific exploration.
- StarGateVR is a tool designed for visualizing and selecting stellar data from the European Space Agency's (ESA's) Gaia Space Astrometry Mission in its native (3-dimensional) space.
- In Fall 2022, the four lead authors applied StarGateVR in designing and carrying out final projects for the AST graduate course Galactic Astrophysics (ASTP-740).

Methods

- Queries were made to the ESA's Gaia archive (<https://gea.esac.esa.int/archive/>).
- Selected data was uploaded into the StarGateVR tool.
- Datasets were explored in VR, and stars of interest were selected and exported for further analysis.

Nearby Young Stars

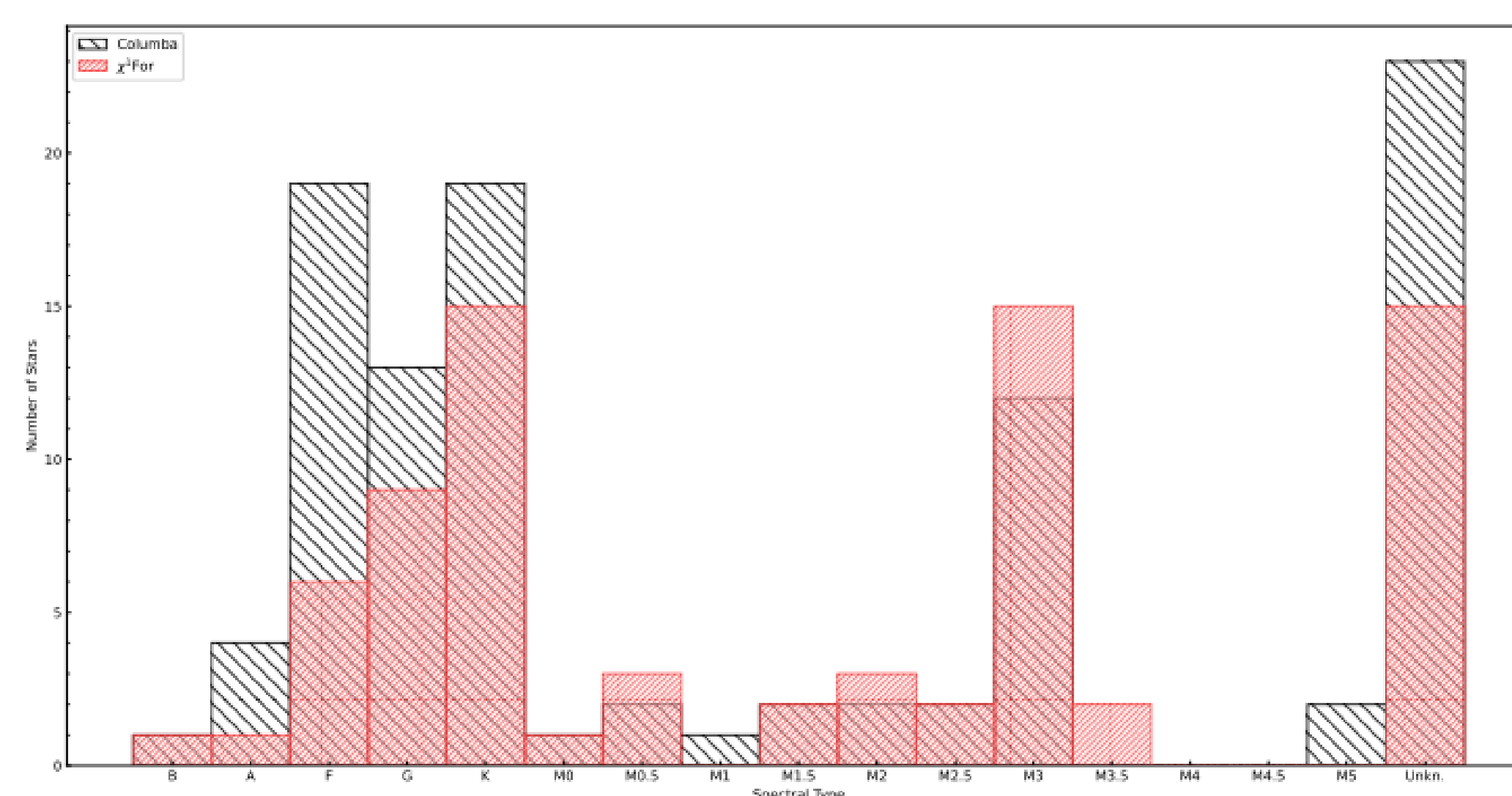


Fig 1. StarGateVR was used to identify 20 new candidate members of the roughly 40-million-year-old Columba Association, located between 100 and 300 light years from Earth. A histogram showing stellar demographics of the Columba association and the associated X¹ Fornacis open cluster. The x-axis represents different types of stars, and the y-axis denotes how many of them were seen in each group.

Stellar Populations Above the Galactic Plane

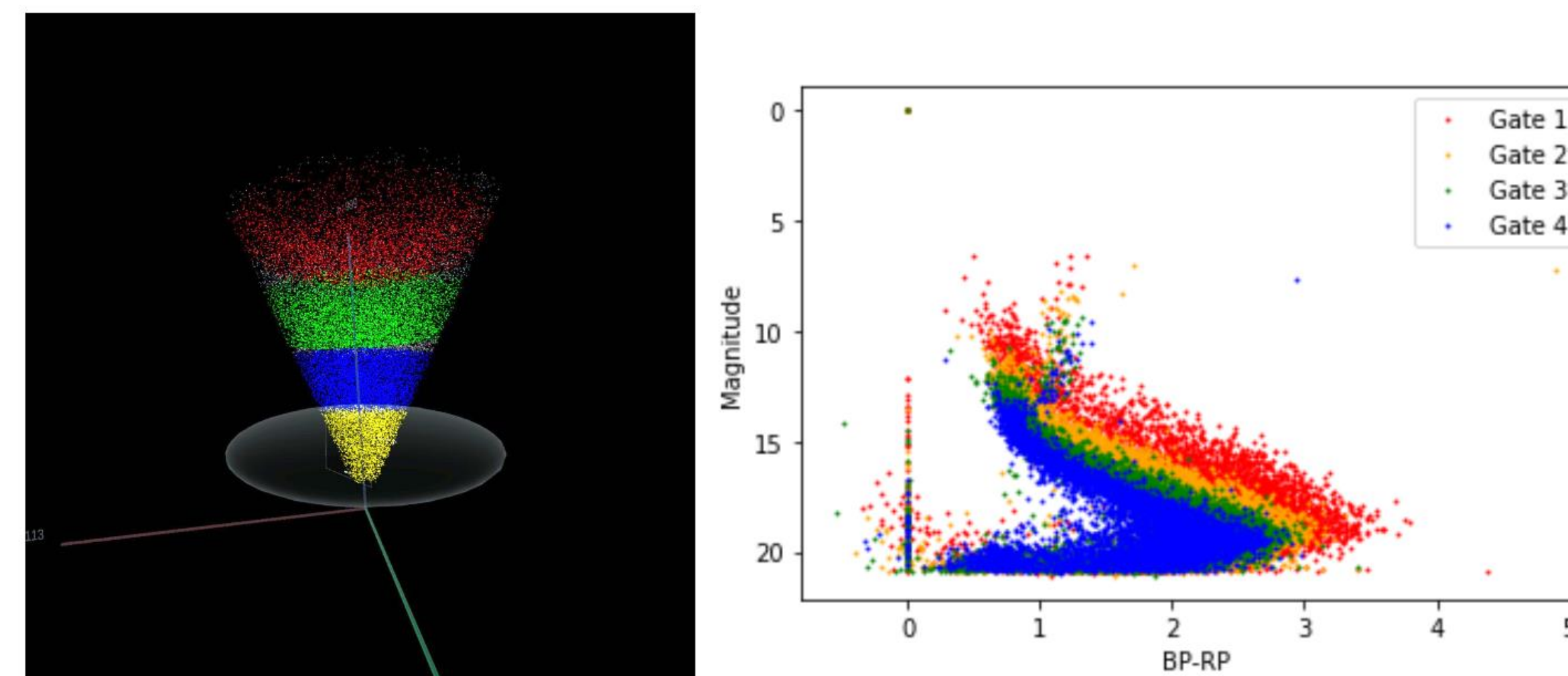


Fig 2. Left: A screenshot taken within the StarGateVR tool showing a cone of stars above the plane of the galaxy, filtered into 4 broad regions by color. Right: The Gaia color-magnitude diagrams (CMDs) for the various scale height bins (Gate 1 being the bottom of the cone etc.). Each point on the CMD is a star, with the x-axis representing its color (bluer stars on the left, redder on the right). The y-axis denotes the star's absolute brightness.

Membership of Messier 41

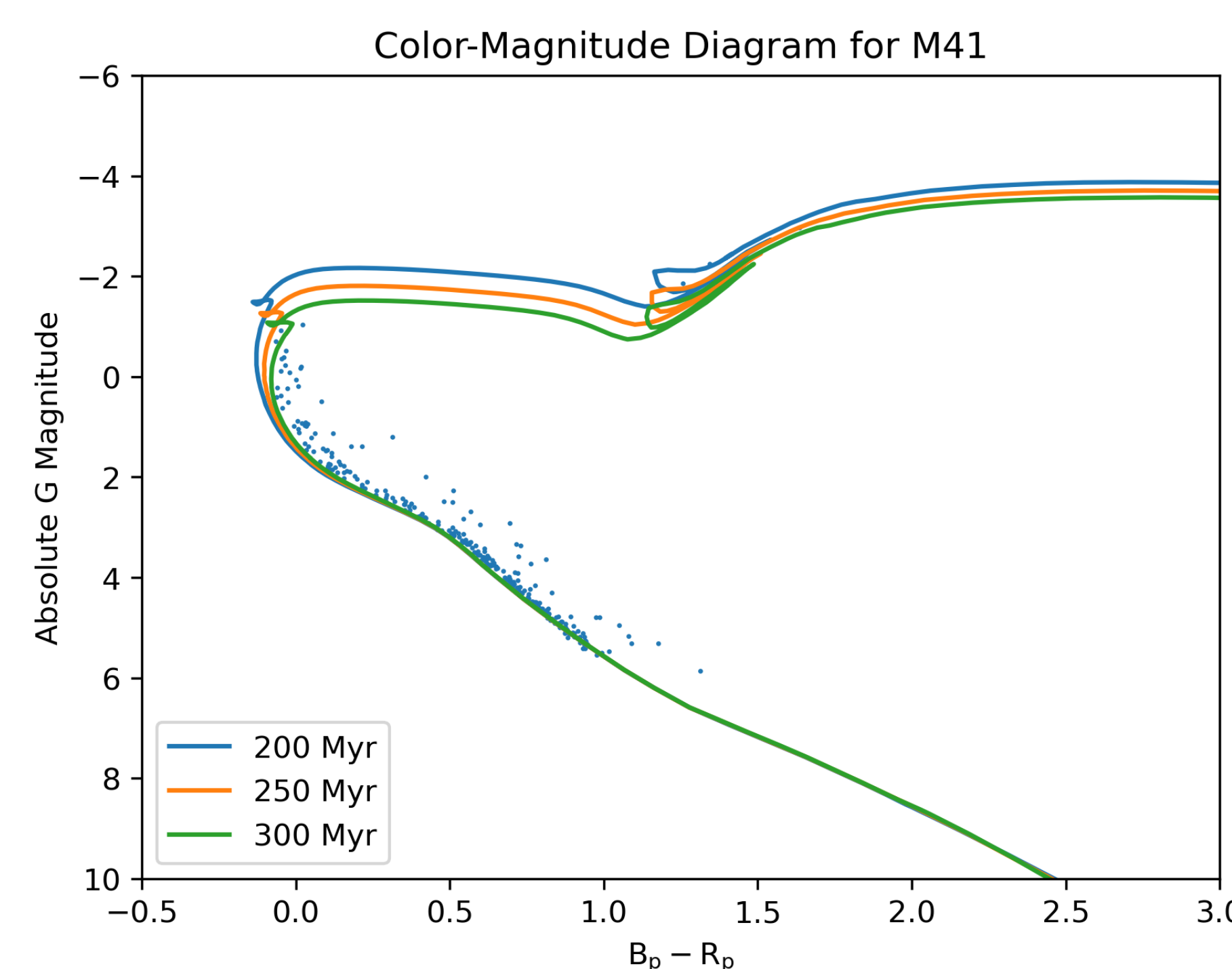


Fig 3. Open clusters are loosely bound groups of many stars. The well studied open cluster Messier 41 was probed using data selected in StarGateVR. Overplotted are isochrones of various ages, which help infer the overall age of M41. The axes shown have the same meanings as those in the right panel of figure 2.

Open Cluster Metallicities

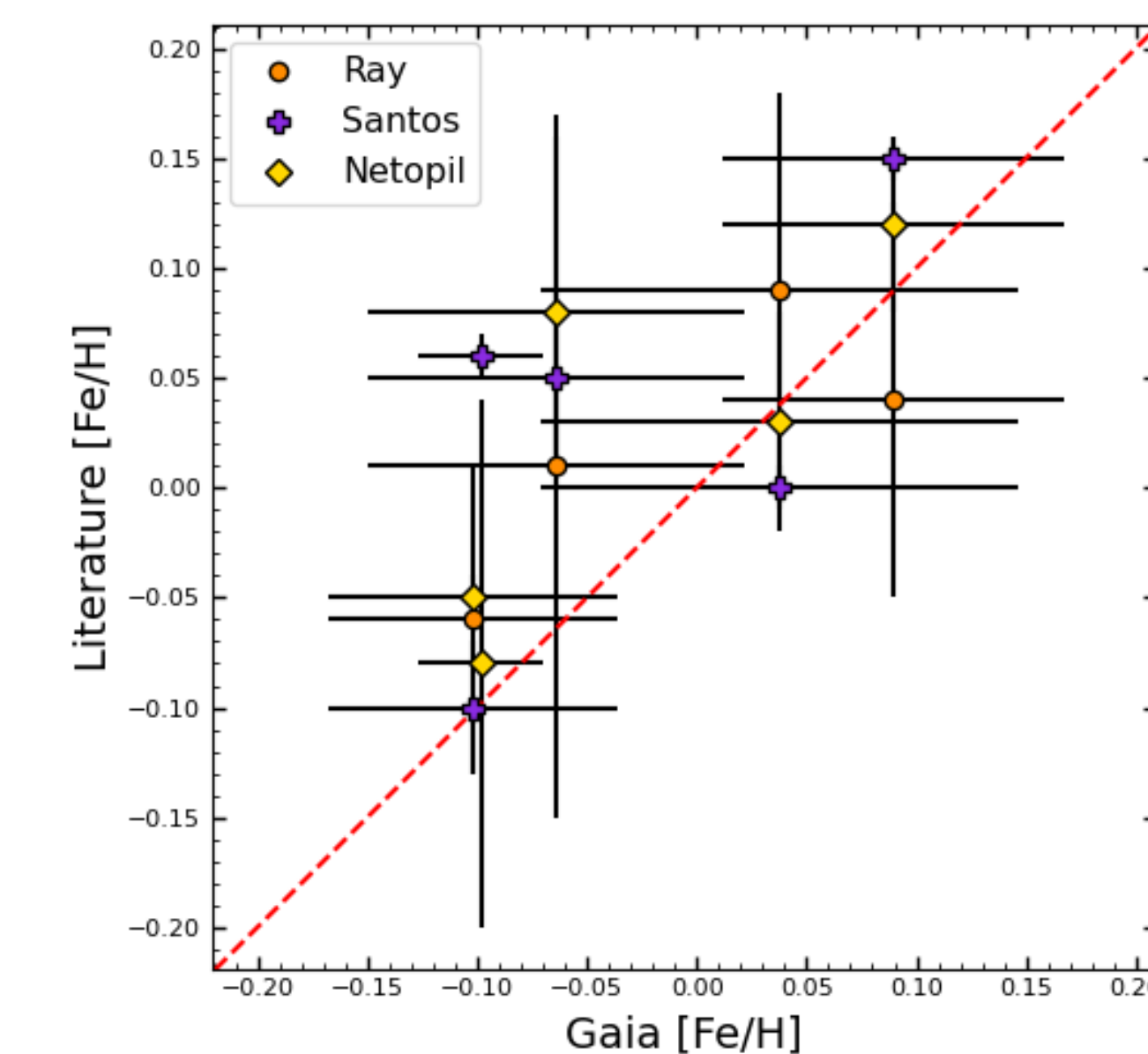


Fig 4. Member stars of five open clusters were selected from Gaia data using StarGateVR, and their metallicities (abundance of selected elements heavier than Helium) were then investigated. The metallicity determined in this work (x-axis) versus metallicity values from literature (y-axis) for each of the five clusters. The red dashed line represents a one-to-one relation between calibrated Gaia and literature metallicities. The trend shows Gaia metallicities are consistent with previous literature results.

Summary & Conclusions

- VR has a wide range of applications to astrophysical research. The StarGateVR tool makes it easy and intuitive to explore data from the Gaia mission.
- We have used it to identify and categorize members of some of the nearest, youngest groups of stars. StarGateVR has additionally been used to ID new candidate members of these systems.
- StarGateVR was used to probe the stellar population at various heights "above" the plane of the Milky Way. These results show the expected demographics of the "thin" and "thick" disk.
- An application of StarGateVR to the open cluster Messier 41 has unveiled new candidate members in the Gaia DR3 data, in addition to allowing for an age estimation consistent with literature values.
- StarGateVR data selection showed that the stellar metallicities produced by the Gaia mission are consistent with previous understandings.