Analysing Star Clusters

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Star clusters are large agglommerations of stars, gravitationally bound together. There are 2 types of star cluster: open clusters and globular clusters. Globular clusters are extremely dense and take on a spherical form due to the millions of stars, and hence extreme gravitational pull. Open clusters are loosely bound, and contain fewer stars. Well known star clusters include The Pleiades, an open cluster visible to the naked eye, and the Hercules Cluster, a globular cluster in the constellation Hercules.

Figure 1: Messier 37, one of the clusters analysed in my study. Credit: Wikisky

Figure 3: My image of Messier 37 in visual light (V filter) compiled of 40 different frames.

Astronomers have come to the conclusion that stars within a cluster were all formed from the same cloud of gas and dust. For this reason, we can make the following assumptions: they are similar in chemical composition, they are the same distance from Earth, and they are all the same age. This makes them a perfect target to study stellar evolution.

In order to analyse the cluster, I first imaged it using a CCD camera connected to a 14-inch Schmidt-Cassegrain telescope, as seen in figure 2. To produce the best image possible, a series of dark, flat, light and bias frames were combined to reduce the amount of noise in the final image. Using specific software, the magnitudes of each star in the cluster were found. I was then able to produce a colour magnitude diagram for each of the clusters.

Figure 2: The telescope and imaging setup at Queen Mary University of London. Credit: Gurjeet Kahlon

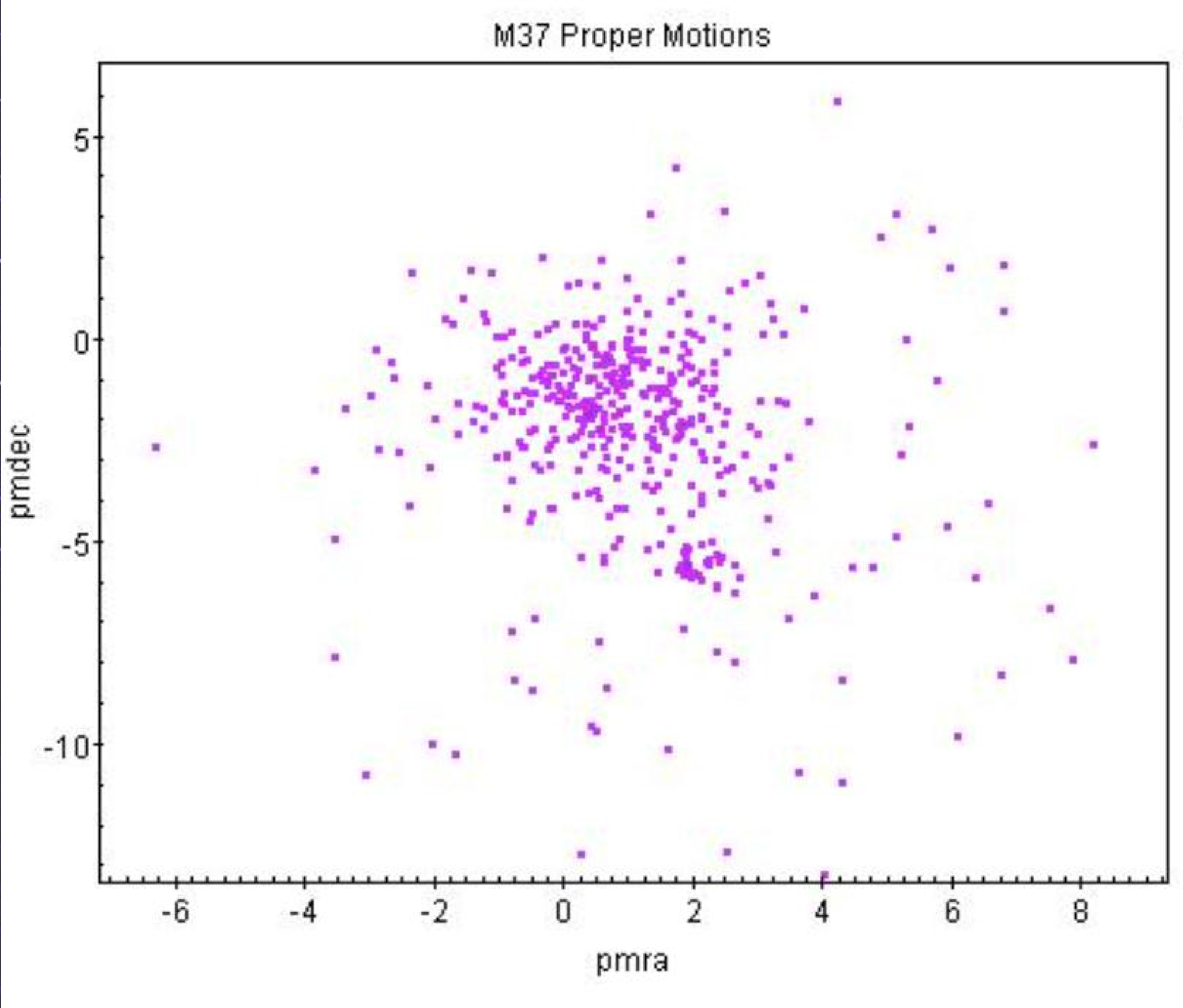

Figure 4: Mapping the positions of the stars in the cluster using their proper motions.

To make my results as accurate as possible, I refined the stars in my data set by their proper motions; the proper motion of a star is its angular velocity as it moves against the backdrop of the night sky. Stars with a different proper motion than that of the cluster were excluded from the colour magnitude diagram as they do not belong to the cluster. They are foreground or background stars.

To find the true colour of the stars, the clusters were imaged in 2 different filters. The difference in magnitude was then found by subtracting the magnitudes for each star. The colour is plotted on the horizontal axis of the diagram.
The visible magnitude is plotted on the vertical axis.
After plotting these quantities, a trend becomes visible; this curve across the graph represents the main sequence, with stragglers to the top right and bottom left corners representing giant and dwarf stars respectively.

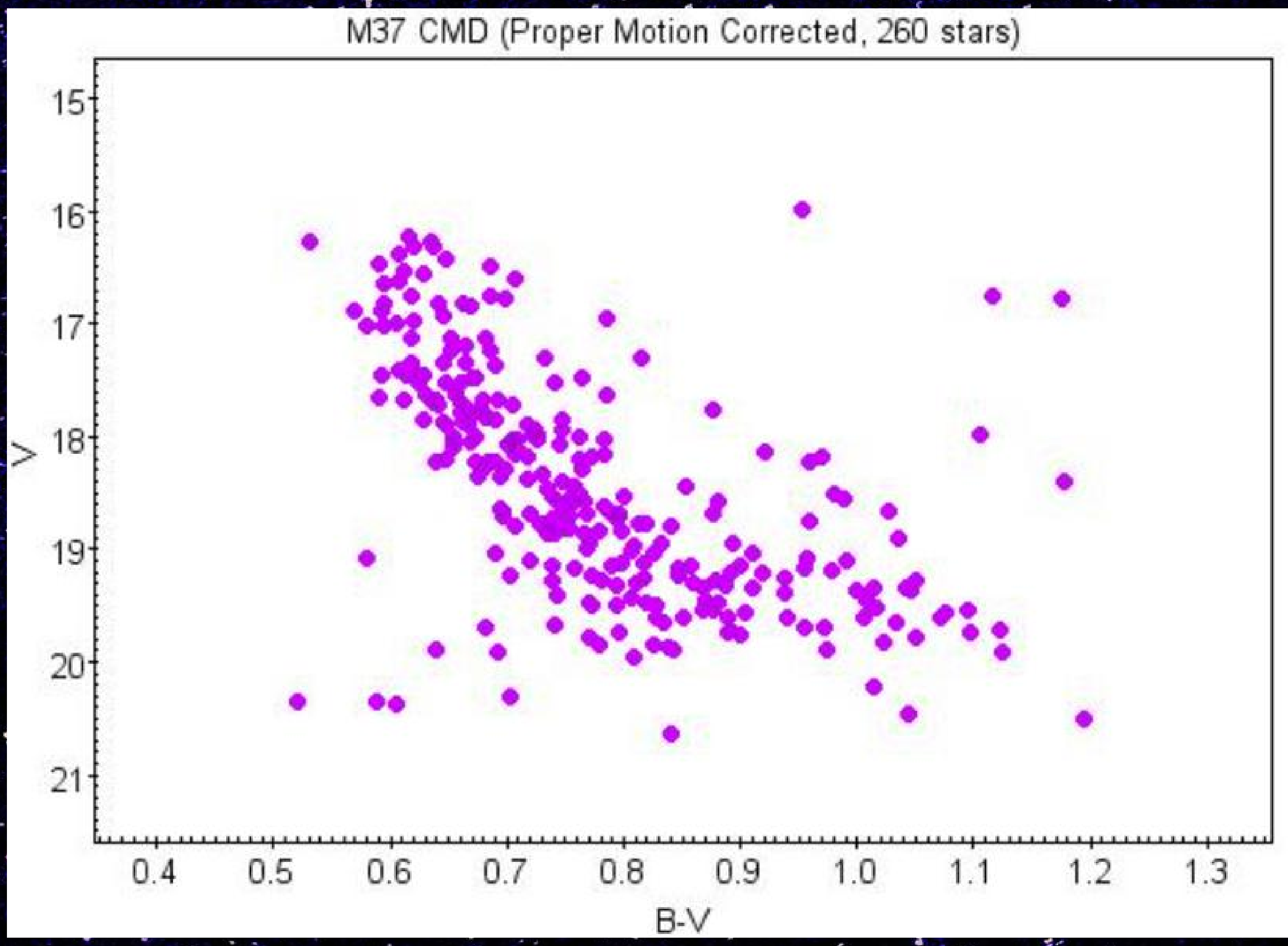

figure 5; Colour magnitude diagram for M37.

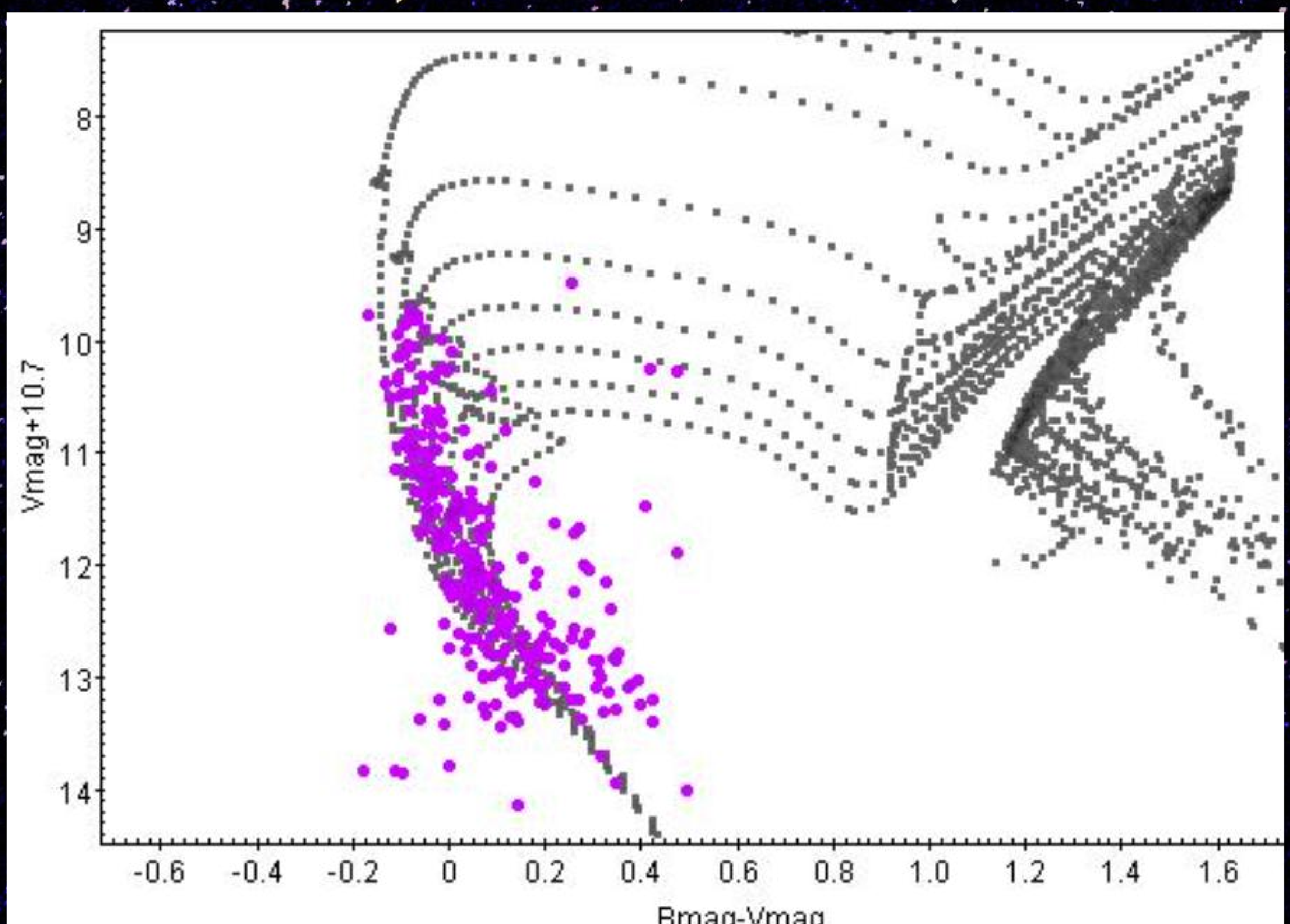

Figure 6: Colour magnitude diagram for M37 plotted against isochrones to determine age. Each isochrone represents 1million years.

The final part of the project involved finding the age of the cluster by plotting my colour magnitude against isochrones. Looking at figure 6, we see the top of my CMD begin to turn off at the 6th isochrone from the bottom, indicating an age of around 6 million years.WComparing with sources found my result to be accurate: M37 is estimated to be anywhere from aruond 330 to 600 million years old