The Search for Low Mass Members of the Young Open Cluster Stock 2

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Abstract:

We present a combined photometric and proper motion survey of the 100Myr open cluster Stock 2. **BVRI** CCD photometry was obtained for 21 5 × 5 arcmin fields. Fifty-nine candidate members were selected from **(B, B − V)** and **(R, R − I)** colour magnitude diagrams using the theoretical isochrones of D’Antona & Mazzitelli (1994). We also obtained SuperCOSMOS scans of three POSS plates. From their position in a proper motion vector-point diagram we estimate that 12 of the 59 candidate members selected above are likely to be cluster members. We also present the results of analysis based only on the POSS data, and identify 311 candidate cluster members.

1. Introduction

Stock 2 is an open cluster that was discovered in 1955 by Jurgen Stock (1955). The nominal cluster center is at **α**(1950) = 2h11m4, **δ**(1950) = −59°2′ (l = 133.4°, b = −1.9°, Lynga 1987). Stock estimated the distance of the cluster to be ∼300 pc (**m − M** = 7.5). Analysis of **UBV** photoelectric photometry by Krzeminski and Serkowski (1966) agreed with this distance, and found the mean reddening to be **E_{B−V}** = 0.375. More recently, in a study of 68 open clusters Piskunov (1980), using existing photometry, redetermined the ages and distances of these clusters. For Stock 2 he found the age to be 100 Myr, and the distance modulus to be **m − M** = 7.4. In a study of the integrated parameters of open clusters Pandy et al. (1989) also lists details of Stock 2. They quote a age of 100 Myr, but a distance of **m − M** = 8.36 and a reddening of **E_{B−V}** = 0.30. Since this distance is so at odds with all previous studies we will ignore it. There have been no studies to date of cluster members fainter than **V** ∼ 13.

2. Observations

2.1. CCD Photometry

Our photometry was obtained using the JKT on La Palma, on the nights of the 20th and 21st October 1995. A 1024×1024pixel Tek CCD was used at the Cassegrain focus so that each pixel corresponds to 0.33arcsec on the sky. Observations were made through Johnson **B** and **V** filters and Harris **R** and **I** filters.

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Exposure times for the cluster fields were 700:100:60:60 seconds respectively. Twelve 5×5 arcmin fields were observed on the 20th October and an additional 9 fields on the following night. The basic CCD reduction was carried out using IRAF’s CCDRED package. The reduction of the crowded fields was carried out using the DAOPHOT (Stetson 1987; Stetson et al. 1990) package in IRAF. The positions of each star was determined using the STARLINK package ASTROM and star positions from a SuperCOSMOS scan of a POSSII photographic plate, and should be accurate to ~ 0.1 arcsec.

2.2. Proper Motion Data

The proper motion survey of Stock 2 was based on SuperCOSMOS scans of three POSS plates: a POSSI E plate taken in 1952, a POSSII B plate taken in 1987 and a POSSII R plate taken in 1989. A region of 3×3 degrees was scanned about the nominal cluster center. The data was analysed using software provided by Dr. Nigel Hambly of ROE (private comm.). Plate photometry, from the two POSSII plates, was calibrated using the previously obtained CCD photometry.
3. Results

3.1. CCD Photometry

The resulting photometric data obtained for the cluster fields is summarized as \((B, B - V)\) (Figure 1) and \((R, R - I)\) (Figure 2) colour-magnitude diagrams. Superimposed on these diagrams are 120, 100 and 80 Myr isochrones (green (solid) lines) from D’Antona & Mazzitelli (1994), after conversion to observational colours and magnitudes. We have included the effects of various uncertainties on these isochrones by imposing on them estimates of the effects of binarity, uncertainty in the distance to the cluster and magnitude dependent photometric uncertainties. The blue (dashed) tracks in the colour magnitude diagrams indicate the effect of these uncertainties. Stars selected in both colour-magnitude diagrams were deemed candidate cluster members (red filled circles). We have found 59 candidate cluster members in the 21 5×5 arcmin fields. From the proper motion analysis, we estimate that 12 of these stars are likely to be cluster members from their position in a vector point diagram.

3.2. Proper Motion Data

An initial broad selection (0.8 mag fainter, 1.8 mag brighter) was made from the plate photometry using a 100 Myr isochrone from D’Antona & Mazzitelli
Figure 3. A vector-point diagram for photometrically selected stars in the region of Stock 2. The orange dots (grey dots) are the stars with membership probabilities $> 50\%$.

(1991). The stars were split into 3 bins covering the range $12 < B_J < 20$, and their proper motions analysed using the method described by Sanders (1971).

311 stars with magnitudes in the range $12 < B_J < 17.3$ were selected on the basis of their having membership probabilities $> 50\%$. The solution for the final bin failed to converge on a meaningful solution, despite clear evidence of a cluster population in the vector-point diagram. The proper motions of the selected stars are shown as orange dots in Figure 3. By counting the number of stars lying in the third quadrant, at a similar distance from the centre of the diagram, we estimate the contamination of this selection to be roughly $20\%$. Further investigation, through measurement of radial velocities, is therefore need to confirm cluster membership.
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