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Study of star formation in young Magellanic Cloud clusters

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Abstract. We estimate the duration of star formation in young clusters of the Small and Large Magellanic Clouds (SMC and LMC). It is estimated as the difference between Post- main sequence (Post-MS) age and Pre- main sequence (PMS) age. The present study aims to determine the PMS ages of clusters by combining the optical and near-IR data. Prelimnary results of this study on 2 clusters in the SMC and clusters in the LMC are presented here.

Keywords : – Galaxy: clusters – star formation

1. Introduction

According to the definition of a cluster, all the stars are formed in a single collapse of the molecular cloud. However, recent observations have shown that members of a cluster are not formed instantaneously, but over a time scale. The aim of the present study is to estimate this formation time scale of stars in clusters in different regions of the SMC and LMC. One needs to study very young massive clusters to estimate this, where the time scale is similar to the cluster age. The duration of star formation is the difference between Post-MS age and PMS age. The Post-MS age of many clusters are known but the PMS ages are not very well known. We determined the PMS ages of clusters, and comparing with the values of Post- MS ages obtained by fitting the Post-MS isochrones, estimated the duration of star formation. The candidates in the LMC are NGC 2100, NGC 1711 and KMHK 242 and in the SMC are NGC 330 and NGC 346.

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Table 1. Results.

Cluster	E(B−V)	PMS age	post-MS age	Duration of SF
NGC 346	0.08	0.3 - 1 Myr	6 Myr	6 Myr
NGC 330	0.10	0.3 - 1 Myr	25 Myr	25 Myr
NGC 2100	0.3	0.4 - 1 Myr	5 Myr	5 Myr
NGC 1711	0.18	0.4 -1 Myr	28 Myr	28 Myr
KMHK 242	0.15	0.3 -1 Myr	9 Myr	9 Myr

2. Methodology and results

The optical data (V, I) for the clusters were obtained from the OGLE III database (Udalski et al. 2008a, 2008b). The photometric data in the near- infrared (NIR, JHKs) data were obtained from IRSF (InfraRed Survey Facility) Magellanic Cloud Point Source Catalog (MCPSC) database (Kato et al. 2007). The reddening and extinction towards the cluster were taken from the already estimated values. After correcting for reddening and distance, the PMS age of the cluster was estimated by fitting the PMS isochrones. The PMS isochrones were taken from Siess, Dufour & Forestini (2000) and the Post-MS isochrones were taken from Marigo et al (2008). By cross-correlating the optical and IR data of the cluster, the V, I, J, H, K values of the cluster members were found. An error value of 0.01 degree in the position was accepted as maximum deviation for cross-correlation. The cluster radius was chosen as 5 arc minutes around the central coordinates of the cluster. The presence of excess radiation in the K band is used to infer the presence of dust around the stars and hence their PMS status. The IR colours (J−H) and (H−K) were calculated for the cross-identified stars. The true magnitude V_0 and the intrinsic colour indices were determined by applying colour and extinction corrections. In the Colour Colour Diagrams (CCD), stars with IR excess appear on the right side of the CCD, beyond the reddening vector having slope of 1.96. Stars with slope (J-H)+0.05/(H-K)>1.96 are the stars with IR excess, where (H−K)>0. Colour Magnitude Diagram (CMD) was plotted between the true magnitude V_0 and intrinsic color index $(V-I)_0$. The post-MS and PMS isochrones for different ages were fitted on the CMD. The presence of PMS stars on each of the isochrones shows that PMS stars have a range in age. The presence of PMS stars of different ages, as young as 0.3–1 Myr in each of these clusters indicates that star formation in these clusters did not occur in a single event, but in multiple continuous or discrete starbursts. We were unable to fit isochrones of ages greater than 1 Myr as deeper IR studies are required to study low mass stars.

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