

THE ANALYSIS OF A STAR CLUSTER FAMILY IN THE NORTHERN PART OF CARINA NEBULA

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ABSTRACT

We studied a cluster family in the northern part of the Carina Nebula (NGC 3372) a group of clusters near NGC 3324 (Tr 15, NGC 3293, Loden 165, Loden 153 and IC 2581). We used data from UCAC4 to determine the cluster's membership and the near infrared CMDs of each cluster. We analyzed the spatial density and elongation as a function of radius for each cluster and found a possible interaction between NGC 3293 and Loden153. However, the shape distortion of NGC 3324 cannot be evaluated because of the inhomogeneity in the coverage of UCAC4 in the east part of NGC 3324.

Key words: open clusters and associations: NGC 3324, Tr 15, NGC 3293, Loden 165, Loden 153, IC 2581

1. INTRODUCTION

The Great Carina Nebula is a nebula that has associated star clusters with similar ages and distances. As a result, they may have interacted with each other in the past or do so in the future. In this paper, we study six clusters in this region, NGC 3324, NGC 3293, Tr 15, IC 2581, Loden 165, and Loden 153. The ages of these clusters are about 10 Myrs or younger, and some of them are embedded in clouds. The closeness and similarity in age of the clusters may indicate that they have a primordial binarity. Previous studies have mentioned the probable binarity between NGC 3324 and Tr 15 and NGC 3293 and IC 2581 but recently (de la Fuente Marcos & de la Fuente Marcos, 2010) also argued for the binarity of NGC 3324 and NGC 3293.

2. DATA

We used kinematic data (position, proper motion, and magnitude) from (UCAC4 Zacharias et al., 2013), the Fourth US Naval Observatory CCD Astrograph Catalog. Some of the clusters have a young age, and are embedded within a cloud. Detail of the cluster data are presented in Table 1.

3. METHOD

First, we plot a spatial density map of the region around NGC 3324 (Figure 1). We suspect clusters in regions of high density. Then, we determined cluster membership using maximum likelihood (Sanders, 1971) with a probability of more than 30%. The maximum likelihood was calculated using EMMIX software (McLachlan et al.,

1999). Then, we plot the cluster members in an HR diagram to see the distribution of the evolutionary tracks (Figure 2). This also confirms the star cluster membership and age of the cluster. We also plot the proper motion of clusters to see the trend of cluster motion (Figure 3). If the clusters have a similar cluster motion and age, they are suspected to have been associated in the past. However, if the clusters are heading in a similar direction, they are likely to merge in the future.

4. RESULTS AND DISCUSSION

The result of this research are:

- NGC 3324-Loden 165 and NGC 3293-Loden 153 do not show evidence of cluster association.
- Loden 153 and Loden 165 do not show evidence of association, but may be merging.
- There is an inhomogeneity in the data coverage of UCAC4 around NGC 3324.

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Table 1
DATA FOR CLUSTERS

Cluster Name	R.A.(J2000) [h m s]	Dec.(J2000) [h m s]	Distance [pc]	Age [years]	Reddening [mag]	Notes
NGC 3324	10 37 20	-58 38 30	2317	6.754	0.438	Associated with NGC 3293 (de la Fuente Marcos & de la Fuente Marcos, 2010)
NGC 3293	10 35 51	-58 13 48	2327	7.014	0.263	Associated with NGC 3324 (de la Fuente Marcos & de la Fuente Marcos, 2010)
Loden 153	10 34 40	-58 07 48	2670	6.74	0.28	
Loden 165	10 35 56	-58 44 03	1900	9.48	0.25	Associate candidate with NGC 3324 (Carraro et al., 2001)
Tr 15	10 44 43	-59 22 00	1853	6.926	0.434	Associated with NGC 3324
IC 2581	10 27 29	-57 37 00	2446	7.142	0.415	Associated with NGC 3293

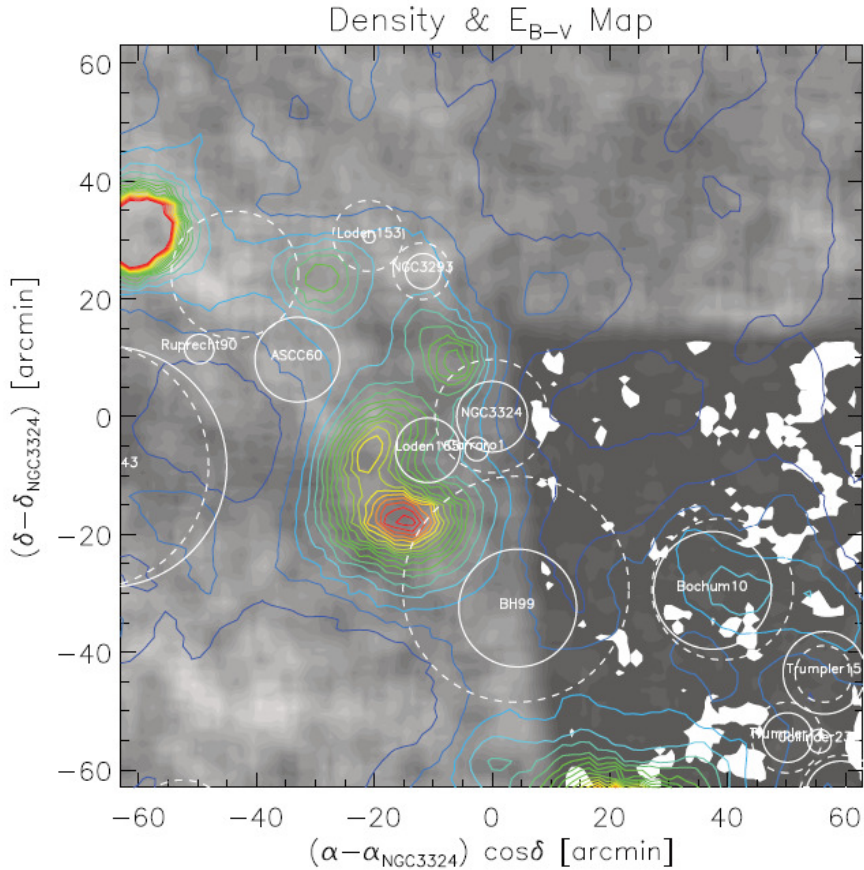


Figure 1. The grayscale gradient shows the spatial density of stars around NGC 3324. The circle marks the radius of the cluster in NCOVOCC (solid) and COCD (dashed). The contour show color excess(E_{B-V}) based on the extinction map from <http://irsa.ipac.caltech.edu/applications/DUST/>. It shows that UCAC4 coverage around NGC 3324 is not homogeneous. There are some close clusters in this region. NGC 3324 and NGC 3293 are close, as are Loden 153 and Loden 165. Trumpler 15 and IC 2581 are outside this field.

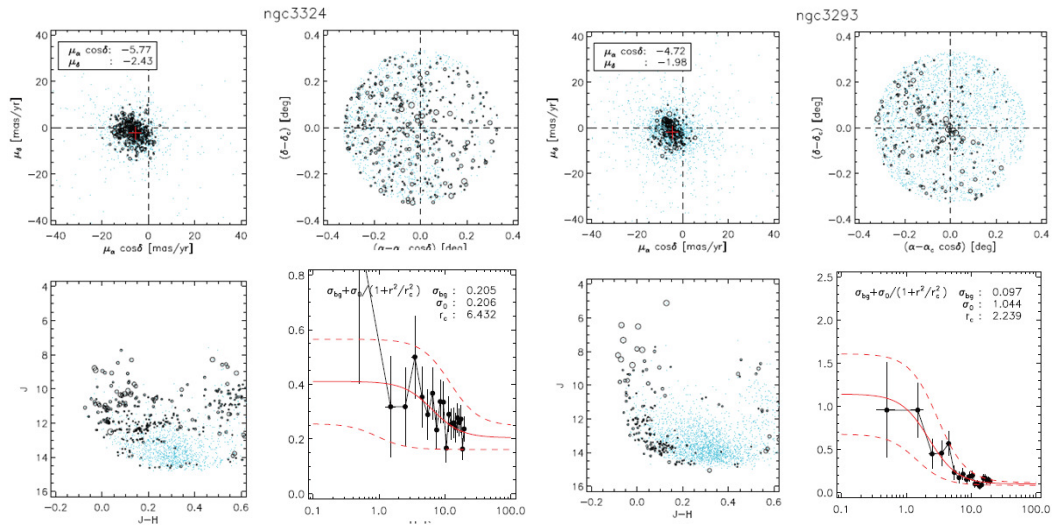


Figure 2. Plot of the distributions of proper motion (upper left), location (upper right), CMD (bottom left), and King Profile (bottom right). Blue points represent stars within radius $20'$ from the cluster center, and circles represent stars with membership probability $P \geq 0.3$. *Left*: Plot of NGC 3324, *Right*: Plot of NGC 3293

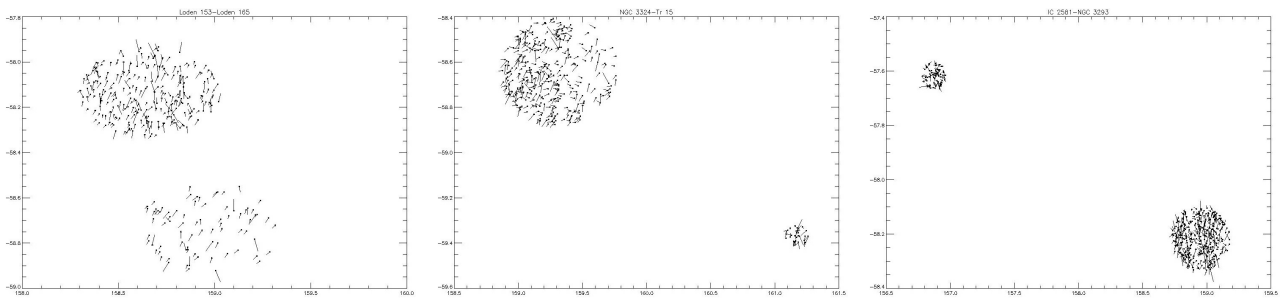


Figure 3. Plots of cluster proper motion. *Left*: Plot of Loden 153 and Loden 165, *Centre*: Plot of NGC 3324 and Tr 15, *Right*: Plot of IC 2581 and NGC 3293.