Physical Association Between the Southern Coalsack and Chamaeleon-Musca Dark Clouds

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Abstract. To investigate a possible physical association between the Southern Coalsack and the Chamaeleon-Musca (SCCM) dark clouds we have obtained $uvby\beta$ photometry for 1017 stars covering the connecting area: $308° \geq l \geq 294°$ and $-20° \leq b \leq 5°$. Analysis of the various colour excess $E(b-y)$ vs. distance diagrams has indicated the presence of a local low absorption volume limited at 150 ± 30 pc from the Sun by an extended interstellar dust sheet-like feature, that is followed by a region where almost no additional reddening is measured for the next 350 pc. Combined with other data on the local ISM the existence of the dust sheet at an identical distance of the SCCM dark clouds have suggested that these clouds could be higher density regions associated to the diffuse lane of dust of the Local-Loop I bubbles' interface.

1 Introduction

A comparison of the colour excess $E(b-y)$ vs. distance diagrams for the Chamaeleon-Musca (Franco 1991) and the Southern Coalsack (Franco 1989) dark clouds shows great similarities. The jump of the colour excess to higher values occurs approximately at the same distance, and the observed minimum value of this rise is almost the same: $\Delta E(b-y) \approx 0\overset{m}{.}100$. Although the clouds are apart by more than 15° these facts suggest that they might be dense condensations embedded in an extended interstellar structure, which may be related to the interface of the Local and Loop I Bubbles.

2 Reddening Distribution

In order to sustain the hypothesis of a physical association of the Southern Coalsack and the Chamaeleon-Musca dark clouds (SCCM), a new photometric programme was carried out. We used the Strömgren Automatic Telescope in La Silla (Chile) to obtain $uvby\beta$ photometry for all SAO stars earlier than GO covering the connecting area: $308° \geq l \geq 294°$ and $-20° \leq b \leq 5°$. The programme resulted in accurately calibrated uvbyβ data for 1017 stars (Corradi & Franco 1995). The data were complemented by the $uvby\beta$ measurements of 213 stars of a previous investigation towards the geometrical

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center of the Chamaeleon-Musca clouds (Franco 1992). Of the final sample, only 510 stars fulfilled the imposed selection criteria to calculate $E(b-y)$ and distance. Their (l,b) positions are given in Fig. 1.

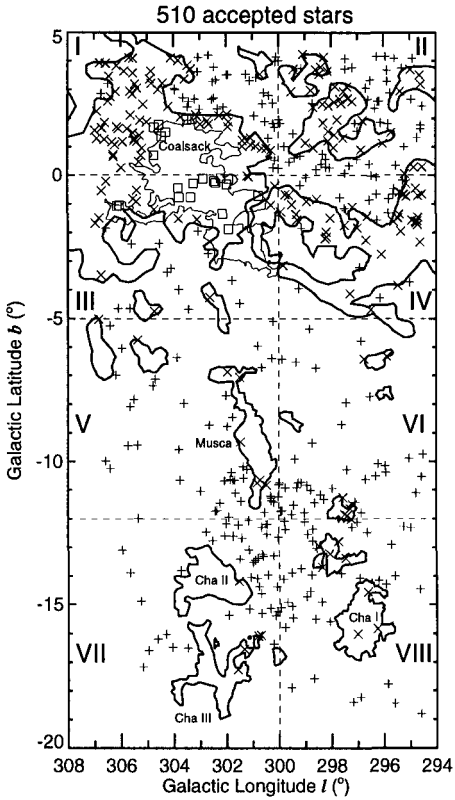

Fig. 1. Distribution of the 510 accepted stars. The thick contours are the lowest opacity level of the photographic Dark Clouds Catalogue (DCC) compiled by Feitzinger & Stüwe (1984). The thinner contour is the outer 2 K km s^{-1} velocity integrated CO emission for the Southern Coalsack (Nyman et al. 1989). Stars with line-of-sight *inside* and *outside* the DCC contours are represented by the (×) and (+) signs, respectively. Stars *inside* the CO contour are indicated by the (□) signs. The horizontal and vertical dashed lines delineate the eight sub-areas, indicated by the roman numbers, used to discuss the reddening distribution

Figure 2 shows the $E(b-y)$ vs. distance diagrams for stars in the *inside* (*left*) and *outside* (*right*) groups of the eight sub-areas ($d \leq 1$ kpc). The structure in all sub-areas is fairly similar, i.e., a foreground region with very low reddening to both groups and a transition region around 150 ± 30 pc, where $E(b-y)$ has a sudden increase forming a lower envelope of minimum absorption. These effects indicate that an extended interstellar structure is permeating the whole area.

As the complete range of $E(b-y)$ from $\approx 0\overset{\mathrm{m}}{.}100$ to $0\overset{\mathrm{m}}{.}300$, shown by the stars in a very narrow distance slot centered on 150 pc, does not change for another 350 pc the dust feature may be followed by another low reddening volume. Note that stars *inside* the CO contour follow the tendency of the others *inside* the DCC contours. The lower envelope of colour excesses does not show clear dependence with the galactic longitude, but may increase with the galactic latitude in the sense that $[E(b-y)_{\min}, b] = [0\overset{\mathrm{m}}{.}050; 0°] \rightarrow$

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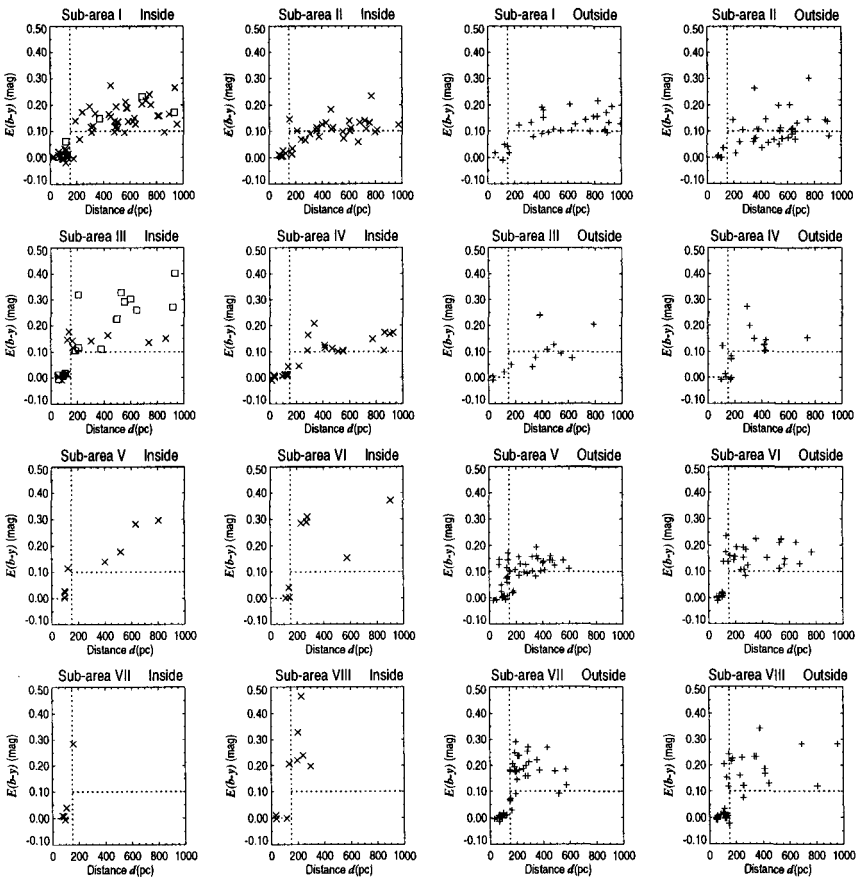

Fig. 2. $E(b-y)$ vs. d diagrams for the eight sub-areas. (*left*) to the *inside* group. (*right*) to the *outside* group. See the details in the text

$[0\overset{m}{.}100; -8°] \rightarrow [0\overset{m}{.}150; -15°]$. The quoted increase might suggest either an inhomogeneous sheet-like structure, that could be roughly perpendicular to the galactic plane, or a sheet-like structure of same column density, curved away from the Sun (Corradi et al. 1997).

3 Connection to the Local-Loop I Bubbles' Interface

Egger & Aschenbach have recently identified on the soft X-ray data a ring-like feature that may have formed at the region of significant compression between the Local and Loop I bubbles. In addition to this result, the molecular gas from $l \approx 290°$ to 360 deg, between $-25° \leq b \leq 25°$, seems to define a large complex of clouds, comprising ρ Oph, R Cra, G317-4, Lupus, Coalsack, Musca

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and Chamaeleon, that is located at almost the same mean distance of 150 pc (Dame et al. 1987, Franco 1990). The existence of the dust sheet at a distance identical to the SCCM, as well as the presence of the two low reddening volumes, suggest that these clouds may be dense condensations in the diffuse medium composing the interface between the Local and Loop I Bubbles. In this case, the ISM could have been compressed from the far side, by the action of energetic events from OB stars of the Sco-Cen association sweeping up the unused material after the star formation (Iwan 1980), and from the near side, by what created the local low density region. A schematic representation of the interaction zone between the two bubbles is shown in Fig. 3.

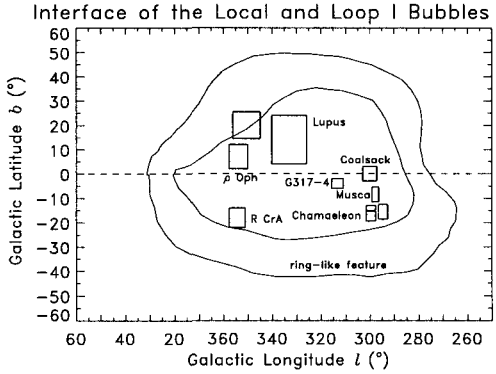

Fig. 3. Schematic representation of the interaction zone between the Local and Loop I bubbles. The locations and sizes of the molecular clouds towards Sco-Cen were taken from Dame et al. (1987) and the annular feature contours' from Egger & Aschenbach (1995)

Further details can be found in the full version of this work that will appear in A&A (Corradi et al. 1997). For our next work high-resolution ($R \approx 60\,000$) spectra of the interstellar NaI D lines for 72 B-type stars towards the SCCM clouds have been obtained. The data will allow us to distinguish the components of the proposed physical association, and combined with the known distance of the stars, to understand the gas kinematics of the interface.

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