INTERSTELLAR REDDENING AT HIGH GALACTIC LATITUDES

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Abstract. Measures in the Strömgren four-color and Hβ systems provide an accurate way to determine color excesses of early-type stars. Fourteen areas at high galactic latitude have now been searched for faint A stars which are then measured photoelectrically to obtain the color excesses. Non-main sequence A stars, which are easily detected by means of the four-color photometry, are not included in the analysis. Within 40° of each pole, the reddening is essentially zero, $E_{b-y} = 0.00$ north of the galactic plane and $E_{b-y} = 0.01$ south of the plane.

1. Introduction

Studies are being made currently to determine the stellar density distribution perpendicular to the galactic plane. An important by-product is the determination of the interstellar reddening in each of the regions under study. At the present time, data on color excesses is available in 26 regions (12 regions in the stellar density program, 5 globular clusters and 9 open clusters) at high galactic latitudes.

2. The Observations

Four-color and Hβ photometry of early-type stars allow one to calculate their intrinsic $b-y$ colors according to a formula,

$$(b-y)_0 = 2.943-\beta-0.1(\delta m_1+\delta c_1)$$

derived by Crawford and Barnes (1970). The quantities δm_1 and δc_1 are the differences between the observed c_1 or m_1 index and the c_1 or m_1 index that the star would have if it were on the zero age main sequence [$\delta m_1 = m_{1_{\text{Hyades}}} - m_{1_{\text{obs}}}$, $\delta c_1 = c_{1_{\text{obs}}} - c_{1_{\text{ZAMS}}}$]. The formula applies to A stars with $2.70 < \beta < 2.88$ for which $\delta c_1 < 0.28$. The color excess is determined by subtracting the calculated $(b-y)_0$ from the observed $b-y$. Color excesses have been determined in this way for the 12 regions in the stellar density program and the 5 regions surrounding globular clusters. The reddenings to the 9 open clusters were determined either by the four-color and Hβ method or by means of UBV photometry.

The reddening data are presented in Table I. The galactic coordinates are listed in columns 1 and 2, the name of the region is listed in column 3, the method used is listed in column 4, the estimate of the color excess, E_{b-y} is listed in column 5, and the source of the reddening estimate is listed in column 6.

Greenberg and Van de Hulst (eds.), Interstellar Dust and Related Topics, 263–267.

TABLE I

Reddening in high galactic latitude regions

l	b	Region	Method	Color excess E_{b-y}	Source
—	+90	NGP	4-C, Hβ	0.000	Philip and Tifft (1971)
—	+90	NGP	UBV	0.000	McClure and Crawford (1971)
—	+90	NGP	4-C, Hβ, (GHK)	0.000	Feltz (1972)
221	+84	Coma	4-C, Hβ	−0.006	Crawford and Barnes (1969a)
221	+84	Coma	UBV	0.000	Hagen (1970)
42	+78	M3	4-C, Hβ	0.004	Crawford and Barnes (1969c)
4	+47	M 5	4-C, Hβ	0.030	Tifft (1972)
0	+45	3 HLF 3	4-C, Hβ	0.072	Philip (1973c)
110	+45	Ursa Major	4-C, Hβ	0.007	Crawford and Barnes (1969a)
59	+41	M13	4-C, Hβ	0.011	Crawford and Barnes (1969c)
206	+33	Praesepe	UBV	0.000	Hagen (1970)
206	+33	Praesepe	4-C, Hβ	−0.002	Crawford and Barnes (1969b)
216	+32	M67	UBV	+0.042	Hagen (1970)
180	+30	4 HLF 1	4-C, Hβ	0.009	Philip (1972)
123	+23	NGC 188	UBV	0.035	Hagen (1970)
351	+16	M4	4-C, Hβ	0.25	Philip (1973a)
180	−22	Hyades	UBV	0.000	Hagen (1970)
137	−23	NGC 752	UBV	0.021	Hagen (1970)
137	−23	NGC 752	4-C, Hβ	0.027	Crawford and Barnes (1970)
167	−24	Pleiades	UBV	0.028	Hagen (1970)
337	−26	NGC 6752	4-C, Hβ	0.056	Tifft (1972)
0	−30	3 HLF 2	4-C, Hβ	0.030	Philip (1973a)
76	−30	1 HLF 2	4-C, Hβ	0.047	Philip (1973a)
290	−30	2 HLF 2	4-C, Hβ	0.015	Philip (1973a)
279	−34	Bok Cluster	4-C, Hβ	0.014	Philip (1973c)
0	−45	3 HLF 4	UBV	0.000	Drilling (1971)
180	−45	4 HLF 4	UBV	0.056	Drilling (1971)
290	−45	2 HLF 4	4-C, Hβ	0.049	Philip (1973a)
76	−60	1 HLF 6	4-C, Hβ	0.002	Philip (1973a)
180	−60	4 HLF 6	4-C, Hβ	0.009	Philip (1973a)
—	−90	SGP	4-C, Hβ	0.013	Philip (1973c)
—	−90	SGP	Average of various methods	0.028	Rodgers (1971)

3. The Distribution of Color Excesses with Position in the Galaxy

The data displayed in Table I are plotted in Figures 1 and 2. In each figure galactic longitudes are indicated along the edges of the figure; galactic latitudes are indicated by concentric circles (in intervals of 20° in b). The color excess, E_{b-y}, determined in any region is indicated by a two digit number (the color excess in hundredths of a magnitude) which is plotted at the position of the center of that region. In this way the distribution of color excesses in regions at high galactic latitudes can be determined. Regions north of the galactic plane are shown in Figure 1. For $b > 50°$, no area was found with a color excess greater than a few thousandths of a magnitude. In Figure 2, there are only two regions for which color excesses have been determined for latitudes

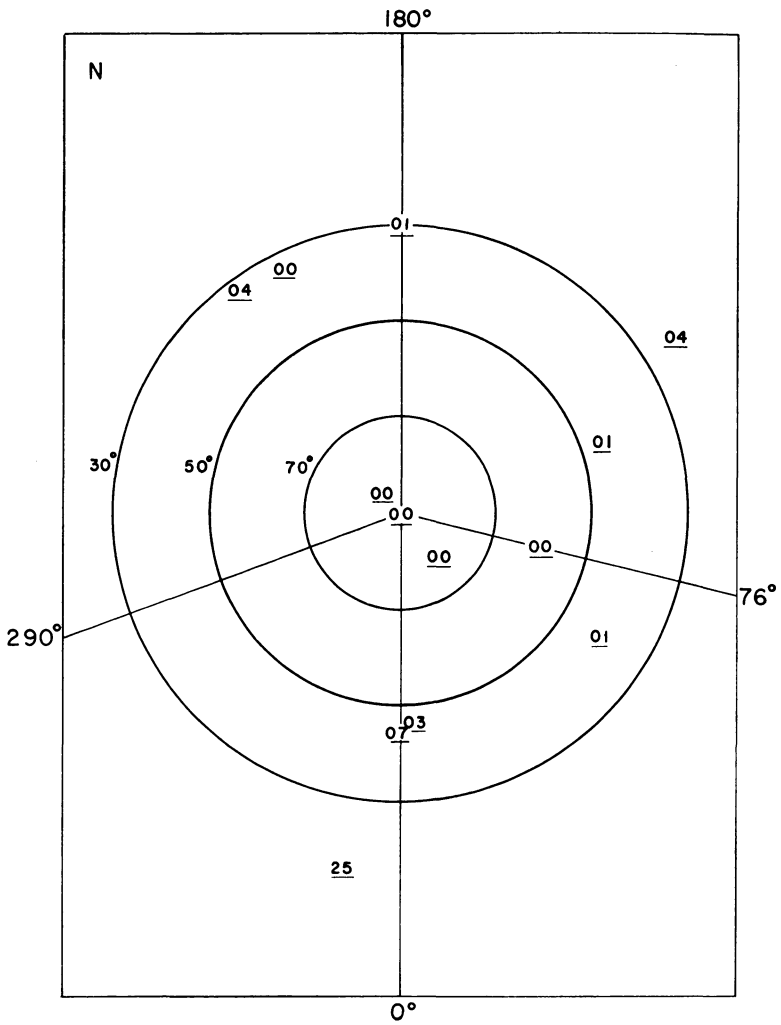

Fig. 1. The underlined two digit numbers represent the color excesses E_{b-y} in hundredths of a magnitude in areas at various galactic longitudes (indicated at the edges of the figure) and galactic latitudes (indicated by concentric circles). North of the galactic plane, for $b > 50°$ there are no color excesses greater than 0.00.

south of $-50°$; their average color excess is 0.01 mag. Thus it can be seen that regions within 40 deg of either galactic pole are essentially unreddened. Reddenings up to a few hundredths of a magnitude are found 60 deg away from each pole.

The stellar density distribution program will allow reddenings to be determined every 15 deg in galactic latitude along the four longitudes indicated in Figures 1 and 2. Reddenings are also being determined in front of globular and open clusters by a number of investigators. In a few more years, the number of high galactic regions in which reddenings have been determined will be greatly increased. Dr Stock and I have

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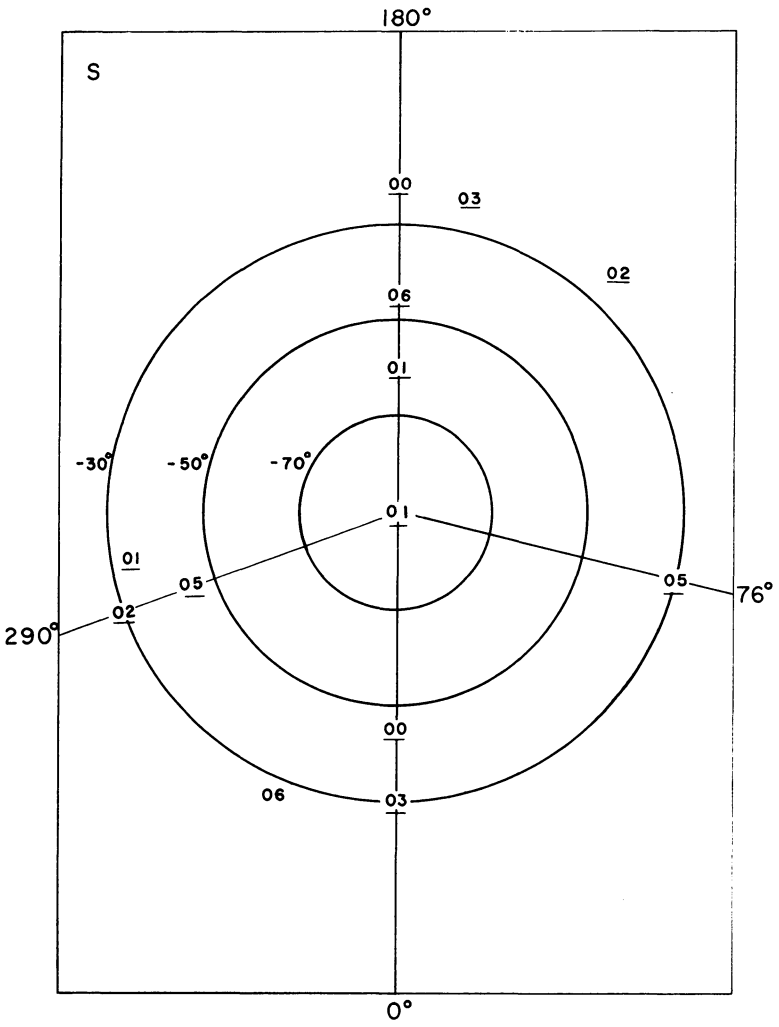

Fig. 2. Same as Figure 1, but for areas south of the galactic plane, the average reddening for $b > 50°$ south is 0.01.

in progress a program of identifying faint early-type stars in 5° strips. The first one (covering six hours of right ascension) covers a strip in front of the SGP (Philip and Stock, 1972); the second extends from the SGP to the NGP along $l = 290°$. Photometry of the early-type stars in these two lists will yield important data concerning the variation of interstellar reddening with galactic latitude.

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