Dust properties in NGC 6611[*]

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Abstract. An investigation on dust properties in the NW portion of NGC 6611 has been conducted polarimetrically to test the existence of abnormal extinction in that section of the open cluster in an independent way.

As previously suggested for the η Carinae nebula by Tapia et al. (1988b) and subsequently confirmed by Marraco et al. (1993), the *canonical* relation between E_{V-K}/E_{B-V} and $\lambda_{\max}$ (the wavelength of maximun interstellar polarization) is not valid for stars belonging to dusty H II regions, as is the case for the observed portion of M 16. This may arise mainly from the presence of silicate grains of a slightly larger size than the standard ISM and also from a considerable increase in mean graphite grain size, according to previous results from Chini & Wargau (1990).

About 50% of the observed stars in NGC 6611 present indications of intrinsic polarization in their measurements; a similar percentage was found in IC 2944 (Vega et al. 1994), another young open cluster in close relation with an H II region.

Key words: ISM: dust, extinction — Galaxy: open clusters and associations: individual (NGC 6611) — ISM: HII regions — ISM: magnetic fields

1. Introduction

NGC 6611 (C1816-138) is a stellar rich open cluster located in the Sagittarius spiral arm, in the plane of the Galaxy ($l = 17°0$, $b = 0°8$). It is embedded in an ionized hydrogen complex (M 16), an extensive nebulosity connected with dense dust clouds. The central portion of the cluster is part of the North-West of M 16, but nowadays it is assumed that it is spread all over the complex (e.g. de Winter et al. 1997).

Prior to the era of the infrared observational campaigns, the extinction law in NGC 6611 was considered to be fairly normal. Gebel (1968) obtained a value of $R_V = 2.5 \pm 0.6$ from a comparison of the radio emission measure for the H II region with Hα and Hβ fluxes. Johnson (1968) obtained a mean value of $R_V = 2.9 \pm 0.5$ for NGC 6611 from an average of estimates from the variable-extinction technique ($R_V = 3.4 \pm 0.7$) and the cluster diameter method ($R_V = 2.3$). The value obtained by Turner (1994) from the variable-extinction method was $R_V = 2.99 \pm 0.08$, with only a localized region on the dusty north side of the cluster displaying evidence for a larger value of 4.42.

Many later investigations on NGC 6611, mostly based on IR studies (Sagar & Joshi 1979; Chini & Krugel 1983; Hillenbrand et al. 1993; de Winter et al. 1997; and others) concluded that the extinction in the NW area is caused either by intracluster or by circumstellar dust while showing variable degrees of anomaly. This in turn causes uncertainties in the determination of the distance to the cluster and consequently has some influence on the conclusions regarding the evolution of NGC 6611 itself. Also, it is generally accepted that the matter in front of the cluster is responsible for an excess $E_{B-V} = 0.50$ mag (e.g. Sagar & Joshi 1979; Thé et al. 1990; Hillenbrand et al. 1993) and that a normal extinction law, characterized by $R_V = 3.1 \pm 0.1$, is valid for the foreground dust.

Our intention is to test independently the existence of abnormal extinction in NGC 6611 through the use of polarimetric techniques. Via polarimetry, it is possible to

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detect stars suspected of having circumstellar envelopes and to remove them from the rest; and then, to concentrate on the extinction caused by the intra-cluster dust.

2. Observations

The stars to be observed polarimetrically were selected from the work of Walker (1961) covering the central core and some dusty regions north of it, where Turner (1974) detected about a dozen stars suffering of an abnormal extinction law.

Observations in the $UBVR_{KC}I_{KC}$ bands (KC: Kron-Cousins, $\lambda_{U_{eff}} = 0.36$ μm, $FWHM = 0.05$ μm; $\lambda_{B_{eff}} = 0.44$ μm, $FWHM = 0.06$ μm; $\lambda_{V_{eff}} = 0.53$ μm, $FWHM = 0.06$ μm; $\lambda_{R_{eff}} = 0.69$ μm, $FWHM = 0.18$ μm; $\lambda_{I_{eff}} = 0.83$ μm, $FWHM = 0.15$ μm) were carried out using the five-channel photopolarimeter of the Torino Astronomical Observatory, attached to the 2.15 m telescope at the Complejo Astronómico El Leoncito (San Juan, Argentina). They were performed on 4 nights (August 26/29) in 1995 and 2 nights (June 18/19) in 1996, both runs of suitable quality. Standard stars for null polarization and for the zero point of the polarization position angle were taken from Clocchiatti & Marraco (1988).

Table 1 lists on its left side, for the 39 observed stars, the percentage polarization (P_λ), the position angle of the electric vector (θ_λ) in the equatorial coordinate system and their respective mean errors for each filter. We indicate also the number of independent integrations with each filter. Star identifications are taken from the work of Walker (1961).

3. Results

Assuming that the polarization is of interstellar origin, the wavelength at which maximum polarization P_{max} occurs can be computed by observing in several photometric bandpasses. This wavelength λ_{max} is a function of the optical properties and characteristic particle size distribution of the aligned grains (McMillan 1978; Wilking et al. 1980). The maximum polarization (in microns) at which P_{max} (in percentage) occurs has been calculated by fitting the observed interstellar polarization in the $UBVRI$ bandpasses to the standard Serkowski polarization law (Serkowski 1973):

$$P_\lambda / P_{max} = \exp\ [-K\ \ln^2\ (\lambda_{max}/\lambda)] \tag{1}$$

and adopting $K = 1.15$.

The left side of Table 2 lists the P_{max} and λ_{max} values for 32 stars, excluding those from Table 1 with errors in their P_V values higher than 15 % and P_B higher than 20%. If the polarization is well represented by the Serkowski relation, σ_1 (the unit weight error of the fit) should not be higher than 1.5 because of the weighting scheme; a higher value could indicate the presence of intrinsic polarization.
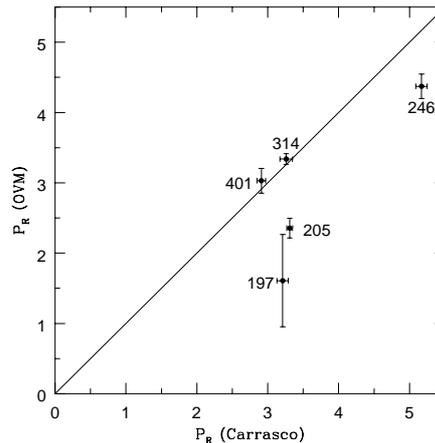

Fig. 1. Relation between P_R polarizations values for stars observed in this work (OVM) and by Carrasco et al. (1975)

The mathematical expression used to determine the individual σ_1 values can be found as a footnote. Excesses are taken from the works of Hillenbrand et al. (1993), Thé et al. (1990), de Winter et al. (1997) or they have been calculated according to Feinstein & Marraco (1971), using UBV colors from Hillenbrand et al. (1993). Star No. 313 shows indications of photometric variability, as it results from a comparison between magnitudes and colors from Thé et al. (1990) and from Chini & Wargau (1990): 13.29 (V), 0.36 ($B - V$) and -0.14 ($U - B$) versus 12.95, 0.58 and -0.19, respectively.

Following Marraco et al. (1993), we have intended to remove the effects on the measured polarizations of the interstellar dust located in front of the complex, leaving only the intra-cluster variations of the extinction. To do so, we adopted a more conservative approach than in Marraco et al. (1993) or in Vega et al. (1994), since in the present case the foreground absorption over the region under study is somewhat patchy and that particular situation prevents us from performing a fair modeling of the effects of the foreground dust parameters in terms of latitude and longitude.

We selected from the observed stars those which seem to be the least affected by reddening and having low values in their polarizations: stars Nos. 349, 367, 374 and 455, excluding star No. 411 by reasons discussed later. Please note that "frontside" is a concept not directly related to the conditions of "foreground" and "member". The *ideal* frontside star is one that has all foreground dust in front of it and all intracluster dust behind it. Sometimes this condition is met by the member stars just in front of most of intracluster dust as explained in Marraco et al. (1993). Those four already mentioned stars, which are hereinafter referred to as "frontside" stars, are noted with asterisks in Tables 1 and 2. They will be used to subtract the effects of the foreground extinction from the light coming from any other object in the zone under study.

Table 1. Polarization results

Star[a]	Observed						Intracluster				
	λ_{max} μm	$\epsilon_{\lambda_{max}}$	P_{max}[b] %	ϵ_p	σ_1[c]	E_{B-V}	λ_{max} μm	$\epsilon_{\lambda_{max}}$	P_{max} %	ϵ_p	σ_1
150	.55	.10	2.85	.30	1.41	0.76	.55	.29	0.99	0.31	1.69
166	.54	.11	4.22	.56	2.15	0.88	.56	.17	2.70	0.52	2.11
175	.40	.03	5.43	.46	0.54	1.16	.42	.05	4.11	0.43	0.59
197	.73	.04	1.82	.11	0.24	0.77	.27	.03	1.41	0.25	0.21
205	.57	.06	2.42	.16	1.30	0.79	.88	.38	1.00	0.42	1.23
223	.59	.01	4.01	.04	1.65	0.85	.59	.01	2.47	0.04	1.37
231	.61	.01	5.31	.06	1.23	1.01	.62	.02	3.55	0.05	0.88
235	.59	.01	5.06	.09	1.02	1.15	.60	.02	3.22	0.07	0.89
245	.30	.07	4.47	.78	0.38	0.79	.24	.12	4.02	3.94	0.44
246	.56	.03	4.53	.14	1.34	1.16	.56	.03	2.80	0.11	1.07
251	.53	.05	5.86	.37	1.65	1.00	.51	.06	4.06	0.34	1.50
254	.53	.02	2.88	.07	1.52	0.73	.50	.05	1.14	0.07	1.41
259	.56	.03	4.70	.19	1.74	1.00	.56	.07	2.91	0.22	1.94
275	.60	.08	2.66	.16	1.87	0.72	.43	.14	1.01	0.22	2.18
280	.51	.09	4.24	.49	0.66	0.73	.56	.16	2.87	0.52	0.79
297	.57	.05	4.01	.16	1.87	0.92	.57	.08	2.20	0.16	1.86
301	.54	.02	2.71	.07	1.41	0.95	.47	.05	0.87	0.08	1.31
306	.50	.02	3.83	.11	0.93	0.92	.44	.03	2.02	0.14	0.90
311	.63	.04	3.08	.12	1.56	0.76	.74	.16	1.48	0.24	2.00
313	.61	.03	2.32	.05	0.81	0.72	1.24	.63	0.79	0.67	1.10
314	.58	.00	3.43	.01	0.32	0.88	.60	.01	1.57	0.01	0.26
343	.66	.03	3.62	.09	0.65	1.11	.75	.08	1.84	0.15	0.67
349 *	.63	.03	1.75	.03	1.38	0.52	....	....	....	....	....
351	.57	.05	3.10	.20	0.67	0.71	.58	.15	1.37	0.25	0.86
367 *	.60	.02	2.21	.04	0.36	0.54	....	....	....	....	....
374 *	.60	.04	2.01	.06	1.47	0.56	....	....	....	....	....
401	.57	.02	3.10	.10	1.31	0.71	.50	.05	1.55	0.12	1.53
406	.69	.04	2.33	.08	0.51	0.88	.33	.04	1.46	0.28	0.52
411	.59	.10	1.93	.04	1.43	0.10	....	....	....	....	....
444	.48	.08	3.43	.36	0.67	1.06	.60	.17	1.98	0.34	0.71
455 *	.50	.05	1.58	.10	1.42	0.66	....	....	....	....	....
503	.45	.03	0.81	.07	0.58	0.80	.70	.03	1.40	0.03	0.51

[a] Walker (1961).
[b] P_{max} at λ_{max}.
[c] $\sigma_1{}^2 = \sum(r_\lambda/\epsilon_{p_\lambda})^2/(m-2)$; with $r_\lambda = P_\lambda - P_{max}\exp(-K\ln^2(\lambda_{max}/\lambda))$.

Having in mind that we are handling observed parameters of the dust we proceeded to average them instead of simply obtaining a mean value for each bandpass. Thus the weighted mean of the λ_{max} value for the "frontside" stars is:

$$\overline{\lambda_{max}} = 0.58 \pm 0.06 \ \mu m.$$

For the polarization and orientation of the electric vector (θ_V) in equatorial coordinates, we get mean values:

$$\overline{P_{max}} = 1.88 \pm 0.02\%$$

and

$$\overline{\theta_V} = 75°3 \pm 2°7$$

respectively.

Now, through the use of the Serkowski relation (1), we can calculate a distribution $\overline{P_\lambda}$ for each bandpass that should characterize the "frontside" stars, in the mean. Then, it is possible to calculate mean Stokes parameters $\overline{Q_\lambda}$ and $\overline{U_\lambda}$ for the group. Subtracting these mean values from the individuals Q_λ and U_λ for the rest of the observed members of NGC 6611 and inverting the procedure, we obtain the values $P_{intracluster}(\lambda)$ and $\theta_{intracluster}(\lambda)$, which are listed on the right side of Table 1.

Once more, the maximum wavelength (in μm) at which P_{max} occurs has been calculated by fitting the intracluster polarization in the five bandpasses to the standard Serkowski polarization law for the "non-frontside" stars. The results are presented on the right side of Table 2, together with their correspondent λ_{max} values.

From their intra-cluster polarization values 8 objects (stars Nos. 150, 166, 251, 259, 275, 297, 311 and 401) have

a value for the intracluster unit weight error of the fit (σ_1) above 1.5. Such value may be considered as a limit due to the weighting scheme, that is: a higher value could be indicative of the presence of intrinsic polarization. Stars 175, 275 (recently mentioned), 306 and 406 have their fitted $\lambda_{\max}$ shorter than the average general value for the interstellar medium (0.55 μm). This second rejection criterion usually gives another clue to intrinsic polarization. Star 197 stands out as a polarimetric variable as it results from comparing P_R observations from Carrasco et al. (1975) and this work, see Fig. 1.

Some objects falling into this two criteria display emission-lines spectra: Nos. 251 and 311 (B2 Ve and B2.5 Ve, respectively; Hillenbrand et al. 1993), Nos. 297 and 306 (B0.5 Ve and B2-B3e, respectively; de Winter et al. 1997), Star 175 has spectral type O5.5 V ((f)) (Hillenbrand et al. 1993). The fitting of the Serkowski's law to star No. 313 gives an abnormal value of 1.24 μm on the right side of Table 2. This star has been mentioned earlier as a visual variable star. The most notable P_λ and θ_λ vs. λ plots are shown in Fig. 2, where the solid curve denotes the Serkowski polarization relation for the general interstellar medium. In particular, the plot for star 275 resembles that for star 109 in the polarimetric study of IC 2944 (Vega et al. 1994), and also the stars in Table 4 (Figs. 4 and 5) in Waldhausen & Marraco (1982), perhaps denoting the presence of circumstellar scattering.

In order to disentangle the relationship between the reddening and the polarization produced by the dust along the line of sight, the upper plot of Fig. 3 examines the relation between $P_{\max}$ and color excess E_{B-V} for the observed stars in NGC 6611. Objects shown as open circles indicate our "frontside" stars. Most objects are located to the right of the interstellar maximum line:

$$P_{\max} < 3 A_V \simeq 3 R_V E_{B-V} \qquad (2)$$

which is derived for the interstellar dust particles (Hiltner 1956). For comparison purposes this relation is also shown in the plot adopting two different values of R_V: 3.1, the "normal" value for the interstellar medium; and 3.75, the most frequent value in the work of Hillenbrand et al. (1993). The only star located to the left of both relations is No. 411. This object has been classified as a K5 III star by de Winter et al. (1997). It is considered to be a nonmember of NGC 6611, with an $E_{B-V} = 0.10$ mag. Polarimetrically, it shows a $P_{\max}$ value of $1.93 \pm 0.41\%$ (for $\lambda_{\max} = 0.58 \pm 0.03$ μm), which is relatively high when related to its excess. Its observed plots have been included in Fig. 2, where an abnormal curve can be seen that reflects more than one origin: interstellar plus circumstellar.

For the interstellar medium, Serkowski et al. (1975) have found a value of 5.03 for the ratio $P_{\max}/E_{B-V}$. In the case of NGC 6611 the stars in the upper plot seem to cluster around 4.2, a value equal to the sample of Carrasco et al. (1975) for NGC 6611. This situation
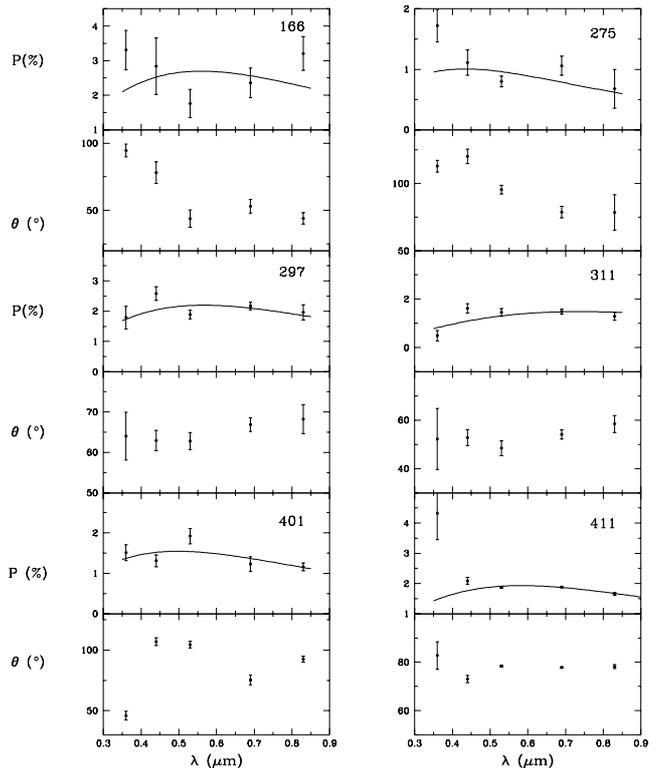

Fig. 2. Intracluster polarization and position angle dependence with wavelength for some of the stars with indications of intrinsic polarization (mismatch between observations and Serkowski's curve fit and/or variable position angle). In the case of star 411, both plots correspond to observed values

denotes a mean polarization efficiency coming from a combined effect of intracluster and foreground material. Although the observed ratio $P_{\max}/E_{B-V}$ may depend on several elements, mainly on the alignment efficiency, the magnetic field strength and the angle between the magnetic field and the line of sight, in this case it shows the depolarization due to radiation crossing at least two dust clouds with different field directions.

The lower plot in Fig. 3 shows the situation for the same group of stars when we subtract the effects of polarization and reddening due to the material in front of the cluster. Open circles indicate, again, the "frontside" stars. No. 411 has been excluded from this plot and also from the intra-cluster values in Tables 1 and 2. In this plot, only two stars are located to the left of the maximum line (2): No. 245 is a visual variable, of spectral type B6e and with suspected circumstellar material as noted by de Winter et al. (1997); and No. 280 being a fast rotation variable emission line star (Hillenbrand et al. 1993). From this plot we infer that most of the stars apparently are not strongly affected by intrinsic polarization. The dominant mechanism of polarization in the observed section of NGC 6611 is, therefore, supposed to be the alignment of grains by a magnetic field, in a similar way as that found
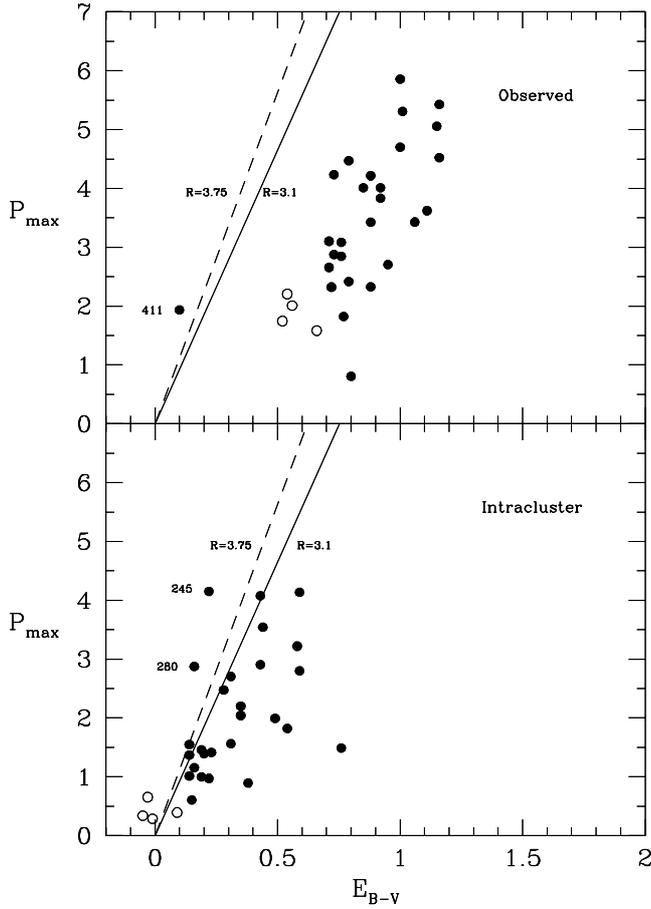
Fig. 3. Polarization efficiency diagrams for observed (upper plot) and intracluster parameters (lower plot). Using $R_V = 3.1$, the line of maximum efficiency is drawn in both diagrams. The same line but for $R_V = 3.75$, is also shown. Open circles are used for our "frontside" stars

in the general interstellar medium, with relatively good efficiency.

Figure 4 includes the plot of P_λ/P_{max} vs. λ/λ_{max} for those stars not excluded from any of the criteria explained in the previous paragraphs showing that their polarization is fully of interstellar origin. Only these stars will be used to test the *canonical* relations hereafter. Star 503 was not included because it is a Herbig Ae/Be. It will be mentioned again later.

For member stars in NGC 6611, individual $(V-K)$ values have been taken from the works of Hillenbrand et al. (1993) and Chini & Wargau (1990); the excesses E_{V-K} were calculated from the relationships (Johnson 1966):

$$E_{V-K} = (V-K) - (V-K)_0$$

where
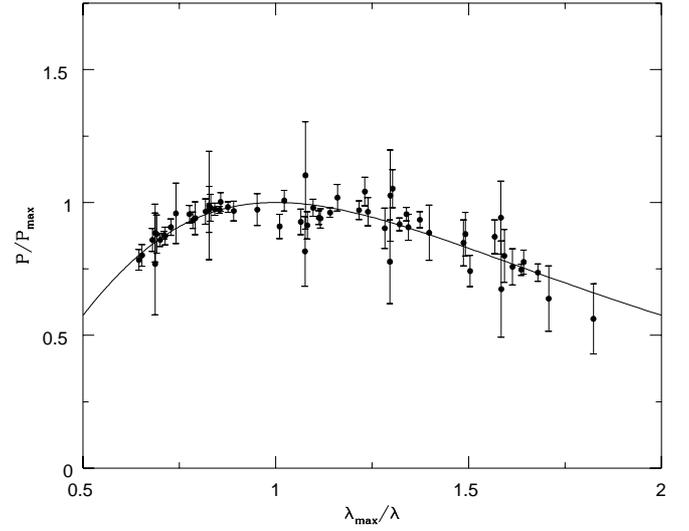
$$(V-K)_0 = 1.05 \, Q$$

and

$$Q = (U-B) - \alpha(B-V)$$

Fig. 4. P_λ/P_{max} vs. λ_{max}/λ plot for the observed stars not excluded from any of the explained criteria
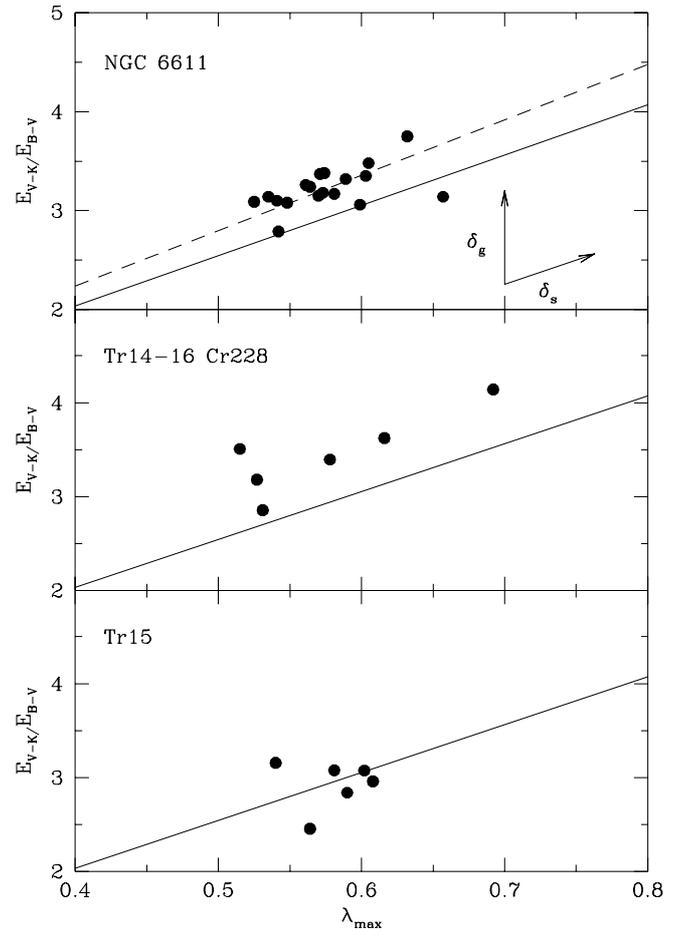

Fig. 5. E_{V-K}/E_{B-V} vs. λ_{max} plots for stars belonging to NGC 6611 (upper), Tr 14/16-Cr 228 (middle) and Tr 15 (lower). In the upper plot, the vectors intend to show the first order results of a mean particle size increase
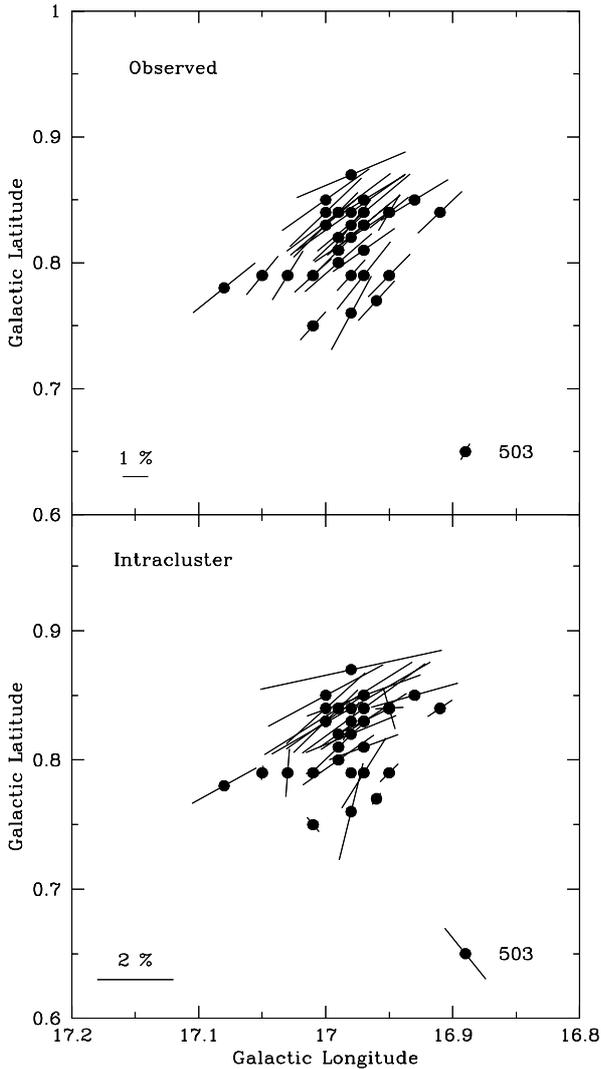
Fig. 6. Observed (upper plot) and intracluster (lower plot) polarization vectors and their orientations for stars belonging to NGC 6611. The length of each vector is proportional to the percentage polarization

where α takes values in the range 0.69 to 0.72. As for the particular case of NGC 6611, we have adopted $\alpha = 0.72$ in the calculations of the Q parameter. This procedure is justified by the fact that it is the same one used by Hillenbrand et al. (1993) and subsequently by Belikov et al. (1999). At the same time, this value is also very similar to the one quoted by Turner (1976) for the cluster, namely $\alpha = 0.74$.

In order to check the *canonical* relationship between R_V and $\lambda_{\max}$ for the interstellar dust we have plotted in the upper panel of Fig. 5 only those stars not suspected of having some kind of intrinsic polarization. For comparison purposes we have also plotted stars from the open clusters Tr 14/16 and Cr 228, embedded within the Carina Nebula (an H II region similar to M 16), in the middle panel; and

from the open cluster Tr 15, to the north of the other two clusters but just outside the H II region, in the lower panel. The $\lambda_{\max}$ data for these two plots come from Marraco et al. (1993) and the infrared photometry is from Tapia et al. (1988a). The plot for Tr 14/16-Cr 228 is identical to the upper panel in Fig. 3 of Marraco et al. (1993). The *canonical* relation of $E_{V-K}/E_{B-V} = 5.09\lambda_{\max}$ is drawn in the three panels as a solid line.

The dashed line in the upper panel was fitted to the 18 observed stars in NGC 6611 giving $E_{V-K}/E_{B-V} = 5.6\ \lambda_{\max}$. This means that if we adopt $A_V/E_{V-K} = 1.12$ we get

$$R_V = 6.3\ \lambda_{\max} \tag{3}$$

in comparison with a *canonical* value for the constant in (3) of 5.5.

As previously suggested for Carina by Tapia et al. (1988b) and subsequently confirmed by Marraco et al. (1993), Fig. 5 clearly demonstrates that the *canonical* relation between E_{V-K}/E_{B-V} and $\lambda_{\max}$ is not valid for stars belonging to dusty H II regions, as is the case for M 16 and the Carina Nebula, but remains in use for Tr 15, located well outside the H II region.

Chini & Wargau (1990) have attempted to model the NGC 6611 dust properties in order to fit the extinction curves obtained with their *UBVRIJHKL* photometry. Using the MRN graphite-silicate dust model (Mathis et al. 1977; Chini & Krugel 1983), they obtained a close fit by increasing (in relation with the model representing the standard ISM) the mean graphite grain size by a factor of 2, while the mean size of silicate grains was increased slightly by a factor of 1.20 ± 0.09. As it is widely known (Whittet 1996; Li & Greenberg 1998), the polarization is accounted for only by silicate grains because graphites are difficult to align. Our mean intracluster $\lambda_{\max}$ is $0.62 \pm 0.10\ \mu m$ and, if we adopt for the ISM a $\overline{\lambda_{\max}}$ value of $0.55 \pm 0.05\ \mu m$, we find that the mean size of the particles responsible for the polarization within the observed region in NGC 6611 is increased by a factor of 1.13 ± 0.09 relative to the general ISM, in general agreement with the ideas of Chini & Wargau (1990). Returning to Fig. 5 we are able to understand now that the *canonical* relationship between R_V and $\lambda_{\max}$ is expected to follow the extinction in the standard ISM where the shape of the extinction curve (R_V) is mainly accounted for the mean silicate grain size. In dusty H II regions, as it is the case of this paper and Tr14/16-Cr 228, variations in R_V are also due to changes in mean graphite grain size. In both cases, standard ISM and dusty H II regions, $\lambda_{\max}$ varies along with mean silicate grain size. The vectors inserted in the upper panel of Fig. 5 intend to show the first order results of a mean particle size increase. This is the reason why our polarization observations of NGC 6611 and also those of the η Carinae nebula do not follow the *canonical* relationship between R_V and $\lambda_{\max}$ of the general interstellar medium. McMillan (1978) concluded that an unimodal size distribution of dielectric
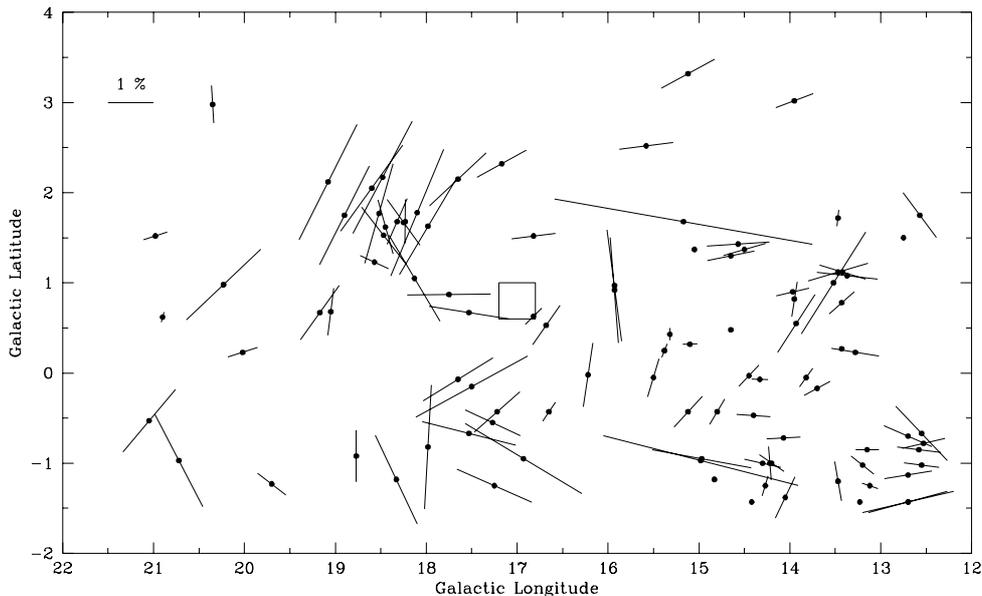
Fig. 7. Polarization vectors and their orientations for stars from the catalog of Axon & Ellis (1976) in the neighborhood of NGC 6611. The length of each vector is proportional to the percentage polarization. The approximate position of the cluster in the region is indicated with a square whose borders are those of Fig. 6

particles could not account for the position of 3 Orion stars observed by Breger (1977) in the R_V vs. λ_{max} diagram. This further points to graphite grain growth as an important factor in changing the shape of the interstellar extinction curve in the direction of dusty H II regions.

Figure 6 depicts the polarization vectors and their orientations for observed and intra-cluster values (upper and lower plots, respectively).

The foreground polarization has an average direction in galactic coordinates of $131°2 \pm 7°2$ ($69°7$ in equatorial coordinates), while the intra-arm polarization amounts to $117°1 \pm 18°7$ ($55°6$ in equatorial coordinates); that is, the projected magnetic field interior to the cluster is somewhat different from the foreground field. As mentioned earlier, star No. 503 with an e-vector of $\theta_V = 157°4$, deviates significantly from the average direction, as other stars from the group with suspected circumstellar dust shells do. Figure 7 shows the observed polarizations in the cluster area from the catalog of Axon & Ellis (1976). The line of sight to M 16 looks into the Sagittarius arm; in spite of this situation, no alignment of the e-vector of the observed field stars polarization is apparent. To conclude neither the field nor the intracluster polarization are particularly aligned, but the later is closer to the direction of the magnetic field that runs along the arm ($\theta_G = 90°$).

4. Conclusions

About 50% of the observed stars (14 out of 28) in NGC 6611 present indications of measured intrinsic polarization. A similar situation was found in the polarimetric study of IC 2944 (Vega et al. 1994), another open cluster in close relation with an H II region (RWC62). On the other hand, practically no observed members showed polarization due to a non-interstellar origin in Hogg 15 and Lynga 14 (Orsatti et al. 1998), two open clusters but without any association with gas.

The NGC 6611 intracluster polarization amounts to $\overline{P_V} = 1.99\%$ (mean of 14 stars). When compared to the polarization found for the "frontside" stars (1.88%), we confirm the presence of polarizing dust in association with the observed members of NGC 6611.

The mean intra-cluster λ_{max} value associated with the observed stars gives $\overline{\lambda_{max}} = 0.62 \pm 0.10$ μm (mean of 14 stars). This dispersion indicates the coexistence of different grain size distributions. When compared to the λ_{max} value for the general interstellar medium, it implies a certain enlargement in mean silicate grain size. Also, it was found that the *canonical* relation $R_V = 5.5\lambda_{max}$ is not valid for stars in dusty H II regions like the observed portion of M 16 and the Carina Nebula where it was previously shown by Tapia et al. (1988b) and subsequently confirmed by Marraco et al. (1993). This may arise mainly from the presence of these before mentioned silicate grains of slightly larger size than the standard ISM and also from a considerable increase in mean graphite grain size, in accordance with previous results from Chini & Wargau (1990).

We plan to extend the observations to other parts of the H II region less connected with dense dust clouds to help clarify the validity of this *non canonical* relation and to re-observe for variability some stars of the present paper in order to further explain the circumstellar polarization in more detail.

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