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DUST EXTINCTION FROM PASCHEN-BALMER LINES

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Contribution to the ESO/MPA workshop on "Spiral galaxies in the Near-IR"

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Abstract. We have studied the dust extinction of spiral galaxies by determining the attenuation of the emission from giant extragalactic H II regions. The aim is to push CCD observations as far into the near-IR as possible to compare the near-IR Paschen lines with blue Balmer lines separated by a wide wavelength interval including the corresponding multiplet lines P_δ/H_ϵ and P_γ/H_δ, which originate at the same upper atomic level.

Introduction. The visual extinction, A_V can be calculated from the observed and predicted ratio of two emission lines at λ_1 and λ_2 as

$$A_V = \frac{2.5 \log(R_o/R_p)}{A_{\lambda_2}/A_V - A_{\lambda_1}/A_V} \quad (1)$$

assuming a foreground absorbing dust screen with the normalized extinction law A_λ/A_V given by Cardelli et al. (1989). A_V has been derived both by applying Eq. (1) to the corresponding multiplet lines and as an average value based on all observed lines (Fig. 1). Spectra were obtained at the NOT with the two-channel Low Dispersion Spectrograph covering $\lambda\lambda$3950–4900 Å and 8500–11000 Å simultaneously to ensure precise relative spectrophotometry.

NGC 5461 is an extensively studied H II region in NGC 5457 (M101) bright enough for observations of the near-IR P_γ emission line. Figure 1 illustrates the advantage of a wide wavelength interval for extinction determination and from a weighted least-squares linear fit of all observed line fluxes represented by the dashed line we derive $A_V = 1.12 \pm 0.07$. For P_δ/H_ϵ and P_γ/H_δ we get $A_V = 1.46$ and 1.38, respectively. A comparison with literature data based on H_α/H_β or synthesis models (Rosa & Benvenuti 1994) shows a considerable scatter amounting to more than 1 mag but with the newer results in favour of the high dust extinction also found in the present study.

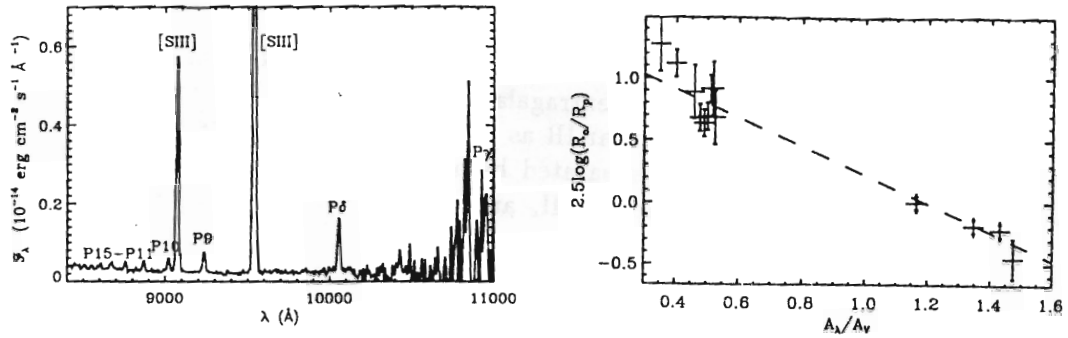

Fig. 1. Left, near-IR spectrum of NGC 5461 with the Paschen lines indicated. Right, observed and predicted fluxes relative to H_β . When displayed in this way they will show a linear relation with a slope of $-A_V$ according to Eq. (1).

NGC 628 and NGC 2403. 7 H II regions were observed in these two spiral galaxies with the results shown in Table 1. A detailed analysis of these data can be found in Petersen & Gammelgaard (1995). Except for the extreme value of region NGC 628, 27 by McCall et al. (1985) the values of A_V derived in this study agree well with the previous published results based on the H_α/H_β ratio but are somewhat higher. For NGC 628 the derived extragalactic extinctions are in the interval 1.4–1.6, while for NGC 2403 we find A_V (Exgal) = 0.7–1.3. By applying extinction corrections from Table 1 to the near-IR S[III]9069,9531 lines and our empirical calibration based on Garnett (1989) we establish a sulphur gradient in NGC 2403 of -0.073 ± 0.021 dex/kpc.

Table 1. Visual extinction derived from Paschen-Balmer line ratios. For comparison, values of A_V based on H_α/H_β from MRS and Fierro et al. (1986) are listed in columns 4 and 5. A_g denotes the Galactic foreground extinction

H II reg ID#	A_V, P_δ/H_ϵ	A_V, lin. fit	A_V (MRS)	A_V (FTP)	A_g
NGC 628, 27	1.57	1.61 ± 0.17	2.12 ± 0.28		0.09
NGC 628, 79	1.78	1.58 ± 0.11	0.99 ± 0.28		0.09
NGC 628, 83	1.65	1.47 ± 0.10	1.03 ± 0.14		0.09
NGC 2403, 1	0.84	0.83 ± 0.02	0.71 ± 0.14	0.77 ± 0.22	0.12
NGC 2403, 2	1.05	0.81 ± 0.09		0.55 ± 0.22	0.12
NGC 2403, 3	1.06	1.00 ± 0.03		0.87 ± 0.22	0.12
NGC 2403, 4	1.59	1.45 ± 0.10		0.77 ± 0.22	0.12

References

Cardelli J.A., Clayton G.C., Mathis J.S., 1989, ApJ 345, 245
Fierro J., Torres-Peimbert S., Peimbert M., 1986, PASP 98, 1032 (FTP)
Garnett D.R., 1989, ApJ 345, 282
McCall M.L., Rybski P.M., Shields G.A., 1985, ApJS 57, 1 (MRS)
Petersen L., Gammelgaard P., 1995, A&A (accepted)
Rosa M.R., Benvenuti P., 1994, A&A 291, 1