Bull. Astr. Soc. India (1984) 12, 249–251

Centre-to-limb variation of CH line profile parameters

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Received 1984 March 9; accepted 1984 May 4

Abstract : Four CH line profiles at $\mu = 1.0$ and 0.2 were Fourier transformed. They show (i) turbulent velocity $\xi_t = 4.0$ km s^{-1}, and (ii) an increase in the Doppler width parameter $\Delta\lambda_D$ by a factor of 1.03 in going from the centre to limb.

Key words : CH molecule—CL variation—Doppler width—Fourier transform—turbulence

1. Introduction

Smith & Gray (1976) have enumerated the merits and limitations of the Fourier transform analysis of solar and stellar line profiles. They have shown how the various parameters like rotation, and micro-, macro-turbulence do become transparent in the frequency (cycle Å^{-1}) domain. Gray (1977) has applied this technique to the solar flux profiles of the Beckers *et al.* (1976) atlas.

In another paper (to be published) we have found that the Doppler widths of weak CN lines increase linearly with equivalent width, whereas Porfireva (1972) has shown that the Doppler widths of CN lines do not change in going from the centre to limb. These two results cannot be reconciled. So we have analysed medium ($\simeq$ 40 mÅ) CH lines by the Smith-Gray (1976) technique and have found that the Doppler width parameter $\Delta\lambda_D$ does increase by a factor of 1.03 in going from the centre to limb.

2. Data and analysis

Intensities of the four CH lines (table 1) at the centre ($\mu = 1.0$) and limb ($\mu = 0.2$) were read at 0.005 Å interval from the Brault & Testerman (1972) atlas. The flux data for these lines were taken from Beckers *et al.* (1976). These CH lines were chosen such that they show good wings, as Fourier analysis is basically a curvature analysis. But all these lines are blended and the blends were eliminated using the technique of Moore *et al.* (1966). The residual intensity ratio are shown in figure 1. All the profiles were read at 55 points and Fourier transformed in two ways : (A) straight away and (C) after apodising it with a cosine bell (to reduce

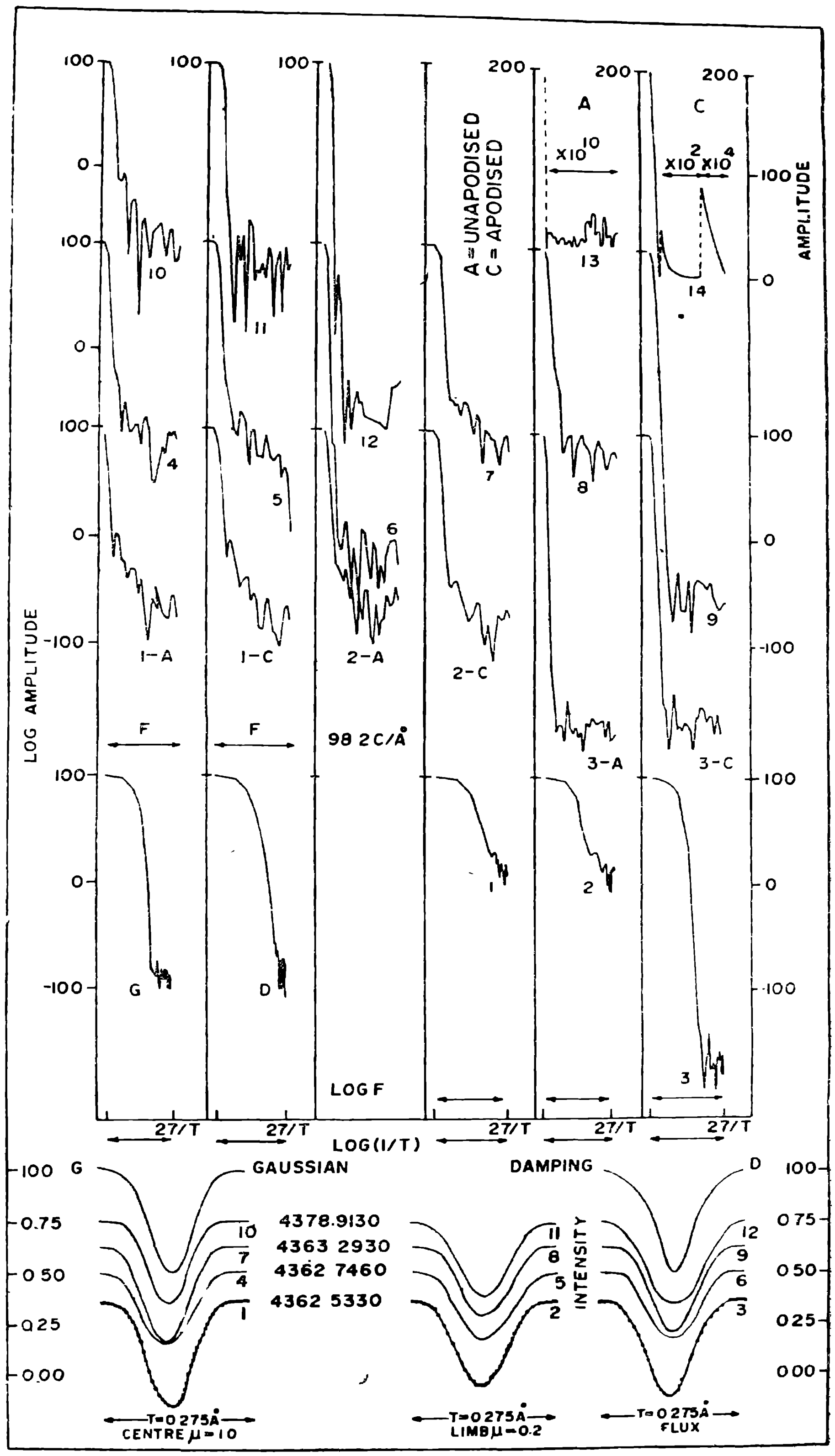

Figure 1. CH line profiles and their Fourier transforms.

Table 1. CH lines and their parameters

No.	λ(Å)	Transition	Equiv. width mÅ*	$\Delta\lambda_{D_1}$ (mÅ)	$\Delta\lambda_{D_2}$ (mÅ)	$\Delta\lambda_{D_3}$ (mÅ)	$\Delta\lambda_{D_1}/\Delta\lambda_{D_2}$
1.	4362.533	$A\,^2\Delta - X\,^2\Delta$	53.0	30.2	29.3	29.4	1.03
2.	4362.746		45.0	29.5	28.9	29.2	1.02
3.	4363.293		60.0	30.1	29.5	—	1.02
4.	4378.913		44.0	30.5	29.4	28.4	1.04

*From Moore *et al.* (1966).

high frequency fluctuations). The amplitude of the transform thus obtained is plotted in figure 1, where the numbers on the transform correspond to those of the profile.

3. Discussion

Gray (1977), from his analysis of the profiles of Beckers *et al.* (1976), has determined the rotational velocity $v \sin i$, micro-turbulence (0.5 km s^{-1}) and the radial tangential macro-turbulence [3.1 km s^{-1} for strong lines and 3.8 km s^{-1} for weak (equivalent width $<$ 50 mÅ) lines].

In the present study, we have concentrated on the slope of the steepest part of the transform, amplitude-frequency relationships and have determined the Gaussian parameter $\Delta\lambda_D$ (Brigham 1974) for the centre ($\mu = 1.0$, $\Delta\lambda_{D_1}$), limb ($\mu = 0.2$, $\Delta\lambda_{D_2}$) and the flux profie ($\Delta\lambda_{D_3}$). The last column of table 1 gives the ratio $\Delta\lambda_{D_1}/\Delta\lambda_{D_2}$. This in the mean equals $1.03 \pm .01$ and shows that the Doppler width is consistently greater at the limb than at the centre, as against the Porfireva (1972) results. If the temperature of the CH line-forming region is taken to be the rotational temperature of the CH lines, as determined by Pande *et al.* (1980), then the macro-tubulence velocity comes out to be 4.0 km s^{-1} for a micro-turbulence velocity of 0.5 km s^{-1} (*cf.* Gray 1977).

Since the values of $\Delta\lambda_{D_1}$ and $\Delta\lambda_{D_2}$ come out to be similar, it casts some doubt on the assertions by Gray (1977) that macro-turbulence is radial-tangential only and not isotropic. However more work is needed to elucidate this aspect.

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