ESTIMATION OF STELLAR SURFACE MAGNETIC FIELDS BY THE CURVE-OF-GROWTH METHOD

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ABSTRACT. The curve-of-growth method of estimating the stellar surface magnetic fields is applied to six Ap stars of different temperatures and one normal (or metallic-line) star σ Aqr. The values of H_s determined by the curve-of-growth technique are in good agreement with those obtained by the photometric method.

The curve-of-growth method of estimating the surface magnetic fields in Ap stars is examined using the 8 to 10 A/mm dispersion spectra. The spectra of faint Ap stars and Ap stars in clusters are usually obtained with such a dispersion. According to the basic assumption of the method proposed by Hensberge and De Loore (1974) the line broadening on the flat part of the curve of growth may be represented as a sum of Doppler's and Zeeman's broadening:

$$\Delta\lambda=(\Delta\lambda_D^2+\Delta\lambda_H^2)^{1/2} \quad , \text{ where}$$

$$\Delta\lambda_H=k\cdot\lambda\cdot z\cdot H_s \qquad (k=4.66\times10^{-13}).$$

Since $W\sim(\mathrm{Log}\,\eta_0)^{1/2}\Delta\lambda$, the equivalent width of a line formed in the presence of magnetic field is enhanced by a factor of $(1+\Delta\lambda_H^2/\Delta\lambda_D^2)^{1/2}$, i.e.,

$$W_H=W_0[1+(k\cdot\lambda\cdot c\cdot z\cdot H_s)^2/V_D^2]^{1/2}.$$

On minimizing the standard deviation of W_0 with respect to the computed curves of growth for various microturbulent velocities, we obtain H_s along with the abundance of the given element and the microturbulent velocity Vt.

This procedure was applied to six Ap stars and a normal star σ Aqr. The spectra of these stars with the dispersion of 8 to 9 A/mm were obtained at the Crimean Observato-

C. R. Cowley et al (eds.), Upper Main Sequence Stars with Anomalous Abundances, 45–47.

Table. Derived parameters of Ap stars.

Star	T_{eff}/Log(g)	Element	H_s kgauss	$Log\frac{Fe}{H}$	V_t km/s	H_s (phot)
6 Aqr	10150 K/4.0	FeI	0.35	-4.01	1	0.10
		FeII	0.36	-4.01	1	
HD 2453	9000 K/3.75	FeI	2.80	-3.80	2	3.13
		FeII	2.32	-3.64	2	
HD 8441	9200 K/3.5	FeI	1.23	-4.00	0	0.65
		FeII	0.70	-3.78	0	
HD 110066	9300 K/3.75	FeI	2.46	-3.62	2	3.12
		FeII	2.16	-3.69	2	
HD 118022 (78 Vir)	9650 K/4.0	FeI	2.30	-3.39	1	2.42
		FeII	1.63	-3.28	1	
HD 168733	14500 K/ 3.6	FeII	0.86	-3.68	2	1.18
HD 192913	11000 K/3.5	FeI	2.26	-3.68	1	1.67
		FeII	1.00	-3.43	1	

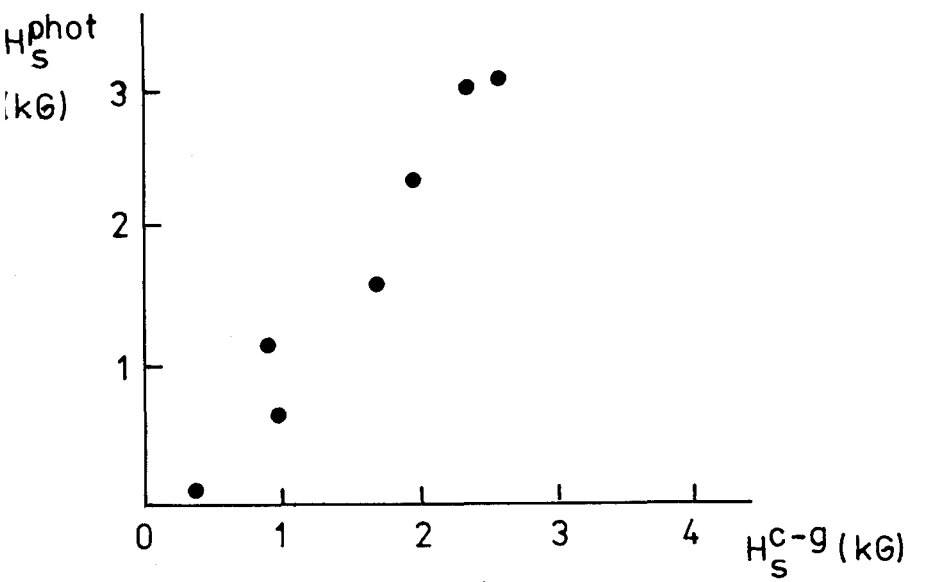

Fig.1. Comparison between estimates of H_s obtained by the photometric method and the curve-of-growth method.

https://doi.org/10.1017/S0252921100091193 Published online by Cambridge University Press

ry (HD 118022), the Bulgarian National Astronomical Observatory (HD 2453, HD 8441 and HD 192913) and the Special Astrophysical Observatory of the USSR Acedemy of Sciences (HD 110066). Data for σ Aqr and HD 168733 were taken from Adelman and Nasson (1980) and Little and Aller (1970). The results are summarized in the Table. The rightmost column of this table contains the H_s values which were obtained using the photometric calibration (see Cramer and Maeder (1980)) and the temperatures from our table. Comparison between our mean estimates of H_s and the photometric ones results in Figure 1.

The following conclusions can be drawn from these results.

1. The curve-of-growth method provides the possibility of estimating the Ap star surface magnetic fields using moderate dispersion spectra.
2. One can simultaneously obtain the more accurate mean abundance of an element under investigation and the value of the microturbulent velocity.
3. The values of H_s obtained from FeII lines are smaller than the respective values obtained from FeI lines for all Ap stars in question. Due to the method error (~ 0.5kgs) it is still unclear whether there actually is the difference in reality.
4. The estimates of H_s yielded by the curve-of-growth method are systematically lower than those yielded by the photometric method. This may partly be explained by the fact that the calibration of the photometric method is insufficiently accurate for the surface magnetic fields smaller than 5 kgs.

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https://doi.org/10.1017/S0252921100091193 Published online by Cambridge University Press