DERIVATION OF THE PARAMETERS NECESSARY TO DETERMINE THE NORTH DIRECTION OF A HELIOGRAM

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Abstract. The accurate determination of the north direction of a heliograph is of basic importance to measure global motion on the Sun. If the alignment of the heliograph is not perfect the north direction of the heliogram changes relative to a fix direction in the image plane of the heliograph. This change depends partly on the alignment errors of the heliograph. Here we propose a method to determine the pole distance and hour angle of the hour axes of the heliograph which are the alignment errors of the heliograph.

To measure global motion on the Sun´s surface with high accuracy we must know the accurate north direction of the heliogram (Smart, 1977). If the alignment of the heliograph is not perfect that direction changes relative to a fix direction in the image plane of the heliograph according to the formula

$$DP_{o\,W}^{\;E} = (\pi/2-|\alpha|)\mathrm{sign}(\alpha) + \lambda\sin(t-\varphi)\sec(\delta)\pm \pm[\omega\sec(\delta)-\varepsilon\tan(\delta)] \quad (1)$$

(Győri, 1989).
The meaning of notations in (1) are: ΔP_o, the angle between the north direction of the image plane and image of a thread located in the primary image plane of the heliograph; α, angle between the imagened image of the declination axis and the image of the thread; λ, pole distance of the hour axis of the heliograph; φ, the hour angle of the hour axis; ω, the angle between the declination axis and hour axis of the heliograph is $\pi/2+\omega$; ε, the angle between the declination axis and optical axis of the heliograph is $\pi/2+\varepsilon$; δ, the declination of the Sun; t, hour angle of the Sun; the plus sign before the last term in (1) stands for the east position (E) of the heliograph and the minus sign for the west position (W).

We propose a method to determine parameters λ and φ. We make use of that well known effect that if the alignment of the heliograph is not perfect the image of a sunspot is continuously being shifted along the north direction of the image plane as the time proceeds (the heliograph is clamped in declination and rotated around the hour axis so that the center of the Sun´s image be on the line containing the centre of the image plane and representing the north direction). The shift d of a sunspot measured from a fiducial point along the north direction can be decribed by formula

$$d=\lambda\left[\cos(\varphi-t)-\cos(\varphi-t_o)\right] \qquad (2)$$

where t_o is the hour angle of the fiducial point.

To get equation (2) λ is supposed to be small ($l < 1°$).

At deriving formula (2) the effect of the refraction and change of the Sun's declination were not taken into account. If one corrects the measured shift for refraction and the change of the declination of the Sun one can fit the curve determined by formula (2) to the corrected shift versus hour angle of the Sun and the parameters λ and φ can be determined.

As an example we provide Figure 1 which shows the corrected shift of a sunspot (*) as the function of the hour angle of the Sun and the curve fitted to them (lam=λ, fi=φ, in degrees).

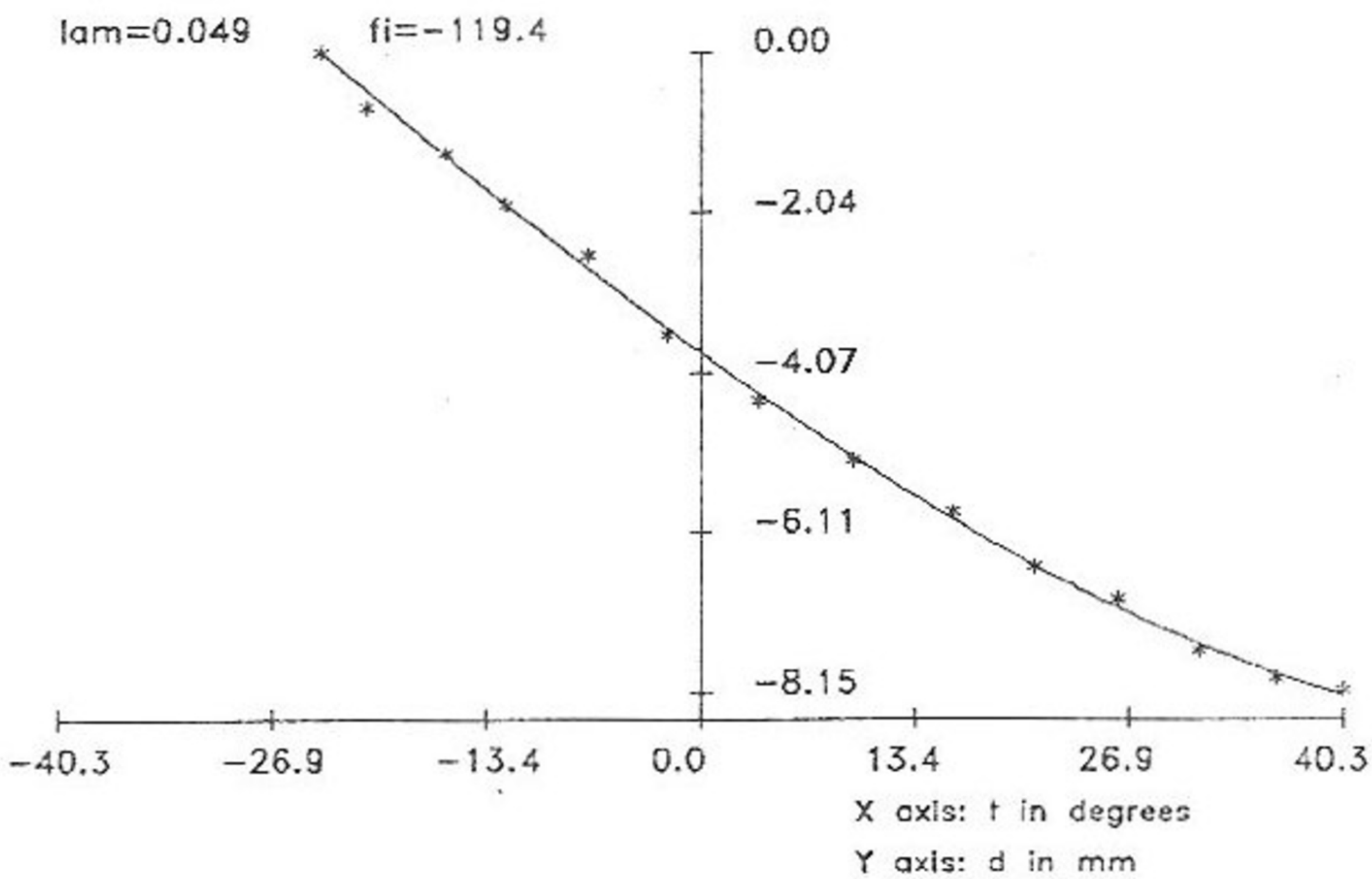

Fig. 1. d vs t. (*) denotes the corrected shift of a sunspot, continuous line is the fitted curve to them (lam=λ, fi=φ, in degrees).

References

Smart, W. M.: 1977, Textbook on Spherical Astronomy, Cambridge University Press, Cambridge.

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