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A Doppler Comparator for Solar Spectra

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Introduction

There are many programmes presently running at the Solar Tower of the Observatory to determine the local Doppler displacements using lines of different mean depths of formation. These studies also cover observations of velocity fields associated with super-granular cells as well as those of the quasi-periodic vertical oscillations in the photosphere. The necessity to evaluate these velocity fields from a huge mass of data of spectrograms lead us to design and construct a Doppler comparator. In this device the light flux from both the wings of a spectral line are directed to, two Light Dependent Resistances (LDR) through a system of two slits with their centres located at $\pm\Delta$ on the line profile. Determination of Doppler displacement at any location on the line consists in equalising the D.C output signals of the two LDRs, by setting the two slits with a micrometer screw so that the line is centred on them and reading this displacement on the micrometer scale. The spectral line is scanned manually along its length and Doppler displacements are obtained at discrete points at the choice of the observer.

Optical Scheme

The Zeiss spectrum projector forms a sharp image of the spectrum S, magnified 16 times. This image is formed immediately behind the collimating lens C (Figure 1) in the plane of the system of two slits G. After passing through the slits and a field lens F, the beam is reflected by the two silvered faces of a right angle prism P and directed towards line shifters L_1 and L_2, diffusers D_1 and D_2 and light dependent resistors LDR_1 and LDR_2. The light-tight box B containing the optical elements beginning with double slit plate G, can be displaced in measurable amounts with a Hilger micrometer screw W, together with its nut N. The axis of the screw is parallel to the direction of dispersion of the magnified spectral image. The screw has a base support having no motion relative to the projector. Collimating lens C is fixed with respect to the projected beam and helps to secure constant directions of the two beams inside the box B, while the box is moved in the light field during measurements.

It is possible to rotate the line shifters L_1 and L_2 from outside the box about axes perpendicular to the plane of the figure. By means of this rotation positions of light spots on the diffusers D_1 and D_2 can be altered in small amounts in order to render illumination on the LDR's exactly equal. Such an adjustment is usually done with the spectrum removed from the beam and the slits uniformly illuminated with selected light intensity, before commencing a series of measurements. Necessary uniformity of the light beam has been obtained by means of an additional (fixed) diffuser D near the projector condensing lens.

The slits are rectangular apertures of suitable size and position on the slit plate G, which is made of glass with a non-transparent mask on it, or of metal. Slit plates can be easily made and are changed according to the width of the observed spectral line and the desired space resolution along the line.

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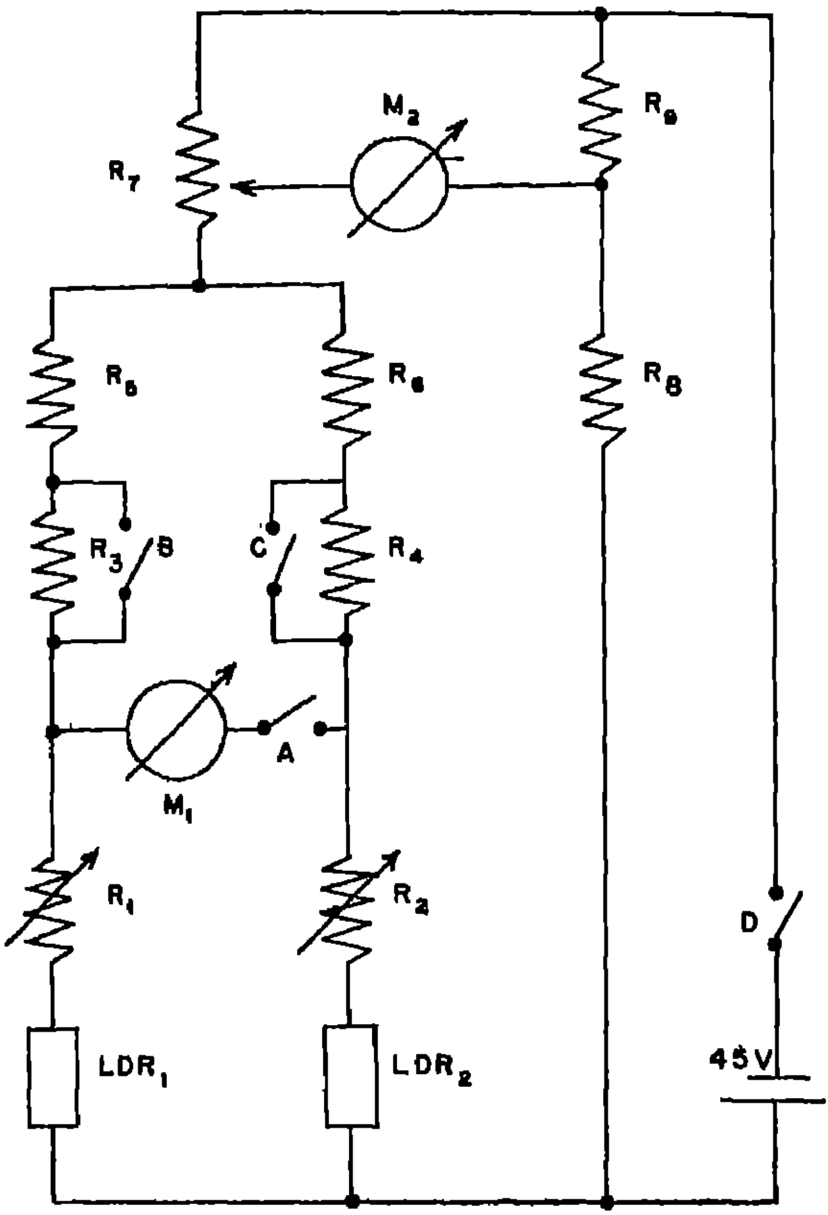

Fig.2. $R_1 = R_2 = 50\ k\Omega$

$R_3 = R_4 = 1\ M\Omega$] Selected pair.
$R_5 = R_6 = 272\ k\Omega$]

$R_7 = 5\ k\Omega$ $R_8 = 320\ k\Omega$ $R_9 = 2\ k\Omega$

LDR_1, LDR_2 — Philips light dependent resistors.

Ten points along each line were measured and such a set of measurements was repeated 8 times. From ten r. m. s. errors $\left(\sigma = \pm \sum \frac{\Delta_i}{\mu - 1}\right)$ a mean value is derived and these results are shown in Table I. The errors are expressed in microns (μ) as well as in velocity units (m/s).

TABLE I

Slits	No. 1	No. 2	No. 6
Space resolution along the slit	5".50	2"·75	0".91
$\lambda = 4554$ Å,	$\pm$ 1.0μ	$\pm$ 1.6μ	$\pm$ 2.7μ
R = 8	$\pm$ 5.9 m/s	$\pm$ 9.4 m/s	$\pm$ 15.9 m/s
$\lambda = 4912$ Å	$\pm$ 2.5μ	$\pm$ 5·3μ	$\pm$ 7.6μ
R = 1	$\pm$ 10.9 m/s	$\pm$ 23.0 m/s	$\pm$ 33.0 m/s

The strongest lines which can be accommodated in the field lens of the comparator are D_1 and D_2 lines of Na with a dispersion 11 mm/Å.

It was also found that after some practice, an observer working with the highest slit can measure about 150 points along 4554 B_a^+ line in one hour. This number would be less for higher space resolution or for a weaker line.

Acknowledgements

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REFERENCE

Evans J. W. & Michard R., 1962, Astrophys. J., **135**, 812.

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