

magnetic activity maintains a strong control over the occurrence of echoes at Halley Bay over the whole range from quiet to severely disturbed conditions.

On almost all the occasions when ΣK_p exceeded about 40, echoes were obtained from the aurora borealis at Jodrell Bank, and these events coincided with the high peaks in the echo activity at Halley Bay from the aurora australis. It therefore seems reasonable to conclude that the great auroræ of the northern hemisphere are accompanied simultaneously by greatly enhanced activity of the aurora australis. It is hoped to make a more detailed study of the time correlations when the full results from Halley Bay become available.

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¹ Little, B. E., and Shrum, C. M., *Trans. Roy. Soc. Canada*, **44** (III), 3 (1950).

² Lovell, A. C. B., *I.G.Y. Annals*, **3**, Part IV, 337 (1957).

³ Bullough, K., and Kaiser, T. R., *J. Atmos. Terr. Phys.*, **5**, 189 (1954).

⁴ Vestine, E. H., and Snyder, E. J., *Terr. Mag.*, **50**, 122 (1945).

A Simple Technique for the Calibration of the Wave-length Scale of Spectrophotometers

It is often essential to test the calibration, setting and working of either old or new spectrophotometers. Generally, this is carried out by the standard plastic, gelatine or glass filters supplied with the instruments. Standard solutions may also be used. We were recently faced with such a problem, but found that no solid standard filters were immediately available or easily obtainable. Further, calibration and standardization with solutions is always associated with numerous difficulties of purity of chemicals and solvents and the actual preparation of standard solutions. It is well known that even chemicals labelled 'chemically pure' are sometimes contaminated. Further, departures from Beer's law and the exact range of wave-length in the so-called monochromatic beam used are also common sources of error. The problem is often complicated by systematic errors such as dichroism, colloidal particles or temperature effects.

An attempt was therefore made to find an easy and reliable method of calibration relatively free from error. This has been achieved by taking advantage of the transmittancy curves of solutions of acid-base indicators such as methyl orange. It is known¹ that the transmittancy curves for the different pH values for any particular indicator all intersect at a point known as the isobestic point, which has a value of 469 m μ for methyl orange. It is clear, therefore, that if an acidic and a basic solution made from equal amounts of the same stock solution of methyl orange are kept in two cells and the difference in their transmittancy observed at different wave-lengths, then ΔT_s would be zero at only one wave-length, namely, 469 m μ . ΔT_s can be determined by simply sliding the two cells containing the acidic and the basic solutions of the indicator, one by one, in the path of the beam. As this method is very similar to a null method, all the disturbing minor

factors remain constant and balance out without affecting the accuracy of the calibration.

An incidental advantage in the method is that the procedure involves the determination of a point of intersection; this is normally more precise than determination of a maximum or minimum absorbency. In practical determinations, the equality of absorbency is far easier to establish than determination of the wave-length corresponding to a maximum or minimum. We have calibrated the spectrophotometer by this method and measured the isobestic point of bromocresol green and have been able to reproduce the value reported in the literature. It is, however, necessary to add here that there must be no impurity in the indicator, the absorbency of which depends on pH. Although we have used methyl orange and bromocresol green, many other indicators would also serve the purpose.

Table 1

Indicator	pH range	Isobestic point (m μ)
Methyl orange	2.6-5.0	469 ¹
Bromocresol green	3.4-5.2	509 ¹
Neutral red	5.6-8.4	480 ²
Thymol blue (acid)	1.2-3.4	485 ²
Thymol blue (alkaline)	7.4-10.2	500 ²
Phenol red	6.2-9.2	481 ²
p-Nitrophenol	5.0-9.0	350 ²

The wave-length values for the isobestic points of a few indicators are given in Table 1. In addition, the transmittancy curves for bromophenol blue (pH range 2.4-5.6), methyl red (pH 3.4-7.0), bromocresol purple (pH 4.8-7.6), cresol red (pH 6.8-9.6) and bromothymol blue (pH 5.8-8.4) are given in the literature², from which the exact wave-length values for their isobestic points may be ascertained.

We are not aware of any previous reports of the use of this principle for accurate calibration.

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¹ cf. Fortune and Mellon, *J. Amer. Chem. Soc.*, **60**, 2607 (1938).

² Wallace, R. Brode, *J. Amer. Chem. Soc.*, **46**, 589 (1924).

³ Briggs, A. I., *Trans. Farad. Soc.*, **50**, 800 (1954).

Photovoltaic Pile

In a previous communication¹, a retinal type of photovoltaic cell is described in which many inert 'point' electrodes are placed in a parallel mosaic arrangement in a small volume of photo-active solution. To indicate that each electrode is a photo-receptor, a separate d.c. amplifier is required. An attempt was then made to construct a multiple-point photovoltaic cell in which all the individual electrodes are connected in series, as shown in Fig. 1. One set of electrodes is kept dark with tape while the other is irradiated as in a thermopile. Only one amplifier¹ is of course needed for this cell. As more light- and dark-electrode pairs are added in series, larger photo-potentials are eventually generated, but at a much slower rate than with the individual point electrodes in parallel; also, with certain photo-active solutes,