student of science are, of course, only side-issues, and do not touch the main problem of evoking, on the part of the pure mathematician, an interest in the applications. The pure mathematician has not the leisure necessary for familiarity with the history and essentials of a proposed problem, but he could assist by turning the thoughts of his better students into such a direction. When he does become interested in an application, he usually studies only the mathematical methods tried more crudely by others. His interest, in fact, lies more in the logic of the matter than in any co-ordination of new phenomena which may be obtained. Yet at the same time he must not be blamed, for the physicist and engineer rarely present their problems in such a form that the mathematician can even begin to seek a solution. He does not know what approximations he may make and yet retain a solution of value. The proper function of a treatise on applied mathematics is to give strict formulations of problems and an account also of the principles which underlie good physical approximations. The applied mathematician who can fulfil this function, and intervene between the mathematician and the experimenter, is now lamentably rare. The temptation to go to one of the extremes is too strong under the present system, though Prof. Brown suggests various ways in which such men could be encouraged to steer the middle course.

The fundamental subjects which, from the present point of view, demand systematic examination, and, more especially, simple exposition from the mathematician, are: the numerical solution of classes of differential equations, symbolic forms adapted for rapid numerical calculation, reduction of a series of numbers to the best formula, and Fourier and other representations of periodic phenomena. Under this last heading a considerable contribution is made by Sir Joseph Larmor's address, which cannot in this respect be noticed at all adequately in our present space. But it is readily accessible, and this fact somewhat precludes the necessity. In so far as it is general the views expressed are essentially similar to those outlined above, and it includes, moreover, an instructive account of the history and present state of the society, with suggestions towards its future adaptation to changing conditions.

In his critical analysis of the Fourier harmonic method Sir Joseph sketches the history of its development, and afterwards points to an insistent question: What is to be done with the accumulated observational data such as are being piled up by meteorologists and statisticians, and to what extent should they be continued? Such questions are of the essence of pure mathematics and not strictly of its technical application. It is a curious fact that progress in such directions was practically stopped by difficulties in running the Kelvin integrating machine. Sir Joseph Larmor makes a powerful appeal to the pure mathematician to revive his former interest in such problems, and cites the work of Schuster as a striking illustration of the success which could be obtained by an organised attack. We may cite, as another illustration, Sir Joseph's own discussion of some of the problems of radiation, which forms the remainder of his address, for it presents many sides of the question which have been only too imperfectly considered by those who work with any aspect of the Fourier analysis.

We can only repeat that it is a fortunate event, and perhaps a sign of the times, that the presidents of the two leading mathematical societies in the English-speaking world should have chosen the same ground so closely, and independently expressed concordant opinions even in points of detail. This fact must surely stimulate workers to an interest in these questions, the elucidation of which, even if only partial, would be a fundamental gain to the whole range of work in the province of natural science.

J. W. NICHOLSON.

PRECISE LEVELLING IN THE WEST OF ENGLAND.[1]

THIS recently published Professional Paper of the Ordnance Survey gives an interesting account of the revision of a line of precise levelling which had been carried out under the direction of a committee of the British Association in the years 1837 and 1838. The line was run from Axmouth, on the coast of the English Channel, to three points on the southern coast of the Bristol Channel, and the terminal points were marked with metal bolts "to afford a basis for a comparison with the position of the lines then determined, at present, and at any future period." When the revision of the primary levelling network of Great Britain was undertaken the revision of this particular line was included in order to see whether there was any indication of earth movement, and in the course of the last three years it has been found practicable to carry out this work by the reserve levelling staff which has to be maintained at Southampton. The earlier levelling was carried out by Mr. T. G. Bunt, and full details are given by Dr. W. Whewell and him in the report of the British Association for 1838.

He used a level by Simms which had a telescope 14 in. in length and a magnification of 26. The bubble is said to have been affected by a movement of 1/100,000 in. of either end. The staff used was at first of brass, but this being found unsatisfactory, it was replaced by one of seasoned oak 9 ft. long and having scales on both sides. Nothing is stated about the verification of the staff divisions. The staff was read with the aid of a vane or target, of which the position was read by a vernier to 1/500 ft., and it is stated that the average error of a single reading was 1/250 in. Lines were levelled in both directions from beginning to end, then from end to beginning, and the discrepancies found are recorded. Mr. Bunt mentions a systematic error which he experienced, viz. that "the heights of all points came out less by the levels returning than by the levels going," and from Portishead to Axmouth, a distance of seventy-four miles, the discrepancy between forward and backward levelling was 1·029 ft. The old levelling books are not now to be found, so that the comparison with modern work could only be made over the distances between Axmouth, Axmouth Church, Stolford, and Perry Farm, where the old marks are still existing.

The discrepancy between the older and the new levelling from Axmouth to Perry Farm, a distance of fifty-seven miles, is but 0·92 in., though at Stolford, fifty-five miles, it reached 2·11 in. The amount of the accidental and systematic errors of Bunt's levelling computed by the formulæ adopted by the International Geodetic Commission is 1·0 mm. and 0·9 mm. per kilometre respectively, against the limits of 1 mm. and 0·2 mm. per kilometre, as laid down by international agreement for precise levelling.

The conclusion arrived at is that there is no evidence of any change in the relative levels of the marks near the shores of the English Channel and the Bristol Channel.

The Ordnance Survey levelling was executed with a Zeiss No. 3 pattern 14-in. level with a parallel plate object-glass micrometer, and invar levelling staves. The operation is one of much interest as affording a comparison between the best class of levelling work in this country at the two periods. H. G. L.

[1] Report on the Re-levelling in 1915-17 of a Line from the English Channel to the Bristol Channel. Ordnance Survey Professional Papers. New Series, No. 4, 1917. Price 6*d*.