## FOURIER'S "ANALYTICAL THEORY OF HEAT"

*The Analytical Theory of Heat.* J. Fourier. Translated by A. Freeman. (University Press, Cambridge, 1878.)

THERE cannot be two opinions as to the value and importance of the *Théorie de la Chaleur*. It has been called "an exquisite mathematical poem," not once but many times, independently, by mathematicians of different schools. Many of the very greatest of modern mathematicians regard it, justly, as the key which first opened to them the treasure-house of mathematical physics.

It is still *the* text-book of Heat Conduction, and there seems little present prospect of its being superseded, though it is already more than half a century old. It contains the first satisfactory definition of Conductivity, the first statement of the *dimensions* of various physical quantities, and the invaluable expression for periodic quantities in terms of harmonics. Many important problems of heat conduction are completely solved, and the results are given so as to be immediately applicable in practice, as for instance to the cooling of spheres (including the secular cooling of the earth) the propagation of periodic changes of temperature into the crust of the earth, &c.

But the heat equations are of the same form as those in certain other branches of physics. Here they are solved once for all, and form a store from which all may freely help themselves. Thus, a very minute fragment of the work sufficed, by its application to electric currents, to render the name of Ohm famous. More important portions have been applied to Diffusion, to Signalling through Submarine Cables, and to various other important questions.

With all its transcendent excellences this great work had two faults at first, and of late it had acquired a third.

(1.) It was a little prolix. Like Ampère's great work, and some others of that wonderfully fertile period, it was made up as a sort of patchwork of memoirs sent to the French Institute. Each memoir was, as it were, complete in itself: and the putting together into one work, without judicious paring down, necessarily involved a good deal of repetition.

(2.) It was so full of printers' blunders and mere slips of the pen that it must have been very carelessly revised.

(3.) It had become very scarce, and consequently expensive.

The Syndics of the Pitt Press deserve great credit for reproducing the book:—and the printers have done their share of the work well. Still, the result can hardly be called satisfactory. For this there are many reasons.

(1.) We think it was a great mistake to translate the book into English. The poetry, except so far as it was in the formulæ, is gone; and the prolixity, which was tolerable in the original, is painful in the translation. The text should have been considerably compressed in translation, or else simply reproduced in French. Every one who has any right to read Fourier reads French, or at least ought to be able to do so. Again, though *Conducibilité* and *Conductibilité* are good French, Conductibility (being altogether erroneous) has hitherto been confined to the lowest class of English books. CONDUCIBILITY, which Mr. Freeman most commonly employs, is not an English word at all;[1] and, even if it were, could not possibly mean Conducting power, or Conductivity.

(2.) We have compared at least one whole chapter with our own annotated copy of the original. Roughly speaking, only about 50 per cent. of the misprints in the original have been corrected. The others, some very misleading, are reproduced. The worst of those we have noticed are at

pp. 124 [Eq$^{n}$. (*a*)], 134, 189, 226.

In p. 181 an erroneous reference is reproduced, and in order to make it fit the text the reference mark is shifted from the general equation (really referred to) to a mere particular example.

(3.) The translator has added a few notes, some by the late Leslie Ellis. But they are very fragmentary. Surely more than a single sentence might have been devoted to the experimental results of Forbes [and Ångström]; Stokes and Duhamel ought to have been mentioned with reference to conduction in non-isotropic solids—and Thomson's proof that Fourier's solution of the problem of the cooling sphere is *complete* deserves much more than the mere casual mention it has received.

## OUR BOOK SHELF

*Anthropology.* By Dr. Paul Topinard, with a Preface by Prof. Paul Broca, translated by Dr. R. Bartley. (London: Chapman and Hall, 1878.)

THIS volume forms another of the Library of Contemporary Science, and it purports to elucidate a science which is well described by Paul Broca as being one of vast dimensions and one in process of rapid development, as well as one which has hitherto not received sufficient attention. The masters of the science engaged in original research naturally shrink from the labour of writing a handbook of a popular character: and it fell to Dr. Topinard's lot to make the attempt—in which attempt he seems pretty fairly to have succeeded. This work falls into three sections: the first treats of the physical characters of man, and of his place in nature. The chief human anatomical peculiarities are briefly alluded to, with a somewhat needless—to our mind—reiteration of the assertion that the organisation of anthropoids is a counterpart of that of man, and differs widely from that of the other Simian groups. The second section treats of the races of mankind; and here we have a great many important and interesting facts marshalled in fair order before us. A few more woodcuts would have been an improvement to this portion. In the concluding section the origin of man is discussed; and the author passes in array the monogenestic theory of Quatrefages, the polygenestic theory of L. Agassiz, the transformation theory of Lamarck, and the natural selection theory of Darwin, and works out in detail the application of each to man and his genealogy. The translation, which is generally good, might, however, in places be improved, and it is sometimes a little confused.

[1] On reference to Richardson we find one instance of the use of the word, by (Bishop?) Wilkins. We freely give Mr. Freeman any benefit which he can extract from the following passage:—

"Duties deriving their obligation from their conducibility to the promoting of ends."

It may interest readers of NATURE to be told that, in looking for the word in the Supplement to the *Imperial Dictionary*, we found the following extraordinary statement (illustrated by a diagram) about Conjugate Foci:—"when rays, falling upon a lens, are so refracted as to converge and meet in a point, either nearer the lens than the principal focus, or farther from it, the point in which they meet, and the principal focus, are called, with respect to each other, *Conjugate Foci*."