production of beats in the ear between pure tones depends on the interval:—

(Ellis's "Helmholtz," p. 260.) "On the other hand we have seen that distinctness of beating and the roughness of the combined sounds do not depend solely on the number of beats. For if we could disregard their magnitudes all the following intervals, which by calculation should have 33 beats, would be equally rough:—

"The semitone	b' c''
,, whole tones	c' d' and d' e'
,, minor third	e g
,, major third	c e
,, fourth	G c
,, fifth	C G
(to which we may add the octave	C_1 C).

"and yet we find that the deeper intervals are more and more free from roughness."

Helmholtz then proceeds to give an approximate determination of this important law, for which we must refer to his work. Our own impression is that this law is almost solely concerned in the variation of the roughness of different combinations. We ourselves hear the roughness of beats up to very high numbers, and consider that up to high numbers beats of sensible intensity do not fail to be heard by reason of their number only. If this is the case the rapidity of beats must be of less importance in the theory of consonance than the law of dependance on intervals exhibited in the above quotation from Helmholtz.

To show the practical importance of this:—

(Pole, p. 213.) "Here we find the two fundamental notes themselves ($c' - e'$) beating at the rate of 64 per second. . . . This is, therefore, a less perfect combination than the fifth; but still the beats are quick, and the effect is not disagreeable."

This seems to us incorrect. If the 64 fundamental beats per second were present with any intensity to speak of, the combination would certainly be most dissonant. It is because the ear receives the two notes on different parts of the sensorium, and so gets them out of each other's way, that the beats do not exist in sensible intensity, and do not produce dissonance.

In the appendix on Beats, and an essay there referred to, Dr. Pole has developed doctrines which arise to some extent from the point of view above indicated. The statement made is substantially that the beats described by Robert Smith ("Harmonics," 1749), have a real existence, besides the various types of beats described by Helmholtz.

Smith's cycles are best seen if the sum of two harmonic curves be described by Donkins's harmonograph, or some such machine. Smith's doctrine consists of the statement that the cycles which appear in the resulting curves are the cause of the beats. (Of course Smith did not use pendulum-vibrations, but the use of these adapts the doctrine to our modern knowledge.)

Now in order that these cycles may be seen, it is necessary that one and the same scribing point should describe the sum of the two motions simultaneously. If the motion be analysed and its two components be described separately on the paper, the cycles fail to appear.

This is what must happen in the ear if the doctrines of Helmholtz are even approximately true. The two sounds (if beyond the minor third apart) fall more or less completely on different parts of the sensorium, and the conditions requisite in the first instance for the formation of Smith's cycles are not fulfilled. Whether, if the cycles existed, the beats could arise out of them in the way in which we hear them, is quite a different question, on which we will not now enter.

The great importance of this question has induced us to prolong our remarks on it. On these points every student should consult Helmholtz's work. But on the more purely musical questions Dr. Pole's book has its own value.

OUR BOOK SHELF

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in Owens College, Manchester. Volume II. Metals. Part II. (London: Macmillan and Co., 1879.)

THIS portion of Professors Roscoe and Schorlemmer's work treats of the metals of the iron, chromium, tin, antimony, and gold groups, also of spectrum analysis, the natural arrangement of the elementary bodies, and the condensation of the gases formerly called permanent. The treatment of these subjects is characterised by the same accuracy of description and clearness of explanation and arrangement that were so conspicuously displayed in the former parts, and the illustrations of metallurgical operations, &c., are well chosen and admirably executed, such, indeed, as are not to be found in any other English manual of chemistry. Amongst them may be especially noticed the figures of the plant for Weldon's method of regenerating manganese dioxide from chlorine residues, of the various forms of blast-furnace, of the Bessemer and Siemens-Martin processes for making steel, and of hydraulic gold-mining as practised in California. The best methods of detecting and estimating the several metals are carefully described, and interesting details are given relating to their history, some of which will, we think, be new to many readers.

Spectrum analysis, in which Prof. Roscoe is known to be a high authority, is well treated and illustrated, and attention is drawn to recent speculations, founded on spectroscopic observation, respecting the possible resolution of the bodies now regarded as elementary, into still simpler forms of matter. In the chapter on the Natural Arrangement of the Elements, a clear view is given of the remarkable relations between the properties of the elements and their atomic weights, first pointed out by Mr. Newlands, and further developed by Lothar-Meyer, and Mendelejeff; and the volume concludes with an account of the condensation of the gases formerly regarded as permanent, in which the ingenious forms of apparatus employed for the purpose by MM. Cailletet and Pictet are fully described and illustrated.

Altogether the two volumes of the work now published form a treatise on Inorganic Chemistry of which English science may well be proud; and the student who masters their contents will not fail to acquire a sound elementary knowledge of the subject. H. WATTS

Elementary Mechanics, including Hydrostatics and Pneumatics. By O. J. Lodge, D.Sc. Chambers's Elementary Science Manuals. (Edinburgh, 1879.)

THIS is one of the comparatively sound text-books which, since the publication of Thomson and Tait's work, have been every year more effectually thrusting aside the cumbrously artificial and often erroneous introductions to Physical Science which reigned almost unchallenged till about sixteen years ago. Dr. Lodge knows his subject well, and has evidently bestowed very careful thought upon it. Still we cannot unreservedly commend his book; and this for several reasons. First, he evidently proceeds under the idea that the subject can be made