Letters to the Editor.

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Isotopes of Mercury and Bismuth and the Satellites of their Spectral Lines.

IN their letter (NATURE, March 29) Messrs. Nagaoka, Sugiura, and Mishima give the wave-lengths of a large number of satellites of Hg 2536 and Bi 4722 measured with wonderful accuracy. I think, however, they have not succeeded in proving that the satellites are connected with the isotopes of mercury and bismuth in the way they indicate. The coincidences of the calculated values of $\delta\lambda$ with the differences of the observed wave-lengths may very well be due to chance. Twenty-three lines, as in the case of mercury, have 253 differences distributed over a space of about 300 units (the unit being 0·001 Ångström). The distribution is somewhat denser for the smaller differences. Hence seven numbers considerably smaller than 300 chosen at random should in any case coincide with seven of the observed differences with an accuracy of about half a unit (the smaller numbers with greater, the greater numbers with less accuracy). It is the same in the case of bismuth, only that here the spacing of the differences is not so close. The allowance for the accuracy of the coincidences has to be somewhat larger.

Take the consecutive letters of the name Nagaoka, and write in a row the numbers giving the position of these letters in the alphabet 13, 1, 7, 1, 14, 10, 1 (*i* and *j* being counted as one letter). Then form 7 numbers by joining three consecutive digits 131, 317, 171, 141, 410, 101 (the number 711 is left out as being larger than all the differences). We find the seven numbers coinciding with the following differences of the satellites of Bi 4722.

$\delta\lambda$ Random.	$\delta\lambda$ Observed.	Lines.
101	102	$b - P$
114	114	$d' - f'$
131	{129 {133	$a - b'$ $a' - d'$
141	141	$d - b$
171	174	$b - b'$
317	315 316 317	$d - b'$ $e - a'$ $f - P$
410	408	$d - d'$ $e - c'$

I can as readily believe in a connexion of Prof. Nagaoka's name with the satellites of Bi 4722 as in the stringency of his proof.

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The Theory of Hearing.

PROF. E. W. SCRIPTURE, in his letter to NATURE of April 26, repeats the criticisms of the resonance theory of hearing put forward by him in his letter to the *Lancet* of November 4, 1922. Prof. Scripture is an authority on phonetics, and his work on the analysis of the speech curves of vowel sounds is of great interest. As to whether he has succeeded in confuting Helmholtz's theory of vowel sounds and establishing the older theory of Willis it is not my province to discuss. I am concerned merely with his deduction that the perception of vowel sounds by the human ear is incompatible with the resonance view of the mechanism of the cochlea.

Now no number of recondite theoretical considerations can outweigh the plain experimental fact that the different vowel sounds are readily reproduced by a series of resonators, even such imperfect resonators as the strings of a piano. The method of demonstrating this was described by Helmholtz for sung vowels, and by Ellis for spoken vowels. " If we suppose the dampers of a pianoforte to be raised, and allow any musical tone to impinge powerfully on its sounding board, we bring a set of strings into sympathetic vibration, namely *all* those strings, and *only* those, which correspond with the simple tones contained in a given musical tone " (Helmholtz's " Sensations of Tone," 2nd English Edition, p. 129).

" Raise the dampers of a pianoforte, so that all the strings can vibrate freely, then sing the vowel *a* in *father* loudly to any note of the piano, directing the voice to the sounding board; the sympathetic resonance of the strings distinctly echoes *a*. On singing *oe* in *toe* the same *oe* is echoed. On singing *a* in *fare* this *a* is re-echoed. For *ee* in *see* the echo is not so good " (*ibid.* p. 61). The experiment with spoken vowels is similar, and is described by Ellis (*ibid.* p. 129, Translator's foot-note), who adds, " The experiment is so easy to make, and so fundamental in character, that it should be witnessed by every student."

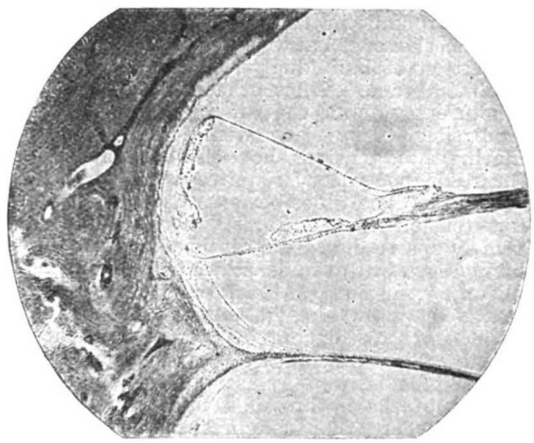

FIG. 1.—Spiral ligament: apical turn of cochlea. ×45.

Prof. Scripture's statement that sounds containing inharmonic partials are incapable of being completely resonated is a new doctrine which cannot be accepted without further proof. If true it would completely dispose of the resonance theory of hearing, as it precludes the possibility of the analysis by resonance of noises, and the cochlea is concerned much more with the analysis of noises than of musical sounds. It is true that a single resonator, such as a single string of a piano, can only completely resonate a compound tone if the fundamental of the string agrees with the fundamental of the tone, and if the partials of the tone all belong to a harmonic series. So far as I am aware, no one but Prof. Scripture has suggested that the same limitation applies to the resonance of sounds by a system of resonators.

I am unable to acquiesce in any of the statements which Prof. Scripture makes regarding the structure