LETTERS TO THE EDITOR.

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Absorption of the Air for Light of Short Wave-lengths.

IN his well-known work on the absorption of the air for light of very short wave-lengths, Schumann has concluded that the opacity is due to oxygen, and that this gas, in thickness of a few millimetres, absorbs *completely* all wave-lengths shorter than about 1800 tenth-metres.

I have recently been investigating the question of gas absorption in this region by means of the vacuum spectroscope which I employed in measuring the lines in the spectrum of hydrogen.

In part my results agree with those of Schumann, for I find that hydrogen, nitrogen, helium, and argon are all quite transparent to very short wave-lengths. In one very important respect, however, I cannot agree with his conclusions, for I find that oxygen is not opaque for *all* wave-lengths below a certain value, but that its absorption is represented by a band with definite limits. With a gas path of nine millimetres and a pressure of one-half an atmosphere, this band extends from 1750 to 1275 tenth-metres.

Though the investigation of the behaviour of oxygen below wave-length 1230 is hindered at present by the opacity of the fluorite windows which enclose the absorption chamber, yet it appears possible that light of even the shortest known wave-lengths may be able to penetrate air paths of more than a centimetre. The application of this result to the behaviour of ether vibrations of extremely high frequency seems important. THEODORE LYMAN.

Jefferson Physical Laboratory, Harvard University, June 21.

The Structure of the Æther.

IN the issue of NATURE of June 13 (p. 150) Dr. C. V. Burton raises an objection, raised elsewhere by Prof. Hicks and Sir Oliver Lodge, to the correlation of the magnetic vector with the velocity of the æther, on the ground that the motion of an observer relative to the æther would alter the relative velocity of the æther, and thus produce a change in the magnetic vector in the direction of the change in the observer's motion.

If it were stated definitely that the magnetic force in the free æther was proportional to the velocity of the æther relative to the observer, the objection would be valid; but this is reading into the scheme of the æther more than can legitimately be done. In the discussion the fact has been apparently overlooked that the correlation of the two vectors extends only to their rates of change in space and time, so that if identified with one another at any one point at any one instant, they will be identical at all points at every instant; otherwise they may differ by any constant, corresponding to a uniform but undetermined constant drift of the æther as a whole, or, what is the same thing, to a uniform unknown velocity of the observer through the æther.

But it should be noticed that it is not permissible to speak of the velocity of an observer relative to the æther, as though the æther were a material medium *given in advance*. Even if it were possible to isolate a fixed frame of reference in such an æther—which appears questionable in an infinite continuum—there is no physical means of determining the velocity of a system relative to it. The æther, as we know it, is defined by its electromagnetic properties, and one property is that a uniform drift of the æther as a whole has no effect on electromagnetic phenomena. It is known that the correlation between a stationary and a moving system as regards the electrodynamic equations is exact, and not only correct to the second order. The objection to Prof. Larmor's scheme of the æther does not apply if that scheme is stated accurately as follows:—"The propagation of electromagnetic effects through space, relative to a given frame of reference, may be illustrated by the propagation of disturbances in a rotationally elastic medium, it being possible *for a given frame of reference* to construct such a medium, in which the rotational displacement at any point is proportional to the electric force at that point, and the velocity relative to the frame of a point of the medium is proportional to the magnetic force." Since the velocity of a point depends on the frame of reference, it follows that the media constructed for two frames of reference moving relatively to one another with constant velocity will not be identical. The æther is, in fact, not a medium with an objective reality, but a mental image which is only unique under certain limitations (*cf.* footnote, p. 334, "Æther and Matter"). Two frames of reference imply two æthers; so long as we restrict ourselves to a single frame, the objection to Larmor's scheme does not arise. E. CUNNINGHAM.

St. John's College, Cambridge, June 28.

Root Action and Bacteria.

I DO not think that there is necessarily any antagonism between the interesting results which Dr. E. J. Russell has for some time past been obtaining and our observations on the behaviour of trees in heated soil. His deal with the growth of plants, ours with the passage of the plant from the dormant to the active condition, a process analogous to that of germination. Nevertheless, it must be freely acknowledged that, until further work on the subject has been done, the view that bacteria are concerned in the matter is a mere suggestion, and Dr. Russell's opinion that the results may be the consequence of chemical changes produced by the heating is somewhat strengthened by the fact that the soil used was poor in lime, containing only about 1 per cent. CaO. There is, however, one strong objection to accepting an explanation based on chemical change, for two of the nine trees, as I mentioned, behaved exceptionally, and showed practically no retardation in starting. These were two which had been planted in earth heated to the highest temperature, 250°, and were two out of three planted in the same batch of heated earth. It seems impossible to explain these two exceptions if the general results are due to chemical change, but they are easily explained if these results are due to bacterial action, for re-inoculation of the soil might readily occur in one case and not in another.

It may be added that, so far, the trees are behaving normally as to their growth, now that they have once started. SPENCER PICKERING.

I HAVE always carefully looked for, but never found, any retardation of germination in our experiments. The young plants all come up at about the same time, and make equal progress for some weeks; then the plants on the heated soil take on a greener colour, become larger in the leaf and thicker in the stem, and ultimately make about 100 per cent. more dry matter than the control plants in unheated soil. There is no doubt, I think, that bacterial action is involved, because the yield is depressed when I inoculate the heated soils either by watering with unsterilised well water or by adding small quantities of unheated soil. A chemical change in the soil compounds must also be involved, because of the increased "availability" of the nitrogen and phosphorus compounds indicated by the analyses quoted in my earlier letter. All non-leguminous plants we have tried so far have shown similar behaviour.

It is, I think, quite possible to explain Mr. Pickering's results on a chemical hypothesis. In certain circumstances—deficiency of lime among others—organic substances which retard germination and growth may be formed in the soil; in other circumstances, *e.g.* admission of air, they are decomposed by soil organisms. If we assume that some of these substances were formed during the heating of Mr. Pickering's soil, and further assume, with him, that in two pots re-inoculation took place, the poisonous bodies would be destroyed and growth would no longer be inhibited. These assumptions are all based on well-known facts; on this view a soil rich in calcium carbonate should behave as our soils have done and cause no retardation.

However, as Mr. Pickering says, more work is wanted before we can get much further. In the meantime, he has established the very important point that growth may be retarded in a heated soil, and the further development of his experiments will be awaited with much interest.

EDWARD J. RUSSELL.