LETTERS TO THE EDITOR.

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The Colour of the Scales of Iridescent Insects in Transmitted Light.

CURIOUS as it may seem, the origin of the brilliant metallic and iridescent colours in birds and insects has never been satisfactorily explained, though it is generally supposed among naturalists and others that they are in some way produced by the interference of light at the surfaces of thin plates, as in the soap-bubble.

Nevertheless, various other explanations have been put forward, and Michelson, with the weight of his great authority, decides unequivocally that they are due to selective reflection at the surface of a very opaque film, as in the case of metals or dry films of aniline dyes. For this conclusion he relies upon the "rigorous optical test of the measurement of the phase-difference and amplitude ratios" when polarised light is reflected. This view has, however, by no means gone unchallenged by Lord Rayleigh, Mallock, and others.

Whatever the truth of the matter may finally prove to be, both those who uphold the theory of selective reflection, and those who uphold the theory of interference, emphasise the fact that the light transmitted through the structures must be complementary to the light which is reflected.

Thus Michelson says: "In the cases which could be investigated for this relation (unfortunately rather few) the transmitted light is complementary to that which is reflected"; and Mallock says: "In cases where the structure is transparent it transmits the complementary colour with nearly the same intensity as the colour reflected." Probably the theory of selective reflection would require the transmitted colours to be more vivid than a theory of "thin plates"; and, as Lord Rayleigh has said, the transmitted colour of the surface layer of beetles' wings (or *E-mailschicht* of Biedermann, which he obtained by maceration in HNO_3 , etc.) "is not nearly so full as it would be if due to anything like an aniline dye."

In spite of what is said by Michelson and Mallock, there are a number of iridescent scales in Lepidoptera, *Hypolimnas bolina*, etc., which, though perfectly transparent, are absolutely colourless. There is the still more anomalous case of the two surface layers of scales of *Morpho achilles*, and other similar species. I should be greatly interested if any of your readers could offer a probable explanation. The appearance of these scales is as follows:—They are perfectly transparent, closely striated, very thin (probably not much more than 0.5μ), and by reflected light they are a bright light blue, which is practically unaltered by the angle of the incident light. *In situ* they show faint diffraction colours due to their striation. But the point to which I wish to direct attention is that, when examined by transmitted light under the microscope, they still have a blue colour, which is, if anything, more saturated than that shown by reflected light. This colour, though not unlike the "optical blue" of the sea and other fine suspensions, cannot be due to a similar cause, since the light transmitted is not red. It is clearly visible with a Zeiss AA objective, but practically invisible with higher powers—DD, etc. Moreover, if the scales are examined with an AA objective, and the condenser racked down, the blue colour will gradually disappear

as the condenser is raised until it becomes invisible with critical illumination. These scales have, as a matter of fact, been mentioned by Biedermann, but he entirely fails to notice their significance.

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3 Selwyn Gardens, Cambridge, March 15.

Matter and Radiation.

THE theory that matter only radiates energy to matter, as suggested by Dr. Shapley and Prof. Soddy in their interesting letters (March 13 and 20), would certainly solve the great problem of solar energy, and is in many ways attractive. But is not the evidence against it very strong? Amongst various arguments that may be advanced against it, let us consider that of the difficulty of reconciling it with the existing surface temperature of the earth.

It is evident that there is an approximate balance between the radiation received by the earth from the sun and that lost, the latter being very slightly larger owing to the heat conducted outwards from the centre. The mean temperature of the earth is about what we would expect on the assumption that it is receiving heat at a known and measured rate from the sun and radiating it uniformly in all directions in accordance with Stefan's law. The fraction of the total solid angle which is subtended by matter is apparently almost infinitesimal, yet the quantity of heat radiated agrees with that deduced from experiments in which the radiating body is entirely surrounded with matter. If we assume that surrounding matter only influences the distribution, and not the total flux of radiation, we are led into all sorts of further difficulties. For example, a large part of the radiation from the dark side of Venus would have to be directed towards the earth, so that the radiation received from Venus should be comparable with that received by Venus from the sun.

Another way of turning the same argument is to consider an isolated solar system. No heat could escape, so it would resemble a system in a perfectly reflecting envelope. Equilibrium would then only be reached when all the members had attained the same temperature. The isolation of the actual solar system in space should certainly be sufficiently close to ensure that its members would attain a temperature approximating to that of the sun.

It is possible that this argument is not new, and that there may be some way of evading it, but, as it appears to be difficult to do so, I think it is worthy of consideration.

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Dublin, March 26.

National Fisheries.

IN NATURE of March 13 is published a paragraph on British fisheries in which the following passage occurs:—"To the trade, fish that is scarce and dear is easier to handle than, and at least as profitable as, fish that is cheap and plentiful. From the point of view of the consumer and of the State, cheap food, a large and prosperous fishing population, and, if possible, some revenue, ought to be the objects of reconstruction of the industries concerned."

The note suggests an antithesis which has no foundation in fact. The fishing industry—producers, research workers, and the "trade"—bases the claim for reconstruction, which this association has voiced, on the fact that it desires to supply the nation with cheap fish. But cheap fish can be supplied only when plentiful catches and regular catches are assured, and to ensure regularity—that is the real crux—without