higher-pitched tone masks a lower one, suggests that the explanation is to be sought in the hydrodynamics of the cochlea. It may be that the larger and slower oscillations of the cochlear fluids associated with vibrations of the basilar membrane in the apical region damp out heterorhythmic vibrations on the proximal side of the membrane over which they pass, and so suppress the higher-pitched tones. It would not follow that the harmonics, which are intermittently homorhythmic, would also be suppressed.

Mr. Wegel finds that subjective harmonics are developed in the case of pure tones of medium intensity. These subjective harmonics apparently do not affect the character of the tone heard. This would suggest that their intensity is not great relatively to that of the fundamental. The ear readily distinguishes between a pure thin tone and a rich full tone in which a number of harmonics are present. If all the "pure" tones we hear contain a whole series of overtones, what distinguishes them from the "rich" tones? That such an extensive "pattern deformation" as is represented in Fig. 1 (NATURE, September 12, p. 393) is generated by each tone which acts on the cochlea is difficult to reconcile with the extraordinary power the ear has of analysing compound musical tones, and even more with its power of instantaneously analysing, and recognising the source of, characteristic noises. This would necessitate an integration of nerve impulses within the auditory tract of almost inconceivable complexity.

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Physics and Metaphysics.

IT is no doubt a splendid simplification to express the ninety or more chemical elements in terms of two entities, and of only two, namely, electrons and protons, but those who face squarely the problems of physics find it a large leap to follow Mr. Bertrand Russell in "What I Believe," when he states (p. 10): "Physical Science is thus approaching the stage when it will be complete, and therefore uninteresting. Given the laws governing the motions of electrons and protons, the rest is merely geography. . . ."

Those familiar with the life and writings of the late Lord Rayleigh will have come to a directly opposite conclusion, namely, this, that the region to be discovered expands continually with discovery.

The assignment to the world of a wound-up system, like a watch, consisting of protons and electrons, ignores in the first place the problem of radiation, about which we have at present two theories utterly incompatible with one another in the minds of even the finest living intellects.

The further question whether life can be interpreted, for it cannot possibly be explained, by the laws of physics alone is a wide and doubtful issue, on which the best informed are the least emphatic. It is unlikely that any great progress will be accomplished in terms of physics as known or imagined to-day.

Sufficient warning may be found in Kelvin's estimate of the age of the earth, where the logic and mathematics were faultless, so that the conclusions appeared inevitable, until a wholly new branch of physics arose, and radioactivity enabled us to realise that the initial concepts of the problem were founded on insufficient data.

Later in Mr. Russell's book (p. 22) we arrive, however, at the refreshing statements that "the philosophy of nature is one thing and the philosophy of value is another"; and again, "It is we who create value"; and yet again, "In this realm we are kings."

Values cannot be appraised in foot-pounds or calories, nor be cribbed and confined to electrons and protons. Shakespeare and Newton were sustained by food calories as other men are. The foot-pounds or ergs of work expended on "Hamlet" or the "Principia" are comparable in magnitude with those used in the efforts of an ordinary writer or worker. But how can we estimate or express the profound differences in the resulting values! These values are not material, nor can they be reduced to electrons, radiation or æther as understood or imagined by most physicists of to-day.

Another scientific heresy, not imputed to Mr. Russell, but common enough to-day, is the avowal that electrons and protons were "created" in the past, that certain "laws" were imposed upon them, and that the universe has since then been a going concern, running itself from these initial impulses alone. The idea that something created at one instant *must* continue to exist at another instant or for a period of time may be eliminated as a crude conception. The continuation of existence is as difficult to explain as is the initial existence itself.

The only solution that may be offered (and yet it is obviously no solution to us) is that time is the great illusion. We are permitted to see the moving picture film of existence unroll, but the record is, was, and will be always there. Most marvellous of all, we are allowed to take part in the production ourselves, or at least to enjoy the illusion of an active participation therein.

Statements of this kind, passing from the region of physics to metaphysics, are naturally open to more condign criticism than those to which this letter ventures to direct attention.

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September 12.

The Worth of Knowledge.

THE comments on the functions of the British Association, in the article in NATURE of September 12 on "The Worth of Knowledge," raise a consideration that should command the attention of the scientific world, whether interested in the Association or not.

We are justly proud of our science and our scientists. We can point to the departments of science, in our universities and schools, as flourishing institutions, and yet doubt whether they are fulfilling their function to the widest and best extent. Our teachers of chemistry, physics, botany, geology, and all the other branches of science, are men whose names command a world-wide respect. Further, we can agree that the time has passed when any man could include in his survey of life a complete and detailed knowledge of science as a whole. The chemist is to be congratulated if he knows all there is to be known of the chemistry of one small group of substances, and similar conditions hold for other fields of science.

Yet, with equal truth, it may be claimed that science is more than a set of separate departments of natural knowledge; and the claim that the future of humanity rests on a scientific basis can scarcely be denied. This truth and claim are to-day fairly well recognised by a wide public, which is doing its best to get as close acquaintance with scientific work as its non-technical education will permit. As Bateson wrote before the War, "I think it needs little observation of the newer civilisations to foresee that they will apply every scrap of scientific knowledge which can help, or seem to help them in their struggle, and I am good enough Selectionist to know that in that day the fate of the recalcitrant communities is sealed." True in those days, it is urgent and equally true now.