should be read, a multiplied by b , the symbol $a.b$ or ab should mean a multiplied into b , so that $a \times b$ and $b.a$ or ab are identical. Perhaps a compromise might be effected on this basis in the notation of quaternion multiplication.

The "unnamed French mathematician" who is quoted in the notice in question as asserting that quaternions have no sense in them, is stated by M. Laisant to have been M. Prouhet, and to have expressed this opinion in the *Nouvelles Annales de Mathématique* (1863, p. 333), in reviewing the first work published in French on quaternions, the author of which was M. Allégret.

W. STEADMAN ALDIS.

Auckland, New Zealand, February 20.

Mr. Crookes and the Transformation of Heat-Radiations into Matter.

PROF. CLIFFORD, in the *Fortnightly Review*, June 1875, wrote as follows:—"But if the ether did absorb light, what would this mean? Vibratory motion of solids, which is really a molecular disturbance, is absorbed by being transformed into other kinds of molecular motion, and so may finally be transformed to the ether. There is no reason why the vibratory motion of the ether should not be transformed into other kinds of ethereal motion; in fact, there is no reason why it should not go to the making of atoms" ("Lectures and Essays," by W. K. Clifford, vol. i. p. 246).

Mr. Crookes, in his Presidential Address to the Chemical Society, March 28, brought forward a somewhat similar hypothesis, for he says:—"If we may hazard any conjecture as to the source of energy embodied in a chemical atom, we may, I think, premise that the heat-radiations, propagated outwards through the ether from the ponderable matter of the universe, by some process of Nature not yet known to us, are transformed at the confines of the universe into the primary—the essential—motions of chemical atoms, which, the instant they are formed, gravitate inwards, and thus restore to the universe the energy which otherwise would be lost to it through radiant heat."

The hypotheses will be seen to be exactly alike, except for the speculation introduced by Mr. Crookes of the transformation taking place "at the confines of the universe." What do we know of the confines of the universe? Nothing. Are we now to begin building up hypotheses on such foundations—foundations concerning which we know nothing, and are not likely to know anything for some time?

HUGH GORDON.

Royal Institution, March 31.

Green Colouring-matter of Decaying Wood.

MR. IRVING writes (p. 511): "After an examination of thin sections" of the decaying wood "with the microscope, I am unable to trace this to any saprophytic organism."

I have at the present time a cocculus, I suppose, growing on the surface of nutrient gelatin, which is stained a beautiful green, highly fluorescent, by the colouring-matter absorbed by it from the micro-organisms. The cultivation is in a test-tube of nutrient gelatin inoculated by scratching the surface of the gelatin with a needle which had been rubbed on a colony, isolated by plate-cultivation, and obtained from a bad water.

The growth, a greenish-white, is entirely on the surface—so entirely that the scratches made in inoculating the gelatin are still visible, three weeks after the inoculation, and the gelatin is perfectly transparent.

Under these circumstances it is quite certain if I made sections of the green gelatin no micro-organisms would be found in them.

It may be that the decaying wood is stained in the same way by colouring-matter absorbed by the sap or the moisture of the wood by micro-organisms growing on its surface.

It is a fact, I believe, that the colouring-matter formed by chromo-genic micro-organisms does not reside in their structures but in the interspaces between them, so it would naturally be absorbed by any solvent they were in contact with, while the organisms themselves might remain entirely on the surface, as they do in the case of my gelatin.

This may explain why Mr. Irving has failed to find micro-organisms in the sections he made. Further, if the colour of his green wood is caused by the same micro-organism which stains my gelatin green, it is a very small one, so small that, with a 1/15-inch oil-immersion object-glass, and a No. 12 compensat-

ing eye-piece of Zeiss, I find it very difficult to decide what shape it is, but I think it is not spherical.

I think Mr. Irving will find references to the literature of chromo-genic micro-organisms in Crookshank's "Manual of Bacteriology."

HENRY ROBINSON.

The University Chemical Laboratory, Cambridge.

Comet α 1888 (Sawerthal).

I SAW comet Sawerthal to-day at 3.40 a.m., with power 20 on a 4½-inch refractor. It was about 50' immediately below θ Pegasi, and had a bright broad tail, which I could only distinguish to a length of 65', on account of the twilight, moon-light, and the comet's low altitude. I thought the tail was slightly curved, concave to south; it pointed on the average to a little above ν Pegasi, or at a position-angle of about 260°. The total light of the head was considerably fainter than θ Pegasi, and considerably brighter than ν , so that it would be from 4 to 4½ mag.; but owing to the unfavourable conditions I could not see it with the naked eye.

T. W. BACKHOUSE.

Sunderland, April 3.

THE HITTITES, WITH SPECIAL REFERENCE TO VERY RECENT DISCOVERIES.¹

II.

THE monuments at Boghaz-Keui and Eyuk are on the east of the River Halys; and it seems doubtful whether there is evidence that the country inhabited by the Hittites extended much, if at all, beyond a line drawn from Sinope on the Euxine to the most westerly bend of the Halys, and continued through the peninsula to the Mediterranean. No doubt sculptures with Hittite characteristics have been found further to the west, as at Giaour-kalessi, in Phrygia, and at Karabel, near to Smyrna and to the coast of the $\mathcal{A}$ gean; but as yet it does not appear certain that these sculptures denote permanent occupation, or that they are more than monuments of successful military expeditions. The Euphrates may be taken as marking vaguely the eastern boundary of the Hittite land. To the south, in Syria, the Hittite country certainly extended as far as Kadesh, a site on or near the present Lake of Homs.

It is with the inscriptions and the engraved seals found in, or connected with, the district I have indicated that Hittite researches are mainly concerned. The few characters on the monument at Karabel are too far obliterated to be, for the present, of much importance. In 1842, Burckhardt visited Hamah, the ancient Hamath, in Syria. He saw in the corner of a house in the bazaar "a stone with a number of small figures and signs, which appear to be a kind of hieroglyphical writing, though it does not resemble that of Egypt" ("Travels in Syria," Lond., 1822, p. 147). But, as Dr. Wright remarks, "so little interest was taken in his discovery, even by professional explorers, that Porter, in Murray's 'Hand-book,' so late as 1868, declares 'there are no antiquities in Hamah'" ("Empire of the Hittites," 2nd ed., p. 1). There were, however, other inscriptions at Hamah besides that noticed by Burckhardt, and the stone bearing one of these was supposed to possess mysterious properties, efficacious for the cure of spinal disease, so that "deformed persons were willing to pay for the privilege of lying upon it, in the hope of a speedy cure" (Burton and Drake, "Unexplored Syria"). After sixty years, or nearly so, from the time of Burckhardt's discovery, attention was called to the Hamath inscriptions, first by Mr. J. A. Johnson, United States Consul at Beyrout, and subsequently (1872) by Capt. R. F. Burton and the late C. F. Tyrwhitt Drake, in the work just quoted. In 1872, however, Dr. Wright was successful in obtaining casts of the Hamath inscriptions, while the originals were trans-

¹ Based on Lectures delivered by Mr. Thomas Tyler at the British Museum in January 1888. Continued from p. 514.