and in assuming the metaphysical or introspective type to be the only one worthy of consideration. In the phrase 'devotees of science' there is a gleam of true meaning, for in its social quality, its instinctiveness, science is akin to religion. One might term science an intellectual religion and not go wide of the mark. While it may be argued that philosophy in the traditional sense does not sanction progress, it cannot be argued that science withholds either sanction or its encouragement. Science is social thought reflected back into the mind of individuals; metaphysics is individual thought radiated outward upon society. The sanction for social progress is therefore derived rather from society as a whole than from individual introspection. For this reason the intellectual sanction is all the more forceful and takes its place beside the moral sanction offered by religion. There need then be no fear that progress is intrinsically irrational, and there may be a science of religion, as there is a religion of science. It is the function of the scientific method to organize for victorious contest the battalions of the intellect, while religion may bring on the moral forces. Therefore it appears that progress is an open-minded movement onward, of which we are all a part, and to which reason, under the sway of the scientific method, gives sanction no less than does emotion.

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THE LIQUEFACTION OF GASES.—A CONTROVERSY.

The scientific world has been treated during the last few weeks to one of those happily to-day rather infrequent controversies which are always unseemly, the more so when the parties are men of eminent scientific reputation. Polemics in science may sometimes be entertaining, but are always unprofitable and tend to bring discredit upon the participants, if not on their work. The recent discussion* on the subject of liquefaction of gases is no exception to the rule.

Prof. Dewar, in defending his failure to give Prof. Olszewski due credit, has made what might have been looked on as a pardonable omission appear almost as intentional deceit. In taking up the cudgels in Prof. Olszewski's defense, Professor Muir has seemed to make an unjust and almost spiteful attack upon Professor Dewar; while Professor Olszewski, whose work was already too well and favorably known to need any defense, has added nothing to his reputation; indeed, he has rather laid himself open to the charge he prefers against Professor Dewar, inasmuch as in his article in the Engineering and Mining Journal he makes but slighting reference to the work of Pictet and Cailletet, and the name of Wróblewski is but once, and that incidentally, mentioned. The following is a summary of the more important work of these investigators in this field:

In 1877 two independent experimenters almost simultaneously succeeded in condensing to liquids the so-called permanent gases. Cailletet, the French ironmaster at Chantillon-sur-Seine, used a hydraulic press, and obtained the necessary lowering of temperature by suddenly diminishing the pressure on the compressed gas. A mist appears in the glass tube containing the gas, and, except in the case of hydrogen, condenses to small drops. Pictet, at Geneva, used the pressure occasioned by the generation of the gas in wrought iron cylinders, and cooled his steel condensing tube with liquid carbon dioxid. In experimenting with hydrogen, Pictet obtained an opaque steel blue liquid, which appeared to solidify

*On the Liquefaction of Gases. Charles Olszewski, James Dewar, M. M. Pattison Muir, *Nature*, Jan. 10, 1895, and following numbers. Letters to the Editor. Also in *The Philosophical Magazine.*

on striking the ground. Later researches of Olszewski and Krzyzanowski have shown that this liquid could not have been hydrogen, and that the gas obtained, as Pictet's was, from potassium formate and caustic potash is by no means pure hydrogen. To Cailletet and Pictet belongs the credit of being the pioneers in this field, and to them in 1878 was awarded the Davy medal of the Royal Society.

A few years later (1883) the work was taken up by Wróblewski and Olszewski at the University of Cracow, and after the death of the former in 1886 was carried on by Olszewski alone, and more recently by Olszewski and Witkowski. The apparatus used was derived from that of Cailletet, the production of cold being by the boiling of liquid ethylene in a vacuum.

The aim of Olszewski's researches has been the exact investigation of the properties and conditions of matter at low temperatures. Many physical constants of the so-called permanent gases have been determined, and especially the optical properties of liquid oxygen have been thoroughly studied. More recently Olszewski was entrusted by Lord Rayleigh and Professor Ramsay with the liquefaction of Argon, and the results of this investigation have been widely published. His latest work is the determination of the critical temperature (—233°) and the boiling point (—243°) of hydrogen, the last gas which still resists condensation to a static liquid.

Professor Dewar, in his position at the Royal Institution of Great Britain, has been looked upon, perhaps, rather as a public lecturer and brilliant experimenter than as an exact investigator. In 1884 he delivered an address at the Royal Institution on the work of Wróblewski and Olszewski, during which oxygen and air were liquefied for the first time in public. He later so improved the apparatus, which was founded on the principles used by Cailletet and by Olszewski, that he could obtain with safety and without great difficulty very considerable quantities ('several pints') of liquid oxygen or air, and his public experiments with this liquid are famous. By the use of liquid air he has studied the electrical resistance of metals and alloys at low temperatures, extending greatly the work of Clausius, Cailletet and Bouty, and Wróblewski in this direction, and has undertaken work on the tension of metals at low temperatures. As far as these latter experiments have been carried, they seem to show that the breaking stress of metals increases decidedly at low temperatures (—182°) and hence that there is no decrease of molecular attraction as absolute zero is approached, although the most powerful chemical affinities are in abeyance, as Professor Dewar has shown. He was also the discoverer of the magnetic properties of liquid oxygen.

In his earlier work Professor Dewar certainly did not fail to give Professor Olszewski due and full credit. Of late years he has failed to often refer to him, and the charge that he has sometimes apparently claimed as his own that which he should have attributed to the Polish professor is, perhaps, not wholly unfounded; yet the claim of the latter for priority was so well understood by scientific men that his attack on Professor Dewar was at least unnecessary. That the Englishman, possibly somewhat rankled that his countrymen should have called on a foreigner to assist in their study of Argon, was led to make a spirited rejoinder, to pose as more of an independent investigator than the facts warrant, and to depreciate the work of his opponent, is perhaps not to be wondered at, but certainly not to be excused. Altogether the discussion is profitless and unfortunate.

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