be, so far as possible, free from errors arising from unknown changes in liquid-air areas and from the unknown solid-air and solid-liquid tensions. It will be seen that the capillary-rise method in reality does this, though there is difficulty in measuring the internal bore and keeping it clean. But the following arrangement seems to be as nearly as possible free from these objections, and to be adapted to measure the tensions of interfacial liquid surfaces as well.

The liquid (mercury excepted) is made to drop from a fine capillary tube having thin walls as in Fig. 1. In forming the drop, it spreads upward over the exterior surface and reaches a limiting size, shape, and position. It then slips down the tube at a uniform velocity with little modification in size or shape, and after suffering a slight check in its motion breaks its connexion and falls. We may then equate the whole tension about the tube with the weight of the drop, so that $T_{ia} \times \pi d_e = W_L$ or $T_{ia} = W_L / \pi d_e$, where T_{ia} is the liquid-air tension and d_e is the external diameter of the tube.

The same drop formation occurs when the tube is arranged to drop water downwards in any lighter oil, or by a bent tube (Fig. 2) upwards in a heavier oil. In this case we have the equation $T_{wo} = \frac{W_w}{\pi d_i} \times \frac{\rho_w \sim \rho_o}{\rho_w}$, where the suffixes w , o , e , and i denote the words water, oil, external, and internal, and ρ is density, from which the tension of the water-oil surface may be calculated.

On the contrary, when oil is dropped either downwards or upwards in water, it does not spread on any exterior water-glass surface, but forms its attachment as in Fig. 3. In this case we have $T_{wo} = \frac{W_o}{\pi d_i} \times \frac{\rho_w \sim \rho_o}{\rho_o}$.

These all give results agreeing with those recorded in the standard tables.

In accordance, then, with this conception of an elemental force not included in the class of "attractive" forces, we should expect that these changes in area would be always attended by a rise in temperature. If it be asked why the enveloping area about a free molecular mass tends to decrease, there is no answer; and neither is there an answer to the question as to why a large mass tends to approach another.

WILSON TAYLOR.

Physics Laboratory,
University of Toronto, Canada, July 15.

The Influence of Science.

THE seeming contradiction in my summary account of the case of Galileo (NATURE, August 5, p. 180), to which Sir Oliver Lodge directs attention in his letter (NATURE, August 26, p. 277), needs an explanation. The great work of Copernicus (1543) was dedicated to a Pope, Paul III.; none of the Roman Congregations found any objection to it, and (Whewell, "History of the Inductive Sciences," I. 418, ed. 1847), says "lectures in support of the heliocentric doctrine were delivered in the ecclesiastical colleges." This was because of its being taught as a purely scientific doctrine.

Sir Oliver writes that Galileo "had endeavoured to get the Church to realise that the doctrine was not really antagonistic to Scripture when reasonably interpreted." This statement needs qualifying. Had Galileo contented himself with teaching the Copernican doctrine as a scientific hypothesis, he would not have been molested. But, being a fierce controversialist, he wanted to confound his many adversaries, the mathematicians, and the Aristotelians, by showing that Scripture was on his side (cp. Sir David Brewster, "Martyrs of Science," p. 58). Hence,

disregarding the advice of the Bishop of Fermo "not to raise the question," and that, too, of many other ecclesiastical friends, among them Cardinals and Prelates, to the same effect, he demanded that "the Pope and the Holy Office should declare the Copernican system to be founded on the Bible." *Hinc illae lacrymae.* On the other hand, the attitude of the Churchmen is well illustrated in a letter from Cardinal Bellarmine to the Carmelite friar, Foscarini, one of Galileo's friends, dated April 12, 1615. He writes: "If a true demonstration should be found that the Sun is placed at the centre of the world, and the Earth in the third heaven, and that the Sun does not turn round the Earth, but the latter round the former, then it will be necessary to proceed with great prudence in the explanation of Scripture, which seems to say the contrary, and rather to avow that we have not understood it, than to declare a demonstrated fact false." Astronomers had to wait until the discovery of aberration by Bradley before such a true demonstration was found.

Sir Oliver also writes that "Galileo was made to recant, to abjure, and curse the theory of the earth's motion." Whewell tells us (*loc. cit.*, p. 419), "He (Galileo) was accused before the Inquisition in 1615, but at that period the result was that he was merely recommended to confine himself to his mathematical reasonings upon the system, and to abstain from meddling with Scripture." After his contempt of court, in the second trial, of the year 1632, he was condemned as "vehemently suspected of heresy." He was sent to Arcetri, and had to recite a penance of certain prayers.

There was no implication in my former letter, as Sir Oliver writes, "that there was really no punishment, and that there was no call for anxiety and distress." The implication was that his troubles were largely, if not entirely, of his own seeking, and that his treatment was, according to the quotations I gave from Whewell, and from De Morgan, comparatively mild. I purposely quoted from non-Catholic writers, as they cannot be suspected of partiality towards the Roman Congregations. To these I add the testimony of Sir David Brewster (*loc. cit.*, p. 88): "During the whole of the trial Galileo was treated with the most marked indulgence." Sir Oliver Lodge's quarrel is, therefore, with such eminent scientific men as Whewell, De Morgan, and Brewster (see also *op. cit.*, p. 77), to whom we may add Huxley, who ("Life and Letters," ii. 424) avowed that "the Pope and the Cardinals had rather the best of it."

But my chief implication was, and is, that the case of Galileo cannot fairly be considered as evidence of the hostility of the Church to natural science, and as a hindrance to her legitimate influence. Finally, I trust Sir Oliver Lodge will not think me discourteous in not treating of the other points raised in his letter, as I do not consider them to be relevant to the present discussion.

A. L. CORTIE, S.J.

Stonyhurst College Observatory,
August 31.

The Production of a Standard Source of Sound.

I HAVE recently had occasion to consider the problem of constructing a simple standard source of sound, and have been favourably impressed by the possibility of employing a "hot wire" grid—as used in the Tucker microphone (Phil. Trans. A, vol. 221, pp. 389-430)—for this purpose. In this microphone the grid is made of fine platinum wire and heated by a current of 20-30 milliamperes. It is mounted in the orifice of a Helmholtz resonator, and when the latter is stimulated by a sound of suitable pitch, the vibration of the air in the orifice causes an increase

in the average rate of loss of heat by convection, and consequently there is a fall in the temperature, and hence in the resistance, of the grid. The fall in resistance can be measured by a Wheatstone bridge method. The way in which it is suggested that this process may be utilised in the construction of a standard source of sound is as follows. The source is made in the form of a cylindrical Helmholtz resonator—say from brass tubing about 2 in. diameter. At one end is fitted a telephone in such a way that the diaphragm forms part of the inner wall of the resonator, while at the other end is the orifice carrying the hot-wire grid. If the telephone diaphragm is made to vibrate by current from a thermionic valve oscillator, and the frequency of the current is adjusted until it is equal or nearly equal to that of the resonator, a pure tone of moderate intensity issues from the orifice. At the same time the hot-wire grid suffers a change of resistance which provides a measure of the amplitude of the vibration in the orifice, and hence of the *strength* of the source. With a standard pattern grid and holder the change in resistance is about 12 ohms when a sound of pitch 200 vibrations/sec. is produced, which is loud enough to be just audible at a distance of 10 feet—the source being placed on the ground in the open. The strength of the source can be varied at will by using a variable series resistance or a shunt with the telephone. The use of resonance serves to purify the note which comes from the telephone, but it is desirable in addition that the oscillator should be of such a type that the telephone note is already fairly pure. The use of a very impure note may lead to poor results, as the resistance change will then depend only partly on the amplitude of the fundamental.

It may be noted that a simple method is known of obtaining the relation between the change in resistance of a grid and the amplitude and frequency of the vibration producing it—the motion being simple harmonic. Hence, if the frequency of the vibration is known, the strength of the source (defined as the rate at which fluid is introduced or abstracted at the source) can be found in absolute measure. The amplitude of the waves—or, if preferred, the flux of energy—in the surrounding medium can then be calculated in certain cases. A simple case is when the source is close to a rigid plane.

Any other means of producing a suitable sound can be used in place of the telephone diaphragm provided it is small enough to go inside a resonator. If the damping factor of the resonator has been determined experimentally, the acoustical output of the primary source inside the resonator can be calculated from the indications of the hot-wire grid in the orifice. The output of the internal source includes (1) the radiation of acoustical energy from the orifice, which has been dealt with above, and (2) work done against viscous forces in the orifice. Unless the orifice is large, (2) is far the more important part, and the radiation losses may be negligible by comparison.

E. T. PARIS.

Signals Experimental Establishment,
Woolwich, S.E.18, Sept. 2.

Occurrence of the Rare Whale, *Mesoplodon Layardi*, on the Tasmanian Coast.

SOME years ago, on July 30, 1918, my friend Mr. G. H. Smith of Leprena, Southern Tasmania, brought me word that a beaked whale, "without teeth," had been cast up on the beach at Recherche Bay near his property, that he had already removed the blubber, and that the carcass still remained on

the shore. Being occupied at the time with university teaching I was unable to visit Recherche Bay till some weeks later. High seas were then running, and the remains had been lifted by these and thrown farther up on the basaltic boulders which strew the beach at this spot. This resulted in some considerable damage to the skeleton. Nearly all the ribs were broken, some into three or four pieces, and many of the neural spines had been smashed from the vertebrae. The skull was also damaged, although some of the flesh and integument was still adhering.

The body was naturally in a somewhat decayed and pulpy condition, but with Mr. Smith's help I was able to save the remains and so obtain the skeleton. This is almost complete and is now in my Department.

My friend was good enough to hand me some measurements and notes which he had made and these I reproduce. The animal "was a female whale. The total length was about 18 ft.; its jaws were 2 ft. 6 in. long, about 4 in. in diameter at the end, no teeth above the gums. Fins 2 ft. long, 8 in. wide, and tapered, not round like the black whale type. Its flukes were about 4 ft. wide; it had the appearance of a fast fish as it was rather thin in the body. There was a small fin on its hump, about a foot high, with a decided rake towards the tail. The colour the same as the sperm whale, dark grey and light underneath." Mr. Smith further states that the blubber yielded 50 gallons of oil of the finest quality, and that he believes that the animal was driven ashore by "killers," of which there were a number in the bay at the time. There were, however, no marks of injury on the body.

The matter of recording this specimen seems called for, particularly in view of the description by Mr. E. R. Waite, director of the South Australian Museum (Rec. S. Aus. Mus., vol. ii., No. 2), of the discovery, on the South Australian coast, of an immature male of this species of *Mesoplodon*. The Tasmanian specimen was a female and mature, as is witnessed by the condition of the skeleton and by the fact that the pulp cavity of the tooth is entirely closed below.

The form of the tooth corresponds exactly with that figured by Gray for his *Callidon guntheri* (Ann. Mag. Nat. Hist., 1871), which, as Flower and Turner suggested, was a female of the present species. It seems now that we must conclude from Waite's description that the mature condition of the tooth in the female represents a stage which is early passed through in the male.

No pelvic bones were discovered, nor was there any trace of the denticles found in the integument of the jaws of other species. The oil has a density of 0.88 at 12.5° C. This whale has now been recorded from the coast of every Australian State except Victoria and West Australia.

T. THOMSON FLYNN.

University of Tasmania, Hobart, July 20.

Atoms and Electrons.

ON the basis of any theory of atomic structure which classifies the elements according to rare gas type, cerium and thorium should be comparable with one another, since the atoms of each are possessed of four electrons more than those of the corresponding inert gases, xenon and niton respectively. There are, however, in the thorium atom, thirty-two more extra-nuclear electrons than in the cerium atom. In spite of this fact, it appears that the *distances between atomic centres in crystals of these elements are practically the same* (Ce = 3.62 A.U. and Th = 3.56 A.U., according to Hull), the distance being, if anything, slightly the