present. The "Studies from the Biological Laboratory" of the Johns Hopkins University for June, contains original matter relating to the pulse wave in the coronary artery, the influence of digitaline on the heart, polar action in nerves, temperature and reflex actions, &c. A reprinted memoir by Staff-Commander Tizzard, R.N., and Mr. John Murray, on "Exploration of the Faroe Channel during the Summer of 1880 in Her Majesty's hired Ship *Knight Errant*," with various subsidiary reports, has also reached us, and we hope soon to refer to its contents.

"THE Photographic Studios of Europe," by Mr. H. Baden Pritchard (London: Piper and Carter) gives copious information that the professional photographer will appreciate and find helpful, but has also much to interest the general reader. It is the outcome of a house-to-house visitation of the principal studios in Europe, and a record, in colloquial style, of the practice observed. For convenient reference the information is tabulated in the introductory chapter, under nine headings (the reception-room, the studio, the dark room, &c.), and the names of the photographers follow, in each case, with the page-numbers. Among matter of a special nature we note accounts of photographing prisoners at Millbank and Pentonville, and at the Prefecture of Police in Paris; also a popular account of Dr. Huggins' photographs of the Stars.

SIGNOR MAUDELIN affirms that the violets *V. syrtica*, *V. tricolor*, and *V. arvensis* contain from 0·083 to 0·144 per cent. of salicylic acid. The other species contain none; at least no appreciable quantity. The wild violet has much more than the tricolor. It is the action of salicylic acid that explains the use of the violet in pharmacy.

MR. W. B. COOPER has lately brought before the Franklin Institute a device for increasing the dynamic effect of the vibrations of diaphragms. To one end of a wire or band he attaches a diaphragm or other pulsating body; the wire is passed a half turn or several turns round a drum or pulley, which is rotated towards the diaphragm. To the other end may be attached a lever having a point adapted to indentation of sheet metal passed under it at uniform speed. With such an arrangement (called a "phonodynamograph") Mr. Cooper has embossed brass of the thickness of writing paper by impact of the voice on a diaphragm like that of the phonograph. (The force of the pull is augmented by force derived from friction on the surface of the pulley). The principle is applicable to the telephone, both for increasing the intensity of the electric impulses transmitted, and augmenting their effects at the receiving station, and Mr. Cooper shows how this may be advantageously done.

THE northernmost place in the world where rye and oats mature is at Kengis, in the Swedish province of Norrbotten, 49 miles to north of the Polar Circle, whereas the northernmost spot where corn is grown is at Muoniovara, 98 miles to north of the Circle. The rye yields, it is stated, 98 per cent., and the oats about 90.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Mrs. Cumberleye; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mr. W. K. Stanley; four Egyptian Ouarans (*Psammosaurus scincus*) from Egypt, a Horseshoe Snake (*Zamenis hippocrepis*), eleven —— Snakes (*Zamenis ventrimaculatus*), an Ocellated Sand Skink (*Seps ocellatus*), South European, presented by Messrs. Wylde Beyts and Co.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a Spotted Bower Bird (*Chlamydodera maculata*) from South Australia, a White-billed Parrakeet (*Tanygnathus albirostris*) from Celebes, a Yellow-billed Sheathbill (*Chionis alba*), captured at sea, off Cape Horn; a Shag (*Phalacrocorax cristatus*), North European, a Cornish Chough (*Fregilus graculus*), British, four Eyed Lizards (*Lacerta ocellata*), South European, purchased; a Humboldt's Lagothrix (*Lagothrix Humboldti*) from Upper Amazon, received in exchange; five Undulated Grass Parrakeets (*Melopsittacus undulatus*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens. The following insects have emerged during the past week in the Insect House:—Silk Moths: *Telea promethea;* Butterflies: *Vanessa antiopa*, *Vanessa polychlorus*, *Vanessa io*, *Melanagria galathea*, *Gonoepteryx rhamni*, *Thecla betulæ*, *Erebia blandina*, *Hipparchia janira;* Moths: *Deilephila euphorbiæ*, *Bombyx castrensis*, *Liparis monacha*, *Liparis dispar*, *Chelonia caja*.

OUR ASTRONOMICAL COLUMN

CONTINENTAL OBSERVATORIES.—The last number of the *Vierteljahrsschrift der Astronomischen Gesellschaft* contains reports of the proceedings of some twenty of the observatories on the continent during the year 1881. At Berlin observations for the zone + 20° to 25°, were actively continued, upwards of 10,000 being made in the year. The 9-inch refractor was employed for comets and small planets, &c., the physical appearances of the comet 1881 III. receiving special attention. With the Declinograph 1200 small stars were observed, making, up to the end of 1881, 12,329 stars, mostly from the eleventh to the thirteenth magnitudes, thus determined, in connection with the identification and observation of the small planets. At Bonn the southern "Durchmusterung" furnished observations of upwards of 14,000 stars, so that rapid progress is being made with this work under the direction of Prof. Schönfeld. At Brussels astronomical physics, as well as meridian observations, have been attended to; the meteors of the August period were extensively observed over Belgium; Christiania was mainly occupied, under Dr. Fearnley, with the zone 65° – 70°, and the curious circumstance of the existence of four variable stars in this zone within a radius of 1° is recorded, the first in 20h. 59m. 20s. + 66° 8′·5, has been estimated by various observers from 5m. (Lalande) to 9m. (Argelander), the second is in 20h. 59m. 48s. + 67° 35′·9, the third in 21h. 7m. 33m. + 67° 54′·4, and the fourth in 21h. 11m. 49s. + 66° 0′·9, for 1855·0. Baron v. Engelhardt, at Dresden, has zealously observed the various comets of the year, and has made 111 observations of 19 minor planets, the principal instrument in the Baron's observatory is an equatorial refractor by Howard Grubb, of Dublin, aperture 306 mm. A new physical observatory has been erected at Herény, Hungary, by Eugen and Alexander von Gothard, the position of which is 12m. 49·8s. east of Berlin, with latitude 47° 16′ 37″; the observatory is provided with a 10¼ inch equatorially mounted reflector by Browning, of London, observations were commenced in the second week of November, and chiefly consisted of the examination of star-spectra. At Keil an 8-inch refractor by Steinheil has been received: meridian observations here were largely devoted to circumpolar stars + 79° to 82°, but according to the present plan, the observations will be continued to the pole. Leipsic is now under the direction of Prof. H. Bruns. At Lund the zone undertaken by the observatory was continued, more than 5200 stars being determined. From the Observatory of Brera, Milan, Prof. Schiaparelli makes the welcome announcement that the late Baron Dembowski had confided to him all his astronomical manuscripts with the condition that they were to be utilised to the best advantage for the science. His measures of double stars, upwards of 20,000 in number, will be published under the auspices of the Accademia Reale dei Lincei; they are to form four volumes, of which the first will contain the measures made by Dembowski at Naples with his Plössl Dialyte in the years 1852-58; the second and third, the observations made at Galarate on stars of the Dorpat Catalogue, and the fourth, the measures of stars in W. Struve's appendix, the Pulkowa Catalogue, and double stars discovered by other astronomers, more especially by the eminent American observer, Mr. Burnham. The first volume is in course of preparation. At Plonsk Dr. Jedrzejewicz continues, in his private observatory, measures of double stars as his principal work. The passages of the red spot on Jupiter, by the middle of the disc, were micrometrically determined from November 25, 1880, to February 5, 1881, from 174 rotations, the period was found to be 9h. 55m. 34·41s. ± 0·13s., and at the same time the jovicentric latitude of the centre of the spot was found −22°·8, and its length in degrees of the

parallel 26°·4; the third and fourth comets of 1881 and Encke's comet were also observed for position. The physical observatory at Potsdam was in full activity, and in addition to the more special subjects of observation undertaken by this important establishment, an extensive series of observations of variable stars was secured in 1881. From Stockholm Dr. Hugo Gylden notifies his determination of the parallax of the star Bradley 3077, or No. 240 in Argelander's Catalogue of 250 stars, forming part of the seventh volume of the Bonn observations: the resulting value is 0″·283 ± 0″·0468; this star has considerable proper motion. Prof. R. Wolf communicates, from Zurich, he monthly numbers of days with and without sun-spots, and the relative numbers: in the whole year's observing-days, the sun was free from spots on five days, and exhibited spots on 297.

ATOMIC ATTRACTION

THE theory of universal gravitation, as I understand it, asserts that the mutual attraction exerted by any two bodies, A and B, is dependent only on their respective masses and on the distance between them, being entirely uninfluenced by the presence of other bodies even in the immediate neighbourhood of A or B. Thus at a given moment the Earth and Venus, being in certain definite positions, exert upon each other a certain force of attraction; the attraction thus taking place between the masses of the two planets would be unaltered by the removal of the Moon from the sphere of action; the gravitation of the Earth and the Moon does not therefore tie up any portion of the attractive energy of the Earth, and so diminish the force with which other bodies gravitate towards it.

A totally different assumption is usually made with regard to that form of attraction which gives rise to chemical phenomena. Here it is supposed that two or more atoms, having combined together, have thereby become incapable, at any rate in the majority of cases, of attracting others to any appreciable extent. Thus I imagine that most chemists hold the view that when hydrogen and oxygen combine together to form water they thereby exhaust, or nearly exhaust, their combining power, that the power of attraction residing in the oxygen atoms is all concentrated upon the hydrogen atoms, just as we might conceive all the attractive power of the Earth concentrated on the moon, thus leaving all other bodies in its neighbourhood free from the influence of gravity. We thus invest matter with two separate forms of attraction differing entirely in their mode of action, and having indeed nothing in common. It is however possible to a certain extent to assimilate chemical attraction and gravitation, and I propose here to discuss some of the results which ensue from the elaboration of this idea. Let us suppose then that the act of chemical combination in no wise alters the power of attraction which the combining atoms exert upon surrounding bodies, and let us see what effect this hypothesis has upon the explanation of various phenomena. In order to do this we must first render as precise as possible our notions of the construction of chemical compounds.

It is now known with certainty that the atomic and molecular volumes of substances are but slightly altered by combination, that is to say, that under comparable conditions the atom of any substance generally occupies about the same space with whatever atoms, similar or dissimilar, it may be combined. This fact seems to me to point to the conclusion that the atoms which make up a molecule are as close together as their periodic motions will permit, and are not merely held in certain positions of equilibrium by various opposing forces; for if the latter supposition were true, I fail to see how it would be possible for the same atom, together with its surrounding proportion of space, to have always the same volume. The immediate proximity of the several molecules in the liquid and solid states must also be assumed, in order to account for the invariability of molecular volumes.

The innumerable facts which have been brought to light by the efforts of those who have investigated the chemistry of the carbon compounds all lead one to suppose that there is some foundation for the ideas propounded by chemists concerning the position of the atoms, and that the constitutional formulæ ascribed to organic substances really represent the construction of the molecule. If this be so it certainly furnishes a further argument in support of the proximity of the atoms.

The assumptions contained in the preceding paragraphs are in no way opposed to the views generally held concerning molecular and atomic motion which we owe to the development of the science of heat. They merely state that there is no force of repulsion exerted between contiguous atoms, and that the vibratory or other movements are small compared with the size of the moving masses.

The object of the following remarks is to show that the hypothesis concerning chemical attraction mentioned above enables us to offer some explanation of the relative volatility of bodies. We all, I presume, look upon the maximum vapour tension of a substance at a given temperature as affording to a certain extent a means of estimating the attraction which its molecules exert among themselves; if there is considerable attraction there will be a low vapour tension, and with little attraction there will be a low boiling point. It follows from this that the attraction between the molecules of hydrogen is relatively extremely small; that in the case of oxygen and nitrogen it is also very small, though probably much larger than in the former case; the attraction mutually exerted by molecules of chlorine will be more considerable; while with bromine, iodine, and other liquid and solid elements it will be greater still. We must not however confound the attraction exerted between *atoms* of a substance with that between the *molecules*, for each atom attracts separately those of the contiguous molecule, so that the attraction between two molecules of bromine, for example, will be four times as great as between two atoms, and generally when the molecule of a substance contains n atoms the attraction between two molecules will be approximately n^2 times that between two atoms. This is of course even approximately true only when the distance between the two molecules is great relatively to their size; when the two molecules are close together the several interatomic attractions will be exercised over very different distances, and will therefore be very unequal in amount. Nevertheless, the above remark enables us to see that in some cases the apparent attraction, as estimated by the boiling-point, may be very misleading. In sulphur, for example, of which the molecule in the solid and liquid states is probably somewhat complex, we have a substance of high boiling-point, though the mutual attraction of the atoms may be comparatively small. The same is the case with carbon and many other substances.

Applying now the above considerations to a few actual cases, we shall see that the relative volatility of different substances is generally satisfactorily explained. Let us designate by $(h\,h)$ the attraction at unit distance between two atoms of hydrogen, by $(o\,o)$ the attraction between two atoms of oxygen, and generally by $(r\,s)$ the attraction at unit distance between any two atoms, R and S. Then in the case of water the molecular attraction will be represented by—

$$4\mathrm{A}(h\,h) + 4\mathrm{B}(h\,o) + \mathrm{C}(o\,o),$$

where A, B, and C are factors dependent on the distances which separate the atoms; now we have seen that $(h\,h)$ and $(o\,o)$ probably have small values, but $(h\,o)$ is not small, hence the attraction between molecules of water should be far greater than that between molecules of oxygen, and the boiling-point much higher, a result which is in accord with fact. The boiling-point of water would probably be much higher than it is, were it not that the attractions between H and O are exerted over comparatively large distances, owing to the hydrogen of one molecule shielding its companion oxygen from the approach of other hydrogen. In the similarly constituted body, H_2S, the value of the molecular attraction will be—

$$4\mathrm{A}(h\,h) + 4\mathrm{B}(h\,s) + \mathrm{C}(s\,s),$$

in which expression A, B, and C may be supposed to have values not differing excessively from those which hold good in the case of water (the sulphuretted hydrogen being supposed liquid). The value $(s\,s)$ is in itself small, and since the force is exerted between two atoms which cannot approach each other very closely, C is also small. The affinity of hydrogen for sulphur being also feeble, the whole value of the molecular attraction is small; sulphuretted hydrogen should therefore be an extremely volatile body, which is actually the case.

With hydrochloric, hydrobromic, and hydroidic acids we have for the molecular attraction the several values—

$$\mathrm{A}(h\,h) + 2\mathrm{B}(h\,cl) + \mathrm{C}(cl\,cl)$$
$$\mathrm{A}'(h\,h) + 2\mathrm{B}'(h\,br) + \mathrm{C}'(br\,br)$$
$$\mathrm{A}''(h\,h) + 2\mathrm{B}''(h\,i) + \mathrm{C}''(i\,i).$$

As the three bodies are similarly constructed we may assume that A, A′, A″, &c., do not materially differ. As the third terms of these expressions increase the second terms diminish; we should therefore expect that there might be no great difference in the vapour-tensions of the three substances; experiment proves that