The average distance between the solar lines in the green, which have not yet been identified, is about 4·4, or more than fourteen times the difference between the centre of the oxygen line and the corresponding solar line. The average distance between the non-identified lines near O α is 4·9, or about twenty-nine times the corresponding difference. In judging, however, of the value of the evidence, I should like the reader to leave the line δ out of account. Although the agreement seems perfect, I have not the same confidence in the correctness of the wave-length as I have with the other lines. The line β is weaker than the others, and the error of observation may be a little larger than with α and γ, which will, I think, be found correct to the decimal place.

Let me point out in a few words the importance of the results obtained. The compound line spectrum of oxygen can only exist under a limited range of physical conditions. It is broken up at a higher temperature into the elementary line spectrum, and at a lower temperature it tumbles together into a continuous spectrum. During its existence its lines may be subject to variations owing to pressure. The spectrum of oxygen is therefore pre-eminently fitted to be at once the pressure gauge and thermometer of the sun. We cannot at the present moment give the exact temperature of the points at which the changes take place; but we can say with certainty why it is that the line spectra of many metalloids are not found reversed in the sun, for the temperature which gives these line spectra is higher than that which gives the compound line spectrum of oxygen, and therefore higher than that of the reversing layer of the sun. Consequently we must look for their band spectra and not for their line spectra. The same may be true for the spectra of some of the heavier elements like gold, silver, and platinum, which have not yet been discovered in the sun. The continuous spectrum of the base of the corona is most likely the continuous spectrum of the cooler oxygen.

As the science of spectroscopy advances we shall be able to determine the physical conditions which exist on the surface of the sun with as great a degree of certainty and a much smaller degree of discomfort than if we were placed there ourselves. I hope that this communication will prove to be a step in that direction. All my experiments were made in the Cavendish Laboratory.

ARTHUR SCHUSTER

St. John's College, Cambridge, November 30

OUR ASTRONOMICAL COLUMN

JUPITER'S SATELLITES.—Amongst the recorded phenomena connected with the motions of the satellites of Jupiter are several notices of observed occultations of one satellite by another, and of small stars by one or other of the satellites. The following cases may be mentioned:—On the night of November 1, 1693, Christoph Arnold, of Sommerfeld, near Leipsic, observed an occultation of the second satellite by the third at 10h. 47m. apparent time. On October 30, 1822, Luthmer, of Hanover, witnessed an occultation of the fourth satellite by the third at 6h. 55m. mean time.

Flaugergues, writing to Baron de Zach, from Viviers, on November 18, 1821, says: "I begin with an observation, very useless, no doubt, but extremely rare, for I have not found a similar one in the collections of astronomical observations which I have examined; *i.e.*, the occultation of a very small star by the third satellite of Jupiter." He proceeds to mention that on August 14, 1821, he repaired to his observatory very early to observe an eclipse of this satellite, and having looked at Jupiter with the telescope, he remarked a very small star near the third satellite. The satellite approached this star, and at 1h. 47m. sidereal time, it appeared to touch it, and at 1h. 56m. 52s. it was not possible to distinguish the star—it had disappeared. The satellite became fainter and disappeared in its turn at 1h. 59m. 10s. sidereal time, on August 13, or 16h. 30m. 8·5s. mean time at Viviers. The sky was perfectly clear, and Flaugergues considered his observations very exact. He adds that he continued to observe for a long time after the immersion of the satellite, hoping to see the star reappear, but he could not again distinguish it; the twilight had much increased, and small stars in the neighbourhood of Jupiter were soon effaced.

There is a similar observation by Mr. G. W. Hough, at Cincinnati Observatory, communicated in a letter to Dr. Brunnow, when Director of the Observatory at Ann Arbor, Michigan, and published in his "Astronomical Notices" Mr. Hough states that on March 28, 1860, he witnessed the end of an expected occultation of a star 9·5 mag., by Jupiter, and the occultation of the same star by the first satellite. When first seen it was distant from the limb of the planet about one diameter of the satellite, or one second of arc, so that the real separation had taken place about six minutes before (or about 8h. 9m. sidereal time), though he was not able to see it. At 10h. 27m. sidereal time the star was occulted by the first satellite and remained invisible eight minutes. Mr. Hough further says that the star is found in the "Redhill Catalogue," an obvious oversight; it would appear to be No. 1630 of Zone + 22° in the *Durchmusterung*, a star of 9·3m. the approximate place of which for 1855 was in R.A. 7h. 8m. 5s., N.P.D. 67° 3'·3.

DONATI'S COMET OF 1858.—This comet which attained so great a celebrity in the autumn of 1858, makes a very close approximation to the orbit of Venus near the descending node, and it may be reasonably inferred that the actual form of its path round the sun may be due to a very near approach of the two bodies at some distant epoch. The discussion of the totality of observations was undertaken some years since by Dr. von Asten, who has published his results in a dissertation entitled "Determinatio orbitæ grandis cometæ anni 1858, e cunctis observationibus." The comet was discovered by Donati on June 2, and was observed until the beginning of March, 1859, at the Cape of Good Hope and at Santiago de Chile; consequently the observations extended over a very wide arc of the orbit, and there have been very few cases where careful discussion could be expected to lead to more reliable results. The period of revolution deduced by Dr. von Asten is 1,880 years, and there is a high probability that this does not differ materially from the true one, applying to the time of the comet's appearance. Prof. Hill, of Washington, also by a complete investigation, obtained a somewhat longer period, but the general character of the orbit remains the same. Employing Dr. von Asten's elements, it will be found that in heliocentric longitude 343°·7, the distance of the comet from the orbit of Venus, is only 0·0047 of the mean distance of the earth from the sun. In 1858 the two bodies came into pretty near proximity, their mutual distance on October 17 being 0·088. It has been mentioned above that the point of closest approach of the orbits of the planet and comet is situated near the descending node; the opposite node falls in the region of the minor planets.

THE OBSERVATORY OF LYONS.—The *Bulletin Hebdomadaire* of the French Scientific Association reports that M. André is actively employed in the establishment of this new astronomical institution and is energetically supported by the Government. M. Raphël Bischoffsheim, the munificent donor of the meridian circle, lately mounted at the Observatory of Paris, has also intimated his intention to present the Lyons Observatory with its fundamental instrument, a meridian-circle of dimensions but slightly inferior to those of the circle, for which the Observatory at Paris is indebted to him. It will also be constructed by Eichens. The Paris meridian-circle is intended to replace the instruments of Gambey, which are now placed in one of the saloons of the institution with other instruments which have seen their day. M. Wolf remarks that the scientific zeal and liberality of M. Bischoffsheim "inaugurates in France a path long followed in England by wealthy amateurs of astronomy."

THE METEORITE OF JUNE 14, 1877.—M. Gruey has calculated the orbit of this meteorite with the assistance of the Observatory of the Puy-de-Dôme, and accounts obtained through the press of Clermont, where he observed it at 8h. 55m. P.M. local time. Observations made at Bordeaux and at Angoulême were combined with those at Clermont. He obtained for the velocity of the meteor relatively to the sun 93 kilometres in a second, in the direction – heliocentric longitude 15° 17′, latitude – 17° 3′, and neglecting the insignificant effect of the earth's attraction upon a velocity so great, and the unknown effect of atmospheric resistance, he found for the heliocentric motion of the meteor the following elements of a hyperbolic orbit. Eccentricity, 7·079, semi-axis, 0·137. Ascending node, 83° 49′, inclination, 18° 14′, perihelion from node, 286° 50′, longitude at appearance, 263° 49′ ; the meteor approaching its perihelion was thus distant 23° from it.

This adds another case to several previous ones in which hyperbolic orbits have been obtained for meteorites by Petit, Galle, Tissot, &c.

PROF. NEWCOMB.—At the meeting of the Royal Society on Thursday last, the distinguished mathematical astronomer, Prof. Simon Newcomb, of Washington, was elected one of its foreign members. There was previously on the list only a single American, viz., Prof. Asa Gray. Prof. Newcomb's important contributions to astronomical science will be admitted to have richly entitled him to an acknowledgment at the hands of our leading society.

CHEMICAL NOTES

MINERAL OIL IN A LAVA OF MOUNT ETNA.—In the basaltic zone which reaches from the foot of Mount Etna in a south-south-easterly direction, near the village of Paterno there is a prehistoric doleritic lava containing olivine, which surrounds the clay deposits of a mud volcano and which has been examined by Sig. Orazio Silvestri. Under the microscope the lava shows an augitic principal mass with a quantity of olivine and many white transparent crystals of labradorite. The lava contains numerous round or irregular cavities which are coated with arragonite and which are filled with mineral oil. This oil, of which there is about 1 per cent. by weight in the whole mass, was taken from one of the cavities at 24° C. At about 17° C. it begins to solidify and is of a yellowish green tint by transmitted light, while by reflected light it is opalescent and light green. Chemical analysis of the liquid proved it to contain :—

Liquid hydrocarbons (boiling point 79°·28) ...	17·97 per cent.
Hydrocarbons solidifying under 0° (b. p. 280°–400°)	31·95 „ „
Paraffine, melting point 52°–57°	42·79 „ „
Asphalt (leaving 12 per cent. of ashes) ...	2·90 „ „
Sulphur	4·32 „ „
	99·93

FORMATION OF CERTAIN BODIES AT TEMPERATURES ABOVE THAT OF THEIR DECOMPOSITION.—MM. Troost and Hautefeuille have lately demonstrated that under certain circumstances it is incorrect to suppose that bodies undergoing decomposition or rather dissociation at a low temperature may not exist as definite compounds at higher temperatures. Their arguments are founded on the decomposition of silicon sesquichloride (Si_2Cl_6) at 800°, which may be represented as—

$$2Si_2Cl_6 = 3SiCl_4 + Si,$$

if, however, the reaction be carried on at a temperature above 1200° the following change takes place—

$$3SiCl_4 + Si = 2Si_2Cl_6.$$

If the tube in which this reaction takes place be cooled suddenly the sesquichloride is found, but if cooled slowly it undergoes gradual decomposition. They also find that although ozone is converted into oxygen at 250°, if a silver tube inclosed in a porcelain tube be kept at about 1300° a deposit of dioxide of silver is produced due to the formation of ozone. They state that the ozone can be recognised by the usual tests if the gas be rapidly drawn off and quickly cooled. They have also examined certain similar phenomena in the production of oxide of silver at 1400°.

IODATES OF COBALT AND NICKEL.—Prof. F. W. Clarke describes these salts, which were prepared by dissolving the carbonates in aqueous iodic acid, and allowing the solution to evaporate spontaneously when salts of the composition $CoI_2O_6.6H_2O$ and $NiI_2O_6.6H_2O$ crystallise out. If the solution of the carbonate of cobalt in iodic acid is evaporated rapidly, then the iodate of Rammelsberg, containing $1\frac{1}{2}$ molecules of water may be obtained, but not otherwise. The cobalt iodate loses four molecules of water at 100°, but the remaining two molecules cannot be driven off without partial decomposition of the salt. The specific gravities of the two salts are almost identical, the cobalt iodate at 21° being 3·6893, the nickel iodate at 22° being 3·6954. No numbers of the solubilities of the two salts are given by Prof. Clarke, but these, when obtained, will be of some interest.

ORIGIN AND FORMATION OF BORACIC ACID.—M. Dieulafait (*Comp. Rend.* lxxxv. 605) finds that under certain conditions by spectrum analysis $\frac{25}{1000000000}$ grammes of boron, and by the colour imparted to a hydrogen flame $\frac{1}{1000000}$ grammes may be detected. He considers boracic acid to be a normal constituent of sea-water and salt marshes lying above beds of carnallite. M. Dieulafait finds that this acid may be recognised in a drop of sea-water weighing about 0·0378 grammes, and that the minimum quantity found in the Mediterranean is two decigrammes per cubic metre of water. He arrives by geological reasoning at conclusions differing from those of Dumas and others with regard to the origin of this body in the lagoons of Tuscany, and thinks that the source of boracic acid in this district may be found in a relatively modern formation.

NEW MODES OF FORMING ETHYLEN OXIDE.—In the *Comptes Rendus*, lxxxv. 624, Mr. H. Greene mentions the results of experiments on the action of certain metallic oxides on the bromide, iodide, and chloriodide of ethylene. Oxide of silver has a rapid action on ethylen iodide at a temperature of 150°, forming ethylen oxide; its action on ethylen bromide produces the same result but requires a higher temperature. Ethylen bromide and chloriodide both act upon sodium oxide at 180°, the latter of the ethylene compounds being the one found most advantageous by the author in preparing ethylen oxide. He has also studied the action of these substances on the oxides of the diatomic metals barium and lead. These oxides do not give ethylen oxide when heated with bromide or chloriodide of ethylene. These experiments show, on the one hand, the analogy between the silver and sodium oxides confirmed by the isomorphism of their anhydrous sulphates and chlorides, and on the other their difference from the group of diatomic oxides.

THE ACTION OF CERTAIN ANTISEPTIC VAPOURS ON THE RIPENING OF FRUITS.—MM. Lechartier and Bellamy give an account in the *Comptes Rendus*, lxxxiv. 1,035, of some experiments they made on the fermentation of apples when inclosed in vapours such as carbolic acid, camphor, and potassium cyanide. From their results it appears that no fermenting action took place in the apples surrounded by vapour of carbolic or hydrocyanic acids, and a slight action only in the one surrounded by camphor vapour. The camphor vapour, in fact, diminishes without entirely destroying the vitality of the cells. In this journal, also, there is an account of