OUR ASTRONOMICAL COLUMN.

COMET 1917*a* (MELLISH).—Prof. Strömgren announces that from observations made on March 22, 23, and 24 (Copenhagen) Mrs. J. Braae and J. Fischer-Petersen have calculated the following orbit and ephemeris :—

$$T = 1917 \text{ April } 9{\cdot}4463 \text{ G.M.T.}$$
$$\left.\begin{aligned}\omega &= 106^\circ\ 51'\ 66\\ \Omega &= 92^\circ\ 47'{\cdot}32\\ i &= 22^\circ\ 48'{\cdot}92\end{aligned}\right\}1917$$
$$\log q = 9{\cdot}41464$$

Ephemeris: Greenwich Midnight.

1917	R.A. h. m. s.	Decl. ° ′	Log *r*	Log Δ	Mag.
April 11	0 43 49	+11 30·3	9·4295	9·8894	4·6
15	0 25 7	5 48·7	9·5156	9·9206	5·2
17	0 20 53	3 32·6	9·5672	9·9407	5·6
19	0 18 45	+1 39·0	9·6172	9·9608	5·9

THE APRIL LYRIDS.—This shower of meteors, though occasionally offering a brilliant display, is, in the majority of years, very slightly visible. It is unfortunate that the period is not definitely known, though there are indications that its best returns occur at intervals of a little more than sixteen years. This feature is by no means supported on conclusive evidence, but it is a point worthy of further investigation.

Abundant showers of Lyrids were observed in 1803, 1851, 1884, and 1901, and it will be interesting to determine whether or not an unusual exhibition of these meteors is presented this year or in 1918. The time of maximum will possibly be at about midnight on April 21, and as there will be no moonlight to interfere, it will be easy to ascertain the character of the display should the weather prove suitable. If the meteors reappear at the time mentioned it will be important to observe the time of maximum and the horary number visible. The position of the radiant is already well known, and it moves eastwards, like that of the August Perseids. Though the chief activity of the Lyrids seems confined to a few hours, yet there are occasional specimens certainly seen between April 16 and 26, and possibly on dates still further removed from the night of maximum.

VARIABILITY OF URANUS.—Prof. E. C. Pickering has announced an interesting discovery which has followed from a series of photometric observations of the light of Uranus, made by Mr. Leon Campbell with the primary object of investigating possible changes in the light-emission of the sun (Harvard Circular, No. 200). The observations revealed a variation in the light of the planet amounting to about 0·15 magnitude in a period of 0·451 day, these figures being based upon 2960 settings. The period of variation agrees very closely with that of the rotation of the planet derived from spectroscopic observations by Lowell and Slipher, and Prof. Pickering concludes that the variation in light is due to unequal brightness of different portions of the planet. If the variations in brightness prove to be permanent, photometric observations will give the rotation period of the planet with a high degree of accuracy.

THE "ANNUAIRE ASTRONOMIQUE" FOR 1917.—The issue of this well-known publication for the current year contains the usual astronomical information in a convenient and interesting form, together with a review of the progress of astronomy. It forms a valuable work of reference for astronomical data of all kinds, including a catalogue of minor planets arranged in the order of their distances from the sun, a list of temporary stars which have been visible to the naked eye, a list of stars with large proper motions, and so on. Among the 140 illustrations we note a useful set of diagrams from which one can readily ascertain the visibility of each of the principal planets on any night of the year. M. Camille Flammarion is to be congratulated on having so successfully conducted this publication for more than half a century.

HEAT ECONOMY IN METAL MELTING.

THE outstanding feature of the proceedings at the annual meeting of the Institute of Metals, held at Burlington House on March 21 and 22, was a general discussion on metal melting, organised by the council. Whether it was chiefly due to the fact that this subject aroused an unusual amount of interest among the members, or that war problems in metallurgy have created a desire to discuss those problems more freely than hitherto, the fact remains that in the last three months the institute has added more new members than it did in the previous two years; that the attendance was very much larger than it has ever been at any other meeting in the course of its history; and that the discussions on the various papers contributed were of unusual fullness and value.

Special appropriateness attached to the fact that Sir George Beilby, the president of the institute, in entering on his second year of office, presided over a discussion which must have been of considerable interest to him in his capacity of Director of the Fuel Research Board set up by the Committee of the Privy Council for Scientific and Industrial Research. Although coke constitutes the fuel most generally used in metal and alloy melting, only one paper was contributed dealing with its use. On the other hand, four papers were concerned with coal-gas, and these included one on the practice of the Royal Mint, and another on the application of the high-pressure gas system installed by the City of Birmingham Gas Committee. Of the remainder one paper dealt with producer gas, another with oil fuel, and a third with an electric resistance furnace. All these papers dealt with the melting of metals and alloys in crucibles, *i.e.* in quantities which seldom exceed 200 lb. in weight. The one paper on the subject dealing with principles rather than practice was by Dr. Carl Hering, an expert on furnace construction, and was entitled "Ideals and Limitations in the Melting of Non-Ferrous Metals." This, in many respects the most suitable for discussion, was not discussed by any of the speakers, and will be briefly commented on in this article.

Dr. Hering enumerates the directions to which perfection points as follows :—A reduction in (i) the loss of heat, (ii) the loss of metal, (iii) the number of bad castings, (iv) the consumption of equipment, and (v) the cost of labour and plant per lb. of good castings. As these are not all independent factors, economy may sometimes result from increasing some if others are thereby reduced more greatly, *e.g.* increased plant cost may save more in labour cost, and an increase in bad castings may even be warranted by the great saving of heat and labour due to working faster

With regard to heat losses, Dr. Hering points out that one of the first things to bear in mind in all high-temperature thermal operations is that insulation against heat loss is in practice at best very poor; that the ideal in this direction is the vacuum jacket of the Dewar thermos bottle, but that this, unfortunately, is impracticable for metal melting. Hence, so long as the metal is hot, just so long will this loss continue. Heat losses, however, depend not only on the thermal insulation, but quite as much also on the length of time during which they take place, so that reducing the duration of these losses reduces them in proportion. To obtain economy in heat, therefore, the ideal is not only to insulate as well as practicable, but also to heat and cast the metal in as short a time as possible, and this ideal may be approached by having each lb. of metal heated for the shortest possible time. *The total loss of heat per lb. of metal while it is hot is the criterion.* From this point of view Dr. Hering states that the ideally perfect melting furnace, if such it can be called, is the electric fuse, in which the intended result is completed in such an exceedingly short time—a fraction of a second—that the heat losses during that time are vanishingly small, and hence the thermal efficiency is practically 100 per cent.

With fuel heating, too great a rapidity of heating generally involves high chimney losses, *i.e.* a lower efficiency in heat transmission to the metal, and hence a limit to the speed is soon reached; but with electric heating there is no chimney loss, and the possibilities of rapid heating are therefore more encouraging. Electric arc heating involves high radiation losses from the arc itself, but in heating the metal by its own resistance the heat can be generated below the surface and in the metal itself, thereby eliminating all heat transmission losses. Extremely rapid heating then becomes possible, being limited only by the size of the heat-generating capacity provided, and in the case of brass or zinc by the volatilisation of the zinc in the part in which the heat is set free. By the resistance method, therefore, the ideal represented by the electric fuse can be approached more closely than by any other known method. Small high-speed furnaces are therefore, from this point of view, an approach to the ideal, particularly as they involve the minimum of contamination of the metal being melted. In Dr. Hering's opinion, it will in time become possible, for light castings at least, to be melted in an electric furnace about as fast as the metal can be cast, in which case the furnace would need to have a metal capacity of only enough for about two moulds. In that case it would be so small that it could be transported to the moulds, thereby saving the usual large heat losses in the transporting crucibles, besides the heat losses in the crucibles themselves.

Another factor, however, is involved, viz. the larger the amount of metal in a furnace, the less the *rate* of heat loss per lb., because the larger the volume, the less is the surface exposed. In a large furnace with a hemispherical hearth the heat loss per lb. of metal through walls having uniform insulation is reduced to about one-half when the capacity is increased from 1 to 10 tons. Hence, for this reason, the larger the furnace the better.

In choosing between these two apparently conflicting ideals the following considerations must be borne in mind:—(i) When melting is the only object, then the metal should be kept hot the shortest possible time; hence there should be used as small a furnace as is consistent with the amount of metal required for one casting. (ii) When there are involved operations such as refining, mixing, uniformity of alloying, the taking of specimens for analysis while melted, or any other process requiring time, the larger the furnace the better.

LIQUID FUEL.

"LIQUID Fuel and its Combustion" was the title of a paper read by Prof. J. S. S. Brame, on February 20, before the Institution of Petroleum Technologists. Attention was directed to the increasing use of liquid fuel, and especially to its connection with those developments of the internal combustion engine which have so largely determined the progress of aviation and submarine navigation. Nevertheless he recalls the warning of Redwood (1905) that no oil supplies are in sight sufficient to replace anything like the bulk of solid fuel consumed. The use of liquid fuel for steam raising and industrial heating is the special subject of the paper, and the following considerations are brought forward. In constancy of chemical composition, whatever the source, and therefore of calorific value, mineral fuel oils compare very favourably with coal, and accordingly physical considerations such as low viscosity and freedom from grit may decide the choice of oil fuels. Turning to our home supplies, it is gratifying to note that the heavy fractions of the Scotch shale oils are ideal in this respect; having been distilled they are clean, while their fluidity is very satisfactory. Another home product, which is deserving of the close attention of liquid fuel experts, is coal-tar, the supply of which must increase with the extension of coal carbonisation. Its production may outgrow its uses in normal channels, and as a home-made liquid fuel its rational utilisation is a matter of high national importance. Nevertheless, for marine purposes tar (and tar oils) must remain inferior to petroleum, since a higher oxygen content and lower calorific value are inevitable, while a capacity for giving off disagreeable fumes may make it objectionable in the confined space of a stokehold. Methods of burning oil are surveyed historically, leading up to the spray burners now almost invariably used which "atomise" the oil.

The method of spraying is varied, depending on the use of compressed air or steam, or on forcing oil alone under pressure through a suitable burner, a method specially adapted for use in marine boilers. On theoretical grounds air injection would seem to be most generally efficient; steam may propel oil satisfactorily into the fire, but afterwards its influence on combustion can only be of negative value. The general arrangements of the system for combustion have more bearing on the success of a plant than the choice of atomiser. It is too often overlooked that, compared with solid fuel, where burning is mainly confined to the fuel bed, oils require a much greater volume of combustion space.

Looking to the future, Prof. Brame points out how much depends on the development of the internal combustion engine; for naval purposes he believes that oil firing with turbines will hold the field.

J. W. C.

RECENT PROGRESS IN SPECTROSCOPY.[1]

II.

RADIATION is an electromagnetic process, and must be determined by the electrical state of the radiator. A molecule may be neutral or for a moment charged by the loss or gain of an electron. This type of ionisation must actually occur, as indicated by the conduction of electricity through the vapour of a compound which shows no evidence of chemical dissociation. What causes the light emission? It may accompany the loss or gain of an electron by a neutral molecule, in which case the emission centre would be charged. It may be due to the shock of elastic collision with an electron or ion, or to the reunion of an electron with a positively charged molecule, in which cases the emission centre would be neutral. Luminous vapours emitting band spectra usually appear to be neutral at the instant of emission, so that it seems probable that band emission is due either to elastic shock or to the

[1] Address delivered to Section B—Physics—of the American Association for the Advancement of Science at the New York meeting, December, 1916, by the chairman of the Section, Prof. E. P. Lewis. Continued from p. 118.