Our Astronomical Column.

CAPELLA.—A knowledge of the parallax of Capella is of special interest owing to the close resemblance of this star's spectrum to that of the sun and the fact that it is a spectroscopic binary with a period of 104¼ days. Prof. F. Schlesinger and Mr. Z. Daniel have made a new determination at the Allegheny Observatory (*Astr. Journ.*, No. 765). They observed both the principal star and Furuhjelm's distant companion. The weighted mean parallax (absolute) is 0·068″ ± 0·006″. Earlier results are: Elkin, 0·079″; Jost, 0·051″; and Adams and Joy, 0·105″.

The star B.D. + 61° 2068, the proper motion of which is 0·77″, was also measured for parallax at Allegheny, the large value 0·139″ ± 0·007″ (absolute) being found. The corresponding absolute magnitude is 9·3 visual and 10·5 photographic.

Attempts were made some twenty years ago to detect the duplicity of Capella telescopically. It was considered for a time that the 28-in. equatorial at Greenwich gave an elongated image, but, in view of the failure of the great American refractors, little reliance was placed on this. A letter from Prof. Hale dated January 6 last (*Observatory*, March) announces that success has been obtained by interferometer methods with the 100-in. reflector. It was deduced that the separation on December 30, 1919, was 0·042″, and the position angle 148° or 328°. It is hoped that a continued series of such observations will give a determination of the inclination of the orbit, and hence of the masses of the components. There is even a prospect that the diameters of such giant stars as Sirius, Antares, and Betelgeux may be determinable with the interferometer.

CAPE OBSERVATIONS OF THE SUN, MERCURY, AND VENUS.—The Cape observations of these bodies, made with the new transit circle and the travelling-wire micrometer during the five years 1907–11, have just been distributed, together with a discussion of results. The corrections to the equinox derived from the three bodies are in good accord, and indicate that Newcomb's system of right ascensions needs the constant correction −0·05s. The corrections to Newcomb's longitudes of perihelia of Mercury, Venus, and the earth are −0·78″, +6·8″, and −7·4″ respectively. These are of interest in relation to the Einstein controversy. Newcomb applied the corrections to the centennial motion of the perihelia given by the Asaph Hall hypothesis, according to which gravitation varies as $r^{-2.0000001612}$. This formula gives +43·37″, +16·98″, and +10·45″ for Mercury, Venus, and the earth, whereas Einstein's formula gives +42·9″, +8·6″, and +3·8″. It will be seen that the adoption of Einstein's law of gravitation by the Nautical Almanac would mean a movement towards Newton's law, not a departure from it.

The following semi-diameters of Mercury and Venus at distance unity were deduced from the observations:—Mercury (latitude observations) 3·36″ ± 0·03″, (longitude) 3·79″ ± 0·17″; Venus (latitude) 8·67″ ± 0·03″, (longitude) 8·97″ ± 0·04″. The tabular values are 3·34″ and 8·40″. As these depend to a considerable extent on observations made during transits, they are likely to be somewhat too small.

The Cape results may be too large owing to irradiation, but, since all the observations were made in daylight, this is not likely to be excessive. But as the mass of Venus is only five-sixths that of the earth, it is probable that its diameter is also smaller, whereas the Cape figures make it equal to the earth.

Basic Slag and its Uses in Agriculture.

AN important discussion on basic slag and its uses in agriculture, organised by the Faraday Society, at which a number of leading representatives of the steel makers and of agriculturists were present, was held in the rooms of the Chemical Society on March 23. Prof. F. G. Donnan presided over the meeting.

The discussion was opened by Dr. E. J. Russell, who gave a general survey of the subject and indicated the nature of the problems concerned. The basic slag produced by the basic Bessemer process had earned a high reputation as a potent agent in the improvement of poor pastures. The effect is indirect, and results from a stimulation of the white clover—whether the action of the phosphate is on the clover plant or on the nodule organism is not yet certain. But whatever the reason, the effect on pasture land is very marked, and British agriculturists could absorb some 300,000 or 400,000 tons a year if this could be produced. Unfortunately for agriculturists, however, the Bessemer process is in danger of supersession, and the basic open-hearth process is taking its place. This new process gives two kinds of slag, both poorer than the Bessemer slag in phosphates.

One of these slags is made by the use of calcium fluoride, and in consequence is less soluble than the other. The great problem before the investigator at the present time is to enrich the low-grade slags so as to make them better worth grinding and transport than they now are.

Open-hearth slag made without fluorspar has hitherto proved practically as effective as the old Bessemer slag when compared on the basis of equal amounts of phosphorus. Fluorspar slag has proved to be of less value, although considerably better than was at first thought.

It is usually assumed, though by no means proved, that the phosphate is the only effective constituent in the slag. At various times it has been suggested that lime, manganese, or iron might be useful; it is also possible that slag contains a silico-phosphate which might have more value than the ordinary phosphate.

The enrichment of the slag cannot apparently be brought about by any change in the pig iron, owing to the great disparity in price between steel and slag; fractionation is, however, possible, or the addition of ground mineral phosphate to the molten slag. Further experiments would be necessary before any decision can be made.

Sir Thomas Middleton gave an account of the place of basic slag in the agricultural system of this country. British farmers tend more and more to produce animal rather than human food. The two main human food-crops—wheat and potatoes—occupied no more than 3,000,000 acres before the war, while 36,000,000 acres were devoted to the crop requirements of cattle and sheep. The value of the wheat and potatoes was about 27,000,000*l.*, while the live stock brought in some 125,000,000*l.* The supreme importance of basic slag arises from the fact that it helps to produce animal food; it is essentially a pasture fertiliser. In the Cockle Park experiments the untreated pasture yielded about 20 lb. of lean meat per acre per annum; after treatment with basic slag the yield rose to 105 lb. of meat per acre. The results of many other experiments show that on thousands of acres in this country the yield of meat might be increased by the use of basic slag. Nor are the advantages of slag confined to grass land. By ploughing up more grass, valuable additions could be made to the tillage land, and if the remaining grass were treated with basic slag there

would be no falling off in total yield, in spite of the diminished area.

Mr. Bainbridge gave an account of the experiments by Dr. Stead and Mr. Jackson on the solubility of basic slag in citric and carbonic acids. The reason why fluorspar makes the phosphoric acid in slag insoluble is that a reaction occurs between fluoride and phosphate, producing an artificial apatite, which, as regards insolubility, resembles natural fluorapatite. Even the most soluble phosphatic slags undergo this change and become insoluble on melting with fluorspar. Carbonic acid, after long-continued attack, generally dissolves out more phosphoric acid than a single attack by the standard citric acid.

Mr. G. Scott Robertson gave details of the field tests made to compare the effect of various types of open-hearth basic slags on grassland. These experiments were made in Essex on London clay, Boulder clay, and chalk. They show that all the phosphatic slags are effective fertilisers; but there are important differences in the agricultural effects, which are not connected with solubility according to the citric acid test; indeed, this test affords no indication of the fertilising value of open-hearth slags. Details of the botanical examination of the plots showed the striking effect of the basic slags in reducing the amount of bare space and in increasing the amount of clover.

Mr. Daniel Sillars made an important contribution from the metallurgical side, discussing the formation of basic slag in the manufacture of steel. The phosphide of iron, Fe_2P, in which state of combination phosphorus exists in molten iron, is oxidised by reactions of the type—

$$5Fe_3O_4 + 2P = 15FeO + P_2O_5$$
$$5Fe_3O_4 + 8P = 15Fe + 4P_2O_5.$$

The P_2O_5 formed may combine with FeO to form $Fe_3(PO_4)_2$, which, however, is unstable in the presence of a large excess of iron, and a reaction such as $Fe_3(PO_4)_2 + 11Fe = 8FeO + 2Fe_3P$ results, and it is in consequence of this reaction that the acid process of steel-making is unable to remove phosphorus. In the basic process the presence of lime affords an opportunity to the phosphoric acid to form a stable body by the reaction—

$$Fe_3(PO_4)_2 + 4CaO = Ca_4P_2O_9 + 3FeO.$$

The calcium phosphate formed is only feebly attacked and decomposed by the metallic iron, but manganese and carbon attack it more vigorously and cause the phosphoric acid to be reduced and the metal to be re-phosphorised. These reactions are, of course, proceeding concurrently, and it is necessary to maintain a certain concentration of ferrous oxide in the slag to minimise, so far as possible, the tendency to re-phosphorisation. Re-phosphorisation is probably due to the reaction between ferrous phosphate and lime being slightly reversible, whereby a small concentration of ferrous phosphate is always present, which is reduced by the carbon unless a source of oxygen is supplied by ferrous oxide in the slag.

In ordinary practice the open-hearth process is carried out by allowing the slag formed by the oxidation of the silicon, phosphorus, and manganese to flow over shutes made in the fore-plates into slag-pots under the furnaces, and no attempt is usually made to remove more slag than that which flows out naturally when the level of the slag in the furnace is higher than the level of the fore-plate. The slag left behind is carried on, and forms part of the finishing slag, which latter is therefore much greater in volume, and therefore lower in phosphoric acid, than the slag removed in the middle of the process. By this method of operation the time spent in tapping the furnace for separation of the slag and for the formation of a new slag is saved, but the slag is inferior both in richness and in citrate solubility if that still forms a criterion of excellence to the agriculturist.

Mr. Ridsdale took part in the discussion, and exhibited specimens of slags examined in the classic investigations by Stead and Ridsdale; and Mr. W. S. Jones contributed a paper on the improvement of low-grade basic slags.

As a result of the discussion it was decided to ask the Ministry of Agriculture to form a Committee which should study possible practical steps to effect improvement in quality and in quantity of the phosphatic slags.

Verification of Screw Gauges for Munitions of War.

THE *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* (November–December, 1919, No. 6) contains an article by M. Cellerier, of the Conservatoire des Arts et Métiers, on the verification of screw gauges, with particular reference to the methods advocated by Mr. Bingham Powell, who was engaged in the United States during the war as Inspector of Gauges and Standards for the British Ministry of Munitions. These methods related chiefly to the measurement of the full, effective, and core diameters; the verification of pitch was neglected until quite a late period of the war, owing to the lack of instruments possessing the requisite precision and rapidity.

Extreme accuracy is of the highest importance in measurements of pitch, as any error in the pitch makes it necessary for the maximum limit of effective diameter to be reduced by double the amount of this error if the gauge is to be accepted as correct. Where the permissible deviations are very small, an error in pitch of a few ten-thousandths of an inch may thus completely annihilate the tolerance on effective diameter. Inaccuracies of pitch are often regarded as essentially progressive; but this is not always the case, as deformations due to hardening may introduce variable errors of quite appreciable magnitude. The method frequently adopted of verifying the pitch by measurements made on a length comprising a number of threads is accordingly much less trustworthy than the practice, long in vogue in France, of testing separately a number of consecutive threads.

For the latter process measuring machines of the pattern used at the National Physical Laboratory are particularly suitable, but at the time when the demand for extreme accuracy in screw gauges for war-work first became pressing it was impossible to obtain one of these machines in America without considerable delay, and accordingly Mr. Powell found it necessary to devise an instrument on the spot. He dispensed with the optical contrivance which forms an essential feature of the laboratory machine, and substituted for the spherical contacts a lever terminating in a small sphere which rests freely in the screw and can be guided conveniently in the axial plane from one thread to another. The lever consists of a very light needle, arranged in such a way that the apparatus can also be used for testing internal screws or nuts by means of appropriate casts taken by an ingenious and delicate method, but only a small segment of the internal thread can be obtained in this way for testing purposes.