which in turn is connected to the steelyard. There are no loose weights; seven poises travel on the steelyard, each representing, when in extreme position, a load of 100,000 lb. on the specimen. These poises are traversed by means of a screw, and can be instantly engaged or disengaged. The machine, in the capable hands of Prof. Dixon, should turn out some useful and interesting results on the strength of built-up structures, for which it seems to be well adapted.

BULLETIN No. 362 of the United States Geological Survey, by Mr. J. S. Burrows, deals with the mine sampling and chemical analyses of coals tested at the United States Fuel-testing Plant in 1907. This is one of a series of papers dealing with work done at the fuel-testing station, work valuable to the coal owner, coal user, and to all interested in the scientific study of coal. The results of the examination of seventeen samples of Jamestown coals are given in this bulletin, including proximate and ultimate analyses and the experimentally determined calorific values. A list is given at the end of the previous survey publications on fuel testing.

BULLETIN No. 365 issued by the United States Geological Survey contains an interesting account of the fractionation of crude petroleum by capillary diffusion, by Messrs. J. E. Gilpin and M. P. Cram. When oil is allowed to rise by capillary attraction in a tube packed with Fuller's earth, there is a decided fractionation of the oil, the fraction at the top of the tube being of lower specific gravity than that at the bottom. There is a tendency for the paraffin hydrocarbons under these conditions to collect in the lightest fractions at the top of the tube, and the unsaturated hydrocarbons at the bottom. If the oil is mixed with Fuller's earth and then displaced with water, about one-third of the oil remains in the earth.

BRIQUETTE-MAKING formed the subject of a paper recently read before the South Wales Institute of Engineers by Prof. W. Galloway. Small coal cannot be burnt so economically in the furnaces of boilers in its original state as when in the form of briquettes, partly on account of so much of it falling through the fire-bars, and partly because the particles lie so closely together as to prevent the free access of the air required for combustion. Briquettes made exclusively with anthracite coal burn too slowly, and it is advisable to mix a certain proportion of bituminous coal to overcome this objection. Up to the present, no kind of agglomerating material other than pitch or resin, or a mixture of these, has given satisfactory results. Briquettes made with resin alone become soft and lose their shape in the fire; those having a mixture of 4 per cent. of pitch and 1½ per cent. of resin give better results. It is of interest to note that the total output in the United Kingdom in 1906 amounted to 1,513,220 tons, while Germany produced 14,500,851 tons of this fuel in the same year. The paper contains full descriptions and drawings of the mixing and drying machinery and presses required for briquette-making, together with estimates of labour required and costs. For example, at an English works making 102½ tons of briquettes per day of ten hours, the total cost, including labour, materials, fuel and stores, interest and depreciation, works out to 9*s*. 7·45*d*. per ton.

A RECENT paper by G. Jaffé in the *Annalen der Physik*, on the electrical conductivity of pure hexane, will possess considerable interest to those who are concerned with the *rôle* of the solvent in electrolysis, as well as to those who are working on the electrical conductivity of gases. The impure material owes much of its conductivity to electrolytic impurities, but these can be removed by electrolysis and by repeated distillation, when samples are obtained with a very minute but practically constant conductivity, about twelve times greater than that of air under similar conditions. The pure hydrocarbon, indeed, shows almost all the electrical properties of a gas of high density. How widely its properties differ from those of purified water or other feeble electrolytes may be seen from the fact that two-thirds of the conductivity vanishes when the measuring vessel is sheathed with lead in such a way as to cut off external radiations, and that the remainder of the conductivity is greatly influenced by the nature of the containing vessel, aluminium giving exceptionally low values. Two other remarkable points of contrast are (1) the constancy of the current at different temperatures, and (2) the fact that an increase of potential from 200 to 2000 volts produces no increase in the current, which reaches a "saturation" value analogous to those of gases, although at a much lower voltage.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE:—

June 3. 11h. 43m. to 15h. 14m. Eclipse of the Moon, visible at Greenwich.
9. 20h. Mars in conjunction with Moon (Mars 2° 33′ N.).
12. 18h. Saturn in conjunction with Moon (Saturn 2° 13′ N.).
17. 12h. Sun eclipsed, invisible at Greenwich.
21. 8h. 22m. Transit (ingress) of Jupiter's Satellite IV. (Callisto).
,, 11h. 41m. Minimum of Algol (β Persei).
,, 14h. Sun enters Cancer, summer begins.
22. 18h. Venus in conjunction with Neptune.
,, Saturn. Major axis outer ring = 39·78″, Minor axis = 8·85″.
23. 1h. Jupiter in conjunction with Moon (Jupiter 4° 21′ S.).
24. 9h. 15m. to 9h. 59m. Moon occults ν Virginis (4·2).

THE DISPERSION OF LIGHT IN INTERSTELLAR SPACE.—In the *Revue générale des Sciences* (No. 8, p. 350), Dr. Ch. Nordmann reviews the work recently performed by MM. Tikhoff and Belopolsky and himself on the dispersion of light in interstellar space. The results obtained in the first experiments have been questioned by a number of astronomers, and, in re-stating the case clearly, Dr. Nordmann disposes of many of the objections.

As has already been recorded in these columns, Dr. Nordmann's method consists in observing the difference, in time, of the minima of variable stars when screens of different colours are employed, whilst in the Tikhoff-Belopolsky method the dispersion is shown by the various displacements of lines in the different parts of the spectra of spectroscopic binaries.

It has been suggested that the observed differences may be due to physical changes in the binary system itself, but Dr. Nordmann argues that if this were the case the displacement of the curves for different parts of the spectrum would vary at different parts of the orbit, whereas if the displacement is due to dispersion in space it would be the same in all parts of the orbit. At present he is content that a matter of so great an importance to astronomers and physicists is re-opened, and would attach no rigorous significance to the quantitative results so far obtained; qualitatively they are in the right direction, and are in accordance with the results of ordinary refractive media. Should the validity of these results be established their importance in any cosmological discussion can scarcely be overestimated; for example, the determination of the distances of binary systems would become greatly simplified.

A REMARKABLE TRANSIT OF JUPITER'S THIRD SATELLITE.—No. 4324 of the *Astronomische Nachrichten* contains an account, by Mr Innes, of a remarkable transit of Jupiter's

third satellite observed at the Johannesburg Observatory on April 3.

Before and after the transit both the north polar cap and the dark marking along the north torrid zone of the satellite were noticed. When the satellite was about three-quarters of its journey across the planet a double dark spot was seen in its position, and re-focussing failed to alter the apparition. Approaching the limb of the planet the n.p. part of the double spot was replaced by a bright spot, smaller than the satellite, but s.p. the remaining grey mark. A few minutes before internal contact took place the dark grey spot disappeared, whilst the bright spot increased in size.

Immediately after last contact J III. was seen against the sky nearly round, but perhaps shaded off a little towards Jupiter, and with a small north polar bright spot with a darkish band below it. When the dark double spot was visible it looked like a close double star, dark instead of bright, having a separation of 0·9″ and an angle estimated at 300°.

THE SPECTRUM OF MAGNESIUM IN HYDROGEN.—The significance of the "magnesium hydride" bands in the spectrum of sun-spots lends great importance to any investigation of their nature, and a paper, by Mr. E. E. Brooks, which appears in the April number of the *Astrophysical Journal* (vol. xxix., No. 3, p. 177), is therefore of astronomical interest.

Experimenting at the Leicester Technical School with magnesium in hydrogen, Mr. Brooks employed a unidirectional, but pulsating, current, which is intermediate between arc and spark, and arrived at the following conclusions regarding its spectrum:—(1) The spectrum represents some transitional unstable state; (2) although hydrogen is essential, the production of the "hydride" spectrum appears to depend far more upon the nature of the discharge than upon the quantity of the gas present; (3) a trace of water vapour appears to be more effective than hydrogen, yet its presence cannot be regarded as essential; (4) if due to a hydride the substance is probably decomposed as fast as it is formed.

THE PERTURBATIONS OF BROOKS'S COMET (1889 V) BY JUPITER IN 1886.—From his investigations of the perturbations, and the resulting path, of Brooks's comet, Prof. Poor concluded that this object could not be identified with the lost comet of Lexell.

In this regard an interesting paper, by Herr G. Deutschland, appears in No. 4321 of the *Astronomische Nachrichten*, giving the results of a re-investigation of the planetary perturbations, taking into account the oblateness of Jupiter. These results exhibit variations from those previously obtained by Prof. Poor, especially in the time of the comet's nearest approach to the planet.

RECENT OBSERVATION OF DANIEL'S COMET, 1907 *d*.—Among the photographic observations recorded by Prof. Wolf in No. 4321 of the *Astronomische Nachrichten* is one of an object which is, possibly, Daniel's comet of 1907. Owing to the faintness of the object and the poor sky, the identification is not quite certain, although the image appears on two plates. The middle of the exposure was at 13h. 25·4m. (Königstuhl M.T.) on April 19, and the position of the object was $\alpha = 15\text{h. } 18{\cdot}7\text{m.}$, $\delta = -7^\circ\ 37'$; magnitude 16·5.

THE VARIABLE STAR 6.1909 URSÆ MAJORIS.—In a note appearing in No. 4324 of the *Astronomische Nachrichten*, Prof. Wolf announces that the variable star near the spiral nebula M101 had decreased in brightness more than half a magnitude by May 9.

POLAR MAGNETIC STORMS.[1]

THE last ten or twenty years have been marked by great activity in Arctic and Antarctic expeditions. The results obtained in the department of terrestrial magnetism form a great contribution to knowledge, and prove that continued effort in this direction will do much to remove the difficulties that enshroud the problem.

[1] The Norwegian Aurora Polaris Expedition, 1902–3. Vol. i., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism." By Kr. Birkeland. Pp. viii+315; 21 plates. (Christiania: H. Aschebourg and Co.; London: Longmans, Green and Co., n.d.) Price 22*s*. net.

The present expedition was the development of preliminary expeditions carried out in the preceding six years by Dr. Birkeland, the object being the study of the connection between and origin of auroræ and magnetic storms. The funds were provided by the Norwegian Government, by learned societies in Norway, and by Dr. Birkeland himself.

The preliminary expeditions had indicated the frequent occurrence of magnetic storms having a probable origin vertically above the vicinity of the North Cape, and the plan of the 1902–3 expedition was to make simultaneous observations at four stations in that region. The four stations were on Iceland, Spitsbergen, Nova Zembla, and in Finmark. Each of the stations was provided with a similar set of recording magnetographs of the pattern due to Eschenhagen. These are admirably suited for expeditions on account of their portability and simplicity of adjustment. They can be given a high sensibility, although some may doubt whether the high value used by Dr. Birkeland was altogether a blessing for the purpose of studying magnetic storms. It was, of course, a distinct advantage in studying the minute and extremely regular periodic movements that were frequently observed. In addition, each station was provided with auxiliary meteorological and electrical apparatus, and one of the stations had an instrument for recording earth currents.

The present volume begins with a description of the equipment and installation of the various stations, and those of us who live in temperate regions may well reflect on the advantage of making physical observations without having to interrupt work for the purpose of suppressing the scientific ardour of a polar bear.

In analysing the magnetic storms, Dr. Birkeland was able to obtain simultaneous records from twenty-three observatories in various parts of the world, in addition to those from the four special stations. Dr. Birkeland at the outset indicates that the results have been analysed and presented with the view of supporting the theory he holds, viz. that these storms are due to the incidence of (negatively) charged corpuscles projected from the sun. The desirability of such a method of procedure may be open to question but we think that the author has gained immensely by so doing, and the results are put in such a form that their value is not in the least prejudiced by whether we accept his ultimate conclusions or not.

The method is in outline as follows. Any disturbance of the magnetic needle may be represented as the effect of a certain electric current. The course of a storm may thus, so far as the horizontal components are concerned, be represented by an arrow of certain length in a certain direction. For each particular storm discussed the records from the various observatories are shown in a plate reduced to a uniform time scale. In the text a general description of the storm is given, followed by charts showing with arrows the direction and magnitude of the assumed disturbing current at different stages and at different places. These are followed by a discussion as to the general character of the horizontal current required to produce the storm.

The current charts are remarkably simple, and give an extremely clear presentation of the results free from any theory. In this way the existence of certain well-defined types of storm is established.

The supposition that these arrows represent true electric currents of corpuscles is almost a natural consequence. Arguments are given to show that they cannot be earth currents, but that they are probably due to streams in the upper regions of the air, the general height being some 400 kilometres.

It is remarkable that the stream so frequently sets between the four stations, and thus confirmatory evidence is obtained from the different signs of the vertical-force variations on opposite sides of the stream.

It is found that the horizontal stream is not always sufficient to account for the facts, but that the horizontal portion must be regarded as a bend in a stream descending vertically, and then with greater or less rapidity returned into space.

Dr. Birkeland supports, and we think very ably, his arguments by reference to experiments on a highly magnetised sphere (a terrella) placed in the path of kathode