the poles. The heavier elements in the Sun are in lower parts of the solar atmosphere than the lighter ones.

The distribution of an element upon the Sun may be examined by means of a spectroheliograph, and the resultant photographs are maps of the Sun showing continents and islands of luminous calcium, hydrogen, and iron vapour.

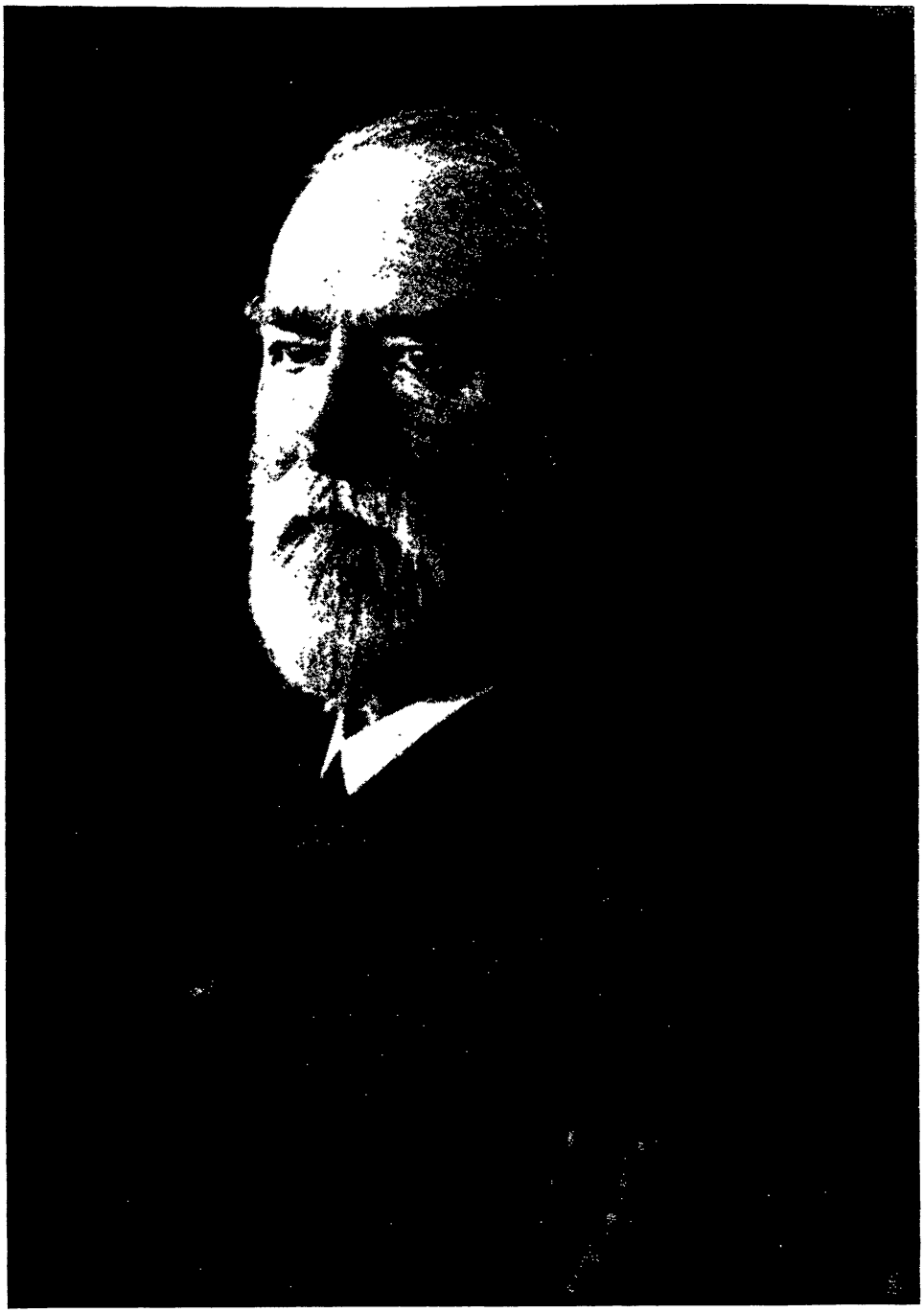
Sun-spots are shown to resemble cyclonic distributions upon the Earth: a section of Sun's atmosphere through a spot illustrates the motion of the vapour in a spot; there is no close resemblance between the general circulation of the Sun and that of our atmosphere. There is evidence of periodic surges in the solar atmosphere extending over a period of 11 years. Thunder-storms probably occur in the Sun upon a scale immense compared with those in the Earth's atmosphere; their influence upon the solar atmosphere is discussed.

The discovery by Abbot that the Sun is variable opens up the prospect of further discoveries in connection with solar and terrestrial phenomena—the most important practical problem in the region of physics or meteorology.

It is the hope of astronomers that the Earth will be completely girdled by observatories, which will take part in the international scheme of co-operation in solar research. The promise of such observatories in Australia and New Zealand is welcomed by all interested in the development of solar and terrestrial meteorology.

Arthur Auwers.

To the roll of distinguished Astronomers whose deaths have occurred in the last few years must now be added the name of Arthur Auwers, who died on January 24, 1915, exactly a year later than his friend Gill. Born on September 12, 1838, he was three years younger than Newcomb and eight years older than Boss. These three Astronomers were the foremost representatives in their generation of those who worked on "fundamental astronomy." This important and somewhat technical branch of Astronomy has for its object the accurate determination of the positions of the brighter stars in the sky and of their proper-motions, so that they may serve like principal points in a geodetic survey as points of reference for the positions of other heavenly bodies and of fainter stars. On the labours of these three Astronomers, in criticizing and correlating the observations of many observatories from 1755 to 1900, our knowledge of planetary and stellar movements is largely grounded. Particularly, we are indebted to Auwers for the re-reduction of Bradley's observations, which enabled him to determine the proper-motions of more than 3000 of the brightest stars of the Northern Hemisphere. These



ARTHUR AUWERS.

results have served as the basis of numerous researches on precession, solar motion, star-streaming, etc., and have also been of great value in co-ordinating and controlling catalogues giving the positions of fainter stars.

Auwers's astronomical career began at the Observatory of the University of Göttingen, where he was an observer of the positions of comets and minor planets, varying his occupation by an occasional computation of orbits. He also made many excellent observations of variable stars, whose study had been greatly increased by Argelander's influence. In the year 1859 he was appointed Assistant at the Observatory at Königsberg, the scene of Bessel's labours from 1810–1846. He was at Königsberg for only three years, 1859–62, but this sufficed to give him a portion of Bessel's spirit. Auwers used the famous heliometer with which the distance of 61 Cygni was determined. Auwers made measures of double stars, and added appreciably to existing knowledge of stellar parallax by extensive series of observations of 61 Cygni, Lal 21258, ζ Ursæ Majoris, and Procyon. He also made an exhaustive investigation of the irregularities in the proper-motions of Sirius and Procyon, to which Bessel had drawn attention and attributed to the presence of a massive but invisible companion. From 1862–66 Auwers was an Assistant at the Observatory at Gotha. His first important contribution to Fundamental Astronomy was published in 1865, and consisted of the establishment of a "Fundamental System of Declinations" and the systematic differences of various Star Catalogues from this system. The basis of this fundamental system of declinations is the mean of 13 Catalogues, including those of Bessel, Struve, Argelander, Pond, Henderson, Johnson (St. Helena), and the earlier catalogues of Airy at Greenwich, with proper-motions determined by comparison with Bradley's positions in 1755, as given in Bessel's 'Fundamenta.' In 1866 Auwers was appointed a Member of the Berlin Academy of Sciences, and changed his residence from Gotha to Berlin. He commenced the great work of the re-reduction of Bradley's observations about this time, a work which occupied him ten years.

Bradley's observations were made at Greenwich from 1750 to 1762. They were not published till 1798, when in an un-reduced form they were edited by Dr. Hornsby for the University of Oxford In 1807 Olbers gave his copy to Bessel, who reduced the observations and published the 'Fundamenta Astronomiæ' in 1819. The progress of Astronomy in the first half of the 19th century, to which this great work contributed so largely, made a further and more complete reduction of Bradley's observations possible and of value. Auwers made the re-reduction with characteristic thoroughness. He obtained Bradley's manuscripts, and went through them figure by figure. The mean position for 1855·0 was calculated for each observation, and the comparison

of the separate results enabled Auwers to detect a considerable number of errors. The instrumental errors were carefully investigated, and particularly the positions of the clock-stars relatively to one another were very completely determined, so as to secure freedom from periodic error in the resulting catalogue. For the observations of zenith distance, to obtain the index-errors of the Quadrants, Auwers reduced 1427 observations of 85 stars observed by Bradley with the Zenith Sector. To these he added a series of observations by Maskelyne made from 1768–86, and a series observed by Bradley at Wanstead. In this way a catalogue of the zenith distances of 130 stars was compiled, which served to give the zenith points for observations with the Quadrants.

This re-reduction by Auwers gave accurate positions for 1755 for 3268 of the brightest stars observable in the latitude of Greenwich. A second catalogue of these stars for the epoch 1865 was derived from the Greenwich observations from 1854 to 1867. Thus, the proper-motions of these stars were obtained with great accuracy. The whole work was published in three volumes. Vol. III., giving the catalogue and proper-motions, appeared in 1888, and Vols. I. and II., giving the method of reduction in detail, in 1903 and 1882. The Gold Medal of the Royal Astronomical Society was awarded to Auwers in 1888, when the judgment of English Astronomers on this great work was expressed by the President, Dr. Glaisher, as "admiration of the manner in which the most refined skill has been combined with the most patient care in its performance."

Auwers took an important part in the execution of the great catalogue of the Astronomische Gesellschaft. It was decided that uniformity among the co-operating observatories would be best secured by making the observations differential. The construction of a Fundamental Catalogue was entrusted to Auwers. This he made to agree systematically with the Pulkova Catalogue of 1865, but used several other catalogues in conjunction with it, and derived proper-motions from comparison with Bradley. A provisional catalogue was published in 1869, and from 1878 onwards ephemerides of the stars were published in the *Berliner Jahrbuch*. Corrections were published in 1878, which made the catalogue definitive as far as the project of the Astronomische Gesellschaft was concerned. Auwers also constructed a fundamental catalogue for the extension from declination $-2°$ to $-23°$. The system of declinations which Auwers obtained was strongly criticized by Boss on the ground of the unknown errors due to the flexure of Bradley's Quadrant, which introduced errors of systematic character into the proper-motions. Boss began with Bessel's observations of 1820, and the proper-motions obtained by comparison of these with positions obtained about the end of the 19th century established the existence of considerable systematic errors in Bradley's declinations. But, although the

observations of Bradley can no longer be taken as the origin for a fundamental system, the large number of stars, and their comparatively small accidental error, has made Auwers's re-reduction—especially when correction is made for systematic errors—the most valuable source for the determination of the proper-motions of stars. It has formed the basis for determinations of the constant of precession, the direction of the solar motion, numerous researches on stellar distribution and movements, and was the material which led to Kapteyn's discovery of two star-streams.

Auwers supplemented his re-reduction of Bradley by reducing Mayer's observations at Göttingen. He thus obtained a catalogue of 1027 stars for the epoch 1755, and made by full comparisons with later catalogues determinations of proper-motions of those stars not observed by Bradley or observed only in one element. Only last year he published a catalogue of 4219 stars for the epoch 1745 from observations by Bradley with the old meridian instruments at Greenwich, before Bird's transit instrument and the new quadrant were installed.

Reference has been made to Auwers's formation of the fundamental catalogue of the Astronomische Gesellschaft. In addition, the Zone Berlin A from Dec. $+14^\circ\ 50'$ to $+20^\circ\ 20'$ was his work. He himself observed the transits of 9789 stars, each star being observed at least twice, the circle being read generally by Dr. Romberg. The bulk of the observing was done between June 29, 1869, and August 12, 1871, a few supplementary observations being made later to clear up errors and to fill gaps caused by bad weather. The instrument employed was the old meridian circle of the Berlin Observatory, constructed by Pistor in 1829, with a circle re-divided by Martins in 1845. The observations have not, therefore, the high accuracy obtained in the other Berlin zones, 20° to 30° Dec. and 70° to 75°. The catalogue is, however, remarkable for the fullness and thoroughness of the comparisons with other catalogues, and the resulting determinations of the proper-motions of the faint stars.

Auwers took a large share in the organization of the German expeditions to observe the Transit of Venus in 1874 and in 1882. He went himself to Luxor in 1874 and to Punta Arenas in South America in 1882. The report of the German undertakings was drawn up by him, and is published in six large volumes. Another Astronomical Expedition made by Auwers was to the Cape in 1889, when he shared with Gill the observations of Victoria for the determination of Solar Parallax. He took an important share in Gill's researches, as he carried out a very complete discussion of the meridian observations made to give the positions of the reference stars.

Auwers was widely known and honoured. He received many marks of distinction in recognition of his work, including from Great Britain the Gold Medal of the Royal Astronomical Society

and the Foreign Membership of the Royal Society. Only two years ago, the occasion of the fiftieth anniversary of his taking his Doctor's degree was celebrated by the institution of the Bradley Medal of the Royal Prussian Academy of Sciences. The Medal, which bears the inscription "In memoriam J. Bradley et F. W. Bessel astronomorum illustrium" and "Condidit A. Auwers die xxv Juni MCMXII," is to be awarded for original research on the lines of Bradley or Bessel. At the same time a copy of the portrait of Bradley belonging to the Royal Society was presented to him. Auwers was a prodigious worker, who revelled in detail, and thought no pains too great, if only greater accuracy could be obtained. Astronomy is pre-eminently a study in which this is necessary, and the labours of such as Auwers are indispensable to secure the foundations of the science. F. W. Dyson.

The Sun-spots of the Third Quarter of 1914.

The Sun's surface was not entirely free from disturbance on any single day during the quarter, spots or faculæ or both being present on all the photographs. The number of groups measured during the period was 24, of which 6 were only shown on single days, thus providing evidence of the continuance of the increase in solar activity noted during the second quarter. The mean daily spotted area also showed a considerable increase, being about double that of the second quarter. The great spot of August, which was visible to the naked eye at the time of the solar eclipse, reached on August 20 an area of 800 millionths of the Sun's visible hemisphere, and on its return in September, with an area of about 480 millionths, was still larger than any other group during the quarter. In fact, the only other group that could be called large, No. 7067, did not reach an area of 300 millionths, though it had probably been larger before it appeared round the eastern limb of the Sun.

The latitude of the groups was still high, as is usual at the present phase of a cycle, not one being within 17° of the Solar Equator. The group in the highest latitude, No. 7052, was remarkable as showing, in an interval of 5 days, a fairly regular drift of 9° in Longitude and, more striking still, of 5° in Latitude towards the Sun's pole.

No marked magnetic disturbance was associated with the passage of the great spot.

Rotation 813 began 1914 July $1^{d}\cdot484$ G.C.T.
" 814 " July $28^{d}\cdot690$ G.C.T.
" 815 " August $24^{d}\cdot921$ G.C.T.
" 816 " September $21^{d}\cdot182$ G.C.T.