Eclipse of 1870, near Cadiz; he was more fortunate than some other members of the Spanish Expedition, and obtained polarimeter measures of the intensity of the atmospheric polarisation during totality, as well as a drawing of the corona. He became a Fellow of our Society in January 1874, and died on April 3, 1875, from an attack of bronchitis.

RICHARD CHRISTOPHER CARRINGTON was born on the 26th of May 1826, at Chelsea. He was the second son of Mr. Richard Carrington, a brewer, at Brentford, in Middlesex. At seven years old he was sent to a school kept by a Mr. Faithful, at Hedley, where he remained until his father sent him to be prepared for college in the house of a clergyman named Blogard. In 1844 he entered at Trinity College, Cambridge, and in 1848 he took his degree, obtaining the place of 36th wrangler.

His father had intended him for the Church; but, as Mr. Carrington says, in speaking of himself in the preface to his *Redhill Catalogue*, "the tenour of my mathematical studies at the University of Cambridge, acting on mechanical propensities to which I had always been addicted, gradually made it clear to me that I was more naturally adapted for the pursuit of some physical science involving observation and mechanical ingenuity" than for a profession like the Church.

The Astronomical lectures of Professor Challis, which he had attended while a student at the University, gave the final impulse which led him, on leaving Cambridge, to prepare himself systematically for the work of an observatory. The consent of his father was given without opposition; and as his probable future means promised him the opportunity of pursuing his selected occupation on his private resources, it was, as he says, "with the object of acquiring experience and of avoiding wasteful and injudicious expense," that he applied for and held for nearly three years the appointment of Observer in the University of Durham. The Observatory had not long been founded, and was but poorly supplied with instruments. The results of his labours here were not very satisfactory to himself, but the accounts of his attempts at organised work while at the Observatory will be found in a little 8vo volume published in 1852.

Finding that there was but little chance of his being supplied with fresh instruments, he determined to abandon the Durham Observatory, and to establish one of his own. He had, however, while at work in the little University town, found good opportunities for reading, and had formed a plan for completing the survey of the heavens which had been commenced by Bessel and Argelander, and had only been carried by them as far as the eighty-first degree of north declination. And at the same time he determined to advance upon their survey by employing a meridian instrument of sufficient power to include stars of the 10th magnitude. After long search for a fitting locality he determined on building a house, with an observatory attached, at Redhill. This he furnished with a transit-circle (now at the Radcliffe Observatory, Oxford) similar to the Greenwich instrument, though smaller, having a telescope of 5-in. aperture and $5\frac{1}{2}$-feet focal length. The instrument and its adjustments are carefully described in the preface to the *Redhill Catalogue.* There was also a $4\frac{1}{2}$-inch equatoreal, which was used for roughly observing the stars in the polar zone and for making a preliminary or working catalogue.

The site for the observatory was fixed upon in June 1852; but the real work of observing was not commenced till 1854.

The survey of the polar zone, which he then began, occupied three years, during which time he catalogued the places of 3,735 stars within a distance of 9° from the pole. Each star, whatever its magnitude, was observed at least three times, and those near the pole were observed more frequently. These observations were also thoroughly reduced and catalogued, and maps corresponding to the catalogue were engraved on copper in nine sections of convenient size.

In addition to the labour of the actual observations and the reductions for the catalogue, considerable time was expended in determining the errors of his instruments, and in making a preliminary or working catalogue of 4,400, from which the 3,735 stars spoken of above were selected.

When the work was ready for the press Mr. Carrington applied to the Admiralty for assistance in printing the volume. The official consideration of the application occupied some weeks, and M. Le Verrier having accidentally heard that the publication was for the time at a standstill, offered to provide for the immediate appearance of the work as a part of the next volume of the *Annales* of the Paris Observatory. The acceptance of M. Le Verrier's offer was, however, rendered unnecessary by the decision of the Admiralty authorities, and the catalogue was published in 1857 in a small folio form.

The labour which had been expended upon the work soon attracted attention, and two years later the Council of our Society decided on bestowing on Mr. Carrington the highest mark of their approval by awarding him the Gold Medal for the year 1859. In presenting the medal, Mr. Main, in his presidential address, remarked that "No one could read the introduction to the *Redhill Catalogue* without gaining an idea of the positive zest with which Mr. Carrington seemed to grapple with difficulties and to conquer them one after another as they occurred."

Professor Schwerd, of Speyer, had, between the years 1826 and 1828, made a catalogue of some 680 polar stars which fell within the zone surveyed by Carrington; Schwerd's observations had been reduced and catalogued by Oëltzen, but of this Carrington was not aware when he commenced his labours. Upon making the discovery, he brought up the places of the 680 stars to his own epoch, and compared them with his own results.

This comparison greatly increased the labour of preparing his catalogue, but gave occasion, as Mr. Main says, "for a most elaborate and instructive dissertation on the whole theory of precession, nutation, and aberration, and especially on the application of it in the case of stars very near the pole." This dissertation, which is contained in the introduction to the *Redhill Catalogue*, is itself a remarkable production, and though the author disclaims any novelty, it will repay the attentive study of any astronomer who may be engaged in observations similar to those of Mr. Carrington.

But to proceed to the subject with which Mr. Carrington's name will, probably, in the future be even more closely connected than with the polar zone of stars. While in 1852 he was superintending the progress of the building of his observatory at Redhill, and was kept for a time from access to instruments, he was led into the study of some series of drawings of the Sun's disk in the possession of our Society. At that time Schwabe's discovery of the periodicity of Sun-spots had but recently been made, and the corresponding periodicity in magnetic disturbances had just been pointed out independently by both General Sabine and Professor Wolf. Carrington was anxious to retrace the dates of maxima and minima of past Sun-spot periods, and was much impressed with the capricious manner in which observations of the solar phenomena had commonly been taken up and laid aside again. As might be expected there were considerable discrepancies in the results of previous observers as to the elements of the position of the Sun's axis and its period of rotation. Carrington, therefore, determined that he would devote himself to a close and methodical record of Sun-spot phenomena for an eleven-year period. There was the personal advantage that he could make the study a subject of secondary importance to the star catalogue which he was about to commence. As he expressed it, "the observation of the stars required the hours of the night, and afforded little matter for speculation; the observation of the Sun was a day-task, and presented more variety and interest."

In order to carry out his plan it was necessary for him to devise a simple system of observation which should be more accurate than any that had been before adopted. The method he pursued did not occur to him at once in its final form, but grew out of a notion of making the disk of the Sun its own circular micrometer, and the process of reduction was successively improved, and more than one volume was commenced and put in the fire as means of simplifying the process came into view by practice and trial.

The image of the Sun was projected on a screen placed at such a distance from the eyepiece of his $4\frac{1}{2}$-inch equatoreal telescope that the Sun's disk projected upon the screen had a diameter of about 11 inches. In the focus of the telescope he placed two bars of flattened gold wire at right angles, or very nearly at right angles, to one another, and turned *approximately* into the position of being inclined 45 degrees on each side of the meridian or parallel of declination. The telescope was fixed and the image of the solar disk was then allowed to pass across the field, and the times of contact of the Sun's limbs and the spots with each of the bars was noted. This operation was repeated three or four times, and from the observed interval of time between the successive contacts the positions of the spots with regard to the Sun's centre were determined. This simple method, requiring no micrometer or clockwork, enabled him to determine the heliographic latitude and longitude of a small spot with an error when near the apparent centre of the Sun's disk of only a few minutes of arc upon the Sun's surface. Besides these measurements, the spots and groups of spots upon the Sun's disk were carefully drawn upon every available occasion, and the work was regularly carried forward for a period of $7\frac{1}{2}$ years, from November 9, 1853, to March 24, 1861. The observations were systematically reduced as time went forward, and they were finally discussed in a ponderous quarto volume published in 1863 with funds from the Royal Society's grant.

But to return to the results of his labours. At the time when Carrington commenced his undertaking, the position of the Sun's axis and the time of his rotation had been at various times roughly determined by Laugier, Böhm, Petersen, and Kysœus; but the determinations were founded on the observations of only a few spots which had been selected without due regard being paid to their being spots suitable for the purpose of measurement. Carrington speedily found that the large and irregular spots were unfitted for the purpose, owing to the rapid transformations taking place in their form from day to day; and small and circular spots when in the neighbourhood of other spots or groups were also found to be unsuitable, owing to the repulsive action which spots appear to exercise upon others in their immediate neighbourhood. Carrington, therefore, selected observations of small isolated spots from his series; and, from a comparison of a large number of their motions, determined the position of the Sun's axis with a precision that had not before been approached.

In determining the period of rotation he found that those spots whose latitudes were great had a drift backwards upon the Sun's surface, so that the rotation period determined from them was longer than that determined from similar spots situated nearer the Sun's equator.

On carefully tabulating the drift of spots in various heliographic latitudes he found that there was a difference of more than two days in the rotation period of spots on the solar equator and in those of spots in latitudes $\pm$ 50°, which is about the extreme limit north and south at which spots usually appear. He further succeeded in showing that the daily drift of different parts of the photosphere follows such a law that the rotation of a spot in heliographical latitude l in one solar day may be fairly represented by the expression $865' \mp 165 \,.\, \sin \frac{7}{4}\,(l - 1°)$.

This important discovery was entirely due to his laborious series of observations and their careful reduction. Previously, indeed as early as 1845, Dr. Peters had satisfied himself that the solar spots had what he called proper motions of their own. But earlier observers had failed to reduce these proper motions to any law, and thus the great systematic drift of the photosphere had not till then been brought to light.

During the year 1858 Carrington's labours in this interesting field of investigation were interrupted by the death of his father, which necessitated his taking the management of the Brentford Brewery, a business of some magnitude. His new occupation did not, however, cause him entirely to abandon his astronomical pursuits. He continued to find time for the supervision of the solar work and for the publication of several interesting papers in the *Monthly Notices* embodying his most important conclusions.

Amongst Carrington's papers in the *Monthly Notices* especial reference ought to be made to a paper published by him in 1858, "On the Evidence which the observed Motions of the Solar Spots offer for the existence of an Atmosphere surrounding the Sun;"* papers "On the Distribution of the Solar Spots in Latitude between the years 1854 and 1858" and "On certain Phenomena in the Motions of Solar Spots."

In the 20th volume of the *Monthly Notices* he published a description of an intensely bright outbreak which he observed in the area of a great solar spot on September 1, 1859. This eruption, which only lasted a few minutes, appears to have been accompanied by a synchronous disturbance of the magnetic needle. No similar outbreak had been noted either before or since, and fortunately Carrington's observations were confirmed by Mr. Hodgson, who happened to be observing the Sun at the same moment at Highgate.

The reader should also refer to a paper "On Dr. Soemerring's Records of the Solar Spots made between the years 1826 and 1829," *Monthly Notices*, vol. xx., p. 71, and a paper "On the Distribution of the Perihelia of the Parabolic and Hyperbolic Comets in relation to the Motion of the Solar System in Space," which was published in the XXIXth volume of the *Memoirs*. Out of the 133 parabolic and hyperbolic orbits which he considered, he found that the perihelia of 61 lie in the hemisphere of which α *Columbæ* is the pole, or the hemisphere from which the Sun is moving, while 72 lie in the other hemisphere, towards the pole of which the Sun is assumed to be moving; the mean angular distance between α *Columbæ* and each perihelion coming out $95^\circ\ 36'$: a result which other evidence shows must be regarded as nugatory and vitiated by uncontrolled conditions,

* Mr. Carrington was subsequently led to modify the conclusions which he draws in this paper.