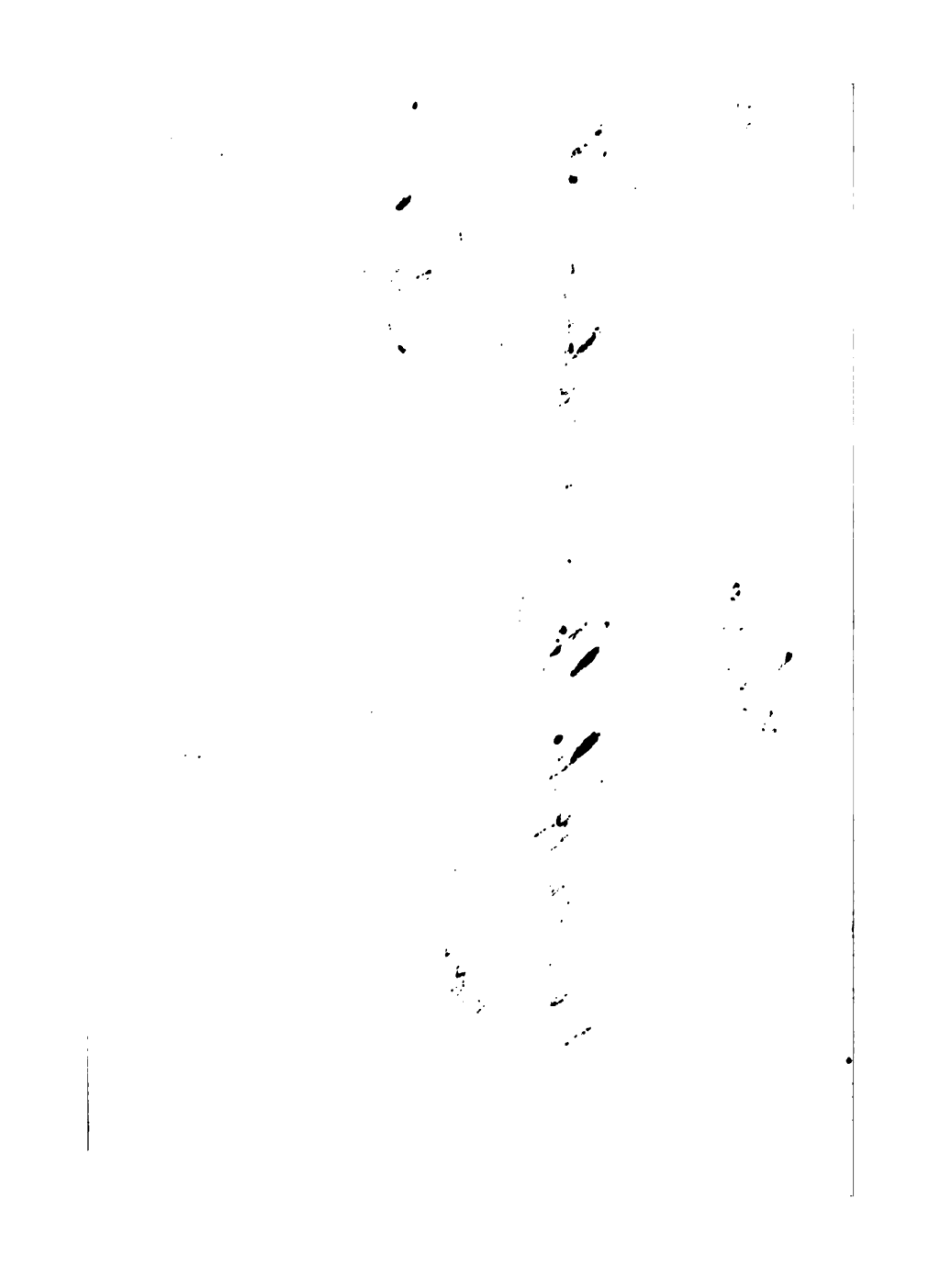
LIFE AND LABOURS
OF THE
REV. JEREMIAH HORROX

Memoir of the Rev. Jeremiah Horrox.



MEMOIR OF THE LIFE AND LABOURS

OF THE

REV. JEREMIAH HORROX,

AUTHOR OF

"THE TRANSIT OF VENUS OVER THE SUN."

November 24th, 1639.

"The pride and boast of British astronomy."

Sir John Herschell.

BY THE

REV. ARUNDELL BLOUNT WHATTON, B.A., LL.B.

London:

WILLIAM HUNT AND COMPANY,

HOLLES STREET, CAVENDISH SQUARE;

AND AVE MARIA LANE, PATERNOSTER ROW.

1875.

In Memoriam

PATRIS DILECTISSIMI

GUL: ROB: WHATTON, F.R.S., F.S.A., ETC.,

VIRI LITERIS HUMANIORIBUS EXIMIE ERUDITI,

HAS EGREGII ADOLESCENTIS RELIQUIAS,

QUEM VIVUS IPSE EST MIRATUS,

CUM QUO MORTUUS, FAS EST CREDERE, CONSORS,

COLLIGENDAS ET IN LUMEN PROFERENDAS CURAVIT

FILIUS AMANTISSIMUS

A. B. W.

—

1859.

1875.

—

To the dear Memory of

MY HUSBAND,

ARUNDELL BLOUNT WHATTON, B.A., LL.B.,

AND OF HIS FATHER,

WILLIAM ROBERT WHATTON, F.R.S., F.S.A., ETC.

M. E. W.

PREFACE TO SECOND EDITION.

At this time, when so much interest has been excited by the Transit of Venus, a re-issue of the "Memoir of Horrox" has been widely called for. To meet this desire, it has been deemed unnecessary to do more than simply reprint the Life as it originally stood, in a cheaper and more popular form; omitting entirely the Translation of Horrox's Treatise on the Transit of 1639, which was appended to the former edition, published in 1859.

M. E. W.

February, 1875.

PREFACE.

WHEN my father was engaged in writing the Biographical department of the History of Lancashire, he was naturally led to consider the merits of JEREMIAH HORROX, the youthful astronomer of that county; and he was so much impressed with his distinguished scientific attainments that, finding it impossible from want of space to do him justice in those pages, he proposed on some future occasion to publish his life in a separate form. Accordingly, he ascertained the precise value of his discoveries, and gathered together much interesting detail connected with his personal history; and he also set about pre-

paring a translation of his celebrated Treatise upon the transit of Venus over the Sun. But he did not live to complete this work. It would appear that much material had been accumulated, but that the arrangement of it had not even been commenced. To him, however, belongs the credit of being the first and only person who has undertaken to supply what is acknowledged to be a deficiency in the literature of our country; and there can be no doubt that, if his life had been spared a little longer, he would have produced a most interesting and instructive volume. Professor Rigaud, of Oxford, who was his friend and associate in these pursuits, says in his "Correspondence of Scientific Men of the 17th century," that "the late W. R. Whatton, Esquire, had made considerable collections for a life of Horrox, which he intended to have prefixed to a new edition of the *Venus in sole visa*, when death in 1835 deprived the world of the fruit of his inquiries."

Since then no further attempt of this kind

has been made to recognise the merits, or to perpetuate the memory of Horrox. Of late years, however, his name, associated with the names of other persons of distinction, has been brought before the public from time to time by various speakers at literary and scientific meetings, especially in Lancashire. Thus, in an address delivered in Liverpool on the celebration of the centenary of the birthday of Roscoe, the Rev. Dr. Hume says, "Neither is Roscoe the first man of high intellectual attainments that Liverpool has numbered among her sons. More than two centuries have elapsed since Jeremiah Horrox, a native of Toxteth Park, and then only twenty years of age, observed the first transit of Venus across the Sun. His high attainments at that early period, in astronomy and pure mathematics, have been the admiration of succeeding men of science. His reputation may be said to have reached his native country from the Continent, by the publication of his treatise *Venus in sole visa*, at Dantzic; and it is only of late years that

Professor Rigaud and Mr. Whatton have laboured successfully to do justice to his memory."

The fame of Horrox has also been disseminated through the instrumentality of the press, letters having occasionally appeared, complaining that no record of his discoveries has been published in our native tongue, and commending the subject to the attention of those competent to deal with it. One of these, taken from the columns of a newspaper, was, a few months ago, enclosed to me by a friend, in which the writer thus alludes to the remarks of Professor Rigaud, already quoted:

"A life of Horrox is much wanted. Very little is known indeed of his daily work, but that little is such as to create a desire of knowing as much about him as possible. The particulars gathered up by Mr. Whatton will, I trust, be heard of, and make us better acquainted with one whom Sir J. Herschel justly calls 'the pride and boast of British astronomy.' And surely the *Venus in sole visa* ought to have an English edition, for if, as Grant remarks, 'it does not

redound to the credit of England that this exquisite relic of one of her most gifted sons should have been allowed to see the light in a foreign land,' neither does it evince a due regard for the labours of scientific men that this famous dissertation has yet to be published in our own country. I should be very much obliged for any information of the Whatton papers."

Upon receipt of this extract, I searched for anything in my possession that might be available, and found sundry memoranda, and some interesting letters from Mr. Rigaud, the perusal of which led me to prosecute the inquiry until I was enabled to carry out, in some degree, the original design, by preparing a Memoir of the life of Horrox, and a translation of his discourse upon the transit of Venus.

It is felt that this little work is a very imperfect substitute for what might have been achieved by abler hands; but being in possession of the details of Horrox's personal history, I should scarcely have been justified in withholding

them, as it is a hopeless task for a stranger, on the spur of the moment, to attempt to look for such particulars as may be collected from a lengthened course of general reading. My aim has been to show the value of his labours, and to fix the place they occupy in the history of science; and also to make his merits more widely known than they are at present, in order that he may enjoy in the estimation of the public the rank which he already holds in the opinion of the learned. Accordingly, such letters and quotations as were written in Latin are here given in English. This will not occasion any confusion, as those which are translations may be distinguished at a glance from others which have been merely copied.

It will be observed that the name of Horrox is sometimes spelt *Horrocks*. I have carefully examined which orthography is the more correct, and have adopted the former, as the name is so entered upon the College Register, and was always so written by Crabtree and Wallis. Grant and

some recent authors use the latter method. The difference is of no importance, and it is only noticed here by way of explanation.

In the translation of the *Venus*, I have endeavoured to adhere closely to the original, and have taken the text of Hevelius as a basis, merely correcting the punctuation from the Greenwich manuscript where it was necessary to do so, and altering the arrangement of the sentences where the difference of language required it. The Dantzic edition is accompanied by voluminous notes which are appended to the end of each chapter, and at first I thought of giving them precisely in the order in which they stand. Afterwards it occurred to me that it would be better to print Horrox's dissertation entire, and to collect the notes together, and put them at the end by themselves, so as to present a clearer view of the treatise, without having the attention continually called off, sometimes, indeed, when there is no difficulty that needs to be explained. At length, however, I decided to omit them

altogether, as they contain nothing of importance connected with Horrox's personal history, and are full of error upon those points which they were designed to elucidate. The mistake that Hevelius has made in his statement of the parallactic angle is an instance of this, and has given rise to many faulty corrections in his comment. Flamsteed noticed it, and did not consider his remarks a very valuable appendage; for in a letter to Collins, he says, "Having well perused the *Venus in sole visa*, I know not what can be added. The notes of Hevelius I find generally useless, and those on the 6th chapter absolutely false." The side notes which are found in the printed edition have also been excluded, as it is certain that they are not authentic. These accretions being removed, the tract appears in the same form, though not in the same dress, as that which it had when it came from the pen of its author; and the reader is enabled to peruse it without distraction, and to arrive at an independent opinion of its merits.

In writing what follows, I have consulted Ferguson, Delambre, Montucla, Grant's Treatise upon Physical Astronomy, and the suggestions of Professor Rigaud contained in the manuscripts in my possession. The correspondence between Huygens and Hevelius is taken from Huygens' papers preserved in the public library at Leyden. No doubt there is abundant room for criticism; but it may be pleaded that the task was wholly unsought, having devolved on me from circumstances over which I had no control, but from the obligation of which it would have been unworthy to retreat. Should these pages be deemed insufficient for the purpose which has been announced, I can only say that I shall be much gratified if some one more competent than myself to do justice to the memory of Horrox, will make use of the material here gathered together, to produce a better work. And I may add, as a further extenuation, that they have been penned in such brief intervals of leisure, during the last few months, as remained over and

above the discharge of more important duties; so that I may fairly take refuge in Horrox's own words, "Ad majora avocatus, quæ ob hæc parerga negligi non decuit."

A. B. W.

39, Weymouth Street, Portland Place,
July 26th, 1859.

MEMOIR OF JEREMIAH HORROX.

WE are familiar with the names of some writers who have contributed scarcely anything of real value to the literature of their country; whilst we are ignorant of the worth of many others who occupy a distinguished position in the commonwealth of science. Thus few persons have heard of JEREMIAH HORROX, although his merits as an astronomer have been acknowledged by the most eminent scientific men who have succeeded him. But he lived in obscurity, and died young. He was not permitted by an allwise Providence to carry on his investigations for more than a few short years. He did not even enjoy the satisfaction of publishing his own discoveries. He was cut off in the midst of usefulness, and others have entered into his labours. Hence he

is comparatively unknown. Happily his performances, as a skilful pioneer for the advancement of knowledge, are well authenticated, and are of sufficient importance to make his name illustrious. He paved the way for some of the most brilliant triumphs of the human intellect. Learned men have freely acknowledged this; and in tender regard for the memory of one who expired whilst full of hope and promise, have constituted themselves the trustees of his reputation, and set their seal to his ability and worth. It is thought, therefore, that the details of his history may not be unacceptable, especially as his valuable services are now about to be recognised by a monument raised by subscription; and that the disinterested efforts of this young philosopher in search of truth cannot fail to enlist the sympathy and admiration of all who are made acquainted with them.

He was born at Toxteth Park, near Liverpool, in the year 1619. Little is known as to the position and circumstances of his family; but in the scanty notices of him that remain, he is generally spoken of as a person of humble origin. It seems probable, however, from his having been

classically educated, and destined for one of the learned professions, that this representation is rather overdrawn, and that the Horrox family were not so obscure as they have been described. Liverpool was not then a seat of industry, enterprise, and intelligence, but a place of comparative insignificance; and Toxteth, far from being a wealthy and elegant suburb, was only a little village, about three miles distant from it, in the County Palatine of Lancaster. It is therefore extremely unlikely that he could have received any considerable advantages in his native place; and in those days, on account of the expenses of travelling and residence, it was not usual for a young man entirely without means to be sent to the ancient seats of learning. Hence we are led to conclude, either that his parents were in easy circumstances, and able to value the benefits of a liberal education, or that the genius of young Horrox attracted the attention, and secured the patronage of some person of distinction. Upon this and other points connected with his opening history, it is to be regretted that we possess so little information; for the auspices under which life commences, and the incidents of childhood,

not unfrequently form an interesting page in the biography of great men. The school campaign, with its successes and failures, its schemes, friendships and amusements, affords ample scope for the display of a boy's taste, talent, and disposition, and gives some indication of what may be expected from him in after life. Thus Isaac Newton, withdrawing from the noisy playground, spent his leisure hours in the construction of water-clocks, and other mechanical contrivances; Halley set up a sun-dial, and had observed the variation of the needle before he left school; Watt took an early pleasure in the manual exercises of his trade; James Ferguson made a watch of wood-work when quite a boy; and it is reasonable to suppose that Horrox in like manner showed a partiality for the pursuits in which he afterwards distinguished himself. In those days lads of more than ordinary promise were admitted to the University much younger than they are at present, especially if introduced by an influential patron; hence we are not surprised to find that as soon as Horrox had received the rudiments of education at Toxteth, he was entered at Emmanuel College, Cambridge, before he had attained his

fourteenth year. The following is a copy of the register:—

"Jeremiah Horrox. Born at Toxteth, Lancashire. Entered Sizar, 18 May, 1632."

His having been placed on the College foundation tends to confirm the surmise that his parents were not affluent, and that his advantages had hitherto been limited. But we know from the history of others who have attained to eminence in the several departments of learning, that the aspirations of genius cannot be wholly crushed by poverty, but that it will rise superior to circumstances, as surely as a blade of grass breaks through a clod of earth, and points its spire to the heavens. Horrox hailed with delight his removal from the village school to a seminary abounding with the means of intellectual improvement, and resolved to make the most of his opportunities. Having read the few subjects which were then included in an academical education, he explored the wide field of classical literature, readily yielding to its allurements, and regarding them as more than a compensation for any amount of labour. He particularly cultivated

the best Latin authors, in order to become familiar with a language which was then the only medium of communication amongst the learned. In this way he acquired a large store of general knowledge, and was enabled to gratify his taste for any favourite pursuit. In a word, he drank deeply at the Castalian fount, and by his industry repaid the effort that had been made to send him to Cambridge.

But whilst he was fully capable of appreciating the advantages of an University, he did not remain at College longer than was absolutely necessary, being desirous of preparing for the work of the ministry, which he had adopted as the profession of his choice. Some doubt has been entertained as to whether he was ever admitted into holy orders. Young men are now required to be twenty-three years of age before they can be ordained, whereas he was not more than twenty. This objection might easily be answered by the fact that two centuries ago the question of age was not so strictly attended to, the Bishop exercising a discretionary power. But fortunately we are able to place the matter beyond conjecture; for in a treatise by John Gadbury, the compiler of almanacks, there is mention of

"Ephemerides of the planetary motions, eclipses, conjunctions, and aspects for fifty years to come, calculated from the British tables, composed first by the *Reverend* Mr. Horrox, and first published by Jeremy Shakerley."

He commenced his ministerial labours in his native county, being ordained to the curacy of Hoole, in Lancashire. This place formerly consisted of a narrow strip of land, having a large extent of moss on the east and west, the waters of Martin-Mere and the Douglas on the south, and the overflow of the Ribble on the north. It was therefore almost an island; and though doubtless an open situation for an astronomer, it could not have been a very agreeable residence. This once desolate spot is now a thriving township containing about a thousand inhabitants. The hand-loom and power-loom furnish their chief employment, though much of the land has been reclaimed, and is under tillage. The parish church, which was erected in the fifteenth century, is dedicated to Saint Michael, and consists of a plain brick nave without side-aisles, a chancel, and a stone tower supported by four pillars. There has long been an endowment for

educational purposes, and about eight years ago a good national school and school-house were built after a plan by the Government architect, at a cost of £600. Mr. Horrox's first letter from Hoole is dated June, 1639, and he continued to reside there for some little time. There is no local record of his official connection with the place, as it was not then constituted an ecclesiastical district, being merely a chapel of ease to the mother Church of Croston, the register of which is comparatively modern; but that he was curate of the parish is a matter of history, for, to omit the testimony of other writers, we may mention that Costard, an eminent astronomer who lived at the beginning of the last century, designates him as "a young clergyman of Hoole, near Preston." There is reason to believe that, besides his ministerial avocations, he was in some way engaged in tuition, as he speaks of his "daily harassing duties" during the time he resided there.

It was whilst he was at the University that he first turned his attention to the study of astronomy. With a love of the sublime, and naturally fond of speculation, in the contemplation of the works of God he found a pursuit at once

congenial to his taste, and calculated to bring into active exercise the highest powers of his mind. It did not satisfy him to look with an untutored eye upon the sun, the moon, and the stars shining in the firmament of heaven: he desired to learn something of their magnitudes, their distances, the periods in which they perform their revolutions, and the laws by which they are governed. "It seemed to me," he says, "that nothing could be more noble than to contemplate the manifold wisdom of my Creator, as displayed amidst such glorious works; nothing more delightful than to view them no longer with the gaze of vulgar admiration, but with a desire to know their causes, and to feed upon their beauty by a more careful examination of their mechanism." Animated with these convictions, he prepared to enter upon the study of astronomy by first cultivating with the utmost patience the aptitude for mathematics which he had evinced from his youth. But he had to work without assistance; for at that time no branch either of mathematical or physical science was taught at Cambridge. In this respect she was considerably behind her sister University. Many scientific men had

already emanated from the cloisters of Oxford. Bacon, Sacrobosco, and Greathead were educated there. In short, the renown which Cambridge has acquired and now enjoys in this kind of learning is of a comparatively recent date. Certainly she had no school for science before the commencement of the seventeenth century. This was owing to the endowments of Oxford being older and richer, and to its collegiate system being earlier established. Thus he had no professional instruction. He could not obtain in the University the books he required, nor was there any one capable of advising him as to which it was most desirable for him to procure. This was particularly the case in reference to astronomy, which had scarcely yet taken root in our land. Its votaries had no measure of experience to consult, no body of doctrine to quote. Not a single public observatory had been erected either in England or France, nor indeed had astronomical observation as yet become fairly organized. The difficulty there was in obtaining works on physical science may be illustrated by the following circumstance. Some time ago Mr. de Morgan met with a book which had formerly belonged to Horrox, and

upon examining it, he found that it contained a written catalogue of the library which, at some period of his life, he seems to have possessed:—

Albategnius.
Alfraganus.
J. Capitolinus.
Clavii Apolog. Cal. Rom.
Clavii Comm. in Sacrobos-cum.
Copernici Revolunitiones.
Cleomedes.
Julius Firmicus.
Gassendi Exerc. Epist in Phil. Fluddanam.
Gemmæ Frisii Radius Astronomicus.
Cornelii Gemmæ Cosmocritice.
Herodoti Historia.
J. Kepleri Astron. Optica.
—— Epit. Astron. Copern.
—— Com. de motu Martis.
—— Tabulæ Rudolphinæ.
Lansbergii Progymn. de motu solis.
Longomontani Astron. Danica.
Magini Secunda Mobilia.
Mercatoris Chronologia.
Plinii Hist. Naturalis.
Ptolemæi Magnum Opus.
Regiomontani Epitome.
—— Torquetum.
—— Observata.
Rheinoldi Tab. Prutenicæ.
—— Com. in Theor. Purbachii.
Theonis Comm. in Ptolom.
Tyc. Brahæi Progymnasmata.
—— Epist. Astron.
Waltheri Observata.

Now it is very remarkable that, so far as we can ascertain, not one of these books had been published in our own country. The above interesting relic was sent to the authorities of Trinity College, Cambridge, with a request that

it might be carefully preserved. The student of to-day can hardly enter into the feelings of a young man thirsting for knowledge, and circumstanced in the manner just described. Not to mention the public lectures, libraries, associations, and other advantages which belong to an University, every department of knowledge is now represented to the general reader by so great an abundance of literature that the only difficulty is to make the best selection. Elementary treatises are published at prices which place them within the reach of the poorest scholar. And after all, books are the best teachers: the minds of many who have immortalized themselves and reflected honour upon their country, have been formed without any other assistance. But in the seventeenth century books were scarce and dear. We conclude, therefore, that there are no such drawbacks to be experienced now as those which oppressed the student in science before the days of popular literature. Horrox laboured under the greatest disadvantages, and hence he has all the more merit. He toiled up the sides of Parnassus without friendly assistance or encouragement: he meditated alone upon the abstruse subjects of

philosophical inquiry. Having procured such treatises as he could afford to purchase, he qualified himself for the successful pursuit of the sublime science with which his name will ever be associated. But he has recorded his troubles in touching language:—

"There were many hindrances. The abstruse nature of the study, my inexperience, and want of means dispirited me. I was much pained not to have any one to whom I could look for guidance, or indeed for the sympathy of companionship in my endeavours, and I was assailed by the langour and weariness which are inseparable from every great undertaking. What then was to be done? I could not make the pursuit an easy one, much less increase my fortune, and least of all, imbue others with a love for astronomy; and yet to complain of philosophy on account of its difficulties would be foolish and unworthy. I determined, therefore, that the tediousness of study should be overcome by industry; my poverty (failing a better method) by patience; and that, instead of a master, I would use astronomical books. Armed with these weapons I would contend successfully; and having heard of others acquiring knowledge without greater help, I would blush that any one should be able to do more than I, always remembering that word of Virgil's:—

"'Totidem nobis animæque manusque.'"

Although astronomy had not taken firm root in our land before the time of Horrox, elsewhere it had considerably revived. Its cultivation in Europe was the commencement of a new æra. For the first two hundred years after its introduction upon the Continent, little ground was gained; but subsequently men of genius and strength arose, who effectually exposed the absurd hypotheses then in vogue, put the science upon a right basis, and by delivering it from the trammels of superstition, led the way in a career of perpetual improvement. Thus Copernicus had re-established the old Pythagorean doctrine which places the sun in the centre of the system. This at once simplified all the planetary movements. The apparent revolution of the heavens was explained by the diurnal rotation of the earth. Tycho Brahé had enriched the science by a series of accurate observations. He had detected the lunar inequality, known as the *variation;* he had proved the path of the comet of 1577 to run out beyond the moon's orbit; and he had prepared, as the most valuable product of his labours, a catalogue of 777 of the fixed stars. Kepler had explained the laws of celestial motion. He had

discovered that the planets move in elliptical orbits, with the sun in the lower focus; that the radius-vector describes equal areas in equal times; and that the squares of the periodic times of any two planets are to each other as the cubes of their mean distances from the sun. He had also some knowledge of the laws of gravitation. Galileo had greatly extended the limits of astronomical vision. Having heard that, by a combination of lenses, objects might be made to appear nearer to the eye, he ascertained the truth of the report, and improved the invention so much that he was soon able to explore the heavens with his telescope, and to reveal new wonders to mankind. Milton alludes to his discovery of the inequalities of the moon's surface:—

> "The moon, whose orb,
> Through optic-glass, the Tuscan artist views
> At evening, from the top of Fesolé
> Or in Valdarno, to descry new lands,
> Rivers, or mountains on her spotty globe."

Besides this he had detected the phases of the planet Venus, the four satellites of Jupiter, the spots on the Sun, Saturn's ring, and a multitude of stars too small to be seen with the naked eye.

Thus by the genius of a few great men, the science was completely reconstructed, and enriched with much valuable learning. Its advancement was also hastened by the preparation of tables for facilitating the long and tedious calculations inseparable from astronomical pursuits. But improvement is unsteady in every department of human industry: like the motion of the heavenly bodies, it is at one time accelerated, and at another retarded. An apostle or reformer suddenly appears, and promotes the welfare of his fellow-men by rectifying abuses, and by bringing to light important truths. After he has delivered his message a calm ensues which lasts until another master-spirit arises. It is so in trade, politics, literature, and science; and it is wisely ordered that time should be allowed for testing by experiment the principles that have been broached. The three astronomers last named were contemporaries; and their departure was followed by a period of comparative inactivity. This was however very soon relieved by the appearance of Horrox, upon whom their mantle may be said to have fallen. But he did not take up the prophetic strain from the point where they had left

it; he did not see the writings of his famous predecessors until after he had laboured at astronomy for some time: he had to work out the grammar of the science for himself; to toil over ground that had already been surveyed; and being without friendly assistance, his worst fears of going astray for want of an able adviser were unfortunately realized. Happening to meet with a treatise by D. H. Gellibrand, a professor of astronomy, in London, in which the works of Lansberg were spoken of with unqualified praise, it occurred to him that it might be advantageous to possess them; and after some difficulty, he succeeded in obtaining the *Uranometriam* the *Tabulas Perpetuas*, and the *Progymnasmata de motu Solis*. Pleased with the acquisition, he was induced to neglect the more valuable works of Tycho and Kepler, and to employ himself in computing Ephemerides from the tables of the Flemish mathematician, not suspecting the speciousness of the titles which he prefixes to his calculations; but after a considerable time spent in this manner, he began to make his own observations, using these Ephemerides to point out the situations of the planets, and hence determining

when their conjunctions, their appulses to the fixed stars, and other remarkable phenomena were to be expected.

In the year 1636, he made the acquaintance of William Crabtree, a draper, residing at Broughton, near Manchester, who had long been devoted to the study of astronomy; and a correspondence was at once commenced between them upon the various subjects connected with their favourite pursuit. This intercourse was the signal for increased assiduity on the part of both, and proved in one respect particularly useful to Horrox,—it opened his eyes to the imperfection of Lansberg's tables. Hitherto, upon noticing a disagreement between them and his own observations, he had supposed the error was attributable to himself; and although the same result invariably followed after repeated trial, and there appeared to be no way of removing the discrepancy, rather than doubt the accuracy of one for whom he entertained so high an opinion, he continued equally self-suspicious, and was almost tempted to despair of success. But upon comparing notes with Crabtree, and perceiving that their observations entirely coincided, he called the

attention of that gentleman to the circumstance, and was by him advised for the future to put less faith in the dictates of Lansberg. This led to a more rigorous examination, both of the tables, and also of the principles upon which they were based; and it soon became evident that much of what was put forth as truth was incapable of demonstration.

Emancipated from this tyranny of error, Horrox gathered fresh courage to proceed; he strove to redeem the time he had lost by redoubling his exertions; and afraid of being again misled by the misrepresentations of others, he learned to place more dependence upon his own judgment. At the same time he determined to avail himself of whatever aids and appliances he could obtain: new books and instruments were procured; and instead of seeking seclusion as before, he verified his operations by a regular correspondence with Crabtree. Besides this agreeable intercourse, the two friends presently became known to Dr. Samuel Foster, the Prælector of Gresham College, an able ally, whom they occasionally consulted.

The removal of a false impression such as the one now described, if it does not give an actual

impulse to the mind, at all events restores its wasted powers, and turns them to the best account. The clouds being dissipated, a new light breaks in, by which we can review the experience of the past, ascertain the strength of our present position, and lay down fresh plans for the future. Having escaped from the empiricism by which his expanding genius had so long been circumscribed, Horrox sought out the writings of Kepler, which Lansberg had stigmatized as "falsa et erronea simo absurda, et inter se pugnantia." He instantly perceived their value. He found that, instead of being composed of fanciful speculation or arbitrary assertion, as he had been led to believe, they contained discoveries of such importance as to constitute a new era in the history of astronomy; and he received with transport the elucidation of general laws which were evidently the conclusions of a patient and legitimate induction. He also fully appreciated the merits of the Rudolphine tables, and considered them incomparably superior to those of Lansberg, as the hypotheses were well established, and reconcilable with one another. To amend these tables was now his chief desire. It occurred to him that they might be improved

by changing some of the numbers, but retaining the hypotheses; and that he would be abundantly repaid for this arduous undertaking by the opportunity it would afford for deducing general principles, and especially for verifying Kepler's laws. Accordingly he applied himself to this task with unwearied diligence; and by making frequent observations, and altering the numbers to suit them where it was necessary, he brought the tables to a surprising degree of accuracy, and in doing so, materially added to his information. Speaking of the gratification he derived from the writings of Tycho and Kepler, and the incentive they were to renewed application, he says, "It was a pleasure to me to meditate upon the fame of these great masters of science, and to emulate them in my aspirations;" and accordingly we find that whilst he fully recognised the merits of the illustrious Dane as a skilful observer, his sagacious intellect clearly apprehended the truth of Kepler's doctrines, the universal acceptation of which he sought to promote.

The first efforts of Horrox's pen were directed towards the preparation of a treatise, the object of which was to refute Lansberg's theories, and to

establish a more correct system of planetary distribution. He thought it important to the interests of science that the false hypotheses which then prevailed should be thoroughly exposed, and a misapplication of time and talent prevented for the future; and he wrote several learned dissertations, some of which were re-cast from beginning to end as often as it appeared to their author that they might be improved by a different mode of treatment. To specify a few of these, we may mention that at the close of the year 1637 he commenced a treatise entitled "*Jeremiæ Horroccii Anti-Lansbergianus, sive disputationes in astronomiam P. Lansbergii, quibus perspicue demonstratur, hypotheses suas nec cœlo nec sibi consentire.*" Having completed upwards of four disputations, he changed his plan, and re-modelling the whole, entitled it "*Astronomiæ Lansbergianæ censura et cum Kepleriana comparatio.*" Of this he wrote three copies agreeing with each other as to their object and arguments, but differing in the mode of discussion, and in their respective lengths: of the first copy he only finished one chapter, of the second nearly four, and of the third upwards of

five. This favourite tract appears again in another dress, being designated as "*Explicatio brevis et perspicua diagrammatis Hipparchi, et Lansbergii erroris,*" but it is in substance the same as the former ones.

He next wrote a treatise against Hortensius, a follower of Lansberg, who had attempted unwarrantably to depreciate the merits of Tycho; and here also he seems not to have grudged the labour of repeated efforts in order to produce an essay that should be perfectly conclusive. Thus we have firstly a paper inscribed "*Contra Hortensii præfationem, Lansbergii Commentationibus de motu Terræ præfixam.*" This was afterwards re-written and styled "*Anti-Lansbergianus, seu astronomiæ veræ vindiciæ. Pars prima in qua respondetur Martinii Hortensii cavillis adversus Tychonem.*" Its title was again changed to "*Dissertatio cum Martino Hortensio de astronomia Tychonica.*" It was next called "*Astronomiæ Tychonicæ apologia, adversus Hortensii cavillas.*" And lastly, "*Epilogus ad Martinum Hortensium, in quo cavillis adversus Tychonem respondetur.*"

There are also other tracts upon similar sub-

jects; for example, the commencement of a work entitled "*Præludium Astronomicum,*" of which the first book only, "*de motu solis,*" was in hand, a chapter of it upon the sun's horizontal parallax being entirely finished; the beginning of another treatise inscribed "*Anti-Lansbergius sive astronomia vindicata;*" and part of another, in which it was proposed to institute a comparison between various hypotheses of the system of the universe, which is inscribed as "*Paris Astronomicus, seu Judicium de vera astronomia, quo trium astronomorum Kepleri, Longomontani, Lansbergii tabulæ astronomicæ, et hypotheses, seu tabularum fundamenta, rationibus physicis, demonstrationibus geometricis, et observationibus astronomicis recentibus et antiquis ad examen mathematicum revocantur.*" These treatises exhibit much foresight and learning, and were well calculated to effect the object for which they were prepared: namely, to explode false doctrines, and to demonstrate the only rational hypothesis of our system.

Horrox next made some considerable improvements in the lunar theory. It is generally acknowledged, and indeed Sir Isaac Newton

expresssly states, that this young philosopher was the first person who discovered the moon's motion to be in an ellipse about the earth, with the centre in the lower focus. This discovery was not merely an extended application of the doctrines of Kepler. That great man had proved the ellipticity of the orbit of Mars, the earth and other of the heavenly bodies, and had endeavoured to explain its cause; but Horrox, in his speculation on the moon's motion, outstripped the discernment of Kepler, inasmuch as he correctly explained the physical cause of the curvilineal motion of the planets, and showed that it arises from the joint action of two separate forces. This was a great step in the progress of celestial dynamics. He tells us that he had spent much time in meditating upon the principle in virtue of which the planets describe oval orbits, and that he thought he had at length hit upon the true theory. Kepler had supposed them to be whirled round by the action of magnetic fibres, by which, as he thought, a mutual influence was exercised similar to that of the poles of loadstones; but being unable to reconcile the rotation of the sphere upon its axis with this supposition, he had recourse to the

singular idea of the exterior only of the planet being endued with rotatory motion. Horrox states at some length his objection to this hypothesis, and having mentioned difficulties which Kepler himself had not perceived, he proceeds thus: "To say, as he doth, 'Hæc contemporatio pertinet ad consilium creatoris,' which I understand to be, 'so is the will of God,' if it had come sooner might have saved a labour of all troublesome inquirys, for it is most true that the will of God is the cause of all things; but resting in generalitys is the death of philosophy. I must have another cause of that ovall figure, which it is most certain all the planets do affect. This will not satisfy me." He then gives his own views, and says that, as the laws of nature are everywhere the same, there can be no doubt that the true principle of the ellipse may be illustrated by means of movements upon the surface of the earth, as, for example, the throwing of a stone into the air, the rotation of which does not impede its progress. In this analogy, to which he refers more than once, we have the true explanation of celestial motion, now understood to be the combined effect of projective and attractive forces. If a stone be

thrown obliquely into the air, its movement is governed by the impulse imparted to it by the hand, together with the attractive power of the earth. In obedience to these two influences, instead of tending in its fall directly towards the centre, it preserves whilst descending the same angle at which it arose; and if its progress were not interrupted by the earth's surface, there is little doubt that it would revolve unceasingly in an elliptical orbit with the centre in the lower focus. Hence arises the general law.—When two spheres are mutually attracted, if not prevented by foreign influences, their straight paths are deflected into curves concave to each other, and corresponding with one of the sections of a cone, according to the velocity of the revolving body. Thus if a sphere were projected by an independent power, as the planets were when launched forth from the Creator's hand, it would move forward in a right line for ever, unless attracted from it by an extraneous force; for instance, the earth would preserve a perfectly straight course whilst permitted to do so, but coming within the sun's influence, it is induced to deviate from the direction originally impressed upon it. Now if

the velocity with which the revolving body is impelled be equal to what it would acquire by falling through half the radius of a circle described from the centre of deflection, its orbit will be circular; but if it be less than that quantity, its path becomes elliptical. This law was subsequently expanded by Sir Isaac Newton into the great principle of gravitation. As is well known, he concluded that the power which causes a body to fall to the earth is of the same nature as that which retains the planets in their orbits; and he pursued this discovery, until he finally evolved an expression to which the phenomena of all the celestial movements may be confidently referred. Whilst thus engaged, he derived important assistance from the writings of Horrox, who, by his sagacious application of projectile to celestial motion, has gained a distinguished place amongst those whose labours have contributed to the establishment of the true system of the universe.

Having ascertained the ellipticity of the moon's orbit, and assigned its cause, he proceeded to examine the various inequalities which render the exact computation of her elements so difficult. If she were not subject to any foreign influence,

the quantity of her ellipsis, the periods of her revolutions, and other particulars would always be the same; but as she is attracted by the sun as well as by the earth, the figure of her orbit is altered, and irregularities are occasioned which require to be corrected, in order that her theory may be satisfactorily developed. Horrox's inquiries led him to a distinct knowledge of the motion of the lunar apsides. He found that the longer axis of the ellipse, or that imaginary line which joins the apogee and perigee, moves slowly round the centre of the earth in the same direction as the moon revolves; and this change of position, which has since been ascertained to amount to rather more than three degrees for each of her sidereal revolutions, he rightly attributed to the perturbative influence of the sun. The beautiful experiment by which he illustrates this phenomenon shows not only that he was perfectly aware that an orbit might be formed by a central force, but also that within certain limits the heavenly bodies exercise a disturbing power upon each other. Crabtree had asked to be favoured with suggestions respecting the motion of the aphelion of a planet. In reply, Horrox, always adhering

to his conviction of the harmony of nature and the possibility of exemplifying celestial movements by those which are common upon the earth, supposes a ball to be suspended by a long cord made fast to a hook in the ceiling. Now if the ball be drawn from the perpendicular, and then suddenly released, it oscillates for a while, with a speed which increases as the centre is approached, and diminishes when that point has been passed. But, if after having been withdrawn from the vertical, a tangential impulse be imparted, the ball will describe an ellipse; and what is particularly to be observed, the major axis will be seen slowly to advance in the same direction with the ball, performing, in course of time, a complete revolution. This illustrates the movement of the apsides of the lunar orbit; though in order to represent nature more correctly, the centre of force should be in the focus of ellipse, whereas in the experiment it is in the centre. Horrox perceived this defect in the illustration, and removed it by supposing a slight breeze to blow continually in the direction of the major axis, by which the relative situation of the point at rest would be changed. This ingenious experiment

has been erroneously ascribed to Hooke, who reproduced it at a meeting of the Royal Society; but it was recorded as Horrox's invention more than five-and-twenty years before the idea was communicated to that learned assembly: and as the doctrines exemplified are of such importance, and were never before suggested by any astronomer, it is very fitting that he should have the credit of their discovery, and that the time when they were first brought to light should be correctly stated.

The principal irregularity affecting the place of the moon in her orbit, next to the equation of the centre, is usually called the *evection*, the existence of which was known to the astronomers of Greece. Its effect is to diminish the equation of the centre when the line of the apsides lies in syzigy, and to increase it when it lies in the quadratures; and it was explained by Horrox, as depending upon the libratory motion of the apsides, and the change which takes place in the eccentricity of the lunar orbit. This conclusion he arrived at from his own observation before he was twenty years of age.

He also determined the value of the *annual equation*, an inequality arising from the sun's

perturbative influence, and which under ordinary conditions, is as the cube of his distance from the earth. It varies according to the position of the latter planet in its orbit as it approaches to, or recedes from its primary. It was noticed both by Tycho and Kepler, but neither of them assigned its quantity. Horrox stated its maximum value to be 11′ 16″, which is within four seconds of what it has since been proved to be, by the most accurate observations.

These improvements in the lunar theory, and the various doctrines which he has illustrated in connection with it, are alone sufficient to secure for him a lasting reputation. Perhaps he is more generally known by his other writings; but this is the subject in which his sagacity is the most conspicuous, and with which his name is the most honourably associated. Its accurate development has from time to time occupied the attention of the ablest astronomers; but it is not too much to say that his discoveries eclipsed the efforts of all his predecessors, and have been the foundation of the advancement towards perfection which has been made in modern times. His views were gradually unfolded in his letters to Crabtree, and

are partly embodied in a systematic treatise entitled "*Novæ Theoriæ lunaris, a Jeremiâ Horroccio primum adinventæ, et postea in emendatiorem formam redactæ, ex epistolis socii ipsius Gulielmi Crabtrei, ad eruditissimum virum Gulielmum Gascoignium scriptis, explicatio.*"

Another instance of his sagacity consists in his detection of the inequality in the mean motions of Jupiter and Saturn. This phenomenon results from the tangential impulse which is exercised to a remarkable degree by these two planets upon each other. It is a law of celestial mechanics that action and reaction are equal and in contrary directions, precisely as they are in reference to terrestrial bodies. If an anvil be struck, the reaction of the hammer is as great as the force communicated by the blow; and in like manner, one planet cannot impart momentum to another without subjecting itself to a corresponding influence. Consequently if the relative positions of Jupiter and Saturn in their orbits are such that the motion of one is accelerated, that of the other will necessarily be retarded; and a want of uniformity arises which in the instance before us is very important, on account of the extent to

which it accumulates. Thus about the time that Horrox lived, and for a hundred and fifty years before, the mean motion of Jupiter was constantly increasing, and that of Saturn slackening; so that upon examining the Rudolphine tables, he found that the calculated places of these planets did not agree with their true situations. Accordingly he suggested that the motion of Jupiter might be corrected by adding 1° 30′ to the aphelion, and 2′ to the mean longitude; and he estimated the quantity of acceleration at 1′ in ten years, which very nearly corresponds with the increment actually given to the mean longitude of Jupiter in each successive period of ten years during the first half of the seventeenth century. He also writes concerning the mean motion of Saturn, that sometimes it appears to be singularly retarded, and that in the time of Walther it was evidently slower than Kepler's calculations had made it; and he proposes to subtract 4′ from the planet's mean longitude at the beginning of the year 1600. He adds that the phenomenon would occasion him greater annoyance were it not for the consolation of his being in all probability the first person to discover it; and he requests

Crabtree to make frequent observations for the purpose of finding out the correction to be applied to the Rudolphine tables. From various remarks which Horrox makes respecting the alteration in the lengths of the periods of these two planets, there is every reason to believe that he had conjectured the inequality of their mean motion to be periodic.

He bestowed considerable attention upon the nature and movements of comets. These bodies have at all times been regarded with great interest: not only by the ignorant, on account of their sudden and terrific appearance as the supposed harbingers of evil and the executioners of vengeance upon a guilty world; but equally by the philosopher who has laboured to explain their extraordinary physical constitution, the irregularity of their movements, their appareut variations in size, and other peculiarities. They were for many ages believed to be only meteors confined within the orbit of the moon. Tycho was the first to refute this opinion by proving that they travel beyond Mercury or Venus. Horrox procured his treatise upon comets, and, without entirely adopting his suggestions, began to speculate upon the

elements of their orbits. His reflections at different times show how he advanced step by step in search of truth, his sagacious intellect laying hold of any outgrowth, and trying its strength to raise him from one firm footing to another. At first he conceived them to be projected from the body of the sun in straight lines, an opinion previously entertained by Kepler, and evidently suggested by the prodigious elongation of their orbits. He next assigned to them a velocity which diminishes as they recede from the sun, and increases as they return to it again. He then improved these conjectures by supposing their path to be curvilineal. Afterwards he says that they move "in an elliptical figure, or near it," and illustrates this stage of his opinions by drawing a diagram for the comet of 1577. The orbit which he traces has an obtuse cusp at the sun, and could not really have been described; but it shows that he had arrived at the conclusion that comets revolve in curves returning into themselves. Wallis enclosed this diagram in a letter to the Royal Society, requesting that it might be carefully preserved, as it is in Horrox's own handwriting. Finally he determines

that comets move "in elliptical orbits," being "carried round the sun" with a "velocity which is probably variable." This hypothesis has since been confirmed by a great number of observations, and is now generally received. It was, however, reserved for Newton fully to determine the elements of these bodies. He proved that any conic section may be described about the sun, consistently with the principle of gravitation; and also that these erratic bodies are subject to the general laws of planetary motion, notwithstanding the elongation of their orbits, and the unusual inclination of their planes to that of the ecliptic.

Horrox also commenced a series of observations on the tides. In his time very little was known as to their physical cause. As there are no tides in the Mediterranean, the ancients probably wrote of them from representation. Kepler explained their elevation more satisfactorily than any of his predecessors. Horrox proposed to investigate the subject thoroughly, and made various experiments for the purpose of ascertaining the extent of their rise and fall at different times and at different places, their direction, and the influences to which

various phenomena respecting them are to be attributed. After he had continued his labours for three months, he wrote to Crabtree, telling him that he had noticed many interesting particulars which had not then been remarked by any one, and that he hoped before long to arrive at some valuable conclusions respecting their nature and cause. Unfortunately we do not possess the result of his observations, no papers containing a systematic account of them having come down to our times. We must, however, allow him the credit of being the first person to undertake a regular course of tidal observations, for the purpose of philosophical investigation.

It is worthy of remark that he approved of, and frequently employed a decimal system of arithmetic. Since the commencement of the seventeenth century, great improvements, most of which are based upon the introduction of the decimal principle, have been made towards abridging the labour of calculation. This method was invented by one Simon Steven, a native of Bruges, in 1602, and it prepared the way for the discovery of logarithms by Sir John Napier, within twelve years afterwards. Horrox strongly recommends

the adoption of a decimal notation, wherever it can be successfully applied; and he expresses his opinion that it would have been better if the circle had been divided into 100 or 1000 parts, instead of 360. He says that such an arrangement would have been preferable to any other, and that the sexigesimal division is attended with many inconveniences. He also proposed to publish ephemerides in this form, in order that astronomers might have an opportunity of judging of its merits. Public attention in England has of late years been particularly directed to this subject, and much has been said and written to prove that the application of the decimal principle to our coinage would simplify the course of exchange, and make the reckoning of money more intelligible to every capacity; but admitting that such an alteration can only be brought about by slow degrees, it is doubtful whether the efforts that have been made for its adoption are at all commensurable with the advantages that would follow; and it does not lessen our appreciation of Horrox's acuteness to reflect that he approved and employed a mode of calculation which has yet to be introduced into many departments of practical business.

Whilst he was studying the writings of Lansberg, he was led to conclude that there would be a transit of Venus in 1639. The calculations of the Flemish astronomer respecting the motions of this planet are for the most part very inaccurate. This obliged Horrox carefully to re-consider them, and in so doing he discovered to his great joy that the conjunction was to be expected. In order to satisfy himself thoroughly upon this interesting point, he consulted the Rudolphine tables, by which his anticipations were confirmed. Strange to say, it does not appear that Kepler had any idea that a transit would take place in 1639; for in a little work published at Leipsic in 1626, entitled "*Admonitiuncula ad Curiosos rerum Cœlestium*," he says, that Venus will pass over the sun's disc in 1631, and not return thither again until 1761. According to Hevelius no transit was witnessed at the former date, and the inaccuracy of the announcement may be traced to the imperfect state of the Rudolphine tables. Kepler died about twelve months before the time at which it should have happened; but Gassendi sought for it at Paris, and although the sky was clear, and he watched during the greater part of

three days, he did not see Venus in the body of the Sun. The consequences of this mistake might have been disastrous to the interests of science; for the assertion that there would be no transit until 1761, had the effect of preventing astronomers from looking out for that of 1639, which took place on the 24th of November (Julian style) as Horrox had calculated, and which but for his foresight would not have been observed. It may not be out of place to remark, that it is now ascertained that the periods between the transits of Venus are 8,235, 243, and 713 years; so that by adding any of these numbers to the date on which some previous one is known to have happened, the result gives the time when another may possibly occur. There will be two more transits of Venus, in the ascending node, during the present century, viz., December 8th, 1874, and December 6th, 1882, the latter of which will be visible in this country. The observation is of considerable value, as it affords means for correcting the planet's elements, and for determining the sun's horizontal parallax.

As soon as Mr. Horrox had satisfied himself as to the time of the conjunction, he wrote to inform

his friend Crabtree that it was to be expected, and requested that he would make what observation he could with his telescope, and especially that he would carefully examine the planet's diameter which, in his opinion, had been considerably overestimated. He also begged him, if time allowed, to communicate with Dr. Foster, as it was desirable that the conjunction should be observed in several places in order to prevent the possibility of failure in case the heavens should be overcast. His letter is dated, Hoole, October 26th, 1639, and he says, "My reason for now writing is to advise you of a remarkable conjunction of the Sun and Venus on the 24th of November, when there will be a transit. As such a thing has not happened for many years past, and will not occur again in this century, I earnestly entreat you to watch attentively with your telescope, in order to observe it as well as you can. Notice particularly the diameter of Venus, which is stated by Kepler to be 7′, and by Lansberg to be 11′, but which I believe to be scarcely greater than 1′. If this letter should arrive sufficiently early, I beg you will apprise Mr. Foster of the conjunction, as, in doing so,

I am sure you would afford him the greatest pleasure. It is possible that in some places the sky may be cloudy, hence it is much to be desired that this remarkable phenomenon should be observed from different localities." He adds that according to the Keplerian tables the conjunction will be visible at Manchester at 8h. 8m. a.m., the latitude of the planet being 14′ 10″ south, but that, according to his own correction, it should be seen at 5h. 57m. p.m., with 10′ south latitude. But inasmuch as a slight change in Kepler's numbers would considerably alter the quantity of the planet's latitude, it would be desirable to watch during the whole day, and also on the preceding evening, and following morning, although he did not doubt but that the transit would take place on the 24th.

After having deliberated on the best method of making the observation, he determined to admit the sun's image into a dark room, through a telescope properly adjusted for the purpose, instead of receiving it through a hole in the shutter merely, as recommended by Kepler. He considered that by the latter method the delineation would not be so perfect, unless it were taken

at a greater distance from the aperture than the narrowness of his apartment would allow; neither was it likely that the diameter of Venus would be so well defined: whereas his telescope, through which he had often observed the solar spots, would enable him to ascertain the diameter of the planet, and to divide the sun's limb with considerable accuracy. Accordingly, having described a circle of about six inches diameter upon a piece of paper, he divided its circumference into 360 degrees, and its diameter into 120 equal parts. This diagram was, in his opinion, sufficiently large for all practical purposes, nor did he think it necessary to carry the subdivision further, as he could depend upon the judgment of his eye with as much confidence as upon any mechanical arrangement he could then contrive. When the proper time came, he adjusted his apparatus so that the image of the sun should be transmitted perpendicularly to the paper, and exactly fill the circle he had described. From his own calculations he had no reason to expect that the transit would take place, at the earliest, before three o'clock in the afternoon of the 24th; but as it appeared from the tables of others that

it might occur somewhat sooner, in order to avoid the chance of disappointment, he began to observe about mid-day on the 23rd. Having continued to watch with unremitting care for upwards of four-and-twenty hours, excepting during certain intervals of the next day when, as he tells us, he was "called away by business of the highest importance, which could not with propriety be neglected," he was at length rewarded for his anxiety and trouble by seeing a large dark round spot enter upon the disc of light. This was beyond doubt the commencement of the transit, as the solar spots are very rarely spherical, and do not consist of matter so regularly disposed, nor so dense, especially about the edges, as the object which he observed. They are generally composed of an umbra, or dark space, which is surrounded by a fainter shade. Venus could not have presented this appearance, as her shadow would be of an equal intensity of darkness and of a circular shape. He therefore examined it attentively, and arrived at some important conclusions. With respect to the inclination, he found by means of a diameter of the circle set perpendicularly to the horizon, the plane of the

circle being slightly sloped on account of the sun's altitude, that to all appearance in the dark chamber, the planet was wholly immersed by a quarter past three, at about 62° 30′, from the vertex on the right hand, and that this inclination continued constant until sunset. He also accurately measured the distance of the Sun's and Venus' centres at various times during the transit. And he confirmed his previous conjectures respecting the planet's diameter, inasmuch as it only exceeded a thirtieth part of the diameter of the sun by about one-fifth subdivision, so that the proportion between them would be as 30′ to 1′ 12″, or at least to 1′ 20″; and this was evident in every situation of Venus. Thus the observation was well executed, and the results in all respects such as he had anticipated. The inclination was the only point upon which he was not quite satisfied, as he was unable to estimate it with very great exactness on account of the rapidity of the planet's motion. Hevelius thinks he might have used with advantage the method employed in observing solar eclipses, by which the sun's image would have been prevented from going beyond the paper, the apparatus having an

observatory circle and a small table fixed at the end of the telescope, so that the most rapid motion of the sun could not have disturbed the observation; but he forgets that even if Horrox had thought of such a plan, his means were probably too limited to allow of his procuring the apparatus. The transit was witnessed at Hoole, the little village before mentioned, of which he was the curate. Its latitude is stated to be 53° 35′, and its longitude about 22° 30′ from the Fortunate Islands, or 14° 15′ west of Uraniburg.

With reference to the important business owing to which, we have said, he was obliged to leave his telescope, Hevelius further tells us, that he would not have suffered his attention to have been withdrawn by any occupation whatever, which could have been undertaken at another time; but that he would have watched Venus more assiduously than he had observed Mercury on a previous occasion, and that he would never have moved his eye from the circle unless some one else had been ready to take his place. But Horrox's absence is fully justified by the fact that the business which called him away was the discharge of his ministerial duties. Little calcu-

lation is necessary to prove that the 24th of November, 1639, old style, happened on a Sunday; and the hours when he was obliged to relinquish his occupation correspond with those at which probably he would be engaged in conducting divine service. The following extract in support of this opinion will be read with interest. It is copied from one of Thomas Hearne's pocket books, and dated February 8th, 1723: "Mr. Horrox, a young man, minister of Hoole, a very poor pittance, within four miles of Preston, in Lancashire, was a prodigy for his skill in astronomy, and had he lived, in all probability, he would have proved the greatest man in the whole world in his profession. He had a very strange unaccountable genius, and he is mentioned with great honour by Hevelius upon account of his discovery of Venus in the Sun, upon a Sunday; but being called away to his devotions, and duty at church, he could not make such observations, as otherwise he would have done."

When Crabtree was informed of the expected transit, he prepared to observe it in the same manner as his friend. But he was not equally successful; for though he watched most attentively,

the sky was so over-cast that the sun could not be seen. At about 3h. 55m. by the clock, the clouds suddenly cleared away, when to his delight he saw Venus fully entered upon the Sun's disc. Overcome with rapture, instead of improving the opportunity thus favourably presented to him, he stood gazing at the spectacle without using his apparatus, nor did he recover his self-possession until the heavens were again obscured. This may provoke a smile from those who know not the overpowering emotion which attends success in a painful and laborious pursuit; but let them remember that such intervals of satisfaction are the only reward which the astronomer receives for his toils of mind and body, for his watchings by night and by day, and for his tedious calculations and patient study. Every inventor and discoverer has his moments of ecstacy. When Pythagoras had fairly demonstrated the great geometrical truth, that the square described on the hypothenuse of a right-angled triangle is equal to the squares constructed upon the other two sides, such was his exultation that he forthwith sacrificed a hundred oxen to the gods; Archimedes, having discovered a method of ascertaining the specific

gravity of different bodies, was so overjoyed as to forget the proprieties of life. Thus Crabtree is not the only person who has lost his self-control in a moment of transport. Nor did he entirely fail to take notice of what he saw; for though he was unable accurately to measure either the distance of the centres, or the angle of inclination, he made a sketch, from memory, of the planet's relative situation, which corresponded with what Horrox had observed, and he estimated its diameter at $\frac{1}{4}$ of that of the Sun. This observation was made at Broughton, near Manchester, where Crabtree resided, the latitude of which is 53° 24′, and the longitude 23° 15′. Horrox also apprised his brother Jonas of the coming transit; but the unpropitious state of the weather prevented him from profiting by the information. It is believed that this phenomenon was not seen by any one except the two friends; and although the observation was made by both under unfavourable circumstances, it has been of considerable advantage to the science of astronomy. Horrox determined the position of the nodes, and the elements of the planet Venus with greater accuracy than had hitherto been attained. He

also found that the time of the conjunction was 5h. 55m., instead of 5h. 57m., as he had anticipated; that the planet's latitude was 8′ 31″ south, instead of 10′; he concluded that the nodes ought to be placed at 13° 22′ 45″ from Sagittarius and the Twins, rather than 13° 31′ 13″ where Kepler placed them; and that of all the tables then in use, the Rudolphine were the most exact.

It may not be out of place to insert here a letter from Crabtree to Gascoigne, an able mathematician, and the inventor of the micrometer, as it refers to the observation, and is otherwise interesting as showing the friendship and esteem which the writer felt for Horrox. After discussing various theories respecting the spots on the sun, and giving his opinion upon some philosophical experiments, Crabtree says:—

"In the mean time let me encourage you to proceed in your noble optical speculations. I do believe there are as rare inventions as Galileo's telescope yet undiscovered. My living in a place void of apt materials for that purpose makes me almost ignorant in those secrets: only what I have from reason, or the reading of Kepler's *Astronomia Optica*, and Galileo. If you impart unto us any of your optical secrets, we shall be thankful and obliged to you, and ready to requite you

in anything we can. It is true which you say, that I found Venus' diameter much less than any theory extant made it. Kepler came nearest, yet makes her diameter five times too much. Tycho, Lansberg, and the ancients about ten times greater than it should be. So also do they differ as widely in the time of the conjunction. By Lansberg the conjunction should have been 16h. 31m. before we observed it: by Tycho and Longomontanus 1 day 8h. 25m. before: by Kepler, who is still the nearest the truth, 9h. 46m. before. So that had not our own observations and study taught us a better theory than any of these, we had never attended at that time for that rare spectacle. You shall have the observation of it when we see you. The clouds deprived me of part of the observation, but my friend and second self Mr. Jeremiah Horrox, living near Preston, observed it clearly from the time of its coming into the sun, till the sun's setting; and both our observations agreed, both in the time and diameter, most precisely. If I can, I will bring him, along with Mr. Townley and myself, to see Yorkshire and you. You shall also have my observations of the sun's last eclipse here at Broughton, Mr. Horrox's between Liverpool and Preston, and Mr. Foster's in London. Lansberg on eclipses, especially the moon, comes often nearer the truth than Kepler, yet it is by packing together errors; his diameters of the sun and moon being false, and his variation of the shadow being quite repugnant to geometrical demonstration. His circular hypotheses, Mr. Horrox, before I could

persuade him, assayed a long time with indefatigable pains and study to correct and amend; changing and turning them every way, still amazed and amused with those lofty titles of perpetuity and perfection so impudently imposed upon them; until we found, by comparing observations in several places of the orbes, that his hypotheses would never agree with the heavens for all times, as he confidently boasts; no, nor scarce for any one whole year together, alter the equal motion, prosthaphæresis, and eccentricity howsoever you will. Kepler's ecliptick is undoubtedly the way which the planets describe in their motions; and if you have read his commentary '*de motu Veneris*,' and his '*Epitome Astronomiæ Copernicæ*,' I doubt not you will say his theory is the most rational, demonstrative, harmonious, simple, and natural that is yet thought of, or I suppose can be; all those superfluous fictions being rejected by him, which others are forced so absurdly to introduce; and although in some respects his tables be deficient, yet being once corrected by due observations, they hold true in the rest, which is that argument of truth which Lansberg's and all others want. Your conceit of turning the circle into 100,000,000 parts were an excellent one, if it had been set on foot when astronomy was first invented. Mr. Horrox and I have often conferred about it. But in respect that all astronomy is already in a quite different form, and the tediousness of reducing the tables of sines, tangents, and all other things we should have occasion to use, into that form; as also

the inconveniences which we foresaw would follow in the composing of the tables of celestial motions, together with the greatness of the innovation, deterred us from the conceit. Only we intend to use the centesmes, and millesmes of degrees, because of the ease in calculation. I have turned the Rudolphine tables into degrees and millesmes, and altered them into a far more concise, ready, and easy form, than they are done by Kepler. My occasions force me to put an abrupt end to my unpolished lines, and without more compliments, to tell you plainly, but sincerely, I am your loving friend (though *de facie ignotus*),

"WILLIAM CRABTREE.

"From my house in Broughton, near Manchester, this 7th of August, 1640."—The superscription of the letter is "To his loving friend Mr. William Gascoigne, at his father's house, in or near Leeds, Yorkshire."

It appeared desirable to Horrox, for many reasons, that an account of the transit should be prepared for the press, and accordingly he wrote an elegant treatise, entitled *Venus in sole visa, seu tractatus Astronomicus, de nobilissima solis et Veneris conjunctione, Novembris die* 24 *Styl. Juliano* MDCXXXIX., *autore Jeremia Horroxio*," detailing the history of the observation and its value to the interests of science. But not being versed in the mysteries of authorship, and wanting

means, he was at a loss to know how to procure its publication. He therefore requested Crabtree to write to his bookseller who would probably be able to advise them in this matter. After a few letters had been interchanged without anything satisfactory being concluded, he determined to accept a long-standing invitation to visit his friend at Broughton, which would enable him to discuss the subject more freely, to confer upon different points connected with their astronomical pursuits, and more especially to give the right hand of fellowship to one for whom he had so high a regard. He had more than once before purposed spending a few days with him, but his intention had as often been frustrated by the unsettled state of his affairs. At length, in order to fix some definite time, he wrote a letter from Toxteth, dated 16th December, 1640, in which he arranged his journey for the 4th of January, and told Crabtree that he might expect him on that day, "if nothing unforeseen should occur." This is the language of one who felt the uncertainty of all human affairs, and was accustomed to act as not knowing "what a day may bring forth." His purpose was never carried into effect.

To the inexpressible grief of every true philosopher, his short, but brilliant, career was closed by death the day before he should have arrived at Broughton. He expired on the 3rd of January, 1641, in the twenty-second year of his age. As the flower of the morning falls before the scythe, so was he cut off in the freshness and vigour of youth. But his death was timely. His work was done. He went to the grave in a full age. Having seen the glory of God afar off, his spirit soared to the heaven of heavens to worship Him as the centre of light and power. It is to be regretted that the particulars of his decease are nowhere recorded, and that we are left to mere conjecture upon a point of so much interest; but there can be little doubt that whatever may have been the immediate cause, his incessant labours by night and by day materially contributed to hasten it. Crabtree felt his loss acutely. His rapid and comprehensive understanding had removed many a difficulty from the path of knowledge, his sympathy had lightened many a toil. On the back of the letter last-mentioned, which was found tied up with several others, was the following touching inscription in Crabtree's handwriting:—

"Letters of Mr. Jeremiah Horrox to me, of the years 1638, 1639, 1640, until his death on the morning of the 3rd of January, when he expired very suddenly, the day before he had proposed coming to me. Thus God puts an end to all worldly affairs; and I am, alas, bereaved of my dearest Horrox! Irreparable loss! Hence these tears!"

The banishment of Tycho was overruled to the advancement of astronomy, for it was owing to this circumstance that Kepler obtained possession of his theories and observations, which he afterwards re-produced and improved with such advantage to the scientific world. But in the remote part of the country in which Horrox died, no one was found capable of appreciating the value of his papers; and consequently, instead of being carefully preserved and kept together until they could be revised with a view to publication, many were destroyed, and the rest were carried away to different places. Thus one portion of them, which had been hastily concealed on account of the troubles of the times, was discovered and committed to the flames by a company of soldiers who entered his father's house in search of plunder. Another portion was appropriated by his brother Jonas, who carried them over to

Ireland, where he died far from home and friends, and the papers were never afterwards recovered. A third fell into the hands of Jeremiah Shakerley, and was made use of by him in the compilation of the British Tables published in the year 1653. He subsequently went out to the East Indies; but before his departure entrusted his literary effects to one Nathaniel Brooks, a London bookseller, in whose possession they remained until they were burnt in the great fire of September, 1666. The only papers that escaped these disasters were found in the house of Mr. Crabtree, who, knowing their intrinsic merit, had claimed them on the ground of past association; and influenced by motives of affection and esteem for their author, had preserved them with the utmost fidelity. It is not known how long this gentleman survived his friend. There are a variety of statements upon this point; but the greater number of them lead us to believe that he followed him to the grave within a very few years. When his establishment at Broughton was broken up, and his library about to be sold, these manuscripts, including that of the Venus, were discovered by Dr. John Worthington, Fellow of Emmanuel

College, Cambridge, a man of distinguished piety and learning, who had been contemporary with Mr. Horrox at the University. In a letter dated 28th of April, 1659, addressed to Hartlib, who had asked to see the dissertation on the transit, he says:—

"I have, as you desire, sent you Mr. Horrox his discourse called "*Venus in sole visa.*" Here are two copies of it, but neither writ to the end. I lent them some years since to a friend who promised out of both to make out one, and then to print it; but other business it seems would not permit him to go through with the work. In some other loose papers I perceive that the author began his tract again and again (so curious was he about it), but these seem to be his last, written with his own hand. He lived at Toxteth Park, near Liverpool, in Lancashire, was some time of Emmanuel College, Cambridge, admitted the same year I was. These papers of his (with many others of astronomical observations) I found in the study of one Mr. Crabtree (a Lancashire man, and his great correspondent in these studies), and I bought them after his death. By sending to some friend about Liverpool or Toxteth, it may be known whether any of Mr. Horrox's kindred have any of his papers.

"Yours, etc.,

"J. WORTHINGTON."

Hartlib having obtained the manuscript of the

transit did not return it as soon as was expected. This appears to have caused the doctor great anxiety, and some little annoyance; for the following year he wrote to desire that it might at once be transcribed and sent back, as he did not think there was another copy of it extant. He also says, lest he should be thought uncourteous, that, as intimated in his previous letter, it had been borrowed on a former occasion by a person who had professed a wish to publish it, a measure which he entirely approved; but he adds that "all who design good things do not persevere when it comes to a business of some labour." A singular fatality seems to have attended these papers, and to have fully justified the anxiety that their owner had expressed concerning them; for while they were in Hartlib's possession, his study was burnt down, and they were with difficulty saved from destruction.

In the year 1660, a copy of the "*Venus in sole visa*," possibly one of those which belonged to Dr. Worthington, came into the hands of Huygens, the Dutch astronomer, who having been asked by Hevelius whether there was anything new going on in the scientific world, said that he could

supply him with a copy of Horrox's celebrated observation. Upon this announcement, Hevelius promised that if he would transmit it by the first opportunity, it should be published with annotations, under cover with his account of the transit of Mercury, which was then nearly ready for the press. After some delay it was forwarded; and when Hevelius received it, he expressed his satisfaction that the two tracts were to be made into one volume, in an eloquent strain: "How greatly does my Mercury exult in the joyous prospect that he may shortly fold within his arms Horrox's long-looked for, and beloved Venus. He renders you unfeigned thanks that by your permission this much-desired union is about to be celebrated, and that the writer is able, with your concurrence, to introduce them both together to the public." The annotations that were appended are very voluminous, being of greater length than the treatise itself. They were evidently written under unfavourable circumstances. Their author was at the time overwhelmed with affliction, and it is clear that they were somewhat hastily drawn up; for besides that they contain errors which could not possibly have remained if proper time

had been allowed for revision, the work was out of the printer's hands in about three months after Hevelius had received the manuscript of the Venus, and a copy of it sent to Huygens with an accompanying letter, dated May, 1662, to this effect:—

"You have doubtless heard, much honoured friend, of the severe domestic calamity by which I was prevented from more quickly fulfilling my promise; and I am sure you will not only readily excuse me, but sympathize with me in this trial, when you understand how grievous an affliction has befallen me. I have sent you by Dr. Peltrius my Mercury, produced amidst great mental anxiety, together with Horrox's Venus, happily risen for the public good; whilst alas, my own beautiful Venus has set, to my infinite sorrow! I pray you to consider them carefully, until I am able to send you something better. The learned world is particularly indebted to you for bringing Horrox's Venus to light, thus having cheerfully bestowed a gift so excellent and acceptable as to demand the thanks of the latest posterity. When you have read the book, I beg you will give me your opinion of its merits, which I shall esteem a great kindness, and in turn you will always find me desirous of serving you."

To which Huygens replied on the 25th of July, 1662:—

"Your most acceptable letter, and shortly afterwards the volume of the new observations, reached me safely, and although I ought to have thanked you before for the valuable gift, I have been so hindered that I could not until now discharge this duty. The illustrious Bullialdus informed me of the great affliction you have sustained by the death of your dearest wife, on which account I feared that this little work, which was then in hand, would be delayed. But you have acted rightly in not suffering your private loss to become a public misfortune; for I cannot say how highly astronomy is indebted to you for so accurate a description of your beautiful observation. Posterity cannot adequately repay you with its thanks. Touching the posthumous work of Horrox, now brought to light, it is more satisfactory that it should have been undertaken by you, than by me; especially as you have prepared an excellent and elegant edition, and increased its value by a commentary. Furthermore, as you ask me freely to give you my opinion of the several particulars treated in the book, I frankly confess that your new method of ascertaining the diameters of the planets by that of Mercury appears less certain to me than to you."

The manuscript which was sent to Hevelius by Huygens does not appear to have been returned to him, as it is not among his papers in the public library at Leyden.

It is remarkable that, in Hevelius' edition of the *Venus*, the name of the place where the observation was made is nowhere to be found. But this circumstance is not attended with any difficulty, as the transit is described to have been seen fifteen miles north of Liverpool, which exactly corresponds with the situation of Hoole. It is clear that Horrox was residing in this village at the time of the conjunction, as all his letters between the months of June, 1639, and July, 1640, are dated from thence; and moreover the name of the place is inserted in the catalogue of his observations. The work is now extremely scarce; there are probably not half a dozen copies of it in the kingdom.

In February, 1663, the subject of Horrox's manuscripts was brought before the Royal Society, and after some discussion, two of its members were instructed to procure from Dr. Worthington any papers which he possessed, for the purpose of being revised and published at the Society's expense. These were readily obtained, and were entrusted to Dr. Wallis, the learned Professor of Geometry at Oxford, who having been desired to peruse them, reported upon their merits to the

Society at considerable length. He said that he and his colleague Dr. Christopher Wren had attentively examined them, and that in their joint opinion, what was written in English, consisting merely of notes from memory and unconnected paragraphs produced at various times, was unsuitable for publication; but that they considered the Latin pieces to be extremely valuable, and well worthy of preservation. Wallis was hereupon requested to gratify the learned world by digesting and preparing such of the manuscripts as he approved; a task which he gladly undertook, and which he was admirably qualified to fulfil. The plan that he adopted was as follows: by judiciously arranging the various tracts and dissertations put into his hands by the Society, including especially those against Lansberg and Hortensius, with others already mentioned, he compiled a perfect treatise, entitled "*Astronomia Kepleriana defensa et promota.*" This is divided into seven disputations, with an introduction instituting a comparison between the merits of Ptolemy, Copernicus, Lansberg, Kepler, and others. The first dissertation is upon various hypotheses, and the formation of tables of the heavenly motions;

the second upon the fixed stars; the third upon the obliquity of the Zodiac; the fourth upon the semi-diameter of the sun; the fifth upon the diagram of Hipparchus; the sixth upon the movements of the stars; and the seventh contains an answer to the cavils of Hortensius against Tycho. Whilst the manuscripts were in course of preparation, several other papers and letters were discovered, which were likewise carefully collated, and printed by Wallis under the same cover as those just enumerated. They consist of extracts from Horrox's letters to his friend Crabtree upon different astronomical subjects, a catalogue of his observations, his new theory of the moon, together with Flamsteed's lunar numbers upon it, also Crabtree's observations at Broughton, and Flamsteed's treatise upon the inequality of the solar year. The Astronomer Royal himself explains the circumstances under which his essay and numbers were appended to this collection of Horrox's writings. In his Autobiography, published some time ago by the Admiralty, we read:—

"I made a journey into Lancashire, and called at Townley, to visit Mr. Christopher Townley, who

happened to be then in London. But one of his domestics kindly received me, and showed me his instruments, and how his micrometer was fitted to his tubes; and from this time forward we often conferred by letters. I procured Mr. Gascoigne's and Mr. Crabtree's papers from him, and Mr. Horrox's theory of the moon, to which he had begun to fit some numbers; but perfected none that I remember. About this time Mr. Horrox's remains and observations, having been collected by Dr. Wallis, were in the press. I found his theory (of which a correct copy had fallen into my hands) agree much better with my observations than any other. Hereupon I fitted numbers to it, which with an explanation of it were printed with his works. Mr. Collins advised me to print my discourse concerning the equation of natural days with them: which I consented to do; and sent it up to him for that purpose translated into Latin."

All these papers combine to form a quarto volume, which was published at the expense of the Royal Society. Wallis announced the completion of his work in a letter to that learned body, dated September 21st, 1664, in which he informed them that he had compared the different copies with the originals, arranged the several subjects in their proper places, and prefixed to the whole an epistle dedicatory to their President, Lord Broun-

ker. A vote of thanks was then passed to Dr. Wallis, and the printing of the book was next referred to the consideration of the Council; but owing to the low state of the Society's funds at this early period of its history, the volume was not issued until nearly eight years afterwards. Its publication is mentioned in a quaint letter from John Collins to Dr. Edward Bernard, written on—

"16 March, 16$\frac{7}{8}$. From my house next the three Crowns in Bloomsbury market." He says, "Dr. Wallis, his comment on the Astronomicall remaines of Horrox, is to goe to the Presse here, and there is a new type provided for the same, the Doctor desired to revise it first, that he might adde a running title to the Topp, I sent it on this day three weekes by Dobins, Moore's coachman, giving notice to the Doctor thereof by the Post, and since wrote to the Doctor, but receiving no answer am afeard the Doctor is by his disease incapacitated, or under some great affliction."

The book at length made its appearance, being entitled "*Jeremiæ Horroccii Angli Opera Posthuma; una cum Gul. Crabtrei observationibus cœlestibus; necnon Joh. Flamstedii de temporis æquatione diatriba numerisque lunaribus ad*

novum lunæ systema Horroccii," printed in London, 1672. In the years 1673 and 1678 it went through two fresh editions, but was so inaccurately revised that the same typographical errors are found in each; for instance, the errata at the end have been allowed to remain without correction, and pp. 127 and 134 are reprinted by mistake 227 and 334. The book has become very valuable, because so few copies of it are known to exist. In one of Hearne's memoranda, dated 1723, we read, "Horrox's posthumous works were printed by Wallis: they are now scarce. Mr. Whiteside, of the Museum, bought them several years agoe, but gave 7*s.* 6*d.* for them."

It has often been said to be a reflection upon our country that the writings of Horrox should have lain dormant for so long a time. As we have seen, it was upwards of twenty years before they were brought to light; and his beautiful dissertation upon the transit of Venus made its appearance in a foreign land. This was no doubt owing in part to the troubled state of the times. Political excitement and civil discord are not favourable to the advancement of literature and

science. Moreover it should be remembered that Horrox was then unknown to fame. He lived in a remote part of the country, and died young. As soon as the value of his papers had been ascertained, measures were immediately adopted for their security, and eventually for their publication. It would indeed have been better if the account of the transit had been bound up with the rest of his posthumous works, according to the expressed wish of Flamsteed; but it seems that Wallis was under the impression at the time that a distinct edition of the *Venus* was about to be prepared by the Astronomer Royal, who was believed to be in possession of an autograph manuscript. No doubt he would willingly have included it in the volume if some good reason had not prevented him, for no one could have shown greater zeal for the honour of Horrox, nor could have more deeply regretted that his celebrated observations should have been so long buried in obscurity. He says, "I cannot help being displeased that this valuable observation, purchaseable by no money, elegantly described, and prepared for the press, should have lain hid for two-and-twenty years, and that no one should

have been found to take charge of so fair an offspring at its father's death, to bring to light a treatise of such importance to astronomy, and to preserve a work for our country's credit and for the advantage of mankind. The complaint is not entirely without foundation; but it is at all events a comfort to reflect that as soon as the manuscripts were discovered, Horrox's fame was endorsed by a Society consisting of the most learned of his countrymen, that his writings were printed at public expense, and that his dissertation upon the transit received a graceful recognition from the leading astronomers of the continent of Europe.

Besides the manuscripts already mentioned, there are others of considerable interest, said to have formerly belonged to Flamsteed, which are now lodged in the library of the Greenwich Observatory. Of these we may enumerate,—firstly, a transcript of the first twelve chapters of the *Venus in sole visa*, being a small book six inches high and four-and-a-half wide, containing fifty-eight clearly written pages, the last of which is not full, breaks off in the middle of the line, and is followed by several blank leaves. The

account of the observations very nearly corresponds with that given by Hevelius. There are however no side-notes, a fact which confirms the belief that those attached to the printed edition formed no part of the original text. Although this document bears no date, the time when it was written may be concluded from a curious circumstance which we must not omit to notice. In the poem on the Telescope, inserted in the middle of the second chapter, there are some verses not to be found in the publication of Hevelius:

> "Et duplici nimium cœlesti a fonte remoti
> Tristia Saturni solatur lumina flamma."

Now Huygens first discovered a satellite of Saturn in the year 1665; Cassini discovered a second in October, 1671, and a third in December, 1672. These lines are therefore evidently an interpolation, since it was not known that Saturn had any satellite until twenty-four years after Horrox's death. They also prove that the manuscript is not of much authority, as it could not have been written for more than thirty years after the same event; and that although it

belonged to Flamsteed, it is not the autograph which he was believed to possess, and from which it was thought he intended publishing a new and revised edition of the Venus. It may, however, be used with advantage for suggesting improved readings, and for making corrections in punctuation.—Secondly, a manuscript upon half sheets of old foolscap, ruled, and doubled so as to make a quarto eight inches high and six wide, which consists of three distinct parts, each paged separately, and headed as follows: (1) "*Jeremiæ Horroxii Præludium Astronomicum,*" agreeing in substance with the tract of a similar name already stated to have been incorporated by Wallis, in the *Opera Posthuma.* Only the first book, "*De Motu solis,*" has been commenced, having two chapters, namely, one entitled, "*De parallaxi solis horizontali,*" and another "*De refractione solis et syderum.* (2) "*Astronomiæ Lansbergianæ censura,*" a short treatise, ending abruptly, the last line of which is written as if it had been intended to be continued on the following page. (3) "*Jeremiæ Horroxii Astronomiæ Lansbergianæ censura et cum Kepleriana Comparatio,*" which contains the *Prolegomena,* and

other pieces found in the printed works. Upon comparing these two manuscripts with the *Opera Posthuma*, the general impression is that they are in many places less full than the published text. Nevertheless they are extremely useful in throwing light on obscure passages, and in enabling us to form some idea of the manner in which Wallis arranged his materials. They are both in the same handwriting, which is certainly better than Flamsteed's, and totally different from his in character. They were probably penned by a regular transcriber; and it may be concluded, therefore, that they are of the same date.—Thirdly, an English manuscript called *Philosophical Exercises*, being a small book, about the size of the *Venus in sole visa*, divided into two parts, namely: (1) A discussion respecting the elliptical motions of the planets, and (2) some more explicit rules upon the same subject. The sun's parallax is treated of nearly in the same way as that great question is discussed in the papers printed by Wallis. Towards the end there is "*A New Theory of the Moon*," which seems, from a comparison of the numbers employed, to have been the same as that adopted by Flamsteed;

but this is only a conjecture, as the latter part of the document is very incomplete. This manuscript is evidently older than either of the other two, nor is there anything against the supposition of its having been written in the lifetime of Horrox. It is invested with peculiar interest, as being the only English composition of his in existence; and it is in general style more like an autograph than a transcription.

No monument was erected to the memory of Horrox, nor any mark set over his grave, for nearly two centuries after his death. In the year 1826, Mr. Holden, of Preston, delivered a course of lectures upon astronomy in Liverpool, and devoted the proceeds of one of his evenings to the erection of a suitable tablet, which was placed in St. Michael's Church, Toxteth Park. This was a proof of his appreciation of the merits of Horrox, and of his love for science; and it was an act which deserves general admiration. The monument is a handsome scroll of white marble, mounted on a black slab, having the appropriate representation of Venus crossing the Sun's disc, beneath which is the following inscription:

Venus in sole visa. Nov. 24, 1639.

IN MEMORY OF
JEREMIAH HORROX, ONE OF THE GREATEST
ASTRONOMERS THIS KINGDOM EVER PRODUCED;
BORN IN TOXTETH PARK IN 1619;
DIED IN 1641, AGED 22.

HIS OBSERVATIONS WERE MADE AT HOOLE,
EIGHT MILES FROM PRESTON, WHERE HE
PREDICTED, AND WAS THE FIRST PERSON
WHO SAW, THE TRANSIT OF VENUS
OVER THE SUN.

THIS MONUMENT WAS ERECTED BY
M. HOLDEN, ASTRONOMER,
1826.

But the name of Horrox is not commemorated in his native place only; it is no less so in the parish of which he was a minister. The traditionary remembrance of the young astronomer which still exists at Hoole, began last year to assume a more substantial form. The Rev. Mr. Brickel, the present incumbent, naturally takes an interest in his fame, and as his successor in office, felt privileged to take measures for handing it down to posterity. Occupying the same pulpit Sunday after Sunday, he longed to identify Horrox with the parish to the end of time, by raising a lasting tribute to his memory. Hitherto

there had been no record of his connection with Hoole; excepting that upon the old church clock and sun-dial Horrox had inscribed the appropriate words "*ut hora, sic vita*," and "*sine sole sileo*," calculated to remind us of the shortness of life, and of our helplessness until the "Sun of righteousness arise" upon the soul "with healing in His wings." With this view Mr. Brickel addressed to the gentlemen of influence in his neighbourhood, and to various scientific men throughout the country, a statement of the facts of the case, and asked their sympathy and assistance. The learned gave their testimony in favour of so distinguished a member of their brotherhood, and men of high position announced their readiness to contribute in furtherance of so laudable an undertaking. When sufficient funds were obtained, it was decided that the church should be beautified, and enlarged by the erection of a chapel to be dedicated to the memory of Horrox, which should contain thirty sittings free to the poor for ever. It was also agreed that a memorial window should be placed in it, together with a mural tablet having the following inscription:

JEREMIAH HORROCKS,

BORN AT LIVERPOOL, EDUCATED AT CAMBRIDGE, THE CURATE
OF HOOLE,
DIED IN THE 22ND YEAR OF HIS AGE, 1641.

THE WISDOM OF GOD IN CREATION WAS HIS STUDY FROM EARLY YOUTH:
FOR HIS WONDERFUL GENIUS AND SCIENTIFIC KNOWLEDGE
MEN SPEAK OF HIM AS
"ONE OF ENGLAND'S MOST GIFTED SONS,"
"THE PRIDE AND BOAST OF BRITISH ASTRONOMY."
AMONGST HIS DISCOVERIES ARE,—THE NEAREST APPROXIMATION TO THE
SUN'S PARALLAX.
THE CORRECT THEORY OF THE MOON, AND THE TRANSIT OF VENUS.

BUT THE LOVE OF GOD IN REDEMPTION WAS TO HIM A YET NOBLER THEME;
THE PREACHING OF CHRIST CRUCIFIED A YET HIGHER DUTY;
LOVING SCIENCE MUCH, HE LOVED RELIGION MORE;
AND TURNING FROM THE WONDERS OF CREATION TO THE GLORIES
OF THE CROSS, HE EXPRESSED THE RULE OF HIS LIFE
IN THESE MEMORABLE WORDS,—
"*Ad majora avocatus, quæ ob hæc parerga negligi non decuit.*"

IN MEMORY OF ONE
SO YOUNG AND YET SO LEARNED,
SO LEARNED AND YET SO PIOUS,
THIS CHURCH IN WHICH HE OFFICIATED,
HAS BEEN ENLARGED AND BEAUTIFIED.

This was accordingly done; and the parish authorities have replaced the old dial and time-piece by a handsome clock, which is both an ornament to the church, and a convenience to the people. In this way the desire to do honour to Horrox has been crowned with success; and

we can only trust that the blessing of God may rest upon the increased numbers who are now enabled to worship in His sanctuary.

In estimating the attainments of this remarkable young man, it must be remembered that we possess only a small portion of his writings, the bulk of them having unfortunately perished. His published works are but a part of what he wrote, and many of the tracts of which they are composed were left in an unfinished state. Hence some doctrines are treated systematically, whilst others are introduced here and there as occasion required. Omitting what might be inferred from a general survey of his papers, it will be sufficient for our purpose to mention such subjects only as are discussed in regular order. We must remember also that since he lived, more than two centuries have passed away, during which period a number of men have arisen, by whose genius and industry astronomy has been considerably developed. Our object is not to show that he was abreast with the learning of the nineteenth century, but that he was greatly in advance of his own times; and that his exertions have in some measure contributed to elevate the science to its

present proud position. The simple question to be answered is: What has been the practical value of his labours? What advantage were they to those who came after him? In other words: What has Horrox done for the improvement of astronomy?

The nature of his controversial papers has already been explained. Their object was to expose the vicious theories then prevailing, and to disseminate rational and correct views respecting the system of the universe. That his treatises against Lansberg and Hortensius were well calculated to effect this, there can be no doubt; but unfortunately they remained so long in an unpublished state that their usefulness was much impaired. Twenty years is a period of great importance in an era of progress. Nevertheless these papers were not unserviceable; as soon as they were printed, they were read with great interest, and passed through more than one edition. His observation of the transit of Venus was most valuable. No other person witnessed, with anything like success, the transit of 1639. By it he was enabled to correct the planet's elements and to prove, contrary to the received

opinion, that her disc does not subtend an angle greater than one minute. He also estimated the sun's horizontal parallax more accurately than any one who came before him: it had previously been supposed to be at least two minutes, and even Kepler had stated it at 57″; but Horrox proved that it could not exceed 14″, which was within 1½″ of the value assigned to it by Halley sixty years afterwards. Horrox's reduction of the sun's parallax is very remarkable; for though he had not diminished it enough, Newton in the first edition of the *Principia* (1687) hesitated in following him so far. He said, "I am not quite certain about the diameter of the earth as seen from the sun. I have assumed it to be 40″, because the observations of Kepler, Riccioli, and Vandelini do not allow of its being much greater. The observations of Horrox and Flamsteed make it somewhat less." He afterwards speaks of the apparent diameter of the earth as "about 24″, and therefore the parallax of the sun would be about 12″, very nearly as Horrox and Flamsteed had determined. But the diameter would agree better with the rule of this corollary if it were a little larger,"—"*quasi* 24″, *adeoque parallaxis*

solaris quasi 12″, *ut Horroccius et Flamstedius propemodum statuere. Sed diameter paulo major melius congruat cum regula hujus corollorarii.*" In the second edition of the *Principia* (1713) all this is omitted, and in a preceding corollary we read "the parallax of the sun from the most recent observations is about 10″." In the third edition he estimated it at 10½″. When it is remembered what expensive expeditions have been sent out from our country for the purpose of observing these transits, it is thought that the importance of the observation, and the conclusions derived from it will not seem to be overrated. But as we have intimated, his fame chiefly rests upon the improvements he made in the lunar theory. His views upon this subject have been received with gratitude by the ablest astronomers. Newton's acknowledgment that he was the first to discover the motion of the moon to be in an ellipse about the earth, with the centre in the lower focus, has been already referred to; the exact words in the *Principia* are "*Horroccius noster lunam in ellipsi circum terram, in ejus umbilico inferiore constitutum, revolvi primus statuit:*" and upon comparing the different

editions of the book, it will be seen that this statement was added to the second, and retained in the third. In his separate work, "*De mundi systemate*," he speaks of Horrox's correction of the lunar theory in terms of great admiration: "There are many inequalities in the moon's motion not yet noticed by astronomers. They are all deducible from our principles, and are known to have a real existence in the heavens. This may be seen in the hypothesis of Horrox, which is the most ingenious, and if I do not deceive myself, the most accurate of all:—*in Horroccii Hypothesi illâ ingeniosissimâ et ni fallor omnium accuratissima videre licet.*" Flamsteed declared his hypothesis for settling the movements of the moon to be the most exact that had ever been originated; and he did not even think it necessary to re-calculate the tables which Horrox, for want of time, had not verified to his own satisfaction. Halley, after speaking of the theories of various eminent men, says: "but that one alone of our Horrox which attributes to the moon's orbit a libratory motion of the apsides, and a variable eccentricity, seems to approach the truth of nature; for it represents the diameters

more agreeably to observation, and shows her motion more accurately than any hypothesis which I have hitherto seen." We may further mention that Sir Isaac Newton largely availed himself of Horrox's suggestions to explain the general principles of perturbation, as laid down in the 66th proposition of the first book of the *Principia.* These improvements are so substantial that there is no difficulty in ascertaining the author to whom they are to be assigned. They stand out as a landmark in the history of the science. Taken in connection with his comments upon the subject of planetary motion, they prove that Horrox holds a prominent position amongst those who have succeeded in developing that great principle by which creation is held together. Few men are permitted to originate, to confirm, and to promulgate a great discovery. This is usually the work of successive generations. Each master-spirit pushes the enterprise a step further; and hence it is often difficult to decide who is fairly entitled to the credit. The final elucidation may be the result of an accumulated experience. The ground is first broken up, then the seed is sown, the tender plant is trained, and it grows and

thrives, until some one more fortunate than the rest gathers the fruit. So it was with the principle of gravitation, the discovery of which cannot be wholly attributed to one man. It was, no doubt, reserved for the transcendent genius of Newton fully to define and to apply it; but the existence of such a power was known to others who came before him; and their ideas respecting it formed part of the data from which he drew his sublime conclusions. Thus Kepler had a considerable knowledge of the subject, and many of his conjectures have been substantiated. Dr. Gilbert published similar doctrines in this country, and gave them a more extended application. But Horrox, by his explanation of the perturbative influence of the sun, and by his illustration of celestial and projectile motion, unfolded the theory more completely than any of his predecessors. He seems to have perfectly understood the identity and universality of this unseen power; for he often tells us that the planets in their orbits are affected by it in the same manner as bodies upon the surface of the earth. His accurate views were at length adopted by Newton, and made the foundation of his philo-

sophy. In proof of this compare the following passages:

"Just as by the force of gravity a projectile might describe an orbit, and revolve round the whole earth; so the moon, either by the force of gravity, if it is endued with gravity, or by any other force urging it towards the earth, may be continually drawn thereto from a rectilineal path, and turned into her present orbit; and without such a force she cannot be retained in her orbit. If the force were less than it is, it would not cause her to deviate from a rectilineal course sufficiently; if it were greater, it would cause her to deviate too much, and draw her from her orbit towards the earth. It is therefore required to be of an exact amount; and it is the business of mathematicians to find the force which can accurately retain a body with a given velocity in any given orbit; and in like manner to find the curvilineal path into which a body going forth with a given velocity from any given place is turned from its rectilineal way by a given force."—*Newton Princip. Mathem. Def. V.*

It is surely conceded by all that the motion of the planetary bodies is neither perfectly circular, nor perfectly uniform; for observations show, beyond dispute, that the figure of the planetary orbits is elliptical or oval, and different from a circle: and the motion of a body in this ellipse is irregular, being increased or diminished according to its distance from

the sun. Physical causes are not wanting to show that this movement is described by a sort of geometrical necessity. We may satisfy ourselves of the truth of this by an appeal to nature; for as a planet is moved by a magnetic impulse, why may not the same principle be exercised in other ways? A weight is thrown into the air: at first it rises quickly, then moves slowly, until at length it is stationary, and falls back to the earth with a velocity which continually increases. It thus describes a libratory movement. This movement arises from the impetus in a right line which has been imparted to it by your hand, together with the magnetic influence of the earth, which attracts all heavy things to itself, as a loadstone does iron. There is no need to dream of circles in the air, and I know not what, when we have the natural cause before our eyes; and as regards the motion of the planets which are subject to similar influences, what reason, I ask, is there to barter an explanation, the truth of which is confirmed by so many examples in nature, for a fictitious dream of circles?"—*Jer. Hor. Op. Posth. Disp. VI. Cap. I.*

These paragraphs contain the same ideas expressed in different language. They both treat of the physical cause of curvilineal motion, which is explained to be the joint action of projectile and attractive forces; and they both speak of it as pervading the planetary system, and illustrate it

by movements upon the surface of the earth. Now as Sir Isaac Newton is known to have been well acquainted with all that passed through Wallis' hands, he must have seen Horrox's treatise "*De Motu Syderum*," from which the above extract is taken; and he tells us himself that he had read his theory of the moon, in which the same principles are laid down. Without wishing to detract from the merits of one who, as an astronomer, has gained an immortal reputation, it is only right that it should be known that some of the leading doctrines upon which the philosophy of the *Principia* is built were first propounded by Horrox. Dr. Tatham in his "Chart and Scale of Truth," delivers his opinion upon this question in these words:

"That every philosopher has an absolute right to avail himself of the labours and discoveries of his predecessors, as a legacy freely given him, is a privilege which philosophy itself always claims. It is, however, a tribute justly due to the memory of this extraordinary genius, Mr. Horrox, whilst we regret the loss of many of his valuable works, to acknowledge, from what has been saved, that he was principally instrumental in calling philosophy out of the regions of fictitious invention, and putting her on the investigation of the

physical causes of things from experiments and observations; that he not only made the applications of projectile motion to the analogical illustration of celestial, but also assigned the forces of projective and attractive, on which all geometrical calculations are founded; and that, without injuring the immortal fame of his great successor, he may be fairly considered the forerunner of Newton."

We may conclude these observations upon the practical value of Horrox's labours by briefly remarking that he was the first to predict and observe the transit of Venus in 1639; to reduce the Sun's parallax nearly to what it has since been determined; to discover the orbit of the Moon to be an ellipse about the earth with the centre in the lower focus; to explain the causes of orbital motion; to ascertain the value of the annual equation with any degree of accuracy; to devise the beautiful experiment of the circular pendulum for illustrating the action of a central force; and to commence a regular series of tidal observations for the purpose of philosophical inquiry: besides all which, he effected improvements in different astronomical tables, recommended the adoption of decimal notation, detected the inequality in the mean

motion of Jupiter and Saturn, and wrote his opinions upon the nature and movements of comets. That so much should have been achieved by so young a man, notwithstanding many disadvantages, may seem almost incredible; but if there is one fact connected with Horrox which, more than another, rests upon incontrovertible evidence, it is the age at which he died. This shows the lustre of his genius, and imparts a melancholy interest to his history. Those who have arrived at distinction in intellectual pursuits have generally done so early in life. Newton laid the foundation of his greatest discoveries before he had attained his thirtieth year; Byron expired at thirty-six; Pascal at thirty-nine; Mozart at thirty-five; and Raphael at thirty-seven; but Horrox's years were fewer still,—they were not *twenty-two* in number. Such being the case, it is almost superfluous to say that he was gifted with the highest mental qualifications. As an instance of his extraordinary sagacity, we may mention his early appreciation of Kepler's works, which the philosophers who were contemporary with Horrox could not understand. Riccioli, Bouillaud, and others studied them to no purpose, whereas he embraced them

at once. He speaks of Kepler as the "Prince of astronomers, to whose discoveries alone all who understand the science will allow that we owe more than to those of any other person." He says that he venerates his "sublime and enviably happy genius, and if necessary would defend to the utmost the Uranian citadel of the noble hero who has so far surpassed his fellows;" and he adds, "no one while I live shall insult his ashes with impunity." At the same time he took nothing upon trust, but carefully examined every theory that was propounded. Thus he writes, "The calculations of Lansberg and Longomontanus are false: their principles and numbers are false. Kepler's hypotheses are true, and he seldom fails in his numbers." He possessed a habit of self-reliance; and we often find him complaining of the servility with which the astronomers of his day followed in each other's track, without verifying by observation the doctrines that were handed down. In his speculations upon physical causes he was never at a loss for a new line of thought; but if it did not lead to a sound conclusion, it was dismissed as readily as it had been called forth. His power of reasoning out natural laws from the

simple facts of common experience deserves especial notice. This is one of the greatest proofs of a philosophic mind. It is in fact to see more than is apparent to the common gaze. It enabled Newton to detect a great principle in the fall of an apple; and Galileo, whilst watching the swinging of a lantern in the cathedral church of Pisa, to conjecture that the oscillation of the pendulum might be turned to important purposes as a measure of time. Horrox beautifully expresses his belief in the harmony of nature: "Astronomy is natural and true. The sea is agitated with the winds; but the æther is clear and open, without wind or any other resistance. The bodies of the planets are solid and firm. Now as a slinger aims accurately, and projects his weapon with certainty, notwithstanding the resistance of the air, why may not the heavenly bodies, in like manner, rotate by an eternal law?" In short, Horrox possessed the spirit of a true philosopher; he was accustomed to generalize facts, to weigh probabilities, and to take the most ultimate views; and he improved to the utmost his noble powers by his unwearied industry and application. But scientific men are the most

capable of forming an opinion of his merits, and to them we will appeal: Newton, and Foster of Gresham College, speak of him as "a genius of the very first rank;" and Sir Isaac, anticipating the publication of his works, expresses himself as "glad that the world will enjoy the writings of that excellent astronomer Horrox." Ferguson alludes to him as "our illustrious countryman;" Brinkley says that, had his life been spared, "his fame would probably have surpassed that of all his predecessors;" Herschel calls him "the pride and boast of British astronomy;" Dr. Whewell, the learned master of Trinity College, writes that, "he has attempted to do him justice;" Lord Brougham thinks that "nothing can be more clear than the great merit of Horrox, and the severe loss sustained by science from his early death;" Professor De Morgan says that "no monument is needed for the name of Horrox, for wherever Newton's *Principia* is known, there is his name known also;" and Professor Airy, the present Astronomer Royal, "joins warmly" in admiration of him. We will only add one more tribute to his praise: Grant, in his learned treatise upon physical astronomy, says that "Horrocks has

exhibited in his researches such sagacity of thought and fertility of invention, such enlightened and judicious views on the various subjects which engaged his attention, and such unwavering confidence in the resources of his own mind," that, if he had remained on earth a few years longer, "his name would have been a household word for future generations."

Horrox was a poet as well as a philosopher. The verses which he has introduced in his account of the transit are very creditable, and evince a bold imagination combined with a judicious taste. They do not aim at being elaborate; indeed, he is so careless of detail, that by some his lines would be considered unpolished. Had he been a painter, his genius would have been impatient of the restraint which is implied by the speciality of arrangement found in the compositions of the pre-Raphaelite school; his ideas are strong and clear, and roughly delineated, whilst his metaphor sometimes borders upon exaggeration. But the sentiment which pervades his verse is delicate and refined. Enamoured of the heavens, he occasionally chooses poetry because it is the best vehicle for his passion; but in his advances he never

forgets what is due to the society of the Muses. The Pierian spring gushes forth with unusual force, but its waters are always sweet and pure. His performances are powerfully conceived, freely executed, and are always in accordance with good taste. It is not often that poetic fancy and mathematical precision are so strongly developed in the same mind.

But intellect is of no value unless sanctified by grace. A man may be accounted a philosopher, he may explain the laws of Nature more successfully than any of his predecessors; but, if in his investigations of natural phenomena, he sees nothing but matter and motion, if he does not recognise the power, the wisdom, and the love of Him who creates and upholds, if he admires the work without admiring the Workman, he is a philosopher "falsely so called." We are happy, therefore, before concluding this Memoir, to be able to bear testimony to Horrox's religious character. It is true that he left no theological papers; but this is not to be wondered at, as he was only permitted to exercise his ministration for so short a time. But if he did not write in the capacity of a clergyman, he thought and

believed as a Christian; for we find sentiments introduced even in his most abstruse works, which show how much he lived under the influence of religion. A few passages in proof of this, besides those which have been already quoted, may be adduced. When he was about to enter upon the arduous task of correcting the Rudolphine tables, he says: "And may He who is the great and good God of astronomy, and the conservator of all useful arts, bless my unworthy efforts for His mercy's sake, and cause them to redound to the eternal glory of His name, and the advantage of mankind." In another place he writes that he will not despair of further discovery, "for I have been blessed by God's grace with such success, that even now I have something to be proud of." In his account of the transit of Venus where he speaks of being summoned, by his religious duties, from the observation which he knew he should never again have the opportunity of making, he draws a contrast between the importance of things temporal and things eternal, which seems to express the general rule of his life and conversation, telling us that he was "called away to higher duties, which must not be neglected for these

non-essentials." Would that this sentiment were more deeply felt by all who are engaged in the business of life! These isolated passages show the spirit in which he did his work; but one of greater length has been preserved, where he speaks expressly of his own religious opinions and convictions. It of course partakes of the fanciful style of the schoolmen, and there is something in a typical representation of the Deity from which our more chastened thoughts necessarily shrink; but this fault belongs to the fondness for conceit which then prevailed, and must not blind us to the piety and humility of the writer. In connection with some crude philosophical speculations, we read: "I conclude that the eccentricity of the planets is caused by the contention between the sun's magneticall (and always attractive) virtue, and the planets' dulnes, naturally desiring to rest unmoved; which dulnes, while the sun's circular motion carrys the planet from the aphelium, is conquered, and so the planets' motion increaseth in fastness; but when the sun's circular revolution doth recarry it backe toward the aphelium, the naturall torpor and dulnes increaseth, by the presence and nearness of that place where it would rest.

"A right type may this be of man's dulnes to good, which is the more by how much a man more rests in himselfe, and is then onely quickned, when the Spirit of God (like the rays of the sun) doth draw our hearts, desirous to rest in themselves, and force them unwilling to follow Christ (as the planets follow the sun's circumvolution, which begets a circular circumference), which following is the onely cause of our comming neer to God (as the sun's circumference brings the planets towards itselfe). All which agrees excellently with that mysticall adumbration of the thrise sacred Trinity in (those poor types of God as one calls them) round circles; wher the father (the center) doth beget the son (the circumference) by efflux of the spirite (the rays). Kepler's astronomy differs from mine, as his religion; He gives the planets a divers nature (good and bad) that they may eyther come to the sun or fly away at their pleasure, or at least (as his second thoughts are) so dispose themselves (in spite of all the sun's magneticall power) that the sun is bound to attract or expell them, according to that position, which themselves defend against all the sun's labouring to incline the fibres. I, on the

contrary, make the planet naturally to be averse from the sun, and desirous to rest in its owne place, caused by a materiall dulnes naturally opposite to motion, and averse from the sun, without eyther power or will to move to the sun of itselfe. But then the sun by its rays attracts, and by its circumferentiall revolution carrys about the unwilling planet, conquering that naturall selfe rest that is in it, yet not so far but that the planet doth much abate and weaken this force of the sun, as is largely disputed afore. So just do the papists, whose free will to good or bad, can by its owne strength, go to God or fly from Him, or at least so frame their own actions as that God is bound to save them or damn them volens nolens. But I will confesse myselfe not equally composed of good and bad, that myselfe may give eyther flesh or spirit the upper hand, but rather wholly desirous to rest in my selfe, wholly averse from God, and therefore justly deserve (as the fixed stars from the sun) to be blown away from God in infinitum, but that God by his Son's taking on Him man's nature, and the undeserved inspiration of His spirit, doth quicken this dulnes, nay deadnes of my nature, yet still,

ah me! how doth it choke and weaken those operations! If any one thinke all this but an idle conceit, I must tell him he doth too rashly deride that booke of creatures, that voyce of the heavens which is heard in all the world, and wherein without question God hath instamped more mysterys than the lazy witts of men, more ready to slight than amend any speculation, are ordinarily aware of. Shall we thinke that He who was content to shadow out these mysterys with the poor blood of buls and goats, will disdain to have them typified in the more glorious bodys of the stars and motions of the heaven; which David accounted such cleare Emblems of God's glory that he goes from speaking of the light of the sun, unto God's law, as if the subject were still the same, without any conclusion to the first, or introduction to the latter. For my part I must ever thinke that God created all other things, as well as man, in his own image, and that the nature of all things is one, as God is one, and therefore an harmonicall agreeing of the causes of all things, if demonstrated, were the quintessence of most truly naturall, philosophy.

Sic itur ad astra,
Repet hum: quicunque velit."

The curious illustrations in this extract will easily be pardoned, when it is remembered that they were in accordance with the phraseology of the day. In later times, Wallis imagined that the doctrine of the Trinity might be exemplified by the three dimensions of a cube; and even the theological treatises of the first half of the seventeenth century abound with expletives which would now be considered unsuitable to the solemnity of the subject. The passage breathes sentiments of the purest piety, and it is gratifying to know that Horrox had such clear views of evangelical truth. The cause of religion is strengthened when men of intellect range themselves on the Lord's side; and the sneer of the scoffer is repressed, whose specious arguments might otherwise unsettle the faith of the weaker brethren, and throw poison into the waters of life. How often do people take exception at some statement of scripture because it appears to them to be irreconcileable with the fresh discoveries of science; and although the point in

dispute may be comparatively unimportant, they magnify its proportions, until the great principles of the Bible are completely put out of sight: whereas, by deferring their judgment for awhile, it would be seen that such discoveries, if true in themselves, are not opposed to the teaching of Revelation. For it should be remembered that all truth proceeds from one great source: it has its foundation in the character of God. Science and religion therefore can never be hostile to each other; because they both work up to a common centre. The beneficence and order which are so conspicuous in the constitution of the universe were made known in the pages of scripture, generations before the physical sciences were cultivated. They are particularly conspicuous in the plan of redemption. In this respect, the arrangements of Providence resemble those of grace. At one time it was thought that the inequalities in the movements of the heavenly bodies would prove fatal to the establishment of the principle of gravitation; instead of which, upon further investigation, it was found, that so far from being a violation of the general law, they afforded a remarkable confirmation of it. In

like manner we read in the Gospel, that God can be "just, and yet the justifier of him which believeth in Jesus." This doctrine would not have been deemed possible by the sages of old, and when first preached, it was a stumbling-block to many; professing themselves to be wise they became fools; but a patient and unprejudiced examination convinces us that it is not only agreeable to the perfections of God, but even throws a lustre on His character, to which mankind before were strangers. Religion and science then are only different departments of truth; they can have no conflicting interests. The subject of this memoir was eminent in the pursuit of both. He saw the work of a Father's hand in the stars of heaven, the flowers of the field, the cattle upon the hillside, the attributes of man, and in the rich provision that has been made for every endangered heir of glory. He knew that even the evil that is in the world is a part of the general plan of administration; that sin is permitted to exist only for the manifestation of a much more abounding grace; and that the present dispensation is introductory to one more perfect and more enduring, when the irregularities

which now perplex us shall be seen to have been ordained in wisdom and love. Thus whilst he took pleasure in following up the path of discovery, and sought to carry the line and compass to the utmost boundaries of science, he was careful to study and to practise beyond everything the laws of God's spiritual kingdom, and thus to prepare for the future world of light and happiness. In a word, the greatest proof of his intelligence was, that he lived and acted for Eternity.

"While yet on earth the youthful pastor trod,
He read the word and traced the works of God;
The courses of the stars prophetic saw,
Unwound their order, and defined their law.
And yet a loftier view his eye could scan—
For this lost world salvation's glorious plan,—
The firmament of souls redeemed from night,
The centre Jesus, and the circle light.
A sage's love, a young apostle's zeal,
The head to reason, and the heart to feel,—
With truth and mercy, graced the preacher's tongue,
And o'er his life a holy radiance flung.
That meteor-life, soon lost to vision here,
Now shines unclouded in a glorious sphere;
Yet here its light his bright example gives,
And here in fame undying Horrox lives."

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