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WHAT CATHOLICS HAVE DONE FOR ASTRONOMY

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If love of one's own is a virtue, if praise of our heroes is a noble passion, then we as Catholics have every reason to glory in the achievements of our co-religionists in all the sciences, and especially in astronomy, the noblest of them all. Catholic names occur in profusion in connection with this sublime study and in its every department. I do not mean that one will not find other names of high distinction, but ours are amongst the greatest in the world, and in some instances are the pioneers and acknowledged leaders.

As Catholic teachers, it is proper that we should know them and emphasize their achievements before our pupils. It behooves us to have at hand the information, founded, if possible, upon non-Catholic testimony, concerning their real worth. We ought to be able to refute glaring historical errors, and to vindicate our heroes from malign aspersions. It is the object of the present paper to contribute somewhat to this noble purpose.

The Calendar.

Passing over the oft-refuted fable that tries to connect Pope Calixtus III. with Halley's comet,[1] we find that the first and most prominent astronomical work done by Catholics is the reformation of the calendar. This is so exclusively the work of our own men that it was carried to its final and complete perfection before Protestantism was born. And it was so well done, thirty years before the invention of the telescope, and two centuries before even this became an instrument of precision, that, involving as it does an exact knowledge of the number of days and fractions thereof in the tropical year and

[1]Calixte III et la Comete de Halley, by J. Stein, S. J., Vatican Press. This is probably the most exhaustive historical investigation of the question that has ever appeared.

in a lunation, with all the advances made during three centuries, we have as yet no adverse criticism to offer.

The Arabians.

It may be in place here to insert a word concerning the knowledge of astronomy we have heard so often ascribed to the Arabians during the so-called "Dark Ages." I give it on the authority of Newcomb, the greatest astronomer of his age, who died a year ago. He says[2] that the Arabians "slavishly followed the system of Ptolemy, and made no attempts to penetrate the mystery of the celestial motions. They had little capacity for speculation, and throughout held the Greek theories in superstitious reverence." And J. W. Draper, a pronounced anti-Catholic, says:[3] "So far as science is concerned nothing is owed to the Reformation."

Observatories.

Catholic Europe deserves the distinction of having founded the first astronomical observatory worthy of the name. "It was erected at Nuremberg in 1472.[4] * * * At this observatory many new methods of observation were invented, so that the revival of practical astronomy may be dated from its foundation." More than a century and a half elapsed before the observatory of Leyden was erected in 1632, and that of Copenhagen in 1641. Shortly after this the observatory of Paris, celebrated by the labors of the Catholic Cassini, was founded in 1667, and contemporaneously with it (1673), Father Verbiest enriched the old Peking observatory in China, founded in 1279, with the latest European scientific equipment. The Greenwich observatory followed in 1675.

In the United States the same interest was manifested, the observatory of Georgetown College being founded in 1844, the fifth in the order of time, and only seven years after the first in the country had been erected.

The Earth.

That the earth is spherical in shape was held as early as the eighth century by Virgilius, commonly called "The

[2]Encyclopedia Americana, title Astronomy.

[3]History of the Conflict between Science and Religion, Chap. VIII, p. 215.

[4]Encyclopedia Brittanica, 9th ed., title Observatory.

Geometer," who was Bishop of Salzburg, and by birth an Irishman. This doctrine of the earth's sphericity received a powerful impulse from the discovery of America by Columbus in 1492, and the encouragement which the great navigator received from the reigning Pontiff showed with what favor his theory was regarded in Church circles.

Copernicus (1473-1543) held not only the spherical shape of the earth, but also its rotation upon its axis, and although the only argument he could adduce in support of his theory was its overwhelming probability, his views were regarded with the greatest favor, and would soon have been adopted in all the schools, had they not received a serious check from the imprudence of Galileo.

The Abbe Picard, first president of the French Academy, was also the first to measure a meridian arc. This he did in France in 1671, and thus obtained a correct knowledge of the true size of the earth.[5] This latter result was so important that it at once gave us Newton's great theory of the universality of gravitation, for as a consequence of Picard's investigations, Newton was able to prove that the same force of gravity which holds bodies to the surface of the earth also controls the moon in her orbit with an intensity that diminishes as the square of the distance. The erroneous value of the size of the earth which Newton had used before, had long stood in the way of reconciling his theory with the moon's actual motion.[6]

But the very first really experimental verification of the earth's rotation on its axis was given to the world in 1851 by Foucault, "that most ingenious of French physicists,"[7] by means of a pendulum swung from the ceiling of the Pantheon in Paris. This experiment was received with the greatest enthusiasm, and has since been verified by thousands of experimenters.

Quite recently also, in 1896, but after eight years of patient labor, Father Carl Braun of Mariaschein, Bohemia, has given

[5]A General Astronomy, C. A. Young, 1st ed., page 93.

[6]Ibidem, p. 256.

[7]Ibidem, p. 95.

us a very reliable estimate of the earth's mass, that is, of its amount of matter, and consequently also of its density.[8]

The Sun.

After the telescope had been invented, the sun was the first celestial body that best lent itself to systematic study. It is immaterial to our purpose to decide whether Galileo or the Jesuit Scheiner was the first to discover the spots on the sun. It is certain, however, that Scheiner was the first eminent solar observer worthy of the name, since he was the first to devote his life to this work. He embodied the results of his investigations in a large volume, entitled "Rosa Ursina," printed in 1626-1630. In this work Scheiner establishes so many important facts that, according to the testimony of Winecke,[9] the labor of the re-discovery of several of them would have been spared to later astronomers if they had only consulted the "Rosa Ursina."

The spectroscope, with which the name of Fraunhofer will ever be associated, was another valuable instrument in the hands of astronomers. Father Secchi, of the Roman College (1849-1878), was quick to realize its value and to apply it to the sun and the stars. His work, "Le Soleil," appeared in 1870, and is the foundation upon which all modern theories respecting the sun are constructed. His explanation of the spots, faculæ, prominences and the corona, is substantially the same that is accepted to-day. He was ably seconded by his contemporary, Respighi, who had won such fame for himself especially in solar spectroscopy and by his catalogue of over twenty-five hundred stars and by his observations of comets and terrestrial magnetism, that the Italian government reinstated both him and Father Secchi in their respective observatories without requiring the oath of allegiance, which they could not take in conscience.

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[8]Die Gravitations—Constante, Die Masse und mittlere Dichte der Erde nach einer neuen experimentellen Bestimmung, by Carl Braun, S. J. Reviewed by J. H. Poynting in Annual Report of the Smithsonian Institution. 1902, p. 203.

[9]P. Christoph Scheiner, S. J., und seine Sonnenbeobachtungen, by John Schreiber, S. J., in Natur und Offenbarung, Vol. 48.

The Sun's Distance.

Probably the most important of all astronomical problems is the determination of the sun's distance from the earth, because upon this unit depends our knowledge of the dimensions of the individual planets, of the solar system and of the whole universe; in short, of the distance and size of all except the nearer celestial objects. Kepler's third law that the square of the time of any planet's revolution about the sun is proportional to the cube of its mean distance from it, enables us to pass from the earth's time of revolution (one year) and its mean distance, and the observed periodic time of any planet, to the latter's distance from the sun. And conversely, when a planet at times comes nearer to us than the sun, we can compute the sun's distance from the earth when we can find our distance from the planet. Only two of the planets, Mars and Venus (and the asteroid Eros, only latterly discovered), can be used for this purpose. The sun's distance when found is then generally expressed in terms of its mean equatorial horizontal parallax, that is, the apparent angular magnitude of the earth's equatorial radius as seen from the sun at its mean distance from us.

It is to the credit of the Catholic Cassini, who lived in France in 1680, that he found the sun's parallax to be 9.5″ and its distance from the earth 86,000,000 of miles, "giving the first reasonable approach to the true dimensions of the solar system."[10] Before his time Kepler had computed the sun's distance to be twelve or fifteen millions of miles, and Hipparchus had made it as low as four or five millions.

Venus, when in transit across the sun's face, may approach us almost within one-fourth of the sun's distance. This is why transits of Venus have been thought to offer the best possible solution of the great problem. In their great rarity, only two occurring in a century, astronomers have found an additional inducement to observe them carefully. Accordingly the astronomers of the eighteenth century strained every nerve to make successful observations of the transits of Venus which occurred in 1761 and 1769. Amongst others, Father Hell,

[10]Young, op. cit., p. 376.

director of the imperial observatory at Vienna, not only organized a corps of observers all over the world, but he went himself to Wardhus, in Lappland, in 1769, and thus occupied the most northerly station in Europe, so that his position was the most favorable for the purpose, the sun being, moreover, on the meridian at midnight at the middle of the transit. Owing to the storm then gathering about the Society of Jesus—it was suppressed four years later—and especially the accusations of the younger Littrow, one of his successors, Father Hell's observations were misunderstood and misinterpreted, so that he lay under a cloud of calumny for more than a century.

Encke, in 1824, made a thorough discussion of the transit observations, giving Father Hell's less weight than they deserved, and obtained the parallax 8.5776″ (95,500,000 miles), a determination whose accuracy was "by no means commensurate with the length of the decimal,"[11] since the very first place is now known to be wrong. In 1867 Newcomb went to Europe to re-examine the original observations. A close study of Father Hell's manuscript convinced him that the illustrious scientist had been seriously maligned, and he published a complete vindication of him.[12] Taking Father Hell's observations into proper account, Newcomb obtained the parallax 8.79″ (equivalent to 93 million miles), the latest and adopted value at present being 8.80″. Father Hell had computed the parallax at 8.70″, thus coinciding with Newcomb's in the first decimal, while Encke's prejudice against Hell's honesty had led him to vitiate this same first decimal by two units.

In the following century the British Government dispatched two distinct expeditions to observe transits of Venus, namely, to Kerguelen Island in 1874, and to Madagascar in 1882, giving the chief command on both occasions to Father Perry, of Stonyhurst College, England.

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[11]Young, Elements of Astronomy, 1892, No. 511.

[12]Monthly Notices of the Royal Astronomical Society of Great Britain, May, 1883, Vol. 43, p. 371, and also in the Astronomical Papers of the American Ephemeris, Vol. II, p. 301, et seq., and latterly in popular form in his Side Lights on Astronomy, Chapter XV.

The Moon.

The moon, being our nearest celestial neighbor, was, naturally, the first of the heavenly bodies to come within the range of the telescope. Accordingly, Galileo gave the moon his special attention, and after establishing the true character of its surface, he even showed how the heights of the lunar mountains may be measured from their shadows.

The first map of the moon was published in 1645 in Spain by Langrenus, the King's cosmographer; the second in 1647 by the Protestant Hevelius, who rejected the nomenclature of lunar objects devised by Langrenus; and the third in 1651 by the Jesuit Riccioli, who restored and improved the original nomenclature so well that it has remained in use ever since.[13]

The Stars.

Even the most ignorant of us know that the stars appear to be of different degrees of brightness or of magnitude. These magnitudes are purely optical, since the three elements that affect it, the star's distance, size and intrinsic brilliancy, are all, except in a few cases, unknown quantities. Hipparchus, in the second century before Christ, divided all the stars visible to the naked eye into six classes, placing the brightest stars in the first and the faintest in the sixth magnitude. This classification remained unaltered until the middle of the 19th century, when Argelander and Heis[14] of Germany reexamined the magnitudes of all the stars visible to the naked eye, and each of them published star maps, the Uranometria Nova and the Atlas Celestis Novus, respectively.

The keen eye of Heis mapped the Milky Way in five degrees of luminosity. He is one of the founders of variable star astronomy, and it is also largely owing to his untiring energy in the observation of meteors, that Schiaparelli was enabled to show that the orbits of certain meteor swarms were identical with those of certain comets.

Following his master in the line of variable star observations, Father Hagen, formerly of the Georgetown College Observatory,

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[13]History of Physical Astronomy, Robt. Grant, p. 229.

[14]Edward Heis, in Popular Astronomy, No. 136, June-July, 1906.

and called in 1906 by Pius X to the directorship of the Vatican Observatory, published an Atlas Stellarum Variabilium, which became at once an indispensable requisite for this branch of astronomy.[15]

In regard to the spectra of the stars, we all know that Secchi's classification is adhered to even at the present day, and that his name can scarcely be omitted with propriety even from an elementary text-book.[16]

Theoretical Astronomy.

Copernicus, in his epoch-making work, "De Orbium Coelestium Revolutionibus," was the first to give us a true knowledge of our solar system and of the position and motions of the earth. While probably not a priest, Copernicus was certainly in holy orders, and was encouraged to publish his theories by Cardinals and Bishops, and actually dedicated his work to the reigning Pope Paul III, by whom it was valued highly. The great beauty and cogency of the Copernican system is its simplicity. He distinguished at the start between the real and apparent motions of the heavenly bodies, which had been hopelessly interwoven before. The earth's true eastward rotation on its axis explained the apparent westward rotation of the heavens. The motion of the earth about the sun like that of any other planet, explained in an elegant and correct manner the retrograde motions of the planets, which had been such perplexing difficulties before his time.

There is not the least possibility of ever detecting any fallacy in the Copernican system, and of replacing it by another. Its truth is founded mainly, though not exclusively, on our knowledge of mechanics, a science of which the world was wholly ignorant until Galileo's experiments and reasonings gave us the laws of falling bodies, the pendulum, and, in fact, the whole of what we call mechanics, generally.

A direct proof of the earth's motion about the sun is furnished by the parallax of the stars, that is, their annual displacement on

[15] Review of Series VI, by J. A. Parkhurst in the Astronomical Journal, Vol. XXXI, No. 4, May, 1910.

[16] For the judgment of an expert consult Scheiner's Astrophysical Spectroscopy, translated by Edwin B. Frost, at present director of the Yerkes Observatory.

the celestial sphere in a small ellipse, which shows that the earth has really changed its position and moved to another point in its orbit. The aberration of light, which causes an apparent forward projection in a star's position, and the shifting of the spectral lines of the stars, prove conclusively that the earth is actually in motion.

Newton's law of gravitation applies rigorously to all bodies whatsoever, not only to the sun and its planets, but also to the action of the planets among themselves. In consequence of this mutual attraction, the planets cannot move in such simple curves as are the conic sections, in which each one would move if it and the sun alone existed. As these mutual attractions are very small when compared with the sun's overpowering influence, the discovery of the planet Neptune from the perturbation of Uranus "is justly reckoned as the greatest triumph of mathematical astronomy."[17] This glory is due to Leverrier, in France, in 1846, with whom Adams, in England, must also be associated, although his calculations were at first neglected. Leverrier happened to indicate the very spot within less than a degree where Neptune, the outermost planet of the solar system, nearly three thousand millions of miles away, was actually discovered.

And, finally, there are the works of Laplace, Leverrier, Tisserand and Poincaré, on celestial mechanics, which, amongst other things, investigate the mutual influence of the sun and its planets upon one another for all time to come. They show that, although all the elements of the planetary orbits are subject to change, those that concern our welfare on earth can vary only within imperceptible limits, while those that do not interest us have no limits set to their variations; in a word, that an overruling Providence has built the solar system on such a firm basis that, as far as its mechanism is concerned, it will endure forever in its present form.

Instrumental Inventions.

In regard to instrumental inventions, Clavius is credited with inventing the vernier, Scheiner was the first to construct an astronomical telescope, that is, one consisting of convex lenses

[17] Young's General Astronomy, page 369.

exclusively, and to mount it equatorially. Boscovich was the first to use the ring micrometer. Braun designed the transit micrometer, which has latterly come into such extended use. He was also one of the first to suggest the principle on which the spectroheliograph is founded. Father Fargis, of Georgetown College, invented the photochronograph, which entirely eliminates the personal equation in time observations.[18]

The Symbol of the Earth.

As a minor matter, I would put in a plea for the restoration of the good old Catholic symbol for the earth. This is a circle with a cross on it, thus beautifully symbolizing the cross dominating the earth. An un-Catholic practice has put the cross inside the circle, and thus perverted its meaning, seeing in it only an allusion to the meridians and other circles generally drawn on the terrestrial globe.

Conclusion.

In this rapid survey of the work done by Catholics in astronomy the chief aim has been to present the subject in a popular form. While the names of many great men have been mentioned, the list is by no means exhausted. The work done by them was of necessity such as might be intelligible to the unprofessional reader, and hence, the technical astronomer may find much to reprehend in this sketch. All that we Catholics can, and do, lay claim to in speaking of our scientists, is that their names are justly illustrious and that they are amongst the greatest that the world has to show. We can establish their right to this distinction upon the most trustworthy testimony, generally non-Catholic. And we earnestly wish that the world at large, or at least its most fair-minded spokesmen, would, from the facts presented, draw this one conclusion, that our holy Faith is at least not opposed to astronomy, a conclusion which, while falling far short of what we, as Catholics, would like to have drawn, may yet be the first and necessary step towards forming a correct judgment concerning the Catholic Church.

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[18] Jesuit Astronomy in Popular Astronomy, No. 111, January, 1904, and No. 115, May, 1904.