JAMES JOSEPH WALSH

CATHOLIC CHURCHMEN IN SCIENCE. FIRST SERIES

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Catholic Churchmen in Science [First Series] / Sketches of the Lives of Catholic Ecclesiastics Who Were Among the Great Founders in Science:

Содержание

James J. Walsh
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PREFACE

The following sketches of the lives of clergymen who were great scientists have appeared at various times during the past five years in Catholic magazines. They were written because the materials for them had gradually accumulated during the preparation of various courses of lectures, and it seemed advisable to put them in order in such a way that they might be helpful to others working along similar lines. They all range themselves naturally around the central idea that the submission of the human reason to Christian belief, and of the mind and

heart to the authority of the Church, is quite compatible with original thinking of the highest order, and with that absolute freedom of investigation into physical science, which has only too often been said to be quite impossible to churchmen. For this reason friends have suggested that they should be published together in a form in which they would be more easy of consultation than when scattered in different periodicals. It was urged, too, that they would thus also be more effective for the cause which they uphold. This friendly suggestion has been yielded to, whether justifiably or not the reader must decide for himself. There is so great a flood of books, good, bad, and indifferent, ascribing their existence to the advice of well-meaning friends, that we poor authors are evidently not in a position to judge for ourselves of the merit of our works or of the possible interest they may arouse.

I have to thank the editors of the ***American Catholic Quarterly Review***, of the ***Ave Maria***, and of ***The Ecclesiastical Review*** and ***The Dolphin***, for their kind permission to republish the articles which appeared originally in their pages. All of them, though substantially remaining the same, have been revised, modified in a number of particulars, and added to very considerably in most cases.

The call for a second edition–the third thousand–of this little book is gratifying. Its sale encouraged the preparation of a Second Series of CATHOLIC CHURCHMEN IN SCIENCE, and now the continued demand suggests a Third Series, which

will be issued during the year. Some minor corrections have been made in this edition, but the book is substantially the same.

I.
THE SUPPOSED OPPOSITION OF SCIENCE AND RELIGION

A common impression prevails that there is serious, if not invincible, opposition between science and religion. This persuasion has been minimized to a great degree in recent years, and yet sufficient of it remains to make a great many people think that, if there is not entire incompatibility between science and religion, there is at least such a diversity of purposes and aims in these two great realms of human thought that those who cultivate one field are not able to appreciate the labors of those who occupy themselves in the other. Indeed, it is usually accepted as a truth that to follow science with assiduity is practically sure to lead to unorthodoxy in religion. This is supposed to be especially true if the acquisition of scientific knowledge is pursued along lines that involve original research and new investigation. Somehow, it is thought that any one who has a mind free enough from the influence of prejudice and tradition to become an original thinker or investigator, is inevitably prone to abandon the old orthodox lines of thought in respect to religion.

Like a good many other convictions and persuasions that exist more or less as commonplaces in the subconscious intellects of a great many people, this is not true. Our American humorist

said that it is not so much the ignorance of mankind that makes him ridiculous as the knowing so many things "that ain't so." The supposed opposition between science and religion is precisely an apposite type of one of the things "that ain't so." It is so firmly fixed as a rule, however, that many people have accepted it without being quite conscious of the fact that it exists as one of the elements influencing many of their judgments–a very important factor in their apperception.

Now, it so happens that a number of prominent original investigators in modern science were not only thoroughly orthodox in their religious beliefs, but were even faithful clergymen and guiding spirits for others in the path of Christianity. The names of those who are included in the present volume is the best proof of this. The series of sketches was written at various times, and yet there was a central thought guiding the selection of the various scientific workers. Most of them lived at about the time when, according to an unfortunate tradition that has been very generally accepted, the Church dominated human thinking so tyrannously as practically to preclude all notion of original investigation in any line of thought, but especially in matters relating to physical science. Most of the men whose lives are sketched lived during the fifteenth, sixteenth, and first half of the seventeenth centuries. All of them were Catholic clergymen of high standing, and none of them suffered anything like persecution for his opinions; all remained faithful adherents of the Church through long lives.

It is hoped that this volume, without being in any sense controversial, may tend to throw light on many points that have been the subject of controversy; and by showing how absolutely free these great clergymen-scientists were to pursue their investigations in science, it may serve to demonstrate how utterly unfounded is the prejudice that would declare that the ecclesiastical authorities of these particular centuries were united in their opposition to scientific advance.

There is no doubt that at times men have been the subject of persecution because of scientific opinions. In all of these cases, without exception, however–and this is particularly true of such men as Galileo, Giordano Bruno, and Michael Servetus–a little investigation of the personal character of the individuals involved in these persecutions will show the victims to have been of that especially irritating class of individuals who so constantly awaken opposition to whatever opinions they may hold by upholding them overstrenuously and inopportunely. They were the kind of men who could say nothing without, to some extent at least, arousing the resentment of those around them who still clung to older ideas. We all know this class of individual very well. In these gentler modern times we may even bewail the fact that there is no such expeditious method of disposing of him as in the olden time. This is not a defence of what was done in their regard, but is a word of explanation that shows how human were the motives at work and how unecclesiastical the procedures, even though church institutions, Protestant and Catholic alike, were used by

the offended parties to rid them of obnoxious argumentators.

In this matter it must not be forgotten that persecution has been the very common associate of noteworthy advances in science, quite apart from any question of the relations between science and religion. There has scarcely been a single important advance in the history of applied science especially, that has not brought down upon the devoted head of the discoverer, for a time at least, the ill-will of his own generation. Take the case of medicine, for instance. Vesalius was persecuted, but not by the ecclesiastical authorities. The bitter opposition to him and to his work came from his colleagues in medicine, who thought that he was departing from the teaching of Galen, and considered that a cardinal medical heresy not to be forgiven. Harvey, the famous discoverer of the circulation of the blood, lost much of his lucrative medical practice after the publication of his discovery, because his medical contemporaries thought the notion of the heart pumping blood through the arteries to be so foolish that they refused to admit that it could come from a man of common sense, much less from a scientific physician. Nor need it be thought that this spirit of opposition to novelty existed only in the sixteenth and seventeenth centuries. Almost in our own time Semmelweis, who first taught the necessity for extreme cleanliness in obstetrical work, met with so much opposition in the introduction of the precautions he considered necessary that he was finally driven insane. His methods reduced the mortality in the great lying-in hospitals of Europe from nearly ten per cent

for such cases down to less than one per cent, thus saving many thousands of lives every year.

Despite this very natural tendency to decry the value of new discoveries in science and the opposition they aroused, it will be found that the lives of these clergymen scientists show us that they met with much more sympathy in their work than was usually accorded to original investigators in science in other paths in life. This is so different from the ordinary impression in the matter that it seems worth while calling it to particular attention. While we have selected lives of certain of the great leaders in science, we would not wish it to be understood that these are the only ones among the clergymen of the last four centuries who deserve an honorable place high up in the roll of successful scientific investigators. Only those are taken who illustrate activity in sciences that are supposed to have been especially forbidden to clergymen. It has been said over and over again, for instance, that there was distinct ecclesiastical opposition to the study of chemistry. Indeed, many writers have not hesitated to say that there was a bull, or at least a decree, issued by one or more of the popes forbidding the study of chemistry. This, is not only not true, but the very pope who is said to have issued the decree, John XXII, was himself an ardent student of the medical sciences. We still possess several books from him on these subjects, and his decree was meant only to suppress pseudo-science, which, as always, was exploiting the people for its own ends. The fact that a century later the

foundation of modern chemical pharmacology was laid by a Benedictine monk, Basil Valentine, shows how unfounded is the idea that the papal decree actually hampered in any way the development of chemical investigation or the advance of chemical science.

Owing to the Galileo controversy, astronomy is ordinarily supposed to have been another of the sciences to which it was extremely indiscreet at least, not to say dangerous, for a clergyman to devote himself. The great founder of modern astronomy, however, Copernicus, was not only a clergyman, but one indeed so faithful and ardent that it is said to have been owing to his efforts that the diocese in which he lived did not go over to Lutheranism during his lifetime, as did most of the other dioceses in that part of Germany. The fact that Copernicus's book was involved in the Galileo trial has rendered his position still further misunderstood, but the matter is fully cleared up in the subsequent sketch of his life. As a matter of fact, it is in astronomy particularly that clergymen have always been in the forefront of advance; and it must not be forgotten that it was the Catholic Church that secured the scientific data necessary for the correction of the Julian Calendar, and that it was a pope who proclaimed the advisability of the correction to the world. Down to our own day there have always been very prominent clergymen astronomers. One of the best known names in the history of the astronomy of the nineteenth century is that of Father Piazzi, to whom we owe the discovery of the first of the asteroids. Other

well-known names, such as Father Secchi, who was the head of the papal observatory at Rome, and Father Perry, the English Jesuit, might well be mentioned. The papal observatory at Rome has for centuries been doing some of the best work in astronomy accomplished anywhere, although it has always been limited in its means, has had inadequate resources to draw on, and has succeeded in accomplishing what it has done only because of the generous devotion of those attached to it.

To go back to the Galileo controversy for a moment, there seems no better answer to the assertion that his trial shows clearly the opposition between religion, or at least ecclesiastical authorities, and science, than to recall, as we have done, in writing the accompanying sketch of the life of Father Kircher, S.J., that just after the trial Roman ecclesiastics very generally were ready to encourage liberally a man who devoted himself to all forms of physical science, who was an original thinker in many of them, who was a great teacher, whose writings did more to disseminate knowledge of advances in science than those of any man of his time, and whose idea of the collection of scientific curiosities into a great museum at Rome (which still bears his name) was one of the fertile germinal suggestions in which modern science was to find seeds for future growth.

It is often asserted that geology was one of the sciences that was distinctly opposed by churchmen; yet we shall see that the father of modern geology, one of the greatest anatomists of his time, was not only a convert to Catholicity, but became a

clergyman about the time he was writing the little book that laid the foundation of modern geology. We shall see, too, that, far from religion and science clashing in him, he afterwards was made a bishop, in the hope that he should be able to go back to his native land and induce others to become members of that Church wherein he had found peace and happiness.

In the modern times biology has been supposed to be the special subject of opposition, or at least fear, on the part of ecclesiastical authorities. It is for this reason that the life of Abbot Mendel has been introduced. While working in his monastery garden in the little town of Brünn in Moravia, this Augustinian monk discovered certain precious laws of heredity that are considered by progressive twentieth-century scientists to be the most important contributions to the difficult problems relating to inheritance in biology that have been made.

These constitute the reasons for this little book on Catholic clergymen scientists. It is published, not with any ulterior motives, but simply to impress certain details of truth in the history of science that have been neglected in recent years and, by presenting sympathetic lives of great clergymen scientists, to show that not only is there no essential opposition between science and religion, but on the contrary that the quiet peace of the cloister and of a religious life have often contributed not a little to that precious placidity of mind which seems to be so necessary for the discovery of great, new scientific truths.

II.
COPERNICUS AND HIS TIMES

All the vast and most progressive systems that human wisdom has brought forth as substitutes for religion, have never succeeded in interesting any but the learned, the ambitious, or at most the prosperous and happy. But the great majority of mankind can never come under these categories. The great majority of men are suffering, and suffering from moral as well as physical evils. Man's first bread is grief, and his first want is consolation. Now which of these systems has ever consoled an afflicted heart, or repeopled a lonely one? Which of these teachers has ever shown men how to wipe away a tear? Christianity alone has from the beginning promised to console man in the sorrows incidental to life by purifying the inclinations of his heart, and she alone has kept her promise.–MONTALEMBERT, Introduction to ***Life of St. Elizabeth***.

II.
COPERNICUS AND HIS TIMES

The association of the name of Copernicus with that of Galileo has always cast an air of unorthodoxy about the great astronomer. The condemnation of certain propositions in his work on astronomy in which Copernicus first set forth the idea of the universe as we know it at present, in contradistinction to the old Ptolemaic system of astronomy, would seem to emphasize this suspicion of unorthodox thinking. He is rightly looked upon as one of the great pioneers of our modern physical science, and, as it is generally supposed that scientific tendencies lead away from religion, there are doubtless many who look upon Copernicus as naturally one of the leaders in this rationalistic movement. It is forgotten that scarcely any of the great original thinkers have escaped the stigma of having certain propositions in some of their books condemned, and that this indeed is only an index of the fallibility of the human mind and of the need there is for some authoritative teacher. The sentences in Copernicus's book requiring correction were but few, and were rather matters of terminology than of actual perversion of accepted teaching. It was as such that their modification was suggested. In spite of this, the impression remains that Copernicus must be considered as a rationalizing scientist, the first in a long roll of original

scientific investigators whose work has made the edifice of Christianity totter by removing many of the foundation-stones of its traditional authority.

It is rather surprising, in view of this common impression with regard to Copernicus, to find him, according to recent biographers, a faithful clergyman in honor with his ecclesiastical superiors, a distinguished physician whose chief patients were clerical friends of prominent position and the great noblemen of his day, who not only retained all his faith and reverence for the Church, but seems to have been especially religious, a devoted adherent of the Blessed Virgin Mother of God, and the author of a series of poems in her honor that constitute a distinct contribution to the literature of his time.

All this should not be astonishing, however; for in the list of the churchmen of the half century just before the great religious revolt in Germany are to be found some of the best known names in the history of the intellectual development of the race. This statement is so contrary to the usual impression that obtains in regard to the character of that period as to be a distinct source of surprise to the ordinary reader of history who has the realization of its truth thrust upon him for the first time. Just before the so-called Reformation, the clergy are considered to have been so sunk in ignorance, or at least to have been so indifferent to intellectual pursuits and so cramped in mind as regards progress, or so timorous because of inquisition methods, that no great advances in thought, and especially none

in science, could possibly be looked for from them. To find, then, that not only were faithful churchmen leaders in thought, discoverers in science, organizers in education, initiators of new progress, teachers of the New Learning, but that they were also typical representatives and yet prudent directors of the advancing spirit of that truly wonderful time, is apt to make us think that surely–as the Count de Maistre said one hundred years ago, and the Cambridge Modern History repeats at the beginning of the twentieth century when treating of this very period–"history has been a conspiracy against the truth."

Not quite fifty years before Luther's movement of protest began–that is, in 1471–there passed away in a little town in the Rhineland a man who has been a greater spiritual force than perhaps any other single man that has ever existed. This was Thomas à Kempis, a product of the schools of the Brethren of the Common Life, a teaching order that during these fifty years before the Protestant Revolution had over ten thousand pupils in its schools in the Rhineland and the Netherlands alone. As among these pupils there occur such names as Erasmus, Nicholas of Cusa, Agricola, not to mention many less illustrious, some idea of this old teaching institution, that has been very aptly compared to our modern Brothers of the Christian Schools, can be realized.

Kempis was a worthy initiator of a great half century. He had among his contemporaries, or followers in the next generation, such men as Grocyn, Dean Colet, and Linacre in England, Cardinal Ximenes in Spain, and Copernicus in

Germany. Considering the usual impression in this matter as regards the lack of interest at Rome in serious study, it is curiously interesting to realize how closely these great scholars and thinkers were in touch with the famous popes of the Renaissance period. The second half of the sixteenth century saw the elevation to the papacy of some of the most learned and worthy men that have ever occupied the Chair of Peter. In 1447 Nicholas V became pope, and during his eight years of pontificate initiated a movement of sympathy with modern art and letters that was never to be extinguished. To him more than to any other may be attributed the foundation of the Vatican Library. To him also is attributed the famous expression that "no art can be too lofty for the service of the Church." He was succeeded by Calixtus III, a patron of learning, who was followed by Pius II, the famous AEneas Sylvius, one of the greatest scholars and most learned men of his day, who had done more for the spread of culture and of education in the various parts of Europe than perhaps any other alive at the time.

The next Pope, Paul II, accomplished much during a period of great danger by arousing the Christian opposition to the Saracens. His encouragement and material aid to the Hungarians, who were making a bold stand against the Oriental invaders, merit for him a place in the rôle of defenders of civilization. To him is due the introduction of the recently discovered art of printing and its installation on a sumptuous scale worthy of the center of Christian culture. His successor, Sixtus IV, deserves the

title of the founder of modern Rome. Bridges, aqueducts, public buildings, libraries, churches–all owe to his fostering care their restoration and renewed foundation. He made it the purpose of his life to attract distinguished humanistic scholars to his capital, and Rome became the metropolis of culture and learning as well as the mother city of Christendom.

Under such popes it is no wonder that Rome and the cities of Italy generally became the homes of art and culture, centers of the new humanistic learning and the shelters of the scholars of the outer world. The Italian universities entered on a period of intellectual and educational development as glorious almost as the art movement that characterized the time. As this was marked by the work of such men as that universal genius Leonardo da Vinci, of Michael Angelo, poet, painter, sculptor, architect; of Raphael, Titian, and Correggio, whose contemporaries were worthy of them in every way, some idea can be attained of the wonderful era that developed. No wonder scholars in every department of learning flocked to Italy for inspiration and the enthusiasm bred of scholarly fellowship in such an environment. From England came men like Linacre, Selling, Grocyn, and Dean Colet; Erasmus came from the Netherlands, and Copernicus from Poland. Copernicus there obtained that scientific training which was later to prove so fruitful in his practical work as a physician and in his scientific work as the founder of modern astronomy.

It may be as well to say at the beginning that even

Copernicus was not the first to suggest that the earth moved, and not the sun; and that, curiously enough, his anticipator was another churchman, Nicholas of Cusa, the famous Bishop of Brixen. Readers of Janssen's ***History of the German People*** will remember that the distinguished historian introduces his monumental work by a short sketch of the career of Cusanus, as he is called, who may be well taken as the typical pre-Reformation scholar and clergyman. Cusa wrote in a manuscript–which is still preserved in the hospital of Cues, or Cusa–published for the first time by Professor Clemens in 1847: "I have long considered that this earth can not be fixed, but moves as do the other stars–***sed movetur ut aliae stellae***." What a curious commentary these words, written more than half a century before Galileo was born, form on the famous expression so often quoted because supposed to have been drawn from Galileo by the condemnation of his doctrine at Rome: ***E pur se muove***--"and yet it moves!" Cusanus was a Cardinal, the personal friend of three popes, and he seems to have had no hesitation in expressing his opinion in the matter. In the same manuscript the Cardinal adds: "And to my mind the earth revolves upon its axis once in a day and a night." Cusanus was, moreover, one of the most independent thinkers that the world has ever seen, yet he was intrusted by the pope about the middle of the fifteenth century with the reformation of abuses in the Church in Germany. The pope seems to have been glad to be able to secure a man of such straightforward ways for his reformatory designs.

The ideas of Nicholas of Cusa with regard to knowledge and the liberty of judgment in things not matters of faith can be very well appreciated from some of his expressions. "To know and to think," he says in one passage, "to see the truth with the eye of the mind is always a joy. The older a man grows, the greater is the pleasure it affords him; and the more he devotes himself to the search after truth, the stronger grows his desire of possessing it. As love is the life of the heart, so is the endeavor after knowledge and truth the life of the mind. In the midst of the movements of time, of the daily work of life, of its perplexities and contradictions, we should lift our gaze fearlessly to the clear vault of heaven and seek ever to obtain a firmer grasp of, and keener insight into, the origin of all goodness and duty, the capacities of our own hearts and minds, the intellectual fruits of mankind throughout the centuries, and the wondrous works of nature around us; but ever remembering that in humility alone lies true greatness, and that knowledge and wisdom are alone profitable in so far as our lives are governed by them."[1] It is no wonder, then, that the time was ripe for Copernicus and his great work in astronomy, nor that that work should be accomplished while he was a canon of a cathedral and for a time the vicar-general of a diocese.

It is now nearly five years since Father Adolph Muller, S.J., professor of Astronomy in the Pontifical Gregorian University of

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[1] ***History of the German People at the Close of the Middle Ages*** . By Johannes Janssen Translated from the German by M A Mitchell and A M Christie. Vol I, p. 3.

Rome, and director of a private observatory on the Janiculum in that city, wrote his historical scientific study[2] of the great founder of modern astronomy. The book has been reviewed, criticized and discussed very thoroughly since then, and has been translated into several languages. The latest translation was into Italian, the work of Father Pietro Mezzetti, S.J.,*[3] and was published in Rome at the end of 1902–having had the benefit of the author's revision. The historical details, then, of Copernicus's life may be considered to have been cast into definite shape, and his career may be appreciated with confidence as to the absolute accuracy and essential significance of all its features.

Nicholas Copernicus–to give him the Latin and more usual form of his name–was the youngest of four children of Niclas Copernigk, who removed from Cracow in Poland to Thorn in East Prussia (though then a city of Poland), where he married Barbara Watzelrode, a daughter of one of the oldest and wealthiest families of the province. His mother's brother, after having been a canon for many years in the cathedral of Frauenburg, was elected Bishop of the Province of Ermland. The future astronomer was born in 1473, at a time when Thorn, after having been for over two hundred years under the rule of the Teutonic Knights, had for some seven years been under the dominion of the King of Poland. There were two boys and

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[2] ***Nikolaus Kopernicus, Der Altmeister der neueren Astronomie, Ein Lebens und Kultur Bild*** . Von Adolf Muller, S.J.

[3] Professor of Astronomy and Physics at the Pontifical Leonine College of Anagni

two girls in the family; and their fervent Catholicity can be judged from the fact that all of them, parents and children, were inscribed among the members of the Third Order of St. Dominic. Barbara, the older sister, became a religious in the Cistercian Convent of Kulm, of which her aunt Catherine was abbess, and of which later on she herself became abbess. Andrew, the oldest son, became a priest; and Nicholas, the subject of this sketch, at least assumed, as we shall see, all the obligations of the ecclesiastical life, though it is not certain that he received the major religious orders.

Copernicus's collegiate education was obtained at the University of Cracow, at that time one of the most important seats of learning in Europe. The five-hundredth anniversary of the founding of this University was celebrated with great pomp only a few years ago. Its origin, however, dates back to the times of Casimir the Great, at the end of the thirteenth or the beginning of the fourteenth century. Its foundation was due to the same spirit of enthusiastic devotion to letters that gave us all the other great universities of the thirteenth century. The original institution was so much improved by Jagello, King of Poland, at the beginning of the fifteenth century, that it bears his name and is known as the Jagellonian University. It was very natural for Copernicus to go back to his father's native city for his education; but his ambitious spirit was not content with the opportunities afforded there. He does not seem to have taken his academic degrees, and the tradition that he received his doctorate

in medicine at the University of Cracow cannot be substantiated by any documentary evidence.

At Cracow, Copernicus devoted himself mainly to classical studies, though his interest in astronomy seems to have been awakened there. In fact, it is said that his desire to be able to read Ptolemy's astronomy in the original Greek, and to obtain a good copy of it, led him to look to Italy for his further education. During his years at Cracow, however, he seems to have made numerous observations in astronomy, as most of the astronomical data in his books are found reduced to the meridian of Cracow. The observatory of Frauenburg, at which his work in astronomy in later life was carried on, was on the same meridian; so that it is difficult to say, as have some of his biographers, that, since Cracow was the capital of his native country, motives of patriotism influenced him to continue his observations according to this same meridian. Copernicus was anxious, no doubt, to come in contact with some of the great astronomers at the universities of Italy, whom he knew by reputation and whose work was attracting attention all over Europe at that time.

How faithfully Copernicus applied himself to his classical studies can be best appreciated from some Latin poems written by him during his student days. These poems are an index, too, of the personal character of the man, and give some interesting hints of the religious side of his character. Altogether there are seven Latin odes, each ode composed of seven strophes. The seven odes are united by a certain community of interest

or succession of subjects. All of them refer to the history of the Redeemer either in types or in reality. In the first one the prophets prefigure the appearance of the Saviour; in the second the patriarchs sigh for His coming; the third depicts the scene of the Nativity in the Cave of Bethlehem; the fourth is concerned with the Circumcision and the imposition of the Name chosen by the Holy Ghost; the fifth treats of the Star and the Magi and their guidance to the Manger; the sixth concerns the presentation in the Temple; and the seventh, the scene in which Jesus at the age of twelve disputes with the doctors in the Temple at Jerusalem.

Copernicus's recent biographers have called attention particularly to the poetical beauties with which he surrounds every mention of the Blessed Virgin and her qualities. As is evident even from our brief resume of the subjects of the odes, the themes selected are just those in which the special devotion of the writer to the Mother of the Saviour could be very well brought out. There are, besides, a number of astronomical allusions which stamp the poems as the work of Copernicus, and which have been sufficient to defend their authenticity against the attacks made by certain critics, who tried to point out how different was the style from that of Copernicus's later years in his scientific writings. The tradition of authorship is, however, too well established on other grounds to be disturbed by criticism of this sort. The poems were dedicated to the Pope. In writing poetry Copernicus was only doing what Tycho Brahe and Kepler, his great successors in astronomy, did after him; and

the argument with regard to the difference of style in the two kinds of writings would hold also as regards these authors.

Copernicus's years as a boy and man–that is, up to the age of thirty-five–corresponded with a time of great intellectual activity in Europe. This fact is not as generally recognized as it should be, for intellectual activity is supposed to have awakened after the so-called Reformation. During the years from 1472 to 1506, however, there were founded in Germany alone no less than six universities: those of Ingolstadt, Treves, Tubingen, Mentz, Wittenberg, and Frankfort-on-the-Oder. These were not by any means the first great institutions of learning that arose in Germany. The universities of Prague and Vienna were more than a century old, and, with Heidelberg, Cologne, Erfurt, Leipsic, and Rostock, besides Greifswald and Freiburg, founded about the middle of the fifteenth century, had reached a high state of development, and contained larger numbers of students, with few exceptions, than these same institutions have ever had down to our own day. In most cases their charters were derived from the pope; and most of the universities were actually recognized as ecclesiastical institutions, in the sense that their officials held ecclesiastical authority.

At this time–the end of the fifteenth and the beginning of the sixteenth century–it was not unusual for students, in their enthusiasm for learning, to attempt to exhaust nearly the whole round of university studies. Medicine seems to have been a favorite subject with scholars who were widely interested in

knowledge for its own sake. Almost at the same time that Copernicus was studying in Italy, the distinguished English Greek scholar, Linacre, was also engaged in what would now be called post-graduate work at various Italian universities, and in the household of Lorenzo the Magnificent at Florence, with whose son–so much did Lorenzo think of him–he was allowed to study Greek. Linacre (as will be seen more at length in the sketch of his life in this volume), besides being the greatest Greek scholar of his time, the friend later of More and Colet and Erasmus in London, was also the greatest physician in England.

To those familiar with the times, it may be a source of surprise to think of Copernicus, interested as we know him to have been in literature and devoted so cordially to astronomy, yet taking up medicine as a profession. He seems, however, to have been led to do so by his distinguished teacher, Novara, who realized the talent of his Polish pupil for mathematics and astronomy and yet felt that he should have some profession in life. A century ago Coleridge, the English writer, said that a literary man should have some other occupation. Oliver Wendell Holmes improved upon this by adding: "And, as far as possible, he should confine himself to the other occupation." Novara seems to have realized that Copernicus might be under the necessity of knowing how to do something else besides making astronomical observations, in order to gain his living; and as medicine was satisfyingly scientific, the old teacher suggested his taking it up as a profession. Copernicus made his medical studies in Ferrara

and Padua, and obtained his doctorate with honors from Ferrara.

Copernicus seems to have taken up the practice of his profession seriously, and to have persevered in it to the end of his life. His biographers say that in the exercise of his professional duties he was animated by the spirit of a person who had devoted himself to the ecclesiastical life. While he did not publicly practise his profession, he was ever ready to assist the poor; and he also acquired great reputation in the surrounding country for his medical attendance upon clerics of all ranks. This continued to be the case, notwithstanding the fact that after the death of his uncle his mother inherited considerable wealth, and the family circumstances changed so much that he might well have given up any labors that were meant only to add to his income. In a word, he seems to have had a sincere interest in his professional work, and to have continued its exercise because of the opportunities it afforded for the satisfaction of a mind devoted to scientific research.

Copernicus acquired considerable reputation by his medical services. His friend Giese speaks of him as a very skilful physician, and even calls him a second AEsculapius. Maurice Ferber, who became Bishop of Ermland in 1523, suffered from a severe chronic illness that began about 1529. He obtained permission from the canons of the cathedral to have Doctor Copernicus, whose ability and zeal he never ceased to praise, to come from the cathedral town where he ordinarily resided to Heilsburg, in order to have him near him. Bishop Ferber's

successor, Dantisco, also secured Copernicus's aid in a severe illness, and declared that his restoration to health was mainly due to the efforts of his learned physician. Giese was so confident of the Doctor's skill that when he became Bishop of Kulm and on one of his episcopal visitations fell ill at a considerable distance from Copernicus's place of residence, he insisted on having the astronomer doctor brought to take care of him.

In 1541 Duke Albert of Prussia became very much worried over the illness of one of his most trusted counsellors. In his distress he had recourse to Copernicus, and his letter asking the Canon of the Cathedral of Frauenburg to come to attend the patient is still extant. He says that the cure of the illness is "very much at his heart"; and, as every other means has failed, he hopes Copernicus will do what he can for the assistance of his faithful and valued counsellor. Copernicus yielded to the request, and the counsellor began to improve shortly after his arrival. At the end of some weeks the Duke wrote again to the canons of the cathedral asking that the leave of absence granted to Copernicus should be extended in order to enable him to complete the cure which had been so happily begun. In this second letter the Duke talks of Copernicus as a most skilful and learned physician. At the end of the month there is a third letter from the Duke, in which he thanks all the canons of the cathedral for their goodness in having granted the desired permission, and he adds that he shall ever feel under obligations "for the assistance rendered by that very worthy and excellent physician, Nicholas Copernicus, a

doctor who is deserving of all honor." Not long afterward, when Copernicus's book on astronomy was published, a copy of it was sent to the Duke, and he replied that he was deeply grateful for it, and that he should always preserve it as a souvenir of the most learned and gentlest of men.

There are a number of notes on the art of medicine made by Copernicus in the books of the cathedral library at Frauenburg. They serve to show how faithful a student he was, and to a certain extent give an idea of the independent habit of mind which he brought to the investigation of medicine as well as to the study of astronomy. Unfortunately, these have not as yet found an editor; but it is to be hoped that we shall soon know more of the medical thinking of a man over whose mind tradition, in the unworthier sense of that word, exercised so little influence.

In 1530 Copernicus wrote a short prelude to the longer work on astronomy which he was to publish later. The propositions contained in this work show how far he had advanced on the road to his ultimate discovery. After a few words of introduction, the following seven axioms are laid down:–

1. The celestial spheres and their orbits have not a single center.

2. The center of the earth is not the center of the universe, but only the center of gravity and of the moon's orbit.

3. The planes of the orbits lie around the sun, which may be considered as the center of the universe.

4. The distance from the earth to the sun compared with that

from the earth to the fixed stars is extremely small.

5. The daily motion of the heavenly sphere is apparent that is, it is an effect of the rotary motion of the earth upon it axis.

6. The apparent motions of the moon and of the sun are so different because of the effect produced by the motion of the earth.

7. The movements of the earth account for the apparent retrograde motion and other irregularities of the movements of the planets. It is enough to assume that the earth alone moves, in order to explain all the other movements observed in the heavens.

It is no wonder that one of his bishop-friends, Frisio, writing to another bishop-friend, Dantisco, said: "If Copernicus succeeds in demonstrating the truth of his thesis–and we may well consider that he will from this prelude–he will give us a new heaven and a new earth." This shorter exposition of Copernicus's views was found in manuscript in the imperial library in Vienna only about a quarter of a century ago. It is mentioned by Tycho Brahe in one of his works on astronomy in which he reviews the various contemporary advances made in the knowledge of the heavens.

The publication of Copernicus's great work, "De Revolutionibus Orbium Celestium," was delayed until he was advanced in years, because his astronomical opinions were constantly progressing; and, with the patience of true genius, he was not satisfied with anything less than the perfect expression of truth as he saw it. It has sometimes been said that it was delayed because Copernicus feared the storm of religious persecution

which he foresaw it would surely arouse. How utterly without foundation is this pretence, which has unfortunately crept into serious history, can be seen from the fact that Pope Paul III accepted the dedication of the work; and of the twelve popes who immediately followed Paul not one even thought of proceeding against Copernicus's work. His teaching was never questioned by any of the Roman Congregations for nearly one hundred years after his death. Galileo's injudicious insistence in his presentation of Copernicus's doctrine, on the novelties of opinion that controverted long-established beliefs, was then responsible for the condemnation by the Congregation of the Index; and, as we shall see, this was not absolute, but only required that certain passages should be corrected. The corrections demanded were unimportant as regards the actual science, and merely insisted that Copernicus's teaching was hypothesis and not yet actual demonstration.

It must not be forgotten, after all, that the reasons advanced by Copernicus for his idea of the movements of the planets were not supported by any absolute demonstration, but only by reasons from analogy. Nearly a hundred years later than his time, even after the first discoveries had been made by the newly constructed telescopes, in Galileo's day, there was no absolute proof of the true system of the heavens. The famous Jesuit astronomer, Father Secchi, says the reasons adduced by Galileo were no real proofs: they were only certain analogies, and by no means excluded the possibility of the contrary propositions with

regard to the movements of the heavens being true. "None of the real proofs for the earth's rotation upon its axis were known at the time of Galileo, nor were there direct conclusive arguments for the earth's moving around the sun." Even Galileo himself confessed that he had not any strict demonstration of his views, such as Cardinal Bellarmine requested. He wrote to the Cardinal, "The system seems to be true;" and he gave as a reason that it corresponded to the phenomena.

According to the astronomers of the time, however, the old Ptolemaic system, in the shape in which it was explained by the Danish astronomer Tycho Brahe, who was acknowledged as the greatest of European astronomers, appeared to give quite a satisfactory explanation of the phenomena observed. The English philosopher, Lord Bacon, more than a decade after Galileo's announcement, considered that there were certain phenomena in nature contrary to the Copernican theory, and so he rejected it altogether. This was within a few years of the condemnation by the Congregation at Rome. As pointed out by Father Heinzle, S.J., in his article on Galileo in the "Catholic World" for 1887, "science was so far from determining the question of the truth or falsity of either the Ptolemaic or the Copernican system that shortly before 1633, the year of Galileo's condemnation, a number of savants, such as Fromond in Louvain, Morin in Paris, Berigard in Pisa, Bartolinus in Copenhagen, and Scheiner in Rome, wrote against Copernicanism."

As we have said, Copernicus's book was not condemned

unconditionally by the Roman authorities, but only until it should be corrected. This assured protection to the principal part of the work, and the warning issued by the Roman Congregation in the year 1820 particularizes the details that had to be corrected. It is interesting to note that whenever Copernicus is spoken of in this Monitum it is always in flattering terms as a "noble astrologer"–the word astrologer having at that time no unworthy meaning. The whole work is praised and its scientific quality acknowledged.

The passages requiring correction were not many. In the first book, at the beginning of the fifth chapter, Copernicus made the declaration that "the immobility of the earth was not a decided question, but was still open to discussion." In place of these words it was suggested that the following should be inserted: "In order to explain the apparent motions of the celestial bodies, it is a matter of indifference whether we admit that the earth occupies a place in the middle of the heavens or not."

In the eighth chapter of the first book, Copernicus said: "Why, then, this repugnance to concede to our globe its own movement as natural to it as is its spherical form? Why prefer to make the whole heavens revolve around it, with the great danger of disturbance that would result, instead of explaining all these apparent movements of the heavenly bodies by the real rotation of the earth, according to the words of AEneas, 'We are carried from the port, and the land and the cities recede'?" This passage was to be modified as follows: "Why not, then, admit a certain

mobility of the earth corresponding to its form, since the whole universe of which we know the bounds is moved, producing appearances which recall to the mind the well-known saying of AEneas in Virgil, 'The land and the cities recede'?"

Toward the end of the same chapter Copernicus, continuing the same train of thought, says: "I do not fear to add that it is incomparably more unreasonable to make the immense vault of the heavens revolve than to admit the revolution of our little terrestrial globe." This passage was to be modified as follows: "In one case as well as in the other–that is, whether we admit the rotation of the earth or that of the heavenly spheres–we encounter the same difficulties."

The ninth chapter of the first book begins with these words: "There being no difficulty in admitting, then, the mobility of the earth, let us proceed to see whether it has one or a number of movements, and whether, therefore, our earth is a simple planet like the other planets." The following words were to be substituted: "Supposing, then, that the earth does move, it is necessary to examine whether this movement is multiple or not."

Toward the middle of the tenth chapter Copernicus declares: "I do not hesitate to defend the proposition that the earth, accompanied by the moon, moves around the sun;" while the wording of this proposition had to be changed so as to substitute the term "admit" for "defend." The title of the eleventh chapter, "Demonstration of the Triple Movement of the Earth," was modified to read as follows: "The Hypothesis of the Triple

Movement of the Earth, and the Reasons Therefor." The title of the twentieth chapter of the fourth book originally read: "On the Size of the Three Stars [***Sidera***], the sun, the moon, and the earth." The word "stars" was removed from this title, the earth not being considered as a star. The concluding words of the tenth chapter of the first book, "So great is the magnificent work of the Omnipotent Artificer," had to be cancelled, because they expressed an assurance of the truth of his system not warranted by knowledge. With these few unimportant changes, any one might read and study Copernicus's work with perfect freedom.

Traditions to the contrary notwithstanding, Galileo, because of the friendship and encouragement of the churchmen in Italy, had been placed in conditions eminently suited for study and investigation. Several popes and a number of prominent ecclesiastics were his constant friends and patrons. The perpetual secretary of the Paris Academy of Sciences, M. Bertrand, himself a great mathematician and historian, declares that the long life of Galileo was one of the most enviable that is recorded in the history of science. "The tale of his misfortunes has confirmed the triumph of the truth for which he suffered. Let us tell the whole truth. This great lesson was learned without any profound sorrow to Galileo; and his long life, considered as a whole, was one of the most serene and enviable in the history of science."

Copernicus, like Galileo, had clerical friends to thank for an environment that proved the greatest possible aid to his

scientific work. His position as Canon of the Cathedral of Frauenburg provided him with learned leisure, while his clerical friends took just enough interest in his investigations and the preliminary announcements of his discoveries to make his pursuit of astronomical studies to some definite conclusion a worthy aim in life. It was this assistance that enabled him to publish his book eventually and bring his great theory before the world.

Copernicus, far from having any leanings toward the so-called "reform" movement (as has often been asserted), was evidently a staunch supporter of his friend and patron Bishop Maurice Ferber, of Ermland, who kept his see loyal to Rome at a time when the secularization of the Teutonic order and the falling away of many bishops all around him make his position as a faithful son of the Church and that of his diocese noteworthy in the history of that time and place. It may well be said that under less favorable conditions Copernicus's work might never have been finished. As it was, his book met with great opposition from the Reformers, but remained absolutely acceptable even to the most rigorous churchmen until Galileo's unfortunate insistence on the points of it that were opposed to generally accepted theories.

During all his long life Copernicus remained one of the simplest of men. Genius as he was, he could not have failed to realize how great was the significance of the discoveries he had made in astronomy. In spite of this he continued to exercise

during a long career the simple duties of his post as Canon of the Cathedral of Frauenberg, nor did he fail to give such time as was asked of him for the medical treatment of the poor or of his friends, the ecclesiastics of the neighborhood. These duties–as he seems to have considered them–must have taken many precious hours from his studies, but they were given unstintingly. When he came to die, his humility was even more prominent than during life. It was at his own request that there was graven upon his tombstone simply the prayer, "I ask not the grace accorded to Paul, not that given to Peter: give me only the favor Thou didst show to the thief on the cross." There is perhaps no better example in all the world of the simplicity of true genius nor any better example of how sublimely religious may be the soul that has far transcended the bounds of the scientific knowledge of its own day.

The greatness of Copernicus's life-work can best be realized from the extent to which he surpassed even well-known contemporaries in astronomy and from his practical anticipation of the opinions of some of his greatest successors. Even Tycho Brahe, important though he is in the history of astronomical science, taught many years after Copernicus's death the doctrine that the earth is the center of the universe. Newton had in Copernicus a precursor who divined the theory of universal gravitation; and even Kepler's great laws, especially the elliptical form of the orbits of the planets, are at least hinted at in Copernicus's writings. He is certainly one of the most original

geniuses of all times; and it is interesting to find that the completeness of his scholarly career, far from being rendered abortive by friction with ecclesiastical superiors, as we might imagine probable from the traditions that hang around his name, was rather made possible by the sympathy and encouragement of clerical friends and Church authorities. Copernicus, the scholar, astronomer, physician, and clergyman, is a type of the eve of the Reformation period, and his life is the best possible refutation of the slanders with regard to the unprogressiveness of the Church and churchmen of that epoch which have unfortunately been only too common in the histories of the time.

III.
BASIL VALENTINE, FOUNDER OF MODERN CHEMISTRY

Let us, then, banish into the world of fiction that affirmation so long repeated by foolish credulity which made monasteries an asylum for indolence and incapacity, for misanthropy and pusillanimity, for feeble and melancholic temperaments, and for men who were no longer fit to serve society in the world. Monasteries were never intended to collect the invalids of the world. It was not the sick souls, but on the contrary the most vigorous and healthful the human race has ever produced, who presented themselves in crowds to fill them.–MONTALEMBERT, ***Monks of the West***.

III.
BASIL VALENTINE, FOUNDER OF MODERN CHEMISTRY

The Protestant tradition which presumes a priori that no good can possibly have come out of the Nazareth of the times before the Reformation, and especially the immediately preceding century, has served to obscure to an unfortunate degree the history of several hundred years extremely important in every department of education. Strange as it may seem to those unfamiliar with the period, it is in that department which is supposed to be so typically modern the–physical sciences–that this neglect is most serious. Such a hold has this Protestant tradition on even educated minds that it is a source of great surprise to most people to be told that there were in many parts of Europe original observers in the physical sciences all during the thirteenth, fourteenth, and fifteenth centuries who were doing ground-breaking work of the highest value, work that was destined to mean much for the development of modern science. Speculations and experiments with regard to the philosopher's stone and the transmutation of metals are supposed to fill up all the interests of the alchemists of those days. As a matter of fact, however, men were making original observations of very profound significance, and these were considered so valuable

by their contemporaries that, though printing had not yet been invented, even the immense labor involved in copying large folio volumes by hand did not suffice to deter them from multiplying the writings of these men and thus preserving them for future generations, until the printing-press came to perpetuate them.

At the beginning of the twentieth century, with some of the supposed foundations of modern chemistry crumbling to pieces under the influences of the peculiarly active light thrown upon older chemical theories by the discovery of radium and the radio-active elements generally, there is a reawakening of interest in some of the old-time chemical observers whose work used to be laughed at as so unscientific and whose theory of the transmutation of elements into one another was considered so absurd. The idea that it would be impossible under any circumstances to convert one element into another belongs entirely to the nineteenth century. Even so distinguished a mind as that of Newton, in the preceding century, could not bring itself to acknowledge the modern supposition of the absurdity of metallic transformation, but, on the contrary, believed very firmly in this as a basic chemical principle and confessed that it might be expected to occur at any time. He had seen specimens of gold ores in connexion with metallic copper, and had concluded that this was a manifestation of the natural transformation of one of these yellow metals into the other.

With the discovery that radium transforms itself into helium, and that indeed all the so-called radio-activities of the very

heavy metals are probably due to a natural transmutation process constantly at work, the ideas of the older chemists cease entirely to be a subject for amusement. The physical chemists of the present day are very ready to admit that the old teaching of the absolute independence of something over seventy elements is no longer tenable, except as a working hypothesis. The doctrine of matter and form taught for so many centuries by the scholastic philosophers which proclaimed that all matter is composed of two principles, an underlying material substratum and a dynamic or informing principle, has now more acknowledged verisimilitude, or lies at least closer to the generally accepted ideas of the most progressive scientists, than it has at any time for the last two or three centuries. Not only the great physicists, but also the great chemists, are speculating along lines that suggest the existence of but one form of matter, modified according to the energies that it possesses under a varying physical and chemical environment. This is, after all, only a restatement in modern terms of the teaching of St. Thomas of Aquin in the thirteenth century.

It is not surprising, then, that there should be a reawakening of interest in the lives of some of the men who, dominated by the earlier scholastic ideas and by the tradition of the possibility of finding the philosopher's stone, which would transmute the baser metals into the precious metals, devoted themselves with quite as much zeal as any modern chemist to the observation of chemical phenomena. One of the most interesting of these–

indeed he might well be said to be the greatest of the alchemists– is the man whose only name that we know is that which appears on a series of manuscripts written in the High German dialect of the end of the fifteenth and the beginning of the sixteenth century. That name is Basil Valentine, and the writer, according to the best historical traditions, was a Benedictine monk. The name Basil Valentine may only have been a pseudonym, for it has been impossible to trace it among the records of the monasteries of the time. That the writer was a monk there seems to be no doubt, for his writings in manuscript and printed form began to have their vogue at a time when there was little likelihood of their being attributed to a monk unless an indubitable tradition connected them with some monastery.

This Basil Valentine (to accept the only name we have), as we can judge very well from his writings, eminently deserves the designation of the last of the alchemists and the first of the chemists. There is practically a universal recognition of the fact now that he deserves also the title of Founder of Modern Chemistry, not only because of the value of the observations contained in his writings, but also because of the fact that they proved so suggestive to certain scientific geniuses during the century succeeding Valentine's life. Almost more than to have added to the precious heritage of knowledge for mankind is it a boon for a scientific observer to have awakened the spirit of observation in others and to be the founder of a new school of thought. This Basil Valentine undoubtedly did.

Besides, his work furnishes evidence that the investigating spirit was abroad just when it is usually supposed not to have been, for the Thuringian monk surely did not do all his investigating alone, but must have received as well as given many a suggestion to his contemporaries.

In the history of education there are two commonplaces that are appealed to oftener than any other as the sources of material with regard to the influence of the Catholic Church on education during the centuries preceding the Reformation. These are the supposed idleness of the monks, and the foolish belief in the transmutation of metals and the search for the philosopher's stone which dominated the minds of so many of the educated men of the time. It is in Germany especially that these two features of the pre-Reformation period are supposed to be best illustrated. In recent years, however, there has come quite a revolution in the feelings even of those outside of the Church with regard to the proper appreciation of the work of the monastic scholars of these earlier centuries. Even though some of them did dream golden dreams over their alembics, the love of knowledge meant more to them, as to the serious students of any age, than anything that might be made by it. As for their scientific beliefs, if there can be a conversion of one element into another, as seems true of radium, then the possibility of the transmutation of metals is not so absurd as, for a century or more, it has seemed; and it is not impossible that at some time even gold may be manufactured out of other metallic materials.

Of course, a still worthier change of mind has come over the attitude of educators because of the growing sense of appreciation for the wonderful work of the monks of the Middle Ages, and even of those centuries that are supposed to show least of the influence of these groups of men who, forgetting material progress, devoted themselves to the preservation and the cultivation of the things of the spirit. The impression that would consider the pre-Reformation monks in Germany as unworthy of their high calling in the great mass is almost entirely without foundation. Obscure though the lives of most of them were, many of them rose above their environment in such a way as to make their work landmarks in the history of progress for all time.

Because their discoveries are buried in the old Latin folios that are contained only in the best libraries, not often consulted by the modern scientist, it is usually thought that the scientific investigators of these centuries before the Reformation did no work that would be worth while considering in our present day. It is only some one who goes into this matter as a labor of love who will consider it worth his while to take the trouble seriously to consult these musty old tomes. Many a scholar, however, has found his labor well rewarded by the discovery of many an anticipation of modern science in these volumes so much neglected and where such treasure-trove is least expected. Professor Clifford Allbutt, the Regius Professor of physics at the University of Cambridge, in his address on "The Historical Relations of Medicine and Surgery Down to the End

of the Sixteenth Century," which was delivered at the St. Louis Congress of Arts and Sciences during the Exposition in 1904, has shown how much that is supposed to be distinctly modern in medicine, and above all in surgery, was the subject of discussion at the French and Italian universities of the thirteenth century. William Salicet, for instance, who taught at the University of Bologna, published a large series of case histories, substituted the knife for the Arabic use of the cautery, described the danger of wounds of the neck, investigated the causes of the failure of healing by first intention, and sutured divided nerves. His pupil, Lanfranc, who taught later at the University of Paris, went farther than his master by distinguishing between venous and arterial hemorrhage, requiring digital compression for an hour to stop hemorrhage from the ***venae pulsatiles***--the pulsating veins, as they were called–and if this failed because of the size of the vessel, suggesting the application of a ligature. Lanfranc's chapter on injuries to the head still remains a noteworthy book in surgery that establishes beyond a doubt how thoughtfully practical were these teachers in the medieval universities. It must be remembered that at this time all the teachers in universities, even those in the medical schools as well as those occupied with surgery, were clerics. Professor Allbutt calls attention over and over again to this fact, because it emphasizes the thoroughness of educational methods, in spite of the supposed difficulties that would lie in the way of an exclusively clerical teaching staff.

In chemistry the advances made during the thirteenth,

fourteenth, and fifteenth centuries were even more noteworthy than those in any other department of science. Albertus Magnus, who taught at Paris, wrote no less than sixteen treatises on chemical subjects, and, notwithstanding the fact that he was a theologian as well as a scientist and that his printed works filled sixteen folio volumes, he somehow found the time to make many observations for himself and performed numberless experiments in order to clear up doubts. The larger histories of chemistry accord him his proper place and hail him as a great founder in chemistry and a pioneer in original investigation.

Even St. Thomas of Aquin, much as he was occupied with theology and philosophy, found some time to devote to chemical questions. After all, this is only what might have been expected of the favorite pupil of Albertus Magnus. Three treatises on chemical subjects from Aquinas's pen have been preserved for us, and it is to him that we are said to owe the origin of the word amalgam, which he first used in describing various chemical methods of metallic combination with mercury that were discovered in the search for the genuine transmutation of metals.

Albertus Magnus's other great scientific pupil, Roger Bacon, the English Franciscan friar, followed more closely in the physical scientific ways of his great master. Altogether he wrote some eighteen treatises on chemical subjects. For a long time it was considered that he was the inventor of gunpowder, though this is now known to have been introduced into Europe by

the Arabs. Roger Bacon studied gunpowder and various other explosive combinations in considerable detail, and it is for this reason that he obtained the undeserved reputation of being an original discoverer in this line. How well he realized how much might be accomplished by means of the energy stored up in explosives can perhaps be best appreciated from the fact that he suggested that boats would go along the rivers and across the seas without either sails or oars and that carriages would go along the streets without horse or man power. He considered that man would eventually invent a method of harnessing these explosive mixtures and of utilizing their energies for his purposes without danger. It is curiously interesting to find, as we begin the twentieth century, and gasolene is so commonly used for the driving of automobiles and motor boats and is being introduced even on railroad cars in the West as the most available source of energy for suburban traffic, that this generation should only be fulfilling the idea of the old Franciscan friar of the thirteenth century, who prophesied that in explosives there was the secret of eventually manageable energy for transportation purposes.

Succeeding centuries were not as fruitful in great scientists as the thirteenth, and yet at the beginning of the fourteenth there was a pope, three of whose scientific treatises–one on the transmutation of metals, which he considers an impossibility, at least as far as the manufacture of gold and silver was concerned; a treatise on diseases of the eyes, of which Professor Allbutt[4]

[4] Address cited

says that it was not without its distinctive practical value, though compiled so early in the history of eye surgery; and, finally, his treatise on the preservation of the health, written when he was himself over eighty years of age–are all considered by good authorities as worthy of the best scientific spirit of the time. This pope was John XXII, of whom it has been said over and over again by Protestant historians that he issued a bull forbidding chemistry, though he was himself one of the enthusiastic students of chemistry in his younger years and always retained his interest in the science[5].

During the fourteenth century Arnold of Villanova, the inventor of nitric acid, and the two Hollanduses kept up the tradition of original investigation in chemistry. Altogether there are some dozen treatises from these three men on chemical subjects. The Hollanduses particularly did their work in a spirit of thoroughly frank, original investigation. They were more interested in minerals than in any other class of substances, but did not waste much time on the question of transmutation of metals. Professor Thompson, the professor of chemistry at Edinburgh, said in his history of chemistry many years ago that the Hollanduses have very clear descriptions of their processes of treating minerals in investigating their composition, which serve to show that their knowledge was by no means entirely theoretical

[5] For the refutation of this calumny with regard to John XXII, see "Pope John XXII and the supposed Bull forbidding Chemistry," by James J. Walsh, Ph. D., LL. D., in the ***Medical Library and Historical Journal***, October, 1905.

or acquired only from books or by argumentation.

Before the end of this fourteenth century, according to the best authorities on this subject, Basil Valentine, the more particular subject of our essay, was born.

Valentine's career is a typical example of the personally obscure but intellectually brilliant lives which these old monks lived. It seems probable, according to the best authorities, as we have said, that his work began shortly before the middle of the fifteenth century, although most of what was important in it was accomplished during the second half. It would not be so surprising, as most people who have been brought up to consider the period just before the Reformation in Germany as wanting in progressive scholars might imagine, for a supremely great original investigator to have existed in North Germany about this time. After all, before the end of the century, Copernicus, the Pole, working in northern Germany, had announced his theory that the earth was not the center of the universe, and had set forth all that this announcement meant. To a bishop-friend who said to him, "But this means that you are giving us a new universe," he replied that the universe was already there, but his theory would lead men to recognize its existence. In southern Germany, Thomas à Kempis, who died in 1471, had traced for man the outlines of another universe, that of his own soul, from its mystically practical side. These great Germans were only the worthy contemporaries of many other German scholars scarcely less distinguished than these supreme geniuses. The second half

of the fifteenth century, the beginning of the Renaissance in Germany as well as Italy, is that wonderful time in history when somehow men's eyes were opened to see farther and their minds broadened to gather in more of the truth of man's relation to the universe, than had ever before been the case in all the centuries of human existence, or than has ever been possible even in these more modern centuries, though supposedly we are the heirs of all the ages in the foremost files of time.

Coming as he did before printing, when the spirit of tradition was even more rife and dominating than it has been since, it is almost needless to say that there are many curious legends associated with the name of Basil Valentine. Two centuries before his time, Roger Bacon, doing his work in England, had succeeded in attracting so much attention even from the common people, because of his wonderful scientific discoveries, that his name became a by-word and many strange magical feats were attributed to him. Friar Bacon was the great wizard even in the plays of the Elizabethan period. A number of the same sort of myths attached themselves to the Benedictine monk of the fifteenth century. He was proclaimed in popular story to have been a wonderful magician. Even his manuscript, it was said, had not been published directly, but had been hidden in a pillar in the church attached to the monastery and had been discovered there after the splitting open of the pillar by a bolt of lightning from heaven. It is the extension of this tradition that has sometimes led to the assumption that Valentine lived in an earlier century, some

even going so far as to say that he, too, like Roger Bacon, was a product of the thirteenth century. It seems reasonably possible, however, to separate the traditional from what is actual in his existence, and thus to obtain some idea at least of his work, if not of the details of his life. The internal evidence from his works enable the historian of science to place him within a half century of the discovery of America.

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