Early Astronomy and the Observatory of Leyden*

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THE Observatory of Leyden had really two founders, Goliüs in 1633 and Kaiser in 1861. I propose to make a comparison between these two epochs and the present time. Looking back from the point of view of the science of to-day at the past, the great differences between now and then are brought into sharp relief. Our times are distinguished by the great facility of communication; the steamship and railway, telegraph and aeroplane have made the world much smaller. We have our international organisations, our periodicals, and although influences outside science at present throw many difficulties in the way of international intercourse, still we men of science feel ourselves more and more to belong to a universal fraternity. In the seventeenth century it was otherwise. Although at that time scientific intercourse was more international than at present, as being much more independent of political influences, yet owing to the absence of periodicals and the slowness of communication, each individual student was in a much more isolated position than now, and international communication bore a much more personal character. Scientific intercourse was mostly by correspondence: people had time to write, and even to read and answer, letters. The period of the second foundation, 1860, is in this respect intermediate between the seventeenth century and our own time. There were few periodicals, communication was maintained much more by correspondence than nowadays and the scientific international organisations as we know them to-day were only just beginning.

If we look at the practice of science, the difference is, if anything, greater. To-day we live, so to speak, on photography; we cannot imagine astronomy without it. But the development of the application of photography to astronomical observations took place very slowly and gradually; in 1861 the photography of the sky had scarcely been begun, although the first photograph of a star had been taken about ten years previously. Perhaps some eccentric worker may have dreamed of a systematic photographic examination of the firmament, but it was not for a quarter of a century that the practical possibility of this on a large scale was generally acknowledged and undertaken.

The second great revolution in the aspect of science was wrought by spectroscopy, the origin of which lies in about the same period. In 1859 Kirchhoff and Bunsen laid the foundations of spectrum analysis: in 1863 Secchi published his first classification of the spectra of the stars. 'The new astronomy' was born at that time. It was the spectroscope that finally abolished the last vestiges of the old belief, a relic of antiquity and

scholasticism, in an essential difference between 'corruptible', sublunary matter and the 'incorruptible', superlunary, divine or heavenly; and introduced, or at least confirmed, the conception of the fundamental unity of the universe.

The development of science is a gradual process. It is often impossible to fix the exact moment at which a new idea was conceived. But the history of science, like other history, can be divided into definite periods, even if these cannot be definitely limited, any more than the historian, I take it, can say exactly on what day the Middle Ages ended and modern history began.

The history of astronomy, I consider, may be divided into four periods. The first, to which Babylonian, Egyptian and the most ancient Greek science belongs, reached its climax in Aristotle and his immediate followers. The second, which we can perhaps best characterise as the Ptolemaic, begins with Hipparchus, and ends with Copernicus. The third period, which I would call the Newtonian, after the man in whose work it culminated, begins a century before Newton with Tycho Brahe, Kepler and Galileo. The fourth, modern astronomy, was, as we saw, opened in 1860 by the introduction of photography and spectroscopy, and it is to all appearance even now still in the first stage of its rising development.

The year of the foundation of the Observatory of Leyden, 1633, falls in the middle of the transition from the second to the third period. It was the year of Galileo's trial; Kepler died rather more than a year before (November 15, 1630); Huygens was a boy of four years old; Newton was not yet born. The "Novum Organon" of Francis Bacon was published in 1620, the "Discours sur la méthode" of Descartes (contemporary of our Goliüs, born in the same year) was to appear in 1637. A good idea of the standard of science then can be gained from the list of books of study given to the youthful Huygens by his teacher Stampioen de Jonge in 1645. Stampioen was not an independent scientific worker, but a teacher. His list of books may be taken to represent what at that time was common knowledge of all educated men. In mathematics, after mention of some elementary books, follows: "to read something more and to come to the highest step of mathematics . . . for this is needed the Book of the Elementa Conica Appolloni pergaei". Apollonius's conic sections, in which according to Stampioen, "the most subtle sciences [are] hid, that are possible to bethink on this earth", was the source to which, at that time, the greatest mathematicians went for help and information. Kepler pinned his faith on it when he was upon the threshold of his discovery of the elliptical orbits of the planets, and in the life of Goliüs it played an important part, as it was the inadequacy of the traditional

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Greek text that drove him to the study of Arabic, which was to be his life's work. Concerning astronomy Stampioen de Jonge says: "there is nothing better than all the books of Lansbergen", doctor and divine of Goes (later of Middleburg, who died on November 8, 1632) who enjoyed a great reputation in his day, which he well deserved. He was an adherent of the Copernican system, without Kepler's elliptic motion however, and from ancient observations, supplemented by those of Tycho and others, including his own and those of his pupil and admirer Hortensius, he deduced new elements for the planets and calculated tables which must have been good, as they enabled Horrox to predict and observe the transit of Venus on December 4, 1639. Yet there are in his book many arguments which to-day sound very strange to our ears. To give an example: the distance of the fixed stars is 28,000 astronomical units "because" their period of revolution round the sun is 28,000 years (through the precession)!

The peroration in Stampioen's advice to Huygens is worth quoting: "Not that the books afore-named, will do it alone, but thereunto is moreover needed. In the first place a sharp intelligence. Further a continual application and finally also a sustained desire and industry for these sciences, which then . . . may be acquired through prolonged study. And moreover to put into practice that which has been learned, is of much more benefit than always and continually . . . to pore over your books."

It seems to me that father Huygens had chosen a sensible mentor for his son, and Christian certainly did not neglect Stampioen's further advice to do something else besides "always and continually . . . to pore over your books". To replace authoritative belief by individual research, book study by 'personal practice', especially *experiment*, is the characteristic which distinguishes the new period from the previous one. The discovery of the telescope in 1608, by which, primarily through the multitude of observations by Galileo, the number and nature of the known phenomena of the universe were suddenly immeasurably increased, is one of the most important moments, perhaps the most important, in the evolution of ideas then taking place. I cannot help pointing out incidentally that in all the discussions as to who should have the honour of this discovery, the name of the discoverer of the *astronomical* telescope, Kepler, is scarcely ever mentioned, while he, of all the more or less independent makers of telescopes, had by far the best insight into the problems of optics.

The sharp light which is thrown upon the opposition between the Copernican and Ptolemaic systems by Galileo's quarrel with the Church, his dialogue on the two systems of the universe of 1632 and his trial and condemnation in 1633, have contributed to the view that this opposition is the essential, typical difference between the old and the new science. This is a mistake. The human mind is a very complicated mechanism;

the way in which it works is often very inconsistent and may be contradictory in external, formal matters, to its inward nature. The difference between the Copernican and the Ptolemaic system belongs to the externals. Thus, three quarters of a century after the appearance of Copernicus's book, the great Snellius, who although he loved to launch his publications under a classic flag (Apollonius Batavus, Eratosthenes Batavus, Tiphys Batavus) was one of the most modern spirits of his time, in the essential contents of his work overflowing with originality and entirely free from all tradition, even such a man as Snellius could be a convinced adherent of Ptolemy, while a figure in the second rank, Lansbergen, a highly meritorious, industrious and conscientious worker, but without originality, proclaimed the Copernican doctrine.

It was at this time that the Observatory of Leyden was founded. Its founder Golius, the Orientalist, was the pupil of Snellius, but he was a man of a quite different mental temperament. He possessed an exceptionally lively, versatile, even daring mind, but was more humanist than scientist, and was urged by a thirst for knowledge and insight, not into the wonderful mysteries of Nature, but into science as a product of human culture. Originally mathematician and astronomer, he was brought to the study of Arabic by the desire to read Apollonius in a better text than the extant Greek one, and in that study he found his true vocation. In his new observatory he now and then made observations of eclipses, comets and planets, which observations seem to have been of good quality, but he took no interest in the fresh marvels revealed by the new telescopes. The foundation of the observatory by Golius was not, as with the second founder, Kaiser, the crowning of a lifelong endeavour, but more an impulse, a concession as it were to the love of his youth, at the time almost extinguished, astronomy.

Looking from the past towards the future, we find a great resemblance between the two epochs. In both there is a rapid development of science, originating with an overwhelming mass of new observational data, then a result of the discovery of the telescope, now of photography and spectroscopy. In both, simultaneous with and after this phase of harvesting new phenomena, there is a rich growth of new theories, a complete breaking with the traditional points of view. At the close of the seventeenth century, fifty years after the period that we have been considering, there came a consolidation of the new theories into a system by Newton, whereby what had been revolutionary became orthodox. Our time is not yet ripe for this. We have had, and still have in our midst, our Kepler, Galileo, Descartes and Huygens; the Newton of the new epoch is still to come. That the consolidation and unification of the different tendencies of present-day astronomy, which appear at the moment to be wild and unrestrained, will come in good time is certain, for science is immortal.