Heinrich Lambert – A Swiss Polymath

Johann Heinrich Lambert (1728-1777)

On August 26, 1728, Swiss polymath **Johann Heinrich Lambert** was born. Lambert provided the first rigorous proof that pi is irrational (i.e. it cannot be expressed as the quotient of two integers). He also was the first to introduce hyperbolic functions into trigonometry as well as the first mathematician to address the general properties of map projections. He also made significant contributions to physics, philosophy, and logic.

"We would wish to discover the Plan of the Universe, and the means employed by the Eternal Architect in the execution of his magnificent design. We will first contemplate the System of which we make a part, and of which our Sun is the center. Thence we will ascend towards those Suns and those innumerable Worlds which are scattered through the immensity of space."
— *Johann Heinrich Lambert, The System of the World (1800)*

Johann Heinrich Lambert – Early Years

Lambert was born in 1728 in the city of Mulhouse (now in Alsace, France), at that time a free imperial city which had formed defensive alliances with the Swiss, as one of five sons and two daughters to Lukas Lambert, a tailor, and his wife Elizabeth. Heinrich attended school in Mulhouse, receiving a reasonably good education up to the age of twelve, studying French and Latin in addition to elementary subjects. However, when he was twelve years old he had to leave school to help his father with tailoring.[1] Nevertheless, he continued to study in his free time whilst undertaking a series of jobs, which included a clerk at a nearby iron works, a private tutor, secretary to Johann Rudolf Iselin, the editor of *Basler Zeitung* and, at the age of 20, private tutor to the sons of Reichsgraf Peter von Salis in Chur. Lambert could now use the excellent library in the Count's home and was in an even stronger position to continue his studies of mathematics, astronomy, and philosophy.[1] Though Lambert became more refined in this cultivated atmosphere, he remained an original character who did not conform to many bourgeois conventions.[2]

The Swiss Scientific Society

Lambert was elected to the Literary Society of Chur and to the Swiss Scientific Society based in Basel. He undertook work for the Scientific Society such as making regular meteorological observations and he began to publish scientific articles, his first being on caloric heat which appeared in *Acta Helvetica* in 1755.

The Grand Tour and Photometria

Travelling "on grand tour" of Europe ("Bildungsreise") with his charges between 1756 and 1758 allowed him to meet established mathematicians in the German states, The Netherlands, France and the Italian states. Among them mathematician Abraham Kästner and astronomer Tobias Meyer in Göttingen, physicist Pieter van Musschenbroek [4] in The Hague, and Jean d'Alembert in Paris.[5] On his return to Chur he began to seek an academic post, which proved to be difficult. He went to Augsburg, where he published his *Photometria* (1760), in which he showed from the assumption that light travels in straight lines that illumination was proportional to the strength of the source, inversely proportional to the square of the distance of the illuminated surface and the sine of the angle of inclination of the light's direction to that of the surface.

Cosmological Letters

In 1761, he published *Cosmologische Briefe über die Einrichtung des Weltbaues* (Cosmological Letters), in which he explained his own version of the nebular hypothesis of the origin of the solar system. Lambert hypothesized that the stars near the sun were part of a group which travelled together through the Milky Way, and that there were many such groupings (star systems) throughout the galaxy. The former was later confirmed by William Herschel.[6]

The Struggle for Recognition

He wanted to gain a position at the Prussian Academy of Sciences in Berlin and so become a colleague of Euler and Lagrange. In 1764, at the invitation of Euler Lambert went to the Prussian Academy of Sciences in Berlin.[7] However, differences between the two mathematicians soon arose, mainly concerning the income of the Academy, which depended on its privilege to sell calendars. It may well be that these differences contributed to Euler's decision to leave Berlin for St Petersburg in 1766. However these were not the only problems that Lambert faced after arriving in Berlin for at first Frederick II refused to appoint Lambert to the Academy on account of his unusual appearance, strange dress and eccentric behavior. These were in part due to his humble background together with the fact that he deliberately chose not to conform to the conventions of the upper classes.[1] Nevertheless, he managed to get settled and in this stimulating and financially stable environment, he worked prodigiously until his death in 1777.

Mathematical Achievements

Lambert was the first to introduce hyperbolic functions into trigonometry. Also, he made conjectures regarding non-Euclidean space. Lambert is credited with the first proof that π is irrational, in a memoir published in 1768. He used a generalized continued fraction for the function tan x. Euler believed but could not prove that π was irrational, although he had already established in 1737 that e and e^2 are both irrational. Also, remarkably, Lambert conjectured that e and π are transcendental. This was not proved for another century when Hermite proved that e is transcendental and Lindemann proved that π is transcendental.[1] Lambert also devised theorems regarding conic sections that made the calculation of the orbits of comets simpler.

Geometry and Logics

Lambert was the first mathematician to address the general properties of map projections. In particular he was the first to discuss the properties of conformality and equal area preservation and to point out that they were mutually exclusive. He actually published seven new map projections under the title A*nmerkungen und Zusätze zur Entwerfung der Land- und Himmelscharten*, (*Notes and Comments on the Composition of Terrestrial and Celestial Maps*, 1772). He also made a major contribution to philosophy and in *Anlage zur Architectonic* (1771) he attempted to transform philosophy into a deductive science, modelled on Euclid's approach to geometry.[1]. Following Leibniz' ideas, Lambert early tried to create an *ars characteristica combinatoria*, or a logical or conceptual calculus. He investigated the conditions to which scientific knowledge must be subjected if it is to enjoy the same degree of exactness and evidence as mathematical knowledge.[3] In 1774 at Berlin he became editor of *Astronomisches Jahrbuch oder Ephemeriden*, an astronomical almanac.[2]

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