Johann Lambert

Physicist, mathematician and astronomer **Johann Heinrich Lambert** (August 26, 1728 – September 25, 1777) was one of the great polymaths of the 18th century. German philosopher Immanuel Kant described him as “the greatest genius of Germany.” A man of great imagination and originality, Lambert wrote on perspective, light, astronomy, logarithms, pyrometry, transcendent quantities, theory of equations, the slide rule, psychology, ballistics, photometry, etc. He had considerable talent for applying mathematics to practical questions. While most of his mathematical work was respectable, it was not always first class and his mathematical discoveries were overshadowed by the work of his contemporaries. There was one exception that being his work with hyperbolic trigonometry, which affords him an enduring place in the history of mathematical development. Lambert also was the first to prove that π was irrational by first showing that if x is a nonzero rational number then tan x cannot be rational. Since tan $\pi/4 = 1$, a rational number, it follows that $\pi/4$ cannot be rational and π cannot be either. Lambert conjectured that both e and π were transcendental, but this would not be proved until a century later when Charles Hermite did so for e and Ferdinand Lindemann for π.

The son of a tailor, Lambert was born in Mülhausen, Alsace, then part of Swiss territory and died of consumption only 49 years later in Berlin. He came from humble surroundings and was largely self-educated. He led an almost vagabond existence working as a bookkeeper, secretary, private tutor and architect while residing in Germany, Holland, France, Italy, and Switzerland. After working as a clerk in an ironworks, followed by a menial post with a newspaper, he was appointed a tutor in the home of the family of Count Andreas von Salis of Coire, which owned an excellent library. There Lambert had sufficient leisure to pursue the study of many subjects. In 1759 he toured Göttingen, Utrecht, Paris, Marseilles, and Turin with his pupils, after which he resigned his tutorship and successively took up residence in Augsburg, Munich, Erlangen, Coire and Leipzig. He lived in a period when scientific activity usually was centered in academies in countries ruled by enlightened despots, who delighted in surrounding themselves with learned men. Lambert spent time at the Berlin Academy of Sciences where he was a colleague of Leonhard Euler and Joseph Lagrange. Once Lambert was asked by Frederick the Great in which science was he most proficient. He immodestly replied, "All."

Lambert was among the first to appreciate the nature of the Milky Way. In his *Cosmological Letters* (1761) he described the disk-shaped form of the Milky Way and the existence of eternal systems of stars (galaxies) throughout space. He was convinced that no body in the universe was devoid of life. He wrote: "The Creator is much too efficient not to imprint life, forces and activity on every speck of dust…. If one is to form a correct notion of the world, one should set as a basis God's intention in its true extent to make the whole world inhabited…" In 1773 Lambert calculated the orbit of a satellite of Venus, which revolved around the planet in 11 days 5 hours, at a mean distance of 66 ½ radii of the planet, in an orbit whose eccentricity was 0.195. He wasn't the only one who observed this satellite. During the 17th and 18th century, 15 different astronomers made 33 observations of the body, yet, the satellite seems to have vanished as it has never been seem since 1768.

Lambert also contributed to cartography. Although maps are flat, the surfaces they represent are curved. "Projection" is the transforming of three-dimensional space onto a two dimensional map. Projections are described by mathematical expressions that convert data from the latitude and longitude of a geographical location on a sphere or spheroid to a representative location on a flat surface. The process distorts at least one of the properties: shape, area, distance, direction, and frequently more. Most maps are generated by projecting global features onto a cylinder, a cone, or a plane [Figure 8.12]. Conic projections involve the transformation to a cone either secant or tangent to the Earth's surface [Figure 8.13] .The *Lambert projection* [Figure 8.14] is a conic projection, conformal everywhere except at the poles. It preserves the shape of small areas exactly, although the scale of the map may vary from point to point. On Lambert maps lines of latitude are shown as parallel curved lines and lines of longitude as straight lines radiating out from the pole. Lambert projections distort areas; however, the area of distortion is minimal near the lines of tangency. His projections are appealing because of their low overall distortion. It is extensively used in ellipsoidal form for large-scale mapping of regions of predominantly east-west extent, such as the Canada, the United States or Russia.

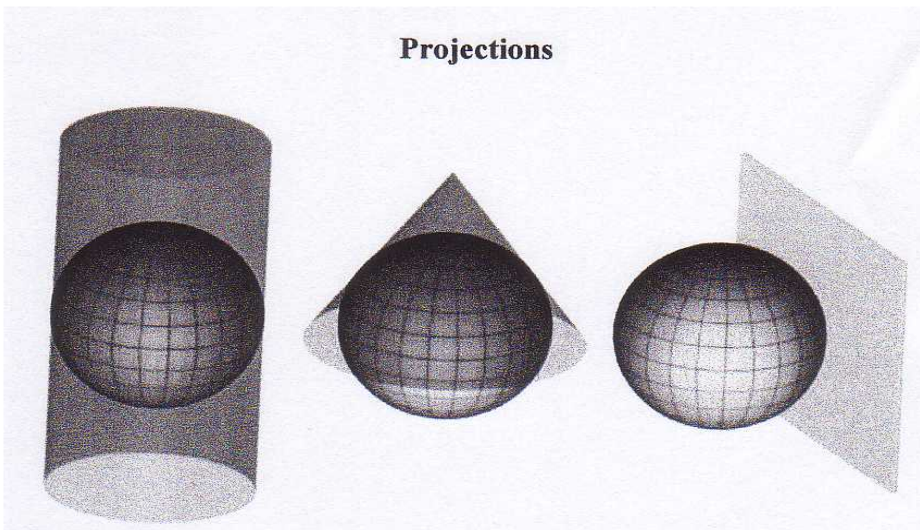

Figure 8.12

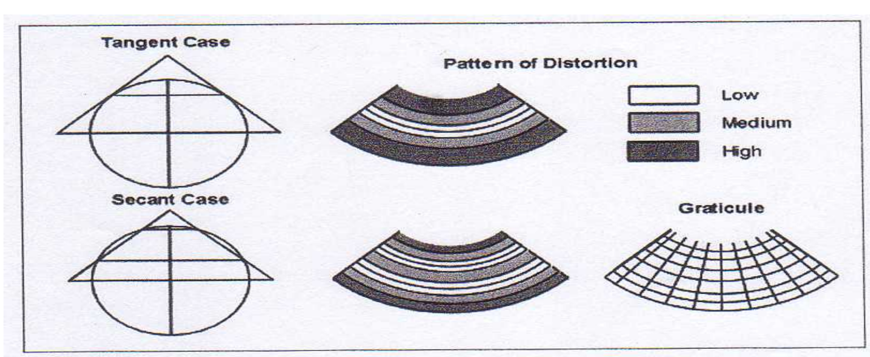

Figure 8.13

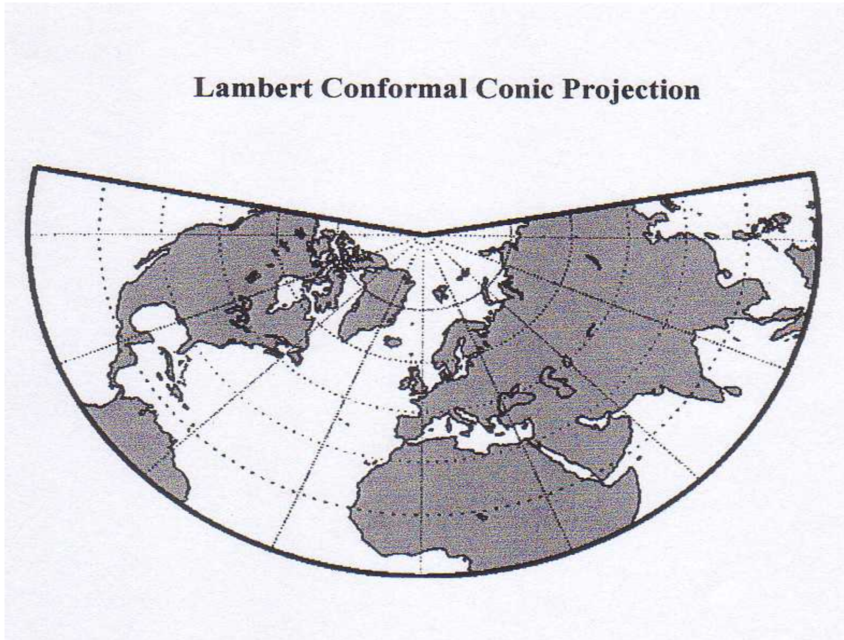

Figure 8.14

Among Lambert's most important contributions was his work in optics, which inspired Francois Arago's subsequent investigations in the area. Lambert was the first to show how to measure the intensity of light, degrees of heat, and humidity. The metric unit of brightness *lambert* (**La** or **Lb**, or **L**) is named for him. One *lambert* is equivalent to the brightness of a perfectly diffusing surface that emits or reflects one lumen per square centimeter. His masterpiece, *Photometria* (1760) was the first significant book on the quantification of light and its effects. It is considered the seminal work in illumination engineering and photometry, the branch of optics dealing with the measurement of the intensity of light.

Lambert made a study of Euclid's parallel postulate and by assuming it to be false, he was able to prove a large number of results, but he did not pursue the matter sufficiently to be considered as one of the founders of non-Euclidean geometry. Lambert became the first to attempt to form functional equations by expressing the given properties in the language of the new differential calculus. He also was the first to express Isaac Newton's second law of motion in the notation of the differential calculus. Lambert might have gained a greater reputation had he not tried to master all fields and instead concentrated his efforts in fewer directions. His work with hyperbolic functions is his most important contribution to mathematics.

Quotation of the Day: "Proofs of the Euclidean [parallel] postulate can be developed to such an extent that apparently a mere trifle remains. But a careful analysis shows that in this seeming trifle lies the crux of the matter; usually it contains either the proposition that is being proved or a postulate equivalent to it." – Johann Heinrich Lambert