Biographical Encyclopedia of Astronomers

Bouguer, Pierre

Born Le Croisic, (Loire-Atlantique), France, February 1698

Died Paris, France, 15 August 1758

Pierre Bouguer was the inventor of the photometer, the heliometer, and the metacenter. He was also a hydrographer, an astronomer, and the father of naval architecture.

Bouguer was one of three children of Jan Bouguer and Marie Françoise Josseau; he was baptized on 10 February 1698. His father was a navigator, but lost a leg in battle and received the certificate of *Maîtrise d'hydrographe*. In June 1691, Jan Bouguer took charge of the new École d'hydrographie in Le Croisic. In the year Pierre was born, Jan published a navigation treatise

Pierre was among his father's pupils at the school. When his father died in 1714, Bouguer was a student at the Jesuit school in Vannes. He applied to succeed his father, went to Brest, and successfully passed the examination to become the *Maître d'hydrographie du Roy* at Le Croisic. The research he performed alongside his teaching was noticed, and in 1730 Bouguer was called to Le Havre, then the most important port on the English Channel. At Bouguer's request, his Le Croisic post was given to his brother Jean

In 1727, Bouguer was awarded a special prize by the Académie royale des sciences for the best way to mast ships. In 1729 and 1731, he obtained similar prizes for determining the altitude of celestial bodies at sea and for the art of determining the orientation of the compass. At the same time, he published his *Essai d'optique sur la gradation de la lumière* (Essay on Optics on the Gradation of Light). All of this brought Bouguer to the attention of Parisian scientists: In 1731, while still residing in Le Havre, he became an associate geometer of the academy, and soon a full member.

Bouguer was selected to be part of the expedition to travel close to the equator (Peru) to decide between Isaac Newton and Giovanni and Jacques Cassini, on the Earth's shape. He embarked at La Rochelle in May 1735, carrying with him, among other instruments, an octant newly made for navigational aids from John Hadley's design. This expedition, under Louis Godin, would take 10 years. Accompanying Bouguer were also Charles La Condamine and two Spanish officers, Jorge Juan and Antonio de Ulloa. This trip had important consequences for Bouguer and his scientific work. Four of the men returned to France with results favoring Newton, while Godin pursued a career in Spain, dying there. The quality of the data, much better than that of the Lapland expedition under Pierre de Maupertuis, allowed Jean-Baptiste Delambre and Pierre Méchain to use it for their determination of the length of the meter in 1799. The measurements were made according to the *Toise du Pérou* they brought with them to Ecuador. Difficulties between Bouguer and La Condamine resulted in several publications, by Bouguer in 1744 and in 1746 (later in 1754), followed by La Condamine in 1751.

In his free time, Bouguer pursued ideas he had during the expedition. He had previously studied refraction, publishing a memoir in 1729. He completed this work in 1737, leaving his name on Bouguer's law, considered valid for a half-century

Bouguer developed *force de la lumière*, the subject now known as photometry. His *Essai d'optique sur la gradation de la lumière* was published in 1729, but the photometer (he called

it a *lucimètre*) came 10 years later. From this work came two of Bouguer's laws, one being related to the degree of illumination variations, the other one linked to the logarithmic scale, leading to the *droite de Bouguer*. His *Traité d'optique sur la gradation de la lumière*, in its definitive form, was posthumously published by his friend Nicolas de La Caille in 1760

In 1747/1748, Bouguer designed a new instrument that he called a *héliomètre* to measure the diameters of the Sun and the Moon, experimenting with it during the following year. The more successful idea of John Dollond in England (1753), of making a two-part achromatic objective instead of two full lenses set close together by Bouguer, was more efficient. Nonetheless, the great success of the heliometer was the first measurement of an accurate stellar parallax by Friedrich Bessel in 1838

From the Peruvian expedition, Bouguer also brought back results on the deflection of the plumb line, mostly influenced by the mountains; he mentioned it in 1754 and in 1756, resulting in the adoption of the term Bouguer anomaly, a phenomenon studied by others later. Bouguer also pursued studies on the Earth's rotation. As a hydrographer, he carried out research into naval science, leading to a number of publications including *De la mâture des vaisseaux* (1727), *Traité du navire, de sa construction et de ses mouvements* (1746), *Nouveau traité de navigation...* (1753), and *De la manœuvre des vaisseaux...* (1757). The most important was the 1746 volume, recounting Bouguer's travels on the Atlantic and to Peru, as well as developing a number of important ideas about shipbuilding

Shipbuilding at that time was in the hands of marine carpenters, who kept their methods secret. In dealing with the stability of a ship, Bouguer posited the notion of the metacentre, a theoretical point situated above the center of buoyancy. As long as the metacenter is also above the ship's center of gravity, buoyancy can restore equilibrium; if the metacenter is below the center of gravity, capsizing can occur. The book was translated into English, appearing as *A Treatise on Ship-building and Navigation....*

Suzanne Débarbat

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