Bürgi, Joost | Encyclopedia.com

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(*b*. Liechtenstein, 28 February 1552; *d*. Kassel, Germany, 31 January 1632)

mathematics, astronomy.

There is no precise account of Bürgi's youth. Most likely he received no systematic education, for he did not even know Latin, the scientific language of his time. From 1579 he was the court watchmaker to Duke Wilhelm IV, and he probably completed his education while working in the duke's observatory at Kassel. There he worked on the construction of several instruments, especially astronomical ones, and made astronomical observations, developing his skill, inventiveness, and accuracy. Bürgi also improved instruments for use in practical geometry. His proportional compasses competed with those of Galileo for priority, although both were probably no more than an improvement of devices already in use.

The fame of Bürgi's instruments, which made possible more accurate astronomical observations in the observatory at Kassel, drew the attention of scientists assembled at the court of Emperor Rudolf II, who tried to establish a science center in Prague and to enlist prominent European scientists. After the death of Wilhelm IV, Bürgi entered the service of Rudolf and became his court watchmaker, also holding this position under Rudolf's successors Matthias and Ferdinand II. He lived in Prague from about 1603 and became assistant to and computer for Kepler, who was working on the results of astronomical observations made by Tycho Brahe. Even after the imperial court moved to Vienna and the leading foreign scientists left Prague, and the Bohemian anti-Hapsburg revolt was defeated (1620), Bürgi remained in Prague. Here he became scientifically isolated, which lessened the favorable response to his results. Shortly before his death (probably as late as 1631) Bürgi returned to Kassel.

In mathematics Bürgi was by no means a theoretician, but an indefatigable and inventive computer whose help Kepler appreciated. Bürgi's manuscript "Arithmetics" was taken to Pulkovo with Kepler's unpublished papers. In this manuscript Bürgi uses (probably independently of Stevin) the decimal point and sometimes substitutes a small arc for it. Starting from the method known as *regula falsi*, Bürgi also elaborated the method of approximate calculation of the roots of algebraic equations of higher degree. The need to make the tables of sines more precise led him to undertake this problem. His tables of sines, which have the difference 2", were never published, and not even the manuscript exists.

The computation of the tables of sines and the elaboration of astronomical data led Bürgi to an easier method of multiplying large numbers. From about 1584 he was engaged, like several other astronomers and computers in the sixteenth century, in the improvement of "prosthaphairesis", the method of converting multiplication into addition by means of trigonometrical formulas—for example, $\sin\alpha \cdot \sin\beta = 1/2[\cos(\alpha - \beta) - \cos(\alpha + \beta)$. Later, possibly at the end of the 1580's, the idea of logarithms occurred to him. Although he did not know Stifel's *Arithmetica integra*, in which the idea of comparing arithmetic and geometric progression is outlined, Bürgi learned of it from other sources. He had computed the tables of logarithms before his arrival in Prague, but he did not publish them until 1620, under the title *Arithmetische und geometrische Progress-Tabulen, sambt gründlichem Unterricht, wie solche nützlich in allerley Rechnungen zu gebrauchen, und verstanden werden sol*; however, the instruction promised in the title remained in manuscript.

The geometrical progression begins with the value 100,000,000 and has the quotient 1.0001. A term of the arithmetical progression 0, 10, 20, 30, 40, … corresponds to each term of the geometrical series. The tables extend to the value 1,000,000,000 in the geometrical progression, with the corresponding value 230,270,022 in the arithmetic progression. Consequently, Bürgi's logarithms correspond to our socalled natural logarithms with the base *e*. By their arrangement they are in fact antilogarithmic, for the basic progressions are logarithms. This circumstance could have made the use and spread of the tables more difficult, but the fate of Bürgi's work was influenced much more by the disintegration of the scientific and cultural center in Prague after 1620. The Prague edition of the tables remained almost unnoticed, and only a few copies were saved; probably the only complete copy is kept, together with the handwritten "instruction", in the library at Danzig. Thus, Bürgi's greatest discovery had no apparent influence on the development of science.

BIBLIOGRAPHY

Bürgi's only published work is *Arithmetische und geometrische Progress-Tabulen, sambt gründlichem Unterricht, wie solche nützlich in allerley Rechnungen zu gebrauchen, und verstanden werden sol* (Prague, 1620), repr. in H. R. Gieswald, *Justus Byrg als Mathematiker und dessen Einleitung zu seinen Logarithmen* (Danzig, 1856).

There is neither a detailed biography nor an analysis of Bürgi's scientific work. Basic bibliographic data in the following works can be of use: G. Vetter, "Dějiny matematických věd v českých zemích od založeni university v r. 1348 až do r. 1620" ("History of Mathematics in the Bohemian Lands From the Foundation of the University in 1348 until 1620"), in *Sbornik pro déjiny přirodnich věd a techniky* (Prague), **4** (1958), 87–88; and "Kratkií obzor razvitija matematiki v cheshtskikh zemliakh do Belogorskoi bitvy", in *Istoriko-matematicheskie issledovaniya*, **11** (Moscow, 1958), 49, 512; E. Voellmy, "Jost Bürgi und die Logarithmen", in *Beihefte zur Zeitschrift für Elemente der Mathematik*, no. 5 (1948); and E. Zinner, *Deutsche und niederländische astronomische Instrumente des 11.–18. Jahrhunderts* (Munich, 1956), pp. 268–276.

LuboŠ NovÝ