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Erhard Weigel (1625–1699)

Mathematician, pedagogue, astronomer, philosopher, inventor, early Enlightenment philosopher, calendar reformer

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Erhard Weigel was baptised in Weiden on 16 December 1625 (Julian date). His parents were Anna Walthier (1589–1653) and Michael Weigel (1591–1637), they had married on 10 February 1617. His father was a clothmaker and his mother the daughter of a carpenter. The paternal grandfather, Veit Weigel (1546–1620), was a teacher at the Latin school and cantor in Weiden.

The Weigel family belonged to the Protestant-Lutheran faith. When re-Catholicisation began in the Upper Palatinate in August 1627, the family fled to the Protestant Margraviate of Ansbach-Bayreuth and settled in Wunsiedel in the Fichtelgebirge, 50 km north of Weiden and 30 km north-east of Bayreuth. Weigel spent his childhood here from 1628 onwards. His youthful years were characterised by the poverty of the exiles and the hardships of war. His father earned his living by working as a journeyman and, from May 1634, as a teacher at the primary schools. After his father died in 1637, his mother took over the position of school mistress. Only eleven years old, Erhard helped with clerical work for high lords. He attended the Latin school until 1644 (the building has been destroyed). He was also encouraged by the archdeacon Jacob Ellrod (1601–1671). In the summer of 1644, Weigel studied at the University of Jena. Although Weigel was already 18 years old, he was not sworn in at the university in Jena. Apparently he still lacked the prerequisites for studying, which he tried to obtain by attending a grammar school with Latin lessons.

At the end of 1644, Weigel went to Halle to study at the Lutherischen Gymnasium, where Christian Gueintz (1592–1650) was headmaster. At the age of 19, he was able to close the gaps in his knowledge, something he had not been able to do under the difficult circumstances in Wunsiedel. In Halle, he met Bartholomaeus Schimpffer (ca. 1610–1662), a mathematician at the court of the Prince of Magdeburg. In his flat, Schimpffer taught him the astrological basics of calendar making and horoscope setting. He earned his living by writing for Schimpffer. In 1645 and 1646, Weigel interrupted his training in Halle for a few weeks and returned to Wunsiedel, where he was taught astronomical calculations by Jacob Ellrod. Weigel finally left Halle in the winter semester of 1647/48 and went to the university and trade fair city of Leipzig. In late 1647 or early 1648, Weigel began to study at the University of Leipzig.

In January 1653, Weigel was appointed as the successor to the late Heinrich Hofmann (1576–1652) as Professor of Mathematics at the University of Jena. He gave his inaugural lecture on 16 July 1653 on the comet of 1652 and from then on, Weigel was a mathematics professor who inspired many students.

Mathematician

From his appointment in 1653 until 1694, Weigel taught mathematics in Jena. In addition to the genuine subjects of geometry and arithmetic, this discipline at the time also included astronomy and music as well as architecture and fortification for their practical realisation . For Weigel, mathematics or mathematical thinking was the "basic method that can be applied in all areas and with the help of which a certain amount of knowledge can be achieved in any area".[1] According to Weigel, "true mathematics is nothing other [...] than the other part (i.e. the precise measurement part) of a different science / in which the properties of things are not only merely described / but precisely measured and ordered / to usable effect".[2] As a result of this view of mathematics, its application in all areas of human endeavour leads to useful inventions of all kinds, which should ultimately be pursued for the good of the community. In Weigel's case, this approach led, for example, to his reform efforts in the fields of education (school experiment), the calendar issue (division into Julian and Gregorian), the aspired establishment of an empire-wide academy (Collerium Artis Consulto rum) and to numerous technical inventions and the construction of Celestial globes and instruments.

A special feature of Weigel's mathematical work is his proposal to introduce a number system with a base of four instead of the decimal system.[3] The Pythagorean doctrine of the tetractys was known from antiquity, in which the numbers 1 to 4 were assigned a significance for the structure of the cosmos. Weigel drew on this and gave the system of four stem "a philosophical elevation" in the sense that everything in the world "could be generated and derived from it, just as all numbers can be represented with the help of the digits of the system of four".[4]

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[1] Stefan Kratochwil: Das Weigel-Projekt: Versuch einer Rokonstruktion des Selbstverständnisses von Erhard Weigel. In: Stefan Kratochwil (ed.): Philosophia mathematica. Die Philosophie im Werk von Erhard Weigel. Jena 2005, pp. 7–21, here p. 20.

[2] Erhard Weigel: Arithmetische Beschreibung der Moral-Weißheit von Personen und Sachen Worauf das gemeine Wesen bestehet/ Nach der Pythagorischen CreutzZahl in lauter tetractysche Glieder eingetheilet. Jena 1674. in: Erhard Weigel Werke, edited and introduced by Thomas Behme. Stuttgart-Bad Cannstatt 2004, pp. 56–57.

[3] Erhard Weigel: Tetractys, Summum cum Arithmeticae tum Philosophiae discursivae compendium, Artis Magna Sciendi genuina Radix. Jena 1673. in: Erhard Weigel Werke, edited and introduced by Thomas Behme. Vol. 6. Stuttgart-Bad Cannstatt 2018, pp. 187–224.

[4] Katharina Habermann: Die Mathematik bei Erhard Weigel – Versuch einer Annäherung. In: Rainer Gebhardt (ed.): Die Entwicklung der Mathematik in der frühen Neuzeit. Annaberg-Buchholz 2020, pp. 137–150, here p. 146.

Pedagogue

Important principles of Weigel's pedagogy have been researched since the end of the 19th century. With his demands for vivid teaching, the promotion of real-life teaching and the valorisation of mother tongue, Weigel can be categorised in the line of tradition of pedagogues such as Wolfgang Ratke, Johann Amos Comenius and Andreas Reyher. What is significant about Weigel's pedagogy is that "the modern concept of education as a measure directed towards the will is presented and [...] founded by him".[5] Another modern view of lesson organisation is the affinity between Weigel's teaching principles and the Socratic method. [6]

In the 1680s, Weigel organised a school experiment in his home. In the private virtue school, Weigel "trialled his concept of a holistic and low-repression education, which was primarily aimed at the formation of virtue and willpower and, taking into account the children's urge to play and exercise, wanted to strengthen their desire to learn."[7]

Astronomer

Weigel's interest in astronomy was reflected in descriptions of his observations of comets and in several disputations . In his pro-loco disputation (1653), he already dealt with the comet that appeared at the end of 1652. Based on his own observations and the determination of the positions in the sky, he came to the conclusion by trigonometric calculation that the comet must be supralunar in nature. As he took a clear stand against the Aristotelians, who saw the origin of a comet in earthly vapours that would condense and rise into the upper layers of air.[8] In his comet writings, Weigel searched for the causes of comet phenomena, which he saw in nature. He did not take

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[5] Karl Schaller: Erhard Weigels Einfluß auf die systematische Pädagogik der Neuzeit. In: Studia Leibnitiana 3 (1971), S. 29.

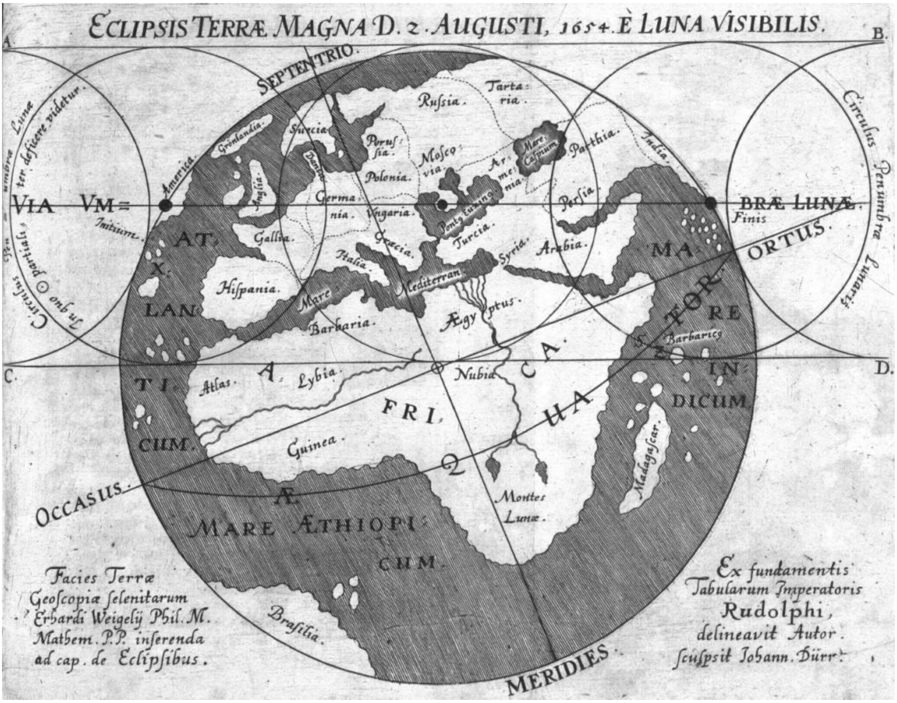
[6] Stefan Kratochwil: Desiderate der Forschungen zu Erhard Weigel. In: Rotraud Coriand, Ralf Koerrenz (Hrsg.): Salzmann, Stoy, Petersen und andere Reformen. Tradition in der Thüringer Bildungslandschaft.Jena 2004, S. 9–21, hier S. 17. Cf. Rotraud Coriand: Durch Lust, Verstand und Willen zur Tugend: Weigels „freudige Kunst- und Tugend-Lehr". In: St. Kratochwil (Hrsg.): Philosophia mathematica. Die Philosophie im Werk von Erhard Weigel. Jena 2005, S. 103–119.

[7] Thomas Behme: Einleitung. In: Erhard Weigel Werke, edited and introduced by Thomas Behme. Stuttgart-Bad Cannstatt 2016, vol. 5, part vol. 1, pp. XIII-LXVI, here p. LX.

[8] Cf. Marion Gindhart: Erhard Weigels *Commentatio astronomica de cometa novo* (1653), or: Funktionalisierungsmöglichkeiten eines polyvalenten Mediums. In: Klaus-Dieter Herbst (ed.): Erhard Weigel (1625–1699) und die Wissenschaften. Frankfurt am Main 2013, pp. 97–103, here p. 100.

part in the usual speculation about the possible effects of comets on earthly life.

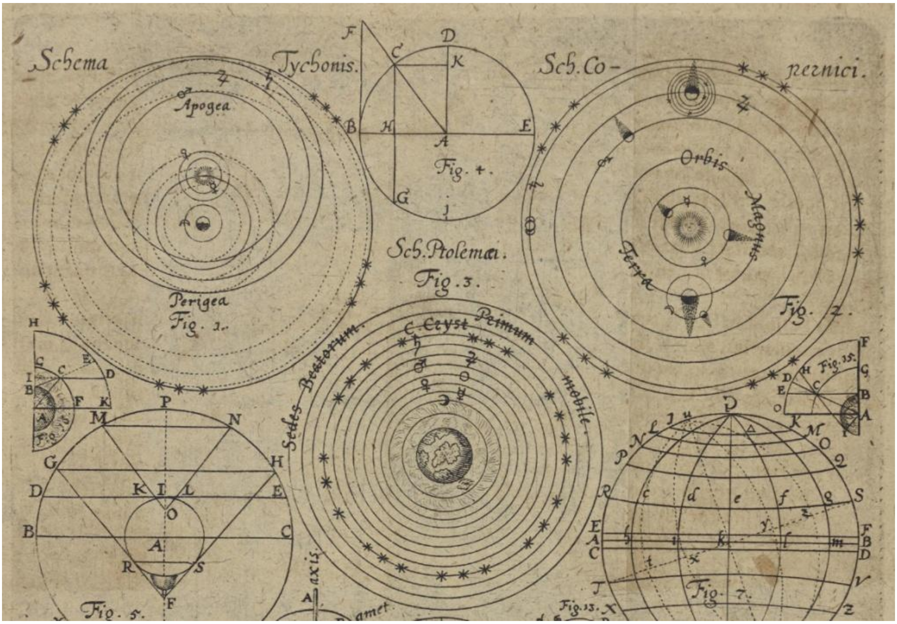
In terms of scientific history, Weigel's dispute on the occasion of the total solar eclipse on 2/12 August 1654 is outstanding. Weigel dealt with this academically without any reference to astrology. He included the latest astrono mical literature for the calculation of the course of the eclipse (degree of eclipse, times and duration) according to Johannes Kepler's Rudolphine Tables. He also made calculations that enabled him to produce a map showing the worldwide course of the zone of totality. This copperplate engraving (Fig.) is considered to be the oldest depiction of the course of a solar eclipse on the globe.[9]



Drawing (copperplate engraving) showing the worldwide course of the solar eclipse on 2/12 August 1654 (from Erhard Weigel: Secundae Partis Geoscopiae Selenitarum Disputatio Secunda De Eclipsibus [...], Jena 1654)

[9] Cf. Klaus-Dieter Herbst: Erhard Weigels Disputation anläßlich der Sonnenfinsternis vom 2./12. August 1654. In: Klaus-Dieter Herbst (ed.): Erhard Weigel (1625–1699) und die Wissenschaften. Frankfurt am Main 2013, pp. 72–95.

In his writings, Weigel conveyed modern views. For example, he discussed the Copernican system alongside the Tychonic system not only as a model for astronomical calculations, but also as a possible reality.



Drawings of the world systems according to Ptolemy, Tycho Brahe and Nicolaus Copernicus (from Erhard Weigel: Astronomiae Pars Sphaerica Methodo Euclideâ conscripta, Jena 1657)

Philosopher

The basis of Weigel's philosophical thinking is the mathematical method as a method to be applied in all fields of knowledge. In "Analysis Aristotelica ex Euclide restituta" (1658), he formulated his goal as "the restoration (restitutio) of philosophy and of education in general from the spirit of a mathematically interpreted Aristotle".[10] Weigel's methodological objective "bears some resemblance to Rene Descartes' attempt to re-found philosophy", although Weigel distanced himself from this endeavour. [11]

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[10] Thomas Behme: Einleitung. In: Erhard Weigel Werke, edited and introduced by Thomas Behme. Stuttgart-Bad Cannstatt 2008, pp. IX–LXV, here p. XV.
[11] Ibid, p. XVII.

Weigel's philosophy is aimed at creating a pansophical universal science.[12] It also contains a moral philosophy that is based on rational principles and experience and aims for happiness and thus the highest good.[13]

His social philosophy in the "Arithmetical Description of the Moral Wisdom of People and Things" (1673) draws parallels between the arithmetical relationships of numbers and the legal and social relationships of people.

In logic, Weigel invented the "measure of inference" (i.e. a logical diagram, a "logometrum"), a method for visualising inferential figures. Gottfried Wilhelm Leibniz, who had studied with Weigel for a semester, and others developed this method further. This led to the first logic machine and is being recognised again today.[14]

Inventor

The house designed by Weigel, which he had built and in which he lived with his family from 1670, became famous in Jena. It contained many technical refinements such as a "flying chair" (lift) and the "Cellar maid", a pipe system in which water is poured into one opening and wine comes out of the second opening next to it. Weigel listed his more than 30 inventions, for example in the "Mathematische Kunstübungen" (1670). He also used the "Astrodicticum simplex" as a star finder during night-time observations with his students, as this instrument can be used in conjunction with a celestial globe to locate or identify a star.

During his lifetime, Weigel was also known for his celestial globes. Today, 18 of these are preserved in museums around the world. In some globes, Weigel introduced new images and designations instead of the classical constellations from antiquity. These heraldic globes show coat of arms and symbols of countries, principalities and cities (fig.). In the copper engraving "Astroscopium", he depicted the "European heraldic sky" plan.

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[12] Thomas Behme: Einleitung. In: Erhard Weigel Werke, edited and introduced by Thomas Behme. Vol. 1. Stuttgart-Bad Cannstatt 2003, pp. XI–XIII.

[13] Thomas Behme: Einleitung. In: Erhard Weigel Werke, edited and introduced by Thomas Behme. Stuttgart-Bad Cannstatt 2004, pp. VII–XXVII, here pp. XXIII–XXIV.

[14] Jens Lemanski: Logic Diagrams in the Weigel and Weise Circle. In: History and Philosophy of Logic 39:1 (2018), pp. 3–28.

Heraldic celestial globe by Erhard Weigel (Trondheim, NTNU Vitenskapsmuseet)

In addition to these small globes, Weigel invented the type of "planetarium". This is a sphere up to 6 metres in diameter into which you could walk and in whose iron shell holes were pierced and arranged in such a way that sunlight shone through during the day and the viewer inside could recognise constellations with the indicated stars up to the third magnitude. Weigel combined this celestial sphere with some technology inside, which depicted the earth with the various phenomena (volcanic eruption , lightning, thunder, rain, fog), and thus created a "Pancosmos". Weigel had such a celestial sphere erected on the roof of Jena Castle.

Weigel also benefited from his technical understanding as the city's chief building director. In this role, he oversaw the construction of the new castle from 1659 to 1661. At the Collegium Jenense, he had the gate building raised by one storey. On the platform thus created, he observed the sky with his students .

Jena with the castle (on the left edge of the picture) and the large celestial sphere on the castle roof (from Theophil Sternfreund: Geschichts=Calender für 1692)

Early enlighteners

In research, Weigel is regarded as one of the early pioneers of the Enlightenment, who also had a lasting influence on the thinking of his most famous students Samuel Pufendorf (jurist), Gottfried Wilhelm Leibniz (philosopher, mathematician), Johann Christoph Sturm (physicist, one of the first to introduce experimenta physics into lectures), Gottfried Kirch (astronomer, calendar maker, he urged his readers to read the newspaper rather than consult the stars), Christoph Semler (pedagogue, founder of the first German secondary school) and Georg Albrecht Hamberger (mathematician, teacher of Christian Wolff). Early Enlightenment thinking was always evident when Weigel emphasised his own reflection based on experience (observations). For example, the daily weather was to be determined by using measuring instruments (thermometer, barometer, hygrometer), which was carried out in the 1690s by Hamberger, Weigel's student and successor in the chair. [15]

Weigel was also an early Enlightenment thinker when he debunked astrology as a belief (e.g. on the occasion of people's fear of an eclipse) and no longer regarded astrology as part of the canon of science.

[15] Klaus-Dieter Herbst: Erhard Weigels Forschungsansatz zu meteorologischen Messungen und die Umsetzung durch Georg Albrecht Hamberger. In: Katharina Habermann, Klaus-Dieter Herbst (eds.): Erhard Weigel (1625–1699) und seine Schüler. Göttingen 2016, pp. 189–206.

Calendar reformer

From 1583 onwards, Christians counted the days according to two different calendars, as the "new" calendar introduced by Pope Gregory XIII meant that 4 October 1583 was immediately followed by 15 October. The omission of 10 days had become necessary because the astronomical precision had caused the astronomical beginning of spring to move forward and thus deviate from the calendar beginning of spring (21 March). This led to turbulence when determining the date of Easter, as it was always celebrated on the Sunday after the first full moon of spring.

The Protestant sovereigns refused to accept the Gregorian calendar in their territories and stuck to the "old" Julian calendar. As a result, dates always had to be given twice throughout the 17th century, e.g. 2/12 August. Against the background of the wars with the "arch-enemy", the Turks, this disunity of Christianity was a thorn in the side of many people, including Weigel. In 1664, Weigel published a proposal in his "Bürgerlicher Zeit-Spiegel" that was "inappropriate for the unity of the times that was most desirable in the Holy Roman Empire ". Other scholars also made proposals, but it was Weigel who most vigorously pursued the unification of time. Although he died in March 1699, three of his confidants in this matter took up the cause. Johann Christoph Sturm in Altdorf, Georg Albrecht Hamberger in Jena and Johannes Meyer in Regensburg persuaded the Protestant imperial estates to decide on 23 September (July) 1699 that the Julian calendar should be replaced by the "Improved Calendar": by omitting 11 days, 18 February 1700 was immediately followed by 1 March. Erhard Weigel, who acted as an advisor to the princes at the highest level, had provided the decisive impetus for the unification of time.[16]

For religious and political reasons, it was not possible to persuade the Protestant imperial estates to adopt the Gregorian calendar. The main difference to the Improved Calendar was the determination of the date of Easter: in the Gregorian calendar, this is done according to the 19-year cycle of the Easter table by Dionysius Exiguus from the year 525, whereas in the Improved Calendar, the times of the beginning of spring and the full moon are determined by astronomical calculation. Since there were occasionally different Easter dates, as happened in 1724 and 1744, the Protestant estates decided in 1775 to switch to the Gregorian calendar, which was renamed the "Improved Imperial Calendar" in 1776, before the Easter celebrations of Catholics and Protestants fell apart again in 1778.

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[16] Edith Koller: Strittige Zeiten. Kalenderreformen im Alten Reich 1582–1700. Berlin, Boston 2014.

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