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Tycho Brahe: Science and Life in the Danish Renaissance

by
John Robert Christianson

Today, we are constantly using data; some even say that we live in an Age of Data. Most of us hardly realize that a Danish astronomer set the whole process in motion more than four hundred years ago. Tycho Brahe (1546-1601) changed the world with his innovative approach to astronomy and observational data. My interest in him started with a college term paper and eventually led to writing and editing books and articles about his life and work in Renaissance Denmark. This research led me to develop new interpretations of his revolutionary approach to understanding the heavens and the natural world.¹

Tycho's discoveries came at a crucial time in history, when the entire world was becoming more interconnected than ever before. The Renaissance was an exciting time to be alive. New knowledge and new perspectives sprang to life from the achievements of Renaissance innovators like Columbus, Copernicus, Gutenberg, Luther, da Vinci, and Michelangelo. Their names are household names to this day – but what about Tycho Brahe? Who has ever heard of him outside of Denmark?

In order to imagine Denmark in that distant time, it helps to think of three famous Danish castles. If you have visited Denmark, you have probably seen Rosenborg Castle in the center of modern Copenhagen, Frederiksborg Castle rising from a lake in Hillerød, or Kronborg Castle guarding the entrance to the Baltic in Helsingør, maybe even all three of them. These castles were built between 1550 and 1650, during the heyday of the Renaissance in Denmark. Imagine what these castles were like when they were new and full of life, swarming with all the energy of a mighty Danish court. Kronborg and Frederiksborg in particular were the power centers and cultural showplaces of a Danish empire that included Greenland, Iceland, and Norway, and extended down into Germany and out to the edge of Russia. The Danish royal castles were connected to the very planets and stars by their statues of Mars, Venus, Jupiter, and other celestial gods. The royal astrologer

was the one who interpreted these connections and read the stars to foretell the future.

When you think of all that, you're envisioning Renaissance life in Denmark. It was not the Italian Renaissance of Venice or Florence, but a Danish Renaissance centered on the courts of King Frederik II (reigned 1559-88) and his son, King Christian IV (reigned 1588-1648). We can still step into the Danish Renaissance when we visit these castles. Sadly, however, one of the greatest monuments of the Danish Renaissance, perhaps the greatest of them all in terms of its lasting influence, is gone forever. This was Uraniborg on the island of Hven, the palace and observatory of Tycho Brahe, the Danish court astrologer.

My most recent book, *Tycho Brahe and the Measure of the Heavens*, describes what Renaissance life was like at Uraniborg and what makes Tycho Brahe's achievement so important in the history of the world.

Tycho Brahe was born to wealth and privilege in one of Denmark's most powerful noble families. His ancestors had been courtiers and commanders of castles for time out of mind. Among the ancestral coats of arms around his portrait were famous families like Rosenkrantz and Gyldenstjerne, mentioned in Shakespeare's *Hamlet*, and even the royal Swedish house of Vasa. Tycho Brahe's four younger brothers all followed the path

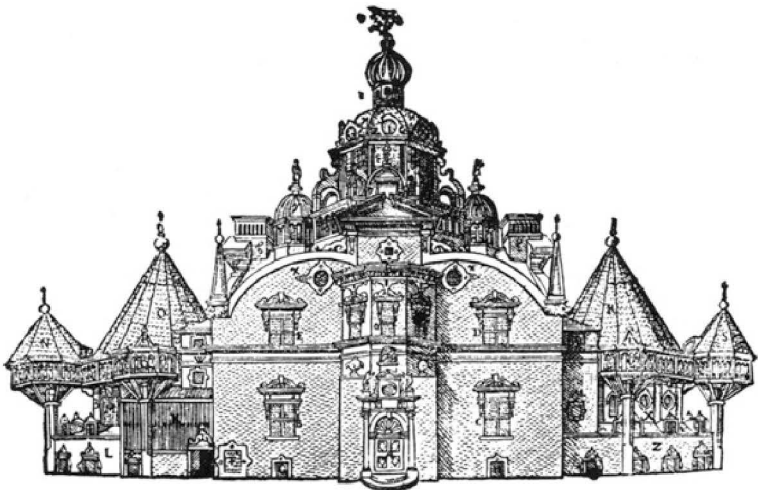


Tycho Brahe surrounded by the family shields of his famous Danish ancestors, depicted by Dutch engraver Jacob de Gheyn II in 1586. *Image courtesy of the Museum of Fine Arts, Houston.*

of their illustrious ancestors. They learned courtesy at foreign courts and fought as armored knights on European battlefields before coming home to serve the Danish crown in high offices. Tycho was the

oldest of the five brothers, but he was the rebel. He did not want to be a courtier and governor of great royal castles. He wanted to be an astronomer. This choice puzzled most of his aristocratic relatives, but his younger sister Sophie Brahe (1559-1643) shared his love of astronomy, chemistry, and gardening; she even worked as his assistant in observing the stars.²

King Frederik II also understood Tycho's passion and liked his ideas. Every Renaissance monarch longed for an astrologer who could see into the future and predict the fates of rulers and kingdoms, and King Frederik knew that every astronomer was an astrologer. In 1576, he put Tycho in charge of the little island of Hven, which he could see from a tower window at Kronborg Castle, and commanded him to build a royal observatory there. From this base, he wanted Tycho to study the stars, become famous as an astronomer, and also serve as the king's astrologer. Why should Danes have to travel to Germany or Italy or England to learn about things like astronomy, King Frederik asked Tycho. Instead, people of other nations who wanted to know about such things should come to Denmark to see and learn that which they could hardly find elsewhere.



Woodcut of Uraniborg from J. L. E. Dreyer, ed., Tychonis Brahe Opera Omnia (Copenhagen, 1913-29), vol. VI, 348-9.

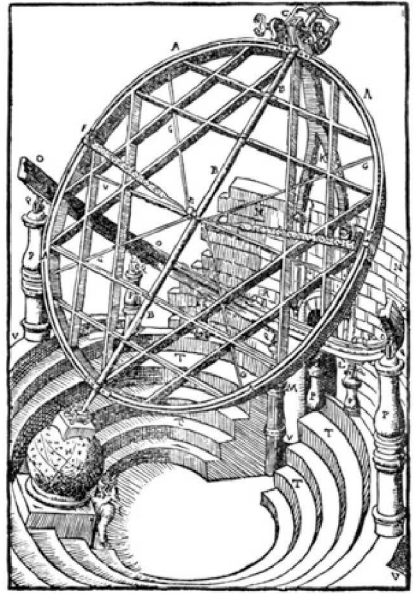
And so, they did. On his little island, Tycho Brahe built Uraniborg to serve as his combined palace, observatory, laboratory, and research center. It was the first modern observatory in the world and became a model for the observatories of Paris and Beijing nearly a century later, and for the Greenwich Observatory exactly one hundred years later. Uraniborg was the place where modern observational astronomy began.

Uraniborg was a lively place. The royal astrologer directed a large staff of astronomers, instrument makers, keen-eyed observers, calculators, natural philosophers, chemists, and cartographers. Since this was the Renaissance, his staff also included classical scholars, artists, poets, historians, musicians, and a prophetic dwarf jester. When the day's work was done and before the night's work of observing began, they would gather for supper around a long table and review the day and the coming night together. Sometimes it ended with wine, music, song, and dance. Other times, to make his astronomical observations more challenging and fun on cold winter nights, Tycho set up two or three teams of observers and had them observe the same star to see which team could get the best results. No matter who won, there would always be more celebration.

On occasion, when princely guests arrived, elaborate Renaissance entertainments were staged. Frederik II's much younger wife, Queen Sophie, came on two occasions with all her court, headed by her lady-in-waiting Beate Bille, Tycho's own mother. The Duke and Duchess of Mecklenburg visited with their nephew and attendants. In 1582, the English ambassador came to bestow the Order of the Garter on King Frederik II at Kronborg Castle and then sailed over to visit Uraniborg. Other guests included the King of Scotland and his court, the Duke of Braunschweig with his court, and the list goes on.

Tycho's career unfolded a full generation before Galileo discovered the telescope. Tycho and his teams had to observe the stars with the naked eye, without the benefit of magnification. Tycho wanted his assistants to achieve the highest possible accuracy under those circumstances, and he put a priority on developing new methods of observation and verification. The better the methods, the more precise the results. This challenge stimulated Tycho Brahe to develop concepts never before used in astronomy or any other science.

Many astronomers had preceded Tycho Brahe, all the way back to ancient Babylon and Egypt, not to mention Greece, China, the Muslims, and the Mayans. They had compiled many observations of the sun, moon, planets, comets, and stars over the centuries. They wrote down their observations or borrowed from others and assumed that they were accurate. Each observation was a record of a celestial position within a given reference grid at a given time. However, none of these earlier astronomers had ever dealt with the problem of verifying their observations. Tycho Brahe was the first person in the history of science to face this problem and develop methods for establishing limits of accuracy and verifying the accuracy of observations within those limits.



*Woodcut from J. L. E. Dreyer, ed.,
Tychonis Brahe Opera Omnia.
(Copenhagen, 1913-29), vol. V, p. 64.*

His innovative approach began with remarkable simplicity. Tycho liked to repeat the same observation over and over again, simply because he loved to observe the stars. When he did so, he expected the results to be the same, but he soon discovered that they varied, which led him to wonder what went wrong. Did the problem lie in the instrument he was using? Did it lie in his method of observing? Had he simply made a mistake? Had something changed in the object he was observing? Tycho began to add new steps to the process of observing nature in order to answer these and similar questions. This eventually left him with a pile of data that he needed to reduce to a verified result. In the end, his new approach allowed him to replace the single, unverified location for a given star accepted by earlier astronomers with a whole data set that established the location of that one star within stated limits of accuracy. He used the same methods to produce verified positions of a thousand other stars, as well as the

planets, sun, and moon. Tycho Brahe's new methods of observation and data reduction laid the foundation for exact empirical science.

My new biography of Tycho Brahe is rather short, but it deals with his methods more fully than ever before. Seventeenth-century scientists built on the foundation of these new methods, starting with Tycho's former assistant, Johannes Kepler, who was able to work out his three laws of planetary motion because he used Tycho's data and knew the limits of accuracy Tycho had established for this data. The new foundation has endured. Ever since Tycho Brahe, scientists have known that data needs to be verified to establish its limits of accuracy, but few of them realize that they owe that fundamental awareness—and some basic principles for achieving it—to a Danish astronomer named Tycho Brahe.

His insights still have modern implications, but Tycho was not a modern person. He was a Renaissance man, and he thought with a Renaissance mind. He believed that God had created the divine geometry of the universe, and that an understanding of this geometry of celestial motion would ultimately reveal the mind of the Creator. To know the mind of God was why he studied the stars. In the Renaissance, other natural philosophers thought as he did, but their thinking did not lead them to the results that Tycho achieved. His breakthrough emerged from applying the mindset of the Renaissance in a unique way, yet, ultimately, it helped to destroy that mindset forever.

Tycho Brahe also lived the lavish lifestyle of a Danish Renaissance aristocrat, attending the court of King Frederick II and King Christian IV at Frederiksborg Castle, helping the royal architects design Kronborg Castle, building his own palace and immense observational apparatus, experimenting with Paracelsian chemistry, writing Latin epigrams, enjoying royal festivals at court, promoting the music of Italian motets and Danish ballads, banqueting and savoring Renaissance life with colleagues, friends, and highborn guests. My biography goes on to cover the rest of Tycho Brahe's eventful life after he left Denmark and came to the court of the Holy Roman Emperor in Prague, where he died and was buried in 1601. I was able to discover what happened to his descendants and show that some of them still continue to live distinguished lives far from Denmark.

In 2013, Luisa Cifarelli of Bologna University, one of Europe's leading nuclear physicists and the first woman president of the European Physical Society (EPS), acknowledged the importance of Tycho Brahe's work in the history of modern astrophysics. She came to Hven with a host of other European dignitaries in order to designate the site of Uraniborg as an EPS Historic Site. None of Tycho Brahe's immense observational instruments have survived, but she and the others were able to enter the ruins of the site where those instruments once stood. It is now a part of the Tycho Brahe Museum, documenting the life and work of this important Danish trailblazer. Tycho Brahe did not live in vain. His innovative approach to observational data helped to change the world.

Endnotes

¹ John Robert Christianson, *On Tycho's Island: Tycho Brahe and His Assistants, 1570-1601* (Cambridge University Press, 2000). Victor E. Thoren, *The Lord of Uraniborg: A Biography of Tycho Brahe*, with contributions by John Robert Christianson (Cambridge University Press, 1990). John Robert Christianson, et al., eds., *Tycho Brahe and Prague: Crossroads of European Science* (Verlag Harri Deutsch, 2002).

² John Robert Christianson, "Tycho Brahe and Sophie Brahe: Gender and Science in the Late Sixteenth Century," in Christianson et al., eds., *Tycho Brahe and Prague*, 30-45.