6

Term Paper on Johannas Kepler

Differential Equations
University of Massachusetts Lowell
Summer 2020

Joel Savitz

June 18, 2020

1 Abstract

Johannes Kepler is a widely known name in mathematical and scientific history. In this paper, I explore his origins and early scientific mindset, then I give a general overview of his early to mid stage academic career, and finally I provide some examples of his more significant contributions to science and discuss his resulting legacy.

2 Early life

Johannes Kepler was born in the Holy Roman Empire in 1517. Despite his father leaving the family when he was five as well as premature birth, he is said to have impressed visitors at his grandfathers's inn with his mathematical prowess from an early age [4]. In Kepler's own words, his love for astronomy began at the age of six when he "was taken by [his] mother to a high place to look at" the great commet of 1577, observing that it "appeared quite red" [7].

After being introduced to Copernican heliocentrism in his study at the University of Tübingen, Kepler defended this position — theologically and technically – in a student disputation [8]. His skill as an astronomer as well as his ununsually strong mathematical ability led him to a an acedemic appointment as a teacher of mathematics and astronomy at the Univesity of Graz in 1594 at the age of 23, begining a long and successful academic career [4].

3 Academic career

Starting off his tenure with a bang, Kelper was the first to publish a defence of Copernican heliocentricsm. This early work, entitled *Mysterium Cosmographicum*, attempted to describe the arrangement of the solar system in terms of inscribed platonic solids, though he later rejected this formulation [4]. Fundamentally, Kepler was driven by religious zeal. His model of the universe was as an image of God and his work connected Christian spiritual concepts with astronomical phenomena. An early draft of the work extensively defended heliocentrism using textual evidence from the bible itself [3].

Kepler spent the next few years at Graz doing research with the goal of extending and elaborating on his first work, but extensive correspondence with Tycho Brahe — a great figure in astronomy and a contemporary of Kepler — convinced Kepler of the inconsistency and inaccuracy of some of his beliefs, so Kepler instead studied the relationship between music, mathematics, and physics,

creating new elaborate theories, but frustration with the inacuracy of existing experimental data as well as the invitation of Brahe led Kepler to relocate to leave Graz on New Year's Day 1600 [4].

Before arriving in Prague, Kepler was a guest of Brahe and he pursued formal employment, but negotiations broke down and Kepler soon moved with his family to Prauge, due in no small part to their banishment from Graz because of their refusal to convert to Catholicism. When Brahe passed unexpectedly in October 1601, Kepler was chosed to suceed him as the imperial mathematician for the Holy Roman Emperor and he was tasked with continuing where Brahe left off. His 11 year tenure in this role is considered to be the most productive period of Kepler's life [4].

One evening in October 1604, a supernova ocurred in space that was visible from the earth. After initially refusing to beleive the rumors, Kepler soon commenced a systematic observation of the phenomenon. His role as imperial mathematician requried the interpretation of this event through an astrological perspective, but he also made the observation that the star was fading, undermining the at the time unquestioned Aristotelian dogma of the immutability of the heavens [4]

4 Contributions to Physics and Mathematics

Over the course of his 58 year lifetime, Kepler made many important contributions to the fields of mathematics and physics. In a pamphlet to a friend for a New Year's gift, he stated what we now refer to as the Kepler conjecture, the proposition "that no arrangement of equally sized spheres filling space has a greater average density than that of the cubic close packing (face-centered cubic) and hexagonal close packing arrangements" [1]. The journal *Forum of Mathematics, Pi* accepted and published a formal proof of the Kepler conjecture authored by a team led by Thomas Hales in 2017, establishing the Kepler conjecture as a mathematical theorem. Hales et al. leveraged the power of the software proof assistants HOL Light and Isabelle [6], utilizing modern automated computational systems to produce previously elusive solutions to ancient questions.

One of the most influential works Kelpler published was *Astronomiae Pars Optica* – The Optical Part of Astronomy — inspired by his earlier study of the moon. In this text, he described the inverse square law that describes the intensity of light and reflection and the sizes of the celestial objects. In addition, many neuroscientists agree that in this text he was the first to recognize that light entering the human eye forms an inverted and reversed image on the retina [5]. He also proposed many fundaamental ideas of projective geometry, relating to conic sections, straight lines with infinite length, and continuous change. *Astronomiae Pars Optica* is widely considered to be one of the foundational texts of modern optics [4].

5 Legacy

Johannes Kepler lives on as his successors stand on his shoulders and the shoulders of giants like him. He was instrumental in the development of a variety of scientific fields including astronomy, physics, mathematics, and optics. A number of scientific ideas are named after Kepler, including Kepler's laws of planetary motion, Kepler's Supernova, and of course the Kepler space telescope, depicted in figure 1. Kepler remains a household name in scientifically literate communities throughout the world.

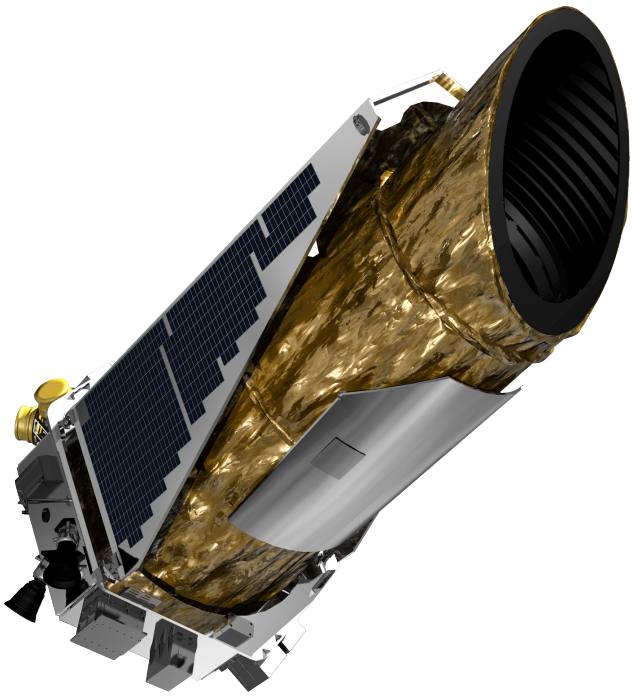

Figure 1: An artist's depiction of the Kepler space telescope [2]

References

[1] Barker, P., and Goldstein, B. R. Theological foundations of kepler's astronomy. *Osiris 16* (2001), 88–113.

[2] Caspar, M. *Kepler*. Dover Publications, New York, 1993.

[3] Koestler, A. *The sleepwalkers : a history of man's changing vision of the Universe*. Arkana, London New York, 1989.

[4] Westman, R. S. Kepler's early physical-astrological problematic. *Journal for the History of Astronomy 32*, 3 (Aug. 2001), 227–236.