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Book Review

Osterhage, Wolfgang. *Johannes Kepler: The Order of Things*. Springer Biographies. Springer International Publishing, 2020. 132p. ISBN 978-3-030-46858-3/ e-book. 54,99 USD.

Luana Paula Goulart de Menezes[1] [https://orcid.org/0000-0002-8833-9759]

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Placing order amid chaos is a fascinating proposition. In some episodes in history, the goal of organizing and attributing meaning to phenomena and, in this way, meeting the human desire to understand the world was treated seriously. Among the most famous names who glimpsed and pursued this purpose is Johannes Kepler (1571-1630). The book entitled *Johannes Kepler: The Order of Things* seeks to present this perspective. The author of this book, Wolfgang Osterhage, situates the events in Kepler's life and his immense effort to find an order underlying all things. In this sense, the book, which belongs to the Springer Biographies series, is not only a biography; Osterhage intends to use Kepler's life and achievements as a kind of catalyst for humanity's effort to find order in environmental and cosmic events.

Regarding the book's structure, we begin by observing its subtitle, bringing a sense of *déjà vu*. *The Order of Things* is the title of one of Michel Foucault's (1926-1984) books. The author comments on this but draws attention to it: while Foucault claims that science creates abstract concepts that are generally debatable and does not focus on describing objective insights, Kepler seeks reality, with no room for relativism (Osterhage 2020, 4-5). However, it is important to keep in mind that even if Kepler seeks an absolute statement, in which the description of reality coincides with the truth, we cannot forget that the path he took was not based on random guesses. His stance is that of someone who seeks criticism and is willing to change his mind. For example, in support of Galileo Galilei (1564-1642), Kepler comments: "Yet let no one assume that by my readiness to agree with Galileo I propose to deprive others of their right to disagree with him. [...]. I have done so with a conviction of their truth and with a serious purpose. Yet I swear to reject them without reservation, as soon as any better-informed person points out an error to me by a sound method" (Kepler and Rosen 1965, 7).

After introducing the book's purpose in Chapter 1, Osterhage describes in Chapter 2 – in what he calls a kind of prologue – some details about Kepler's tendencies in the search for harmony in the world. Osterhage speculates that when the man looked at visible things above his head, the question may have arisen how we could understand phenomena of space and time. According to him, for centuries, before effectively understanding the behavior of the stars, scholars were content to describe the things they observed. Initially, this was

[1] Luana Paula Goulart de Menezes is a PhD candidate in Science and Mathematics Education Program at the State University of Maringá – UEM (Brazil). Address: Av. Colombo, 5790 - Zona 7, Maringá - PR, Brazil, 87020-900. E-mail: lluanagoulart@gmail.com

Kepler's sole goal: to contemplate the beauty of harmony as such, without directing their efforts to understand the underlying causes, unless these were to be found in God's plan.

In the search for order, one element becomes essential: simplicity. For Osterhage, simplicity implies a search for commensurability, finding relationships between whole numbers in the explanations of planetary orbits. Such a task of understanding cosmic harmonies included in Kepler the music of the spheres of the Pythagoreans. While there may be a repulsion to such ideas, Osterhage reminds us that there are harmonies in the cosmos, such as the rotations of moons around their host planet.

In addition to the issues around understanding nature objectively, Osterhage also seeks to point out other elements that motivate the pursuit of order. For example, he lists Aesthetics, Homeostasis, Gestalt, Mythology, Communication, Power, Benefits, and Values (Osterhage 2020, 7-14). Each of these items is discussed in the book and seems to be an enlightening attempt to present the theme in a broader context, highlighting a human character in understanding the world.

In the following Chapters (from the 3rd to the 9th), the author describes Kepler's life and work. Among his peers, he writes that Kepler was a contemporary of Tycho Brahe (1546-1601). In Uraniborg, Tycho collected astronomical data of great precision, which later and with Kepler's intense work, culminated in the famous Rudolphin Tables. Another well-known contemporary was Galilei, already mentioned here. Both shared ideas in common, such as the fact that they believed in the Copernican hypothesis. Still, as Osterhage presents well, even though Kepler and Galileo were exposed to the same cataclysms, we can notice different impacts since the situation in Italy was different from that of Central Europe.

About the scholar in focus in the book, Osterhage presents a lot of information: Kepler was born on December 27, 1571, in Weil der Stadt (town of Weil). Historically, this epoch consists of the transition from the Renaissance's end and the Humanist period's end to the Baroque. His life was not easy at all; he went through periods of witch-hunting, his mother was accused of being a witch, and, in addition, several religious wars had a profound effect on the astronomer's life.

According to Osterhage, Kepler was baptized a Catholic but brought up as a Protestant. However, the information about baptism seems doubtful to us. Max Caspar – one of Kepler's most renowned biographers, presents a series of circumstances that did not show any conviction related to the religion of his baptism. Thus, we are unsure whether it was a Catholic clergyman or, more likely, a Protestant preacher who performed the sacrament (Caspar and Hellman 1993, 33).

Beyond occasional information, the author, in a compelling way, uses Plato's parable of the cave to illustrate the problem of the Keplerian quest to understand the world behind the world, that is, to understand its harmony. The famous dialogue between Socrates and Glaucus ends with the assumption that one of their prisoners would return to the cave and reveal the truth about the real world. As is to be assumed, the prisoners who remained in the cave would not believe the reality behind the shadows they saw: the prisoner who returned would be in danger of being killed. In Osterhage's opinion, although this is not exactly what happened to Kepler, he was the person who decided to discover the secret workings of the world, while many seemed to see, like the prisoners, only shadows or reflections of the real world. Perhaps we can go a little further, for even though he was not at risk of death, Kepler encountered much opposition, as did the returning prisoner. This applied from when he supported Copernicus. About himself, he writes: "No matter how far I have advanced, I have been strongly opposed everywhere" (Baumgardt 1951, 53).

Besides having had a complicated background of wars and oppositions, Kepler lived in a family that was not kind. His mother had a controversial personality, a cranky person, and his father was a military man. Moreover, Kepler's health was fragile: he was afflicted by many diseases. Without a doubt, he was not a boy who would have a future as a military man or a peasant. For him, fate had in store a hard work with other objectives. Nevertheless, in his childhood, we can find events that give hints about his future endeavor: at the age of six, he observed a comet with his mother and, at the age of nine, a lunar eclipse. This information is narrated by Osterhage in more detail, along with Kepler's school journey until he reached the renowned University of Tübingen.

In the context of ideas, it is expected that various scholars influenced Kepler, and many of his ideas are found in later researchers. From this perspective, Osterhage seeks to dialogue with past and future lines of thought concerning Kepler. In later research, he provides a lay reader with a good overview of recent efforts in the field of physics. Here it is worth noting that Osterhage has a PhD in Physics and another in Information Science.

In the past, Osterhage looks for good notions for understanding Kepler's context. He points to some ideas from the Pythagoras of Samos (c. 570-c. 495 BC). Kepler encountered two significant subjects in Pythagorism: music theory and regular polyhedral. And also, from Nicholas of Cusa (1401-1464), Kepler was impressed by geometric mysticism.
Closer to the present, we find, for example, David Bohm (1917-1992). For him, there is a reason why we do not understand the phenomena treated by physics and about things and events in our world of experience. This reason is that we do not recognize that they are part of a kind of totality or a kind of whole determined by a sphere of higher dimension and implicit order. This idea, Osterhage writes, is found in Kepler, even though he had no notion of quantum physics.

Returning to Kepler's ways, we can read in Osterhage's book about Michael Maestlin (1550-1631), a professor who was of fundamental importance in Kepler's life. There is also an account of Kepler's departure from the University of Tübingen to Graz (Austria), where Kepler taught and wrote his first book, *Mysterium Cosmographicum*. There is also information available about his first marriage (with Barbara Müller), his work with predictions in the field of astrology, and the counter-reformation in Graz.

Osterhage points out that Kepler learned about Copernicus' ideas from Maestlin. One of the questions that intrigued him was the planetary distances. And at that time, only six planets were known: Mercury, Venus, Earth, Mars, Jupiter, and Saturn. Kepler tried several numerical combinations, but a solution was only proposed in 1766 by Johann Titius and published by Johann Bode in 1772. The proposal consists of a mathematical formula $R_n = 4 + 3 \cdot 2^n$. The n is the natural number of the planet sequence, starting with Venus ($n = 0$); the result R_n is the average radius of a planet's orbit around the Sun. Still, we must pay attention that "The result is not the absolute value, but a value relative to the Earth's" (Osterhage 2020, 35). Osterhage points out that the formula gives good results, except for Mercury and Neptune. However, a comment is worth making here: when $n \to -\infty$ we have a good approximation for the distance in UA from the planet mercury ($R_{-\infty} = 4$, dividing by 10, we find 0.4 UA, the actual value is about 0.39 UA). The biggest mistake in comparing the real values is Neptune and Pluto's cases. And, of course, Pluto is no longer considered a planet. We also add the formula that predicts the existence of the asteroid belt, which is located the dwarf planet called Ceres. Unfortunately, there is no physical explanation of the formula, and for this reason, it was discarded and considered only a numerical resource. Osterhage remarks, however, it has recently been taken up "to analyze extra-solar planetary systems" (Osterhage 2020, 35).

On *Mysterium Cosmographicum*, the author describes the Keplerian model with the regular solids and interspersed spheres. Osterhage comments that the cube, tetrahedron, and dodecahedron were known to the Pythagoreans. The discovery of the octahedron and icosahedron is attributed to Theaetetus (c. 417-c. 369 BC). Solids have also been related to the element theory: earth for the cube, air for the octahedron, fire for the tetrahedron, water for the icosahedron, and ether for the dodecahedron.

Kepler even sent his first book to Galilei, who later requested more copies. Kepler took this opportunity to send a letter to Galilei and encouraged him to expose and defend the Copernican model in addition to the copies. Tycho Brahe also received a copy. The latter was impressed with Kepler's ingenuity, and even though he had some disagreements, he invited him to work together. With religious conflicts gaining strength, Kepler had to consider the invitation seriously. The relationship between the two was not always easy. Still, it was of paramount importance in the history of science, as we see the union of accurate data and a creative mind. The result is the great book *Astronomia Nova*, which contains the first two well-known laws of planetary motion.

Harmonices Mundi, another important work by Kepler, is also remembered in Osterhage's book. According to the author, most of the work is on music, and the geometrical part is a repetition of *Mysterium*. The chords are derived from the minimum and maximum velocities in the elliptical paths of the planets, and the music of the spheres is replaced by non-audible acoustic harmony. In this work, we find the third law of planetary motion. Osterhage writes that nowadays, it seems that hardly anyone pays attention to Kepler's assumptions of *Harmonices* anymore. However, he points out that there is a relationship between physics and music, and even more than 400 years after Kepler, there are still studies on mathematics and statistics in this art.

Although we do not specify here, a reader of the book will find important events in Kepler's life, such as the places he lived (Prague, Linz, Ulm, his stay at Sagan) and his death in Regensburg. Some details about people connected to Kepler, his second marriage with Susanna Reuttinger, and some data about children. However, some information needs to be checked. For example,the death of Kepler's first wife was probably from "Hungarian spotted typhus" (Caspar 1993, 207), a disease brought by Austrian troops and not smallpox as written in the book.

An important observation is that in Osterhage's book, it is possible to learn about other works of Kepler, besides the works we have mentioned, such as his studies on optics and chronologies. However, we need to mention that a reader of the book will not find an in-depth study of Kepler's works but rather some of his general ideas.

In Chapter 10, Osterhage presents many recent discussions, revisiting the order of things. He takes up the fact that Kepler believed that he had deciphered God's harmonic design. He describes that Kepler's universe is closed, neglects the rest of the world beyond, and considers the referential in the fixed stars. Another condition for the functioning of Kepler's system is the assumption of absolute time and absolute space. Newton was convinced of this and even tried to provide proof with a thought experiment using a bucket. The arguments used were refuted by George Berkeley (1685-1753) and later by Ernst Mach (1838-1916), who argued that Newton neglected the influence of all other matter in the universe.

In Osterhage's reading, there was not much left of Kepler's legacy, the harmony of the cosmos was destroyed in the first half of the 20th century, but much of the motivation to find order in things remained. At this point, the author quotes a passage by John A. Wheeler, "Someday a door will surely open and expose the glittering central mechanism of the world in its beauty and simplicity". In this sense, the hope is that the pieces scattered throughout the world would be joined together in a harmonious construction.

Much of the status of recent physics can be read in the book. The author cites four fundamental forces identified in nature: gravitation, electromagnetism, weak interaction, and strong interaction. He presents the current status of atomic, nuclear, particle, and other physics, and what has not been achieved to date: "The unification of the four known forces in nature" and "The synthesis of quantum theory and the theory of relativity" (Osterhage 2020, 101). Among the unsolved problems and mysteries in the realm of speculation, the author provides some examples: String theory, Cosmological constant and dark matter, TOE (The theory of everything), unifying all interactions, and The Big Crunch.

It seems that the search for a unified theory continues. Stephen Hawking (1942-2018) proclaimed that we would succeed in about ten years or, at the latest, in twenty years. After that time, he said that the projected twenty years were beginning. However, according to Osterhage, even Hawking started with not believing in the possibility of a TOE. It is due to Gödel's incompleteness theorem, according to which no part of a system establishes a conclusion about the whole.

Although Kepler did not seek a theory of everything from Hawking's perspective, he was one of the people who approached topics and problems in various ways, with music, geometry, theology, and mysticism. In nowadays, with the fields becoming more and more specialized, it is hard to imagine a scientist who can unify theories. For Osterhage, perhaps only John Nash (1928-2015) can be an example of someone who came close to Kepler. Nash was able to connect various topics in problem-solving, such as "economic science, game theory, and strategy, and at the same time created byproducts with consequences for the description of space-time" (Osterhage 2020, 110). The book's concluding chapter presents Kepler's legacy and the possibility of finding someone who can put an order to things – perhaps a utopia.

In conclusion, according to us, the best biography book remains *Kepler* by Max Caspar because Caspar searched many events in Kepler's life in a way that is not as synthesized as Osterhage's biography. In addition, there are some omissions in the book, such as the friendship between Kepler and David Fabricius (1564-1617). Furthermore, there are few lines from Kepler himself. For those who seek the book with academic interest, something that can be negative is the fact that some of the references in the direct quotations are omitted. However, overall, it still seems to be an attractive proposition. Among the positive aspects of Osterhage's proposal is the dynamism in science regarding ideas and finding an order. The way the author combines elements from Kepler's life in contrast with later scholars is an interesting perspective and one that can generate good reflections on how ideas and goals are discussed, taken up, refined, or eliminated in the complex development of science over time. The language is accessible, and from this point of view, it is a good book as far as the dissemination of knowledge is concerned, especially for bringing many discussions of recent physics. At the end of the book, we also find a list of Kepler's complete works and a timeline.

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