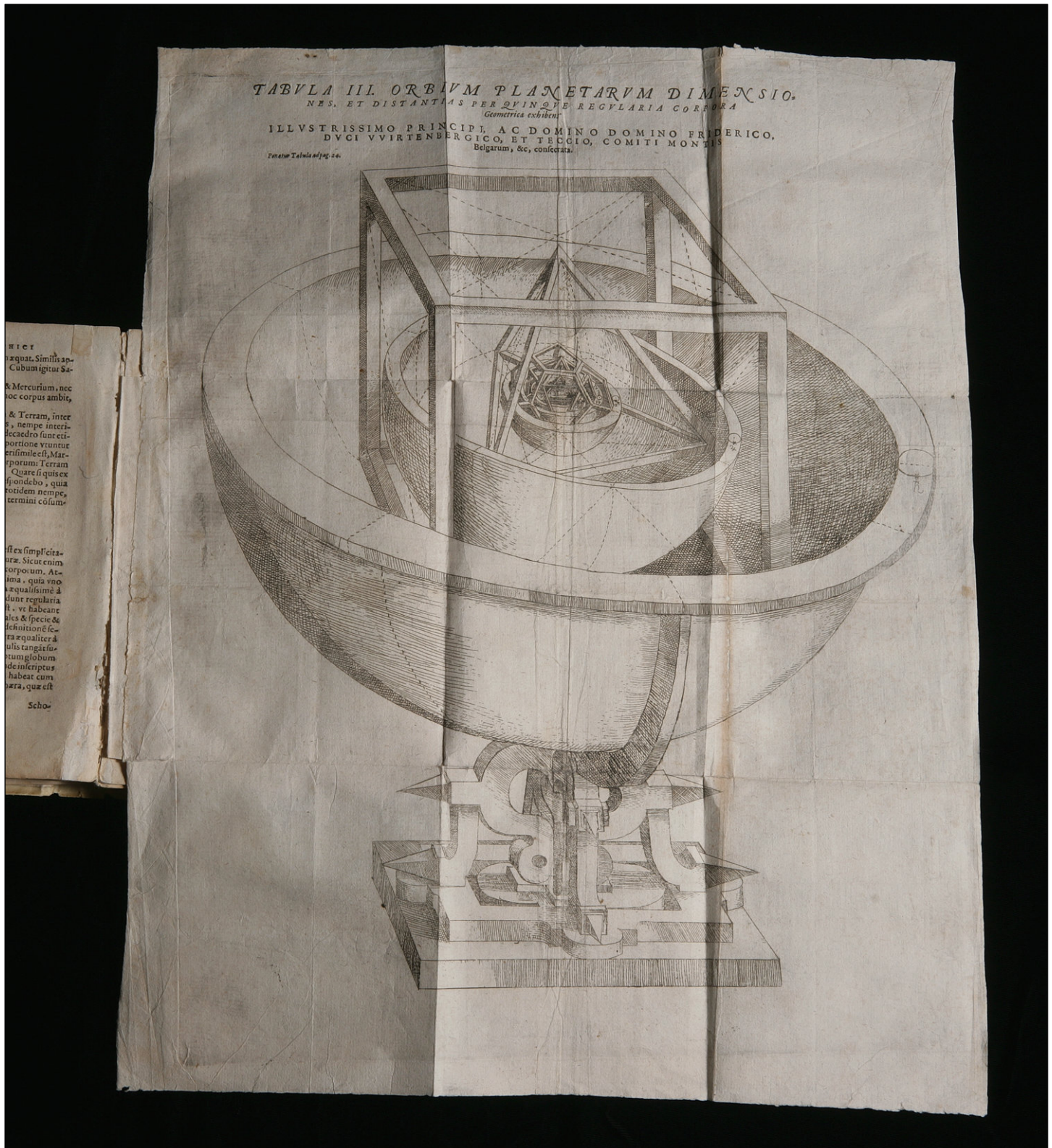


Blueprints of the Universe

Johann Kepler

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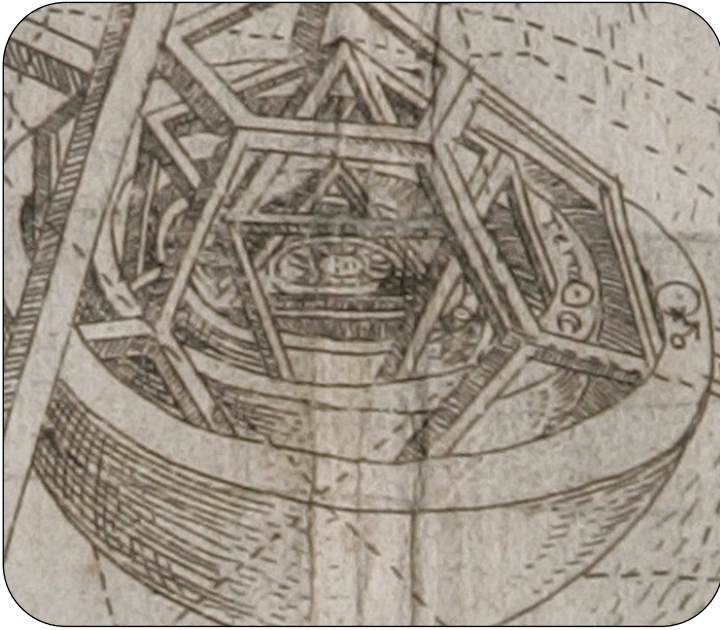


Johann Kepler, *Mysterium cosmographicum* (Tübingen, 1596), “Mystery of the Cosmos”

Exhibit: Galileo's World | Gallery: Music of the Spheres, no. 18

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Is there a mathematical basis of the universe?



Johann Kepler: Blueprints of the Universe

Kepler's blueprint of the universe is rightly considered one of the brilliant illustrations in the history of astronomy. In it, Kepler used the five regular Pythagorean solids to refute the major objections to Copernicanism.

By far the best known 16th-century defender of Copernicus was Johann Kepler. In this work he demonstrated that vast empty regions lying between the planetary spheres, which were required by Copernicus, were not wasted space. Rather, these gaps perfectly matched, within the limits of observational error, the geometry of the 5 regular Pythagorean solids.

In the *Mysterium*, Kepler addressed two major differences between the systems of Ptolemy and Copernicus and turned them both to Copernicus' advantage.

First, the number of the planetary spheres: in the Earth-centered Ptolemaic system there are 7 planets, including the Sun and the Moon, not counting the outermost sphere of fixed stars. In the Copernican system, there are only 6 planets, not counting the outermost sphere of fixed stars: The Sun and the Earth switch places. The number of planets decreases by one, because the Moon is demoted; it becomes a satellite of the Earth, within the Earth's sphere, rather than a planet. So Kepler asked, *why should there be only 6 planets instead of 7?*

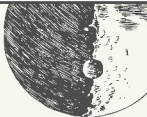

Second, and more critically, the distances of the planets: In the Ptolemaic system all the planetary spheres nest together with no intervening spaces. By contrast, in the Copernican system, the spheres of the planets become thin, separated by large distances. Skeptics asked, why would the Divine Architect have wasted so much empty space? Indeed, Kepler calculated that the gaps are quite large, so that most of the universe is empty space.

Kepler's blueprints of the universe used the 5 regular Pythagorean solids to address both the number of the planets and the amazing proportions of the planetary spheres.

For Kepler, the mystery of the universe was now revealed, because the Divine Architect knew Pythagorean geometry and used it to construct a Copernican universe! Instead of nesting one planetary sphere immediately after another, in the ideal blueprints of the cosmos, the Creator alternated planetary spheres with regular solids. The vast empty regions lying between the planetary spheres, as required by Copernicus, were not wasted space. Rather, these gaps perfectly matched the geometry of the solids within the limits of observational error.

Kerry Magruder

*"And how intense was my pleasure from this discovery can never be expressed in words.... Day and night I was consumed by computing, to see whether this idea would agree with the Copernican orbs, or if my joy would be carried away by the wind. Within a few days everything worked, and I watched as one body [regular solid] after another fit precisely into its place among the planets" (Kepler, *Mysterium cosmographicum*).*

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