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with

## Paolo Bussotti

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### THE CONCEPT OF FORCE IN JOHANNES KEPLER

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# THE CONCEPT OF FORCE IN JOHANNES KEPLER

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The concept of force has reached its standard form with Newton. Before Newton the word "force" was used without a definition. Therefore when, in the Renaissance period and in the XVI-XVII centuries, the word force was employed in order to explain physical or astronomical phenomena, its status was ambiguous or, at least, polysemous. However the "force" was almost invariably connected to vitalistic and astrological items: The celestial bodies were in general seen as bodies that exerted an influence on the human things and, with regard to the movements in the sky, there was no research to look for the kind of "force" that could determine such movements. The models of universe were kinematical, not dynamical. Kepler was the scientist who changed this way of thinking: starting from his early work *Mysterium Cosmographicum* (1596) he explicitly claimed he was looking for the causes of the movements of the planets in the sky. In *Mysterium* Kepler identified the perfect solids (sphere and regular polyhedra) as the archetypical causes of the planetary paths in the solar system, but, in the final sections of his book, he also began to mention a "force" that could be the cause of the movements. At the beginning this "force" was still involved with vitalistic points of view. Furthermore Kepler provided only a sketch of the mathematical relations determined by such force in the movements of the planets. However, in the years between the publication of the *Mysterium* and the *Astronomia Nova* (1609), Kepler developed his concept of force. Therefore the *Astronomia Nova* is important not only for the so called "first and second Kepler's laws", but also because Kepler tried to create an astronomy based on the concept of force. This concept is different from Newton's. Kepler defined some precise mathematical relations connected to his concept of force and tried to explain many phenomena basing on them. Basically Kepler's concept of force is not suitable to develop a satisfying mechanics, but the idea to provide a dynamical foundation to the kinematical results was revolutionary. Therefore the precise comprehension of Kepler's concept of force is important from a historical point of view, but it is also significant from a physical point of view in the comparison with Newton's concept force looking for the similarities and the differences (that are more numerous and profound than the similarities) both in the philosophical bases and the mathematical treatment.

The literature on the concept of force in Kepler includes various important papers and parts of books dedicated to Kepler. A fundamental text is B. Stephenson, *Kepler's Physical Astronomy*, 1987. Nevertheless, a complete research on the Keplerian concept of force and a comparison with Newton's concept of force is still lacking. Dr. Raffaele Pisano and I are carrying out a research on this problem. I propose a lecture in which the basic notions of Keplerian concept of force are described and explained.

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