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[32] Johannes Kepler –from Planets to Dark Matter

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Johannes Kepler was the first who described the motions of the planets correctly. He no longer considered circular orbits but he introduced elliptical orbits which was quite revolutionary at his time.

The orbits can be described by his famous three laws. In this lecture we mainly consider Kepler's third law. It enables us to determine one of the most important parameters in Astrophysics, the mass. The mass of a star determines its evolution but it can be only inferred from perturbation by another mass, such is the case for exoplanets, double stars.

We give several examples of stellar mass determinations and then address to motions of stars close to the galactic center. How can we observe those motions and what are the conclusions from those. The next step then is to consider a whole galaxy and to test whether Kepler's third law accurately describes the motion of galactic orbits. This led to the postulation of dark matter. Finally, the dynamics of galaxy clusters is reviewed and their velocity dispersion also shows a clear deviation from Kepler's third law.

Thus Kepler's laws are fundamental for mass determination and the observed deviations led to fascinating new ideas about the structure of the universe.

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