

## Numeric calculation of celestial bodies with spreadsheet analysis

Alexander Koch

Städt. Johannes-Scharrer-Gymnasium, Nürnberg, Germany (alexander.koch@jsg-nuernberg.de)

The motion of the planets and moons in our solar system can easily be calculated for any time by the Kepler laws of planetary motion. The Kepler laws are a special case of the gravitational law of Newton, especially if you consider more than two celestial bodies. Therefore it is more basic to calculate the motion by using the gravitational law. But the problem is, that by gravitational law it is not possible to calculate the state of motion with only one step of calculation. The motion has to be numerical calculated for many time intervals. For this reason, spreadsheet analysis is helpful for students.

Skills in programmes like Excel, Calc or Gnumeric are important in professional life and can easily be learnt by students. These programmes can help to calculate the complex motions with many intervals. The more intervals are used, the more exact are the calculated orbits.

The students will first get a quick course in Excel. After that they calculate with instructions the 2-D-coordinates of the orbits of Moon and Mars. Step by step the students are coding the formulae for calculating physical parameters like coordinates, force, acceleration and velocity. The project is limited to 4 weeks or 8 lessons. So the calculation will only include the calculation of one body around the central mass like Earth or Sun. The three-body problem can only be shortly discussed at the end of the project.