

Interactive N-Body Gravitational Simulator

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The goal of the project is to make mathematical formulas more visual and understandable. To this end, we created an N-body gravitational simulator that works in a web browser. The main motivation for the project lies in the limitations of Newtonian physics: while pre-calculating the motion of two bodies is easy, for three or more bodies ($N \geq 3$), an exact formula describing the motion does not exist. To solve this problem, our system uses computer calculations to determine gravitational forces in small time intervals (step-by-step) and demonstrates all of this visually.

For the operation of the simulation, the system uses Newton's law of universal gravitation. The main difficulty of such programs is maintaining accuracy. When calculating with standard methods (e.g., Euler's method), errors are frequent: orbits become unstable and bodies artificially "gain" energy.

To avoid this, we used the so-called "Symplectic Euler" (Semi-Implicit Euler) method. It ensures that orbits remain stable and energy is not lost, without overloading the computer. Furthermore, the program accounts for collisions—bodies merge upon contact in full compliance with the laws of physics (conservation of momentum).

References:

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