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PHYSICS SIMULATIONS (LECTURE NOTES)

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Simulating Orbital Mechanics

1.1 Preface

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1.2 Relevant Physics Background

Already in the 17th century, *Isaac Newton* formulated the gravitational force existing between any two objects with masses greater than zero. The strength of the force is given by the equation

$$F = G\frac{m_1 m_2}{r^2}, \tag{1.1}$$

where m_1 and m_2 are the respective masses of the two objects, r is the distance between them, and G is a the *universal gravitational constant*,

$$G = (6.6743 \pm 0.0015) \times 10^{-11} \left[\mathrm{N\,m^2\,kg^{-2}}\right] \tag{1.2}$$

The direction of the force is the line connecting the centers of mass of the two objects. Due to Newton's third law, the forces acting on the two objects are equal and opposite: the force applied by m_1 on m_2, $F_{1\to2}$, is pointing **from** m_2 **onto** m_1, and the force applied by m_2 on m_1, $F_{2\to1}$ is pointing **from** m_1 **onto** m_2 - and is exactly opposite to $F_{1\to2}$, i.e. in vector notation

$$\vec{F}_{1\to2} = -\vec{F}_{2\to1}. \tag{1.3}$$

1.3 Forward Euler Method

1.4 Backward Euler Method

1.5 Verlet Integration

1.6 Runge-Kutta Method

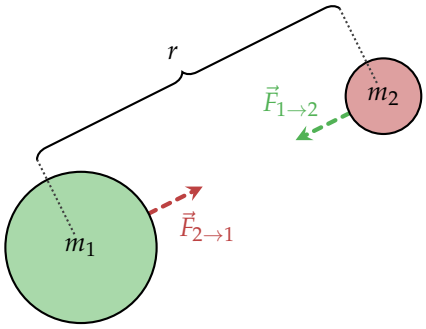

Figure 1.1: Text