3body – simple 3D Physics simulator

Version 2.0.0

The 3body simulator makes computations with the following assumptions:

- The objects can be treated as point masses and point charges
- Electrostatic and magnetostatic approximations are used, i.e., the acceleration of each charged particle is small and energy loss due to EM radiation is negligible
- All gravitational fields are weak
- The computation is divided into "steps", which are time intervals small enough for the acceleration of each object to be considered as constant

The following equations are used in computation:

Eq 1(a) – Lorentz force law

$$\mathbf{F}_{EM} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

Eq 1(b) – Electric field (Coulomb's law with special relativistic modification)

$$\mathbf{E} = \frac{q}{4\pi\varepsilon_0} \frac{1-\beta^2}{(1-\beta^2 sin^2\theta)^{3/2}} \frac{\hat{\mathbf{r}}}{|\mathbf{r}|^2}$$

Eq 1(c) - Magnetic field (Biot-Savart law for moving point charge)

$$\mathbf{B} = \frac{\mu_0 q}{4\pi} \frac{1-\beta^2}{(1-\beta^2 sin^2\theta)^{3/2}} \mathbf{v} \times \frac{\hat{\mathbf{r}}}{|\mathbf{r}|^2} = \frac{1}{c^2} \mathbf{v} \times \mathbf{E}$$

Eq 2(a) – Gravitational analog of Lorentz force (compatible with special relativity)

$$\mathbf{F}_G = m(\mathbf{g} + \mathbf{v} \times \mathbf{\Omega})$$

Eq 2(b) – "Gravito-electric field" (derived from traditional Newtonian gravity)

$$\mathbf{g} = -GM \frac{1-\beta^2}{(1-\beta^2 sin^2\theta)^{3/2}} \frac{\hat{\mathbf{r}}}{|\mathbf{r}|^2}$$

Eq 2(c) – "Gravito-magnetic field" (also known as gravitational torsion field)

$$\mathbf{\Omega} = \frac{1}{c^2} \mathbf{v} \times \mathbf{g}$$

Eq 3 – Newton's second law with special relativistic modification

$$\mathbf{a} = \frac{\mathbf{F}}{\gamma m} - \frac{\mathbf{u}}{\gamma m c^2} (\mathbf{F} \cdot \mathbf{u})$$