Classical Mechanics (Numerical Simulation)

- Collision in two dimensions
- Harmonic oscillator (+ damped oscillator, forced oscillator)

$\displaystyle{ m\frac{d^2}{dt^2}x = -2\zeta\frac{d}{dt}x - k x + f \sin \omega t \;\;\; (m=1) }$

- Coupling of two linear oscillators 1
- Coupling of two linear oscillators 2

$\displaystyle{ \left\{ \begin{array}{l} m_{1}\frac{d^2}{dt^2}x_{1} = -k_{1}x_{1} + k^{\prime} \left(x_{2} - x_{1} \right) \\ m_{2}\frac{d^2}{dt^2}x_{2} = -k_{2}x_{2} - k^{\prime} \left(x_{2} - x_{1} \right) \end{array} \right. }$

- Motion in the potential U(x) (+ damping)

$\displaystyle{ \begin{array}{l} m\frac{d^2}{dt^2}x = -\mu\frac{d}{dt}x - \frac{dU}{dx} \;\;\; (m=1) \\ U(x) = -\frac{1}{2}x^2 + \frac{1}{4}x^4 \end{array} }$

- Parabolic motion (+ viscous resistance, inertial reisistance)

$\displaystyle{ \begin{array}{l} \frac{d}{dt}\vec{r} = \vec{v} \\ m\frac{d}{dt}\vec{v} = -m \vec{g} - \gamma_1 \vec{v} - \gamma_2 |\vec{v}| \vec{v} \end{array} }$

- Monkey Hunting
- Satellite orbits around a planet 1 (, where the planet is fixed)

$\displaystyle{ m\frac{d^2}{dt^2}\vec{r} = -G\frac{Mm}{r^2} \frac{\vec{r}}{r} }$

- Satellite orbits around a planet 2 (, where the planet can move)
- Swing-by Motion

- Wave Motion

$\displaystyle{ \rho\frac{\partial^2}{\partial t^2}u = T \frac{\partial^2}{\partial x^2}u }$

- Rutherford Scattering

- Single Pendulum Motion

$\displaystyle{ \frac{d^2}{dt^2}\theta = -\frac{g}{\ell} \sin\theta }$

- Double Pendulum Motion 1
- Double Pendulum Motion 2 (+ time sequence and phase space)

$\displaystyle{ \frac{d}{dt} \left(\begin{array}{c} \theta_{1} \\ \theta_{2} \end{array} \right) = \left(\begin{array}{c} \omega_{1} \\ \omega_{2} \end{array} \right) }$

$$\displaystyle{ \frac{d}{dt} \left(\begin{array}{c} \omega_{1}\\ \omega_{2} \end{array} \right) = \sin(\theta_{1}-\theta_{2}) A^{-1} \left(\begin{array}{c} -\mu\alpha\omega_{2}^{2} \\ \omega_{1}^{2} \end{array} \right) -A^{-1} \left(\begin{array}{c} \sin \theta_{1} \\ \sin \theta_{2} \end{array} \right) }$$

$$\displaystyle{ A^{-1} = \frac{1}{\alpha \{ 1 - \mu \cos^{2} (\theta_{1}-\theta_{2}) \}} \left(\begin{array}{cc} \alpha & - \mu\alpha\cos(\theta_{1}-\theta_{2})\\- \cos(\theta_{1}-\theta_{2}) & 1 \end{array} \right) }$$