

2011.11.8
物性物理学C

ブラウン運動とLangevin方程式

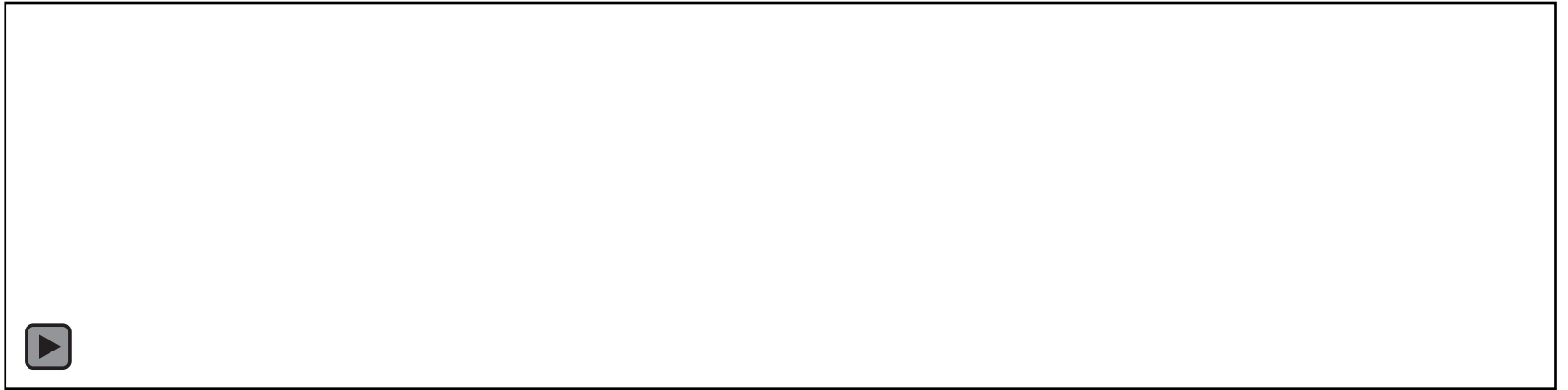
Langevin方程式

$$m \frac{d^2 \mathbf{r}}{dt^2} = -k \frac{d\mathbf{r}}{dt} + \boldsymbol{\xi}(t)$$

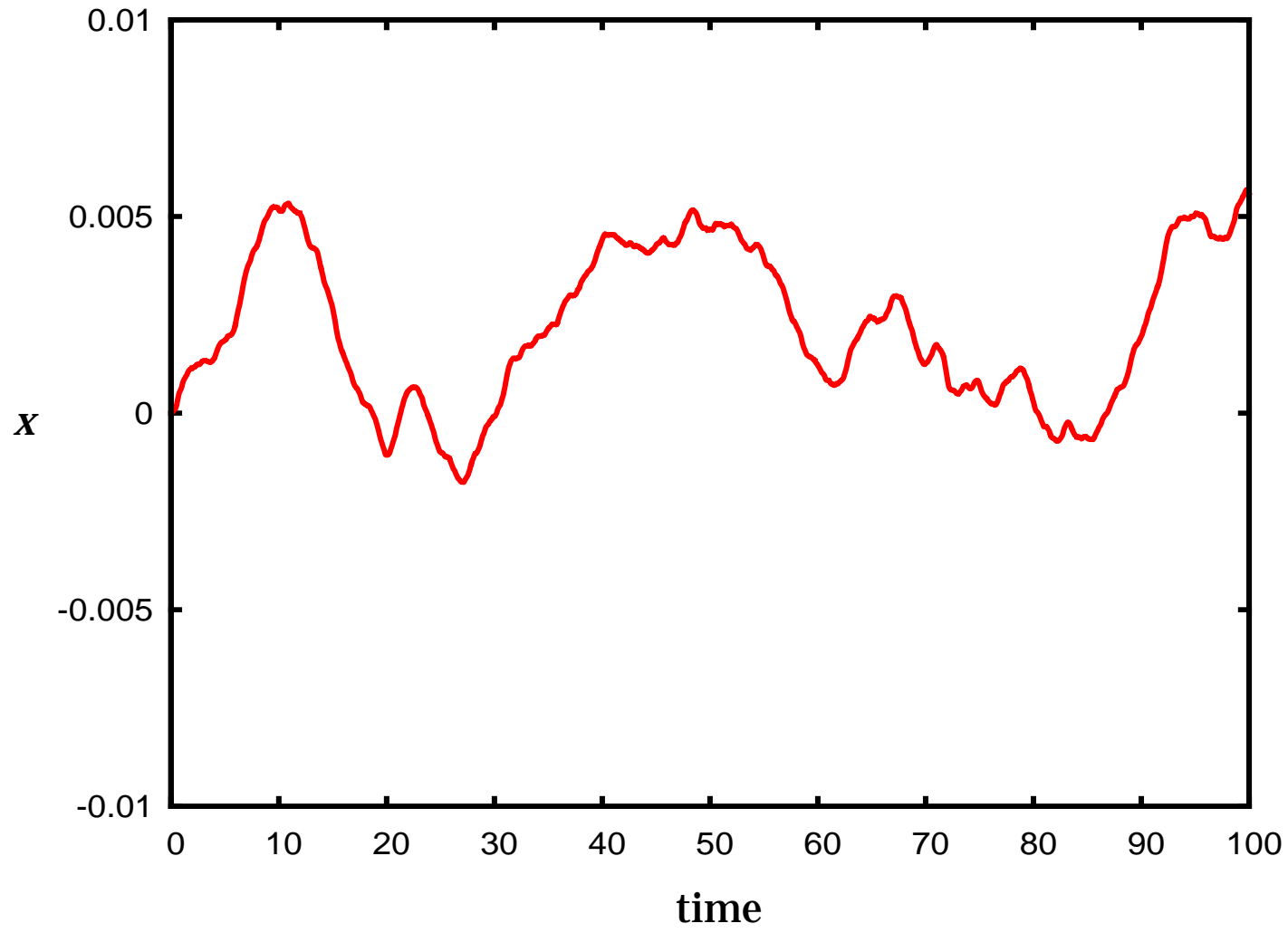
$$\langle \boldsymbol{\xi}(t) \rangle = 0$$

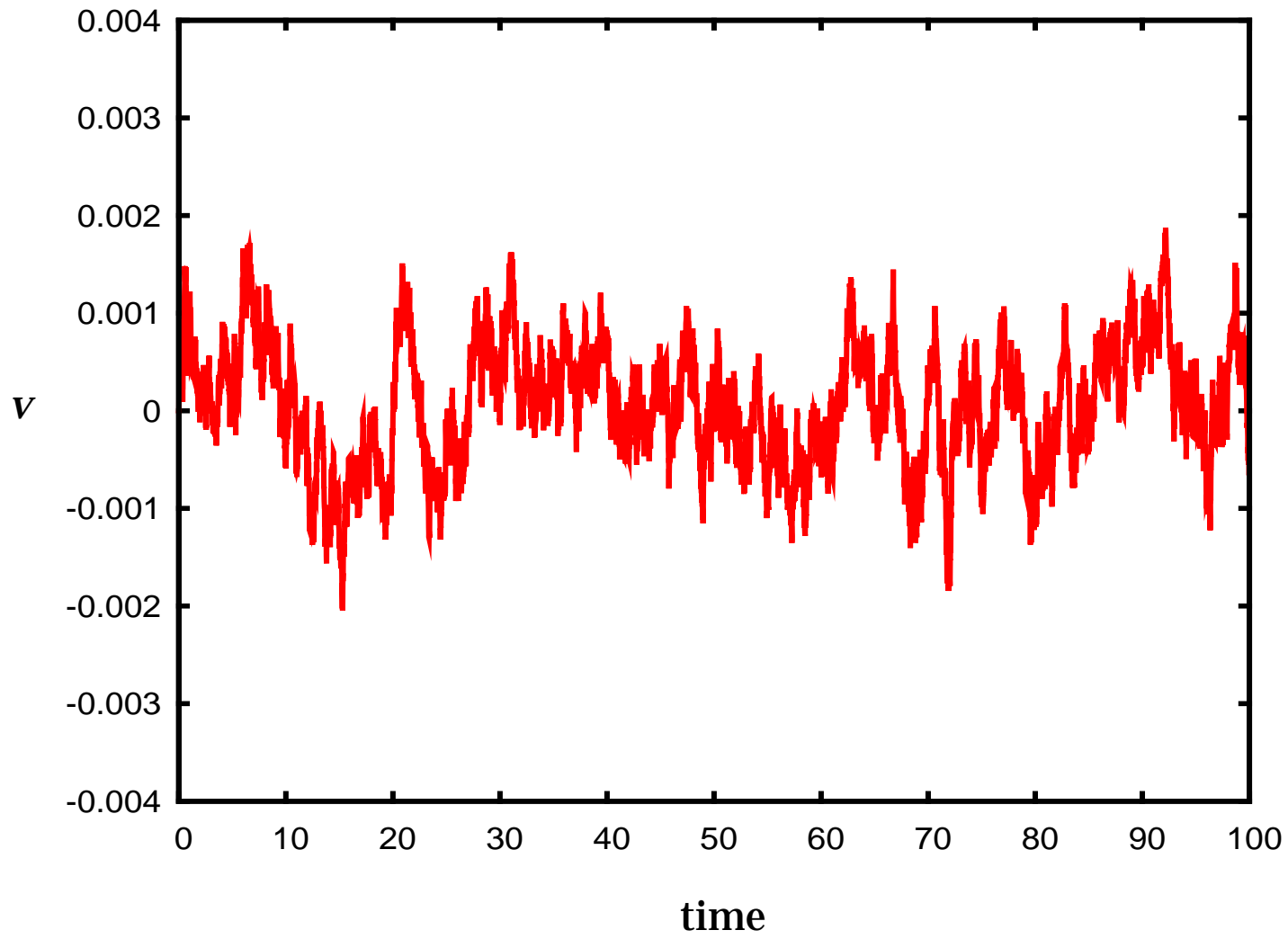
$$\langle \boldsymbol{\xi}(t) \cdot \boldsymbol{\xi}(s) \rangle = 2M\delta(t-s)$$

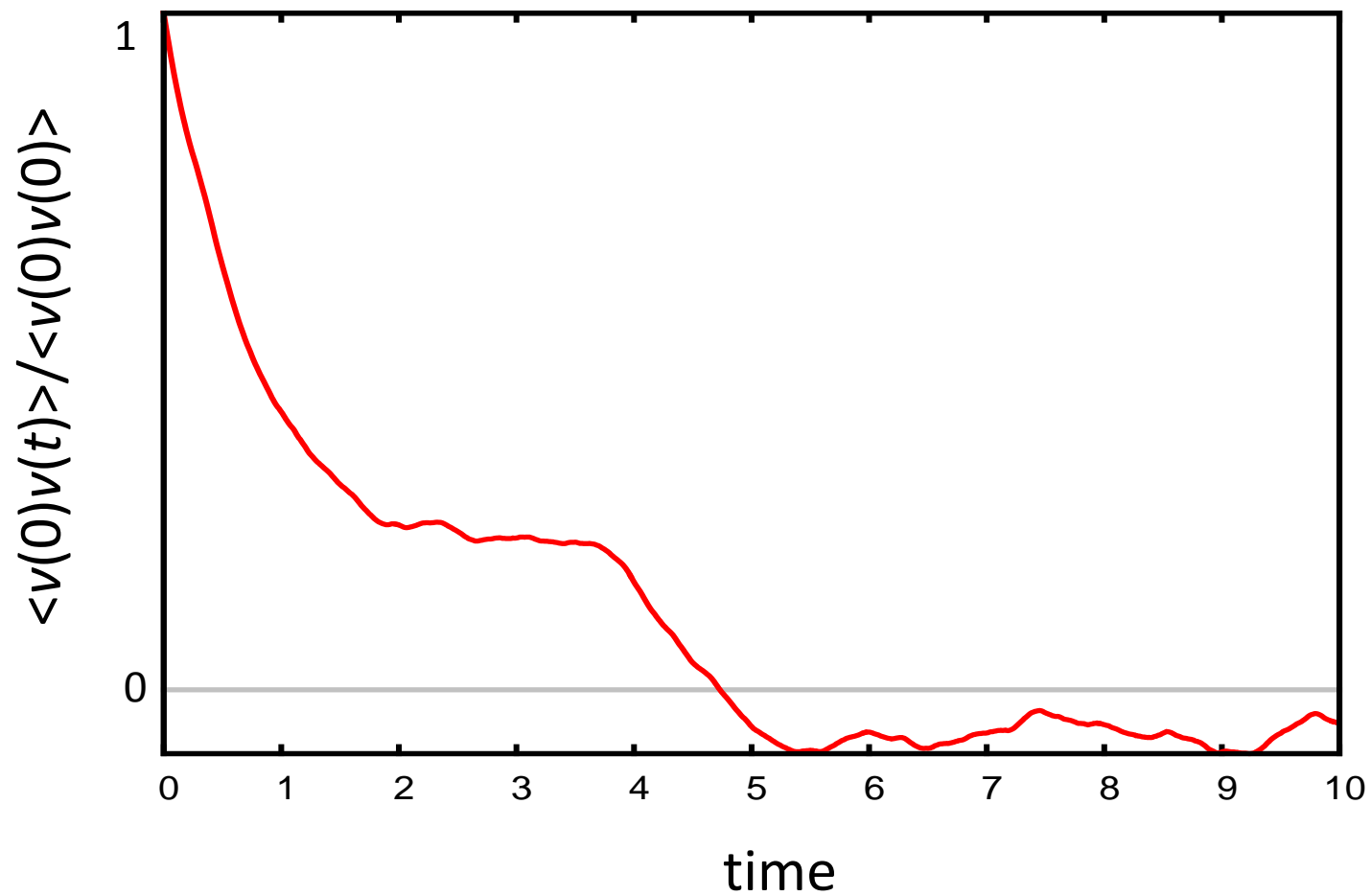
1次元系でのLangevin方程式による挙動



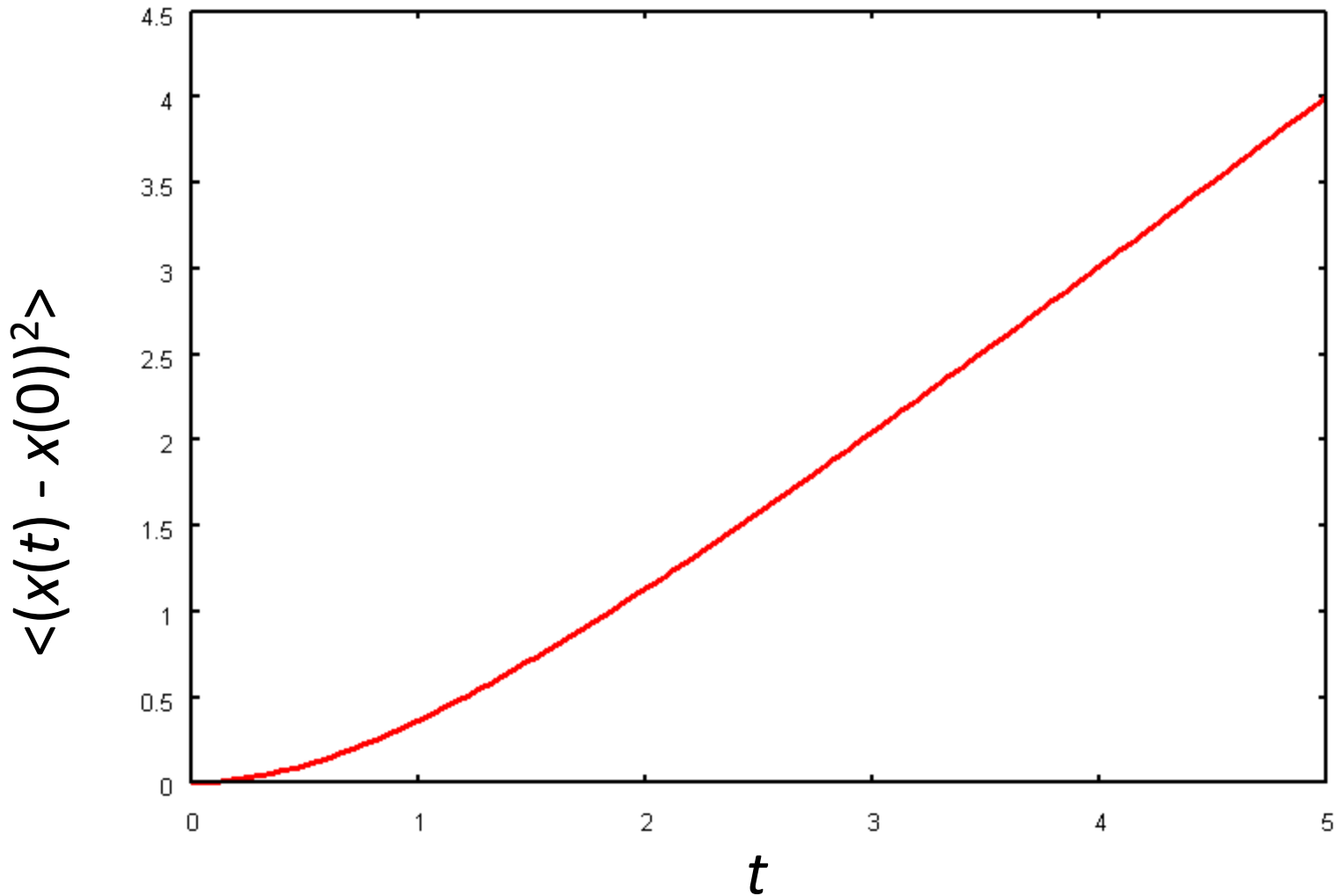
x





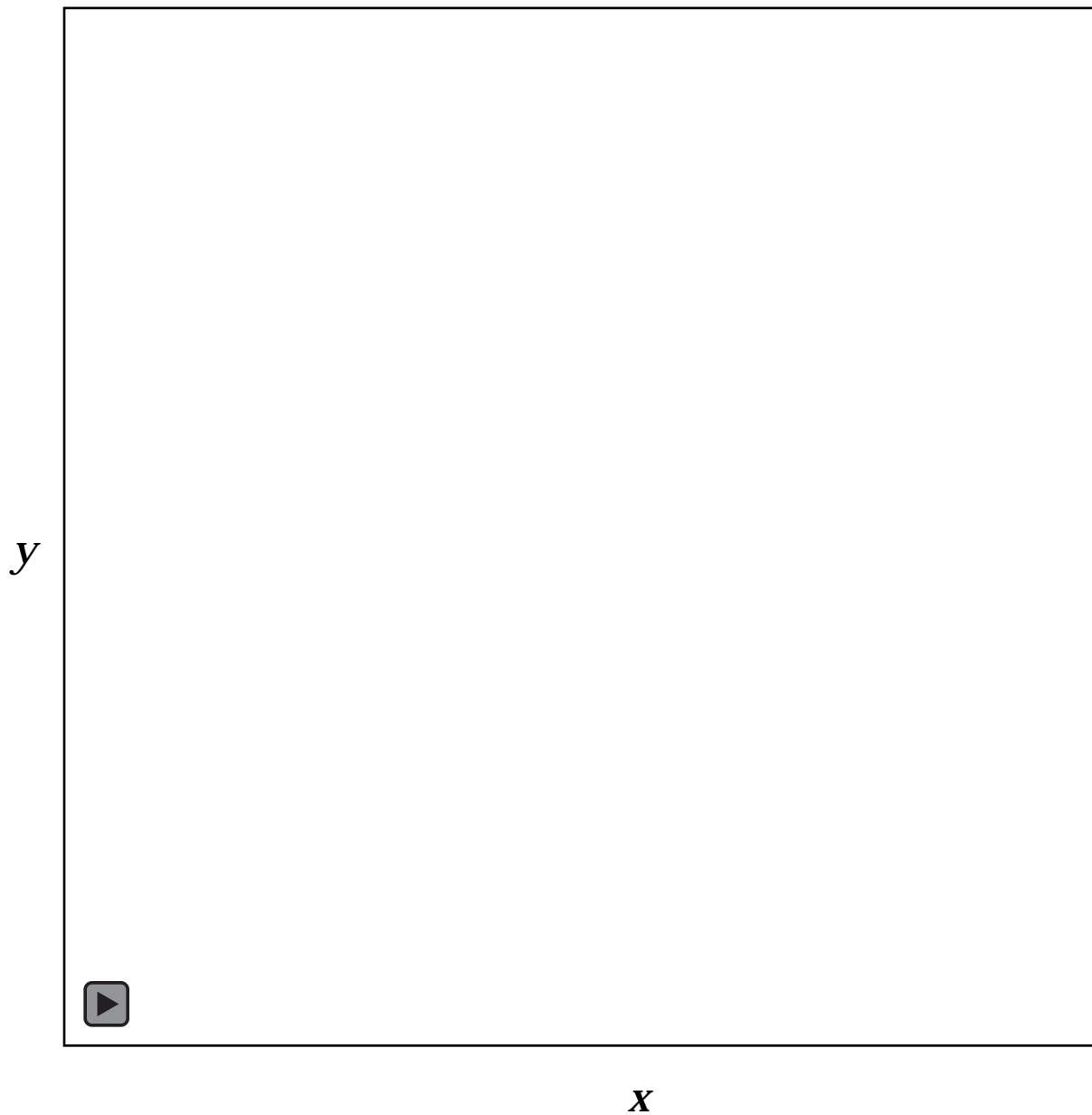


$$\langle v(0)v(t) \rangle / \langle v(0)v(0) \rangle \propto \exp(-t/\tau)$$



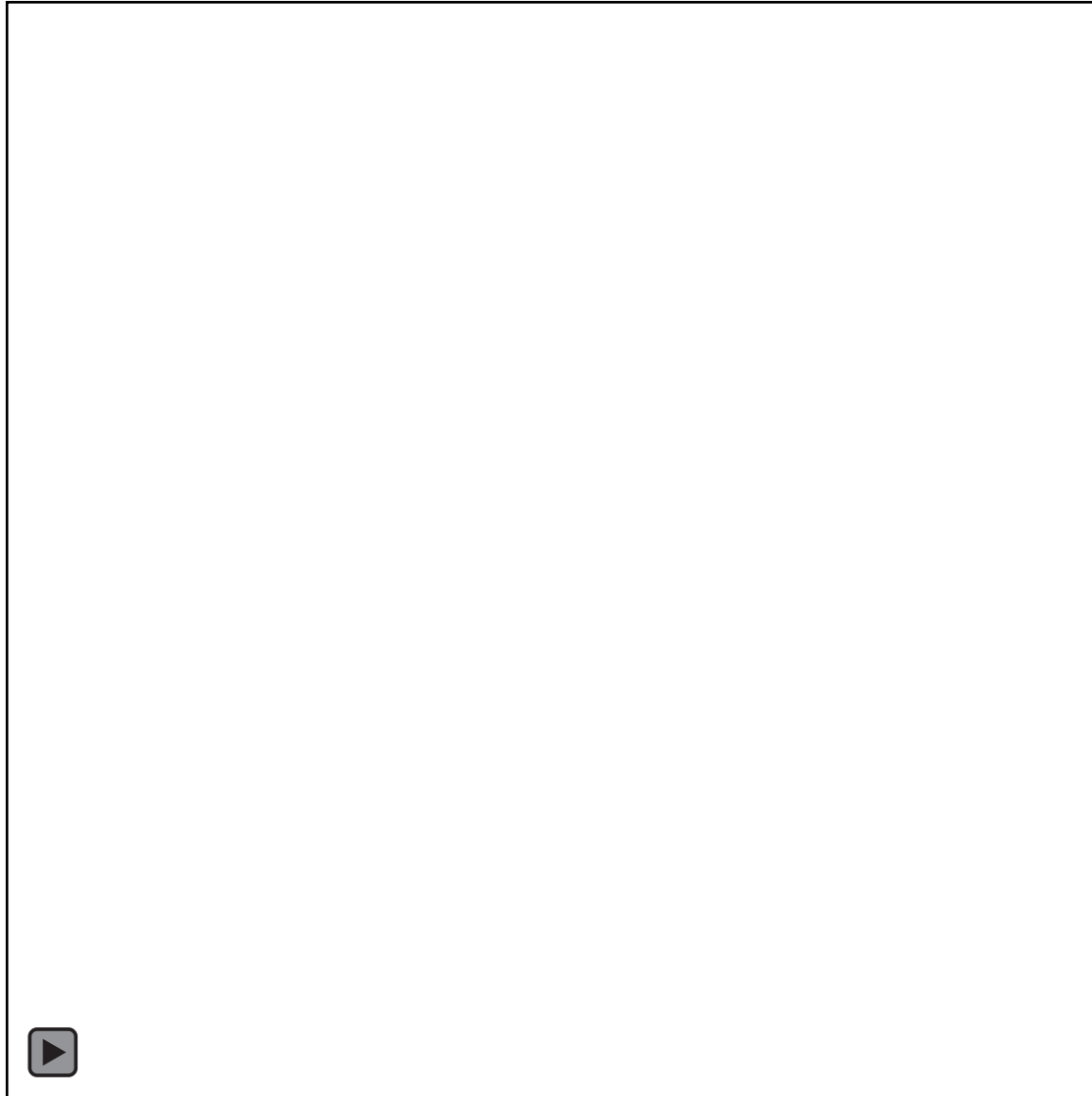
$$\langle (x(t) - x(0))^2 \rangle = (2Mt/\gamma) [t - (m/\gamma) \exp(-\gamma t/m)]$$

2次元での数値計算



軌跡を残すと

y



x