

2009.10.27
物性物理学C

ランダムウォークとブラウン運動

ブラウン運動

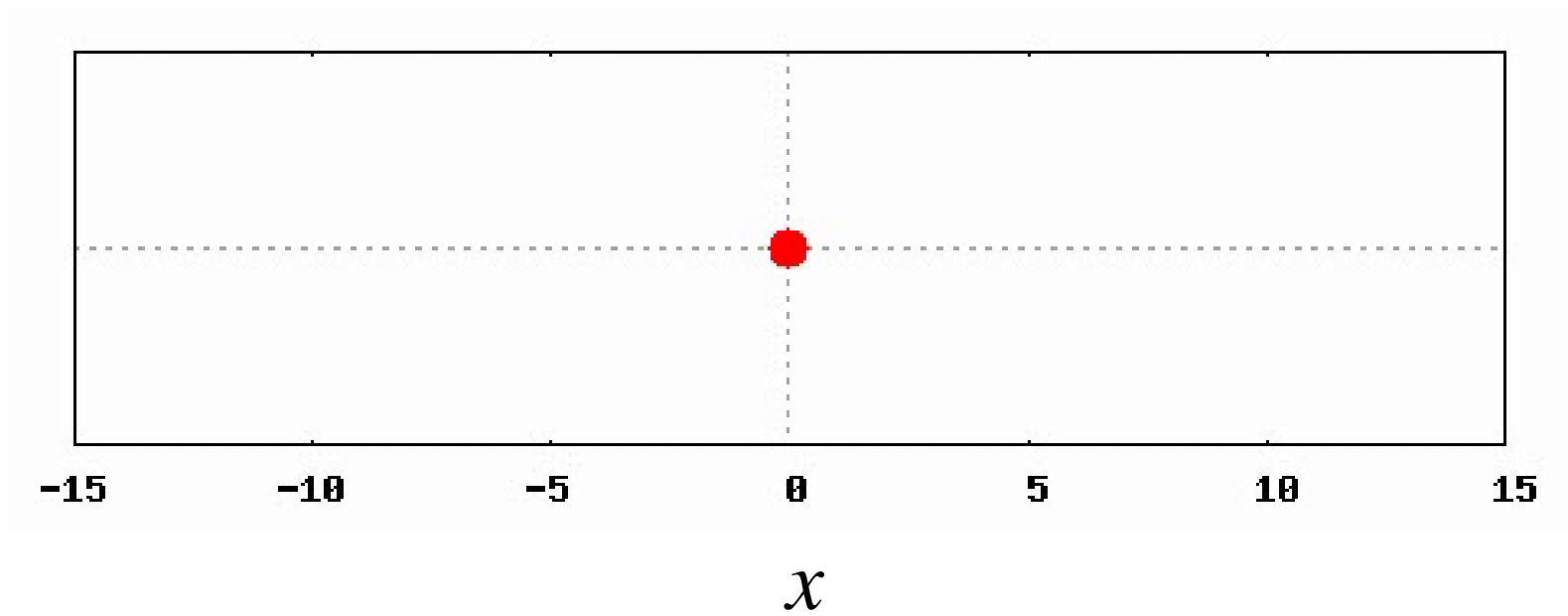
著作権の関係上、ブラウン運動の実験の動画を公開できません。見たい人は直接北畑までお願いします。

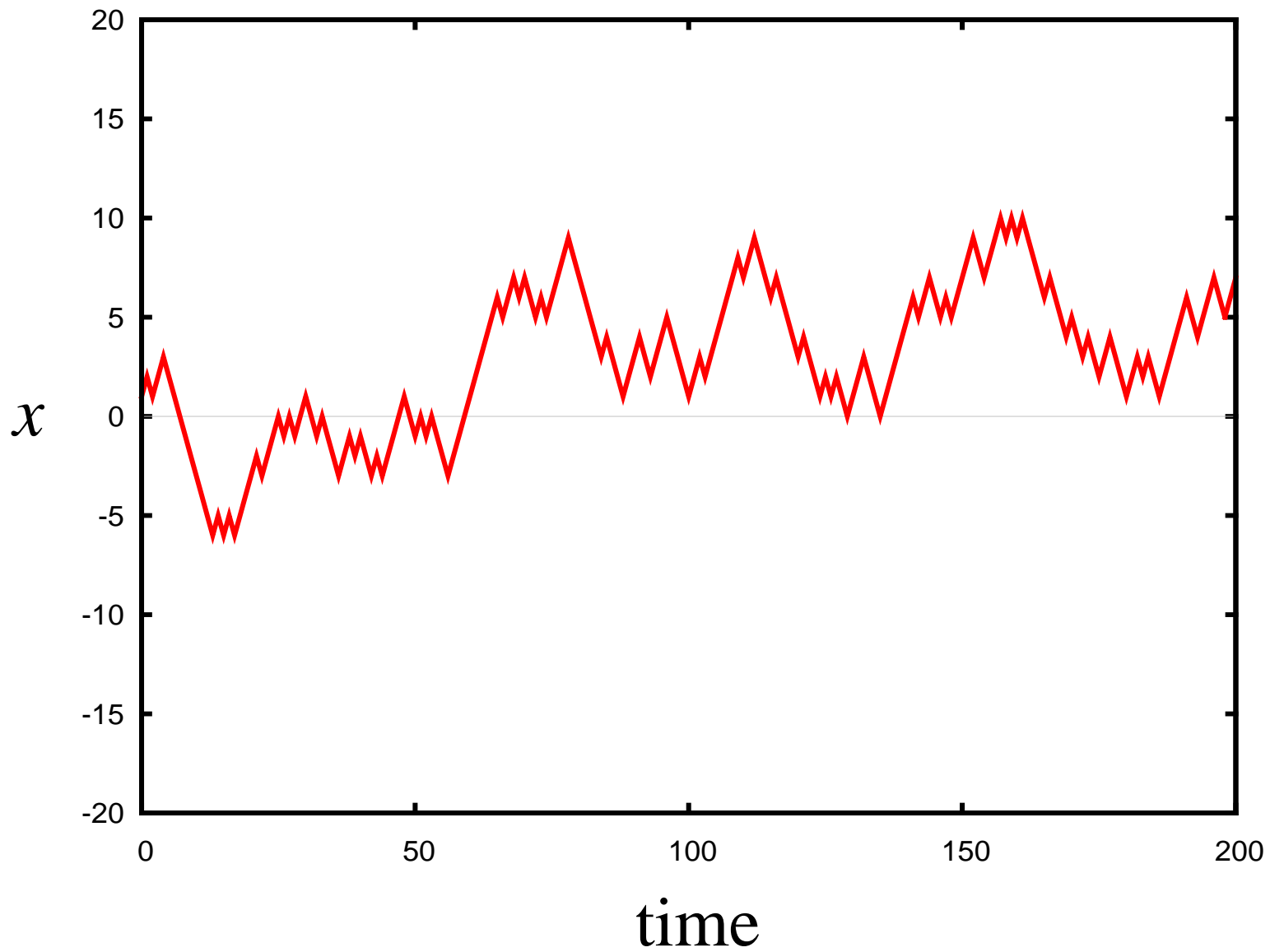
ランダムウォーク

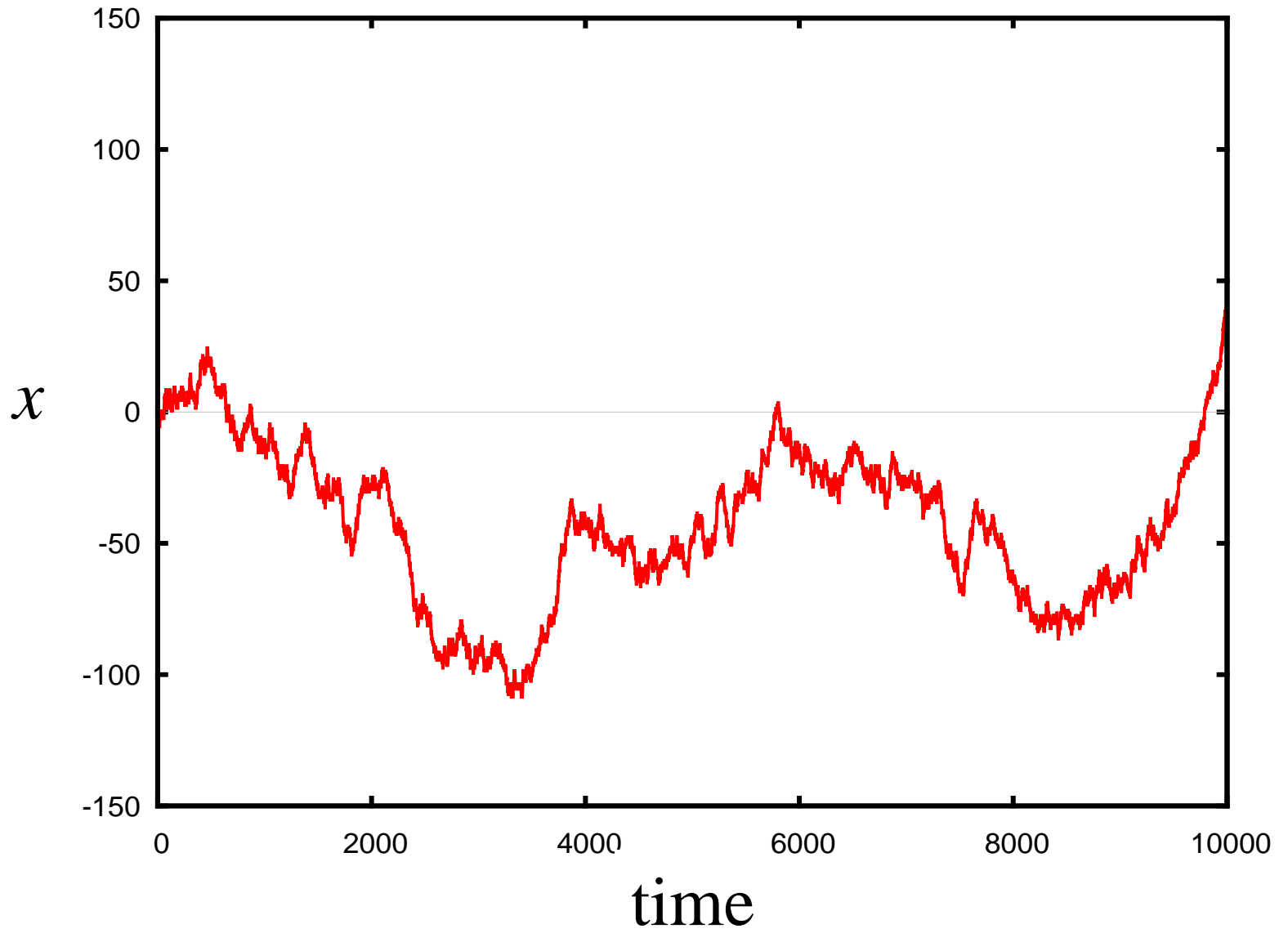
$$x_{i+1} = x_i + \xi_i$$

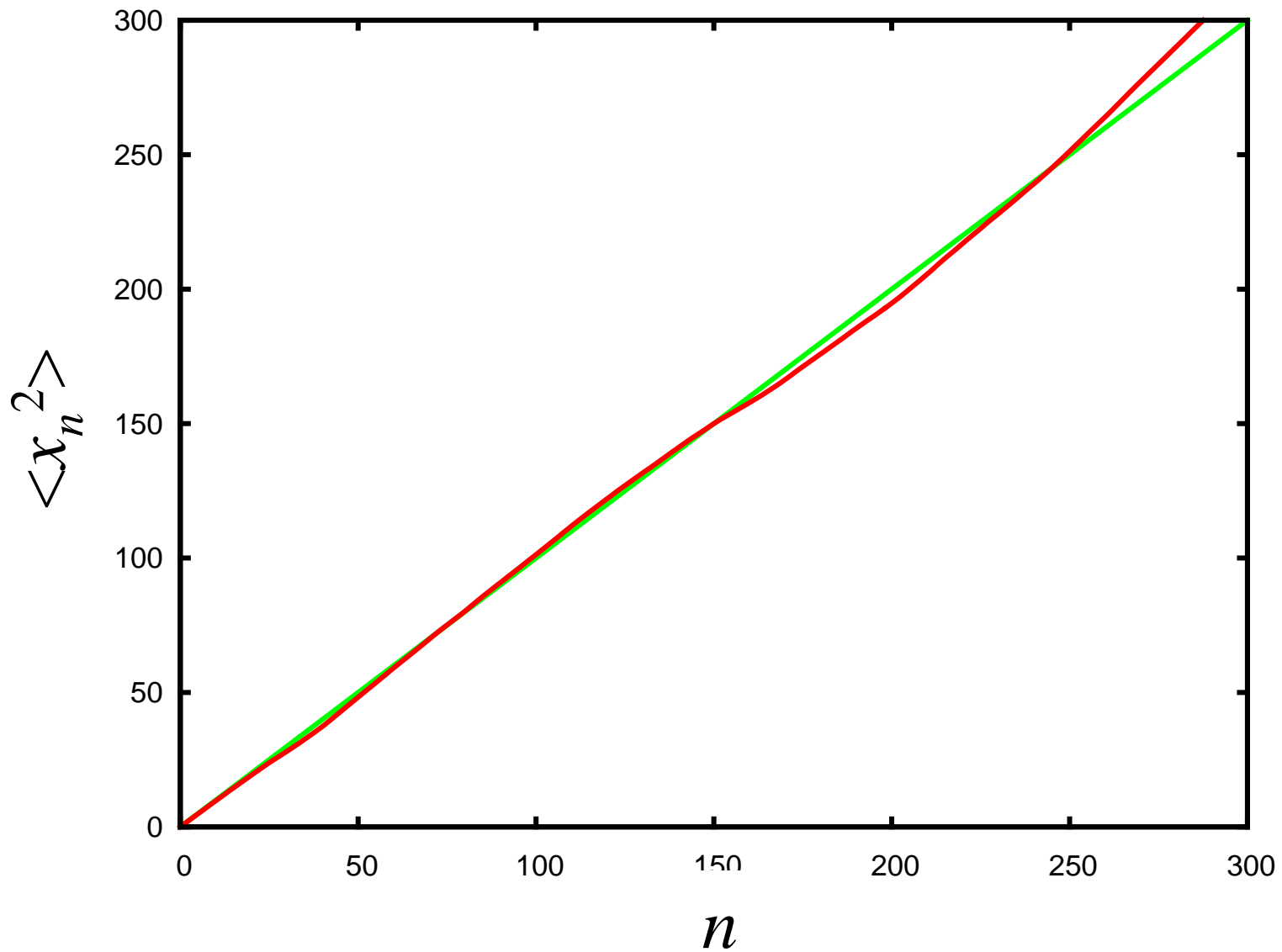
$$\xi_i = \begin{cases} 1 & (\text{Prob. } 1/2) \\ -1 & (\text{Prob. } 1/2) \end{cases}$$

$$\langle \xi_i \xi_j \rangle = \delta_{ij}$$









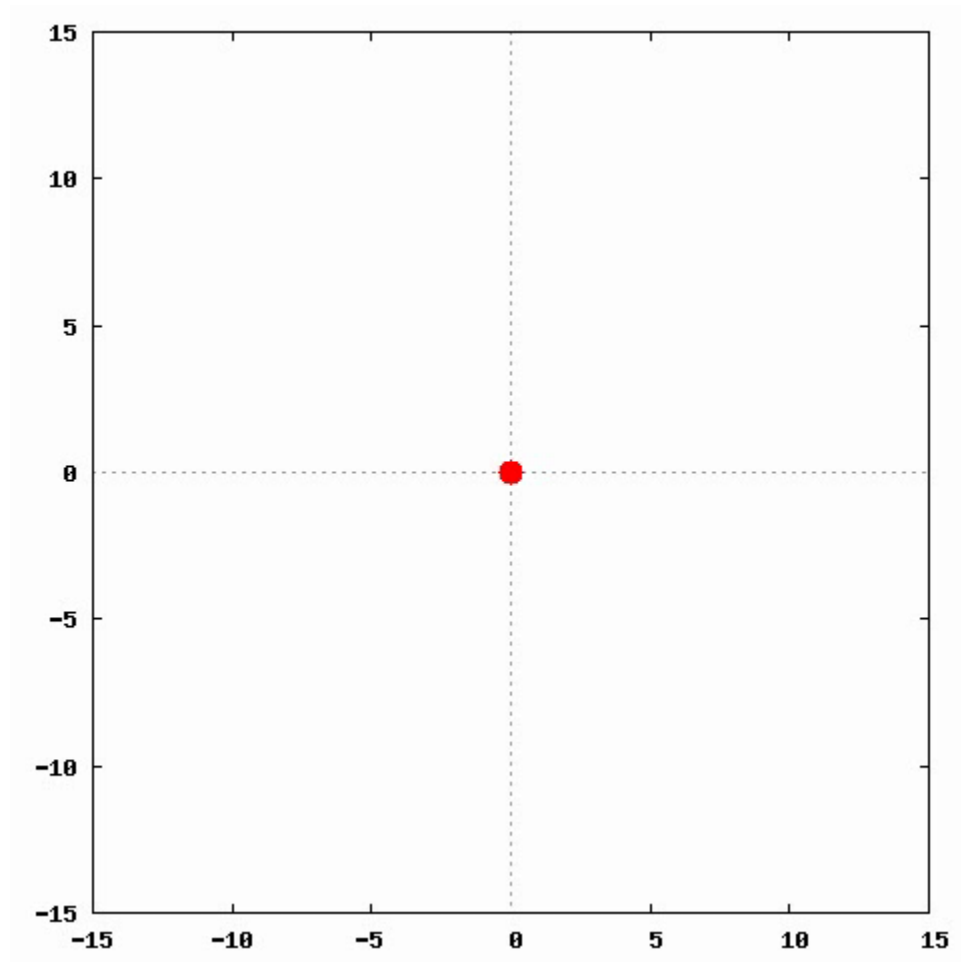
$$\begin{aligned}\langle x_n^2 \rangle &= \left\langle \left[\sum_{k=0}^{n-1} \xi_k \right]^2 \right\rangle \\ &= \left\langle \sum_{k=0}^{n-1} \sum_{k'=0}^{n-1} \xi_k \xi_{k'} \right\rangle \\ &= \sum_{k=0}^{n-1} \sum_{k'=0}^{n-1} \langle \xi_k \xi_{k'} \rangle \\ &= \sum_{k=0}^{n-1} \sum_{k'=0}^{n-1} \delta_{kk'} \\ &= n\end{aligned}$$

2次元の場合

$$\mathbf{r}_{i+1} = \mathbf{r}_i + \boldsymbol{\xi}_i \quad \mathbf{r}_i = (x_i, y_i)$$

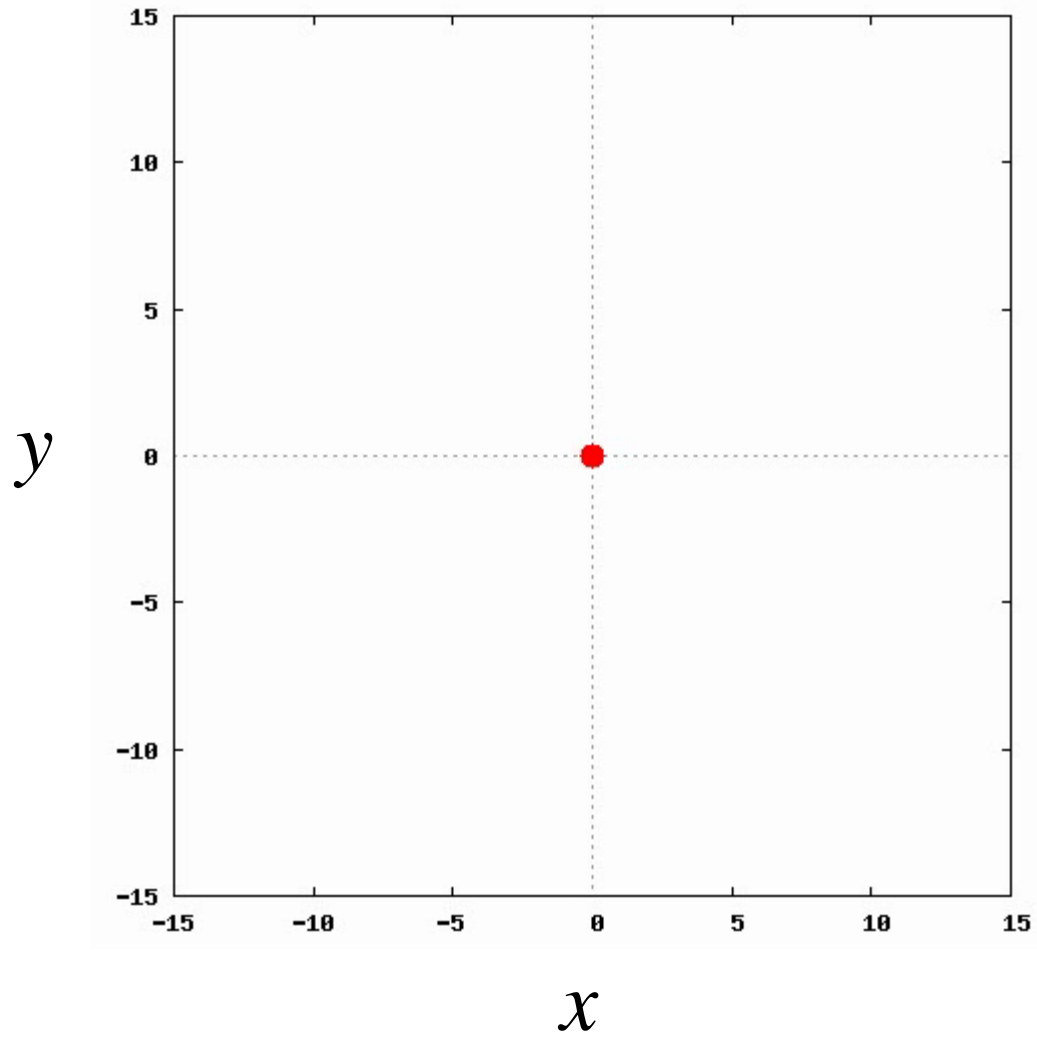
$$\boldsymbol{\xi}_i = \begin{cases} (1, 0) & (\text{Prob. } 1/4) \\ (-1, 0) & (\text{Prob. } 1/4) \\ (0, 1) & (\text{Prob. } 1/4) \\ (0, -1) & (\text{Prob. } 1/4) \end{cases}$$

$$\langle \boldsymbol{\xi}_i \cdot \boldsymbol{\xi}_j \rangle = \delta_{ij}$$

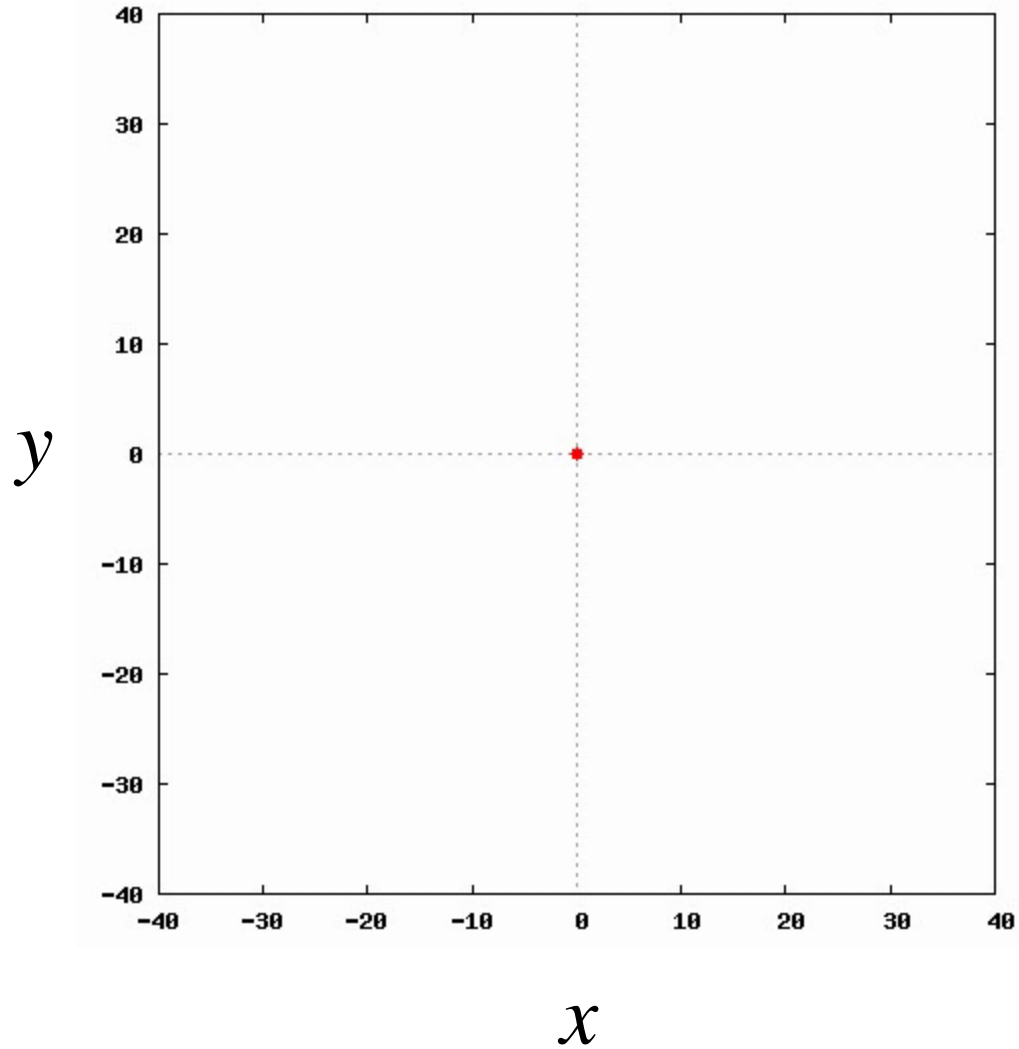


x

y



100個の粒子



1000個の粒子

