Controlling particle currents with evaporation and resetting from an interval

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[1] Phys. Rev. Research **2**, 043138

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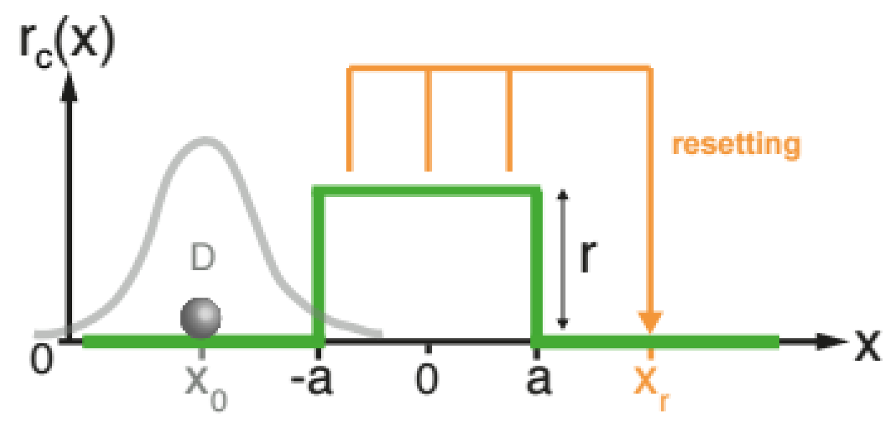
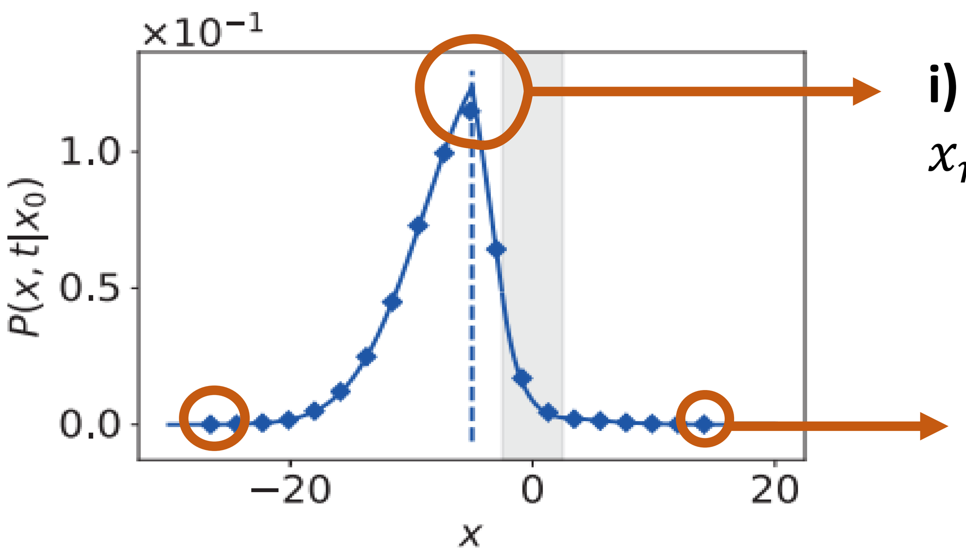
Stochastic resetting from an interval

Model: one dimensional Brownian motion resetting at space dependent rate $r_c(x) = r\theta(a-|x|)$ to a prescribed resetting point x_r.



Master Equation: $\partial_t P(x,t|x_0) =$
$D\partial_x^2 P(x,t|x_0) - r_c(x)P(x,t|x_0) + \delta(x-x_r)\int dy\ r_c(y)P(y,t|x_0).$

DIFFUSION — LOSS DUE TO RESETTING — GAIN DUE TO RESETTING



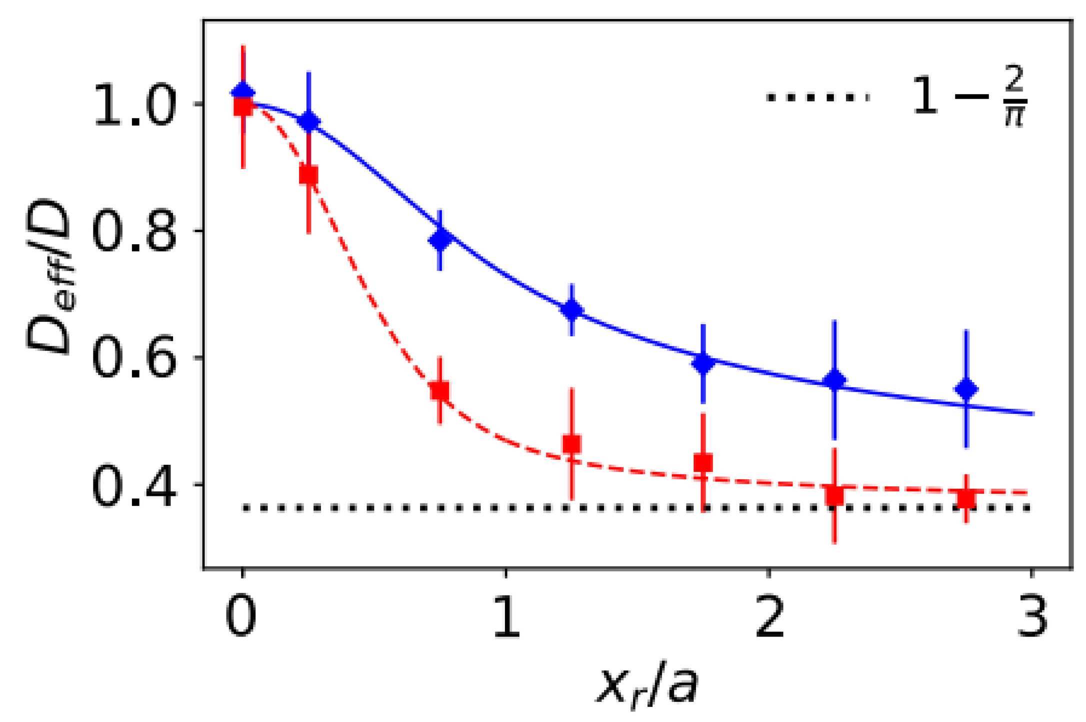
i) Resetting induces a **cusp** at x_r at all times

ii) Diffusion is responsible for **Gaussian tails**

Brownian yet non-Gaussian: non-Gaussian distribution but

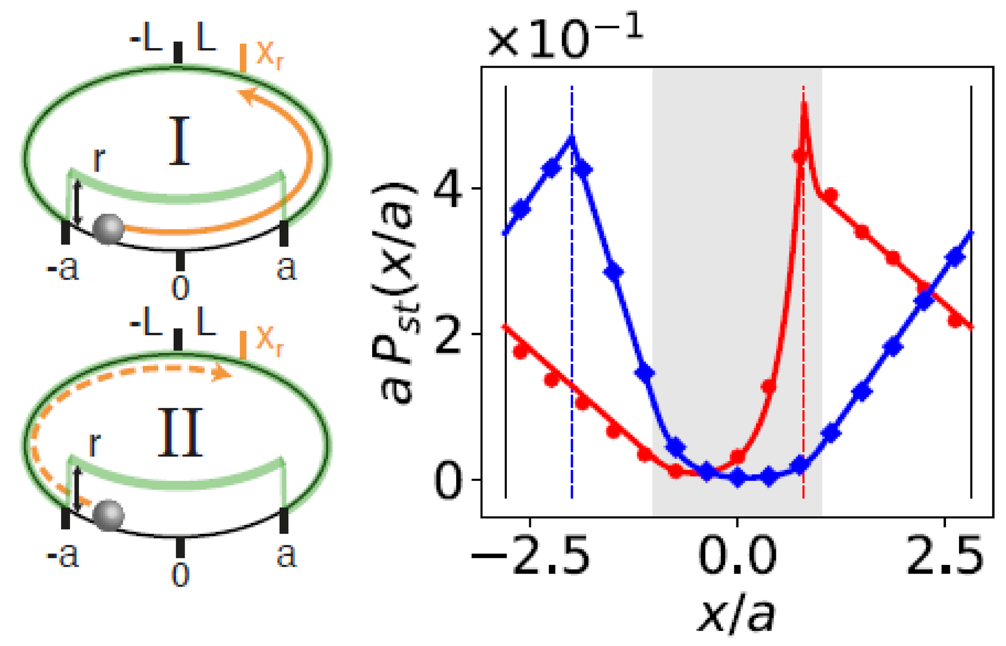
ii) $\sigma^2(t) \simeq D_{eff}\, t$ for $t \gg 1$, with

i) $1 - \frac{2}{\pi} < \frac{D_{eff}}{D} \leq 1.$



Resetting on a ring

Model: Brownian particle resetting at space dependent rate $r_c(x)$ on $(-L, L)$ with periodic boundary conditions; this ensures the existence of a **stationary state**.



Particles can reset both clockwise and conterclockwise: this is fixed by a **protocol.**

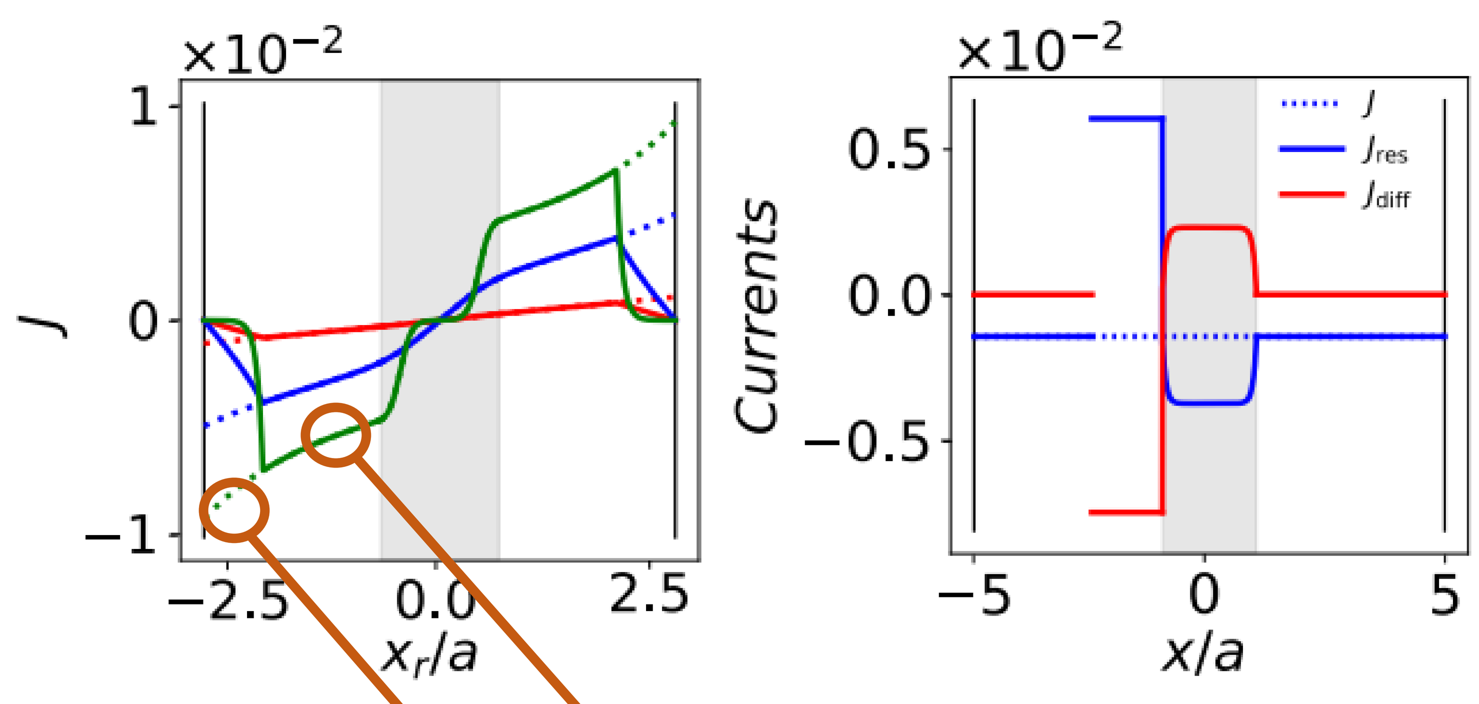
Resetting is **instantaneous**

Infinite possible particle currents

Only one $P(x,t|x_0)$

GAUGE INVARIANCE

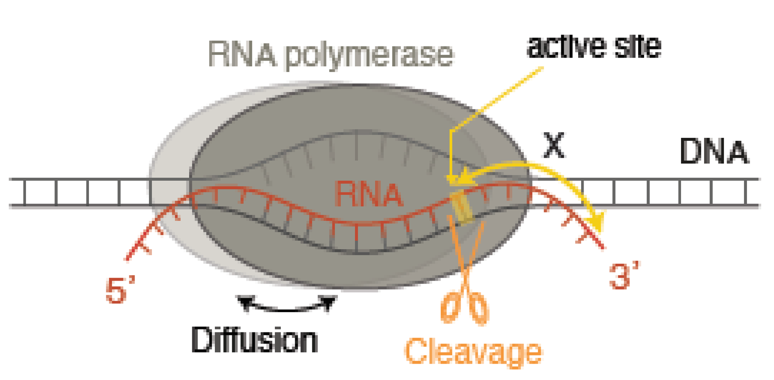
The total current J is composed by two contributions
i) J_{diff} **independent** of the protocol;
ii) J_{res} **dependent** of the protocol.

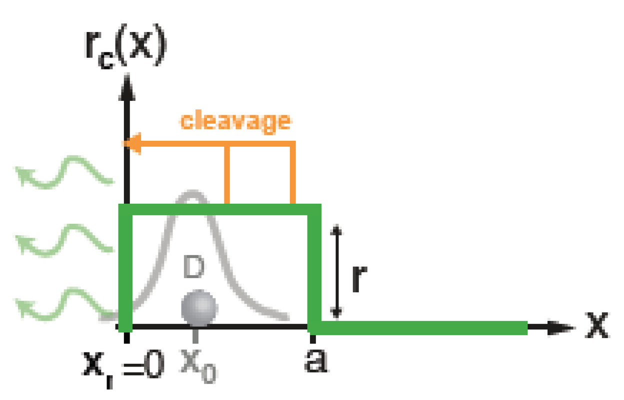


Minimal path protocol

$J_{res}(\pm L) = 0$ *protocol*

Application: Modelling backtrack recovery of RNA polymerase





RNA polymerases along a DNA template during transcriptional pauses. Two recovery mechanisms from the inactive state ("backtracking"): **i)** Brownian diffusion, and **ii)** active **cleavage** of the backtracked RNA. **Model :** evolution of the backtrack depth $x \geq 0$, **i)** diffusion in d = 1 starting from $x_0 > 0$ with an absorbing boundary in the origin, **ii)** resetting of the backtrack depth $x \rightarrow x_r = 0$ at a rate r from the region $(0, a)$.

distribution

Distribution of the length of cleaved RNA

$$Q_{res}(x = ay|x_0 = ay_0)$$
$$= \rho\frac{\sinh(y_<\rho)}{a\cosh\rho}\{1 - \theta(1-y_0)[1-\cosh((1-y_>)\rho)]\}$$

Cleavage efficiency

$$\eta_{res}(y_0) \equiv \eta(x_0 = ay_0)$$
$$= 1 - \frac{\cosh((1-y_0)\rho) + \theta(y_0-1)[1+\cosh((1-y_0)\rho)]}{\cosh\rho}$$

with $\rho = a\sqrt{r/D}, y_< = \min(y, y_0)$, and $y_> = \max(y, y_0)$.