Differentiating velocity with respect to time allows for autocorrelation in time and spatially-varying drift in the model.

### (Continuous Time Correlated Random Walk, Johnson et al. 2008)

At time t and location  $\{X(t), Y(t)\}'$ ,

 $dv_{x}(t)$ 

 $dv_{v}(t)$ 

 $\begin{vmatrix} (\mu_{x} - v_{x}(t)) \\ (\mu_{y} - v_{y}(t)) \end{vmatrix}$ 



#### Mean drift



## Instantaneous velocity at time t (damping force)



#### Controls autocorrelation



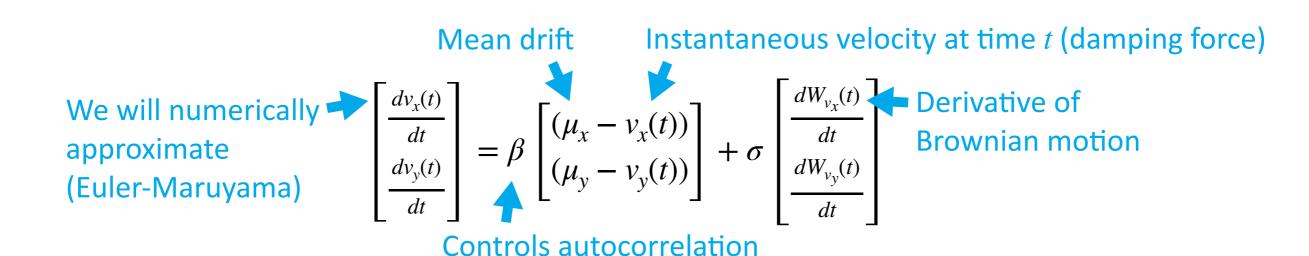
## Derivative of **Brownian motion**



## We will numerically approximate (Euler-Maruyama)

Differentiating velocity with respect to time allows for autocorrelation in time and spatially-varying drift in the model.

At time t and location  $\{X(t), Y(t)\}'$ ,



# How can we understand this equation?

$$\begin{bmatrix} \frac{dv_{x}(t)}{dt} \\ \frac{dv_{y}(t)}{dt} \end{bmatrix} = \beta \begin{bmatrix} (\mu_{x} - v_{x}(t)) \\ (\mu_{y} - v_{y}(t)) \end{bmatrix} + \sigma \begin{bmatrix} \frac{dW_{v_{x}}(t)}{dt} \\ \frac{dW_{v_{y}}(t)}{dt} \end{bmatrix}$$