

$$\dot{\mathbf{x}}_i = \frac{1}{N} \sum_{\substack{j=1 \\ j \neq i}}^N \left[\frac{\mathbf{x}_j - \mathbf{x}_i}{|\mathbf{x}_j - \mathbf{x}_i|} (1 + J \cos(\theta_j - \theta_i)) - \frac{\mathbf{x}_j - \mathbf{x}_i}{|\mathbf{x}_j - \mathbf{x}_i|^2} \right] - F \frac{\mathbf{x}_0 - \mathbf{x}_i}{|\mathbf{x}_0 - \mathbf{x}_i|^2}$$

$$\dot{\theta}_i = \frac{K}{N} \sum_{\substack{j=1 \\ j \neq i}}^N \frac{\sin(\theta_j - \theta_i)}{|\mathbf{x}_j - \mathbf{x}_i|}$$

$$\dot{\mathbf{x}}_0 = v$$