



# What mutations can do other than create genetic diversity

Peter Schuster

Institut für Theoretische Chemie, Universität Wien, Austria

and

The Santa Fe Institute, Santa Fe, New Mexico, USA



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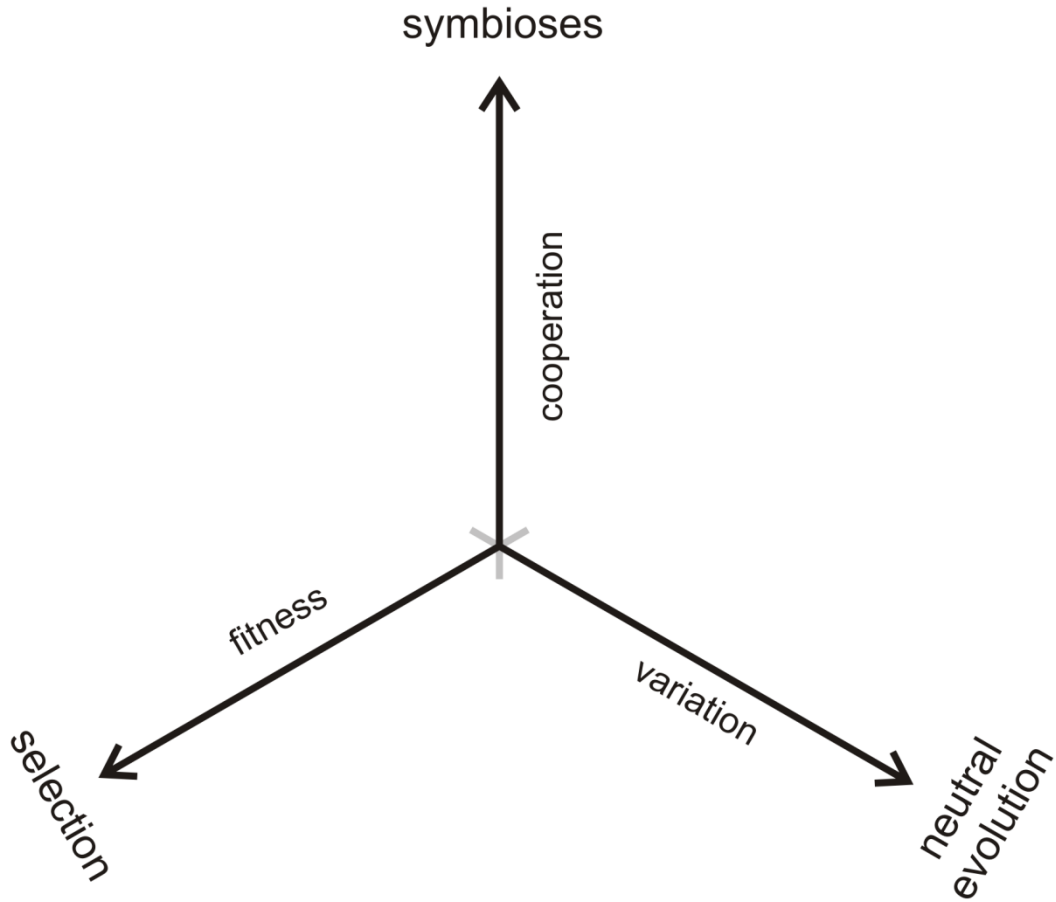
Web-Page for further information:

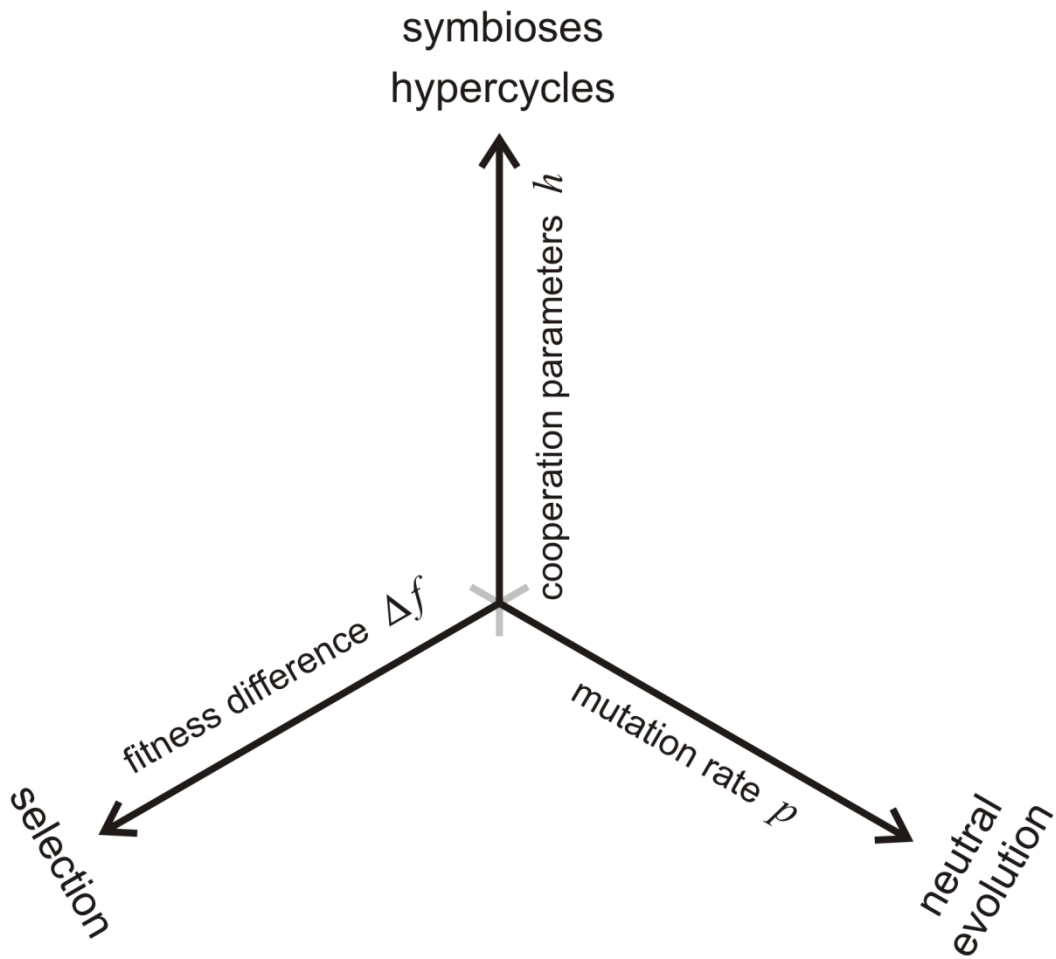
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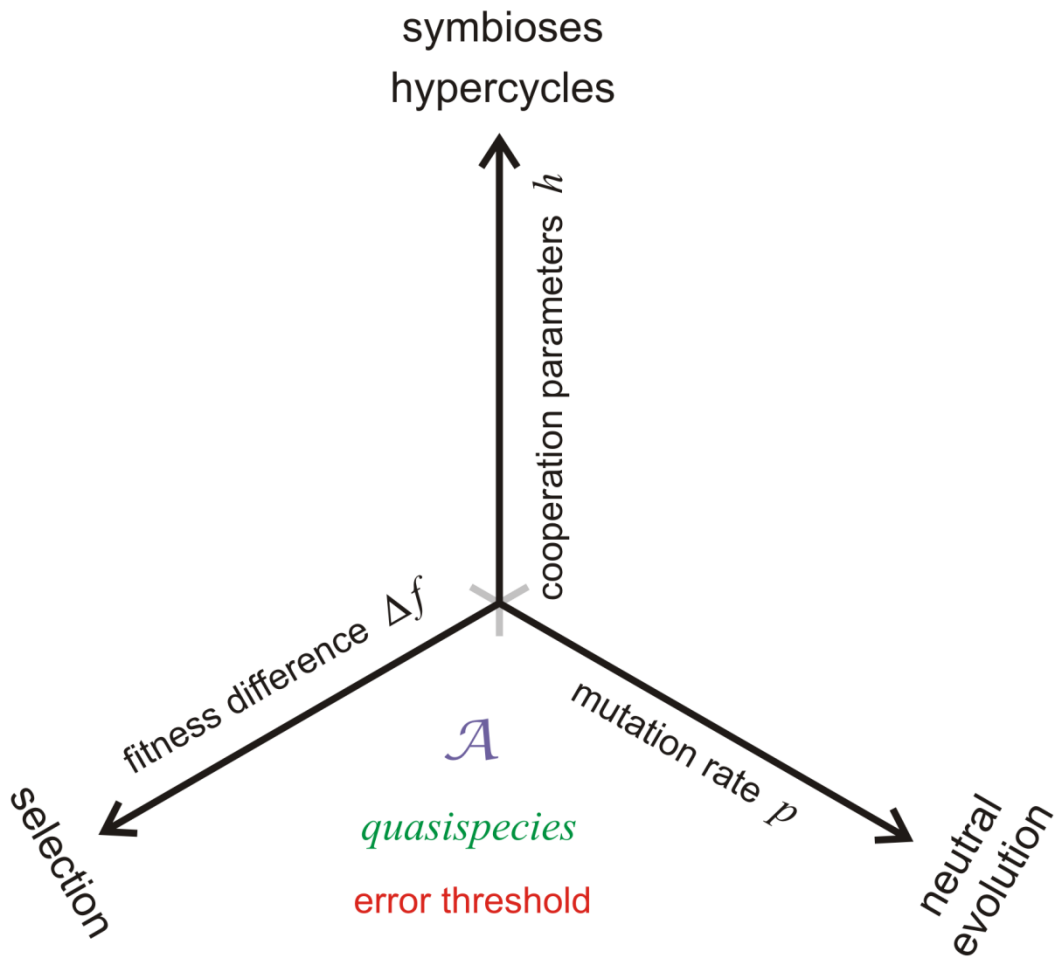
Peter Schuster. Increase in complexity and information through molecular evolution. *Entropy*, in press, 2016

1. A general model for evolution
2. The role of mutation - quasispecies
3. Can mutations counteract extinction ?
4. The case of five species
5. The case of four species
6. Some conclusions

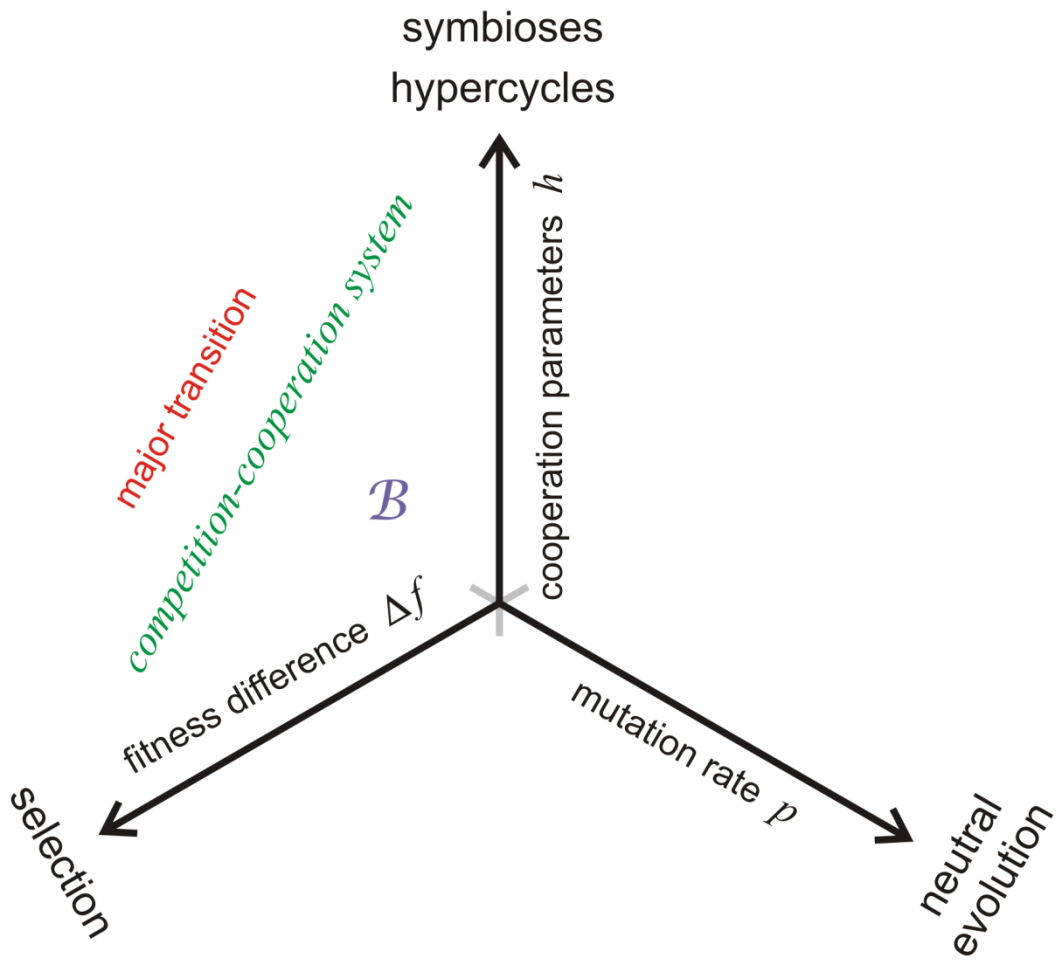
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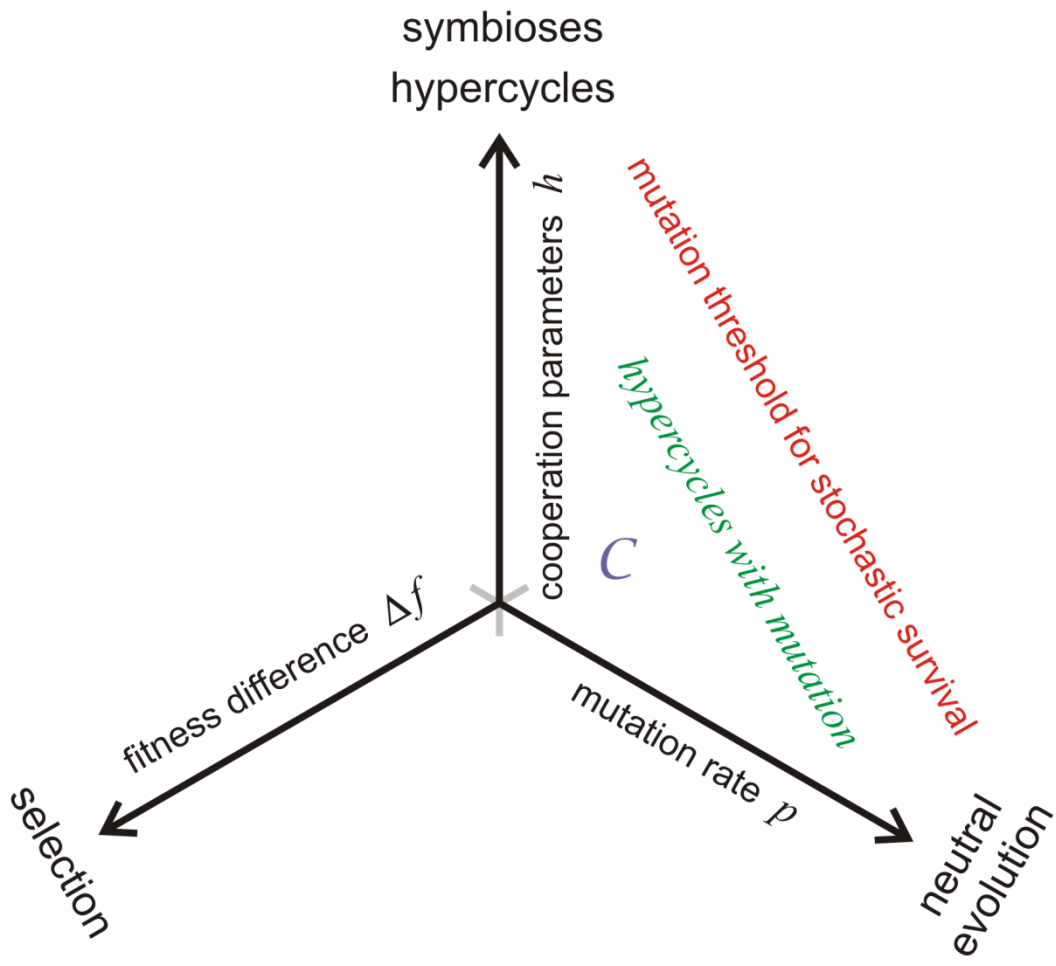


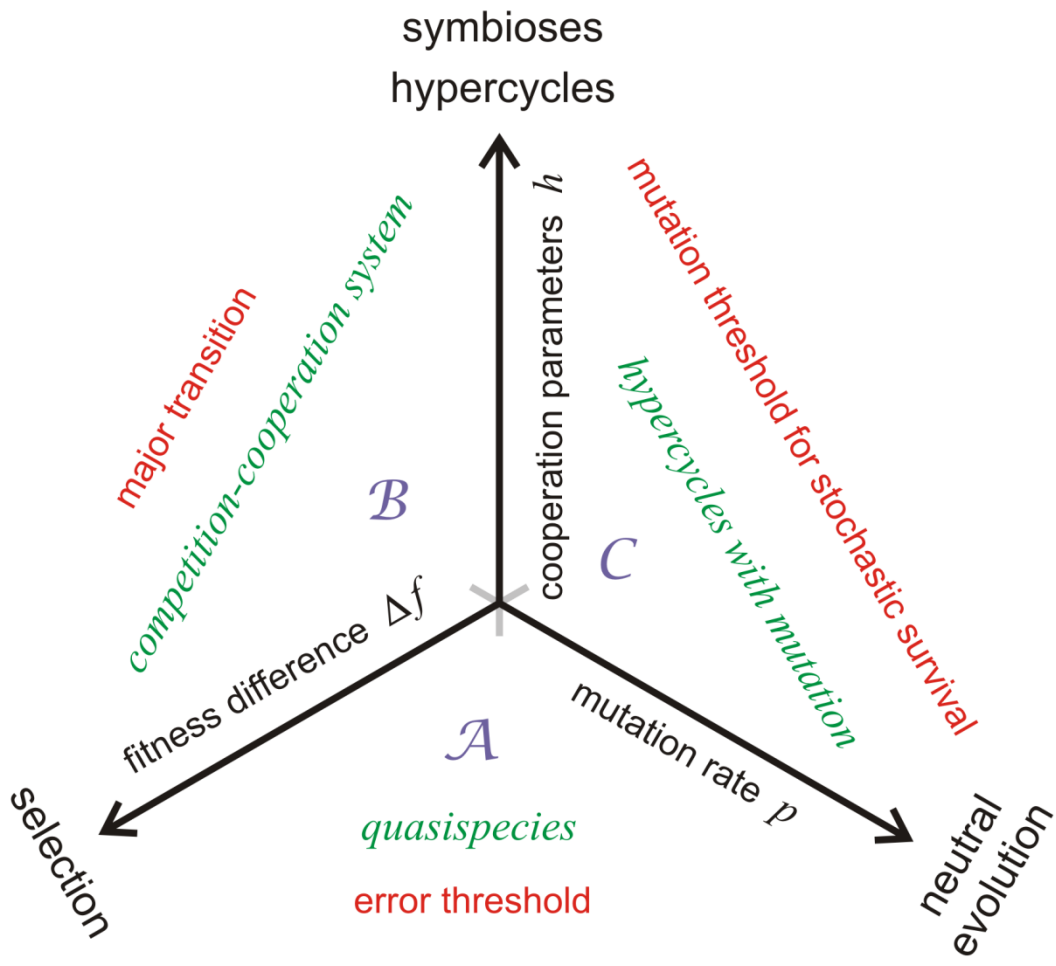


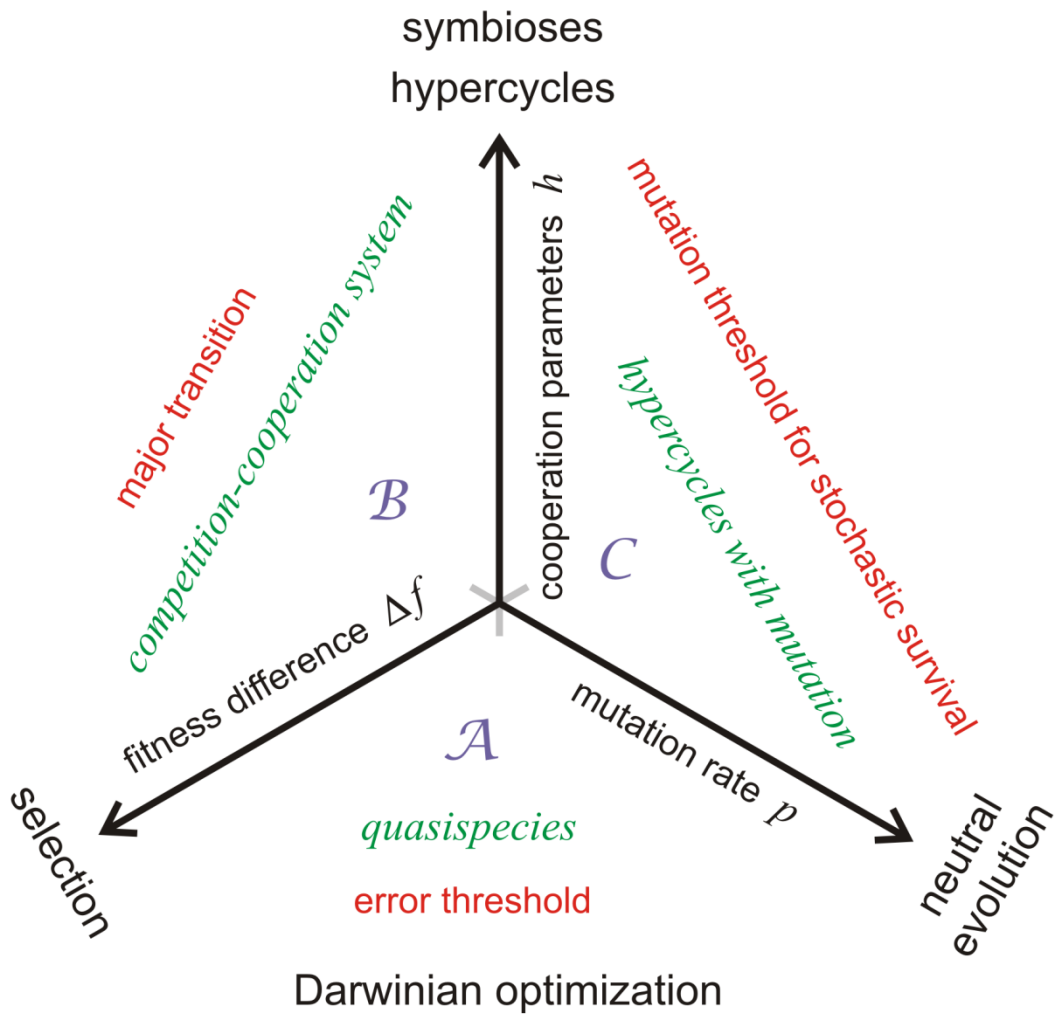


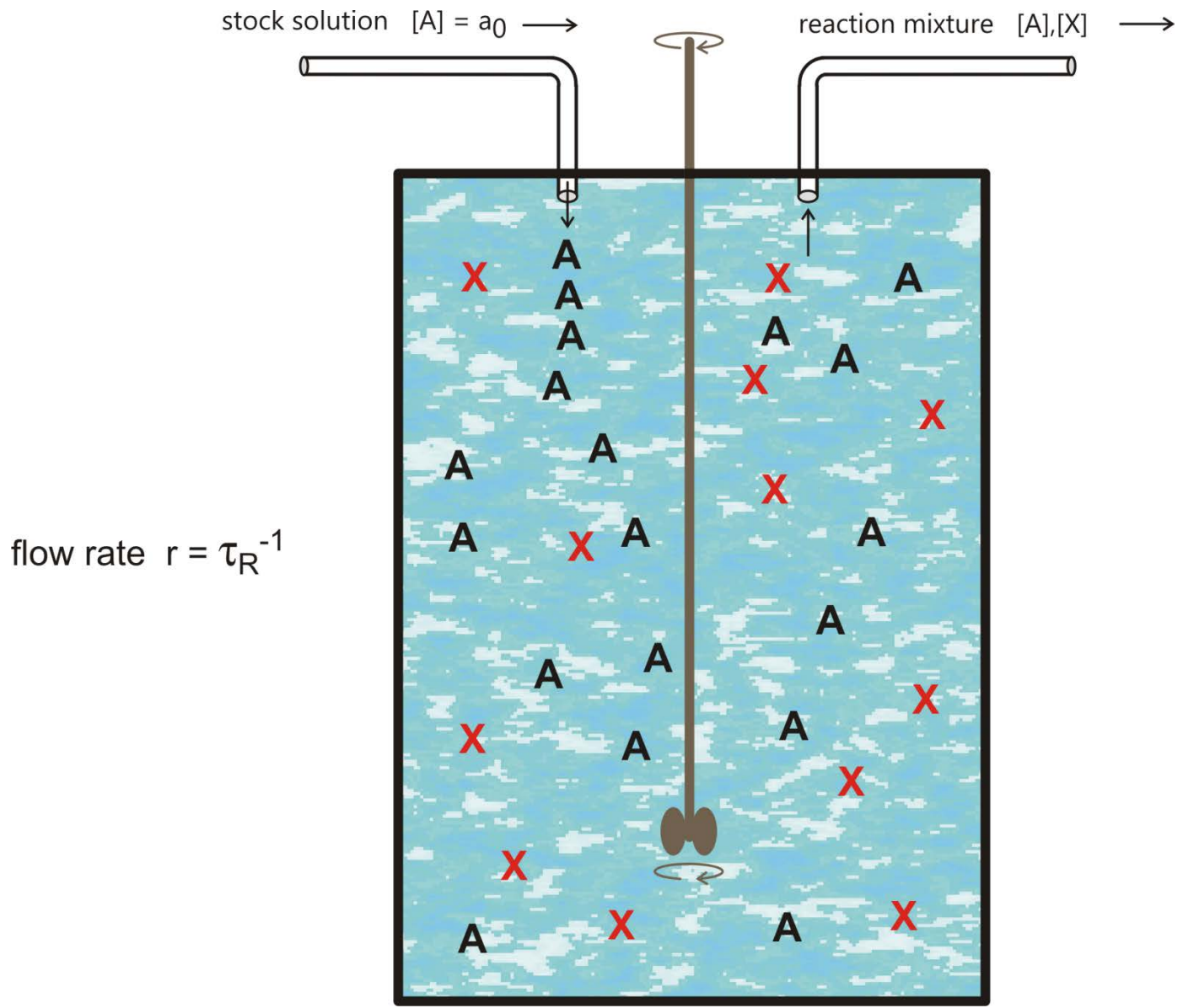






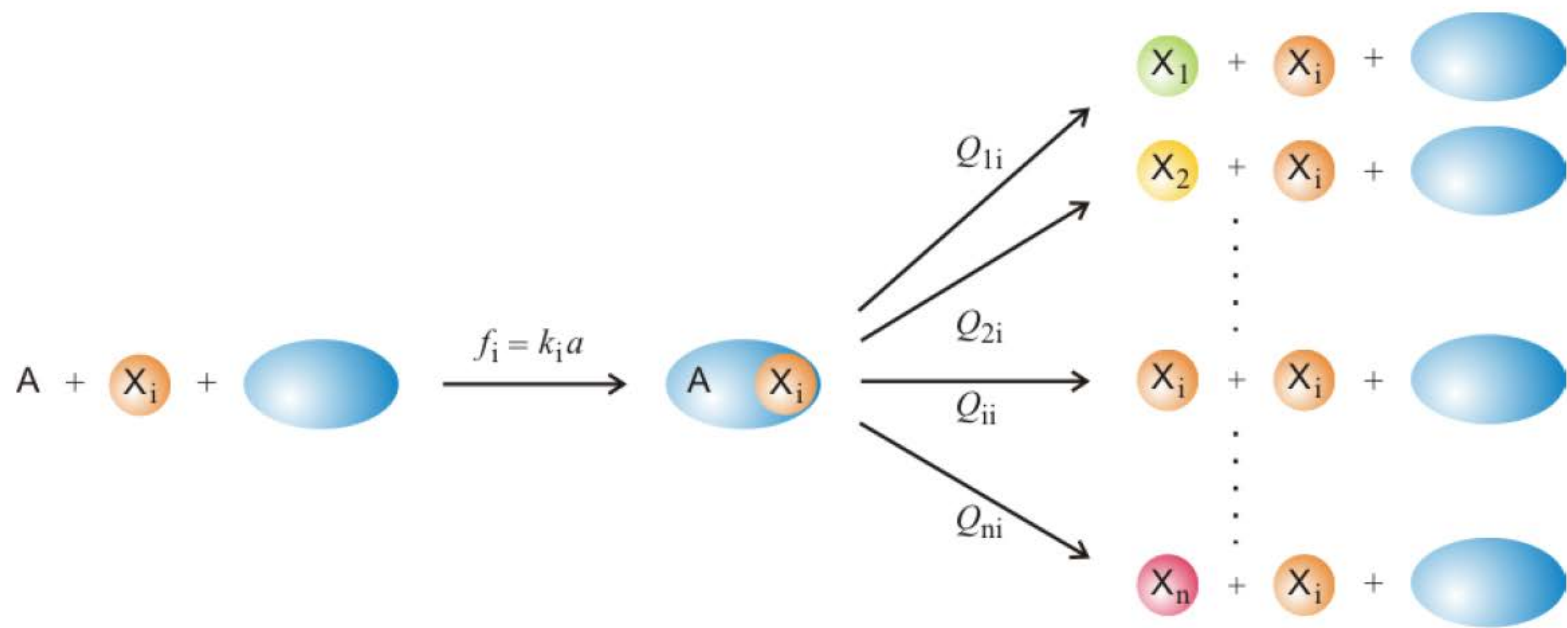






The continuously fed stirred tank reactor (CFSTR)

$$\begin{array}{lcl}
* & \xrightarrow{a_0 r} & A, \\
A + X_i & \xrightarrow{k_i Q_{ji}} & X_i + X_j; \quad i, j = 1, \dots, n, \\
A + X_i + X_{i+1} & \xrightarrow{l_i Q_{ji}} & X_i + X_j + X_{i+1}; \quad i, j = 1, \dots, n; \quad i \bmod n, \\
A & \xrightarrow{r} & \emptyset, \quad \text{and} \\
X_i & \xrightarrow{r} & \emptyset; \quad i = 1, \dots, n.
\end{array}$$



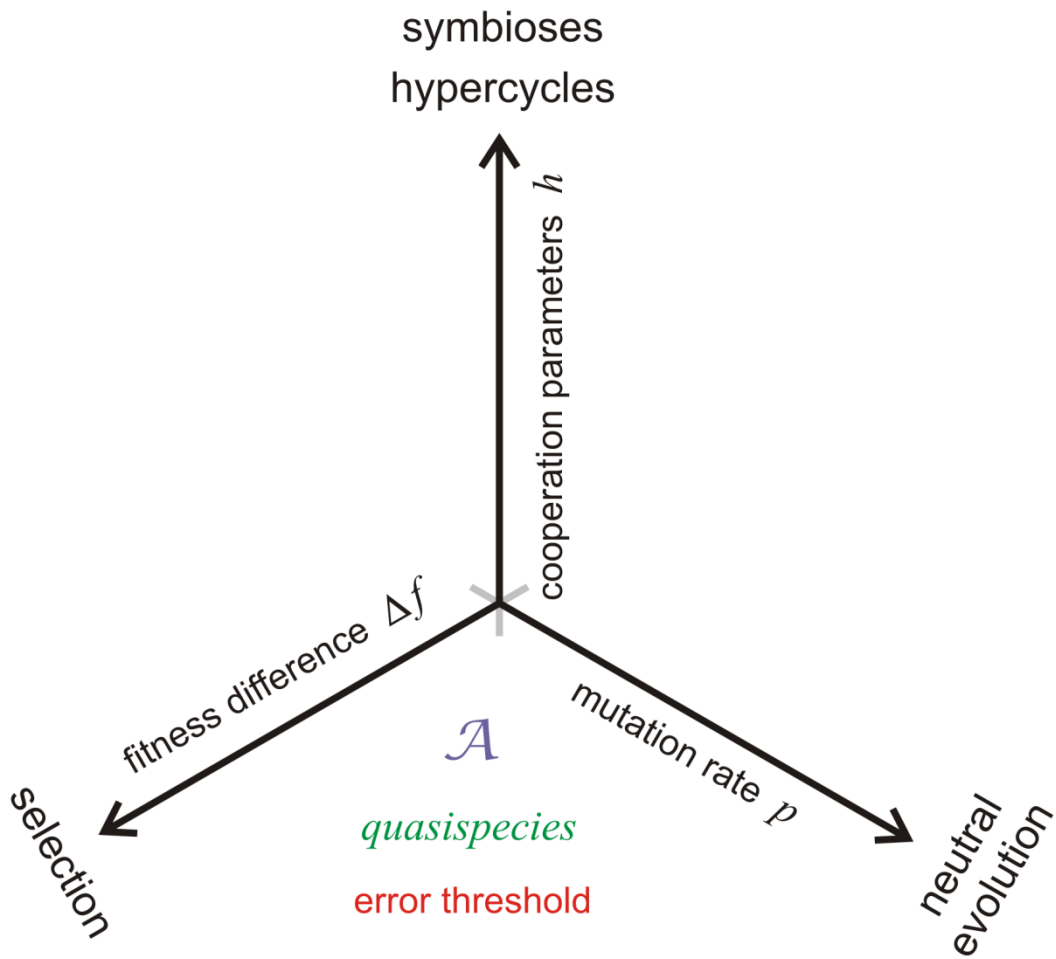
$$\frac{da}{dt} = -a \sum_{j=1}^n x_j (k_j + l_j x_{j+1}) + r (a_0 - a) \text{ and}$$

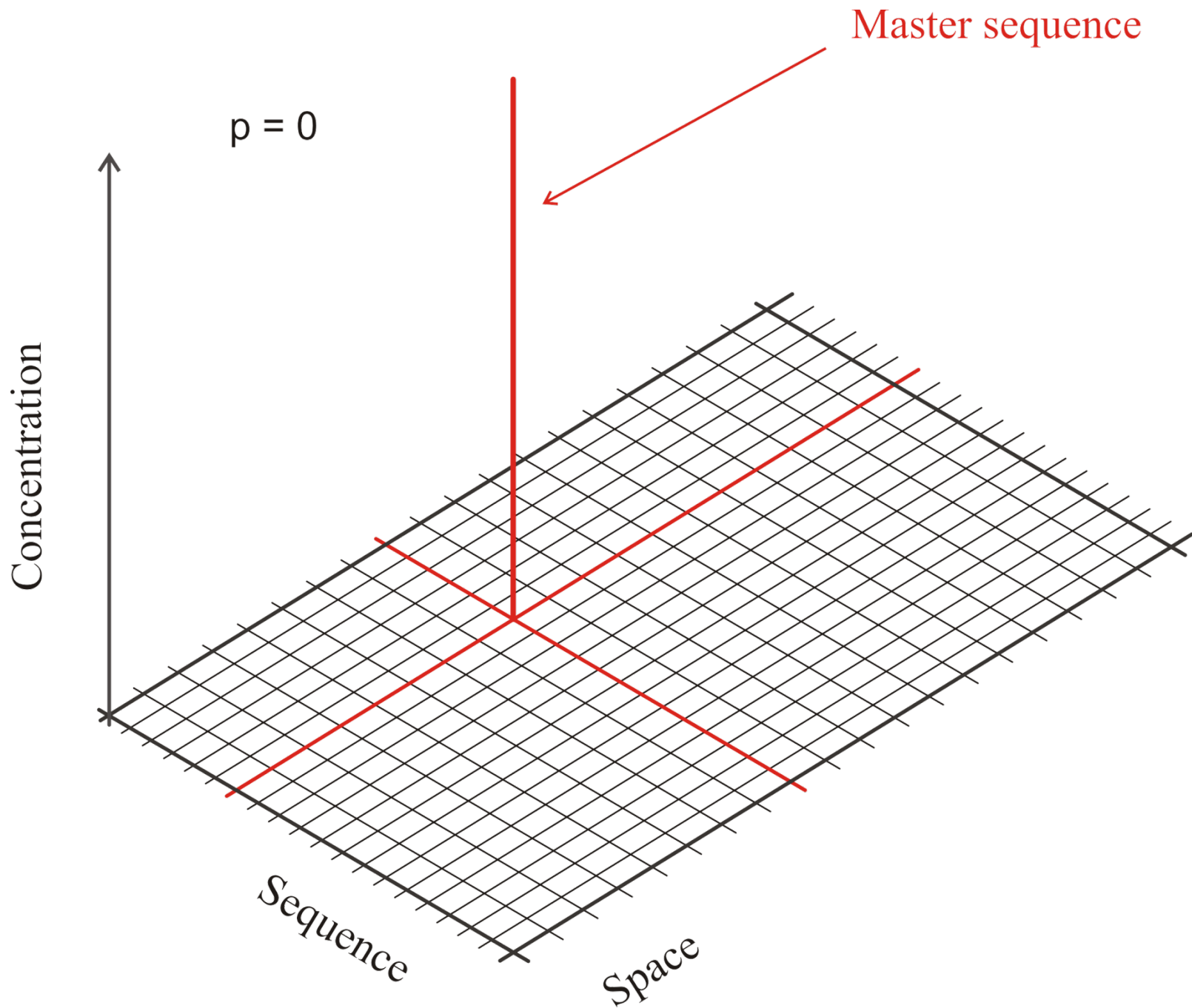
$$\frac{dx_i}{dt} = a \left( \sum_{j=1}^n Q_{ij} (k_j + l_j x_{j+1}) x_j \right) - r x_i; \quad i, j = 1, \dots, n; \quad j \text{ mod } n$$

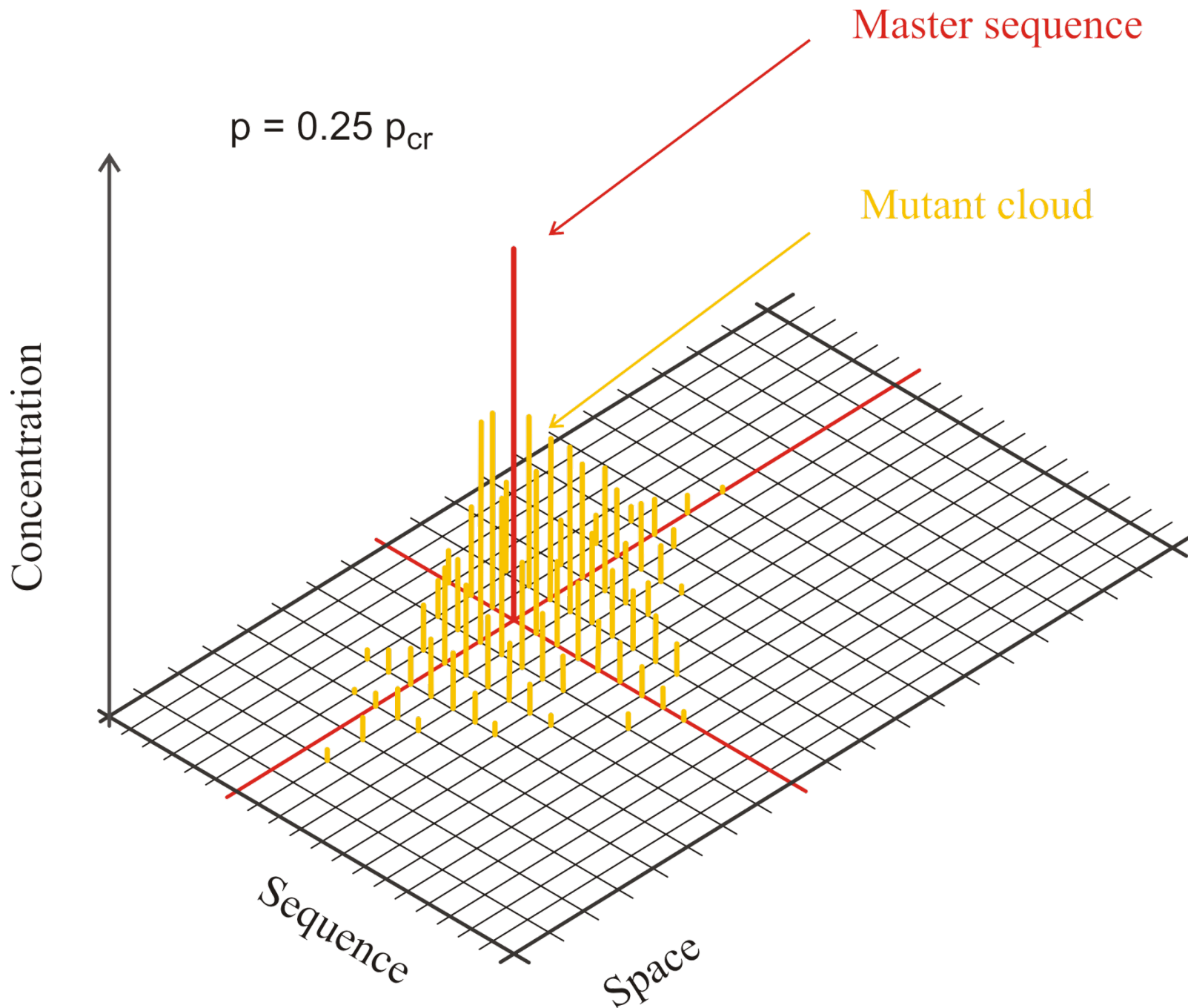
$$Q_{ij}(p) = Q \varepsilon^{d_H(X_i, X_j)} \text{ with } Q = (1 - p)^v = Q_{ii} \forall i = 1, \dots, n \text{ and } \varepsilon = \frac{p}{1 - p}.$$

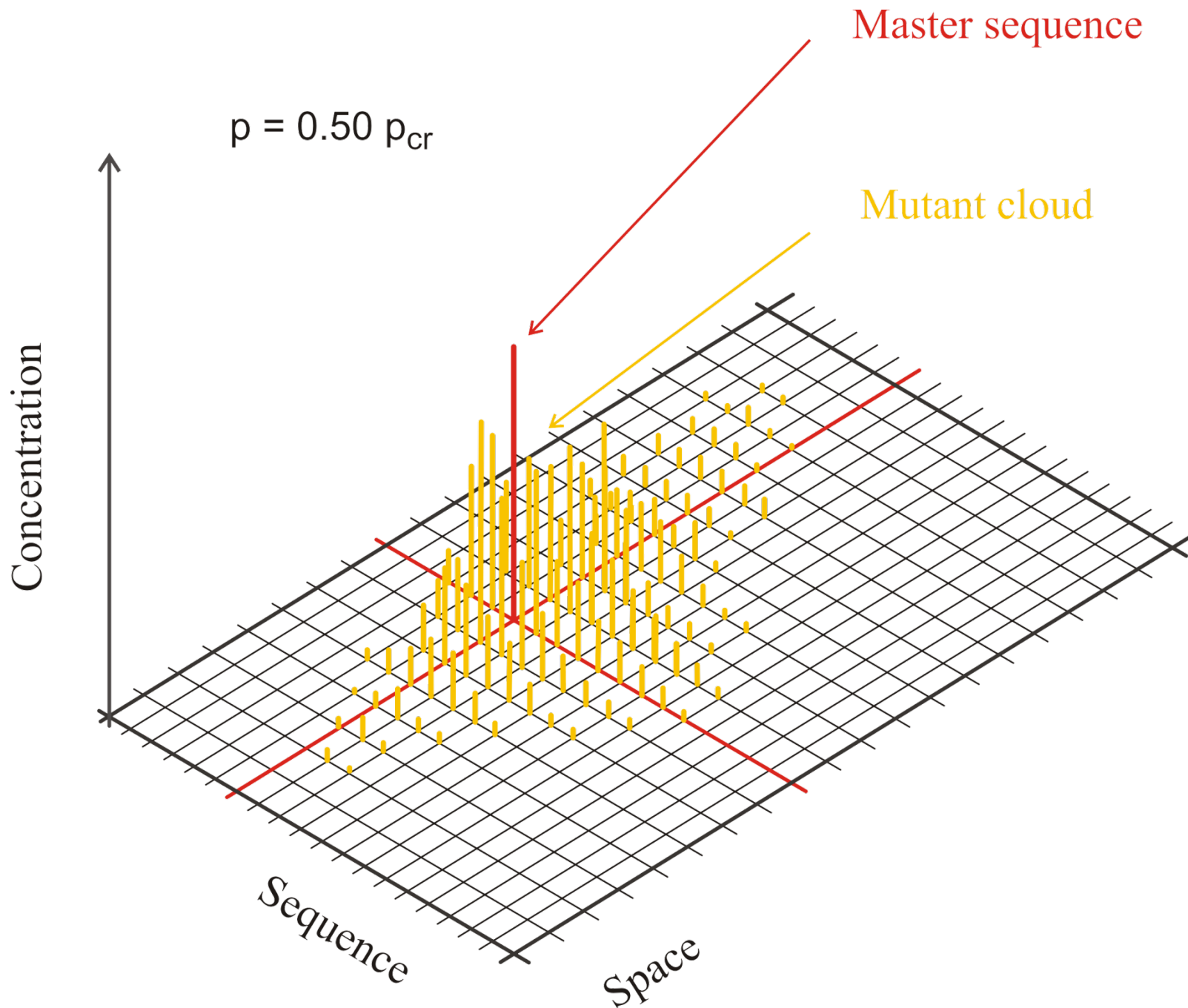


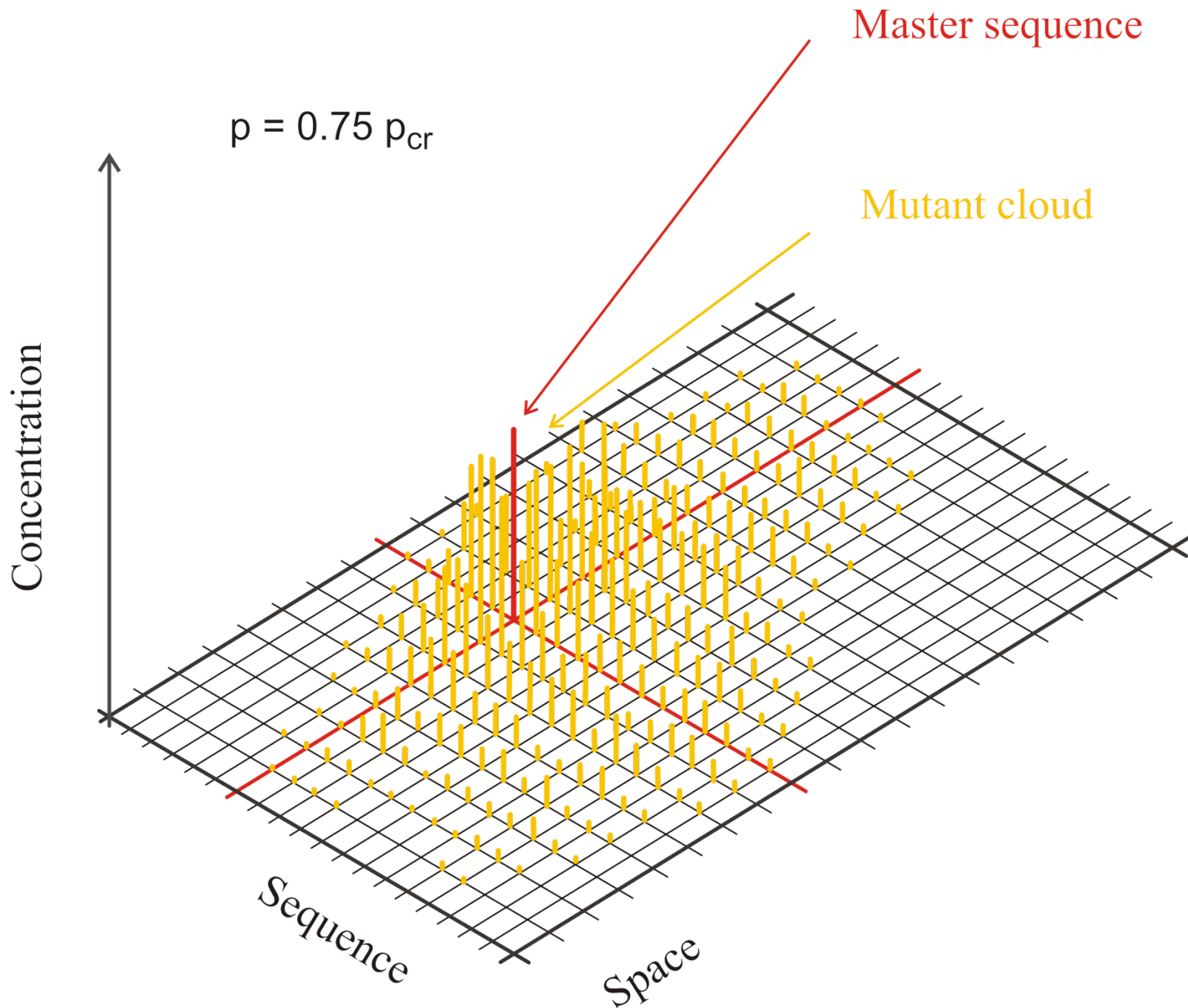
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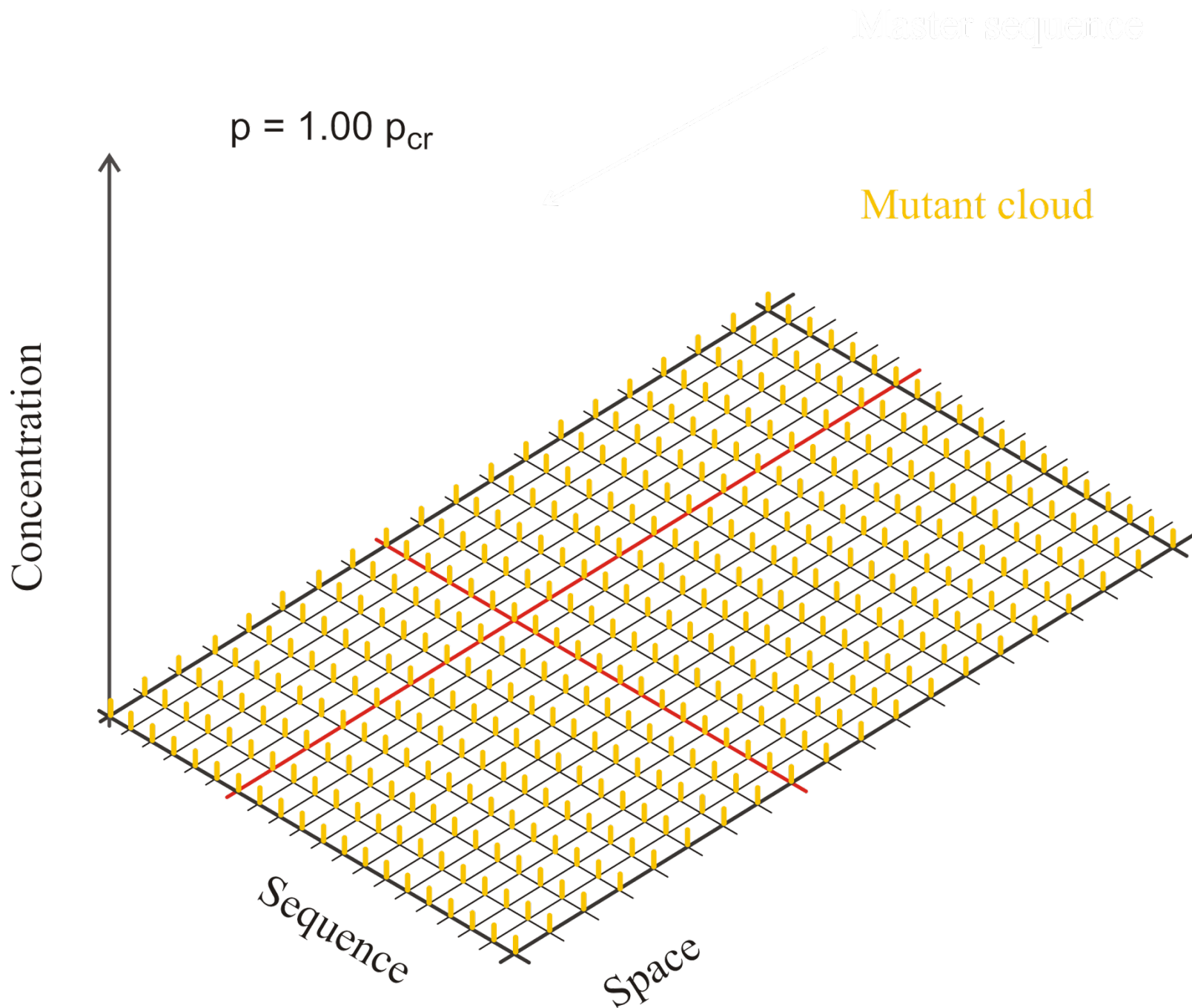


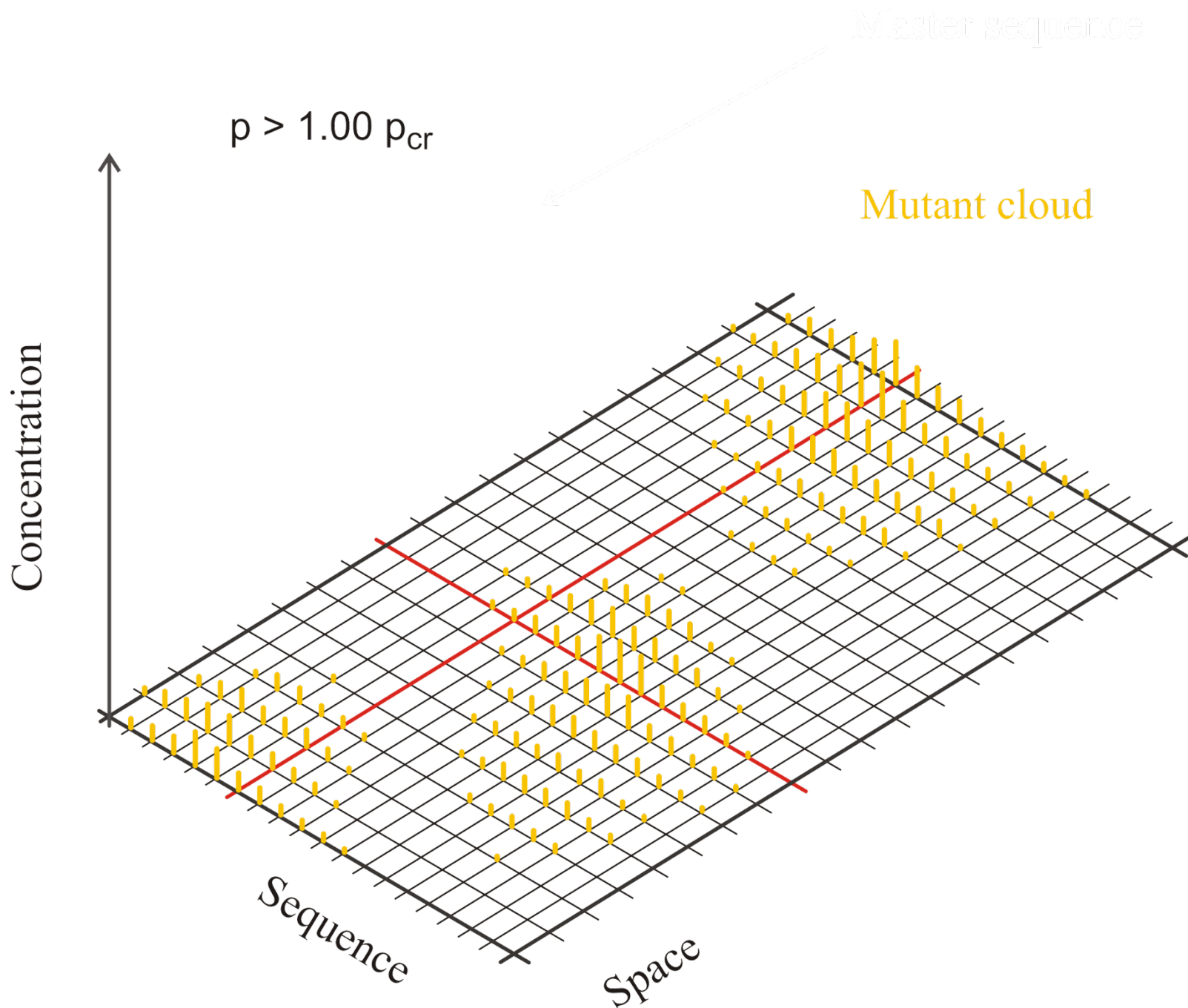




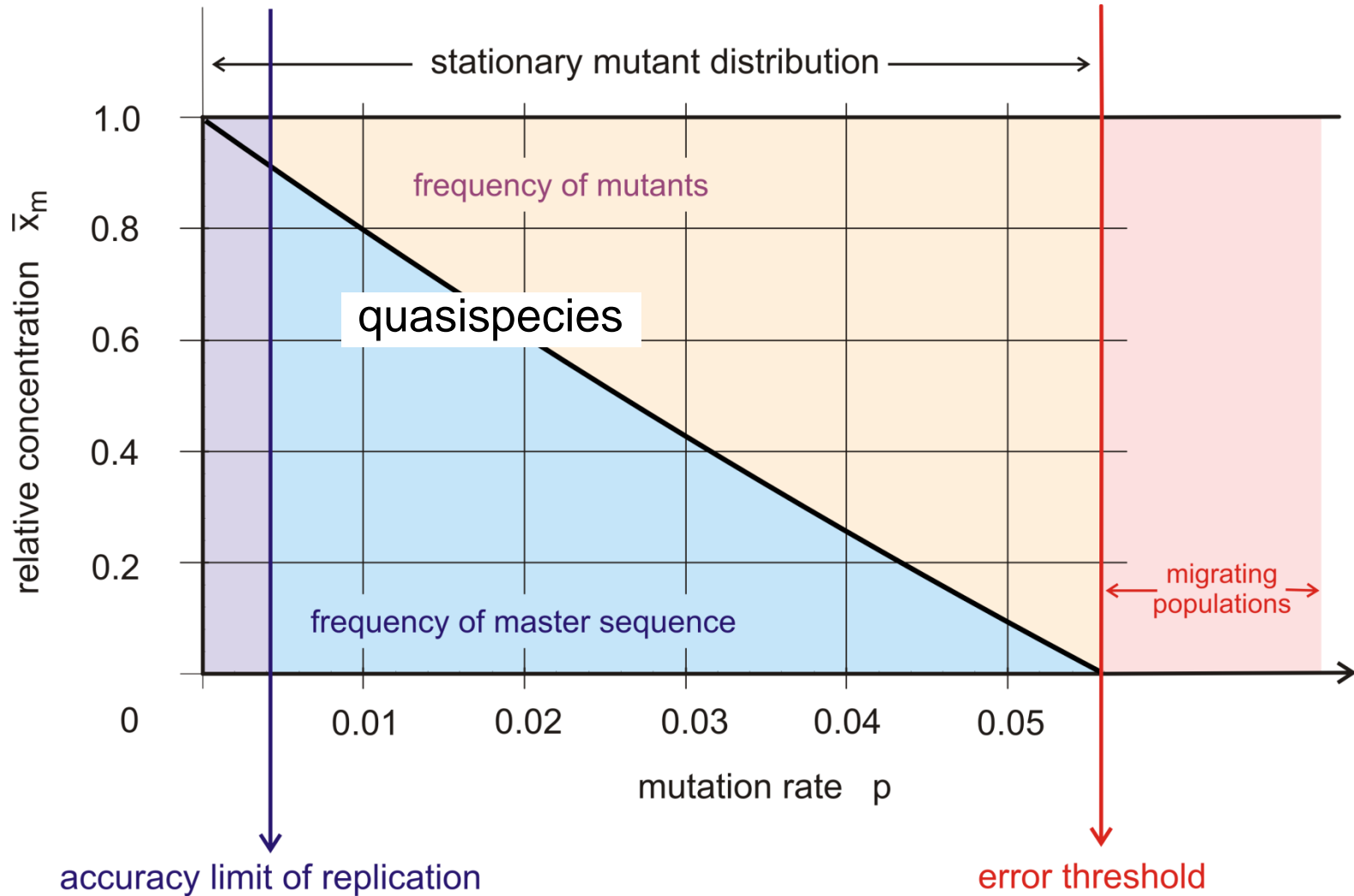






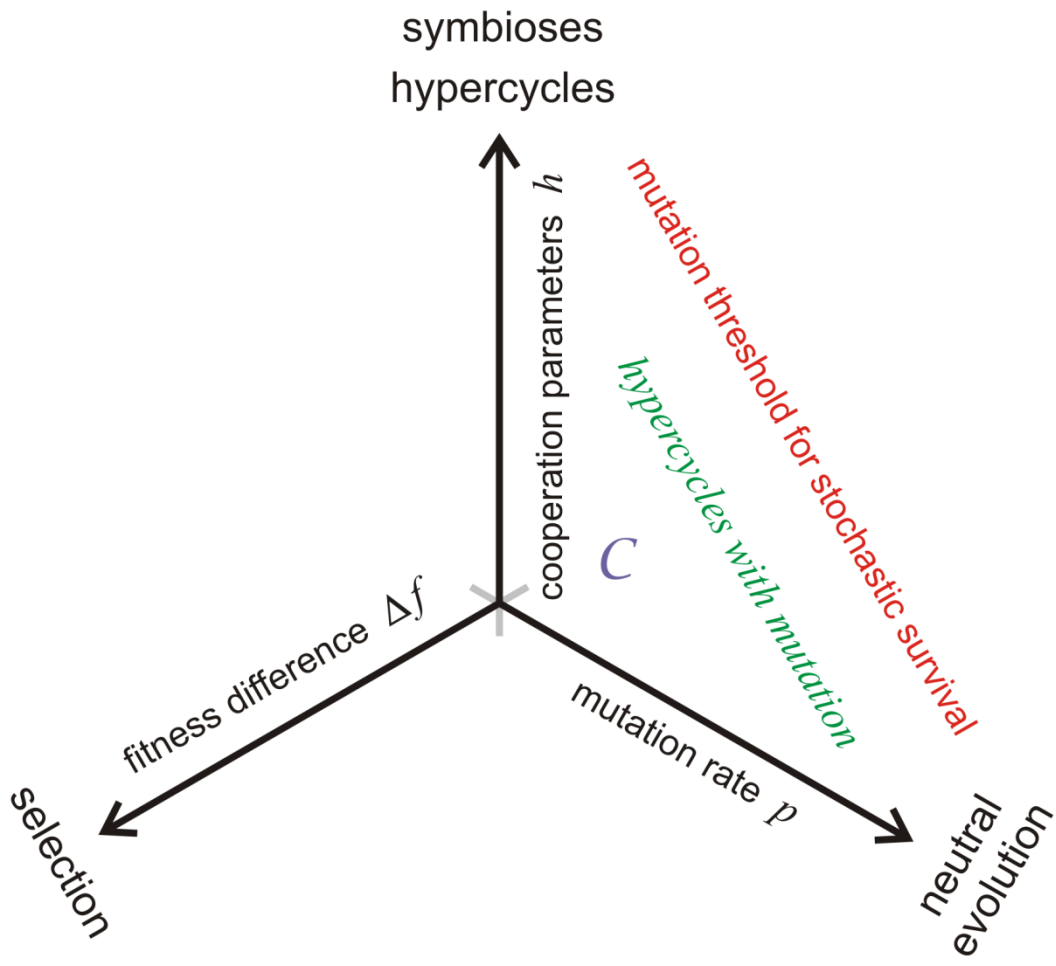




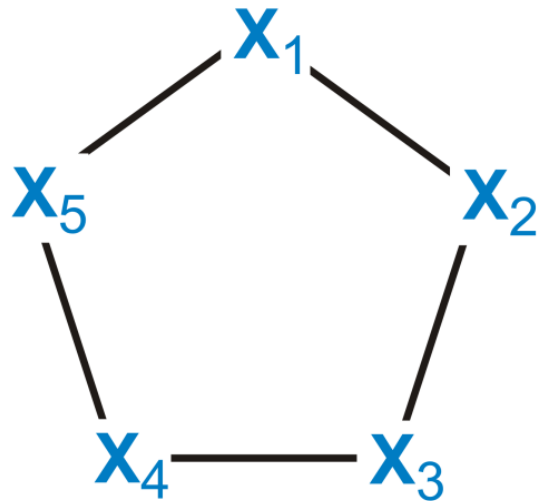


The error threshold in replication and mutation

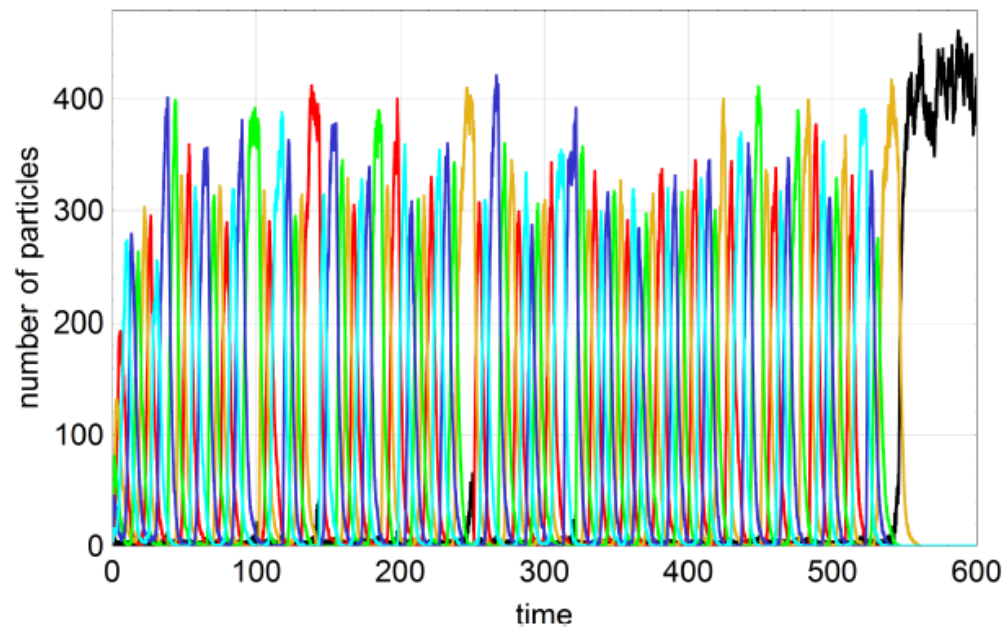
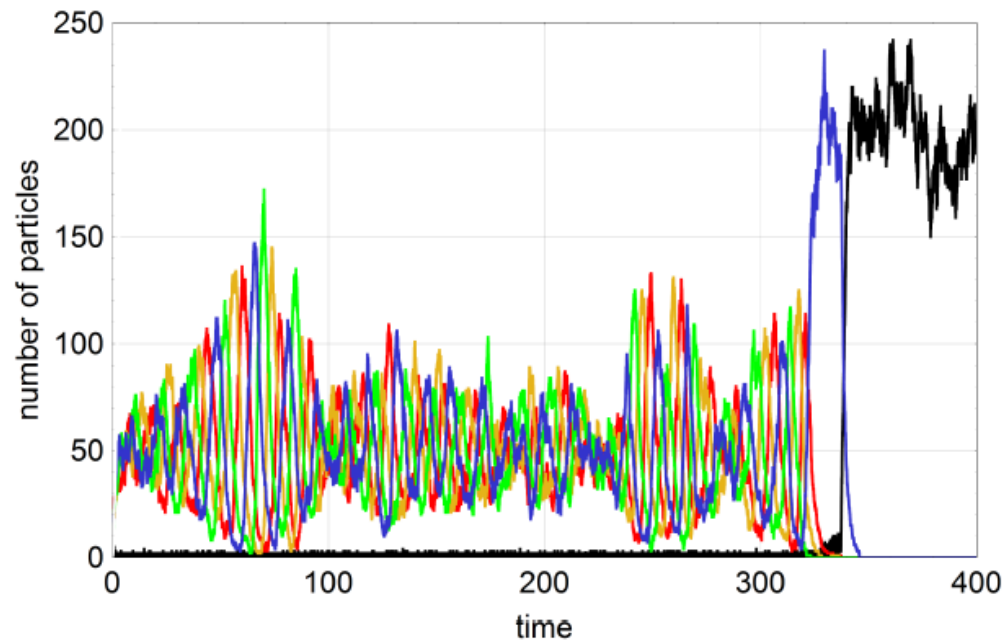
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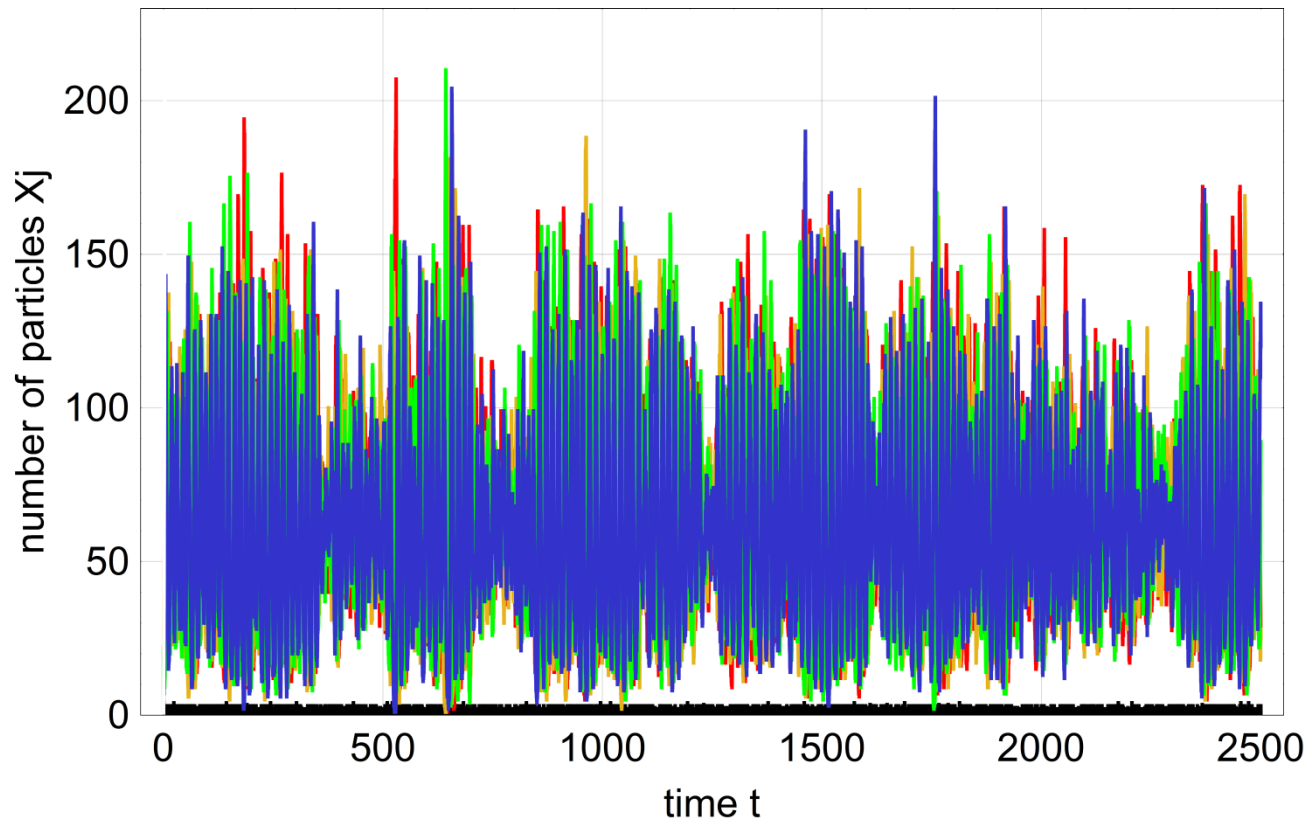


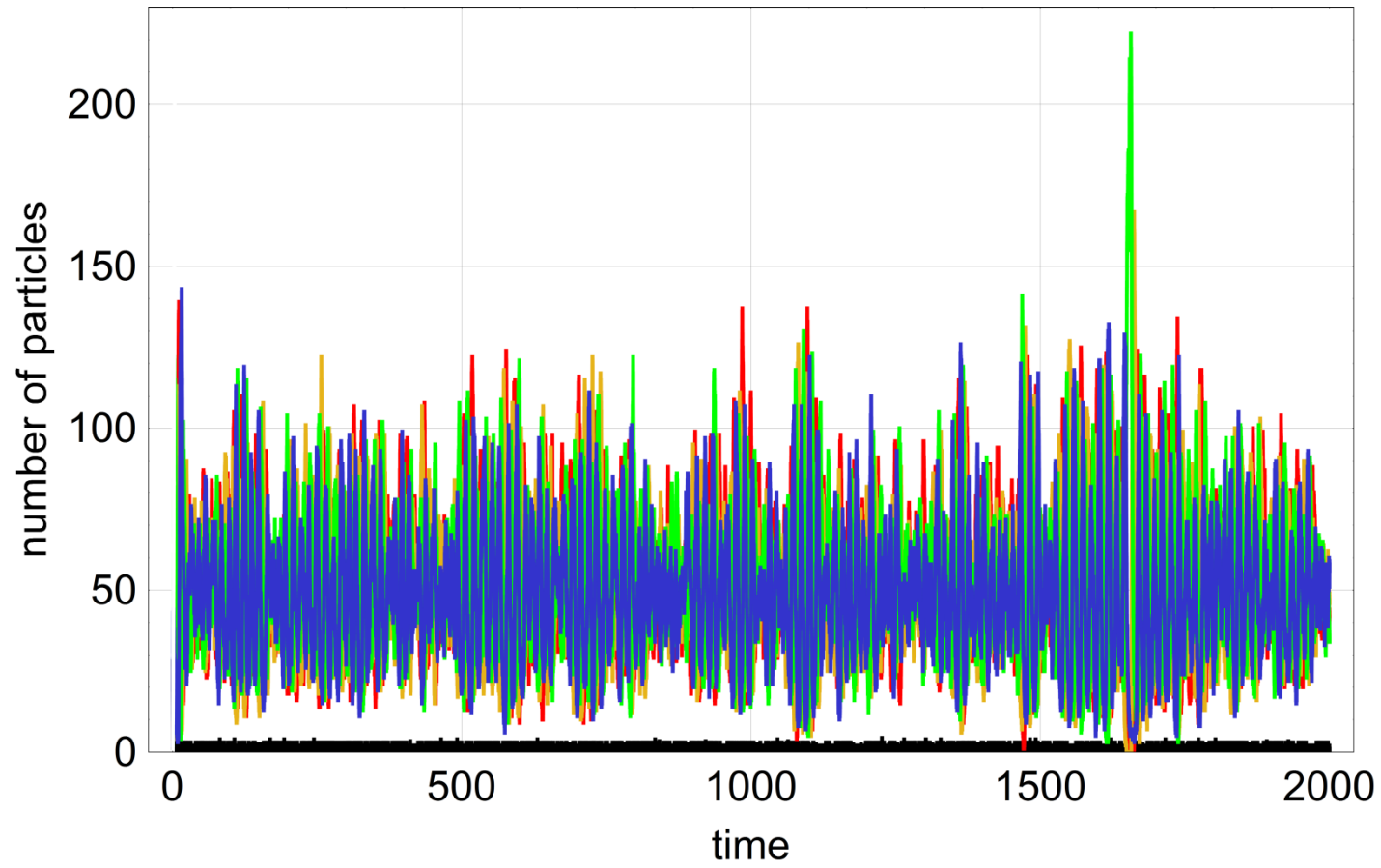
$$\mathbf{A} + \mathbf{X}_j + \mathbf{X}_{j+1} \xrightarrow{l_j} 2\mathbf{X}_j + \mathbf{X}_{j+1}; \quad j = 1, \dots, n; \quad j \bmod n$$

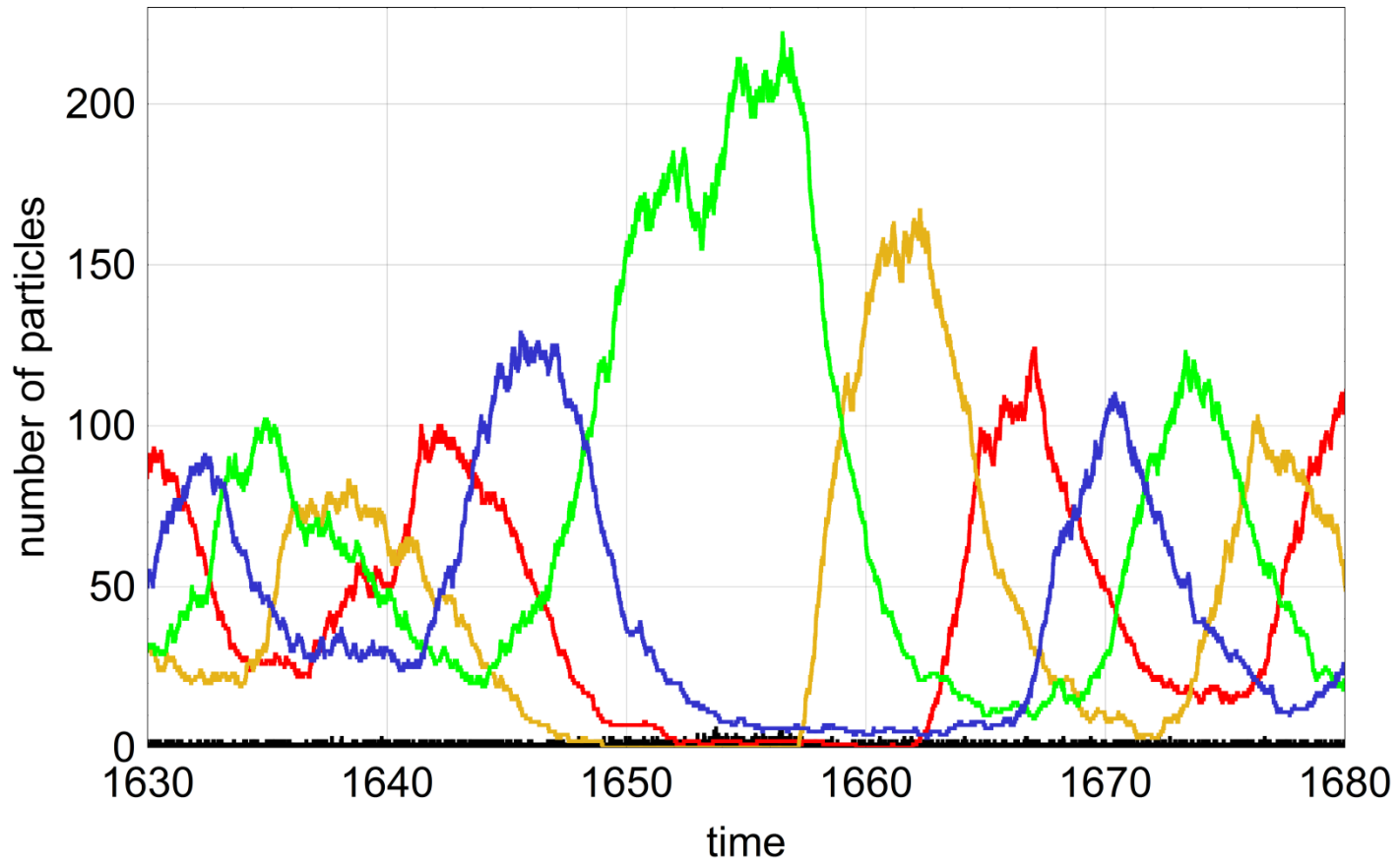


$$\mathbf{X}_n \Leftarrow \mathbf{X}_1 \Leftarrow \mathbf{X}_2 \Leftarrow \dots \Leftarrow \mathbf{X}_{n-1} \Leftarrow \mathbf{X}_n$$

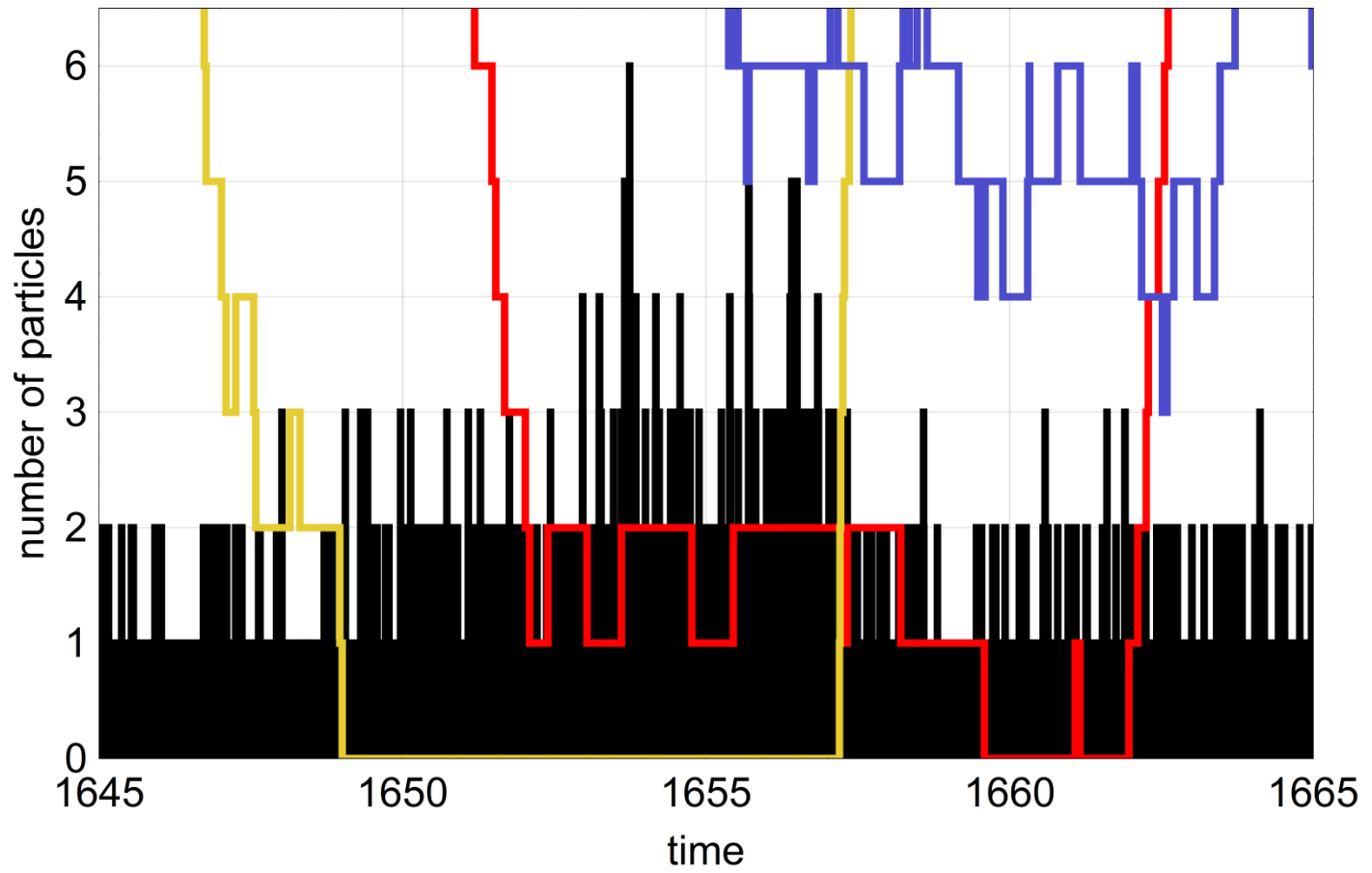




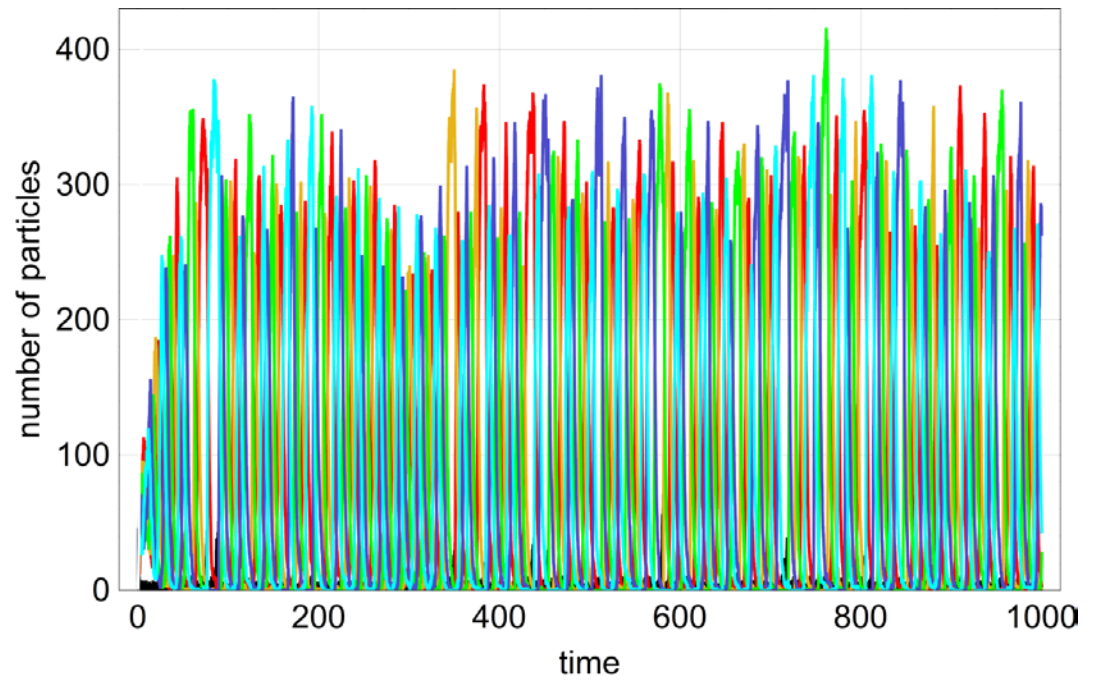
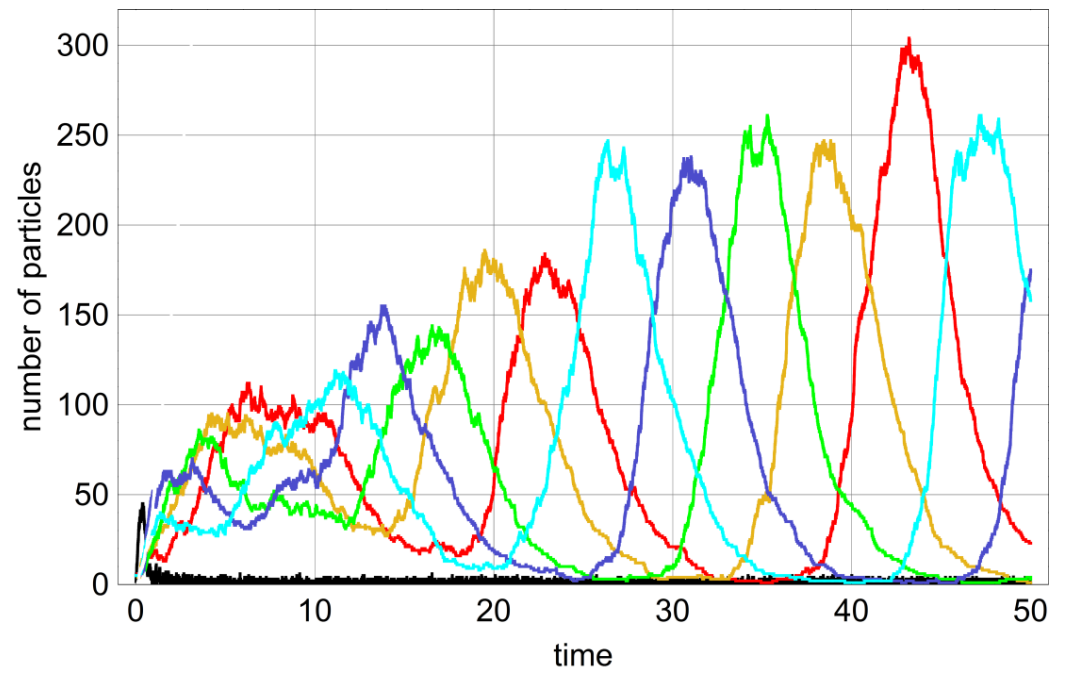


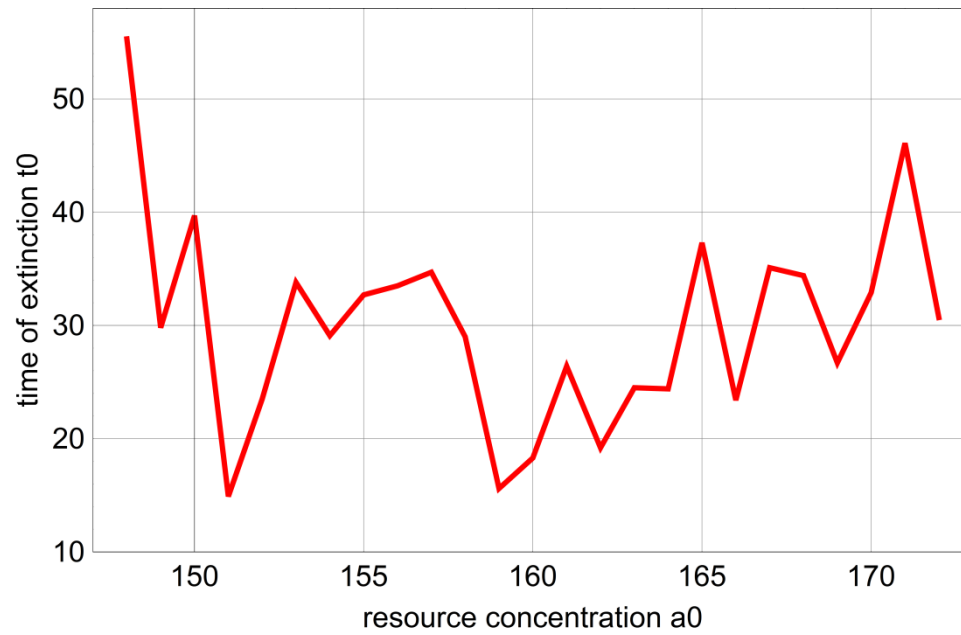




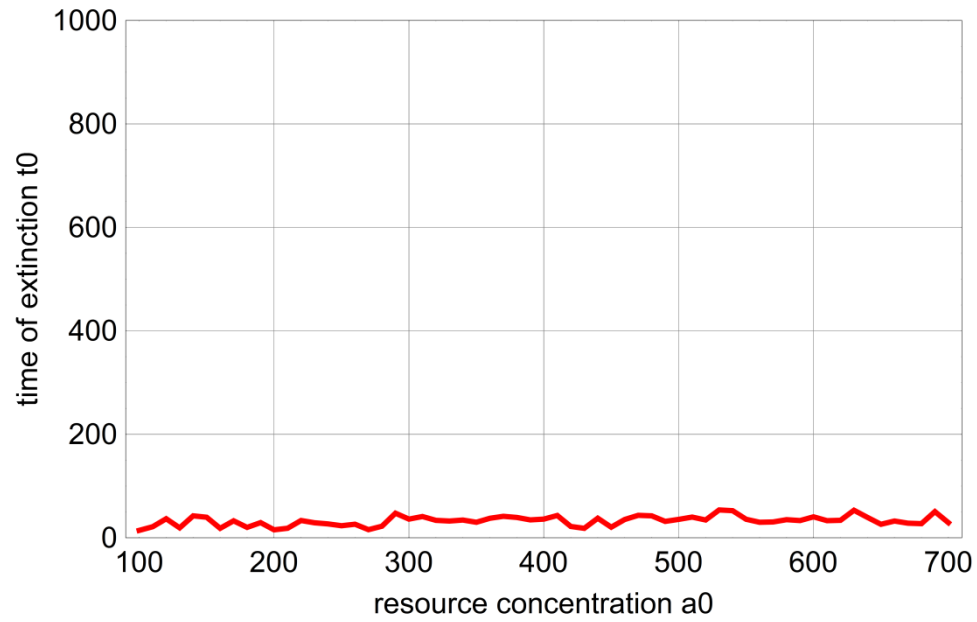


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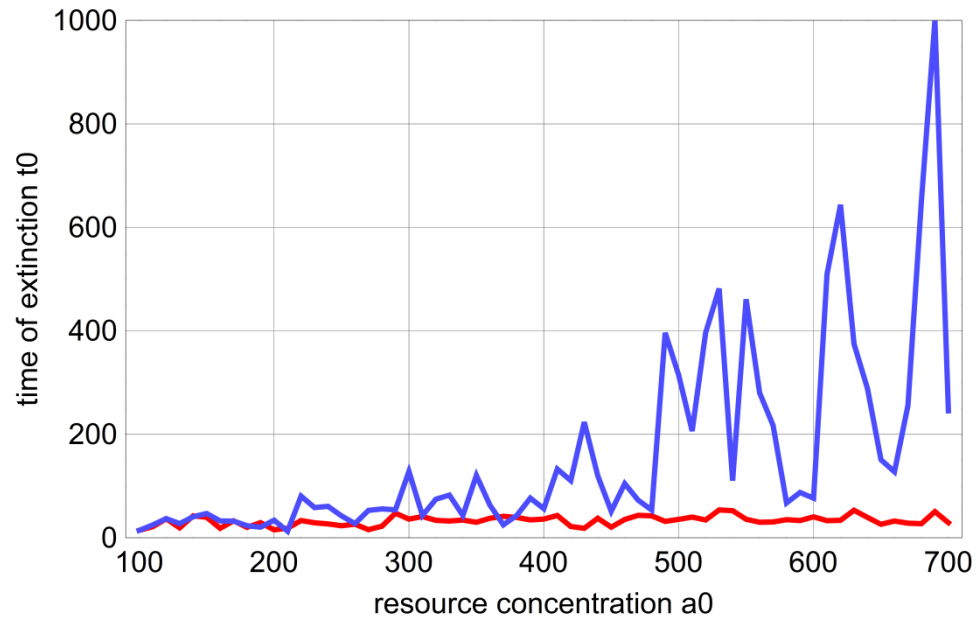




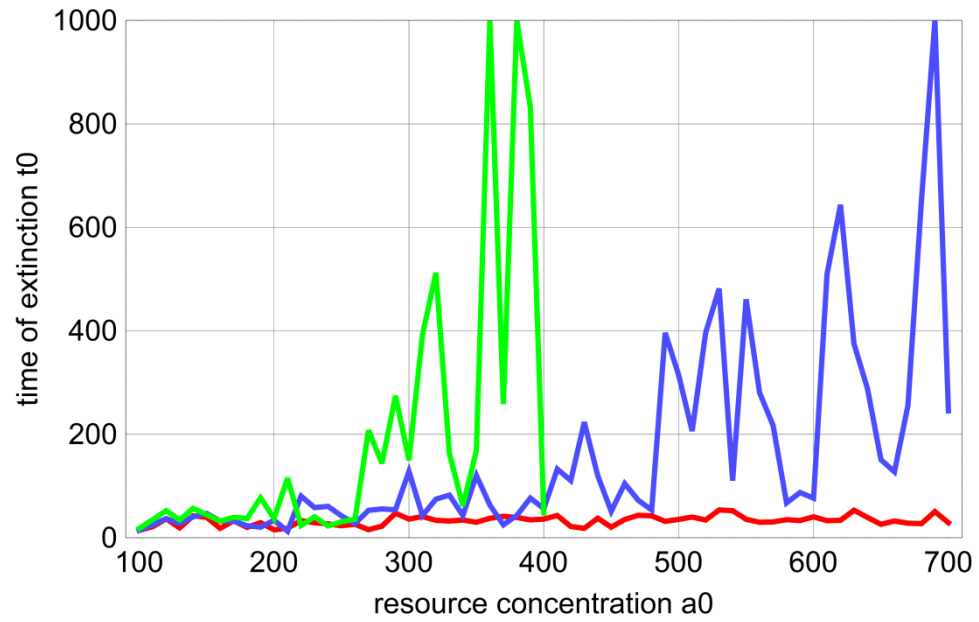
mutation rate:  $p = 0.0000$



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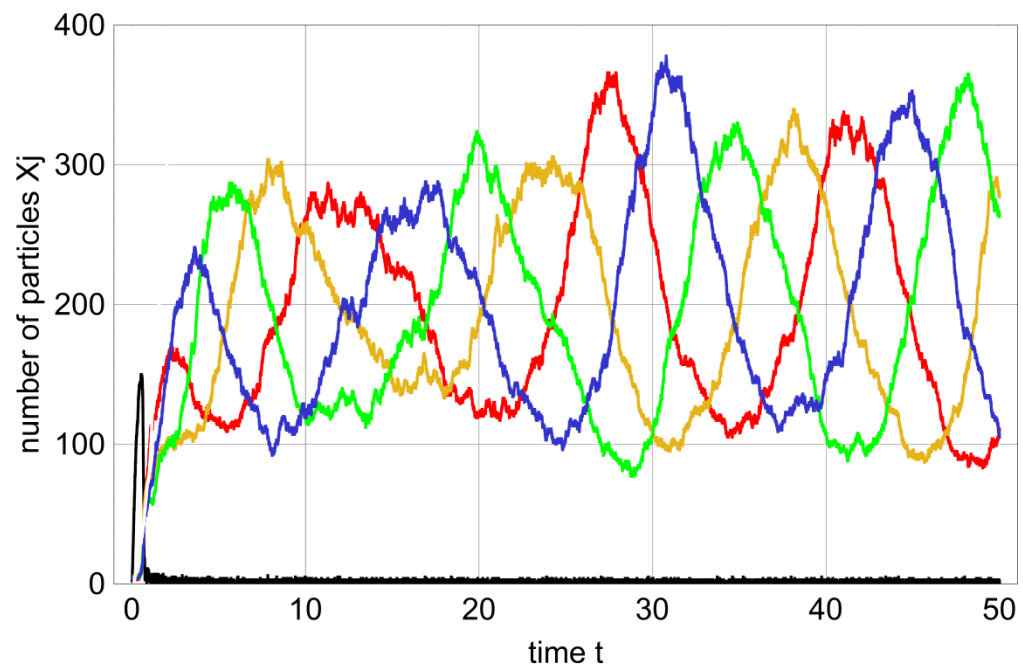
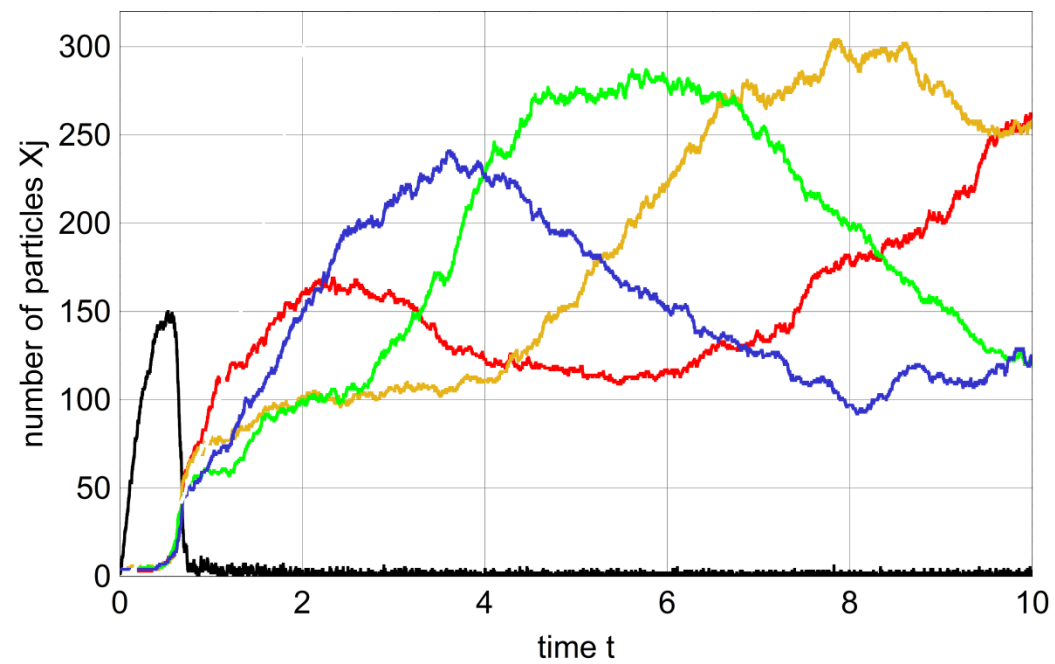
mutation rate:  $p = 0.0010$

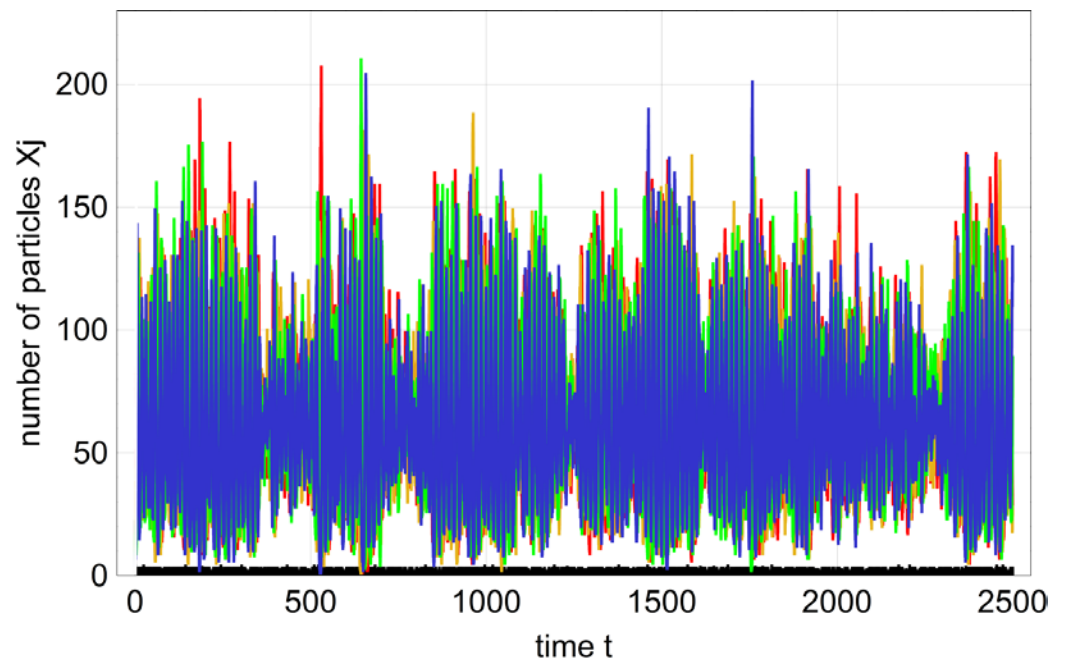
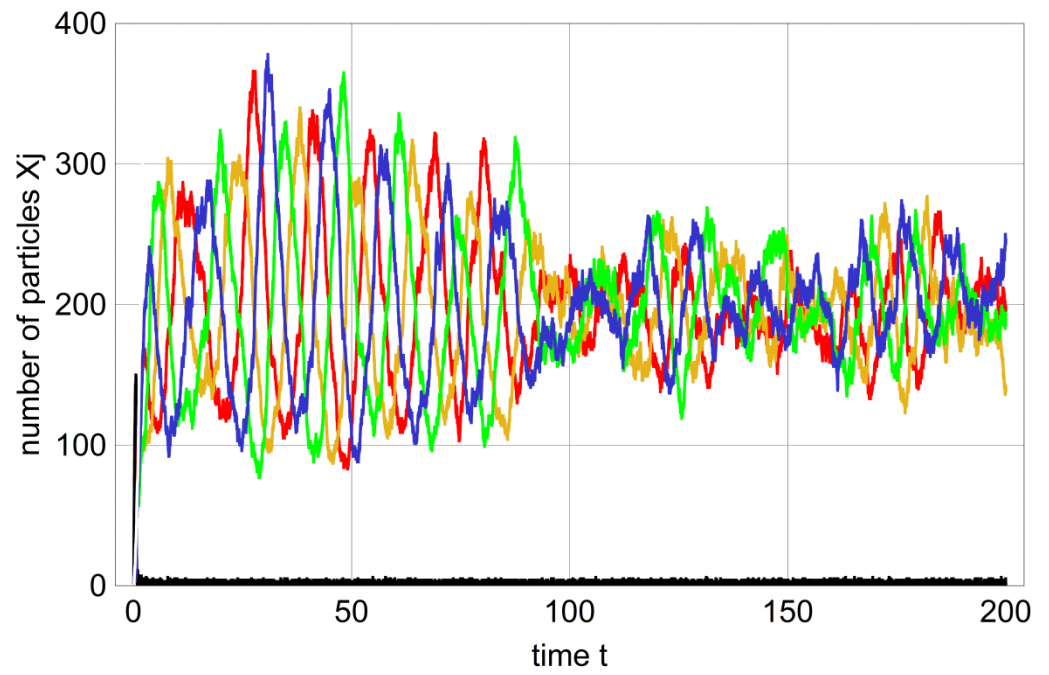


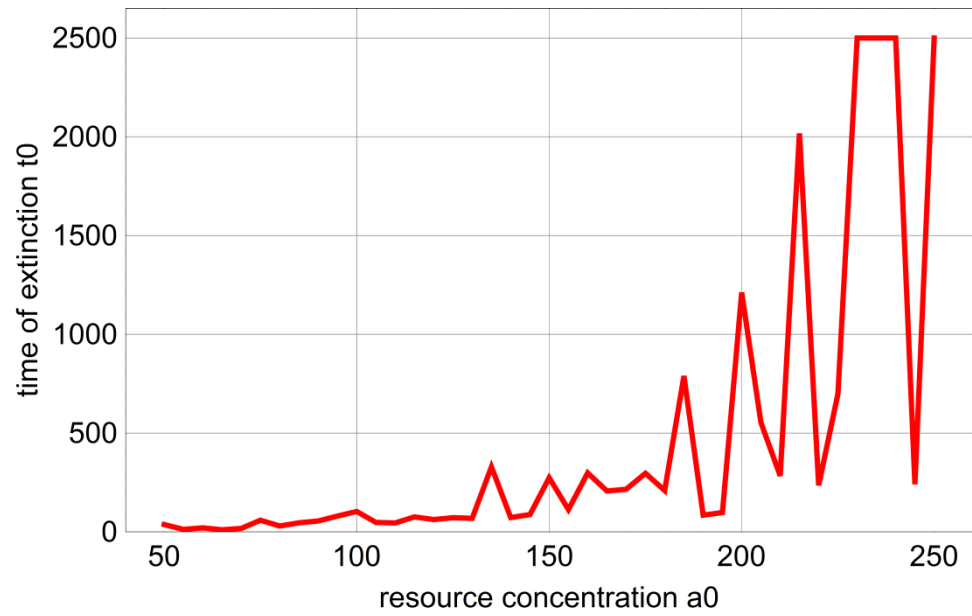
mutation rate:  $p = 0.0020$

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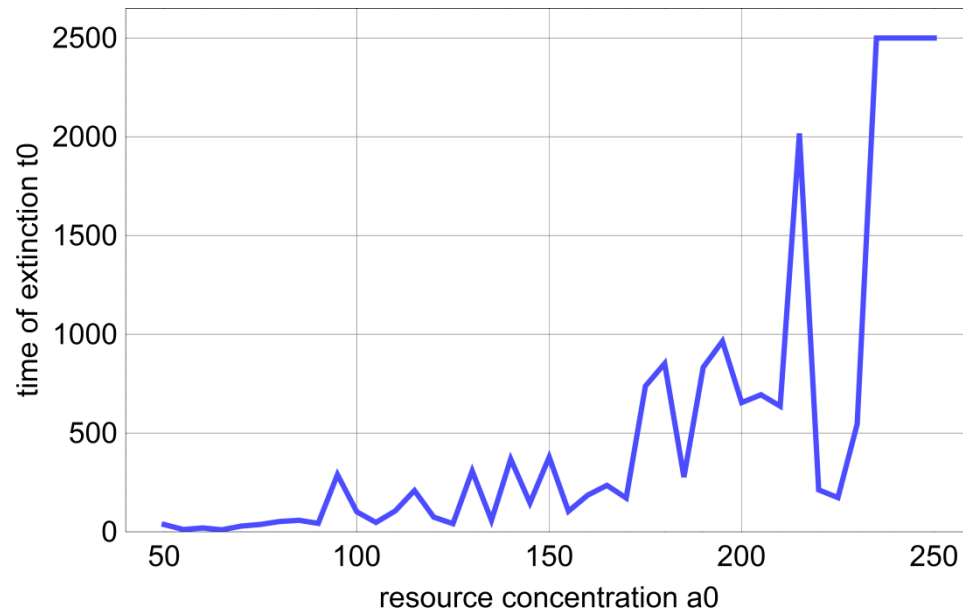




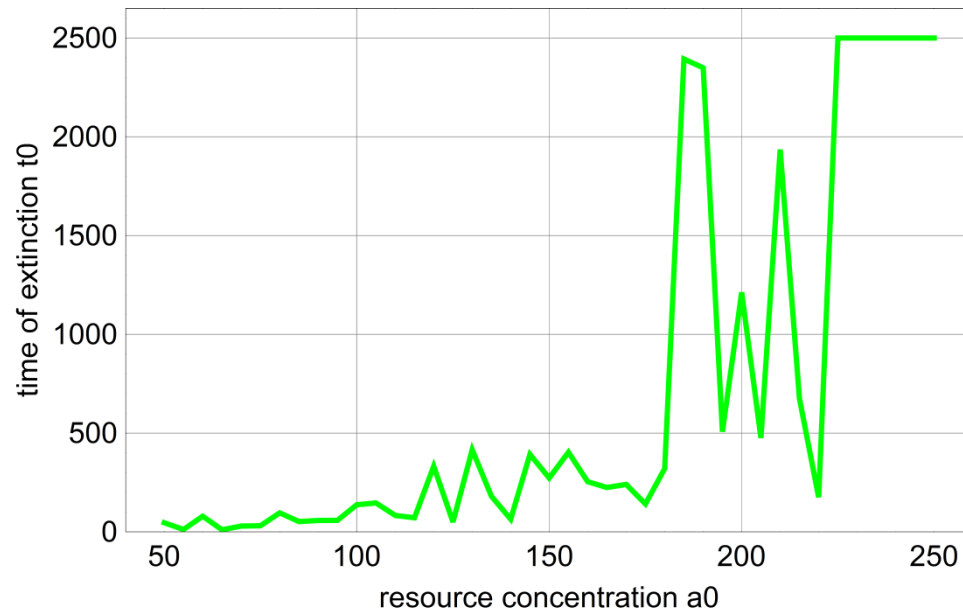




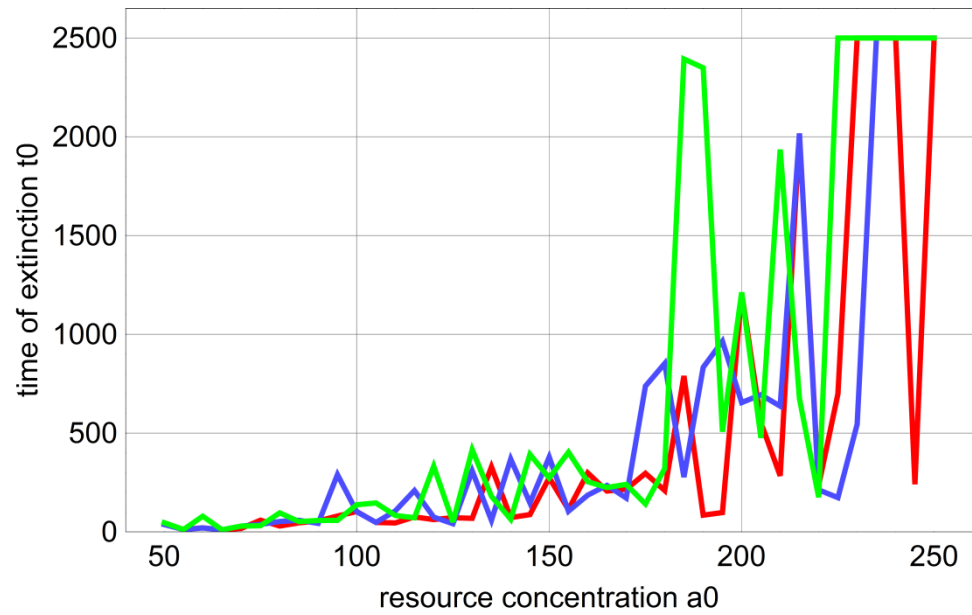
mutation rate:  $p = 0.0000$



mutation rate:  $p = 0.0010$

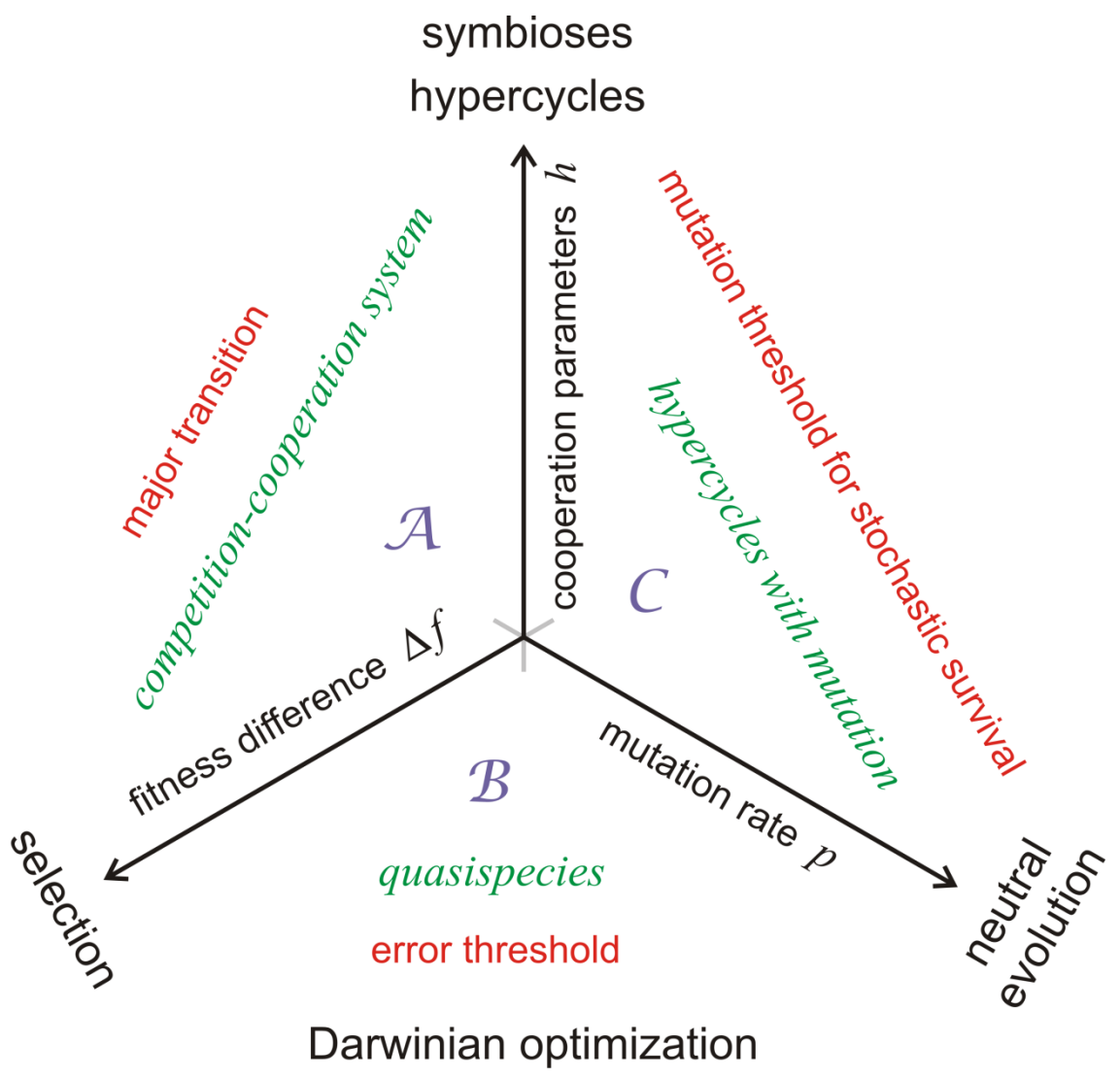


mutation rate:  $p = 0.0020$



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Thank you for your attention!

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