1

$$[A]+[B]=N \quad \text{---} \ (1)$$

$$[\dot{B}]=\frac{\beta[B][A]}{N}-\gamma[B]$$

$$[\dot{B}]=\frac{\beta[B](N-[B])}{N}-\gamma[B] \ \{\because \text{eq}^n\ (1)\}$$

$$[\dot{B}]=\frac{\cancel{N}\beta[B]}{\cancel{N}}-\frac{\beta[B]^2}{N}-\gamma[B]$$

$$=-\frac{\beta[B]^2}{N}-\gamma[B]+\beta[B]$$

$$[\dot{B}]=-\frac{\beta}{N}[B]^2+(\beta-\gamma)[B]$$

$$[\dot{A}]=-\frac{\beta[B][A]}{N}+\gamma[B]$$

$$[\dot{A}]=-\frac{\beta(N-[A])[A]}{N}+\gamma(N-[A])$$

$$=-\frac{\beta\cancel{N}[A]}{\cancel{N}}+\frac{\beta[A]^2}{N}+N\gamma$$

$$-\gamma[A]$$

$$= -\beta[A] + \frac{\beta}{N}[A]^2 + N\gamma - \gamma[A]$$

$$\cancel{[\dot{A}] = \left(\frac{\beta}{N}\right)[A]^2 - N}$$

$$[\dot{A}] = \frac{\beta}{N}[A]^2 - (\beta+\gamma)[A] + N\gamma$$

(2) $\underline{[\dot{B}]}$

(2)

$$\frac{[\dot{B}]}{[B]^2}$$

$$\int [\dot{B}] = -\frac{\beta [B]^2}{N} + (\beta - \gamma)[B]$$

$$\int_{[B_0]}^{B_0(t)} [\dot{B}] = \int_{[B_0]}^{[B](t)} -\frac{\beta y^2}{N} + (\beta - \gamma) y$$

$$= -\frac{\beta y^3}{3N} + \frac{(\beta-\gamma) y^2}{2}$$

$$= -\frac{\beta([B](t))^3}{3N} + \frac{(\beta-\gamma)([B](t))^2}{2}$$

$$+ \frac{\beta([B_0])^3}{3N} + \frac{(\beta-\gamma)[B_0]^2}{2}$$

$$\frac{[\dot{B}]}{[B]^2} = \beta y - \frac{\beta}{N} + \gamma y$$

$$\int \frac{[\dot{B}]}{[B]^2} = \int (\beta+\gamma) y - \frac{\beta}{N}$$

$$\frac{[\dot{B}]}{[B]^2} = \frac{(\beta+\gamma)y^2}{2\times(y')} - \frac{\beta\, y}{N(y')} + ($$

$$[\dot{B}]\,y^2 = \frac{(\beta+\gamma)y^2}{2\times(y')} - \frac{\beta y}{N(y')} \Big|_{\frac{1}{[B_0]}}^{\frac{1}{[B](t)}} \quad \therefore\; y = \frac{1}{[B]}$$

~~for B^*~~ for B^*

equate it to 0, find root

$$= \frac{(\beta+\gamma)\cdot 1}{2\times \ln[B](t)\,[B]^2_{(t)}} - \frac{\beta}{N\times(\ln[B](t))\times[B](t)}$$

$$= \frac{(\beta+\gamma)}{\ln[B_0]\,[B_0]^2} - \frac{\beta}{N(\ln[B_0])[B_0]} = 0$$

$$\frac{(\beta+\gamma)}{2\times \ln[B](t)}\frac{1}{([B](t))^2} - \frac{\beta}{N\times(\ln[B](t))\times[B](t)}$$

$$= \frac{(\beta+\gamma)}{\ln[B_0][B_0]^2} - \frac{\beta}{N(\ln[B_0])[B_0]}$$

$$\frac{(\beta+\gamma)}{2} - \frac{\beta\,([B](t))}{N} = (\beta+\gamma)([B](t))^2$$

$$- \frac{\beta\,([B](t))^2}{N\,[B_0]}$$

$$f(n) = -\frac{([B](t))^2}{2[B_0]} - \frac{\beta [B](t)}{[B_0] N} + \frac{\beta ([B](t))}{N} - \frac{(\beta+\gamma)}{2} = 0 \quad \text{— (2)}$$

$$[B](t) = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$B^{**} = \frac{\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) \pm \sqrt{\left(\frac{\beta}{N}\left(\frac{1}{B_0}+1\right)\right)^2 - \frac{\gamma}{\cancel{2}\times 2\times[B_0]}}}{\cancel{2}\times\frac{1}{\cancel{2}\times[B_0]}}$$

$$B^{*} = B_0\left[\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) \pm \sqrt{\frac{\beta}{N}\left(\frac{1}{B_0}+1\right)^2 + \frac{(\beta+\gamma)}{B_0}}\right]$$

Check stability.

eqn (1)

$$f'(n) = -\frac{\cancel{2}([B](t))^2}{\cancel{2}\times[B_0]} - \frac{\beta}{[B_0] N}.$$

check value

if $f'(n) < 1$ stable

$f'(n) > 1$ unstable.

substitute

$$-\left[\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) \pm \sqrt{\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) + \frac{(\beta+\gamma)}{B_0}}\right]$$

$$-\frac{\beta}{[B_0]N}$$

for $\beta = 0.5$,

$B_0 = 1$ $\quad N = 1000$, $\gamma = 0.5$

$$-\left[\frac{0.5}{1000}\left(\frac{1}{1}+1\right) \pm \sqrt{\left(\frac{0.5}{1000}\right)\left(\frac{1}{1}+1\right)^2 + (0.5+0.5)^2}\right]$$

$$-\frac{0.5}{1\times 1000}$$

$$= -\left[\frac{2\times 0.5}{1000} \pm \sqrt{\left(\frac{0.5}{1000}\times 4+1\right)^2}\right] - \frac{0.5}{1\times 1000}$$

$$-\left[0.0001 \pm \sqrt{(1+0.0002)^2}\right] - 0.0005$$

$$= -\left[0.0001 \pm 1.0001\right] - 0.0005$$

$$= -0.0001 \mp 1.0001 - 0.0005$$

-ve sign with positive root unstable equillibrium

+ve sign with negative root stable equillibrium stable equillibrium

$$B^* = B_0\left[\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) + \sqrt{\frac{\beta}{N}\left(\frac{1}{B_0}+1\right)^2 + \frac{(\beta+\gamma)}{B_0}}\right]$$

unstable equillibrium

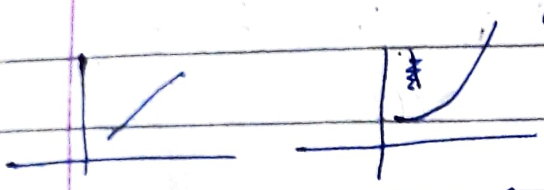
$$B^* = B_0\left[\frac{\beta}{N}\left(\frac{1}{B_0}+1\right) - \sqrt{\frac{\beta}{N}\left(\frac{1}{B_0}+1\right)^2 + \frac{(\beta+\gamma)}{B_0}}\right]$$

5) on $B_0 = 0$ ~~...~~

$[B](t) = 0$

on different value of B_0 graph shifts horizontally ~~...~~ vertically upwards (for +ve B_0 values) or downwards (for -ve values of B_0)

We get a linear function on changing value of R_0 but on changing γ simultaneously we will get ~~x~~ a ~~quadratic~~ parabola.



R_0 change γ & R_0 changes.

Simulation

4.3) ~~with~~ As gillespie is for small N only.

we observed that a few ~~x~~ value of [A] ~~and~~ [B] are ~~x~~ similar to mean field & for [B] a little difference is observed for value of B.

For correcting it, ~~a~~ ~~xx~~ value of ~~R_0~~ ~~xx~~, N can be increased and it starts giving same values [A], [B] for both (mean field & gillespie)

4) for first case
$\beta = 0.51$, $\gamma = 0.5$, $N = 1000$

graph of meanfield
[B](t) is inclined to 0.
[A](t) is decreasing and
a parabola
[B] is superimposing on [B](t)
[A] is showing a quite deviation
to [A](t).

For improvement we can
increase value of N as [A] for
gillipie will start overlapping meanfield.

for $\beta = 0.95$, $\gamma = 0.51$, $N = 1000$

graph of meanfield
[B](t) is slightly upward
0 and it is a parabola.

A[t), it is decreasing, and becomes
0 then it is showing
-ve values which means 0.
as no negative number of particles may also occur

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A bit of x

~~A~~ ~~A~~ [B] is superimposed to [B](t)
[A] is deviated from [A](t)
Increase N for superimposing it.

A bit of critical thinking

(1). State A and [B] might be same physical or chemical state of a particle and equillibrium between these state is observed.

This model can be applied to

(1) Filling of water tank. If rate of filling of tank is maintained with rate of outflow of water from tank then it will appear that tank is neigther filling ~~...~~ means level of

tank is neither increasing nor decreasing.

example

2 ~~~~. Conversition of number of particle of oxygen in ~~gaseous~~ gaseous state {[B]} and liquid state [A]

It might be noticed that ~~after~~ in nature ~~me~~ [A] & [B] are in equillibrium