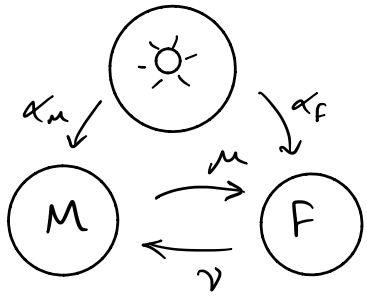
Macrophage / Fibroblast interaction



θ, θ_F, θ_M are phases.

$$\frac{d\theta}{dt} = \omega_0$$

$$\frac{d\theta_F}{dt} = \omega_F + \mu \sin(\theta_M - \theta_F - \phi_F) + \alpha_F \sin(\theta - \theta_F - \psi_F) + \zeta_F$$

$$\frac{d\theta_M}{dt} = \omega_M + \nu \sin(\theta_F - \theta_M - \phi_M) + \alpha_M \sin(\theta - \theta_M - \psi_M) + \zeta_M$$

Scale time on the diurnal forcing (effectively, $\omega_0 = 1$)

Assume: $\omega_F = \omega_M = 1$ (intrinsic clocks have 24 hour basic state)

ζ_F and ζ_M are noisy forcing terms — ignore to start with

ϕ_F, ϕ_M, ψ_F, ψ_M are phase differences.

The "equilibrium" state has $\theta_F = \theta - \psi_F$, $\theta_M = \theta - \psi_M$

then $\theta_M - \theta_F = -(\psi_M - \psi_F)$, requiring $\phi_F = \psi_F - \psi_M$ or $\mu = 0$
$\phi_M = \psi_M - \psi_F$ or $\nu = 0$.

Wounding might be modelled by increasing μ (upregulating influence of M on F). If $\phi_F \neq \psi_F - \psi_M$, then forcing of M is out of phase with diurnal driver and phase of F may be disrupted.