



# *Lecture 33*

11/22/2021

*Phase space  
analysis*

8/30/2021 near Mather house

# *Table of Contents*

1) The Murray System

2) Factor and draw Null clines

3) Find Equilibrium points

4) Behavior on null clines

5) Filling in the void

# *Review Harmonic Oscillator*

$$x'(t) = y$$

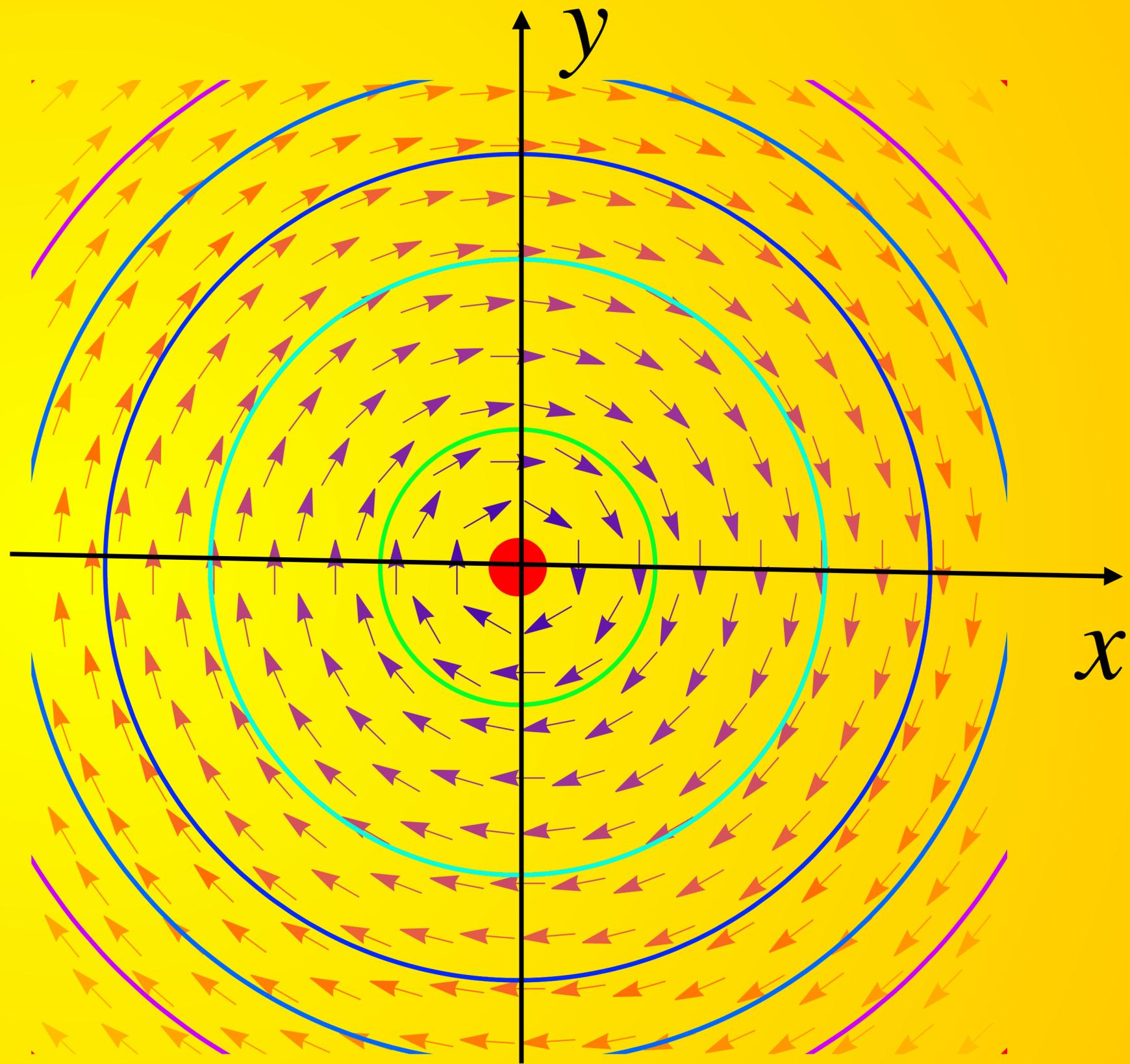
$$y'(t) = -x$$

**Was also the Romeo-Julia System.**

# *Harmonic Oscillator*

$$x'(t) = y$$

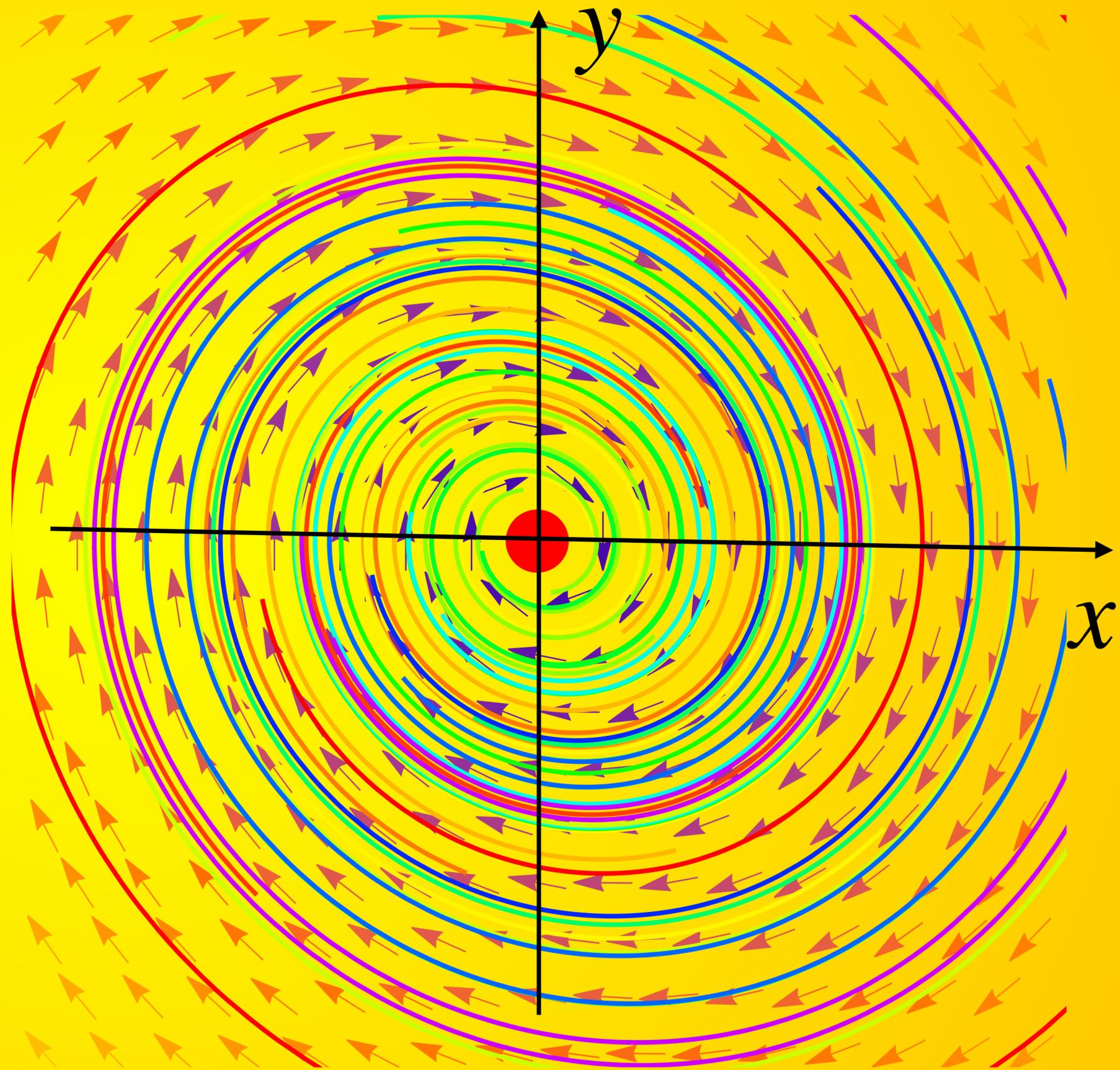
$$y'(t) = -x$$



# *Damped Oscillator*

$$x'(t) = y$$

$$y'(t) = -x - by$$



# *Competing*

$$x'(t) = x(6 - 2x) - xy$$

$$y'(t) = y(4 - y) - xy$$

We will do this analysis in class.

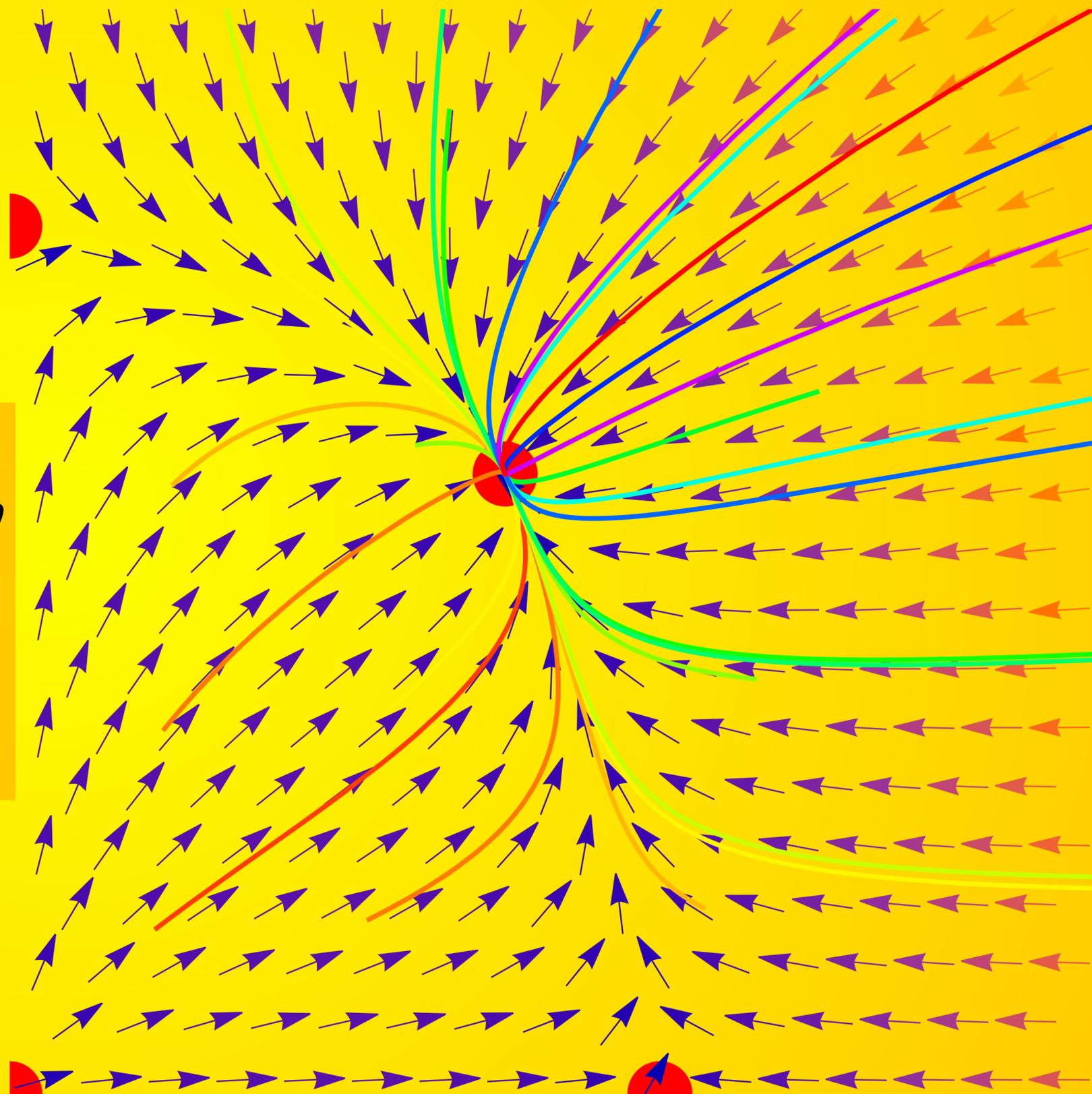
# Competing

$$x'(t) = x(6 - 2x) - xy$$

$$y'(t) = y(4 - y) - xy$$

growth of x  
gets slowed  
with large y

growth of y  
gets slowed  
with large x



*Reminders*

HW 21 due Monday after thanksgiving

Happy Thanksgiving!



*The End*