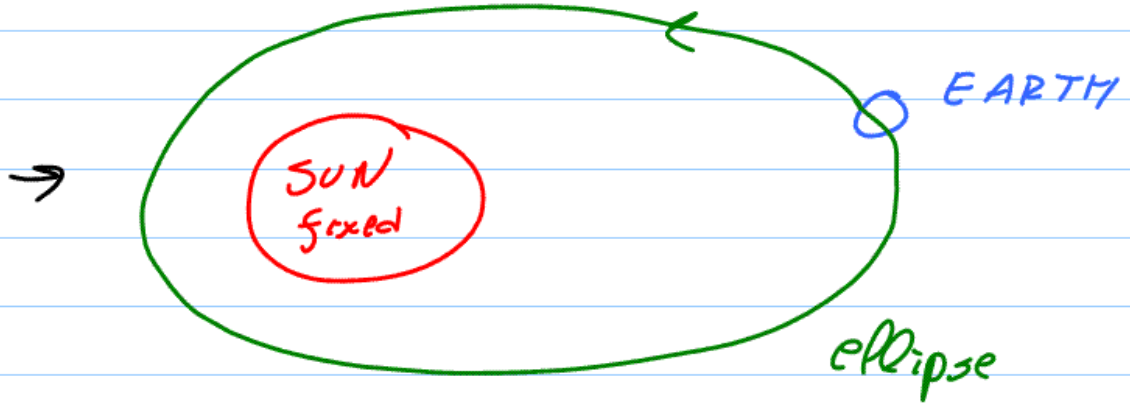
PHY100S - The Magic of Physics - Class 15

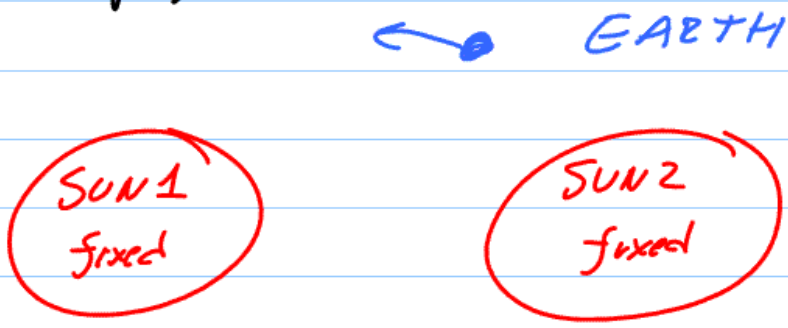
"It is by logic we prove; it is by intuition we invent." -- Poincare (1904)

CHAOS

Newton 1670's



2nd Simplest



"Three-body problem"

Approximate soln!

Know: ⊙ position & velocity of Earth at some time

⊙ Forces acting on Earth
⇒ acceleration

Calculate: new position & speed a small time later

(only approximate)

smaller time, better approx

Analytic soln does not exist!

4 non-interacting planets.
start at same position

speeds: 1.00
1.01
1.02
1.03

LOGISTIC MAP

Models population dynamics
over-simplification

number (next generation)
$\propto$ number (this generation)

$\rightarrow$ number (next) $= L$ number (this)

L ↑ fertility

overpopulation factor

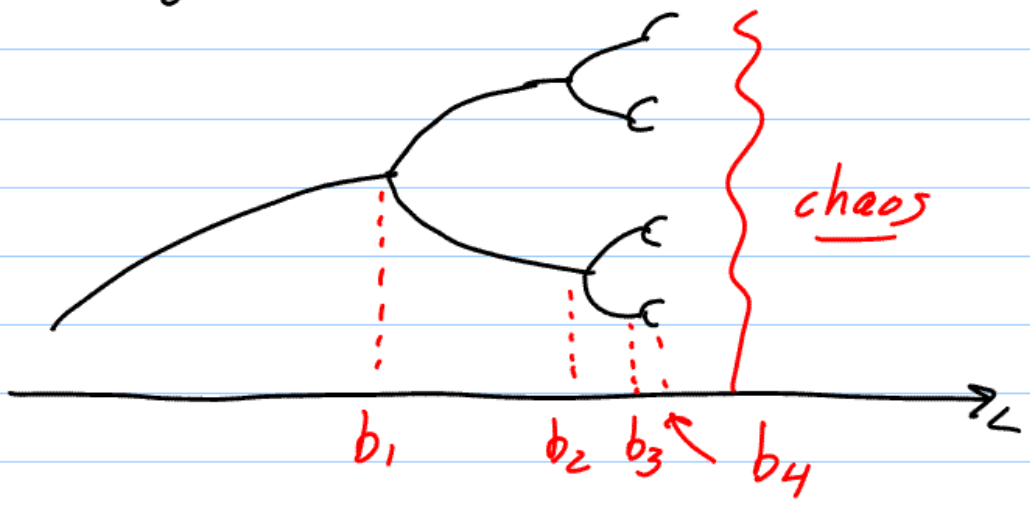
$- \left[100{,}000 - \text{number (this)} \right]$

Increase L:

steady state population values

BIFURCATE

Feigenbaum mid - 1970's



$$\frac{b_2}{b_1} = \frac{b_3}{b_2} = \frac{b_4}{b_3} = \frac{b_{n+1}}{b_n} = \text{constant}$$

= Feigenbaum number = 4.669201 ....

π = 3.1415926 ...

e = 2.71828 ...

Lorenz - early 1960's

over-simplified model of turbulence

not solvable analytically

approximate solution

dimensionality! > 2
< 3