



<https://magazine.eacr.org/how-to-design-an-award-winning-conference-poster/>

<https://www.planetary.org/articles/design-sci-poster>

<https://guides.nyu.edu/posters>

<https://our.umd.edu/poster-guide-design>

Chaos...

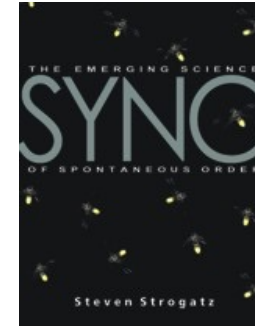
Complex behavior, arising in a deterministic nonlinear dynamic system, which exhibits two special properties:

- sensitive dependence on initial conditions
- characteristic structure



Nonlinearity and chaos are ubiquitous!

- Hearts, brains, populations
- Planets, black holes, pulsars



Chaotic Evolution of the Solar System

Gerald Jay Sussman and Jack Wisdom
Science 257:66

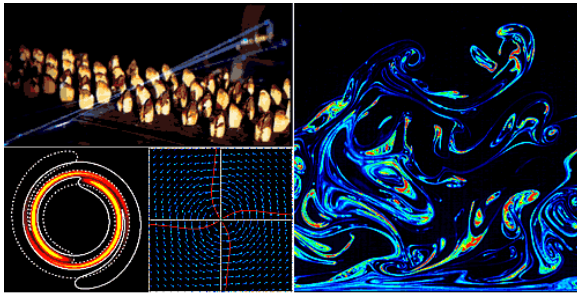
www.nasa.gov/mission_pages/cassini/multimedia/pia06243.html



- **Flows** (of heat, fluid, ...)

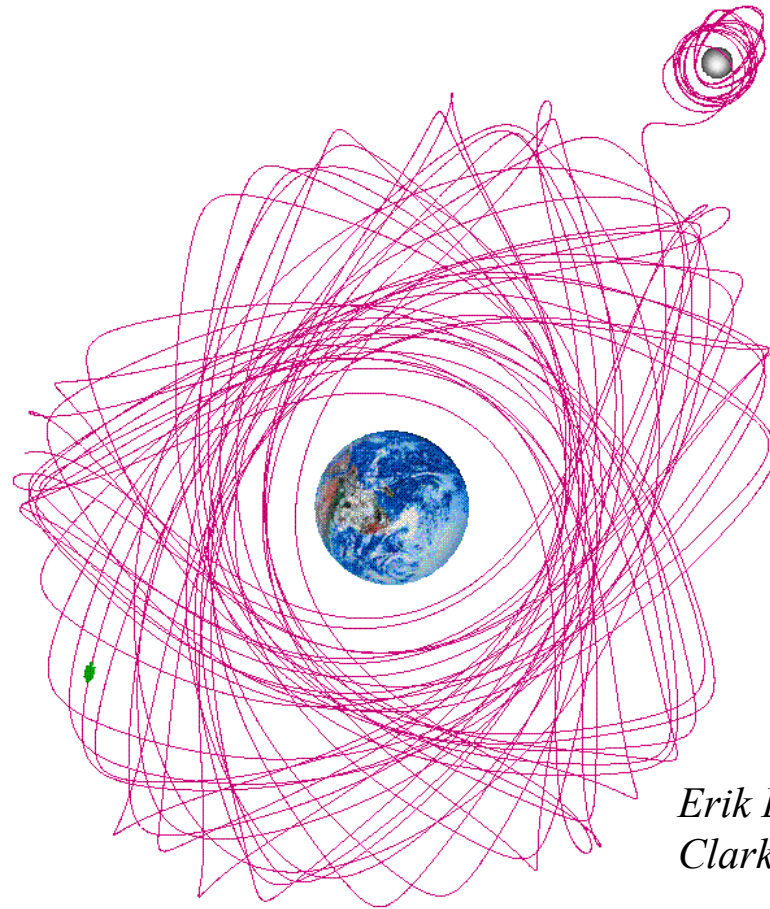
...and many other examples across science & engineering

Can we *actively* exploit those properties?

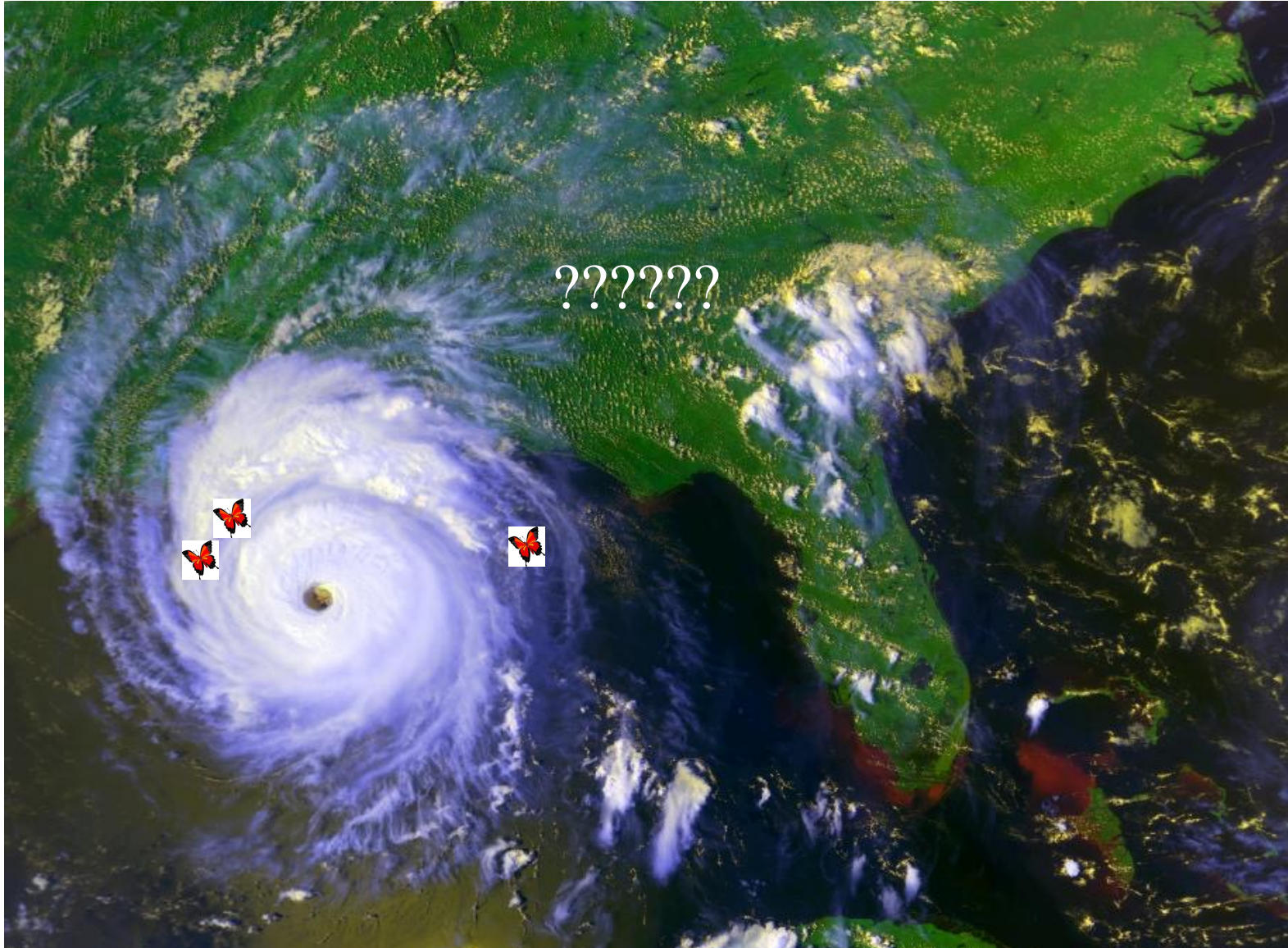


Clockwise from upper left: measuring turbulence over clams, odor plume structure, analytical vortex structure, vortex-induced mixing of egg and sperm.

J. Crimaldi, CU



*Erik Bollt,
Clarkson*



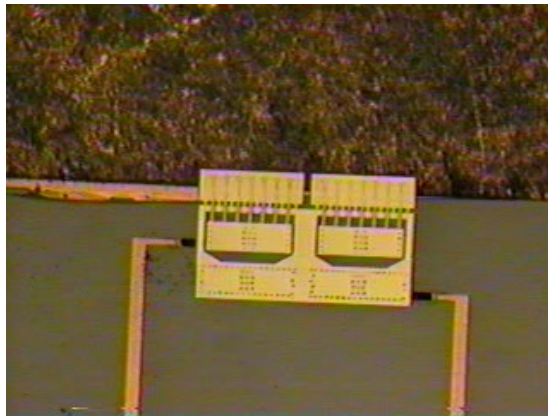
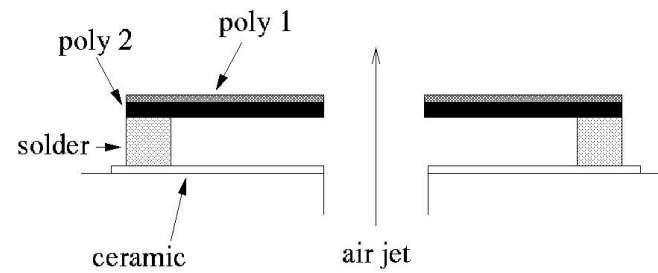
???????





Rhymes with Orange
31 January 2022

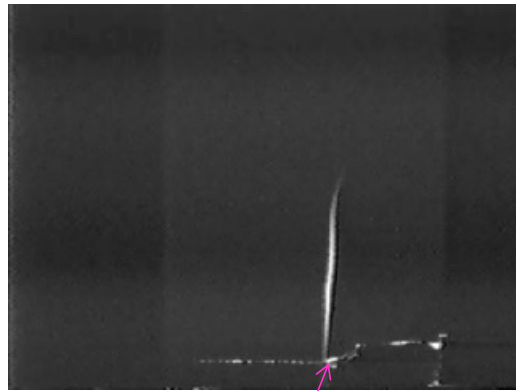
Engineered butterflies



*Video : overhead
view at 2Hz, 10V*

Area of individual MEMS flap is 1.0 x 0.25mm

The Butterfly effect in action...



Flap (stationary)



Flap moving @ 6Hz

10cm

$Re \sim 25$

Forcing generates coherent structures that enhance
entrainment and mixing!

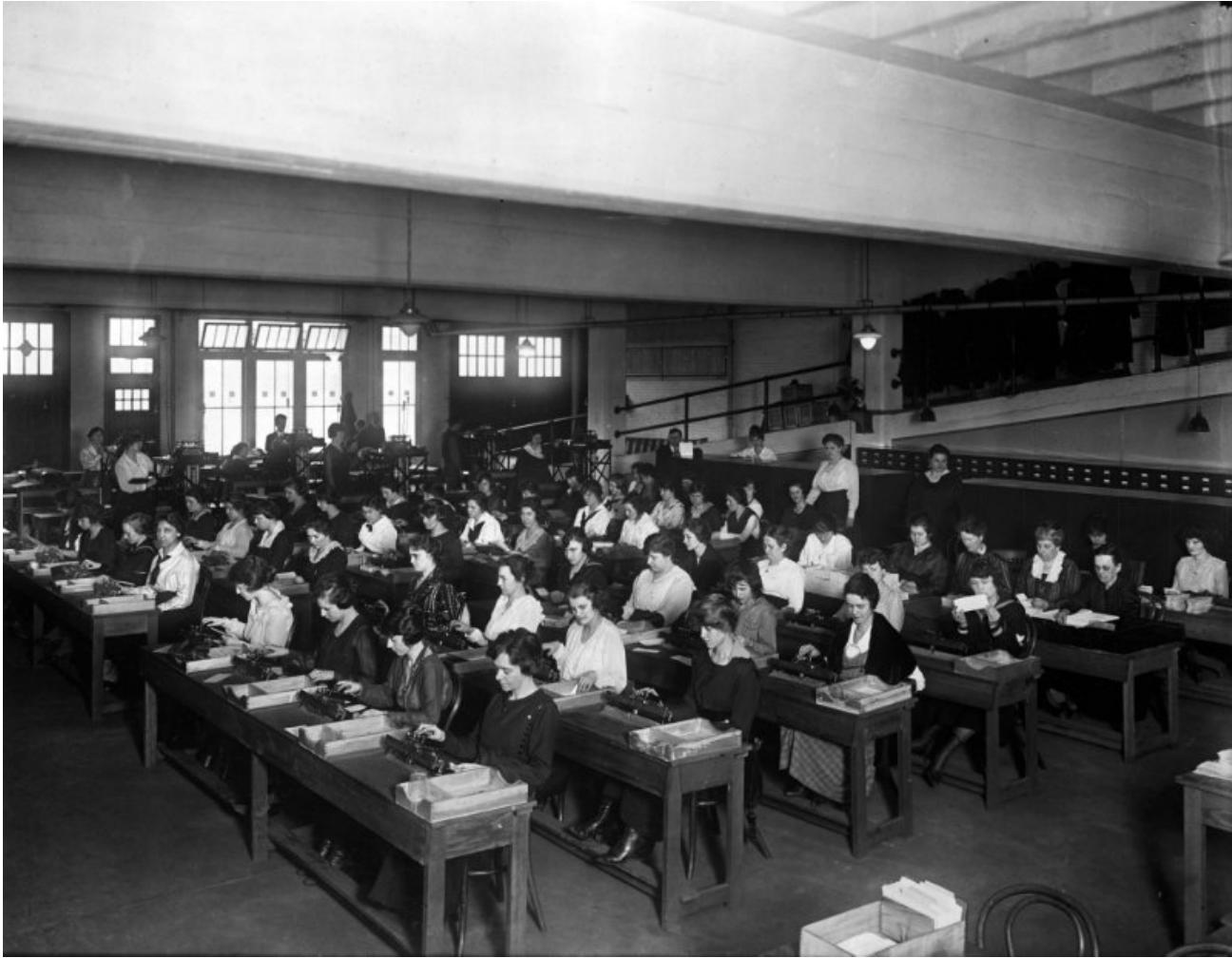
More on this:

CSCI 4446 T/Th 9:15am every spring semester

What all of this has to do with computers, part I:

- The equations that model chaotic systems cannot be solved* by hand. You have to solve them numerically, with a computer (see: CSCI 3656)
- Before the advent of widely available programmable digital computers, this was a real pain...

* In closed form

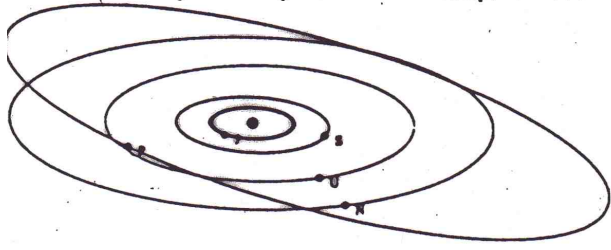


www.computerhistory.org

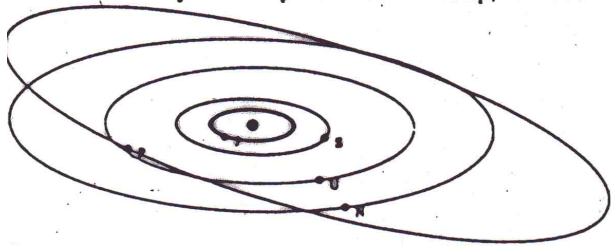
What all of this has to do with computers, part I:

- The equations that model chaotic systems cannot be solved by hand. You have to solve them numerically, with a computer.
- Before the advent of widely available programmable digital computers, this was a real pain.
- So my field only really took off in the 1970s. Computers are our laboratories!
- But there are some important things to consider when a computer is your lab tool...

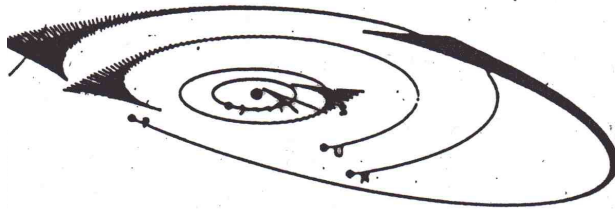
symmetric partitioned multistep, $h = 100$



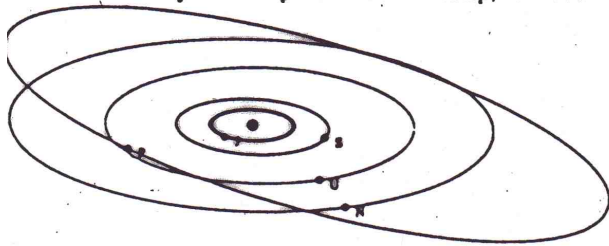
symmetric partitioned multistep, $h = 100$



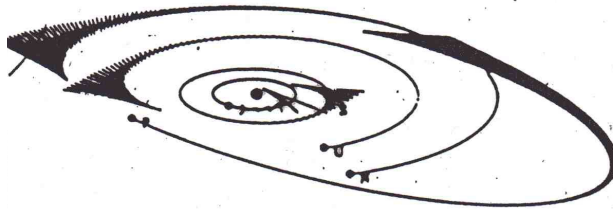
symmetric multistep, $h = 100$



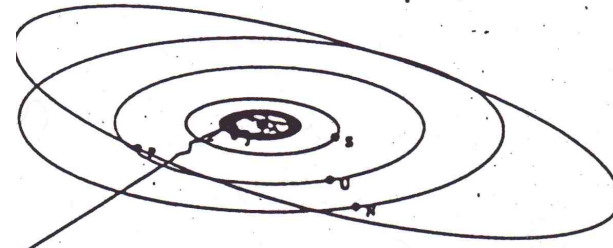
symmetric partitioned multistep, $h = 100$



symmetric multistep, $h = 100$



Adams explicit, $h = 100$



Moral: computer simulators can run amok

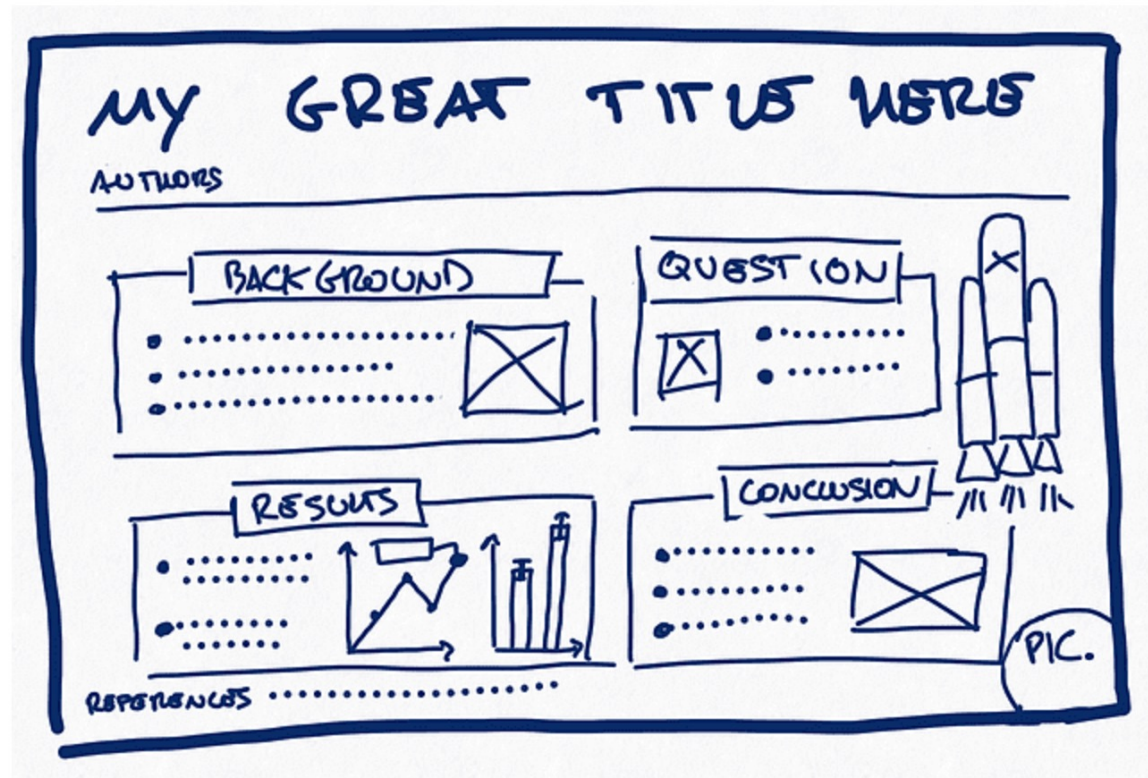
(in “interesting” ways!)

- can cause distortions, bifurcations, etc.
- and these look a lot like the kinds of effects that result from *real, physical* dynamics...
- whence: algorithms, parameters, and even the arithmetic system!
- best practice: test whether your results include spurious numerical dynamics by changing those things

Your assignment (part I)

Step 2 – Concept

Here is where the fun starts. Grab a piece of paper, or open up your design software, and make a first draft.



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