Emergence Lecture 14 CHAOS

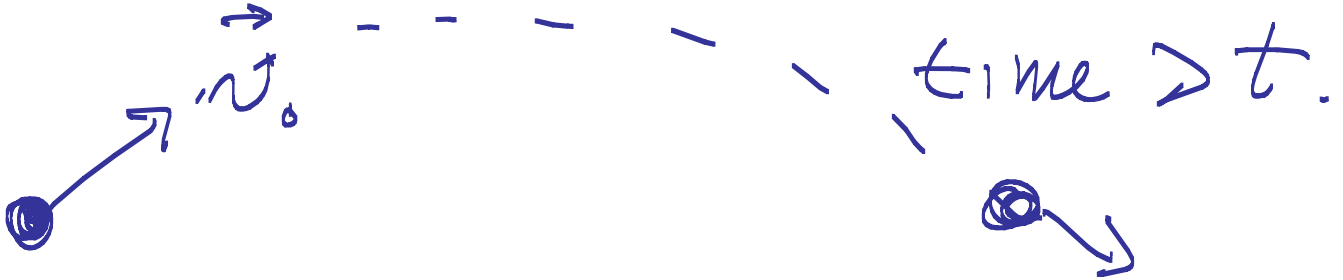
Deep Simplicity

ch 1, 2, 3, → about chaos.

Basic idea

initial conditions

"laws"



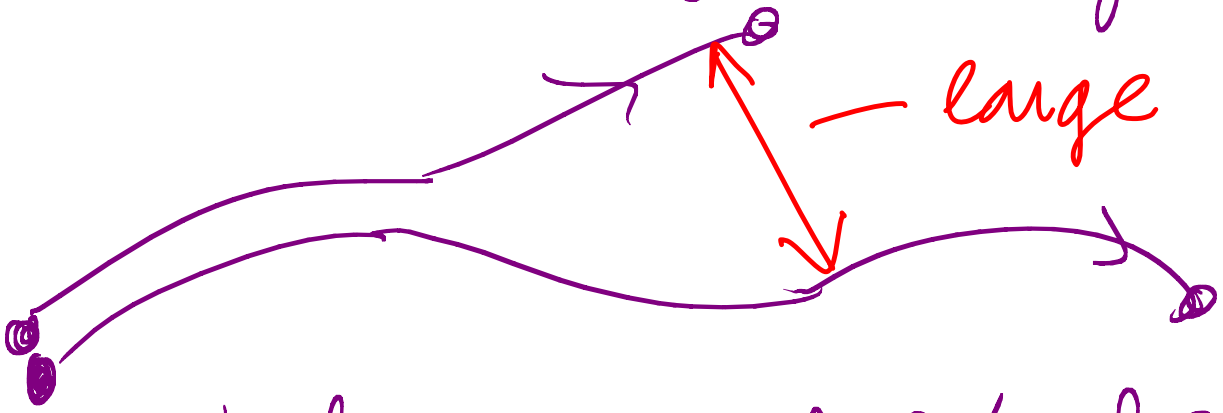
Newton's Eq^{n}s say $t \to -t$.
completely deterministic
reversible.

Deterministic $\Longleftrightarrow$ random.
not so sharp a distinction!

CHAOS $\equiv$ "effectively" random.
$\Longrightarrow$ "sensitive dependence on initial conditions".

NOT random.

effectively random — unpredictable even though deterministic!



— large for later time.

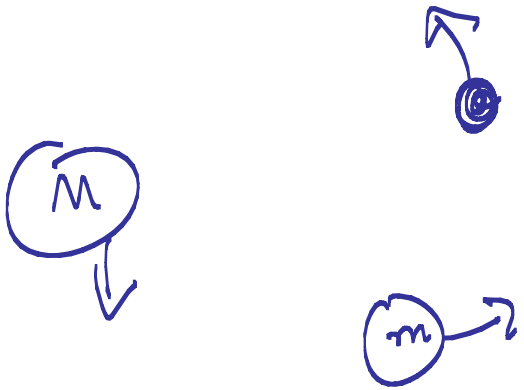
diverges

2 initial conditions VERY close

"Butter Fly effect". — Jurassic Park.

small details → large consequences

3 Body problem.



? → chaotic.

Newton solved 2 body prob.
"in closed form"

Poincaré did → NO closed form for 3 bodys (or more).

"chaos" — Lorenz.

convection
- air gets lighter when it's hot
- heavier if cooler.

Lorenz Model
→ chaotic motion

Motion described by "an attractor"

"butterfly attractor". 1960s.

1970s → simple computer models.

James Gleick — "CHAOS — making a new science"

popular book.

→ launched the fad for "chaos theory".

CHAOS ⟷ Fractals.