PHYSICS 221a   Non-Linear Dynamics   Spring 2017

<u>TOPICS</u>

I.   <u>Basics</u>

  i.   Overview and definitions

  ii.   Chaos, Entropy and their measurement
        a.) Orbit stability, stable/unstable manifolds
        b.) Lyapunov exponents
        c.) KS entropy, relation to other entropies
        d.) Chaotic flows and magnetic dynamics

  iii. Countings DOF's, Attractors and Dimension
        a.) Attractors and their significance
        b.) Fractal dimension, measure and its dimension
        c.) Spectrum of dimension
        d.) Fractal attractions in experiments, computing the conformation
            dimension

II.   <u>Patterns</u>

  i.)   Patterns in space – Convection and its evolution
         a.) Review of linear theory of Rayleigh-Benard convection
                b.) Envelope theory → Newell-Whitehead equation
         c.) Secondary convection roll bifurcations and patterns
         d.) Flux-driven convection: Chapman-Proctor model
         e.) Convection and mean flows: Howard-Krishnamurti
        model
  ii.) Patterns in Time – Synchronization
        a.) Oscillation entrainment, circle map
        b.) Interacting oscillators
        c.) Phase dynamics in space, time
            Kuramoto-Sivashinsky model

d.) Kuramoto transition, noise effects

e.) Synchronization in chaotic systems

iii.) Patterns and Structure in Transitions

a.) Turing instability, patterns, spirals

b.) Fisher fronts – 2nd order

c.) FN Waves – 1st order transitions, bi-stable, exictable media

d.) Negative Diffusion – Cahn-Hilliard equation and spinodal decomposition

e.) Gas dynamic and collision-less shock – an introduction

f.) Combustion: slow and fast (detonation)

III. <u>Multi-Scale Interaction</u>

i.) Structure formation by aggregation

a.) Coagulation →Schmoluchowski theory of colloids and extensions

b.) Coalescence →Slysozov-Lifshitz model

c.) (Inverse) cascade →2D fluid turbulence, relaxation

d.) Ballistic agglomeration →concepts in planet formation by sticking

ii.) (Wave) Turbulence

a.) Wave kinetics →Follow the Golden Rule!
      Time scales

b.) Non-local interactions, cascades, K-space avalanches

c.) Wave – Mean Interaction, -- NLS, modulations, instability, collapse

d.) Resonance clusters

e.) Statistics and Intermittency