

# RHYTHMS COURSE

JON CANNON, BEN POLLETTA

Content-goals:

- (1) Classical models of brain rhythms
- (2) Basic experimental/analysis techniques for rhythms

Skill-goals:

- (1) Read experimental rhythms papers
- (2) Ask questions and hypothesize at the edge of the field
- (3) Turn experimental results into psuedo-computational models

Assignments:

- Day 1: Papers accompanied by comprehension worksheets
  - Restate
  - Interpret data/figures
- Day 2: Synthesis assignment
  - Extrapolate/hypothesize
  - Pose questions
  - Design model

Tools:

- Qualitative analysis of vector fields in phase plane

By week:

- (1) Introductory week
  - Syllabus
  - Review the neuron
    - Neurons maintain electrical potential difference with environment
    - Different types of ions are conducted in and out through channels, affecting potential

- \* Terminology: INWARD vs. OUTWARD, Polarizing vs. Hyperpolarizing
- \* Terminology: Conductance
- Some ion channels open and close with voltage
- Neurons interface at synapses
  - \* Some open INWARD excitatory channels
  - \* Some open OUTWARD inhibitory channels.
- Introduce 2D vector fields
  - The spike:  $V$  vs.  $n$
  - STATE determines DIRECTION
- Introduce the frequency domain
  - How to read a power spectrum
    - \* What does a sine wave look like in the freq domain?
    - \* What does a sum of sine waves look like?
    - \* Look at other signal/spectrum pairs
  - How to read a spectrogram
- (2) Gamma 1: What does the data say?
  - Fast-spiking cells are critical.
  - Frequency is connected to inhibition time constant
- (3) Gamma 2: What neural mechanism creates it?
- (4) Gamma 3: What function might it serve?

### **PART 1: Cortico-thalamic rhythms**

- (5) Alpha 1: What does the data say?
  -
- (6) Alpha 2: What neural mechanisms create it?
  -
- (7) Beta 1: What does the data say?
  -
- (8) Beta 2: What neural mechanisms create it?

•

## **PART 2: Hippocampal rhythms**

(9) Theta 1: What does the data say?

•

(10) Theta 2: What neural mechanisms create it?

•

(11) Ripples 1: What does the data say?

•

(12) Ripples 2: What neural mechanisms create it?

•

(13) Ripples/Theta: What functions are theta and ripples serving

•

(14) Projects 1

(15) Projects 2

(16) Projects 3

## OLD OUTLINE

16 weeks

1a. Introduction: what are rhythms? 1b. Methods:

Gamma Themes: Synchronous spiking, feedback inhibition 1. 2. 3.

## PART 1: Cortico-thalamic rhythms

Alpha Themes: (Negative) attention, central control by thalamus, bursting Papers: Topics: 4. 5.

Beta Themes: Top-down control, laminar architecture 6. 7.

Delta 8.

## PART 2: Cortico-hippocampal rhythms

Theta Themes: Nested rhythms, phase coding 9. 10. 11.

SWR Themes: Sequences, plasticity 12. 13.

14-16 Projects

## 1. REFERENCES