Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Network oscillations of inferior olive neurons: entrainment and phase-locking of locally-coupled oscillators THOMAS CHARTRAND, MARK S. GOLDMAN, TIMOTHY J. LEWIS, University of California, Davis — Although the inferior olive is known to contribute to the generation of timing and error signals for motor control, the specific role of its distinctive spatiotemporal activity patterns is still controversial. Olivary neurons display regular, sometimes synchronized oscillations of subthreshold membrane potential, driven in part by the highest density of electrical coupling of any brain region. We show that a reduced model of coupled phase oscillators is sufficient to reproduce and study experimental observations previously only demonstrated in more complex models. These include stable phase differences, variability of entrainment frequency, wave propagation, and cluster formation. Using the phase-response curve (PRC) of a conductance-based model of olivary neurons, we derive our phase model according to the theory of weakly-coupled oscillators. We retain the heterogeneity of intrinsic frequencies and heterogeneous, spatially constrained coupling as weak perturbations to the limit-cycle dynamics. Generalizing this model to an ensemble of coupled oscillator lattices with frequency and coupling disorder, we study the onset of entrainment and phase-locking as coupling is strengthened, including the scaling of cluster sizes with coupling strength near each phase transition.

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Date submitted: 13 Nov 2014 Electronic form version 1.4