JR note: on repetitive firing of HH model. Feb 15, 2009

- Does not fire APs (action potentials) at arbitrarily low frequency for steady applied current, I_{app}. Hodgkin (1948) called this Class/Type II excitability.
- For large I_{app}, responses shrink in size…not really APs. Only steady depolarization for very large I_{app} – "nerve block".
- Firing frequencies are higher at higher temperature. Threshold value of I_{app} for repetitive firing increases with temperature.
- HH model (and a class of other AP models) show bistability just above threshold value for step of I_{app}.
- Ref'ce: Rinzel J. and Miller R.N. (1980) Numerical calculation of stable and unstable periodic solutions to the Hodgkin-Huxley equations, *Math. Biosci.*, 49: 27-59

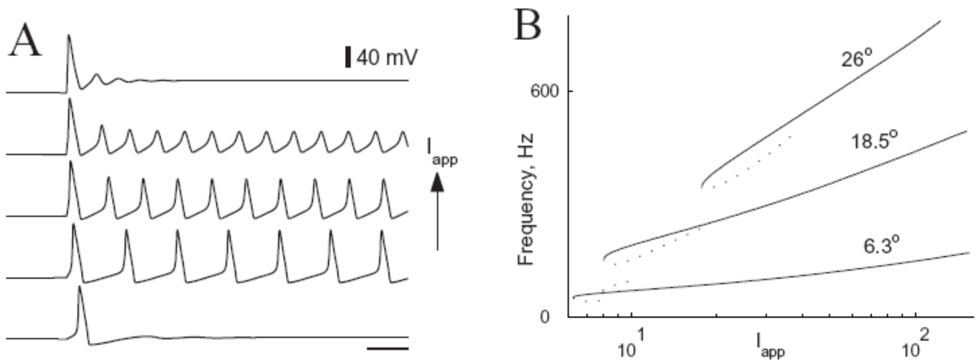

Fig. 5. Repetitive firing through Hopf bifurcation in Hodgkin-Huxley model. *A:* Voltage time courses in response to a step of constant depolarizing current (several levels of current: from bottom to top: I_{app}= 5, 15, 50, 100, 200 in μamp/cm^2). Scale bar is 10 msec. *B:* f-I curves for temperatures of 6.3 18.5, 26°C, as marked. Dotted curves show frequency of the unstable periodic orbits.

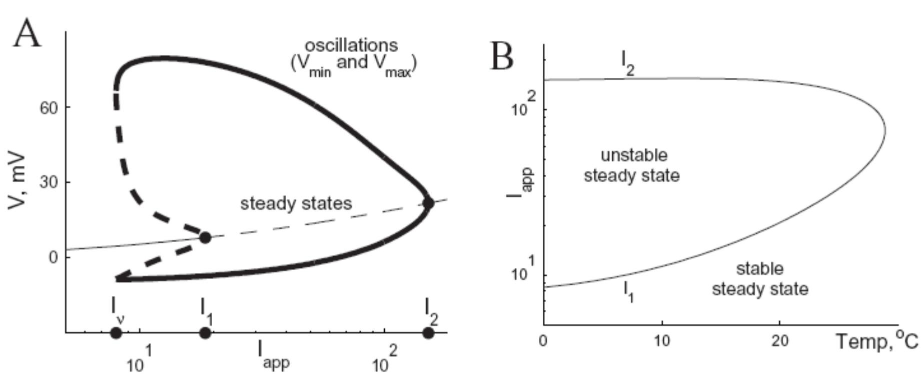

Fig. 7. *A:* Bifurcation diagram showing the possible behaviors for the Hodgkin-Huxley equations for different values of I_{app} at temperature 18.5° C. I_1 and I_2 denote Hopf bifurcations of the steady states, I_ν bifurcation of the periodic solutions. *Thin solid curves:* stable steady state, *thin dashed curves:* unstable steady state, *thick solid curves:* maximum and minimum V of the stable limit cycle, *thick dashed curves:* maximum and minimum V of the unstable limit cycle. *B:* Range of I_{app} where the steady state is unstable plotted as a function of temperature. In both panels I_{app} is in μA/cm^2.