

$$v_{Na} = 115\text{mV}, \quad v_K = -12\text{mV}, \quad v_{Na} = 10.6\text{mV}, \quad C = 1\mu\text{Farad/cm}^2,$$

where " $\Omega$ " is one Ohm, the unit of resistance.

Non-dimensionalise with  $v = v/v_{Na}$  and  $\tau = t/[5\text{ms}]$ , as  $\tau_n(v) \sim O(5\text{ms})$ , and we have

$$\begin{aligned} \epsilon \frac{dv}{d\tau} &= I_{ext} - g(v, n) \stackrel{\text{def}}{=} I_{ext} - [m_{\infty}^3(v)(0.85 - n)(v - 1) + \gamma_K n^4(v + v_K) + \gamma_L(v - v_L)] \\ \frac{dn}{d\tau} &= k(v, n) \stackrel{\text{def}}{=} \frac{1}{\tau_n^*(v)} [n_{\infty}(v) - n], \end{aligned} \quad (21)$$

with

$$\epsilon = \frac{C}{G_{Na}[5\text{ms}]} = 2 \times 10^{-3}, \quad \gamma_K = \frac{G_K}{G_{Na}} \sim 0.3, \quad \gamma_L = \frac{G_L}{G_{Na}} \sim 3 \times 10^{-3},$$

$$I_{ext} = \frac{I_{ext}}{G_{Na}v_{Na}}, \quad v_K = -\frac{v_K}{v_{Na}} \sim 0.1, \quad v_L = -\frac{v_L}{v_{Na}} \sim 0.1, \quad \tau_n^*(v) = \tau_n(v)/[5\text{ms}] \sim O(1).$$

We can now sketch the nullclines, and noting the different timescales of the membrane potential response to the gating variable response (as  $\epsilon \ll 1$ ) we can consider the phase plane trajectories in terms of fast and slow dynamics.

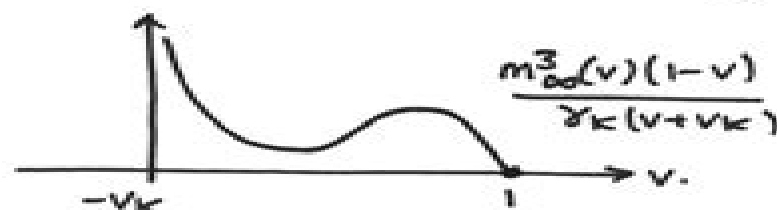
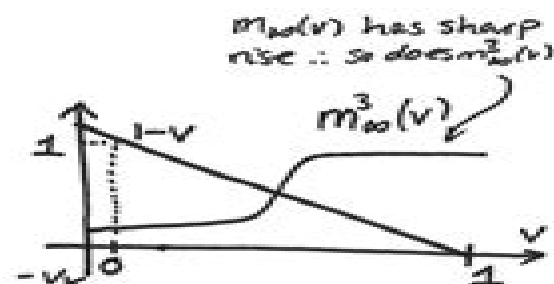
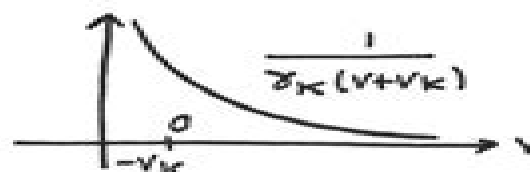
Plotting nullclines.  $I_{ext} = 0$ .

$$\begin{aligned} -\epsilon dv/d\tau = g &= m_{\infty}^3(v)(0.85 - n)(v - 1) + \gamma_K n^4(v + v_K) + \gamma_L(v - v_L) \\ dn/d\tau = k &= \frac{1}{\tau_n^*(v)} [n_{\infty}(v) - n] \end{aligned}$$

$\gamma_L$  small: neglect this below.

v nullcline

$$\frac{n^4}{0.85 - n} = \frac{m_{\infty}^3(v)(1 - v)}{\gamma_K(v + v_K)}$$



# Mathematical Physiology

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## **Mathematical Physiology:**

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*Introduction to Mathematical Physiology and Biology*, 1999 [An Introduction to Mathematical Modeling in Physiology, Cell Biology, and Immunology](#) James Sneyd, 2002 In many respects biology is the new frontier for applied mathematicians This book demonstrates the important role mathematics plays in the study of some biological problems It introduces mathematicians to the biological sciences and provides enough mathematics for bioscientists to appreciate the utility of the modelling approach The book presents a number of diverse topics such as neurophysiology cell biology immunology and human genetics It examines how research is done what mathematics is used what the outstanding questions are and how to enter the field Also given is a brief historical survey of each topic putting current research into perspective The book is suitable for mathematicians and biologists interested in mathematical methods in biology

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**Modeling Human Atrial Patho-Electrophysiology from Ion Channels to ECG - Substrates, Pharmacology, Vulnerability, and P-Waves** Loewe, Axel, 2016-08-03 Half of the patients suffering from atrial fibrillation AF cannot be treated adequately today This book presents multi scale computational methods to advance our understanding of patho

mechanisms to improve the diagnosis of patients harboring an arrhythmogenic substrate and to tailor therapy The modeling pipeline ranges from ion channels on the subcellular level up to the ECG on the body surface The tailored therapeutic approaches carry the potential to reduce the burden of AF      *Democratic Global Governance* Irene Lyons

Murphy,2010-09-28 *Democratic Global Governance* is a component of *Encyclopedia of Institutional and Infrastructural Resources in the global Encyclopedia of Life Support Systems EOLSS* which is an integrated compendium of twenty one Encyclopedias The theme on *Democratic Global Governance* relates the critical international issues of the post war era to the major decisions of the UN and its IGO network It is divided into two topics the first concerns global governance and the collective decision processes of the UN system while the second reviews and analyzes the impact of the nongovernmental sector as it has grown in strength and become part of a nascent global civil society This volume is aimed at the following five major target audiences University and College students Educators Professional practitioners Research personnel and Policy analysts managers and decision makers and NGOs      **Range and Animal Sciences and Resources Management -**

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