480W Worksheet #5 (PW & LS) 1a

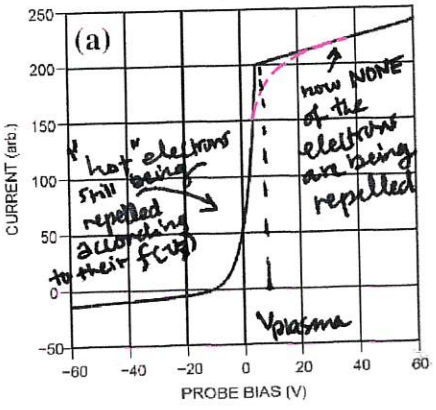
Goals

#1 To 'see' connections between 2 very different experiments, Plasma waves & laser spectroscopy of the ground state of RbI

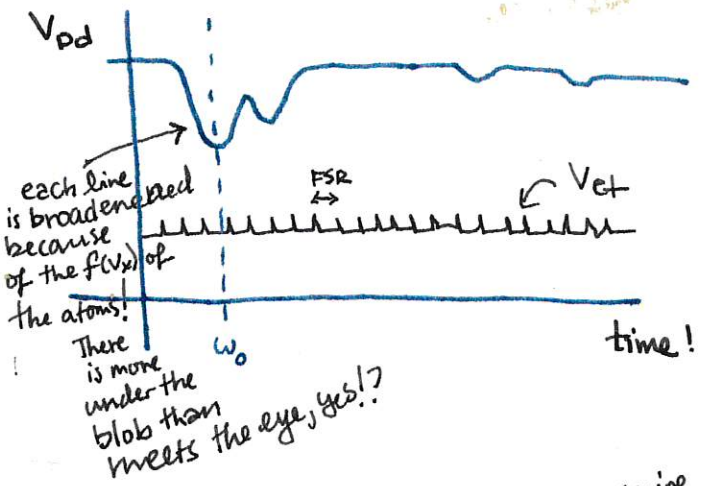
#2 To acquire useful perspectives (figures of merit, appreciating scales {as a contra-example, a figure drawn 'not to scale'}) regarding the features of real signals – so that – we may connect theory and squiggle, model and graph.

Some Graphs

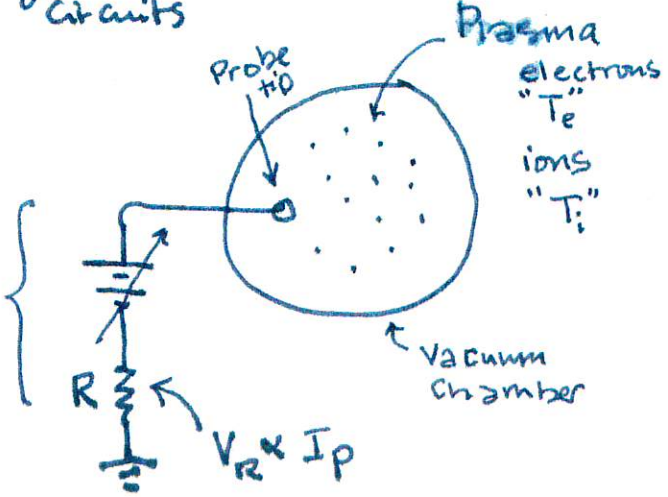
(A) from Merlino, Am. J. Phys. Vol 75, 1081 (2007). PW

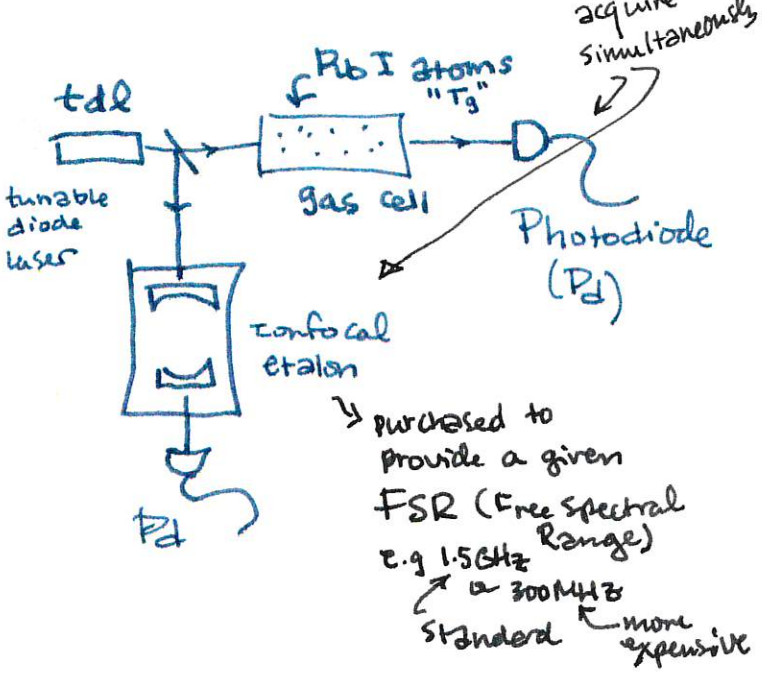


(B) LS



Transducers & Circuits





Connect to theory usefully

Task #1

Define in words

a) $\psi^*_E(x)\,\psi_E(x)\,dx$ .... probability of finding quanton between x & $x+dx$ as a result of a position measurement (1-D). $\int \psi^*\psi$ not a probability ooops... if quanton is in energy eigenstate $\psi_E(x)$

b) $A v^2 e^{-\frac{\frac{1}{2}mv^2}{kT}}\,dv$

c) $B\,e^{-\frac{1}{2}mv_x^2/kT}\,dv_x$ .... probability of finding a classical particle of mass m to have a velocity along $\hat{x}$ between v_x & v_x+dv_x as a result of a velocity measurement.

B ← normalization constant

Task #2

label the axes of both graphs. Give as much detail as you can. Yes/No Would it be useful to have a qualitative sketch of a) what you anticipate your raw data will look like with the qualitative features 'explained', b) actual data, c) a discussion of connections, corrections, notice of figures of merit – control setting required to produce it, along w. an up dated sketch (Block diagram) of all measuring circuits? Why? Explain.

Task # 3

PW - - - -

i) plot I_e vs V_b on a new set of axes, assuming that V_b takes on all the values between $V_b \gg V_{pl}$ & $V_b \ll V_{pl}$ where V_{pl} is 'the plasma potential'.

ii) Set up (but do not solve) the mathematical expression for $I_e(V_b)$.

iii) Why is the electron branch of the graph labeled (A) so much 'taller' than the ion branch? Construe, explain.

Merlino, ibid.

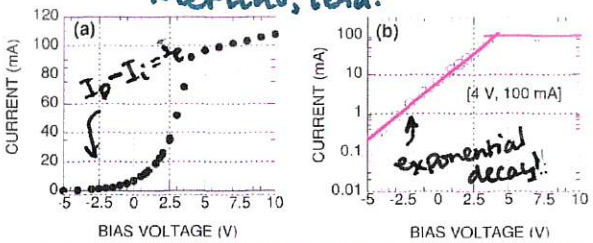
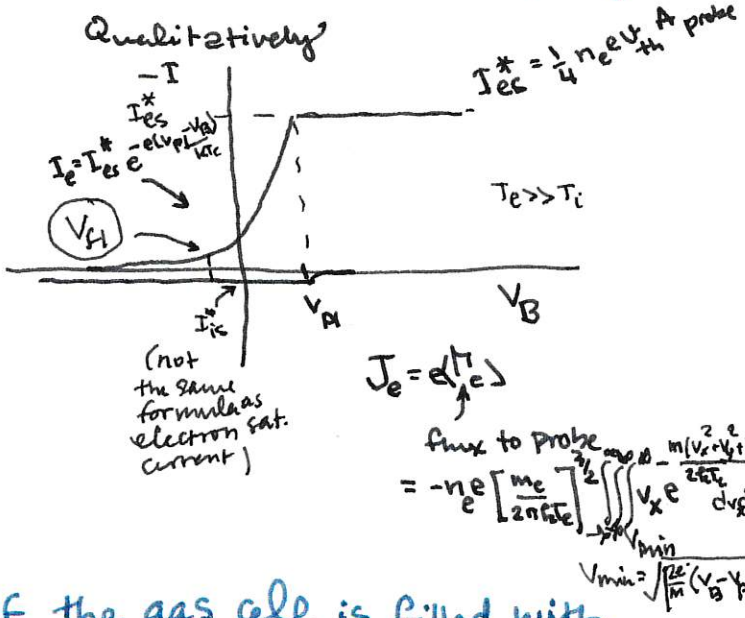


Fig. 5. Langmuir probe I-V characteristic obtained in a multidipole plasma in argon at a pressure of 0.5 mTorr. (a) Electron current. (b) log $I(V_B)$ versus V_B. The semilog plot of the electron current provides a clear demarcation of the plasma potential and electron saturation current. T_e is found from the slope of the exponentially decreasing portion.

Qualitatively

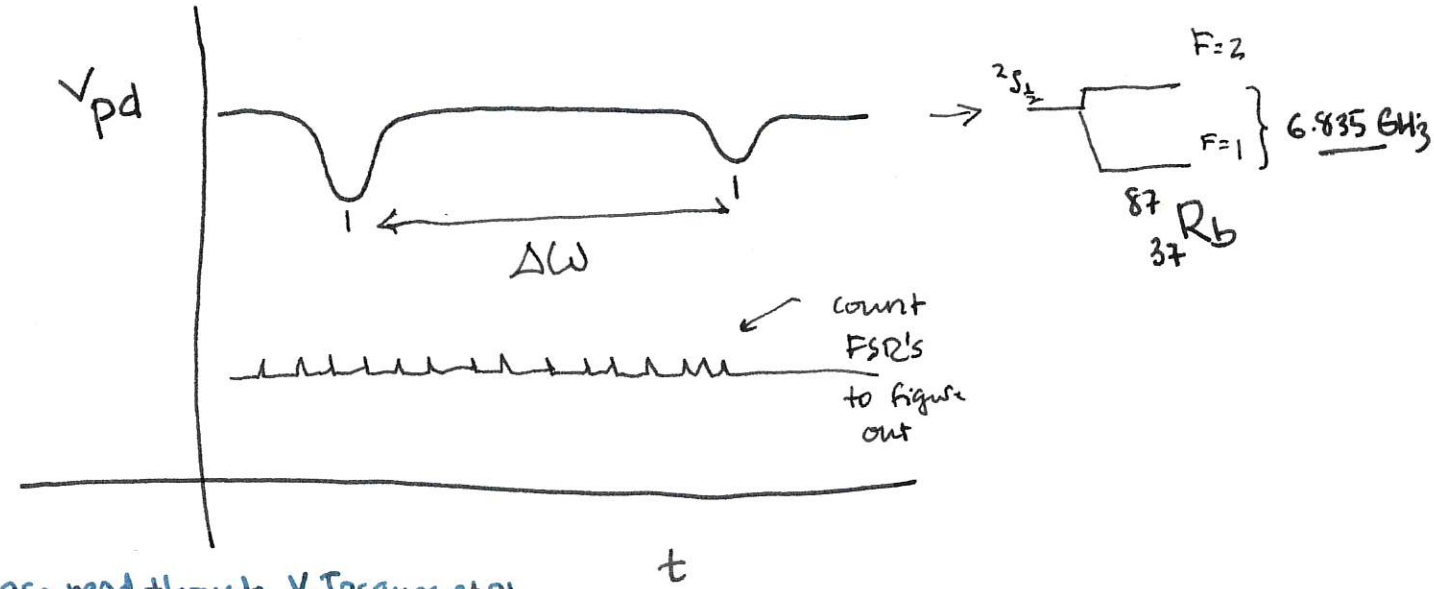


LS - - - -

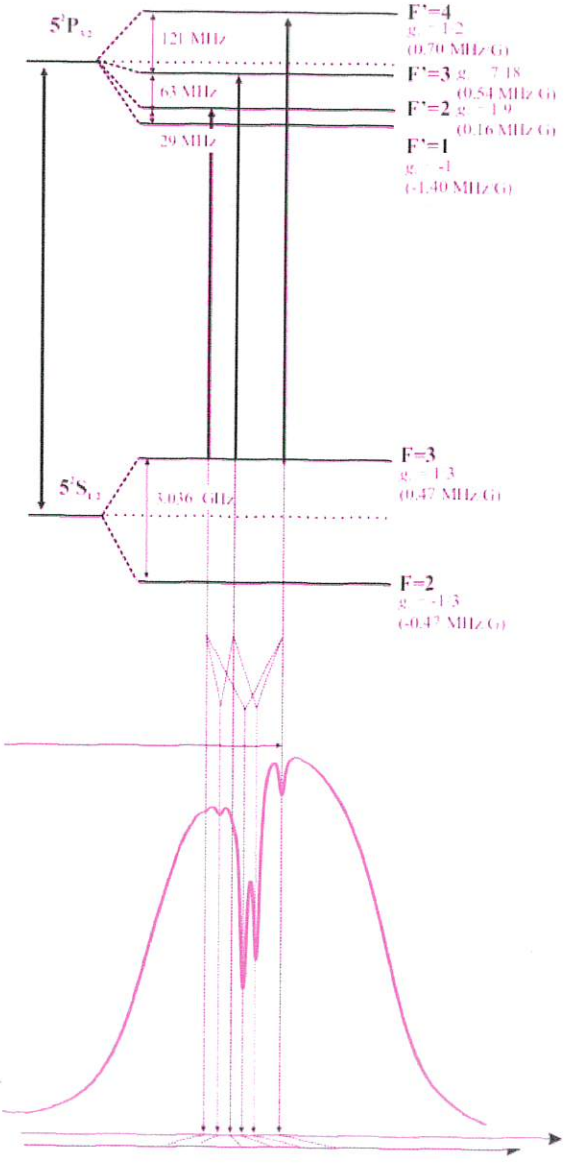
i) plot I_{pd} vs ω as if the gas cell is filled with isotopically pure $^{87}_{37}Rb$, assuming ω takes on all the values between $\omega \gg \omega_0$ and $\omega \ll \omega_0$

ii) set up (but do not solve) the expression for I_{pd}. What assumptions would you like to introduce to make this task easier and more focused on 'the physics' less on the devices

iii) If $\Delta W_{hfs} \gg \hbar\Gamma_g$ what should this graph look like, why, and please 'reconcile' your understanding with the graph labeled (B)



Please read though V. Jacques et al. Eur J. Phys. 30 921ff (2009).



- So there is much more under the blob than meets the eye! (er, photo detector)
- Why?
  - Draw a partial Grotrian Diagram for $^{87}_{37}Rb$ to explain it. How many lines will you see?
  - How to measure 'sub-Doppler' features .... How to eliminate Doppler Broadening?
    - * look at page (2) bottom right – schematic of absorption experiment
    - * how to modify this to enable the measurement of sub doppler features? Redraw!

YES I do expect ½ of the students to have read sec. 6.6 of Melissinos.