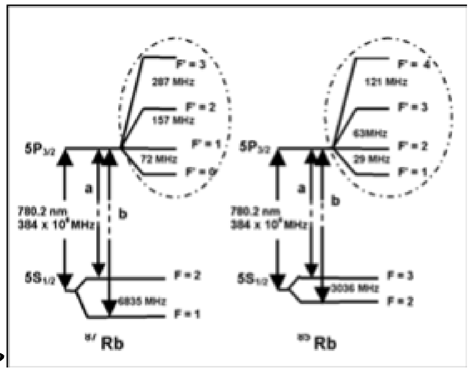
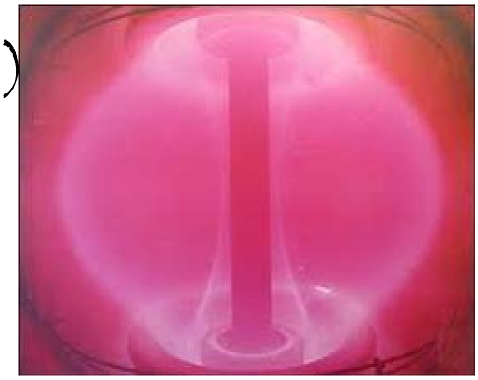
Experimental Physics, 480W, L12

Goal # 1 : How do the ν experiments work? (new labs:plasma & laser spectroscopy)





Goal # 1 Do good experimental work.

Goal #2 Write Mathematical prose well.

Goal #2 Write Mathematical prose well.....ok, so, a comment about formatting, this time AIP (not LaTeX....)

For this paper (and next), strict AIP formatting rules will be operative!

- journal article:

[1]R. P. Feynman, Phys. Rev. **94**, 262 (1954).

- book

[8]E. Beutler, "Williams hematology," (McGraw-Hill, New York, 1994) Chap. 7, pp. 654–662, 5th ed.
[9]D. E. Knuth, "Fundamental algorithms," (Addison-Wesley, Reading, Massachusetts, 1973) Section 1.2, pp. 10–119, 2nd ed., a full INBOOK entry.

How does LaTeX produces this output? In 2 ways:

1) use \begin{thebibliography}{99} ...\bibitem {label} stuff, \bibitem{label} more stuff.....\end{thebib....}

- latex your .tex file twice for every change in citations and references!

2) use BibTeX

- create/edit a papername.bib file with entries according to a rigid format (see aipsamp.bib)
- latex your .tex file, then
- BibTeX your .tex file, then
- latex your .tex file again twice!....then you should have it......

```
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 # "\providecommand{\singleletter}[1]{#1}%"
}

@BOOK{Bire82,
   author      = {N. D. Birell and P. C. W. Davies},
   year        = 1982,
   title       = {Quantum Fields in Curved Space},
   publisher   = {Cambridge University Press}
}

@ARTICLE{feyn54,
   author      = "R. P. Feynman",
   year        = "1954",
   journal     = "Phys.\ Rev.",
   volume      = "94",
   pages       = "262",
   doi         = "10.1029/2002JD002268",
}

@ARTICLE{epr,
   author      = "A. Einstein and {\relax Yu} Podolsky and N. Rosen",
   year        = "1935",
   journal     = "Phys.\ Rev.",
   volume      = "47",
   pages       = "777",
}
```
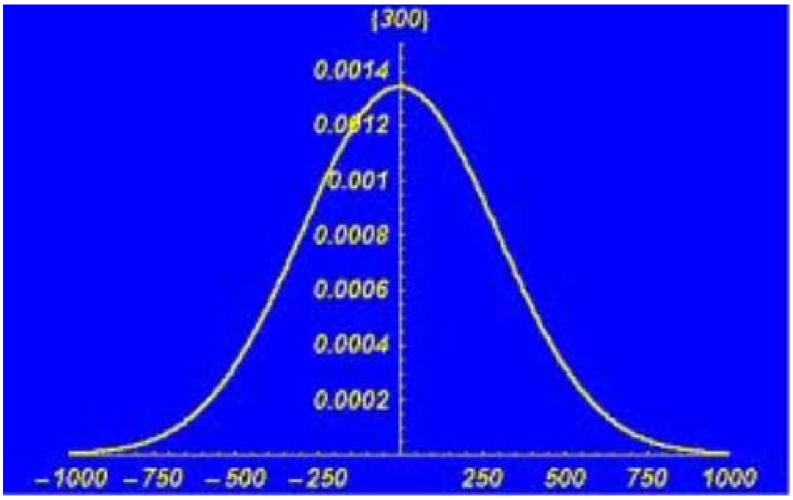
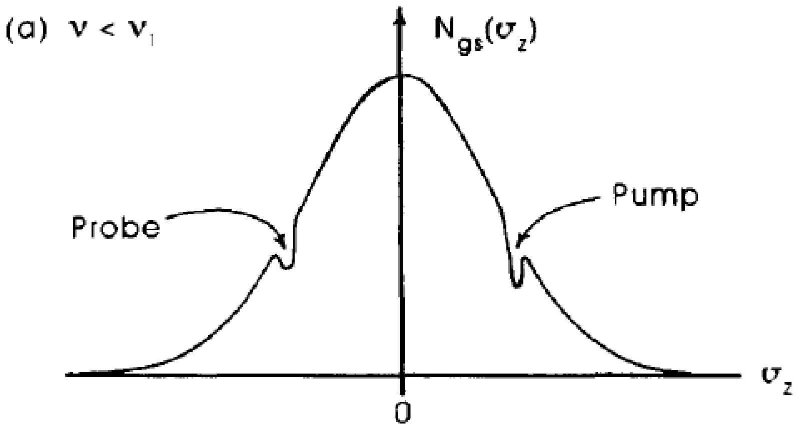
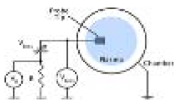

The 2 new experiments have a number of physics ideas in common: one idea is this thing called the

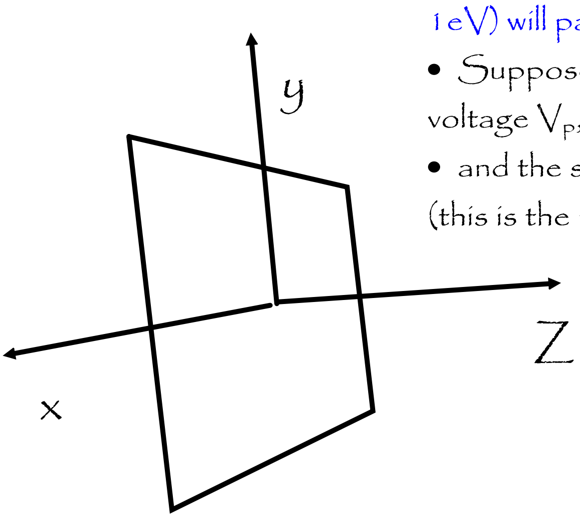
VELOCITY SPACE DIAGRAM or
VELOCITY DISTRIBUTION FUNCTION





tral lines. To understand these it helps to look at Fig. 4, which shows the number of atoms in the ground state, $N_{gs}(v_z)$ as a function of atomic velocity v_z (where positive v_z is parallel to the probe beams). In Fig. 4(a) the laser





Imagine an oriented rectangular plane of Area `A'; what flux of electons (given a 1-D Maxwell-Boltzmann VDF, kT= 1 eV) will pass onto the plane?

- Suppose further, that the plane is metallic, and biased to a voltage V_p,
- and the space potential in which the electrons move is V_s (this is the plasma potential).

hints:

- not all of the vdf can be collected! Set up an integral over velocity space!
- If the probe is biased negatively w.r.t the plasma, the electrons must have some minimum velocity in Z to reach the probe!

Goal:

Try to understand why the electron current collected by a Langmuir Probe may be expressed as

$$Ie = (n_e e v_{th} A/4)^* \, e^{\{-e(Vp - Vs)/kTe\}}$$

Question: Why is it that when $V_p < V_s$, the probe collects a fraction of the random flux & not the whole? Why does this Boltzmann factor appear?

Answer: if $V_p < V_s$ the probe is more negative than the plasma so that only those electrons with $KE > |e(V_p - V_s)|$ can surmount the repulsive potential.

$$\bar{J}_e = e\langle \underset{\langle nv\rangle}{\Gamma_e} \rangle = -n_e e \left[\frac{m_e}{2\pi k T_e}\right]^{3/2} \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{v_{min}}^{\infty} v_x \, e^{-\frac{1}{2}\frac{m_e}{kT_e}(v_x^2+v_y^2+v_z^2)} \, dv_x dv_y dv_z$$

which, is the same as before

$$\bar{J}_e = -n_e e \left[\frac{m_e}{2\pi k T_e}\right]^{3/2} \left[\frac{2\pi k T_e}{m_e}\right]^{2/2} \left\{ -\frac{1}{2a^2} e^{-u} \right|_{u_{min}}^{\infty}$$

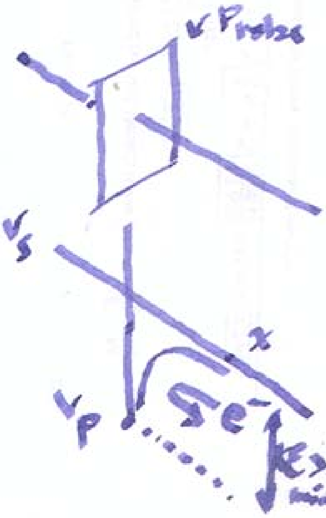
$$= -n_e e \left(\frac{m}{2\pi k T_e}\right)^{\frac{1}{2}} \left[\frac{kT_e}{m} e^{-u_{min}} \right]$$

$\frac{1}{a^2} = \frac{2kT_e}{m}$

$u = a^2 v_x^2$

$u_{min} = a^2 v_{x_{min}}^2$

$\frac{m}{2kT_e}\left[\frac{2e}{m}(V_s - V_p)\right]$



$KE_{min} > -e(V_p - V_s) \Rightarrow v_{min} = \sqrt{\frac{2e}{m}(V_s - V_p)}$