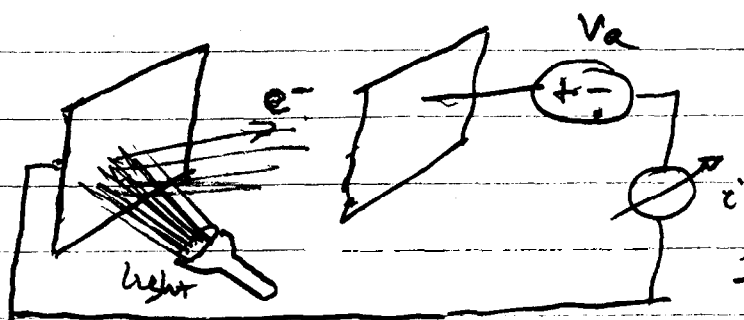
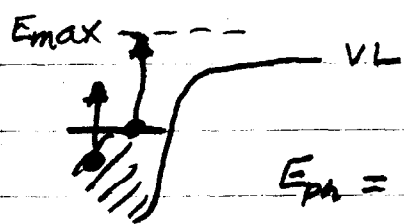


Photoelectric emission



Einstein 1905 explains why intense red light does not eject electrons

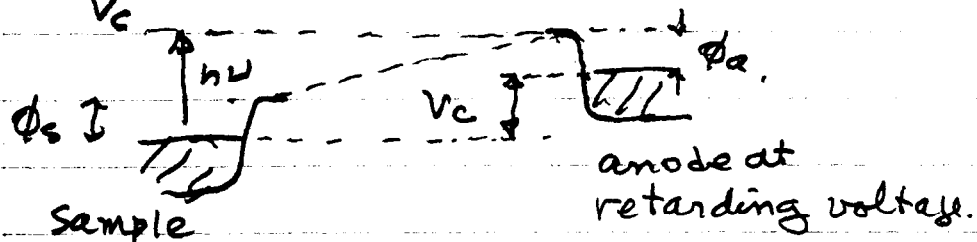
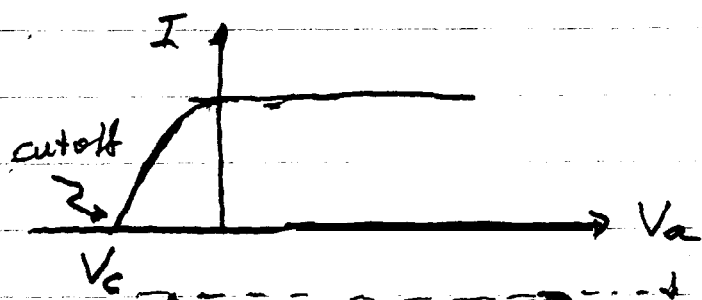


$$E_{ph} = h\nu = \frac{hc}{\lambda}$$

$$E_{ph}(\min) = \phi$$

$$E_{max} = h\nu - \phi$$

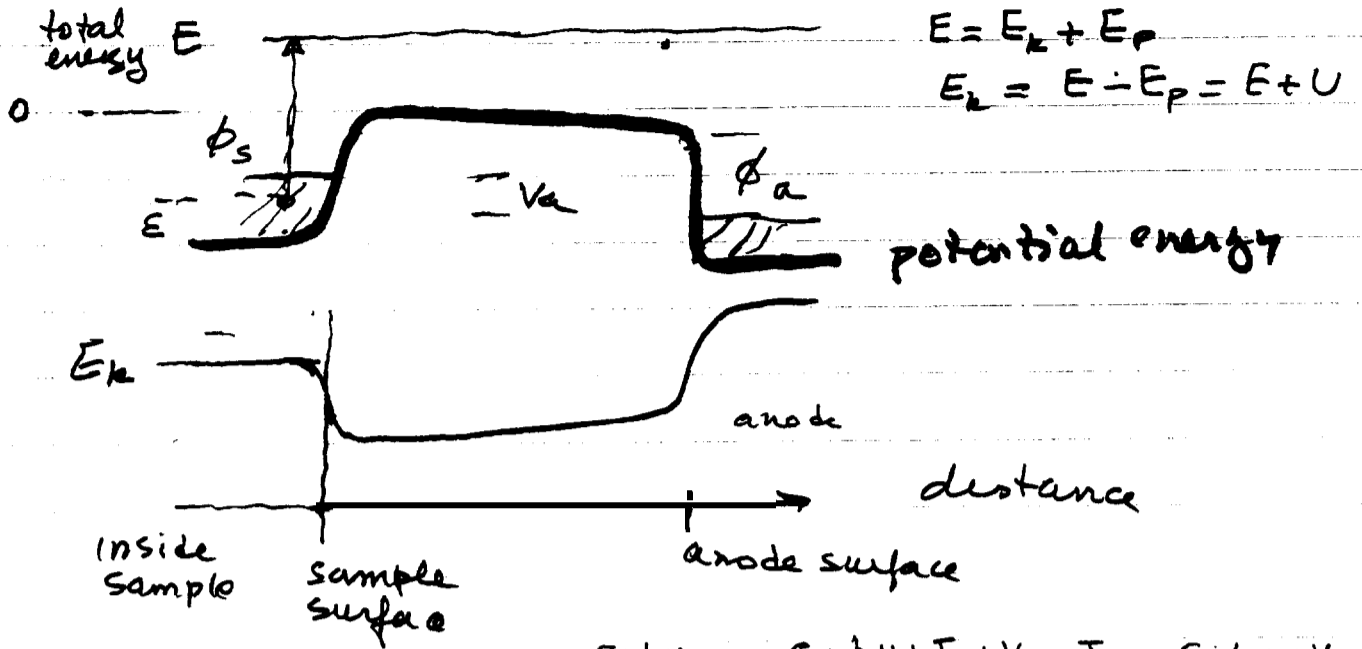
How is it measured?



At cutoff. $h\nu = V_c + \phi_a \Rightarrow V_c = h\nu - \phi_a$

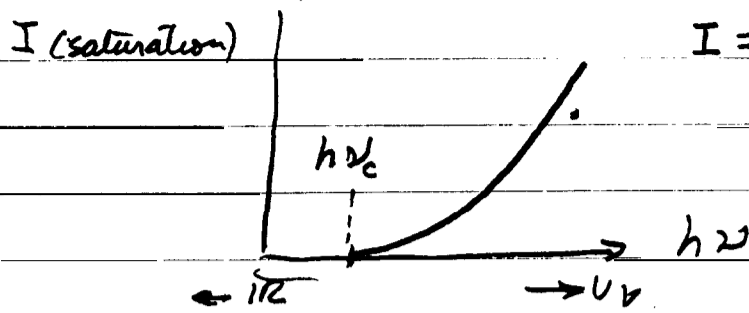
V_c measures anode ϕ , not sample's. Common error is to take $V_c = h\nu - \phi_s$

Electron kinetic energy varies from emitter to anode.



E_k	$E + h\nu$	$E + h\nu - \phi_s - I_s$	$E + h\nu - \phi_s + V_a - I_s$	$E + h\nu + I_a + V_a - I_s = E + h\nu + V_a + \phi_s - \phi_a$
U	I_s	I_s	$V_a + I_a + V_a$	

Fowler's equation



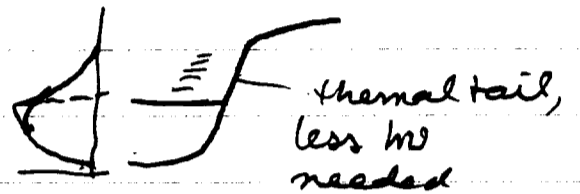
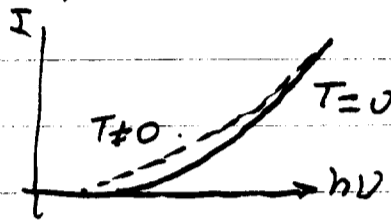
$$I = C(h\nu - \phi)^n$$

$n=2$ for metals
at $T=0$

$$\lambda = 12,398 \text{ \AA} / h\nu (\text{eV})$$

$h\nu = \phi_s$ this method measures ϕ_s of emitter

Thermal effects

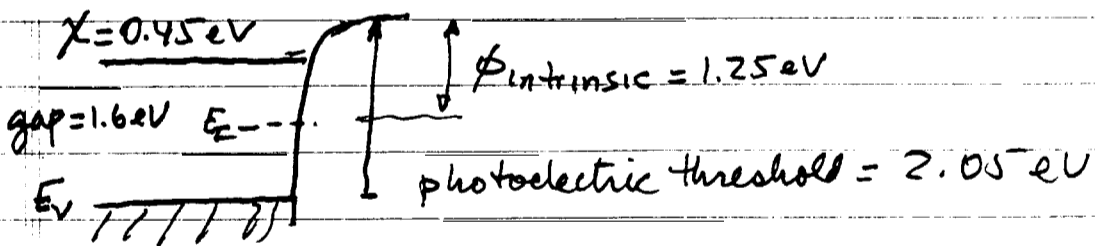


Photocathodes

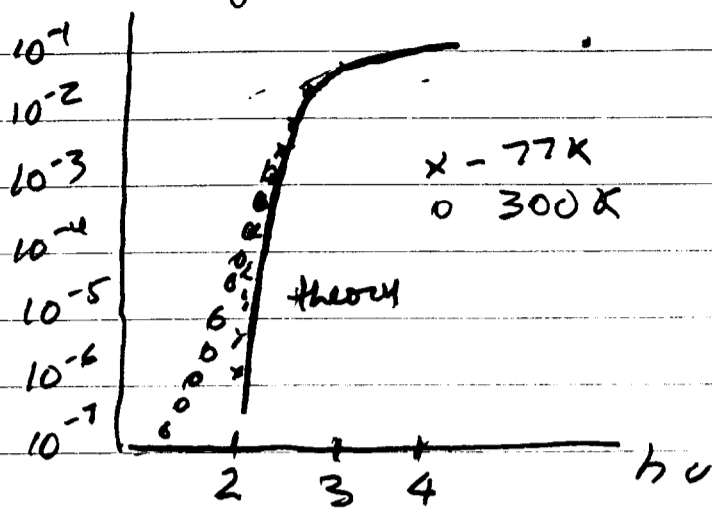
normal metals, $\phi \sim 4 \text{ eV}$	$\lambda_c \sim 3100 \text{ \AA}$	(UV)
alkali metals, $\phi \sim 2 \text{ eV}$	$\lambda_c = 6200 \text{ \AA}$	(visible)
Cs/metal $\phi \sim 1.4 \text{ eV}$	$\lambda_c = 8900 \text{ \AA}$	near IR

unstable

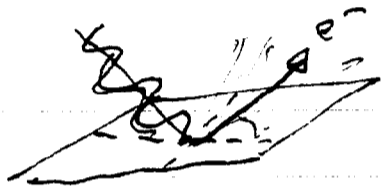
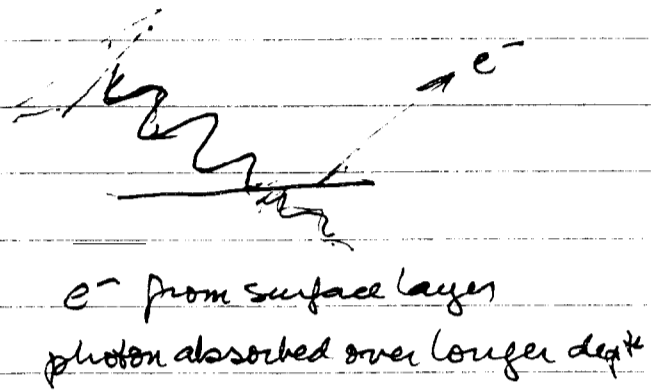
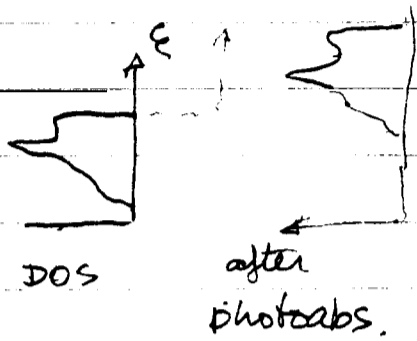
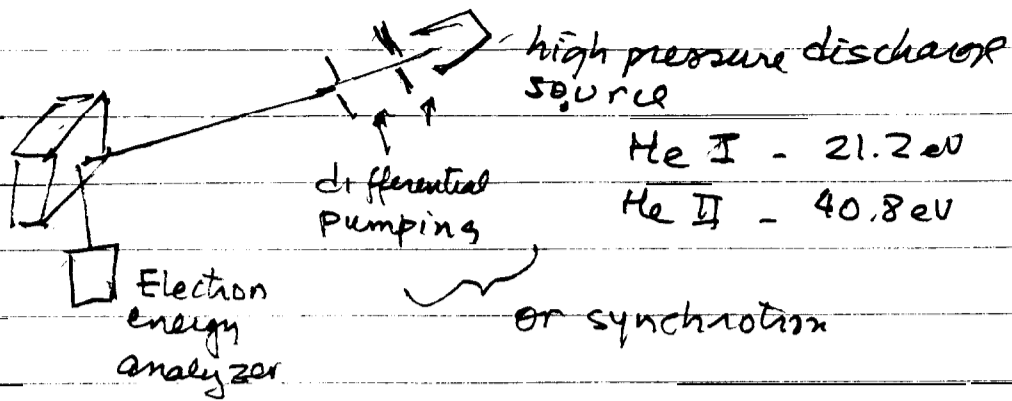
Cs_3Sb (semiconductor)



Quantum yield, $e^-/\text{photons}$



UPS Ultraviolet Photoelectron Spectroscopy

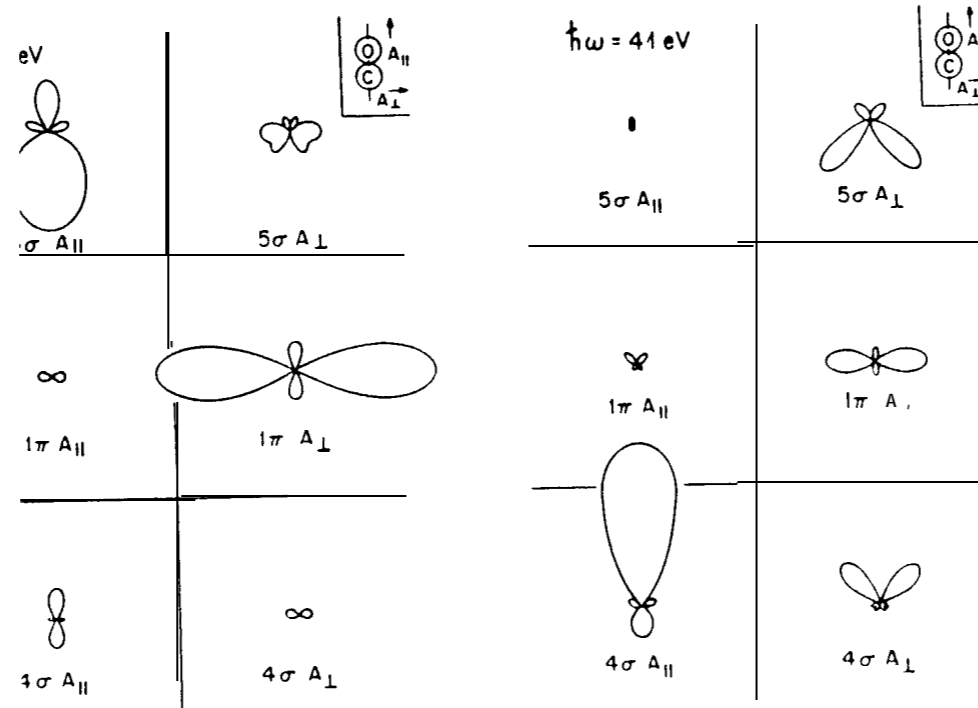


3. step.

- Absorption
- Transport
- Escape



$$\text{Absorption} \propto (\vec{A} \cdot \vec{p})^2 f(\vec{p})$$



2. — Calculated angular distributions of photoemission from principal valence states of an oriented CO molecule. $A_{||}$ and A_{\perp} to polarization directions parallel and perpendicular to the molecular axis. (Davenport, Ref. [3].)

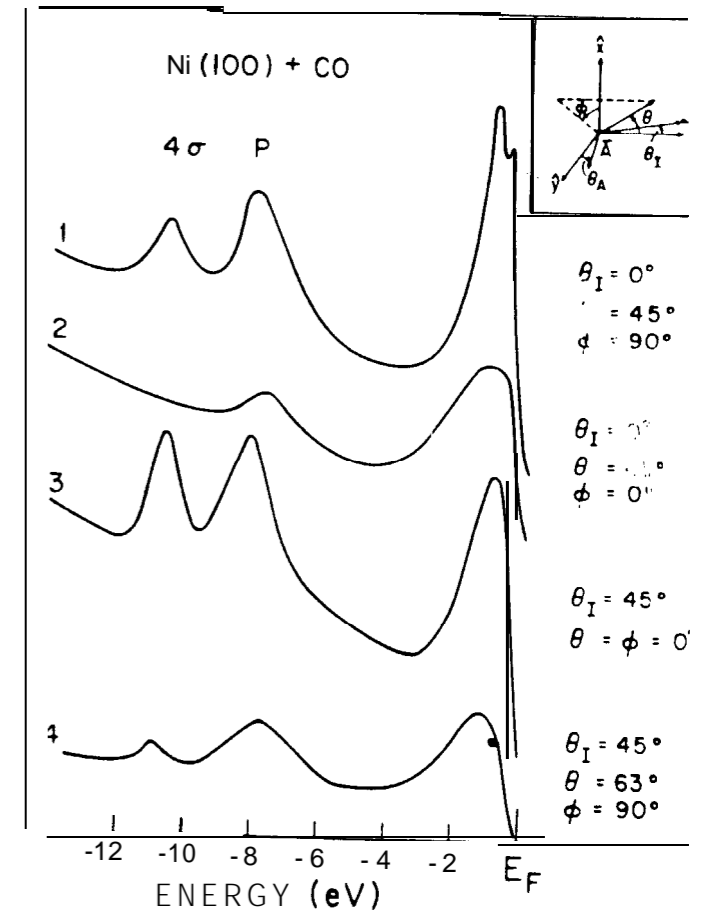
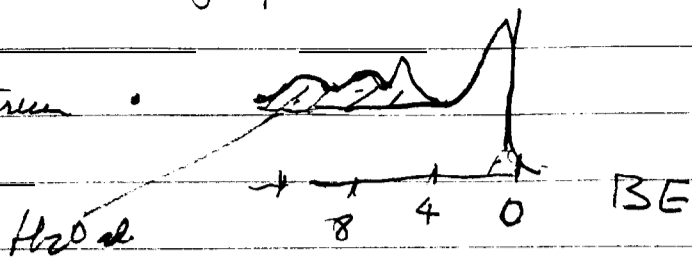


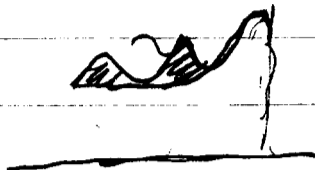
FIG. 3. — Experimental photoemission spectra for CO ads on Ni(100) taken for various angles of emission and condition polarization. (Allyn et al., Ref. [4].)

UPS example - fingerprinting

Typical metal spectrum .

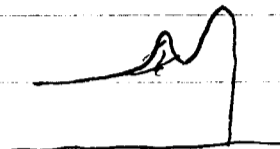


H₂O des.
into OH.



complete
dissociation

~ just O.



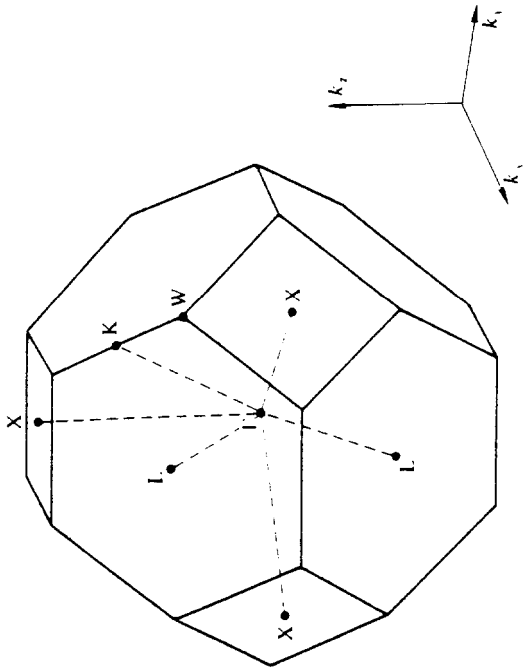


Fig. 2.3. The Brillouin zone in reciprocal space for a face-centred cubic or diamond lattice.

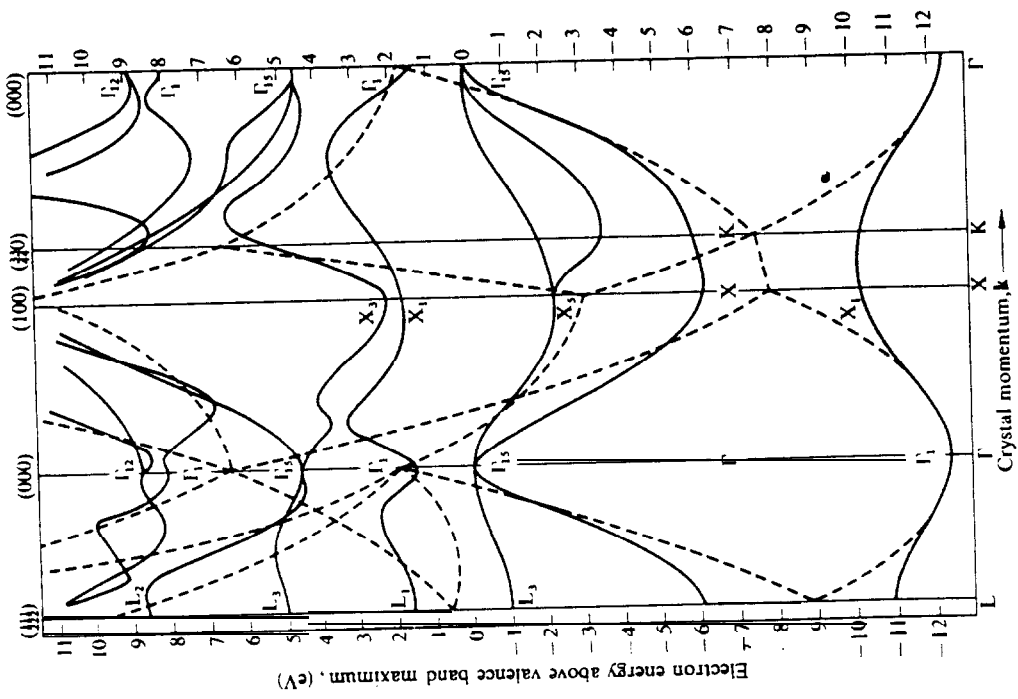


Fig. 2.4. Pseudopotential band structure of GaAs (Walter and Cohen 1969) and the empty-lattice approximation (dashed lines).