LECTURE #1

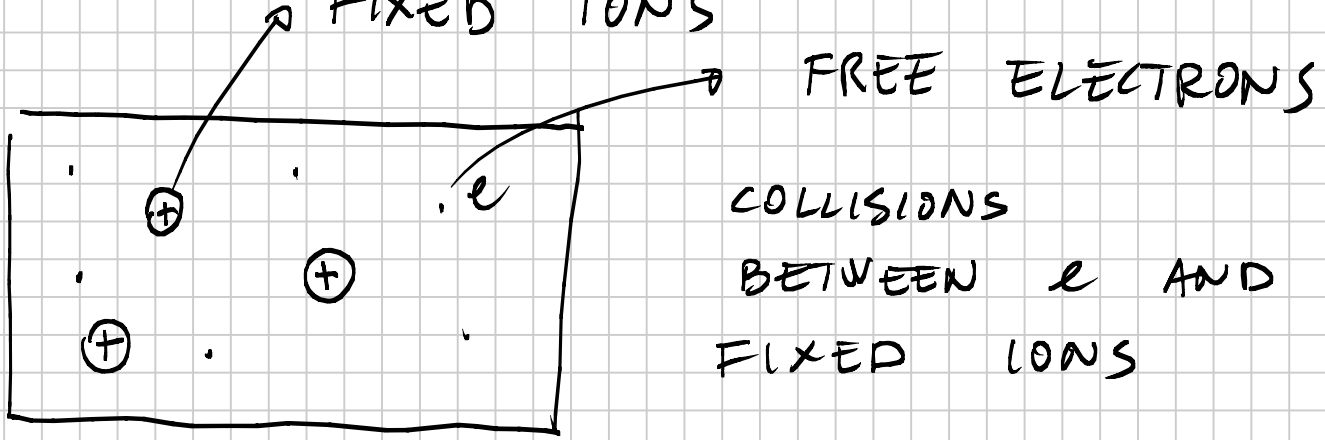
Note Title 1/11/2010

NAME	GROUP	WHY	INTERESTS	UNDERGRAD JAM CMP CLASS
TERRY	RUAN	CLOSE TO EXP	ELECTRON DIFFRACT	YES
MIKE	LYNCH	DIFFERENT THAN WHAT I'M DOING NOW	SOLAR CELLS	YES
JASON	RUAN	GENERAL INTEREST	ULTRAFAST DYNAMICS	YES
DING	NO GROUP	LIKE SIMULATIONS PART	LATTICE STRUCTURES	YES
XU	MORELLI	LINK WITH EXPERIMENT	SPINTRONICS SEMICONDUCTOR MAGNETISM	YES
CHENG	NO GROUP	INTERESTS CMP EXP	ALL CMP	YES
GIFT	DUXBURY	LIKE COMPUTATIONAL PHYSICS	POLYMERS SOLAR	YES

BAI | LAI | ALREADY WORKING ON CMP | EXCITON DYNAMICS | YES

DRUDE MODEL

METALS

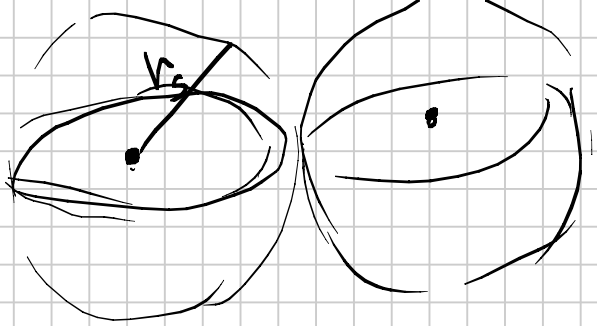


COLLISIONS BETWEEN e AND FIXED IONS

n DENSITY OF ELECTRONS $\sim 10^{22}\ cm^{-3}$

n DOES NOT INCLUDE "CORE" ELECTRONS

r_s



$$\frac{1}{n} = \frac{4}{3}\pi r_s^3$$

$$\boxed{\frac{r_s}{a_B} \sim 2 \sim 3}$$

$$a_B = \frac{\hbar^2}{me^2} = .5\,\text{Å}$$

$\frac{r_s}{a_B} \longrightarrow 10 \rightarrow$ WIGNER CRYSTAL (COULOMB CORRELATIONS ARE VERY IMPORTANT)

ASSUMPIONS OF DRUDE MODEL

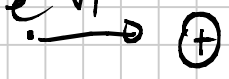
① NO e-e INTERACTION (INDEPENDENT e APPROXIMATION)

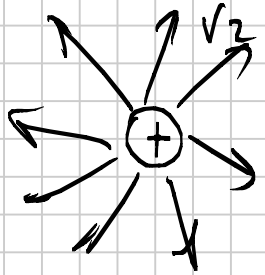
② NO e-ION INTERACTION BETWEEN TWO COLLISIONS (FREE ELECTRONS)

(3) RELAXATION TIME τ

$\Delta t \rightarrow \frac{\Delta t}{\tau}$ PROBABILITY TO HAVE A COLLISION

BEFORE





ISOTROPIC

MARKOVIAN APPROXIMATION

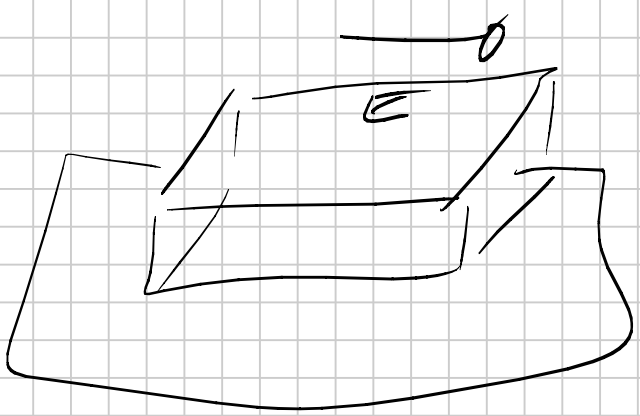
THERMAL EQUILIBRIUM

DRUDE MODEL GOOD FOR:

(1) DC CONDUCTIVITY

(2) HALL EFFECT

(3) AC CONDUCTIVITY



$$\vec{v}(t) = -\frac{e\vec{E}}{m}t \qquad \vec{J} = -env_{AV}$$

$$\langle v(t) \rangle_{AVE} = -\frac{eE}{m}\tau = v_{AV} \qquad \vec{J} = \boxed{\frac{e^2 n \tau}{m}}\vec{E} = \sigma_0 \vec{E}$$

$\sigma_0 = \frac{ne^2\tau}{m}$ = DRUDE CONDUCTIVITY $\qquad \sigma = \frac{1}{\rho}$ ρ = RESISTIVITY

τ FROM EXPERIMENT

$\tau \sim 1 \sim 10$ fs

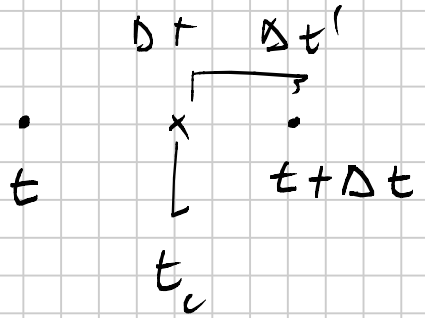
FEMTOSECONDS = 10^{-15} s

PICOSECONDS = 10^{-12} s

NANOSECONDS = 10^{-9} s

EQUATION OF MOTIONS FOR 1 ELECTRON

$\vec{p}(t)$ APPLY FORCE $\vec{F}$



$$P_{COLL} = \frac{\Delta t}{\tau}$$

PROB OF COLLISION

$$\vec{p}(t+\Delta t) = \left(1 - \frac{\Delta t}{\tau}\right)\left(\vec{p}(t) + \vec{F}\Delta t\right) + \underbrace{\frac{\Delta t}{\tau} F \Delta t'}_{O(\Delta t^2)}$$

PROB OF NO COLLISION

KEEP ONLY 1ST ORDER IN Δt

$$\vec{p}(t+\Delta t) - \vec{p}(t) = -\frac{\vec{p}(t)\Delta t}{\tau} + \vec{F}\Delta t$$

$\Delta t \to 0$

$$\frac{d\vec{p}}{dt} = -\frac{\vec{p}}{\tau} + \vec{F}$$

$\frac{1}{\tau}$ → DAMPING OF LINEAR MOMENTUM

HALL

AC CONDUCTIVITY