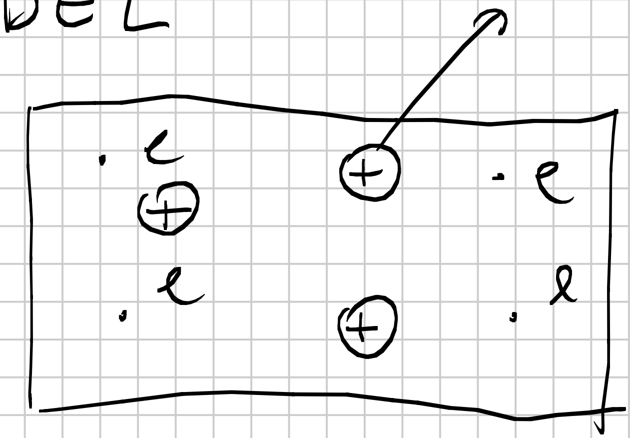
LECTURE #1

Note Title 1/12/2009

DRUDE MODEL

METAL =



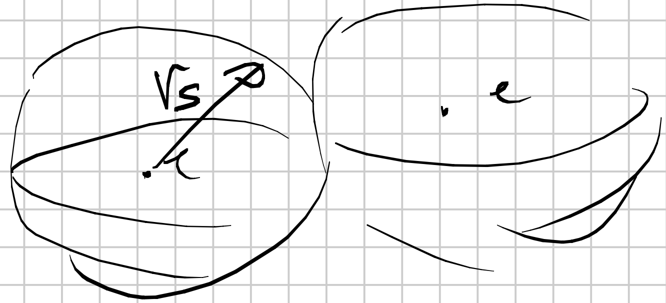
POSITIVE IONS FIXED

COLLISIONS BETWEEN e AND FIXED IONS

CLASSICAL GAS OF FREE ELECTRONS

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

r_s



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

m = e MASS

$$a_B = \frac{\hbar^2}{m e^2} \sim .5\ \text{Å}$$

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

ASSUMPTIONS DRUDE MODEL:

① NO e-e INTERACTION (INDEPENDENT e APPROX)

② NO e-ION INTERACTION (FREE e APPROX)

③ RELAXATION TIME τ

TIME INTERVAL Δt → $\frac{\Delta t}{\tau}$ PROBABILITY TO HAVE e-ION COLLISION DURING Δt

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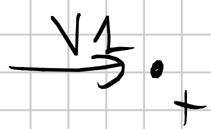
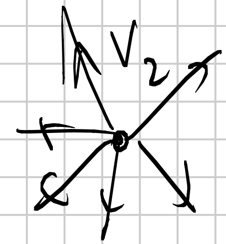
IN THE CORRECT PICTURE

τ HAS TO DO WITH e-PHONON SCATTERING

$\frac{1}{\tau}$ SCATTERIN RATE



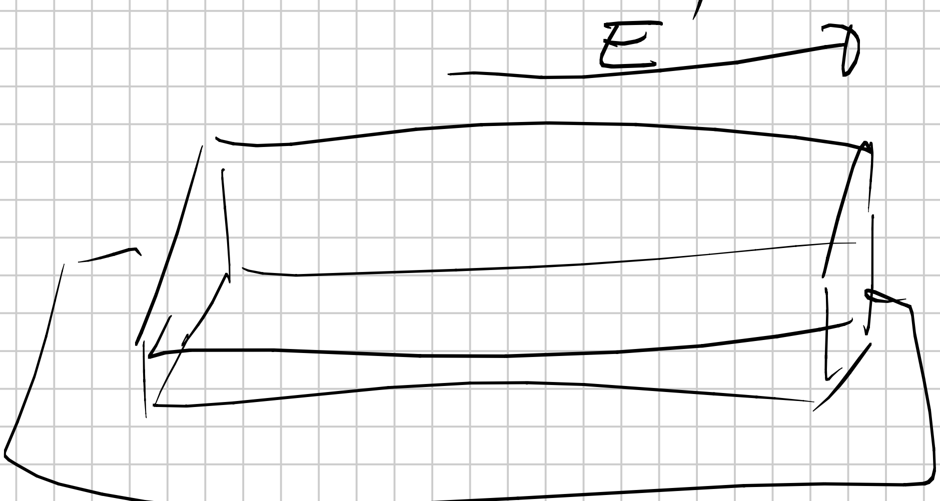


MARKOV APPROXIMATION

THERMAL EQUILIBRIUM

DRUDE MODEL GOOD FOR

1. DC CONDUCTIVITY
2. HALL EFFECT
3. AC CONDUCTIVITY



$(e > 0)$

$$\vec{v}(t) = -\frac{e\vec{E}}{m}\,t$$

$$\vec{v}_{AVERAGE} = -\frac{e\vec{E}}{m}\,\tau$$

$$\vec{J} = \sigma_0 \vec{E}$$

$$\vec{J} = -e\,n\,\vec{v}_{AVE} \Rightarrow \vec{J} = \frac{e^2 n \tau}{m}\vec{E}$$

$$\sigma_0 = \frac{n e^2 \tau}{m}$$ (DRUDE CONDUCTIVITY)

$$\frac{1}{\sigma_0} = \rho_0$$ (RESISTIVITY)

τ CAN BE ESTIMATED FROM σ

$\tau \sim$ 1 – 10 FEMTO-SECONDS

FEMTO S 10^{-15} SECONS

PICO S 10^{-12} SEC

NANO S 10^{-9} SEC

	GROUP	WHY	INTERESTS	CLASS
MARTIN	PIERMAROCCHI	BROAD	OPTICS	V
RAKHI	BASS	PRACTICAL	SPINTRONICS	V
SAURABH	DUXBURY	INTERDISCIPLINARY	STOCHASTIC OPTIMIZATION	V
TRI	BIRGE	NANOTUBES	SENSORS	X
PAMPA	RUAN	CM MAKES SENSE	CRYSTALLOGRAPHY	V
KRITSADA	THEORY	THE/EXP	NANO	X
DAT	MAHANTI	PRACTICAL	DFT	V

MATT	THEORY	APPLICATION	SOLAR CELLS	✓
RYAN	LAI	"	EXCITONS	×
NICK	OLKMAN	"	MEMS	×
MARSHALL	LAI	BROAD	QUANTUM OPTICS	✓