Review: Lienard model

\[ \dot{x} = \frac{W_0^2}{w_0^2 - w^2} \]

- \( w_0 \) from spring model
- \( w_0 = \sqrt{\frac{1}{2m}} \)
- \( w = \sqrt{\frac{k}{m}} \)

Conductors: intuition says electrons form damper, no restoring force.

- \( \dot{E} + \omega_0 = 0 \)

More rigorously, can go back to wave eqn

\[
\frac{\partial^2 E}{\partial t^2} - \rho \frac{\partial E}{\partial x} = \mu_0 \frac{\partial}{\partial x} \left( \frac{\partial E}{\partial t} \right) - \mu_0 \frac{\partial^2 E}{\partial t^2}
\]

- \( J_{	ext{curr}} = \text{conduction} = \text{charge flow} \)
- \( J_{	ext{curr}} = \frac{\partial \phi}{\partial t} + \frac{\mu_0}{2} \frac{\partial^2 \phi}{\partial t^2} \)

For velocity, \( \frac{\partial \phi}{\partial t} = 0 \) do Newton 2 after with spring

\[ \phi = \frac{q \cdot \psi}{\mu_0} \]

Gets same result! (done back)

\[ \tilde{V} = \sqrt{1 + \tilde{x}} \]

\[ \tilde{V} = \sqrt{1 - \frac{w_0^2}{w^2 + w_0^2}} \]

If you remember how to take square root, can separate into real and imaginary parts

(or get Mathematica to do it)

\[ \text{Fig 2.6} \]

\[ W \]

\[ 54 \]

\[ (\text{HW p2.8}) \]

\[ 2 \]

\[ 54 \]

\[ \text{Fig 2.5} \]

\[ \text{conts} \]

\[ \text{Fig 2.6} \]

\[ \omega \]

\[ \tilde{V} = \sqrt{1 + \tilde{x}} \]

\( K \) can be quite large

- Skin depth can be quite small

- \( n \sim \omega_0 \)

- Intensity \( \tilde{z} = \frac{5}{2} \tilde{K} \tilde{w} \)
Conductivity: \( \sigma \neq 0 \), \( \rho = 0 \)

\[
\frac{d^2 E}{dt^2} - \mu \frac{dE}{dr} = \frac{q}{\mu} \frac{dE}{dr} + \frac{d^2 p}{dt^2} - \frac{1}{c_0} \nabla (\nabla \cdot E)
\]

\( J_{\text{surf}} = \tilde{J}_0 e^{i(t - x)} \)

\( \tilde{J}_{\text{surf}} = q N v \)

Chebyshev's Law (same phase, same expansion)

\( \nabla \cdot E = 0 \)

\( \nabla^2 E = \frac{\partial^2 E}{\partial x^2} + \frac{\partial^2 E}{\partial y^2} + \frac{\partial^2 E}{\partial z^2} \)

\( \lambda = \sqrt{-\mu \mu} \)

(General wavemaker model)

\( N^2 = 1 + \frac{w p}{2} \mu + \mu^2 \)

\( W_p = \frac{N^2}{16} \mu \epsilon \)

(Conduction and bending theory)

\( \sigma = \frac{w p}{2} \mu + \mu^2 \)

\( N^2 = 1 + \frac{w p}{2} \mu + \mu^2 \)

\( \frac{f}{w} = \frac{1}{2 \omega} \left( \frac{1}{\mu} \right) \)

\( \frac{f}{w} = \frac{1}{2 \omega} \left( \frac{1}{\mu} \right) \)

What does \( W_p \) represent?
"Good conductor" $\gamma$ small, $\ll \omega$. Then $\gamma = \frac{w_p^2}{\omega^2}$

Then $n^2 = 1 - \frac{w_p^2}{\omega^2}$

Hacht: "$w_p$ serves as a critical value below which the index is complex as the penetrability wave drops off exponentially."

$w > w_p$: $n$ real, absorption small, conductor transparent

$w < w_p$: $n$ complex, absorption important, conductor reflective (I think)

![Reflectance Figure from Hacht](in PowerPoint)
\[
\langle S \rangle = \frac{1}{2} E \langle r \rangle \\
\text{Note: } \langle r \rangle = \frac{1}{2} \text{ due to symmetry}
\]

\[
I = \langle S \rangle = \frac{1}{2} E \langle r \rangle
\]

\[
T = \langle S \rangle = \frac{1}{2} E \langle r \rangle
\]

\[
S = \frac{1}{2} E \langle r \rangle
\]

\[
t = \langle E \rangle
\]

\[
S = \frac{1}{2} \langle E \rangle
\]

\[
\text{For any } \langle F \rangle
\]

\[
\text{and any } \langle G \rangle
\]

\[
\langle F \rangle = \frac{1}{2} \langle E \rangle
\]

\[
\langle G \rangle = \frac{1}{2} \langle E \rangle
\]

\[
\text{Remember the trend of always increasing the number of terms in the sum.}
\]

\[
\text{As the temperature approaches zero,}
\]

\[
\text{lowest level of energy.}
\]

\[
\text{Lows are lowest.}
\]

\[
\text{The ground state is lowest in energy.}
\]

\[
\text{The higher energy states are less populated.}
\]

\[
\text{As the temperature approaches zero,}
\]

\[
\text{the population of the higher energy states decreases.}
\]

\[
\text{The system populates the lowest energy states.}
\]

\[
\text{Therefore, the system is found in the lowest energy state.}
\]

\[
\text{This is the ground state of the system.}
\]

\[
\text{The system is found in the ground state.}
\]

\[
\text{The system is found in the ground state.}
\]