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Problem Set 1 (due Friday, 11.04.2014 in the lecture)

Questions

(Q1) Recapitulate the physical meaning of the Debye length, the plasma parameter, the coupling parameter, and the plasma frequency.

(Q2) How does a magnetic mirror work?

(1.1) log-temperature-log-density plot

On a $\log T$ (with T in K) *vs* $\log n$ (with n in m^{-3}) plot, draw lines of constant Debye length and of constant plasma parameter. Further, indicate the areas where typical

1. magnetically confined plasma in tokamaks,
2. ionospheric plasma,
3. glow discharge plasma,
4. flames,
5. interplanetary plasma,
6. interstellar plasma,
7. the solar corona,
8. the solar photosphere,
9. the solar core,
10. inertial confinement fusion plasma,
11. metals,
12. the solar wind near the earth, and
13. lightning

reside.

(1.2) larmor radii

Calculate the Larmor radius for

(i) a 10-keV electron in the earth's magnetic field of $5 \times 10^{-5}\,\mathrm{T}$,

(ii) a solar wind proton with velocity $300\,\mathrm{km/s}$ in the magnetic field of $5 \times 10^{-9}\,\mathrm{T}$,

(iii) a 1-keV He^{+} ion in the solar atmosphere near a sun spot where $B = 5 \times 10^{-2}\,\mathrm{T}$.

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(1.3) PLASMA FREQUENCY AGAIN

In the lecture, we derived the plasma frequency by displacing the electrons in a plasma slab rigidly with respect to the ions by a small distance δ. Show that the same expression for the plasma frequency is obtained if we compress the electrons instead of displacing them.