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Problem Set 9 (due Friday, 20.06.2014 in the lecture)

Questions

(Q1) Explain the Bogoliubov hierarchy of time scales.

(Q2) What is the 'Coulomb logarithm'?

(Q3) Which assumptions entered the derivation of the Lenard-Balescu collision term?

(9.1) fourier transform of coulomb potential

Determine the Fourier transform of the Coulomb potential by

(a) Fourier-transforming a Debye-screened potential and taking the proper limit,

(b) considering Poisson's equation for a point charge.

(9.2) maxwellians as stationary solutions of collision terms

Show that the electron-electron collision term

$$\left.\frac{\partial f(\mathbf{v})}{\partial t}\right|_{\mathrm{c,ee}} = \frac{e^4 n \ln\Lambda}{8\pi\epsilon_0^2 m^2}\nabla_{\mathbf{v}}\cdot\int \mathrm{d}^3v'\,\frac{1-\hat{\mathbf{g}}\hat{\mathbf{g}}}{g}\cdot\left[\nabla_{\mathbf{v}}-\nabla_{\mathbf{v}'}\right]f(\mathbf{v})f(\mathbf{v}')$$

vanishes for local Maxwellian distributions of the form

$$f_{\mathrm{M}}(\mathbf{r},\mathbf{v},t)\sim\exp\left\{-\frac{m[\mathbf{v}-\mathbf{u}(\mathbf{r},t)]^2}{2k_{\mathrm{B}}T(\mathbf{r},t)}\right\},$$

where $n(\mathbf{r},t)$, $\mathbf{u}(\mathbf{r},t)$, and $T(\mathbf{r},t)$ are local density, mean velocity, and temperature, respectively.

(9.3) dielectric propagator

Show that $\mathcal{U}_{-\mathbf{k}}(\mathbf{v},\mathbf{v}';\mathrm{i}\omega)$ is the complex conjugate of $\mathcal{U}_{\mathbf{k}}(\mathbf{v},\mathbf{v}';-\mathrm{i}\omega)$.