M_j and $x_j = n_j/n$ are the molecular weight and concentration of species j, $z_j e$ is the charge on species j, $\bar{R}$ and A are the universal gas constant and Avogadro's constant and $|q^{11}|$ is the same determinant as in the numerator, but without the last row and last column. In the present computations, subscript 1 was taken to denote the atoms and 2 to denote the ions. Generalization of these expressions to an additional ion or another neutral involves merely the insertion of one row and one column in both numerator and denominator. In the limit $B \to 0$, $\lambda_h^{\perp}$ reduces to $\lambda_h^{||}$ and λ_h^H to 0.

Electron Thermal Conductivity:

$$\lambda_e \equiv \lambda_e^{\perp} + i\,\lambda_e^H = -\,C_3\, x_e\, T^{\frac{1}{2}} \frac{q^{22}}{q^{11}q^{22} - (q^{12})^2} , \tag{B8}$$

$$C_3 = \frac{75k}{8} \left(\frac{2\pi\bar{R}}{M_e}\right)^{\frac{1}{2}} = 1.2630 \times 10^7 , \tag{B9}$$

$$q^{11} = 8\sqrt{2}\, x_e\, \bar{Q}_{ee}^{(2,2)} + 8 \sum_j x_j \left[\frac{25}{4} \bar{Q}_{ej}^{(1,1)} - 15\, \bar{Q}_{ej}^{(1,2)} + 12\, \bar{Q}_{ej}^{(1,3)}\right] + i\, C_4 \frac{15\omega_e}{4nT^{\frac{1}{2}}} , \tag{B10}$$

$$q^{12} = 8\sqrt{2}\, x_e \left[\frac{7}{4} \bar{Q}_{ee}^{(2,2)} - 2\, \bar{Q}_{ee}^{(2,3)}\right] + 8 \sum_j x_j \left[\frac{175}{16} \bar{Q}_{ej}^{(1,1)} - \frac{315}{8} \bar{Q}_{ej}^{(1,2)} + 57\, \bar{Q}_{ej}^{(1,3)} - 30\, \bar{Q}_{ej}^{(1,4)}\right] , \tag{B11}$$

$$q^{22} = 8\sqrt{2}\, x_e \left[\frac{77}{16} \bar{Q}_{ee}^{(2,2)} - 7\, \bar{Q}_{ee}^{(2,3)} + 5\, \bar{Q}_{ee}^{(2,4)}\right] + 8 \sum_j x_j \left[\frac{1225}{64} \bar{Q}_{ej}^{(1,1)} - \frac{735}{8} \bar{Q}_{ej}^{(1,2)} + \frac{399}{2} \bar{Q}_{ej}^{(1,3)} - 210\, \bar{Q}_{ej}^{(1,4)} + 90\, \bar{Q}_{ej}^{(1,5)}\right] + i\, C_4 \frac{105}{16} \frac{\omega_e}{nT^{\frac{1}{2}}} , \tag{B12}$$

$$C_4 = \left(\frac{2\pi M_e}{\bar{R}}\right)^{\frac{1}{2}} = 6.4388 \times 10^{-6} , \qquad (B13)$$

where the subscripts e and j denote the electrons and the ions or atoms, respectively.

Electrical Conductivity (mho/cm):

$$\sigma = C_5 \frac{x_e}{T^{\frac{1}{2}}} \frac{q^{11} q^{22} - (q^{12})^2}{|q|} , \qquad (B14)$$

$$C_5 = 3e^2 A\left(\frac{\pi}{2M_e \bar{R}}\right)^{\frac{1}{2}} = 2.7214 \times 10^5 , \qquad (B15)$$

$$|q| = \begin{vmatrix} q^{00} & q^{01} & q^{02} \\ q^{01} & q^{11} & q^{12} \\ q^{02} & q^{12} & q^{22} \end{vmatrix} , \qquad (B16)$$

$$q^{00} = 8 \sum_j x_j \bar{Q}_{ej}^{(1,1)} + i C_4 \frac{3\omega_e}{2nT^{\frac{1}{2}}} , \qquad (B17)$$

$$q^{01} = 8 \sum_j x_j [\frac{5}{2} \bar{Q}_{ej}^{(1,1)} - 3\bar{Q}_{ej}^{(1,2)}] , \qquad (B18)$$

$$q^{02} = 8 \sum_j x_j [\frac{35}{8} \bar{Q}_{ej}^{(1,1)} - \frac{21}{2} \bar{Q}_{ej}^{(1,2)} + 6 \bar{Q}_{ej}^{(1,3)}] . \qquad (B19)$$

Note that ω_e is negative since $z_e e$ is negative (see Eq. (B7)).

Thermal Diffusion Coefficient:

$$D_e^T = C_6 x_e T^{\frac{1}{2}} \frac{q^{01} q^{22} - q^{02} q^{12}}{|q|} , \qquad (B20)$$

$$C_6 = \frac{15(2\pi M_e \bar{R})^{\frac{1}{2}}}{4 A} = 3.3334 \times 10^{-5} . \qquad (B21)$$

Recall that the above expressions for the electron properties have been used for conditions other than low degrees of ionization and weak magnetic fields