gas mass density, $p_e = n_e kT$, $p = nkT$ and the superscripts $\parallel$, $\perp$ and H denote the parallel, perpendicular and Hall components of a particular coefficient . The thermal conductivity is conveniently broken up into three components, e.g.

$$\lambda^{\parallel} = \lambda_h^{\parallel} + \lambda_r^{\parallel} + \lambda_e^{\parallel} \tag{18}$$

where the subscripts h, r and e denote the heavy (atoms and ions), reactive and electron components of thermal conductivity.

The heavy thermal conductivity was computed with the expression derived with the second approximation in the Chapman-Enskog method, as modified to include the effect of an applied steady magnetic field.[30*] Because of the high molecular weight of argon, the pressure must be considerably below atmospheric to obtain a change of properties from the no-field case with presently practical magnetic fields (see Fig. 6).

The reactive thermal conductivity was found from the expression[1,30]

$$\lambda_r \equiv \lambda_r^{\perp} + i\,\lambda_r^{H} = \frac{n n_e n_a m_a}{\rho k T^2 (n_e + n_a)} (\Delta \tilde{h})^2 \mathcal{D}_{ia} \tag{19}$$

where the complex binary diffusion coefficient is given by

$$\mathcal{D}_{ia} \equiv \mathcal{D}_{ia}^{\perp} + i\mathcal{D}_{ia}^{H} = \frac{3}{16n} \left(\frac{2\pi k T}{\mu} \right)^{\frac{1}{2}} \frac{1}{\bar{Q}_{ia}^{(1,1)}} \frac{1}{1 + i\,\omega_{ia}\tau_{ia}} \tag{20}$$

and $\Delta\tilde{h} = \tilde{h}_e + \tilde{h}_i - \tilde{h}_a$ is the reactive enthalpy on a per particle basis. The chief contribution to $\Delta\tilde{h}$ comes from the ionization energy (corrected for lowering[27]), but translational and excitation energies are also of importance. Neglect of the latter, for example, causes errors in λ_r of 10% or more.

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* Complete expressions given in Appendix B.

The ion-atom cyclotron frequency in Eq. (20) is computed from

$$\omega_{ia} = \frac{n_i m_i \omega_a + n_a m_a \omega_i}{\rho} \tag{21}$$

where the cyclotron frequency of species j with charge $z_j e$ (=-e for electrons and 0 for atoms) is given by

$$\omega_j = \frac{e z_j B}{m_j c}$$

The mean time between collisions follows from

$$\tau_{ia} = \frac{3}{4} \left(\frac{\pi \mu}{8kT} \right)^{\frac{1}{2}} \frac{1}{\left(\frac{\rho}{m_i + m_a} \right) \bar{Q}_{ia}^{(1,1)}} \tag{22}$$

The parallel components follow from the perpendicular components as $B \to 0$.

As is implied in Eq. (19), only single ionization was considered in computing λ_r and λ_h . Above 20000°K for 1 atm pressure, slight errors will be introduced in these coefficients by the neglect of the second ion. Unless the magnetic field is large enough to reduce λ_e significantly (but small enough to leave λ_r and λ_h unaffected), these errors so introduced will be negligible. Since such a combination of magnetic field, pressure and temperature does not seem likely, no attempt was made to include this second ion when computing λ_r and λ_h.

It was pointed out some time ago[1,33] that the approximations to the electron properties converge extremely slowly at low degree of ionization in the rare gases demonstrating the Ramsauer effect. Studies of the convergence show that the sixth[34] and even the twelfth[31] approximations have not converged to the true values. A theory