$$\tilde{h}_j' = E_\infty^j - \frac{3}{2} \Delta E_\infty^j + \frac{3kT}{4} \qquad (31)$$

For the atom all known levels were included in evaluating the partition function and the excitation energy. The levels not known are those for high principal and orbital quantum numbers and could be readily estimated by assuming hydrogenic structure. This latter procedure was necessary since it was found that the excitation energy of the atoms, necessary for the computation of $\Delta\tilde{h}$ in Eq. (19), was overestimated at the higher temperatures if Eqs. (30) and (31) were used. Levels above the lowered ionization potential were not included in the atom partition function or excitation energy computation.

The first ion is not appreciably excited at temperatures considered here, so the use of Eq. (31) has little effect on the accuracy of $\tilde{h}_j$. Similarly, there is only small effect on the number densities of the principal constituents due to the use of Eq. (30). The lowering of the ionization potential was computed from Debye-Hückel theory;[27] the small correction to the pressure was neglected.

The parallel transport coefficients computed at 1 atm pressure for T=3000-35000°K are collected in Table IV.* The three components of λ are plotted in Fig. 2. A feature worth noting in the latter is the large drop in λ_h from the pure atom thermal conductivity (λ_a) due to the larger ion-atom and ion-ion cross sections (see Table II). The reactive thermal conductivity also displays the characteristic pronounced maximum near 50% ionization.

The effect of a magnetic field on λ_e is illustrated in Fig. 3, where $\lambda_e^{\perp}$ and λ_e^H are plotted for fields of 25 and 100kG and a gas pressure of 1 atm. We note the expected reduction of $\lambda_e^{\perp}$ below the $\lambda_e^{\parallel}$ curve, and the increase of λ_e^H as the magnetic field is increased. In mean-free-path theory, the effect of the magnetic field on the transport coefficients can be estimated by consideration of the parameter $\omega_e\tau_e$, where τ_e is the average time between collisions of electrons and ω_e the electron cyclotron frequency. The equation for τ_e is somewhat arbitrary; in analogy to Eq. (22) it has

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* Coefficients at other pressures and with an applied magnetic field are listed in appendices C and D.

been taken as

$$\tau_e = \left[\frac{4}{3}\left(\frac{8kT}{\pi m_e}\right)^{\frac{1}{2}} \Sigma_j n_j \overline{Q}_{ej}^{(1,1)}\right]^{-1} \tag{32}$$

where the sum runs over all heavy species.

The parameter $\omega_e \tau_e$ is plotted in Fig. 4 for argon at 1 atm pressure and several B-fields. Quite noticeable are the high values at lower temperatures as a result of the decreasing ion number density. Because of the large electron-ion cross section, the ion term in the sum of Eq. (32) is dominant down to very low ionization. The relative maximum at high temperatures denotes the point where electron collisions with the second ion become important.

The mean-free-path expressions for the transport coefficients are of the form

$$\lambda_e \equiv \lambda_e^{\perp} + i\lambda_e^{H} = \frac{\lambda_e^{\parallel}}{1 + i\,\omega_e\tau_e} \tag{33}$$

We would thus expect $\lambda_e^{\perp}$ and λ_e^{H} to be about the same size when $|\omega_e|\tau_e \approx 1$, which turns out to be the case (see Figs. 3-4). Other features of Fig. 3 can also be explained on the basis of this simple formula, as can the shape of the curves for the perpendicular and Hall components of electrical conductivity shown in Fig. 5. Particularly interesting in the latter figure are the maxima in $\sigma^{\perp}$ for B=25 and 100kG and in σ^{H} at 5kG. The former corresponds to the minimum in the $\omega_e\tau_e$ curves of Fig. 4, while the latter arise from the large decrease of $\sigma^{\perp}$ relative to σ^{H} as $\omega_e\tau_e$ crosses unity near 8000°K.

As mentioned above, a combination of high magnetic field and low pressure is necessary to show an effect of the field on the heavy properties, λ_r and λ_h. At 1 atm pressure, $\lambda_r^{\perp}$ and $\lambda_h^{\perp}$ differed negligibly from $\lambda_r^{\parallel}$ and $\lambda_h^{\parallel}$ even at the highest fields considered (200kG). Only at p=0.01 atm or below was there appreciable difference.