10. — THE BROADENING OF He I 4471 Å
AND ITS FORBIDDEN COMPONENTS

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We have computed the profile of He I 4471 Å and its forbidden components for electron number densities in the range $10^{14}$ to $3 \times 10^{17} \text{ cm}^{-3}$ for temperatures 10,000, 20,000 and 40,000° K.

For the densities involved the broadening of the ions can be treated in the quasi-static approximation and the broadening by the electrons in the impact approximation. Since these mechanisms are statistically independent the resultant profile is obtained by averaging the electron broadened profiles, calculated for different fields, over the ion microfield distribution.

The calculation is simplified by ignoring the broadening of the lower level (which contributes less than 1% to the width). The spin-orbit splitting of the lower level is, however, taken into account for densities below $10^{16} \text{ cm}^{-3}$. For a given electric field the energies of the perturbed upper levels (i.e. the $n = 4$ triplet levels) are found by diagonalizing the Hamiltonian matrix with the field perturbation included. In the presence of the electric field the upper states no longer have definite parity, so that in addition to the allowed transitions $4\,^3D' \rightarrow 2\,^3P$, the forbidden transitions $4\,^3F' \rightarrow 2\,^3P$ and (to a lesser extent) $4\,^3P' \rightarrow 2\,^3P$ also occur.

To calculate the electron broadening of the upper levels the work of Griem, Baranger, Kolb and Oertel (1962, Phys. Rev., 125, 177) is extended to include off-diagonal elements of the $S$ (and $\Phi$) matrix for electron-atom collisions. The splitting of the upper levels according to the value of $|M_L|$ has been taken into account in this calculation.

For the average over the ion fields we use the distribution functions calculated by Hooper (1968, Phys. Rev., 165, 215). The profiles shown include the Doppler broadening by the helium atoms. Equal electron, ion and atom temperatures are assumed; the work can readily be extended to allow for different electron, ion and atom temperatures. For each profile the total intensity of the allowed and forbidden components has been normalized to unity.

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Fig. 1. — He I 4471 Å profiles for \( n_e = 10^{14} \) cm\(^{-3} \)
Fig. 2. — He I 4471 Å profiles for $n_e = 3 \times 10^{14} \text{ cm}^{-3}$
Fig. 3. — He I 4471 Å profiles for \( n_e = 10^{15} \text{ cm}^{-3} \)
Fig. 4. — He I 4471 Å profiles for $n_e = 3 \times 10^{15} \text{ cm}^{-3}$.
Fig. 5. — He I 4471 Å profiles for $n_e = 10^{14}$ cm$^{-3}$
Fig. 6. — He I 4471 Å profiles for $n_e = 3 \times 10^{16}$ cm$^{-3}$
Fig. 7. — He I 4471 Å profiles for $n_e = 10^{17}$ cm$^{-3}$
Fig. 8. — He I 4471 Å profiles for $n_e = 3 \times 10^{17}$ cm$^{-3}$