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THERMAL CYCLOTRON ABSORPTION COEFFICIENTS. II. OPACITIES IN THE STOKES FORMALISM

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ABSTRACT

We extend the discussion of the calculation of the cyclotron opacities $\alpha_\pm$ of the ordinary and extraordinary mode (Chanmugam et al.) to the opacities κ, q, v in the Stokes formalism. We derive formulae with which $\alpha_\pm$ can be calculated from κ, q, v. We are hence able to compare our calculations of the opacities, which are based on the single-particle method, with results obtained with the dielectric tensor method of Tamor. Excellent agreement is achieved. We present extensive tables of the opacities in the Stokes formalism for frequencies up to 25 ω_c, where ω_c is the cyclotron frequency, and temperatures $kT = 5$, 10, 20, 30, 40, and 50 keV.

Furthermore, we derive approximate formulae with which κ, q, v can be calculated from $\alpha_\pm$ and hence use the Robinson & Melrose analytic formulae for $\alpha_\pm$ in order to calculate the opacities in the Stokes formalism. We compare these opacities to accurate numerical opacities and find that the analytic formulae can reproduce the qualitative behavior of the opacities in the regions where the harmonic structure is unimportant.

Subject headings: atomic processes — plasmas — radiation mechanisms: nonthermal — stars: neutron — white dwarfs

1. INTRODUCTION

Cyclotron radiation (or magneto-bremsstrahlung) is produced by electrons as they are spiraling in a magnetic field (e.g., Ginzburg 1964; Bekefi 1966). This radiation is called synchrotron radiation when the electrons move at ultrarelativistic speeds. The collective emission of electrons in a magnetized plasma depends on the velocity distribution of the electrons, for which we formally use the correct relativistic Maxwellian distribution. Then the cyclotron emission of the magnetized plasma is described by the temperature T, the frequency ratio $s = \omega/\omega_c$, the angle θ between the magnetic field and the line of sight, and finally the dimensionless plasma parameter $\Lambda = \omega_p^2 L/\omega_c c = 6\times 10^7 (L/10^7\,\mathrm{cm})(N/10^{16}\,\mathrm{cm}^{-3})(B/10\,\mathrm{MG})^{-1}$. Here $\omega_p = (4\pi Ne^2/m)^{1/2} = 5.64\times 10^{12}(N/10^{16}\,\mathrm{cm}^{-3})^{1/2}\,\mathrm{s}^{-1}$ is the plasma frequency, $\omega_c = eB/mc = 1.76\times 10^{14}(B/10\,\mathrm{MG})\,\mathrm{s}^{-1}$ is the cyclotron frequency, ω is the angular frequency, N is the electron number density, B is the magnetic field strength, and L is the characteristic size of the system. If cyclotron emission is an important source of radiation then by Kirchhoff's law it is also a strong absorber of radiation. Therefore cyclotron absorption is important for the transfer of radiation through a strongly magnetized plasma.

Cyclotron emission can be detected from many astronomical systems. Examples are the thermal and nonthermal radio emission of the Sun and stars (e.g., Dulk 1985). Cataclysmic variables containing accreting magnetic white dwarfs are also a source of strongly polarized optical and near-infrared radiation with magnetic fields of $B \sim 10$ MG (Chanmugam & Dulk 1981; Meggitt & Wickramasinghe 1982, hereafter MW). X-ray cyclotron lines are seen in accreting neutron stars which are consistent with magnetic fields of $B \sim 10^{12}$ G (Trümper et al. 1978; Zheleznyakov 1984).

In order to describe polarized radiative transfer the four Stokes parameters I, Q, U, V can be used (Pacholczyk 1977). The corresponding transfer equation for polarized radiation contains three independent opacities commonly denoted as κ, q, and v plus the two Faraday mixing coefficients f and h. Alternatively, the propagation of an electromagnetic wave through a magnetized plasma can be described by two orthogonal waves referred to as the ordinary (+) and the extraordinary (−) wave. Under the assumption of large Faraday rotation and Faraday pulsation, and homogeneous fields along the line of sight, one obtains two uncoupled transfer equations for these two modes, and the transfer is described by only two opacities $\alpha_\pm$ corresponding to these modes (Ramaty 1969). The condition for large Faraday rotation, which is valid for quasi-longitudinal propagation, is $\omega_p^2\omega_c L/\omega^2 c = \Lambda/s^2 \gg 2\pi$ while for large Faraday pulsation (for quasi-transverse propagation) one must have $\omega_p^2\omega_c^2 L/2\omega^3 c = \Lambda/2s^3 \gg 2\pi$ (Pacholczyk 1977; see also Appendix A). As these conditions and the condition of homogeneous fields are often fulfilled in laboratory and astrophysical plasmas it has been common in the past to solve the transfer equations for the ordinary and extraordinary mode.

Extensive discussions of cyclotron opacities exist in plasma physics (e.g., Bekefi 1966; Tamor 1977, 1978; De Barbieri 1980; Bornatici et al. 1983) and in astrophysics (e.g., Ramaty 1969; Pavlov, Mitrofanov, & Shibanov 1980; Chanmugam & Dulk 1981; MW). In these papers two different methods were used. In the single-particle method the radiation emitted by one electron in a magnetic field was calculated, and from this the emissivity of a collection of thermal electrons was obtained. The cyclotron opacities were then derived using Kirchhoff's law (e.g., Bekefi 1966). On the other hand one has the dielectric tensor method in which the opacities are obtained from the complex dielectric tensor (e.g., Tamor 1977, 1978). The accuracy of the opacities in these papers were inadequately dis-

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cussed as they were mostly presented in form of figures. As cyclotron opacities vary with s by many orders of magnitude it is difficult to compare opacities calculated by different authors, as differences of order unity easily remain undetectable in such figures. It is therefore important to compare numerical tables of opacities to decide on the accuracy of different numerical methods.

Chanmugam et al. (1989, hereafter Paper I) made thorough comparisons between different numerical methods and analytic approximations for the opacities $\alpha_\pm$ for a thermal plasma and found discrepancies in the literature in the values of the published opacities. They also produced extensive tables of numerically accurate opacities. Here we extend their work to the opacities κ, q, and v. We provide accurate numerical checks for our opacities, and we also produce extensive tables of these opacities for different temperatures kT, angles θ, and frequency ratios s. To our knowledge, these are the first extensive tables for the thermal opacities κ, q, v (see Pacholczyk 1970 for synchrotron opacities in nonthermal plasmas). These opacity tables may be used in a wide variety of applications in plasma physics and astrophysics. Furthermore, future calculations of opacities can be compared with the values given in these tables. This extension of the work done in Paper I is also necessary as one cannot solve the radiative transfer equation using only $\alpha_\pm$ for plasmas in general inhomogeneous magnetic fields. This is not possible in general even if one subdivides the line of sight into small regions which are short enough for the magnetic field to be approximately homogeneous and which are long enough to fulfill the condition of large Faraday rotation and Faraday pulsation (see Appendix A). A convenient way to handle the case of inhomogeneous magnetic fields is by using the Stokes formalism and the corresponding opacities.

To calculate the opacities κ, q, and v we use the single-particle method. We use an analytic expression for Q/V which is valid for large Faraday rotation and pulsation to provide an accurate check of our opacities. We also show that the criteria for the validity of this analytic expression as given by MW are incomplete (see Appendix A). We also derive formulae from which $\alpha_\pm$ can be calculated from κ, q, v. This way we can test our opacities by calculating from them the opacities in the ordinary and extraordinary mode $\alpha_\pm$, and we can compare them to earlier numerical results. Furthermore, we derive approximate formulae to obtain κ, q, and v from α_+ and α_-. That way we can use analytic approximations for $\alpha_\pm$ due to Robinson & Melrose (1984, hereafter RM; Dulk 1985) in order to get corresponding expressions for κ, q, and v. We then compare these analytic expressions of κ, q, and v with accurate numerical results.

2. CYCLOTRON OPACITIES

2.1. *Opacities in the Stokes Formalism*

Polarized radiation can be described by the Stokes parameters I, Q, U, V (Rybicki & Lightman 1979). The total intensity is given by I, while the degree of polarization is $(Q^2 + U^2 + V^2)^{1/2}/I$. The degree of linear polarization is $(Q^2 + U^2)^{1/2}/I$, and the degree of circular polarization is V/I. The position angle χ for linear polarization is given by $\tan 2\chi = U/Q$. When the magnetic field $\boldsymbol{B}$ is lying in the $y-z$ plane with the z-axis in the direction of propagation (in which case the emissivity corresponding to the Stokes parameter U is $\epsilon_U = 0$), the transfer equation can be written as (Pacholczyk 1977)

$$\frac{d}{dl}\begin{pmatrix} I \\ Q \\ U \\ V \end{pmatrix} = \begin{pmatrix} \epsilon_I \\ \epsilon_Q \\ 0 \\ \epsilon_V \end{pmatrix} + \begin{pmatrix} -\kappa & -q & 0 & -v \\ -q & -\kappa & -f & 0 \\ 0 & f & -\kappa & -h \\ -v & 0 & h & -\kappa \end{pmatrix}\begin{pmatrix} I \\ Q \\ U \\ V \end{pmatrix}, \quad (1)$$

where l is the path length. Here

$$f = (\omega_p^2/c\omega_c)\cos\theta/(\omega^2/\omega_c^2 - 1), \quad (2)$$

$$h = (\omega_p^2/c\omega_c)\sin^2\theta/2(\omega^3/\omega_c^3 - \omega/\omega_c) \quad (3)$$

are the Faraday mixing coefficients. The quantities ϵ_I, ϵ_Q, ϵ_V are the emissivities for the respective Stokes parameters.

We are interested in the case of cyclotron emission and absorption in a collisionless plasma with a magnetic field $\boldsymbol{B}$. The velocity distribution of the electrons is assumed to be the relativistic Maxwellian distribution. Then the emissivity for the Stokes parameter I is given by (MW)

$$\epsilon_I = \frac{Ne^2\mu}{2cK_2(\mu)}\int_{-1}^{1} d\beta_\parallel \sum_{n=n_1}^{\infty} F_I \exp(-\mu\gamma)(\omega s\gamma^4/n) \quad (4)$$

where

$$F_I = (\cot\theta - \beta_\parallel \csc\theta)^2 J_n^2(n\xi) + \beta_\perp^2 J_n'^2(n\xi). \quad (5)$$

Here, $\mu = mc^2/kT$, $\beta = v/c$ is the dimensionless velocity, $\gamma = (1-\beta^2)^{-1/2}$, $c\beta_\parallel$ and $c\beta_\perp$ are the velocities of the electron parallel and perpendicular to the magnetic field, respectively, and $\xi = \beta_\perp \sin\theta/(1 - \beta_\parallel\cos\theta)$. Here, $K_2(\mu)$ is the modified Bessel function. The frequency ratio s is related to γ through the equation $\gamma = n/s(1 - \beta_\parallel\cos\theta)$. Also n_1 is the minimum value of n such that $\beta_\perp^2 > 0$. The emissivities ϵ_Q, ϵ_V for the Stokes parameters Q and V are obtained from the above equation for ϵ_I by substituting for F_I with F_Q and F_V, respectively, where (MW)

$$F_Q = (\cot\theta - \beta_\parallel\csc\theta)^2 J_n^2(n\xi) - \beta_\perp^2 J_n'^2(n\xi), \quad (6)$$

$$F_V = -2(\cot\theta - \beta_\parallel\csc\theta) J_n(n\xi)\beta_\perp J_n'(n\xi). \quad (7)$$

By using Kirchhoff's law, one hence determines the opacities $\kappa = \epsilon_I/\mathcal{B}$, $q = \epsilon_Q/\mathcal{B}$, and $v = \epsilon_V/\mathcal{B}$ where $\mathcal{B} = kT\omega^2/4\pi^3c^2$ is the Planck function in the Rayleigh-Jeans limit. We can use this limit because $\hbar\omega/kT \ll 1$ here.

Because much computing time is required to calculate the Bessel function J_n of high order and its derivative J_n', it is common to use an approximation given by Wild & Hill (1971; MW) for these functions. The accuracy of this approximation was discussed in Paper I. They found that an error not larger than about 2% results in the opacities. This approximation is therefore sufficient for radiative transfer calculations. However, as a reference we calculate all opacities in this paper using more precise numerical codes for the Bessel function J_n, its derivative J_n', and $K_2(\mu)$ given in Press et al. (1992).

2.2. *Relation between κ, q, v and $\alpha_\pm$*

The propagation of electromagnetic waves in a magnetoactive plasma can be described by two normal modes (Ginzburg 1964; Ramaty 1969), which are the ordinary mode (+) and the extraordinary mode (−). The intensity in the respective modes is denoted by $I_\pm$. Let us denote the transverse components of the electric field vector of the electromagnetic wave by E_x and E_θ, where E_θ lies in the plane of the magnetic field $\boldsymbol{B}$ and the direction of propagation while E_x is perpendicular to this plane. Then the polarization coefficients for the ordinary and extraordinary mode are given by

$$a_\pm(s,\theta) = -i(E_x/E_\theta)_\pm = \frac{2s\cos\theta}{-\sin^2\theta \pm [\sin^4\theta + 4s^2\cos^2\theta]^{1/2}}, \quad (8)$$

where we have assumed that $\omega \gg \omega_p$ as is generally the case. Then we can also set the refractive index to one. The opacities $\alpha_\pm$ for these two modes are given by (Chanmugam & Dulk 1981)

$$\alpha_\pm = \frac{1}{\mathscr{B}}\frac{Ne^2\mu}{cK_2(\mu)}\int_{-1}^{1} d\beta_\parallel \sum_{n=n_1}^{\infty}\frac{1}{(1+a_\pm^2)} \times \{-\beta_\perp J_n'(n\xi) + [a_\pm(\cot\theta - \beta_\parallel \csc\theta)J_n(n\xi)]\}^2 \times \exp(-\mu\gamma)(\omega s\gamma^4/n). \quad (9)$$

As we pointed out before, the transfer equations for the normal modes are particularly simple in the case of large Faraday rotation and Faraday pulsation, and the solution for $I_\pm$ is easily obtained. In this special case the solution for the Stokes parameters also simplifies. By comparing these two solutions one can easily express $\alpha_\pm$ in terms of κ, q, and v (see eqs. [A18]–[A24]). One gets

$$\alpha_\pm = \kappa - \frac{1-a_\pm^2}{1+a_\pm^2}q + \frac{2a_\pm}{1+a_\pm^2}v. \quad (10)$$

As far as we are aware this relation has not been shown before. One also obtains the relation

$$\kappa = (\tfrac{1}{2})(\alpha_+ + \alpha_-). \quad (11)$$

While these equations were first obtained intuitively in the case of large Faraday rotation and pulsation they are valid in general as we shall show. For this purpose we define $A_n = (\cot\theta - \beta_\parallel \csc\theta)J_n(n\xi)$ and $B_n = \beta_\perp J_n'(n\xi)$. Now we insert the expressions for κ, q, and v into equation (10), and as $a_\pm$ does not depend on the integration variable $\beta_\parallel$ and the summation index n we can write

$$\alpha_\pm = \frac{1}{\mathscr{B}}\frac{Ne^2\mu}{2cK_2(\mu)}\int_{-1}^{1} d\beta_\parallel \times \sum_{n=n_1}^{\infty}\left[(A_n^2+B_n^2) - \frac{1-a_\pm^2}{1+a_\pm^2}(A_n^2-B_n^2) + \frac{2a_\pm}{1+a_\pm^2}(-2A_nB_n)\right]e^{-\mu\gamma}(\omega s\gamma^4/n), \quad (12)$$

$$= \frac{1}{\mathscr{B}}\frac{Ne^2\mu}{cK_2(\mu)}\int_{-1}^{1} d\beta_\parallel \sum_{n=n_1}^{\infty}\frac{1}{1+a_\pm^2} \times (a_\pm^2A_n^2 + B_n^2 - 2a_\pm A_nB_n)e^{-\mu\gamma}(\omega s\gamma^4/n), \quad (13)$$

$$= \frac{1}{\mathscr{B}}\frac{Ne^2\mu}{cK_2(\mu)}\int_{-1}^{1} d\beta_\parallel \sum_{n=n_1}^{\infty}\frac{1}{1+a_\pm^2} \times (-B_n + a_\pm A_n)^2e^{-\mu\gamma}(\omega s\gamma^4/n). \quad (14)$$

The right-hand side agrees with equation (9). Equation (11) is well known, and we will therefore not show the proof here (it is similar to the proof of eq. [10] and uses the relation $a_+a_- = -1$, which in turn can be shown easily from eq. [8]).

While we can get $\alpha_\pm$ from κ, q, and v, we need one more independent equation to do the reverse. However, information (the phase relation between the modes) is lost when one goes from the Stokes parameters to $I_\pm$. Therefore no such third relation exists. Nevertheless we can derive an approximately valid relation. If the radiation is completely polarized one has $I = \sqrt{Q^2+V^2}$. In the optically thin case with small Faraday rotation and pulsation we have $I/\mathscr{B} = \kappa l$, $Q/\mathscr{B} = ql$, $V/\mathscr{B} = vl$ where l is the path length (from eqs. [A1]–[A4]). It then follows that

$$\kappa^2 \approx q^2 + v^2. \quad (15)$$

However, radiation is never completely polarized (Rybicki & Lightman 1979), and equation (15) is only valid approximately. As the opacities are atomic quantities equation (15) remains valid with the same accuracy even in the case of large Faraday rotation and pulsation and if the radiation is optically thick. Using equation (15) we can calculate q and v as follows:

$$q \approx a\Delta - |b|\sqrt{\kappa^2-\Delta^2}, \quad (16)$$

$$v \approx -b\Delta + \mathrm{sgn}(b)|a|\sqrt{\kappa^2-\Delta^2}, \quad (17)$$

where $\Delta = (\alpha_- - \alpha_+)/2$. We also defined the quantities $a = (1-a_+^2)/(1+a_+^2)$ and $b = 2a_+/(1+a_+^2)$. We will discuss the validity of the above equations below.

3. DISCUSSION

We start the discussion by first investigating the accuracy of our numerical calculations. For this purpose, we compare in Table 1 the opacities $\alpha_\pm$ obtained using the dielectric tensor method of Tamor (1977, 1978) to $\alpha_\pm$ as calculated by us from opacities in the Stokes formalism and using equation (10). This comparison is important as the methods used are very different. While our calculation is based on the single-particle method, the Tamor method is based on the dielectric tensor. If agreement is achieved between these two calculations, then this confirms the accuracy of our code. Note that we vary θ from large values (89°) when the radiation is almost completely linearly polarized to small values when circular polarization is dominant. In the former case $\alpha_\pm$ as calculated by us mostly depends on the value of q, while in the latter case $\alpha_\pm$ is mostly dominated by v. Therefore we can test here the accuracy of the calculations for both q and v. The fact that these

TABLE 1

COMPARISON BETWEEN ABSORPTION COEFFICIENTS $\alpha_\pm$ OBTAINED USING THE TAMOR METHOD AND USING THE OPACITIES IN THE STOKES FORMALISM

		α_-		α_+	
θ	s	This Work	Tamor	This Work	Tamor
		$kT = 20$ keV			
89°	5	9.573E-04	9.578E-04	3.437E-05	3.439E-05
	10	5.080E-06	5.084E-06	2.487E-07	2.489E-07
	15	9.990E-08	1.000E-07	7.712E-09	7.721E-09
80	5	7.291E-04	7.295E-04	1.309E-04	1.310E-04
	10	3.602E-06	3.605E-06	1.320E-06	1.322E-06
	15	6.629E-08	6.635E-08	3.036E-08	3.039E-08
60	5	6.501E-04	6.503E-04	1.014E-04	1.015E-04
	10	2.066E-06	2.067E-06	4.182E-07	4.186E-07
	15	3.045E-08	3.048E-08	7.378E-09	7.388E-09
30	5	1.236E-04	1.237E-04	1.825E-06	1.827E-06
	10	8.585E-08	8.594E-08	2.431E-09	2.434E-09
	15	4.130E-10	4.136E-10	1.605E-11	1.608E-11
		$kT = 50$ keV			
89	5	5.145E-03	5.146E-03	3.024E-04	3.025E-04
	10	1.520E-04	1.520E-04	1.094E-05	1.095E-05
	15	1.219E-05	1.220E-05	1.198E-06	1.198E-06
80	5	4.272E-03	4.273E-03	1.036E-03	1.037E-03
	10	1.095E-04	1.095E-04	4.542E-05	4.544E-05
	15	8.296E-06	8.296E-06	4.223E-06	4.225E-06
60	5	3.517E-03	3.517E-03	6.705E-04	6.707E-04
	10	7.834E-05	7.836E-05	2.132E-05	2.134E-05
	15	5.276E-06	5.275E-06	1.698E-06	1.700E-06
30	5	1.275E-03	1.276E-03	4.164E-05	4.167E-05
	10	1.136E-05	1.137E-05	6.417E-07	6.423E-07
	15	4.030E-07	4.033E-07	3.045E-08	3.049E-08

two methods agree to better than 0.02% indicates that our numerical code is very accurate. The values of opacities as presented here in all tables are in units of $\omega_p^2/\omega_c c$. This way the results are independent of the magnetic field and the number density of electrons.

Another check on the accuracy of our code may be made by calculating Q/V. In the case of large Faraday rotation and Faraday pulsation one obtains for the ratio Q/V the analytic expression (MW; see Barrett & Chanmugam 1984 for a simple derivation)

$$Q/V = h/f = \sin^2\theta/2s\cos\theta\,. \qquad (18)$$

However, as we show in Appendix A the criteria for the derivation of this expression as given by MW are insufficient. One can calculate the general Stokes parameters, and if the conditions of large Faraday rotation and Faraday pulsation are fulfilled the ratio Q/V should agree with the above analytic expression. The ratio Q/V for a number of different parameters are calculated as a function of θ in Appendix A. The condition of large Faraday rotation and pulsation is fulfilled for example for $kT = 20$ keV, $s = 15$, and $\Lambda = 10^9$ (Fig. 1; cf. Fig. 2). Then for angles θ between 2° and 88° the calculated value of Q/V deviates from its theoretical value no more than 0.001%.

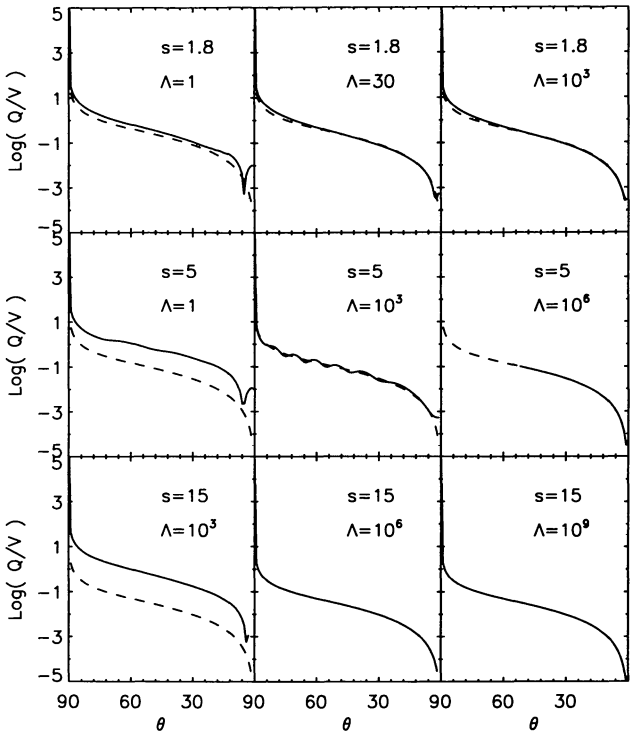

FIG. 1.—Calculated value (*solid line*) and value in case of large Faraday rotation and Faraday pulsation (*dashed line*) of the ratio Q/V for $kT = 20$ keV for different s and Λ. In some cases there is no difference between the solid and the dashed curves.

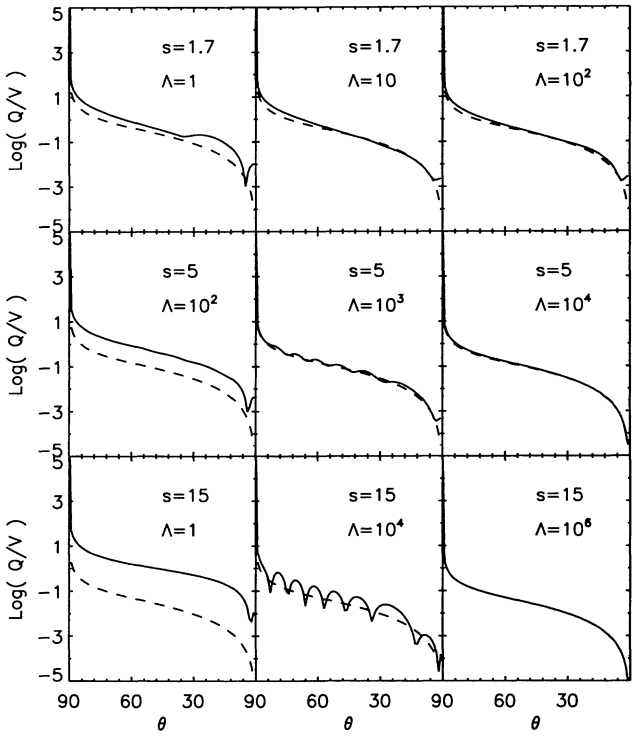

FIG. 2.—Same as the previous figure but for $kT = 50$ keV

The main use of the relation between $\alpha_\pm$ and κ, q, and v is that analytic approximations of the cyclotron opacities $\alpha_\pm$ (for which there are many) can be used to obtain analytic approximations for the opacities in the Stokes formalism (for which, as far as we are aware, there are none). Such analytic approximations are much faster to compute than the exact expressions for the opacities as given in equation (9) (mainly because of the Bessel functions and the required sum and integral). The accuracies of several of these analytic expressions have been discussed in Paper I. There it was found that the best analytic formulae for the opacities are given by RM (see also Dulk 1985). These are

$$\alpha_\pm = 2.67\times10^{-9}\frac{N}{B}\frac{\mu^2(1-15/8\mu)}{n_\pm^2\sin^3\theta}\times\frac{\gamma_0^{3/2}(\gamma_0^2-1)^{1/2}}{(1+a_\pm^2)}\frac{\xi_0^2(\xi_0^2-1)}{s_0^{3/2}x^{1/2}}\times\left\{\left[c_{2\pm}\left(1+\frac{0.85s_c}{s_0}\right)^{-1/3}+(1-n_\pm^2\beta_0^2)^{1/2}\times(1-n_\pm^2\beta_0^2\cos^2\theta)^{1/2}\right]^2+\frac{n_\pm^2\beta_0^2a_\pm^2\xi_0\sin^4\theta}{2(s_0+s_c)}\right\}\times(1-n_\pm^2\beta_0^2\cos^2\theta)\left(1+\frac{4.5297s_c}{s_0}\right)^{1/6}Z^{2s_0}\times\exp\left[-\mu(\gamma_0-1)\right], \quad (19)$$

where

$$\gamma_0=\left[1+\frac{2s}{\mu}\left(1+\frac{9x}{2}\right)^{-1/3}\right]^{1/2}, \quad \beta_0=(1-\gamma_0^{-2})^{1/2}, \quad (20)$$

$$x=\frac{s\sin^2\theta}{\mu},$$

$$n_\pm\approx1-\frac{\omega_p^2}{\omega^2}, \quad \xi_0=(1-\beta'^2)^{-1/2}, \quad (21)$$

$$a_+=-\frac{1}{a_-}=-\frac{[a+(1+a^2)^{1/2}]\cos\theta}{|\cos\theta|},$$

$$a=\frac{\sin^2\theta}{2s|\cos\theta|}, \quad s_0=\gamma_0(1-n_\pm^2\beta_0^2\cos^2\theta)s, \quad (22)$$

$$\beta'=\frac{n_\pm\beta_0\sin\theta}{(1-n_\pm^2\beta_0^2\cos^2\theta)^{1/2}},$$

$$s_c=\frac{3\xi_0^3}{2}, \quad c_{2\pm}=a_\pm\cos\theta(1-n_\pm^2\beta_0^2), \quad (23)$$

$$Z=\frac{\beta'e^{1/\xi_0}}{1+1/\xi_0},$$

TABLE 2

COMPARISON BETWEEN ACCURATE ABSORPTION COEFFICIENTS κ, q, v AND THOSE OBTAINED USING THE RM FORMULAE

		κ		q		v	
θ	s	This Work	RM	This Work	RM	This Work	RM
				$kT=20$ keV			
89°	5	5.0E-04	6.3E-04	−4.7E-04	−6.2E-04	−1.4E-05	−1.0E-04
	10	2.7E-06	3.1E-06	−2.5E-06	−3.1E-06	−6.0E-08	−2.8E-07
	15	5.4E-08	6.1E-08	−5.1E-08	−6.1E-08	−1.1E-09	−3.3E-09
80	5	4.3E-04	6.1E-04	−3.9E-04	−5.9E-04	−1.3E-04	−1.4E-04
	10	2.5E-06	2.9E-06	−2.3E-06	−2.8E-06	−5.5E-07	−7.0E-07
	15	4.8E-08	5.5E-08	−4.5E-08	−5.3E-08	−9.8E-09	−1.3E-08
60	5	3.8E-04	4.4E-04	−2.8E-04	−3.2E-04	−2.4E-04	−3.0E-04
	10	1.2E-06	1.4E-06	−9.4E-07	−1.1E-06	−7.6E-07	−9.6E-07
	15	1.9E-08	2.1E-08	−1.5E-08	−1.6E-08	−1.1E-08	−1.3E-08
30	5	6.3E-05	5.8E-05	−1.6E-05	−1.6E-05	−6.0E-05	−5.5E-05
	10	4.4E-08	3.0E-08	−1.4E-08	−8.3E-09	−4.2E-08	−2.9E-08
	15	2.1E-10	1.2E-10	−8.0E-11	−3.5E-11	−2.0E-10	−1.1E-10
				$kT=50$ keV			
89	5	2.7E-03	3.1E-03	−2.4E-03	−3.0E-03	−5.7E-05	−8.1E-04
	10	8.1E-05	8.9E-05	−7.4E-05	−8.8E-05	−1.5E-06	−1.5E-05
	15	6.7E-06	7.1E-06	−6.1E-06	−7.1E-06	−1.1E-07	−8.1E-07
80	5	2.7E-03	3.0E-03	−2.3E-03	−3.0E-03	−5.5E-04	−5.3E-04
	10	7.7E-05	8.5E-05	−6.9E-05	−8.4E-05	−1.4E-05	−1.6E-05
	15	6.3E-06	6.7E-06	−5.7E-06	−6.6E-06	−1.0E-06	−1.2E-06
60	5	2.1E-03	2.5E-03	−1.5E-03	−2.0E-03	−1.2E-03	−1.5E-03
	10	5.0E-05	5.7E-05	−3.9E-05	−4.6E-05	−2.6E-05	−3.3E-05
	15	3.5E-06	3.8E-06	−2.8E-06	−3.2E-06	−1.6E-06	−2.1E-06
30	5	6.6E-04	8.0E-04	−2.2E-04	−2.8E-04	−6.1E-04	−7.5E-04
	10	6.0E-06	6.3E-06	−2.6E-06	−2.3E-06	−5.3E-06	−5.8E-06
	15	2.2E-07	2.1E-07	−1.0E-07	−8.5E-08	−1.9E-07	−1.9E-07

TABLE 3

ABSORPTION COEFFICIENTS FOR $kT = 5$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	4.217E-12	-3.414E-12	-1.353E-12	2.044E-09	-9.815E-10	-1.786E-09	1.164E-05	-3.402E-06	-1.113E-05
1.6	1.020E-08	-8.728E-09	-2.520E-09	9.076E-07	-5.158E-07	-7.419E-07	3.826E-04	-1.317E-04	-3.591E-04
1.7	7.955E-06	-7.140E-06	-1.412E-06	1.420E-04	-9.480E-05	-1.046E-04	5.274E-03	-2.132E-03	-4.822E-03
1.8	2.060E-03	-1.927E-03	-2.329E-04	7.962E-03	-6.186E-03	-4.912E-03	3.237E-02	-1.532E-02	-2.850E-02
1.9	1.320E-01	-1.280E-01	-7.109E-03	1.303E-01	-1.159E-01	-5.678E-02	8.676E-02	-4.801E-02	-7.222E-02
2.0	1.315E-05	-1.314E-05	-7.204E-08	1.161E-01	-1.143E-01	-1.604E-02	9.665E-02	-6.232E-02	-7.380E-02
2.1	1.244E-16	-9.881E-17	-4.279E-17	1.455E-13	-6.177E-14	-1.313E-13	3.258E-02	-2.448E-02	-2.146E-02
2.2	5.790E-14	-4.778E-14	-1.710E-14	2.087E-11	-9.963E-12	-1.825E-11	1.547E-03	-1.349E-03	-7.533E-04
2.3	1.456E-11	-1.244E-11	-3.628E-12	1.723E-09	-9.217E-10	-1.446E-09	1.608E-06	-5.226E-07	-1.506E-06
2.4	2.088E-09	-1.839E-09	-4.291E-10	8.571E-08	-5.119E-08	-6.815E-08	1.461E-05	-5.136E-06	-1.368E-05
2.5	1.763E-07	-1.596E-07	-2.901E-08	2.642E-06	-1.754E-06	-1.952E-06	9.168E-05	-3.589E-05	-8.434E-05
2.6	8.820E-06	-8.183E-06	-1.114E-06	5.081E-05	-3.728E-05	-3.391E-05	3.959E-04	-1.724E-04	-3.563E-04
2.7	2.511E-04	-2.382E-04	-2.280E-05	5.929E-04	-4.776E-04	-3.417E-04	1.191E-03	-5.760E-04	-1.042E-03
2.8	3.505E-03	-3.390E-03	-2.032E-04	3.804E-03	-3.333E-03	-1.750E-03	2.474E-03	-1.327E-03	-2.087E-03
2.9	1.371E-02	-1.350E-02	-3.809E-04	9.875E-03	-9.288E-03	-3.059E-03	3.460E-03	-2.056E-03	-2.780E-03
3.0	2.502E-09	-2.502E-09	-2.265E-11	2.169E-03	-2.144E-03	-2.450E-04	3.099E-03	-2.039E-03	-2.331E-03
3.1	1.542E-11	-1.358E-11	-3.166E-12	7.099E-10	-4.089E-10	-5.753E-10	1.627E-03	-1.183E-03	-1.115E-03
3.2	5.626E-10	-5.053E-10	-9.907E-11	1.231E-08	-7.686E-09	-9.513E-09	4.110E-04	-3.294E-04	-2.447E-04
3.3	1.501E-08	-1.373E-08	-2.230E-09	1.617E-07	-1.090E-07	-1.177E-07	3.593E-05	-2.987E-05	-1.849E-05
3.4	2.927E-07	-2.722E-07	-3.592E-08	1.610E-06	-1.168E-06	-1.086E-06	1.241E-05	-5.314E-06	-1.115E-05
3.5	4.111E-06	-3.880E-06	-4.050E-07	1.203E-05	-9.362E-06	-7.365E-06	3.277E-05	-1.495E-05	-2.915E-05
3.6	3.996E-05	-3.824E-05	-3.032E-06	6.579E-05	-5.458E-05	-3.542E-05	7.108E-05	-3.506E-05	-6.179E-05
3.7	2.453E-04	-2.377E-04	-1.344E-05	2.481E-04	-2.182E-04	-1.121E-04	1.244E-04	-6.635E-05	-1.052E-04
3.8	7.600E-04	-7.450E-04	-2.674E-05	5.664E-04	-5.239E-04	-1.985E-04	1.741E-04	-1.003E-04	-1.422E-04
3.9	5.636E-04	-5.582E-04	-9.563E-06	5.558E-04	-5.354E-04	-1.292E-04	1.913E-04	-1.188E-04	-1.496E-04
4.0	1.778E-10	-1.620E-10	-2.731E-11	5.496E-05	-5.445E-05	-5.236E-06	1.603E-04	-1.074E-04	-1.188E-04
4.1	2.335E-09	-2.155E-09	-3.134E-10	1.784E-08	-1.230E-08	-1.270E-08	9.811E-05	-7.072E-05	-6.781E-05
4.2	2.490E-08	-2.326E-08	-2.873E-09	1.150E-07	-8.397E-08	-7.692E-08	4.093E-05	-3.154E-05	-2.590E-05
4.3	2.130E-07	-2.012E-07	-2.080E-08	6.131E-07	-4.726E-07	-3.801E-07	1.128E-05	-8.793E-06	-6.743E-06
4.4	1.437E-06	-1.371E-06	-1.163E-07	2.672E-06	-2.168E-06	-1.510E-06	4.262E-06	-2.448E-06	-3.306E-06
4.5	7.392E-06	-7.118E-06	-4.819E-07	9.319E-06	-7.923E-06	-4.691E-06	5.828E-06	-2.942E-06	-5.021E-06
4.6	2.727E-05	-2.649E-05	-1.375E-06	2.499E-05	-2.218E-05	-1.086E-05	9.074E-06	-4.857E-06	-7.658E-06
4.7	6.380E-05	-6.249E-05	-2.334E-06	4.793E-05	-4.416E-05	-1.718E-05	1.225E-05	-6.975E-06	-1.006E-05
4.8	7.125E-05	-7.031E-05	-1.681E-06	5.670E-05	-5.392E-05	-1.554E-05	1.418E-05	-8.576E-06	-1.128E-05
4.9	1.516E-05	-1.507E-05	-1.736E-07	2.885E-05	-2.813E-05	-5.253E-06	1.389E-05	-8.917E-06	-1.063E-05
5.0	3.543E-09	-3.325E-09	-3.810E-10	1.668E-06	-1.652E-06	-1.447E-07	1.132E-05	-7.704E-06	-8.270E-06
5.3	4.460E-07	-4.287E-07	-3.066E-08	6.029E-07	-5.046E-07	-3.159E-07	1.777E-06	-1.318E-06	-1.145E-06
5.6	7.331E-06	-7.183E-06	-2.631E-07	5.436E-06	-5.015E-06	-1.923E-06	1.120E-06	-6.371E-07	-9.201E-07
5.9	3.185E-07	-3.169E-07	-2.882E-09	1.461E-06	-1.434E-06	-2.189E-07	1.250E-06	-8.233E-07	-9.385E-07
6.2	1.312E-07	-1.267E-07	-7.841E-09	1.409E-07	-1.209E-07	-6.870E-08	4.378E-07	-3.208E-07	-2.930E-07
6.5	1.041E-06	-1.021E-06	-3.585E-08	7.591E-07	-7.029E-07	-2.613E-07	1.407E-07	-8.489E-08	-1.102E-07
6.8	1.899E-07	-1.885E-07	-2.547E-09	3.527E-07	-3.435E-07	-6.498E-08	1.509E-07	-9.743E-08	-1.149E-07
7.1	3.759E-08	-3.647E-08	-1.989E-09	3.417E-08	-2.990E-08	-1.556E-08	8.020E-08	-5.716E-08	-5.566E-08
7.4	1.714E-07	-1.683E-07	-5.614E-09	1.234E-07	-1.148E-07	-4.104E-08	2.655E-08	-1.775E-08	-1.913E-08
7.7	4.927E-08	-4.882E-08	-8.050E-10	6.895E-08	-6.678E-08	-1.407E-08	2.055E-08	-1.315E-08	-1.572E-08
8.0	1.065E-08	-1.036E-08	-5.055E-10	8.666E-09	-7.714E-09	-3.669E-09	1.369E-08	-9.549E-09	-9.735E-09
8.3	3.142E-08	-3.087E-08	-9.762E-10	2.253E-08	-2.105E-08	-7.214E-09	5.692E-09	-3.978E-09	-3.967E-09
8.6	1.074E-08	-1.063E-08	-1.991E-10	1.333E-08	-1.286E-08	-2.890E-09	3.302E-09	-2.147E-09	-2.482E-09
8.9	3.005E-09	-2.932E-09	-1.294E-10	2.406E-09	-2.184E-09	-9.096E-10	2.378E-09	-1.632E-09	-1.716E-09
9.0	4.409E-09	-4.313E-09	-1.691E-10	3.131E-09	-2.864E-09	-1.159E-09	1.966E-09	-1.374E-09	-1.392E-09
9.5	2.314E-09	-2.287E-09	-4.733E-11	2.694E-09	-2.591E-09	-6.091E-10	6.343E-10	-4.260E-10	-4.617E-10
10.0	1.299E-09	-1.276E-09	-4.122E-11	9.061E-10	-8.448E-10	-2.936E-10	3.152E-10	-2.208E-10	-2.223E-10
10.5	2.977E-10	-2.932E-10	-8.015E-12	3.823E-10	-3.656E-10	-9.005E-11	1.156E-10	-7.899E-11	-8.305E-11
11.0	2.982E-10	-2.937E-10	-8.097E-12	2.223E-10	-2.100E-10	-6.400E-11	5.546E-11	-3.895E-11	-3.897E-11
11.5	6.847E-11	-6.721E-11	-2.236E-12	6.875E-11	-6.499E-11	-1.860E-11	2.229E-11	-1.542E-11	-1.583E-11
12.0	5.861E-11	-5.779E-11	-1.451E-12	4.900E-11	-4.662E-11	-1.290E-11	1.057E-11	-7.448E-12	-7.394E-12
12.5	2.037E-11	-2.002E-11	-6.351E-13	1.621E-11	-1.526E-11	-4.693E-12	4.537E-12	-3.173E-12	-3.192E-12
13.0	1.126E-11	-1.110E-11	-2.816E-13	1.038E-11	-9.903E-12	-2.622E-12	2.157E-12	-1.527E-12	-1.502E-12
13.5	5.726E-12	-5.634E-12	-1.621E-13	4.290E-12	-4.052E-12	-1.218E-12	9.730E-13	-6.863E-13	-6.789E-13
14.0	2.465E-12	-2.428E-12	-6.626E-14	2.283E-12	-2.174E-12	-5.807E-13	4.677E-13	-3.326E-13	-3.239E-13
14.5	1.472E-12	-1.450E-12	-3.887E-14	1.142E-12	-1.084E-12	-3.093E-13	2.191E-13	-1.557E-13	-1.518E-13
15.0	6.390E-13	-6.290E-13	-1.774E-14	5.492E-13	-5.221E-13	-1.433E-13	1.069E-13	-7.645E-14	-7.364E-14
16.0	1.798E-13	-1.770E-13	-4.896E-15	1.447E-13	-1.375E-13	-3.815E-14	2.565E-14	-1.843E-14	-1.756E-14
17.0	5.125E-14	-5.049E-14	-1.353E-15	4.037E-14	-3.840E-14	-1.055E-14	6.423E-15	-4.638E-15	-4.373E-15
18.0	1.469E-14	-1.448E-14	-3.805E-16	1.162E-14	-1.107E-14	-2.991E-15	1.673E-15	-1.214E-15	-1.133E-15
19.0	4.310E-15	-4.247E-15	-1.108E-16	3.422E-15	-3.263E-15	-8.694E-16	4.521E-16	-3.296E-16	-3.043E-16
20.0	1.310E-15	-1.291E-15	-3.354E-17	1.034E-15	-9.869E-16	-2.604E-16	1.263E-16	-9.253E-17	-8.457E-17
21.0	4.119E-16	-4.060E-16	-1.049E-17	3.217E-16	-3.071E-16	-8.044E-17	3.642E-17	-2.680E-17	-2.426E-17
22.0	1.333E-16	-1.314E-16	-3.367E-18	1.030E-16	-9.834E-17	-2.557E-17	1.081E-17	-7.991E-18	-7.165E-18
23.0	4.423E-17	-4.360E-17	-1.108E-18	3.383E-17	-3.234E-17	-8.347E-18	3.301E-18	-2.449E-18	-2.175E-18
24.0	1.501E-17	-1.480E-17	-3.731E-19	1.139E-17	-1.089E-17	-2.791E-18	1.034E-18	-7.699E-19	-6.780E-19
25.0	5.211E-18	-5.138E-18	-1.286E-19	3.923E-18	-3.754E-18	-9.543E-19	3.318E-19	-2.480E-19	-2.165E-19

TABLE 3—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	2.537E-04	-2.016E-05	-2.529E-04	3.436E-04	-2.023E-05	-3.428E-04	7.222E-04	-6.181E-06	-7.221E-04
1.6	1.826E-03	-1.646E-04	-1.819E-03	7.316E-04	-1.673E-05	-7.314E-04	1.043E-04	-3.721E-07	-1.043E-04
1.7	7.248E-03	-7.450E-04	-7.209E-03	2.412E-03	-6.135E-05	-2.411E-03	2.886E-04	-8.217E-07	-2.886E-04
1.8	1.750E-02	-2.040E-03	-1.738E-02	5.060E-03	-1.446E-04	-5.058E-03	6.023E-04	-1.899E-06	-6.023E-04
1.9	2.778E-02	-3.651E-03	-2.754E-02	7.040E-03	-2.250E-04	-7.037E-03	7.991E-04	-2.810E-06	-7.991E-04
2.0	3.062E-02	-4.516E-03	-3.028E-02	8.432E-03	-2.986E-04	-8.427E-03	9.664E-04	-3.754E-06	-9.664E-04
2.1	2.375E-02	-3.918E-03	-2.343E-02	6.296E-03	-2.471E-04	-6.291E-03	7.120E-04	-3.056E-06	-7.120E-04
2.2	1.226E-02	-2.260E-03	-1.205E-02	4.644E-03	-2.001E-04	-4.639E-03	5.431E-04	-2.553E-06	-5.431E-04
2.3	5.457E-03	-1.114E-03	-5.342E-03	2.340E-03	-1.106E-04	-2.338E-03	3.161E-04	-1.622E-06	-3.161E-04
2.4	1.724E-03	-3.883E-04	-1.680E-03	9.384E-04	-4.849E-05	-9.371E-04	1.505E-04	-8.401E-07	-1.505E-04
2.5	4.938E-04	-1.157E-04	-4.795E-04	3.390E-04	-1.897E-05	-3.385E-04	6.185E-05	-3.745E-07	-6.185E-05
2.6	1.786E-04	-3.092E-05	-1.753E-04	1.223E-04	-7.157E-06	-1.221E-04	2.102E-05	-1.375E-07	-2.102E-05
2.7	2.037E-04	-2.582E-05	-2.019E-04	5.186E-05	-2.858E-06	-5.177E-05	5.234E-06	-3.637E-08	-5.234E-06
2.8	2.828E-04	-3.620E-05	-2.805E-04	2.997E-05	-1.286E-06	-2.994E-05	2.269E-06	-1.607E-08	-2.269E-06
2.9	3.436E-04	-4.728E-05	-3.403E-04	2.621E-05	-9.251E-07	-2.619E-05	7.647E-07	-4.785E-09	-7.647E-07
3.0	3.565E-04	-5.293E-05	-3.526E-04	2.694E-05	-9.764E-07	-2.693E-05	4.754E-07	-2.476E-09	-4.753E-07
3.1	3.190E-04	-5.103E-05	-3.149E-04	2.541E-05	-9.666E-07	-2.539E-05	3.509E-07	-1.540E-09	-3.509E-07
3.2	2.477E-04	-4.262E-05	-2.440E-04	2.038E-05	-8.273E-07	-2.037E-05	2.779E-07	-1.259E-09	-2.779E-07
3.3	1.655E-04	-3.056E-05	-1.626E-04	1.584E-05	-6.838E-07	-1.582E-05	2.238E-07	-1.059E-09	-2.238E-07
3.4	9.514E-05	-1.878E-05	-9.326E-05	1.063E-05	-4.884E-07	-1.062E-05	1.494E-07	-7.473E-10	-1.494E-07
3.5	5.176E-05	-1.078E-05	-5.062E-05	6.912E-06	-3.362E-07	-6.904E-06	1.041E-07	-5.501E-10	-1.041E-07
3.6	2.685E-05	-5.720E-06	-2.622E-05	3.833E-06	-1.969E-07	-3.828E-06	6.233E-08	-3.482E-10	-6.233E-08
3.7	1.385E-05	-2.789E-06	-1.355E-05	2.285E-06	-1.228E-07	-2.282E-06	3.368E-08	-1.987E-10	-3.368E-08
3.8	9.569E-06	-1.706E-06	-9.397E-06	1.181E-06	-6.526E-08	-1.179E-06	1.948E-08	-1.209E-10	-1.948E-08
3.9	7.983E-06	-1.265E-06	-7.873E-06	6.030E-07	-3.314E-08	-6.020E-07	1.040E-08	-6.762E-11	-1.040E-08
4.0	7.427E-06	-1.155E-06	-7.333E-06	3.623E-07	-1.920E-08	-3.618E-07	5.039E-09	-3.410E-11	-5.039E-09
4.1	6.820E-06	-1.088E-06	-6.732E-06	2.400E-07	-1.193E-08	-2.397E-07	2.334E-09	-1.624E-11	-2.334E-09
4.2	5.838E-06	-9.764E-07	-5.756E-06	1.717E-07	-7.992E-09	-1.715E-07	1.094E-09	-7.651E-12	-1.094E-09
4.3	4.677E-06	-8.228E-07	-4.604E-06	1.291E-07	-5.808E-09	-1.289E-07	5.441E-10	-3.716E-12	-5.441E-10
4.4	3.519E-06	-6.502E-07	-3.458E-06	9.832E-08	-4.430E-09	-9.821E-08	2.962E-10	-1.929E-12	-2.962E-10
4.5	2.442E-06	-4.722E-07	-2.395E-06	7.399E-08	-3.411E-09	-7.391E-08	1.774E-10	-1.097E-12	-1.774E-10
4.6	1.620E-06	-3.251E-07	-1.587E-06	5.422E-08	-2.585E-09	-5.416E-08	1.137E-10	-6.792E-13	-1.137E-10
4.7	1.055E-06	-2.163E-07	-1.032E-06	3.842E-08	-1.899E-09	-3.837E-08	7.493E-11	-4.411E-13	-7.493E-11
4.8	6.780E-07	-1.390E-07	-6.630E-07	2.627E-08	-1.346E-09	-2.623E-08	4.928E-11	-2.903E-13	-4.927E-11
4.9	4.499E-07	-8.954E-08	-4.404E-07	1.738E-08	-9.207E-10	-1.736E-08	3.202E-11	-1.910E-13	-3.202E-11
5.0	3.227E-07	-6.113E-08	-3.164E-07	1.121E-08	-6.099E-10	-1.119E-08	2.054E-11	-1.255E-13	-2.054E-11
5.3	1.671E-07	-2.973E-08	-1.644E-07	2.876E-09	-1.594E-10	-2.872E-09	4.941E-12	-3.328E-14	-4.941E-12
5.6	8.140E-08	-1.564E-08	-7.987E-08	9.275E-10	-4.877E-11	-9.262E-10	9.007E-13	-6.522E-15	-9.006E-13
5.9	3.136E-08	-6.413E-09	-3.067E-08	3.507E-10	-1.822E-11	-3.502E-10	1.809E-13	-1.332E-15	-1.809E-13
6.2	1.206E-08	-2.415E-09	-1.181E-08	1.278E-10	-6.992E-12	-1.277E-10	4.099E-14	-2.918E-16	-4.099E-14
6.5	5.619E-09	-1.086E-09	-5.509E-09	4.356E-11	-2.494E-12	-4.349E-11	1.040E-14	-7.277E-17	-1.040E-14
6.8	2.723E-09	-5.414E-10	-2.667E-09	1.457E-11	-8.446E-13	-1.455E-11	2.741E-15	-1.978E-17	-2.741E-15
7.1	1.214E-09	-2.512E-10	-1.187E-09	5.203E-12	-2.987E-13	-5.194E-12	7.044E-16	-5.363E-18	-7.044E-16
7.4	5.296E-10	-1.102E-10	-5.175E-10	1.973E-12	-1.135E-13	-1.970E-12	1.767E-16	-1.394E-18	-1.766E-16
7.7	2.463E-10	-5.056E-11	-2.409E-10	7.527E-13	-4.419E-14	-7.514E-13	4.294E-17	-3.434E-19	-4.294E-17
8.0	1.202E-10	-2.485E-11	-1.175E-10	2.857E-13	-1.720E-14	-2.851E-13	1.123E-17	-8.966E-20	-1.123E-17
8.3	5.787E-11	-1.223E-11	-5.652E-11	1.088E-13	-6.653E-15	-1.086E-13	3.093E-18	-2.475E-20	-3.093E-18
8.6	2.745E-11	-5.880E-12	-2.679E-11	4.186E-14	-2.573E-15	-4.178E-14	9.067E-19	-7.415E-21	-9.066E-19
8.9	1.326E-11	-2.844E-12	-1.294E-11	1.677E-14	-1.038E-15	-1.674E-14	2.521E-19	-2.106E-21	-2.521E-19
9.0	1.048E-11	-2.247E-12	-1.022E-11	1.236E-14	-7.670E-16	-1.233E-14	1.679E-19	-1.414E-21	-1.679E-19
9.5	3.310E-12	-7.198E-13	-3.229E-12	2.772E-15	-1.764E-16	-2.766E-15	2.117E-20	-1.849E-22	-2.117E-20
10.0	1.052E-12	-2.326E-13	-1.025E-12	6.307E-16	-4.097E-17	-6.293E-16	2.789E-21	-2.486E-23	-2.789E-21
10.5	3.443E-13	-7.678E-14	-3.353E-13	1.495E-16	-9.866E-18	-1.492E-16	3.861E-22	-3.496E-24	-3.861E-22
11.0	1.160E-13	-2.622E-14	-1.129E-13	3.660E-17	-2.457E-18	-3.651E-17	5.556E-23	-5.148E-25	-5.556E-23
11.5	3.970E-14	-9.085E-15	-3.861E-14	9.174E-18	-6.271E-19	-9.152E-18	8.200E-24	-7.827E-26	-8.199E-24
12.0	1.391E-14	-3.216E-15	-1.352E-14	2.363E-18	-1.642E-19	-2.357E-18	1.286E-24	-1.254E-26	-1.286E-24
12.5	4.977E-15	-1.164E-15	-4.835E-15	6.240E-19	-4.405E-20	-6.224E-19	2.037E-25	-2.018E-27	-2.037E-25
13.0	1.812E-15	-4.283E-16	-1.759E-15	1.687E-19	-1.210E-20	-1.683E-19	3.427E-26	-3.486E-28	-3.427E-26
13.5	6.720E-16	-1.605E-16	-6.520E-16	4.686E-20	-3.414E-21	-4.673E-20	5.846E-27	-6.058E-29	-5.846E-27
14.0	2.536E-16	-6.118E-17	-2.459E-16	1.325E-20	-9.797E-22	-1.322E-20	1.036E-27	-1.095E-29	-1.036E-27
14.5	9.723E-17	-2.369E-17	-9.422E-17	3.836E-21	-2.876E-22	-3.825E-21	1.840E-28	-1.977E-30	-1.840E-28
15.0	3.788E-17	-9.316E-18	-3.668E-17	1.130E-21	-8.593E-23	-1.127E-21	3.367E-29	-3.678E-31	-3.367E-29
16.0	6.008E-18	-1.505E-18	-5.811E-18	1.043E-22	-8.156E-24	-1.040E-22	1.281E-30	-1.453E-32	-1.281E-30
17.0	1.007E-18	-2.568E-19	-9.727E-19	1.030E-23	-8.261E-25	-1.026E-23	5.295E-32	-6.243E-34	-5.295E-32
18.0	1.775E-19	-4.604E-20	-1.713E-19	1.088E-24	-8.946E-26	-1.084E-24	2.316E-33	-2.807E-35	-2.316E-33
19.0	3.282E-20	-8.650E-21	-3.163E-20	1.220E-25	-1.028E-26	-1.215E-25	1.169E-34	-1.471E-36	-1.169E-34
20.0	6.339E-21	-1.697E-21	-6.102E-21	1.449E-26	-1.249E-27	-1.443E-26	6.010E-36	-7.760E-38	-6.010E-36
21.0	1.276E-21	-3.465E-22	-1.226E-21	1.812E-27	-1.598E-28	-1.805E-27	3.365E-37	-4.491E-39	-3.365E-37
22.0	2.667E-22	-7.350E-23	-2.561E-22	2.381E-28	-2.143E-29	-2.371E-28	2.049E-38	-2.805E-40	-2.049E-38
23.0	5.783E-23	-1.615E-23	-5.546E-23	3.279E-29	-3.013E-30	-3.265E-29	1.314E-39	-1.852E-41	-1.314E-39
24.0	1.297E-23	-3.671E-24	-1.242E-23	4.721E-30	-4.425E-31	-4.700E-30	9.012E-41	-1.303E-42	-9.011E-41
25.0	3.003E-24	-8.611E-25	-2.874E-24	7.084E-31	-6.768E-32	-7.050E-31	6.535E-42	-9.686E-44	-6.534E-42

TABLE 4

ABSORPTION COEFFICIENTS FOR $kT = 10$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	1.599E-05	-1.330E-05	-2.698E-06	1.083E-04	-6.184E-05	-8.700E-05	2.628E-03	-8.328E-04	-2.491E-03
1.6	5.722E-04	-4.973E-04	-7.311E-05	1.904E-03	-1.260E-03	-1.379E-03	1.337E-02	-4.985E-03	-1.240E-02
1.7	1.080E-02	-9.767E-03	-9.789E-04	1.917E-02	-1.450E-02	-1.185E-02	4.378E-02	-1.911E-02	-3.934E-02
1.8	1.020E-01	-9.569E-02	-5.830E-03	1.075E-01	-9.130E-02	-5.138E-02	9.426E-02	-4.801E-02	-8.096E-02
1.9	3.367E-01	-3.267E-01	-9.104E-03	2.699E-01	-2.513E-01	-8.051E-02	1.319E-01	-7.812E-02	-1.060E-01
2.0	2.315E-06	-2.314E-06	-1.289E-08	5.984E-02	-5.920E-02	-4.580E-03	1.138E-01	-7.805E-02	-8.243E-02
2.1	6.032E-08	-4.952E-08	-1.095E-08	5.306E-07	-2.780E-07	-4.433E-07	5.114E-02	-4.040E-02	-3.106E-02
2.2	1.050E-06	-8.876E-07	-1.617E-07	5.630E-06	-3.276E-06	-4.462E-06	7.405E-03	-6.620E-03	-3.183E-03
2.3	1.312E-05	-1.139E-05	-1.688E-06	4.474E-05	-2.873E-05	-3.312E-05	3.359E-04	-1.192E-04	-3.111E-04
2.4	1.198E-04	-1.067E-04	-1.261E-05	2.710E-04	-1.906E-04	-1.837E-04	9.296E-04	-3.593E-04	-8.564E-04
2.5	8.016E-04	-7.309E-04	-6.710E-05	1.258E-03	-9.619E-04	-7.596E-04	2.131E-03	-9.158E-04	-1.921E-03
2.6	3.857E-03	-3.593E-03	-2.465E-04	4.428E-03	-3.647E-03	-2.292E-03	4.019E-03	-1.917E-03	-3.525E-03
2.7	1.255E-02	-1.192E-02	-5.739E-04	1.134E-02	-9.963E-03	-4.752E-03	6.244E-03	-3.298E-03	-5.288E-03
2.8	2.333E-02	-2.259E-02	-6.793E-04	1.900E-02	-1.760E-02	-5.864E-03	7.939E-03	-4.635E-03	-6.424E-03
2.9	1.396E-02	-1.374E-02	-1.943E-04	1.526E-02	-1.473E-02	-2.874E-03	8.123E-03	-5.228E-03	-6.188E-03
3.0	1.222E-06	-1.070E-06	-1.485E-07	1.238E-03	-1.227E-03	-7.743E-05	6.477E-03	-4.580E-03	-4.548E-03
3.1	6.948E-06	-6.192E-06	-7.297E-07	1.543E-05	-1.070E-05	-1.060E-05	3.805E-03	-2.934E-03	-2.390E-03
3.2	3.276E-05	-2.969E-05	-2.937E-06	5.579E-05	-4.121E-05	-3.539E-05	1.509E-03	-1.232E-03	-8.298E-04
3.3	1.278E-04	-1.176E-04	-9.626E-06	1.717E-04	-1.344E-04	-9.900E-05	4.419E-04	-3.122E-04	-2.698E-04
3.4	4.075E-04	-3.805E-04	-2.527E-05	4.466E-04	-3.683E-04	-2.292E-04	3.295E-04	-1.578E-04	-2.860E-04
3.5	1.037E-03	-9.819E-04	-5.150E-05	9.656E-04	-8.342E-04	-4.291E-04	4.850E-04	-2.456E-04	-4.171E-04
3.6	2.008E-03	-1.925E-03	-7.662E-05	1.679E-03	-1.510E-03	-6.229E-04	6.493E-04	-3.547E-04	-5.421E-04
3.7	2.678E-03	-2.598E-03	-7.366E-05	2.202E-03	-2.049E-03	-6.469E-04	7.722E-04	-4.542E-04	-6.219E-04
3.8	1.953E-03	-1.914E-03	-3.449E-05	1.903E-03	-1.821E-03	-4.074E-04	8.101E-04	-5.120E-04	-6.244E-04
3.9	3.698E-04	-3.660E-04	-3.404E-06	7.698E-04	-7.517E-04	-1.043E-04	7.416E-04	-5.020E-04	-5.417E-04
4.0	1.043E-05	-9.567E-06	-8.150E-07	4.777E-05	-4.423E-05	-1.019E-05	5.834E-04	-4.205E-04	-3.995E-04
4.1	2.920E-05	-2.709E-05	-1.982E-06	3.412E-05	-2.735E-05	-1.866E-05	3.884E-04	-2.941E-04	-2.476E-04
4.2	7.117E-05	-6.674E-05	-4.144E-06	7.235E-05	-6.031E-05	-3.592E-05	2.199E-04	-1.685E-04	-1.335E-04
4.3	1.490E-04	-1.411E-04	-7.328E-06	1.354E-04	-1.169E-04	-6.005E-05	1.191E-04	-8.375E-05	-7.729E-05
4.4	2.621E-04	-2.505E-04	-1.067E-05	2.200E-04	-1.959E-04	-8.550E-05	8.625E-05	-5.083E-05	-6.664E-05
4.5	3.732E-04	-3.599E-04	-1.223E-05	3.026E-04	-2.770E-04	-1.005E-04	9.121E-05	-5.168E-05	-7.461E-05
4.6	4.031E-04	-3.919E-04	-1.023E-05	3.379E-04	-3.166E-04	-9.287E-05	1.028E-04	-6.133E-05	-8.210E-05
4.7	2.918E-04	-2.858E-04	-5.435E-06	2.843E-04	-2.715E-04	-6.203E-05	1.077E-04	-6.790E-05	-8.301E-05
4.8	1.085E-04	-1.069E-04	-1.493E-06	1.570E-04	-1.518E-04	-2.638E-05	1.034E-04	-6.872E-05	-7.657E-05
4.9	1.575E-05	-1.517E-05	-5.476E-07	4.560E-05	-4.350E-05	-8.093E-06	9.059E-05	-6.316E-05	-6.413E-05
5.0	1.654E-05	-1.558E-05	-8.967E-07	1.666E-05	-1.423E-05	-7.471E-06	7.219E-05	-5.234E-05	-4.875E-05
5.3	6.578E-05	-6.330E-05	-2.276E-06	5.289E-05	-4.809E-05	-1.827E-05	2.480E-05	-1.728E-05	-1.668E-05
5.6	5.058E-05	-4.951E-05	-9.701E-07	5.061E-05	-4.828E-05	-1.104E-05	1.789E-05	-1.136E-05	-1.369E-05
5.9	7.549E-06	-7.187E-06	-3.342E-07	7.992E-06	-7.193E-06	-2.743E-06	1.388E-05	-9.826E-06	-9.625E-06
6.2	1.674E-05	-1.619E-05	-5.080E-07	1.340E-05	-1.235E-05	-4.180E-06	6.694E-06	-4.825E-06	-4.422E-06
6.5	1.018E-05	-9.951E-06	-2.072E-07	1.047E-05	-9.964E-06	-2.310E-06	3.781E-06	-2.495E-06	-2.772E-06
6.8	3.068E-06	-2.945E-06	-1.133E-07	3.031E-06	-2.780E-06	-9.320E-07	2.933E-06	-2.051E-06	-2.059E-06
7.1	4.382E-06	-4.250E-06	-1.203E-07	3.572E-06	-3.325E-06	-1.026E-06	1.730E-06	-1.251E-06	-1.150E-06
7.4	2.386E-06	-2.328E-06	-5.300E-08	2.475E-06	-2.348E-06	-5.615E-07	9.697E-07	-6.701E-07	-6.764E-07
7.7	1.130E-06	-1.090E-06	-3.659E-08	1.043E-06	-9.660E-07	-3.024E-07	6.899E-07	-4.814E-07	-4.844E-07
8.0	1.196E-06	-1.162E-06	-3.077E-08	1.004E-06	-9.403E-07	-2.709E-07	4.557E-07	-3.291E-07	-3.051E-07
8.3	6.472E-07	-6.302E-07	-1.556E-08	6.593E-07	-6.236E-07	-1.546E-07	2.720E-07	-1.933E-07	-1.843E-07
8.6	3.962E-07	-3.834E-07	-1.165E-08	3.517E-07	-3.277E-07	-9.735E-08	1.822E-07	-1.283E-07	-1.260E-07
8.9	3.453E-07	-3.359E-07	-8.592E-09	2.985E-07	-2.805E-07	-7.711E-08	1.257E-07	-9.069E-08	-8.448E-08
9.0	2.966E-07	-2.888E-07	-7.143E-09	2.701E-07	-2.547E-07	-6.667E-08	1.088E-07	-7.877E-08	-7.255E-08
9.5	1.369E-07	-1.328E-07	-3.754E-09	1.195E-07	-1.119E-07	-3.181E-08	5.294E-08	-3.783E-08	-3.592E-08
10.0	7.731E-08	-7.521E-08	-1.915E-09	7.277E-08	-6.869E-08	-1.762E-08	2.828E-08	-2.058E-08	-1.876E-08
10.5	4.389E-08	-4.267E-08	-1.118E-09	3.780E-08	-3.554E-08	-9.676E-09	1.455E-08	-1.053E-08	-9.721E-09
11.0	2.316E-08	-2.251E-08	-5.880E-10	2.122E-08	-2.002E-08	-5.196E-09	7.901E-09	-5.786E-09	-5.202E-09
11.5	1.383E-08	-1.345E-08	-3.404E-10	1.215E-08	-1.146E-08	-2.992E-09	4.234E-09	-3.098E-09	-2.794E-09
12.0	7.650E-09	-7.440E-09	-1.918E-10	6.770E-09	-6.387E-09	-1.659E-09	2.346E-09	-1.730E-09	-1.532E-09
12.5	4.511E-09	-4.390E-09	-1.102E-10	3.996E-09	-3.775E-09	-9.638E-10	1.299E-09	-9.586E-10	-8.472E-10
13.0	2.639E-09	-2.568E-09	-6.465E-11	2.300E-09	-2.172E-09	-5.566E-10	7.348E-10	-5.454E-10	-4.757E-10
13.5	1.558E-09	-1.516E-09	-3.782E-11	1.368E-09	-1.294E-09	-3.265E-10	4.176E-10	-3.107E-10	-2.697E-10
14.0	9.383E-10	-9.136E-10	-2.259E-11	8.139E-10	-7.698E-10	-1.938E-10	2.411E-10	-1.802E-10	-1.548E-10
14.5	5.644E-10	-5.495E-10	-1.354E-11	4.898E-10	-4.636E-10	-1.157E-10	1.402E-10	-1.050E-10	-8.968E-11
15.0	3.452E-10	-3.362E-10	-8.211E-12	2.981E-10	-2.823E-10	-7.002E-11	8.252E-11	-6.205E-11	-5.251E-11
16.0	1.316E-10	-1.282E-10	-3.096E-12	1.129E-10	-1.070E-10	-2.620E-11	2.933E-11	-2.218E-11	-1.851E-11
17.0	5.184E-11	-5.052E-11	-1.205E-12	4.413E-11	-4.187E-11	-1.013E-11	1.079E-11	-8.205E-12	-6.751E-12
18.0	2.102E-11	-2.049E-11	-4.834E-13	1.777E-11	-1.687E-11	-4.036E-12	4.094E-12	-3.131E-12	-2.542E-12
19.0	8.753E-12	-8.535E-12	-1.991E-13	7.349E-12	-6.984E-12	-1.653E-12	1.600E-12	-1.230E-12	-9.857E-13
20.0	3.735E-12	-3.643E-12	-8.411E-14	3.116E-12	-2.964E-12	-6.938E-13	6.420E-13	-4.958E-13	-3.927E-13
21.0	1.631E-12	-1.591E-12	-3.636E-14	1.352E-12	-1.287E-12	-2.982E-13	2.641E-13	-2.049E-13	-1.604E-13
22.0	7.275E-13	-7.099E-13	-1.606E-14	5.996E-13	-5.711E-13	-1.310E-13	1.112E-13	-8.666E-14	-6.706E-14
23.0	3.310E-13	-3.231E-13	-7.243E-15	2.713E-13	-2.585E-13	-5.873E-14	4.786E-14	-3.744E-14	-2.866E-14
24.0	1.535E-13	-1.498E-13	-3.328E-15	1.250E-13	-1.193E-13	-2.684E-14	2.101E-14	-1.650E-14	-1.250E-14
25.0	7.241E-14	-7.070E-14	-1.557E-15	5.868E-14	-5.600E-14	-1.249E-14	9.405E-15	-7.414E-15	-5.558E-15

TABLE 4—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	5.616E-03	-7.473E-04	-5.522E-03	1.805E-02	-1.408E-03	-1.799E-02	2.920E-02	-2.563E-04	-2.920E-02
1.6	1.205E-02	-1.137E-03	-1.200E-02	6.037E-03	-3.059E-04	-6.025E-03	5.295E-03	-5.003E-05	-5.295E-03
1.7	2.281E-02	-2.429E-03	-2.268E-02	6.949E-03	-2.072E-04	-6.945E-03	1.789E-03	-1.377E-05	-1.789E-03
1.8	3.380E-02	-4.076E-03	-3.355E-02	9.413E-03	-2.777E-04	-9.409E-03	1.235E-03	-5.449E-06	-1.235E-03
1.9	4.042E-02	-5.494E-03	-4.005E-02	1.097E-02	-3.585E-04	-1.096E-02	1.279E-03	-4.843E-06	-1.279E-03
2.0	4.006E-02	-6.107E-03	-3.959E-02	1.119E-02	-4.054E-04	-1.118E-02	1.289E-03	-5.136E-06	-1.289E-03
2.1	3.348E-02	-5.702E-03	-3.299E-02	9.789E-03	-3.920E-04	-9.781E-03	1.136E-03	-4.964E-06	-1.136E-03
2.2	2.363E-02	-4.479E-03	-2.320E-02	7.774E-03	-3.422E-04	-7.767E-03	9.284E-04	-4.441E-06	-9.284E-04
2.3	1.459E-02	-3.060E-03	-1.427E-02	5.424E-03	-2.615E-04	-5.418E-03	6.780E-04	-3.540E-06	-6.780E-04
2.4	8.024E-03	-1.839E-03	-7.808E-03	3.464E-03	-1.821E-04	-3.459E-03	4.546E-04	-2.582E-06	-4.546E-04
2.5	4.015E-03	-9.743E-04	-3.890E-03	2.061E-03	-1.173E-04	-2.057E-03	2.850E-04	-1.754E-06	-2.850E-04
2.6	2.012E-03	-4.748E-04	-1.949E-03	1.160E-03	-7.076E-05	-1.158E-03	1.673E-04	-1.112E-06	-1.673E-04
2.7	1.266E-03	-2.546E-04	-1.234E-03	6.406E-04	-4.107E-05	-6.392E-04	8.923E-05	-6.381E-07	-8.923E-05
2.8	1.041E-03	-1.725E-04	-1.023E-03	3.539E-04	-2.305E-05	-3.531E-04	4.803E-05	-3.669E-07	-4.803E-05
2.9	9.897E-04	-1.517E-04	-9.767E-04	1.943E-04	-1.208E-05	-1.939E-04	2.496E-05	-2.022E-07	-2.496E-05
3.0	9.499E-04	-1.489E-04	-9.378E-04	1.297E-04	-7.427E-06	-1.294E-04	1.228E-05	-1.040E-07	-1.228E-05
3.1	8.678E-04	-1.443E-04	-8.556E-04	9.158E-05	-4.659E-06	-9.144E-05	5.956E-06	-5.146E-08	-5.956E-06
3.2	7.438E-04	-1.323E-04	-7.318E-04	7.310E-05	-3.541E-06	-7.300E-05	3.300E-06	-2.841E-08	-3.300E-06
3.3	5.977E-04	-1.137E-04	-5.867E-04	5.854E-05	-2.780E-06	-5.847E-05	1.811E-06	-1.487E-08	-1.811E-06
3.4	4.516E-04	-9.145E-05	-4.422E-04	4.668E-05	-2.254E-06	-4.662E-05	1.058E-06	-7.999E-09	-1.057E-06
3.5	3.252E-04	-6.952E-05	-3.175E-04	3.643E-05	-1.833E-06	-3.639E-05	6.825E-07	-4.751E-09	-6.825E-07
3.6	2.263E-04	-5.045E-05	-2.204E-04	2.759E-05	-1.456E-06	-2.755E-05	4.678E-07	-3.103E-09	-4.678E-07
3.7	1.536E-04	-3.503E-05	-1.493E-04	2.038E-05	-1.128E-06	-2.034E-05	3.310E-07	-2.172E-09	-3.310E-07
3.8	1.056E-04	-2.398E-05	-1.026E-04	1.450E-05	-8.404E-07	-1.447E-05	2.363E-07	-1.574E-09	-2.363E-07
3.9	7.500E-05	-1.649E-05	-7.296E-05	1.013E-05	-6.122E-07	-1.011E-05	1.654E-07	-1.135E-09	-1.654E-07
4.0	5.634E-05	-1.177E-05	-5.493E-05	7.014E-06	-4.390E-07	-6.999E-06	1.132E-07	-8.035E-10	-1.132E-07
4.1	4.465E-05	-8.883E-06	-4.365E-05	4.785E-06	-3.075E-07	-4.775E-06	7.607E-08	-5.603E-10	-7.607E-08
4.2	3.681E-05	-7.126E-06	-3.604E-05	3.246E-06	-2.120E-07	-3.239E-06	5.040E-08	-3.865E-10	-5.040E-08
4.3	3.071E-05	-5.928E-06	-3.010E-05	2.218E-06	-1.454E-07	-2.212E-06	3.294E-08	-2.634E-10	-3.294E-08
4.4	2.556E-05	-5.023E-06	-2.504E-05	1.540E-06	-1.003E-07	-1.536E-06	2.118E-08	-1.758E-10	-2.118E-08
4.5	2.093E-05	-4.236E-06	-2.048E-05	1.093E-06	-7.009E-08	-1.090E-06	1.346E-08	-1.157E-10	-1.346E-08
4.6	1.681E-05	-3.516E-06	-1.643E-05	7.935E-07	-4.997E-08	-7.918E-07	8.510E-09	-7.545E-11	-8.510E-09
4.7	1.324E-05	-2.859E-06	-1.292E-05	5.882E-07	-3.644E-08	-5.870E-07	5.381E-09	-4.896E-11	-5.381E-09
4.8	1.025E-05	-2.275E-06	-9.983E-06	4.427E-07	-2.714E-08	-4.418E-07	3.415E-09	-3.173E-11	-3.415E-09
4.9	7.846E-06	-1.777E-06	-7.633E-06	3.359E-07	-2.053E-08	-3.352E-07	2.160E-09	-2.035E-11	-2.160E-09
5.0	5.986E-06	-1.371E-06	-5.818E-06	2.553E-07	-1.566E-08	-2.548E-07	1.342E-09	-1.270E-11	-1.342E-09
5.3	2.775E-06	-6.245E-07	-2.698E-06	1.111E-07	-7.125E-09	-1.108E-07	3.747E-10	-3.510E-12	-3.747E-10
5.6	1.446E-06	-3.167E-07	-1.408E-06	4.643E-08	-3.147E-09	-4.632E-08	1.158E-10	-1.056E-12	-1.158E-10
5.9	7.863E-07	-1.762E-07	-7.654E-07	1.919E-08	-1.346E-09	-1.914E-08	3.836E-11	-3.485E-13	-3.836E-11
6.2	4.146E-07	-9.676E-08	-4.026E-07	8.142E-09	-5.770E-10	-8.120E-09	1.325E-11	-1.264E-13	-1.325E-11
6.5	2.149E-07	-5.112E-08	-2.084E-07	3.610E-09	-2.562E-10	-3.601E-09	4.422E-12	-4.420E-14	-4.422E-12
6.8	1.144E-07	-2.716E-08	-1.109E-07	1.656E-09	-1.186E-10	-1.651E-09	1.457E-12	-1.529E-14	-1.457E-12
7.1	6.321E-08	-1.504E-08	-6.129E-08	7.699E-10	-5.634E-11	-7.677E-10	4.884E-13	-5.291E-15	-4.883E-13
7.4	3.545E-08	-8.571E-09	-3.434E-08	3.609E-10	-2.713E-11	-3.599E-10	1.671E-13	-1.841E-15	-1.670E-13
7.7	1.987E-08	-4.898E-09	-1.922E-08	1.699E-10	-1.304E-11	-1.694E-10	6.022E-14	-6.715E-16	-6.022E-14
8.0	1.117E-08	-2.789E-09	-1.080E-08	8.097E-11	-6.317E-12	-8.071E-11	2.184E-14	-2.449E-16	-2.183E-14
8.3	6.374E-09	-1.601E-09	-6.157E-09	3.937E-11	-3.110E-12	-3.924E-11	8.222E-15	-9.340E-17	-8.222E-15
8.6	3.694E-09	-9.347E-10	-3.567E-09	1.941E-11	-1.551E-12	-1.935E-11	3.143E-15	-3.650E-17	-3.143E-15
8.9	2.164E-09	-5.538E-10	-2.088E-09	9.728E-12	-7.889E-13	-9.694E-12	1.217E-15	-1.452E-17	-1.217E-15
9.0	1.813E-09	-4.660E-10	-1.749E-09	7.742E-12	-6.310E-13	-7.715E-12	8.987E-16	-1.083E-17	-8.986E-16
9.5	7.567E-10	-1.981E-10	-7.289E-10	2.513E-12	-2.104E-13	-2.504E-12	1.901E-16	-2.391E-18	-1.901E-16
10.0	3.234E-10	-8.580E-11	-3.111E-10	8.377E-13	-7.184E-14	-8.345E-13	4.099E-17	-5.292E-19	-4.099E-17
10.5	1.416E-10	-3.813E-11	-1.361E-10	2.873E-13	-2.516E-14	-2.862E-13	9.566E-18	-1.271E-19	-9.565E-18
11.0	6.315E-11	-1.727E-11	-6.062E-11	1.014E-13	-9.066E-15	-1.010E-13	2.260E-18	-3.072E-20	-2.260E-18
11.5	2.870E-11	-7.953E-12	-2.752E-11	3.663E-14	-3.344E-15	-3.647E-14	5.511E-19	-7.671E-21	-5.511E-19
12.0	1.329E-11	-3.731E-12	-1.273E-11	1.353E-14	-1.261E-15	-1.347E-14	1.392E-19	-1.992E-21	-1.392E-19
12.5	6.256E-12	-1.780E-12	-5.984E-12	5.106E-15	-4.848E-16	-5.082E-15	3.670E-20	-5.408E-22	-3.670E-20
13.0	2.992E-12	-8.616E-13	-2.858E-12	1.969E-15	-1.904E-16	-1.959E-15	9.881E-21	-1.498E-22	-9.880E-21
13.5	1.453E-12	-4.234E-13	-1.386E-12	7.738E-16	-7.620E-17	-7.698E-16	2.720E-21	-4.227E-23	-2.720E-21
14.0	7.155E-13	-2.110E-13	-6.821E-13	3.097E-16	-3.103E-17	-3.080E-16	7.661E-22	-1.216E-23	-7.660E-22
14.5	3.572E-13	-1.065E-13	-3.402E-13	1.261E-16	-1.286E-17	-1.255E-16	2.194E-22	-3.550E-24	-2.194E-22
15.0	1.807E-13	-5.447E-14	-1.719E-13	5.224E-17	-5.413E-18	-5.195E-17	6.411E-23	-1.055E-24	-6.410E-23
16.0	4.793E-14	-1.475E-14	-4.549E-14	9.394E-18	-1.004E-18	-9.338E-18	5.920E-24	-1.021E-25	-5.919E-24
17.0	1.330E-14	-4.176E-15	-1.260E-14	1.791E-18	-1.973E-19	-1.780E-18	6.088E-25	-1.098E-26	-6.087E-25
18.0	3.847E-15	-1.230E-15	-3.635E-15	3.601E-19	-4.082E-20	-3.577E-19	6.399E-26	-1.189E-27	-6.398E-26
19.0	1.156E-15	-3.762E-16	-1.090E-15	7.605E-20	-8.855E-21	-7.552E-20	7.281E-27	-1.397E-28	-7.279E-27
20.0	3.596E-16	-1.190E-16	-3.383E-16	1.682E-20	-2.010E-21	-1.669E-20	9.130E-28	-1.823E-29	-9.128E-28
21.0	1.156E-16	-3.889E-17	-1.085E-16	3.877E-21	-4.747E-22	-3.847E-21	1.177E-28	-2.435E-30	-1.176E-28
22.0	3.831E-17	-1.309E-17	-3.590E-17	9.304E-22	-1.166E-22	-9.227E-22	1.571E-29	-3.330E-31	-1.571E-29
23.0	1.306E-17	-4.529E-18	-1.222E-17	2.315E-22	-2.969E-23	-2.296E-22	2.226E-30	-4.824E-32	-2.226E-30
24.0	4.574E-18	-1.608E-18	-4.269E-18	5.966E-23	-7.817E-24	-5.912E-23	3.480E-31	-7.842E-33	-3.479E-31
25.0	1.642E-18	-5.853E-19	-1.530E-18	1.588E-23	-2.124E-24	-1.573E-23	5.711E-32	-1.337E-33	-5.709E-32

TABLE 5

ABSORPTION COEFFICIENTS FOR $kT = 20$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	1.324E-02	-1.110E-02	-1.133E-03	1.879E-02	-1.300E-02	-1.207E-02	3.860E-02	-1.412E-02	-3.582E-02
1.6	5.701E-02	-4.976E-02	-3.675E-03	6.421E-02	-4.934E-02	-3.471E-02	7.689E-02	-3.289E-02	-6.920E-02
1.7	1.658E-01	-1.503E-01	-7.559E-03	1.579E-01	-1.325E-01	-6.714E-02	1.217E-01	-6.053E-02	-1.049E-01
1.8	2.969E-01	-2.788E-01	-8.511E-03	2.615E-01	-2.357E-01	-7.849E-02	1.539E-01	-8.852E-02	-1.247E-01
1.9	2.212E-01	-2.147E-01	-2.995E-03	2.269E-01	-2.161E-01	-3.856E-02	1.537E-01	-1.015E-01	-1.137E-01
2.0	1.399E-04	-1.127E-04	-1.500E-05	2.002E-02	-1.974E-02	-9.641E-04	1.163E-01	-8.721E-02	-7.491E-02
2.1	5.676E-04	-4.701E-04	-5.225E-05	8.484E-04	-5.600E-04	-5.732E-04	6.007E-02	-5.001E-02	-3.121E-02
2.2	1.896E-03	-1.613E-03	-1.476E-04	2.404E-03	-1.712E-03	-1.476E-03	1.697E-02	-1.395E-02	-7.444E-03
2.3	5.242E-03	-4.573E-03	-3.401E-04	5.796E-03	-4.414E-03	-3.171E-03	5.886E-03	-2.422E-03	-5.323E-03
2.4	1.201E-02	-1.073E-02	-6.359E-04	1.190E-02	-9.614E-03	-5.662E-03	8.968E-03	-4.064E-03	-7.948E-03
2.5	2.251E-02	-2.056E-02	-9.467E-04	2.063E-02	-1.755E-02	-8.284E-03	1.233E-02	-6.177E-03	-1.059E-02
2.6	3.345E-02	-3.120E-02	-1.074E-03	2.950E-02	-2.622E-02	-9.610E-03	1.524E-02	-8.411E-03	-1.258E-02
2.7	3.669E-02	-3.488E-02	-8.458E-04	3.306E-02	-3.046E-02	-8.272E-03	1.692E-02	-1.024E-02	-1.329E-02
2.8	2.497E-02	-2.416E-02	-3.771E-04	2.592E-02	-2.458E-02	-4.613E-03	1.679E-02	-1.107E-02	-1.238E-02
2.9	6.262E-03	-6.108E-03	-7.404E-05	1.066E-02	-1.025E-02	-1.334E-03	1.474E-02	-1.050E-02	-1.004E-02
3.0	1.027E-03	-9.029E-04	-6.290E-05	1.490E-03	-1.243E-03	-5.795E-04	1.127E-02	-8.547E-03	-6.996E-03
3.1	1.954E-03	-1.747E-03	-1.034E-04	1.895E-03	-1.527E-03	-9.044E-04	7.420E-03	-5.795E-03	-4.225E-03
3.2	3.303E-03	-2.999E-03	-1.491E-04	3.032E-03	-2.537E-03	-1.287E-03	4.316E-03	-3.211E-03	-2.482E-03
3.3	4.916E-03	-4.530E-03	-1.867E-04	4.354E-03	-3.767E-03	-1.617E-03	2.693E-03	-1.672E-03	-1.906E-03
3.4	6.340E-03	-5.923E-03	-1.990E-04	5.546E-03	-4.939E-03	-1.769E-03	2.453E-03	-1.365E-03	-2.002E-03
3.5	6.893E-03	-6.522E-03	-1.753E-04	6.142E-03	-5.606E-03	-1.649E-03	2.715E-03	-1.601E-03	-2.161E-03
3.6	6.032E-03	-5.770E-03	-1.225E-04	5.723E-03	-5.328E-03	-1.270E-03	2.855E-03	-1.794E-03	-2.179E-03
3.7	3.933E-03	-3.791E-03	-6.678E-05	4.262E-03	-4.019E-03	-7.899E-04	2.811E-03	-1.872E-03	-2.045E-03
3.8	1.772E-03	-1.697E-03	-3.612E-05	2.386E-03	-2.242E-03	-4.326E-04	2.584E-03	-1.811E-03	-1.782E-03
3.9	8.721E-04	-8.021E-04	-3.432E-05	1.124E-03	-1.005E-03	-3.175E-04	2.214E-03	-1.615E-03	-1.444E-03
4.0	1.063E-03	-9.764E-04	-4.209E-05	9.443E-04	-8.115E-04	-3.584E-04	1.771E-03	-1.322E-03	-1.100E-03
4.1	1.376E-03	-1.277E-03	-4.757E-05	1.192E-03	-1.046E-03	-4.106E-04	1.337E-03	-9.955E-04	-8.127E-04
4.2	1.613E-03	-1.512E-03	-4.838E-05	1.402E-03	-1.256E-03	-4.296E-04	9.882E-04	-7.078E-04	-6.205E-04
4.3	1.693E-03	-1.600E-03	-4.386E-05	1.503E-03	-1.370E-03	-4.070E-04	7.657E-04	-5.134E-04	-5.231E-04
4.4	1.563E-03	-1.489E-03	-3.525E-05	1.452E-03	-1.341E-03	-3.470E-04	6.646E-04	-4.261E-04	-4.881E-04
4.5	1.249E-03	-1.194E-03	-2.547E-05	1.245E-03	-1.160E-03	-2.672E-04	6.365E-04	-4.130E-04	-4.715E-04
4.6	8.606E-04	-8.230E-04	-1.788E-05	9.408E-04	-8.784E-04	-1.927E-04	6.194E-04	-4.175E-04	-4.439E-04
4.7	5.563E-04	-5.266E-04	-1.428E-05	6.444E-04	-5.955E-04	-1.440E-04	5.808E-04	-4.057E-04	-4.000E-04
4.8	4.337E-04	-4.048E-04	-1.389E-05	4.565E-04	-4.124E-04	-1.257E-04	5.218E-04	-3.749E-04	-3.457E-04
4.9	4.529E-04	-4.228E-04	-1.442E-05	4.062E-04	-3.626E-04	-1.255E-04	4.503E-04	-3.296E-04	-2.886E-04
5.0	4.959E-04	-4.660E-04	-1.423E-05	4.300E-04	-3.872E-04	-1.263E-04	3.757E-04	-2.767E-04	-2.359E-04
5.3	4.087E-04	-3.895E-04	-9.068E-06	3.936E-04	-3.646E-04	-9.000E-05	2.109E-04	-1.469E-04	-1.410E-04
5.6	2.012E-04	-1.900E-04	-5.335E-06	2.085E-04	-1.916E-04	-5.034E-05	1.566E-04	-1.100E-04	-1.069E-04
5.9	1.737E-04	-1.643E-04	-4.443E-06	1.547E-04	-1.413E-04	-4.055E-05	1.125E-04	-8.250E-05	-7.151E-05
6.2	1.255E-04	-1.194E-04	-2.865E-06	1.223E-04	-1.133E-04	-2.786E-05	7.106E-05	-5.131E-05	-4.568E-05
6.5	7.748E-05	-7.331E-05	-1.979E-06	7.538E-05	-6.933E-05	-1.830E-05	4.955E-05	-3.542E-05	-3.285E-05
6.8	6.276E-05	-5.958E-05	-1.510E-06	5.730E-05	-5.274E-05	-1.399E-05	3.664E-05	-2.691E-05	-2.333E-05
7.1	4.430E-05	-4.213E-05	-1.031E-06	4.283E-05	-3.965E-05	-9.787E-06	2.508E-05	-1.843E-05	-1.583E-05
7.4	3.091E-05	-2.932E-05	-7.539E-07	2.919E-05	-2.693E-05	-6.938E-06	1.755E-05	-1.280E-05	-1.128E-05
7.7	2.400E-05	-2.281E-05	-5.599E-07	2.221E-05	-2.053E-05	-5.200E-06	1.296E-05	-9.566E-06	-8.199E-06
8.0	1.729E-05	-1.644E-05	-4.018E-07	1.646E-05	-1.524E-05	-3.748E-06	9.324E-06	-6.928E-06	-5.814E-06
8.3	1.276E-05	-1.213E-05	-2.999E-07	1.190E-05	-1.101E-05	-2.756E-06	6.677E-06	-4.947E-06	-4.193E-06
8.6	9.752E-06	-9.280E-06	-2.234E-07	9.063E-06	-8.398E-06	-2.065E-06	4.938E-06	-3.678E-06	-3.085E-06
8.9	7.227E-06	-6.876E-06	-1.656E-07	6.782E-06	-6.291E-06	-1.528E-06	3.653E-06	-2.738E-06	-2.254E-06
9.0	6.562E-06	-6.244E-06	-1.507E-07	6.138E-06	-5.693E-06	-1.386E-06	3.294E-06	-2.470E-06	-2.030E-06
9.5	4.189E-06	-3.989E-06	-9.443E-08	3.884E-06	-3.606E-06	-8.676E-07	2.001E-06	-1.505E-06	-1.232E-06
10.0	2.664E-06	-2.538E-06	-5.978E-08	2.461E-06	-2.287E-06	-5.461E-07	1.242E-06	-9.399E-07	-7.555E-07
10.5	1.729E-06	-1.647E-06	-3.830E-08	1.595E-06	-1.484E-06	-3.495E-07	7.779E-07	-5.910E-07	-4.711E-07
11.0	1.133E-06	-1.080E-06	-2.488E-08	1.040E-06	-9.678E-07	-2.261E-07	4.946E-07	-3.777E-07	-2.969E-07
11.5	7.495E-07	-7.149E-07	-1.631E-08	6.868E-07	-6.399E-07	-1.479E-07	3.177E-07	-2.436E-07	-1.896E-07
12.0	5.017E-07	-4.787E-07	-1.082E-08	4.580E-07	-4.271E-07	-9.782E-08	2.065E-07	-1.590E-07	-1.224E-07
12.5	3.386E-07	-3.233E-07	-7.242E-09	3.083E-07	-2.877E-07	-6.529E-08	1.356E-07	-1.047E-07	-7.983E-08
13.0	2.307E-07	-2.203E-07	-4.892E-09	2.095E-07	-1.956E-07	-4.400E-08	8.987E-08	-6.970E-08	-5.258E-08
13.5	1.585E-07	-1.514E-07	-3.334E-09	1.435E-07	-1.341E-07	-2.990E-08	6.011E-08	-4.679E-08	-3.496E-08
14.0	1.098E-07	-1.049E-07	-2.290E-09	9.909E-08	-9.268E-08	-2.049E-08	4.056E-08	-3.168E-08	-2.344E-08
14.5	7.658E-08	-7.320E-08	-1.586E-09	6.895E-08	-6.453E-08	-1.415E-08	2.759E-08	-2.162E-08	-1.585E-08
15.0	5.380E-08	-5.145E-08	-1.106E-09	4.832E-08	-4.526E-08	-9.847E-09	1.891E-08	-1.486E-08	-1.080E-08
16.0	2.710E-08	-2.593E-08	-5.490E-10	2.422E-08	-2.271E-08	-4.866E-09	9.081E-09	-7.180E-09	-5.131E-09
17.0	1.399E-08	-1.339E-08	-2.795E-10	1.244E-08	-1.168E-08	-2.467E-09	4.479E-09	-3.560E-09	-2.503E-09
18.0	7.384E-09	-7.074E-09	-1.456E-10	6.538E-09	-6.144E-09	-1.280E-09	2.263E-09	-1.808E-09	-1.252E-09
19.0	3.979E-09	-3.814E-09	-7.749E-11	3.508E-09	-3.299E-09	-6.782E-10	1.169E-09	-9.388E-10	-6.405E-10
20.0	2.185E-09	-2.095E-09	-4.204E-11	1.918E-09	-1.806E-09	-3.665E-10	6.166E-10	-4.974E-10	-3.346E-10
21.0	1.221E-09	-1.171E-09	-2.322E-11	1.068E-09	-1.006E-09	-2.017E-10	3.314E-10	-2.684E-10	-1.782E-10
22.0	6.936E-10	-6.657E-10	-1.305E-11	6.040E-10	-5.697E-10	-1.129E-10	1.813E-10	-1.474E-10	-9.661E-11
23.0	4.000E-10	-3.841E-10	-7.443E-12	3.470E-10	-3.276E-10	-6.418E-11	1.008E-10	-8.229E-11	-5.325E-11
24.0	2.339E-10	-2.247E-10	-4.308E-12	2.022E-10	-1.910E-10	-3.702E-11	5.691E-11	-4.663E-11	-2.982E-11
25.0	1.387E-10	-1.332E-10	-2.528E-12	1.194E-10	-1.129E-10	-2.165E-11	3.259E-11	-2.680E-11	-1.694E-11

TABLE 5—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	4.454E-02	-1.120E-02	-4.239E-02	1.189E-01	-9.825E-03	-1.184E-01	1.557E-01	-1.406E-03	-1.557E-01
1.6	3.790E-02	-5.126E-03	-3.726E-02	4.970E-02	-4.188E-03	-4.950E-02	6.352E-02	-6.460E-04	-6.351E-02
1.7	4.562E-02	-5.355E-03	-4.525E-02	2.565E-02	-1.810E-03	-2.556E-02	2.655E-02	-2.953E-04	-2.655E-02
1.8	5.235E-02	-6.739E-03	-5.191E-02	1.834E-02	-9.250E-04	-1.831E-02	1.076E-02	-1.236E-04	-1.076E-02
1.9	5.435E-02	-7.856E-03	-5.378E-02	1.643E-02	-6.770E-04	-1.641E-02	5.173E-03	-5.566E-05	-5.172E-03
2.0	5.137E-02	-8.308E-03	-5.069E-02	1.525E-02	-6.091E-04	-1.524E-02	2.875E-03	-2.528E-05	-2.875E-03
2.1	4.465E-02	-8.039E-03	-4.392E-02	1.375E-02	-5.850E-04	-1.373E-02	1.956E-03	-1.341E-05	-1.956E-03
2.2	3.595E-02	-7.162E-03	-3.522E-02	1.178E-02	-5.410E-04	-1.177E-02	1.521E-03	-9.124E-06	-1.521E-03
2.3	2.710E-02	-5.929E-03	-2.643E-02	9.620E-03	-4.815E-04	-9.608E-03	1.219E-03	-7.238E-06	-1.219E-03
2.4	1.938E-02	-4.599E-03	-1.881E-02	7.528E-03	-4.094E-04	-7.517E-03	9.575E-04	-5.854E-06	-9.575E-04
2.5	1.327E-02	-3.354E-03	-1.282E-02	5.679E-03	-3.341E-04	-5.669E-03	7.348E-04	-4.744E-06	-7.348E-04
2.6	8.924E-03	-2.331E-03	-8.585E-03	4.151E-03	-2.627E-04	-4.143E-03	5.495E-04	-3.787E-06	-5.495E-04
2.7	6.113E-03	-1.582E-03	-5.872E-03	2.964E-03	-2.004E-04	-2.957E-03	3.985E-04	-2.941E-06	-3.985E-04
2.8	4.386E-03	-1.074E-03	-4.222E-03	2.080E-03	-1.490E-04	-2.075E-03	2.835E-04	-2.239E-06	-2.835E-04
2.9	3.372E-03	-7.573E-04	-3.261E-03	1.428E-03	-1.071E-04	-1.423E-03	1.987E-04	-1.677E-06	-1.987E-04
3.0	2.767E-03	-5.737E-04	-2.691E-03	9.883E-04	-7.662E-05	-9.852E-04	1.351E-04	-1.215E-06	-1.351E-04
3.1	2.367E-03	-4.701E-04	-2.311E-03	6.807E-04	-5.364E-05	-6.784E-04	9.099E-05	-8.685E-07	-9.099E-05
3.2	2.054E-03	-4.077E-04	-2.008E-03	4.833E-04	-3.811E-05	-4.816E-04	6.107E-05	-6.160E-07	-6.107E-05
3.3	1.773E-03	-3.630E-04	-1.733E-03	3.454E-04	-2.677E-05	-3.442E-04	3.999E-05	-4.245E-07	-3.999E-05
3.4	1.506E-03	-3.226E-04	-1.469E-03	2.538E-04	-1.911E-05	-2.530E-04	2.592E-05	-2.880E-07	-2.592E-05
3.5	1.253E-03	-2.819E-04	-1.220E-03	1.929E-04	-1.410E-05	-1.923E-04	1.679E-05	-1.939E-07	-1.679E-05
3.6	1.024E-03	-2.412E-04	-9.937E-04	1.497E-04	-1.067E-05	-1.493E-04	1.090E-05	-1.300E-07	-1.090E-05
3.7	8.226E-04	-2.017E-04	-7.961E-04	1.178E-04	-8.240E-06	-1.174E-04	7.131E-06	-8.700E-08	-7.131E-06
3.8	6.535E-04	-1.653E-04	-6.308E-04	9.341E-05	-6.489E-06	-9.315E-05	4.729E-06	-5.854E-08	-4.729E-06
3.9	5.162E-04	-1.333E-04	-4.972E-04	7.439E-05	-5.187E-06	-7.419E-05	3.196E-06	-3.983E-08	-3.196E-06
4.0	4.078E-04	-1.062E-04	-3.921E-04	5.926E-05	-4.185E-06	-5.910E-05	2.187E-06	-2.725E-08	-2.187E-06
4.1	3.241E-04	-8.430E-05	-3.114E-04	4.718E-05	-3.405E-06	-4.705E-05	1.491E-06	-1.835E-08	-1.491E-06
4.2	2.603E-04	-6.700E-05	-2.502E-04	3.746E-05	-2.778E-06	-3.735E-05	1.013E-06	-1.212E-08	-1.013E-06
4.3	2.118E-04	-5.366E-05	-2.037E-04	2.958E-05	-2.256E-06	-2.949E-05	7.403E-07	-8.805E-09	-7.403E-07
4.4	1.747E-04	-4.358E-05	-1.683E-04	2.325E-05	-1.820E-06	-2.317E-05	5.383E-07	-6.329E-09	-5.382E-07
4.5	1.458E-04	-3.594E-05	-1.406E-04	1.822E-05	-1.464E-06	-1.816E-05	3.820E-07	-4.345E-09	-3.819E-07
4.6	1.227E-04	-3.009E-05	-1.184E-04	1.426E-05	-1.174E-06	-1.421E-05	2.902E-07	-3.348E-09	-2.902E-07
4.7	1.037E-04	-2.553E-05	-1.002E-04	1.114E-05	-9.360E-07	-1.110E-05	2.118E-07	-2.404E-09	-2.118E-07
4.8	8.784E-05	-2.184E-05	-8.483E-05	8.717E-06	-7.452E-07	-8.683E-06	1.604E-07	-1.849E-09	-1.604E-07
4.9	7.431E-05	-1.876E-05	-7.171E-05	6.829E-06	-5.918E-07	-6.801E-06	1.192E-07	-1.376E-09	-1.192E-07
5.0	6.270E-05	-1.612E-05	-6.044E-05	5.362E-06	-4.695E-07	-5.340E-06	9.007E-08	-1.064E-09	-9.006E-08
5.3	3.703E-05	-9.994E-06	-3.554E-05	2.653E-06	-2.355E-07	-2.641E-06	3.759E-08	-4.662E-10	-3.759E-08
5.6	2.173E-05	-5.990E-06	-2.080E-05	1.370E-06	-1.219E-07	-1.364E-06	1.576E-08	-2.102E-10	-1.576E-08
5.9	1.307E-05	-3.600E-06	-1.250E-05	7.333E-07	-6.596E-08	-7.300E-07	6.509E-09	-9.259E-11	-6.508E-09
6.2	8.118E-06	-2.243E-06	-7.768E-06	4.008E-07	-3.688E-08	-3.989E-07	2.722E-09	-4.072E-11	-2.722E-09
6.5	5.135E-06	-1.444E-06	-4.909E-06	2.209E-07	-2.093E-08	-2.198E-07	1.150E-09	-1.781E-11	-1.150E-09
6.8	3.264E-06	-9.404E-07	-3.113E-06	1.229E-07	-1.201E-08	-1.223E-07	5.102E-10	-8.093E-12	-5.101E-10
7.1	2.080E-06	-6.107E-07	-1.980E-06	6.894E-08	-6.919E-09	-6.856E-08	2.300E-10	-3.701E-12	-2.300E-10
7.4	1.339E-06	-3.970E-07	-1.272E-06	3.916E-08	-4.011E-09	-3.893E-08	1.068E-10	-1.739E-12	-1.067E-10
7.7	8.736E-07	-2.611E-07	-8.295E-07	2.257E-08	-2.349E-09	-2.243E-08	5.069E-11	-8.390E-13	-5.069E-11
8.0	5.774E-07	-1.745E-07	-5.478E-07	1.321E-08	-1.396E-09	-1.313E-08	2.428E-11	-4.081E-13	-2.427E-11
8.3	3.850E-07	-1.180E-07	-3.647E-07	7.825E-09	-8.400E-10	-7.776E-09	1.176E-11	-2.006E-13	-1.176E-11
8.6	2.582E-07	-8.030E-08	-2.442E-07	4.690E-09	-5.120E-10	-4.659E-09	5.923E-12	-1.052E-13	-5.922E-12
8.9	1.743E-07	-5.484E-08	-1.646E-07	2.839E-09	-3.156E-10	-2.820E-09	2.958E-12	-5.404E-14	-2.957E-12
9.0	1.532E-07	-4.835E-08	-1.446E-07	2.407E-09	-2.693E-10	-2.390E-09	2.381E-12	-4.407E-14	-2.381E-12
9.5	8.138E-08	-2.609E-08	-7.668E-08	1.067E-09	-1.230E-10	-1.059E-09	7.635E-13	-1.471E-14	-7.633E-13
10.0	4.414E-08	-1.440E-08	-4.151E-08	4.844E-10	-5.730E-11	-4.808E-10	2.520E-13	-5.002E-15	-2.519E-13
10.5	2.434E-08	-8.077E-09	-2.283E-08	2.252E-10	-2.728E-11	-2.234E-10	8.703E-14	-1.779E-15	-8.701E-14
11.0	1.363E-08	-4.592E-09	-1.276E-08	1.069E-10	-1.325E-11	-1.060E-10	3.086E-14	-6.466E-16	-3.085E-14
11.5	7.761E-09	-2.652E-09	-7.252E-09	5.180E-11	-6.567E-12	-5.135E-11	1.135E-14	-2.439E-16	-1.134E-14
12.0	4.482E-09	-1.554E-09	-4.179E-09	2.556E-11	-3.314E-12	-2.533E-11	4.377E-15	-9.803E-17	-4.376E-15
12.5	2.622E-09	-9.216E-10	-2.440E-09	1.283E-11	-1.699E-12	-1.271E-11	1.678E-15	-3.865E-17	-1.677E-15
13.0	1.554E-09	-5.532E-10	-1.443E-09	6.544E-12	-8.843E-13	-6.480E-12	6.444E-16	-1.508E-17	-6.442E-16
13.5	9.319E-10	-3.360E-10	-8.639E-10	3.390E-12	-4.669E-13	-3.355E-12	2.615E-16	-6.363E-18	-2.614E-16
14.0	5.652E-10	-2.063E-10	-5.229E-10	1.782E-12	-2.501E-13	-1.763E-12	1.083E-16	-2.690E-18	-1.083E-16
14.5	3.465E-10	-1.279E-10	-3.199E-10	9.498E-13	-1.357E-13	-9.394E-13	4.460E-17	-1.138E-18	-4.459E-17
15.0	2.145E-10	-8.009E-11	-1.977E-10	5.128E-13	-7.460E-14	-5.070E-13	1.878E-17	-4.873E-19	-1.877E-17
16.0	8.462E-11	-3.228E-11	-7.770E-11	1.550E-13	-2.331E-14	-1.531E-13	3.518E-18	-9.524E-20	-3.517E-18
17.0	3.456E-11	-1.345E-11	-3.162E-11	4.901E-14	-7.605E-15	-4.838E-14	7.097E-19	-2.024E-20	-7.094E-19
18.0	1.457E-11	-5.776E-12	-1.328E-11	1.615E-14	-2.581E-15	-1.593E-14	1.482E-19	-4.381E-21	-1.481E-19
19.0	6.323E-12	-2.551E-12	-5.743E-12	5.524E-15	-9.082E-16	-5.444E-15	3.319E-20	-1.009E-21	-3.317E-20
20.0	2.819E-12	-1.156E-12	-2.551E-12	1.955E-15	-3.301E-16	-1.925E-15	8.195E-21	-2.653E-22	-8.190E-21
21.0	1.288E-12	-5.367E-13	-1.161E-12	7.146E-16	-1.237E-16	-7.031E-16	1.839E-21	-5.987E-23	-1.838E-21
22.0	6.019E-13	-2.546E-13	-5.411E-13	2.690E-16	-4.772E-17	-2.645E-16	4.791E-22	-1.632E-23	-4.788E-22
23.0	2.874E-13	-1.233E-13	-2.575E-13	1.041E-16	-1.889E-17	-1.023E-16	1.339E-22	-4.732E-24	-1.338E-22
24.0	1.400E-13	-6.089E-14	-1.250E-13	4.133E-17	-7.668E-18	-4.057E-17	3.323E-23	-1.187E-24	-3.320E-23
25.0	6.946E-14	-3.060E-14	-6.182E-14	1.681E-17	-3.184E-18	-1.648E-17	9.954E-24	-3.761E-25	-9.946E-24

TABLE 6

ABSORPTION COEFFICIENTS FOR $kT = 30$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	7.907E-02	-6.633E-02	-4.520E-03	8.291E-02	-6.230E-02	-4.205E-02	8.817E-02	-3.635E-02	-7.967E-02
1.6	1.677E-01	-1.465E-01	-7.222E-03	1.605E-01	-1.305E-01	-6.583E-02	1.279E-01	-6.121E-02	-1.109E-01
1.7	2.613E-01	-2.369E-01	-7.958E-03	2.390E-01	-2.075E-01	-7.435E-02	1.582E-01	-8.723E-02	-1.297E-01
1.8	2.687E-01	-2.523E-01	-5.171E-03	2.535E-01	-2.321E-01	-5.401E-02	1.673E-01	-1.052E-01	-1.266E-01
1.9	1.229E-01	-1.190E-01	-1.207E-03	1.480E-01	-1.412E-01	-1.815E-02	1.495E-01	-1.059E-01	-1.010E-01
2.0	3.437E-03	-2.774E-03	-2.474E-04	1.277E-02	-1.144E-02	-2.603E-03	1.093E-01	-8.533E-02	-6.317E-02
2.1	7.629E-03	-6.329E-03	-4.698E-04	8.085E-03	-5.892E-03	-4.344E-03	6.139E-02	-5.023E-02	-2.969E-02
2.2	1.469E-02	-1.251E-02	-7.652E-04	1.455E-02	-1.121E-02	-6.921E-03	2.529E-02	-1.796E-02	-1.367E-02
2.3	2.457E-02	-2.144E-02	-1.068E-03	2.317E-02	-1.875E-02	-9.587E-03	1.557E-02	-7.248E-03	-1.359E-02
2.4	3.553E-02	-3.174E-02	-1.265E-03	3.254E-02	-2.748E-02	-1.147E-02	1.941E-02	-9.915E-03	-1.641E-02
2.5	4.372E-02	-3.991E-02	-1.246E-03	3.981E-02	-3.488E-02	-1.166E-02	2.249E-02	-1.258E-02	-1.824E-02
2.6	4.431E-02	-4.124E-02	-9.865E-04	4.139E-02	-3.739E-02	-9.824E-03	2.420E-02	-1.472E-02	-1.866E-02
2.7	3.468E-02	-3.280E-02	-6.017E-04	3.494E-02	-3.229E-02	-6.619E-03	2.415E-02	-1.586E-02	-1.751E-02
2.8	1.870E-02	-1.778E-02	-3.013E-04	2.213E-02	-2.064E-02	-3.609E-03	2.229E-02	-1.563E-02	-1.504E-02
2.9	7.020E-03	-6.394E-03	-2.157E-04	9.901E-03	-8.913E-03	-2.192E-03	1.893E-02	-1.397E-02	-1.181E-02
3.0	6.228E-03	-5.472E-03	-2.575E-04	5.910E-03	-4.865E-03	-2.282E-03	1.475E-02	-1.118E-02	-8.581E-03
3.1	8.268E-03	-7.382E-03	-2.971E-04	7.478E-03	-6.299E-03	-2.654E-03	1.063E-02	-7.955E-03	-6.051E-03
3.2	1.001E-02	-9.066E-03	-3.105E-04	9.019E-03	-7.798E-03	-2.829E-03	7.440E-03	-5.176E-03	-4.592E-03
3.3	1.095E-02	-1.005E-02	-2.922E-04	9.974E-03	-8.817E-03	-2.746E-03	5.707E-03	-3.572E-03	-4.097E-03
3.4	1.070E-02	-9.942E-03	-2.466E-04	1.002E-02	-9.020E-03	-2.416E-03	5.319E-03	-3.254E-03	-4.059E-03
3.5	9.209E-03	-8.626E-03	-1.884E-04	9.036E-03	-8.243E-03	-1.933E-03	5.402E-03	-3.473E-03	-3.973E-03
3.6	6.905E-03	-6.486E-03	-1.367E-04	7.240E-03	-6.643E-03	-1.443E-03	5.286E-03	-3.566E-03	-3.709E-03
3.7	4.660E-03	-4.341E-03	-1.056E-04	5.202E-03	-4.742E-03	-1.084E-03	4.949E-03	-3.475E-03	-3.304E-03
3.8	3.333E-03	-3.045E-03	-9.619E-05	3.637E-03	-3.241E-03	-9.124E-04	4.432E-03	-3.207E-03	-2.821E-03
3.9	3.130E-03	-2.838E-03	-9.691E-05	2.988E-03	-2.607E-03	-8.790E-04	3.805E-03	-2.802E-03	-2.329E-03
4.0	3.382E-03	-3.091E-03	-9.552E-05	3.044E-03	-2.671E-03	-8.750E-04	3.152E-03	-2.325E-03	-1.892E-03
4.1	3.477E-03	-3.205E-03	-8.863E-05	3.176E-03	-2.826E-03	-8.328E-04	2.558E-03	-1.856E-03	-1.554E-03
4.2	3.332E-03	-3.093E-03	-7.767E-05	3.122E-03	-2.810E-03	-7.503E-04	2.088E-03	-1.469E-03	-1.325E-03
4.3	2.976E-03	-2.775E-03	-6.515E-05	2.880E-03	-2.613E-03	-6.449E-04	1.772E-03	-1.210E-03	-1.186E-03
4.4	2.492E-03	-2.327E-03	-5.367E-05	2.500E-03	-2.277E-03	-5.378E-04	1.593E-03	-1.080E-03	-1.097E-03
4.5	2.002E-03	-1.865E-03	-4.507E-05	2.067E-03	-1.879E-03	-4.475E-04	1.494E-03	-1.031E-03	-1.016E-03
4.6	1.623E-03	-1.502E-03	-3.978E-05	1.675E-03	-1.513E-03	-3.838E-04	1.403E-03	-9.928E-04	-9.232E-04
4.7	1.409E-03	-1.297E-03	-3.681E-05	1.399E-03	-1.253E-03	-3.451E-04	1.287E-03	-9.292E-04	-8.191E-04
4.8	1.331E-03	-1.225E-03	-3.459E-05	1.255E-03	-1.119E-03	-3.211E-04	1.151E-03	-8.420E-04	-7.134E-04
4.9	1.297E-03	-1.199E-03	-3.192E-05	1.197E-03	-1.071E-03	-2.994E-04	1.008E-03	-7.414E-04	-6.149E-04
5.0	1.230E-03	-1.142E-03	-2.863E-05	1.151E-03	-1.037E-03	-2.732E-04	8.708E-04	-6.387E-04	-5.300E-04
5.3	8.511E-04	-7.925E-04	-1.912E-05	8.459E-04	-7.686E-04	-1.858E-04	5.735E-04	-4.090E-04	-3.675E-04
5.6	5.894E-04	-5.460E-04	-1.417E-05	5.666E-04	-5.110E-04	-1.331E-04	4.355E-04	-3.165E-04	-2.744E-04
5.9	4.712E-04	-4.387E-04	-1.057E-05	4.474E-04	-4.057E-04	-1.009E-04	3.187E-04	-2.357E-04	-1.931E-04
6.2	3.383E-04	-3.150E-04	-7.607E-06	3.299E-04	-2.998E-04	-7.256E-05	2.237E-04	-1.641E-04	-1.377E-04
6.5	2.533E-04	-2.356E-04	-5.755E-06	2.411E-04	-2.186E-04	-5.419E-05	1.667E-04	-1.228E-04	-1.027E-04
6.8	1.968E-04	-1.834E-04	-4.323E-06	1.875E-04	-1.706E-04	-4.101E-05	1.260E-04	-9.403E-05	-7.568E-05
7.1	1.473E-04	-1.373E-04	-3.247E-06	1.414E-04	-1.288E-04	-3.067E-05	9.272E-05	-6.917E-05	-5.567E-05
7.4	1.137E-04	-1.060E-04	-2.489E-06	1.078E-04	-9.813E-05	-2.341E-05	6.972E-05	-5.211E-05	-4.193E-05
7.7	8.839E-05	-8.251E-05	-1.905E-06	8.400E-05	-7.663E-05	-1.794E-05	5.345E-05	-4.025E-05	-3.169E-05
8.0	6.822E-05	-6.369E-05	-1.467E-06	6.482E-05	-5.917E-05	-1.377E-05	4.061E-05	-3.068E-05	-2.393E-05
8.3	5.351E-05	-4.999E-05	-1.140E-06	5.054E-05	-4.616E-05	-1.068E-05	3.106E-05	-2.351E-05	-1.828E-05
8.6	4.207E-05	-3.932E-05	-8.882E-07	3.977E-05	-3.637E-05	-8.318E-06	2.409E-05	-1.832E-05	-1.407E-05
8.9	3.314E-05	-3.099E-05	-6.961E-07	3.127E-05	-2.861E-05	-6.503E-06	1.870E-05	-1.427E-05	-1.084E-05
9.0	3.068E-05	-2.869E-05	-6.427E-07	2.890E-05	-2.645E-05	-6.000E-06	1.718E-05	-1.313E-05	-9.951E-06
9.5	2.097E-05	-1.963E-05	-4.338E-07	1.972E-05	-1.807E-05	-4.042E-06	1.142E-05	-8.768E-06	-6.563E-06
10.0	1.449E-05	-1.358E-05	-2.965E-07	1.358E-05	-1.246E-05	-2.755E-06	7.689E-06	-5.932E-06	-4.377E-06
10.5	1.012E-05	-9.488E-06	-2.049E-07	9.464E-06	-8.693E-06	-1.899E-06	5.237E-06	-4.059E-06	-2.958E-06
11.0	7.145E-06	-6.701E-06	-1.431E-07	6.661E-06	-6.125E-06	-1.323E-06	3.606E-06	-2.807E-06	-2.020E-06
11.5	5.088E-06	-4.775E-06	-1.009E-07	4.732E-06	-4.356E-06	-9.310E-07	2.509E-06	-1.961E-06	-1.394E-06
12.0	3.656E-06	-3.433E-06	-7.177E-08	3.392E-06	-3.125E-06	-6.610E-07	1.762E-06	-1.383E-06	-9.714E-07
12.5	2.648E-06	-2.488E-06	-5.150E-08	2.451E-06	-2.261E-06	-4.733E-07	1.248E-06	-9.833E-07	-6.832E-07
13.0	1.933E-06	-1.817E-06	-3.725E-08	1.785E-06	-1.648E-06	-3.417E-07	8.917E-07	-7.050E-07	-4.845E-07
13.5	1.421E-06	-1.337E-06	-2.715E-08	1.310E-06	-1.210E-06	-2.485E-07	6.420E-07	-5.094E-07	-3.464E-07
14.0	1.052E-06	-9.901E-07	-1.992E-08	9.676E-07	-8.946E-07	-1.820E-07	4.657E-07	-3.707E-07	-2.496E-07
14.5	7.840E-07	-7.380E-07	-1.472E-08	7.195E-07	-6.657E-07	-1.343E-07	3.402E-07	-2.716E-07	-1.811E-07
15.0	5.877E-07	-5.535E-07	-1.095E-08	5.382E-07	-4.984E-07	-9.964E-08	2.501E-07	-2.003E-07	-1.323E-07
16.0	3.359E-07	-3.167E-07	-6.160E-09	3.065E-07	-2.842E-07	-5.588E-08	1.378E-07	-1.110E-07	-7.195E-08
17.0	1.961E-07	-1.850E-07	-3.543E-09	1.783E-07	-1.655E-07	-3.203E-08	7.762E-08	-6.285E-08	-4.005E-08
18.0	1.167E-07	-1.102E-07	-2.078E-09	1.057E-07	-9.825E-08	-1.873E-08	4.464E-08	-3.633E-08	-2.277E-08
19.0	7.065E-08	-6.676E-08	-1.242E-09	6.377E-08	-5.935E-08	-1.115E-08	2.616E-08	-2.139E-08	-1.320E-08
20.0	4.347E-08	-4.110E-08	-7.541E-10	3.911E-08	-3.644E-08	-6.754E-09	1.560E-08	-1.281E-08	-7.787E-09
21.0	2.714E-08	-2.568E-08	-4.651E-10	2.435E-08	-2.271E-08	-4.154E-09	9.454E-09	-7.793E-09	-4.670E-09
22.0	1.718E-08	-1.627E-08	-2.910E-10	1.537E-08	-1.435E-08	-2.591E-09	5.814E-09	-4.810E-09	-2.844E-09
23.0	1.102E-08	-1.044E-08	-1.845E-10	9.825E-09	-9.180E-09	-1.638E-09	3.625E-09	-3.010E-09	-1.756E-09
24.0	7.150E-09	-6.777E-09	-1.184E-10	6.357E-09	-5.945E-09	-1.049E-09	2.289E-09	-1.907E-09	-1.099E-09
25.0	4.691E-09	-4.449E-09	-7.684E-11	4.160E-09	-3.893E-09	-6.790E-10	1.463E-09	-1.223E-09	-6.959E-10

TABLE 6—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	9.412E-02	-2.759E-02	-8.834E-02	2.017E-01	-1.718E-02	-2.010E-01	2.470E-01	-2.288E-03	-2.470E-01
1.6	6.479E-02	-1.275E-02	-6.239E-02	1.055E-01	-9.653E-03	-1.050E-01	1.309E-01	-1.368E-03	-1.309E-01
1.7	6.146E-02	-8.813E-03	-6.041E-02	5.755E-02	-5.225E-03	-5.726E-02	6.867E-02	-7.981E-04	-6.867E-02
1.8	6.277E-02	-8.747E-03	-6.207E-02	3.523E-02	-2.853E-03	-3.506E-02	3.473E-02	-4.409E-04	-3.472E-02
1.9	6.192E-02	-9.466E-03	-6.118E-02	2.530E-02	-1.705E-03	-2.520E-02	1.830E-02	-2.469E-04	-1.829E-02
2.0	5.772E-02	-9.830E-03	-5.687E-02	2.018E-02	-1.136E-03	-2.013E-02	9.692E-03	-1.335E-04	-9.691E-03
2.1	5.099E-02	-9.625E-03	-5.005E-02	1.730E-02	-9.139E-04	-1.726E-02	5.260E-03	-6.922E-05	-5.259E-03
2.2	4.293E-02	-8.923E-03	-4.197E-02	1.468E-02	-7.516E-04	-1.466E-02	3.287E-03	-3.967E-05	-3.287E-03
2.3	3.468E-02	-7.874E-03	-3.374E-02	1.246E-02	-6.693E-04	-1.244E-02	2.274E-03	-2.484E-05	-2.274E-03
2.4	2.709E-02	-6.648E-03	-2.622E-02	1.034E-02	-5.903E-04	-1.032E-02	1.636E-03	-1.598E-05	-1.636E-03
2.5	2.060E-02	-5.387E-03	-1.983E-02	8.410E-03	-5.138E-04	-8.394E-03	1.226E-03	-1.098E-05	-1.226E-03
2.6	1.541E-02	-4.216E-03	-1.476E-02	6.709E-03	-4.393E-04	-6.695E-03	9.381E-04	-7.994E-06	-9.381E-04
2.7	1.151E-02	-3.216E-03	-1.098E-02	5.265E-03	-3.686E-04	-5.252E-03	7.208E-04	-6.026E-06	-7.208E-04
2.8	8.679E-03	-2.412E-03	-8.267E-03	4.076E-03	-3.036E-04	-4.064E-03	5.546E-04	-4.681E-06	-5.546E-04
2.9	6.700E-03	-1.803E-03	-6.387E-03	3.109E-03	-2.452E-04	-3.099E-03	4.316E-04	-3.896E-06	-4.316E-04
3.0	5.339E-03	-1.367E-03	-5.106E-03	2.360E-03	-1.957E-04	-2.352E-03	3.275E-04	-3.084E-06	-3.275E-04
3.1	4.395E-03	-1.068E-03	-4.222E-03	1.778E-03	-1.538E-04	-1.771E-03	2.476E-04	-2.455E-06	-2.476E-04
3.2	3.713E-03	-8.688E-04	-3.582E-03	1.343E-03	-1.202E-04	-1.338E-03	1.863E-04	-1.956E-06	-1.863E-04
3.3	3.190E-03	-7.363E-04	-3.086E-03	1.011E-03	-9.277E-05	-1.007E-03	1.382E-04	-1.529E-06	-1.382E-04
3.4	2.758E-03	-6.431E-04	-2.671E-03	7.663E-04	-7.136E-05	-7.626E-04	1.019E-04	-1.189E-06	-1.019E-04
3.5	2.380E-03	-5.701E-04	-2.304E-03	5.875E-04	-5.509E-05	-5.845E-04	7.473E-05	-9.174E-07	-7.472E-05
3.6	2.041E-03	-5.068E-04	-1.972E-03	4.549E-04	-4.262E-05	-4.526E-04	5.455E-05	-7.016E-07	-5.455E-05
3.7	1.735E-03	-4.479E-04	-1.672E-03	3.558E-04	-3.310E-05	-3.539E-04	3.971E-05	-5.342E-07	-3.971E-05
3.8	1.463E-03	-3.915E-04	-1.405E-03	2.813E-04	-2.589E-05	-2.798E-04	2.887E-05	-4.049E-07	-2.887E-05
3.9	1.225E-03	-3.380E-04	-1.173E-03	2.246E-04	-2.042E-05	-2.235E-04	2.103E-05	-3.063E-07	-2.103E-05
4.0	1.020E-03	-2.884E-04	-9.740E-04	1.809E-04	-1.624E-05	-1.800E-04	1.535E-05	-2.313E-07	-1.535E-05
4.1	8.483E-04	-2.437E-04	-8.078E-04	1.471E-04	-1.311E-05	-1.464E-04	1.113E-05	-1.729E-07	-1.113E-05
4.2	7.058E-04	-2.045E-04	-6.708E-04	1.207E-04	-1.076E-05	-1.201E-04	7.947E-06	-1.265E-07	-7.946E-06
4.3	5.889E-04	-1.710E-04	-5.592E-04	9.942E-05	-8.904E-06	-9.895E-05	5.865E-06	-9.547E-08	-5.864E-06
4.4	4.940E-04	-1.430E-04	-4.689E-04	8.184E-05	-7.377E-06	-8.146E-05	4.349E-06	-7.212E-08	-4.348E-06
4.5	4.171E-04	-1.199E-04	-3.960E-04	6.752E-05	-6.151E-06	-6.720E-05	3.115E-06	-5.208E-08	-3.114E-06
4.6	3.545E-04	-1.011E-04	-3.368E-04	5.593E-05	-5.189E-06	-5.566E-05	2.370E-06	-4.014E-08	-2.369E-06
4.7	3.034E-04	-8.599E-05	-2.886E-04	4.617E-05	-4.353E-06	-4.594E-05	1.744E-06	-2.960E-08	-1.744E-06
4.8	2.611E-04	-7.378E-05	-2.486E-04	3.819E-05	-3.673E-06	-3.799E-05	1.322E-06	-2.249E-08	-1.322E-06
4.9	2.258E-04	-6.386E-05	-2.151E-04	3.157E-05	-3.098E-06	-3.140E-05	9.990E-07	-1.697E-08	-9.988E-07
5.0	1.958E-04	-5.569E-05	-1.866E-04	2.608E-05	-2.608E-06	-2.593E-05	7.657E-07	-1.299E-08	-7.656E-07
5.3	1.285E-04	-3.790E-05	-1.221E-04	1.472E-05	-1.552E-06	-1.463E-05	3.454E-07	-5.705E-09	-3.453E-07
5.6	8.396E-05	-2.576E-05	-7.940E-05	8.393E-06	-9.182E-07	-8.337E-06	1.703E-07	-2.839E-09	-1.703E-07
5.9	5.487E-05	-1.719E-05	-5.169E-05	4.873E-06	-5.453E-07	-4.838E-06	8.533E-08	-1.450E-09	-8.532E-08
6.2	3.636E-05	-1.146E-05	-3.422E-05	2.895E-06	-3.288E-07	-2.874E-06	4.324E-08	-7.561E-10	-4.323E-08
6.5	2.460E-05	-7.795E-06	-2.315E-05	1.753E-06	-2.016E-07	-1.740E-06	2.258E-08	-4.207E-10	-2.257E-08
6.8	1.692E-05	-5.440E-06	-1.591E-05	1.084E-06	-1.269E-07	-1.076E-06	1.177E-08	-2.312E-10	-1.177E-08
7.1	1.174E-05	-3.853E-06	-1.100E-05	6.784E-07	-8.115E-08	-6.730E-07	6.087E-09	-1.238E-10	-6.086E-09
7.4	8.177E-06	-2.736E-06	-7.644E-06	4.287E-07	-5.255E-08	-4.251E-07	3.221E-09	-6.895E-11	-3.221E-09
7.7	5.731E-06	-1.942E-06	-5.345E-06	2.734E-07	-3.436E-08	-2.710E-07	1.713E-09	-3.777E-11	-1.713E-09
8.0	4.054E-06	-1.386E-06	-3.776E-06	1.758E-07	-2.262E-08	-1.742E-07	9.242E-10	-2.102E-11	-9.239E-10
8.3	2.897E-06	-1.000E-06	-2.696E-06	1.140E-07	-1.497E-08	-1.129E-07	4.942E-10	-1.142E-11	-4.941E-10
8.6	2.089E-06	-7.304E-07	-1.940E-06	7.466E-08	-9.977E-09	-7.391E-08	2.767E-10	-6.512E-12	-2.766E-10
8.9	1.516E-06	-5.373E-07	-1.405E-06	4.937E-08	-6.703E-09	-4.886E-08	1.599E-10	-3.867E-12	-1.598E-10
9.0	1.364E-06	-4.855E-07	-1.263E-06	4.312E-08	-5.887E-09	-4.267E-08	1.322E-10	-3.206E-12	-1.321E-10
9.5	8.108E-07	-2.940E-07	-7.484E-07	2.219E-08	-3.107E-09	-2.195E-08	5.320E-11	-1.335E-12	-5.319E-11
10.0	4.904E-07	-1.805E-07	-4.516E-07	1.169E-08	-1.680E-09	-1.155E-08	2.170E-11	-5.582E-13	-2.169E-11
10.5	3.017E-07	-1.130E-07	-2.771E-07	6.272E-09	-9.262E-10	-6.196E-09	9.000E-12	-2.349E-13	-8.997E-12
11.0	1.881E-07	-7.159E-08	-1.722E-07	3.423E-09	-5.184E-10	-3.379E-09	4.013E-12	-1.118E-13	-4.012E-12
11.5	1.188E-07	-4.585E-08	-1.085E-07	1.900E-09	-2.945E-10	-1.875E-09	1.720E-12	-4.849E-14	-1.720E-12
12.0	7.598E-08	-2.973E-08	-6.920E-08	1.072E-09	-1.697E-10	-1.057E-09	7.895E-13	-2.337E-14	-7.892E-13
12.5	4.918E-08	-1.951E-08	-4.466E-08	6.137E-10	-9.925E-11	-6.048E-10	3.704E-13	-1.125E-14	-3.702E-13
13.0	3.216E-08	-1.293E-08	-2.913E-08	3.564E-10	-5.883E-11	-3.511E-10	1.657E-13	-5.113E-15	-1.656E-13
13.5	2.125E-08	-8.643E-09	-1.920E-08	2.097E-10	-3.530E-11	-2.064E-10	8.279E-14	-2.671E-15	-8.274E-14
14.0	1.418E-08	-5.836E-09	-1.277E-08	1.249E-10	-2.142E-11	-1.228E-10	3.821E-14	-1.231E-15	-3.819E-14
14.5	9.545E-09	-3.974E-09	-8.578E-09	7.525E-11	-1.315E-11	-7.398E-11	2.015E-14	-6.866E-16	-2.014E-14
15.0	6.481E-09	-2.728E-09	-5.810E-09	4.585E-11	-8.155E-12	-4.505E-11	9.351E-15	-3.136E-16	-9.345E-15
16.0	3.061E-09	-1.315E-09	-2.730E-09	1.755E-11	-3.227E-12	-1.722E-11	2.535E-15	-9.221E-17	-2.533E-15
17.0	1.489E-09	-6.522E-10	-1.321E-09	6.979E-12	-1.324E-12	-6.841E-12	6.736E-16	-2.492E-17	-6.731E-16
18.0	7.436E-10	-3.317E-10	-6.570E-10	2.872E-12	-5.611E-13	-2.811E-12	2.097E-16	-8.343E-18	-2.095E-16
19.0	3.806E-10	-1.727E-10	-3.347E-10	1.219E-12	-2.449E-13	-1.192E-12	5.845E-17	-2.353E-18	-5.840E-17
20.0	1.992E-10	-9.183E-11	-1.744E-10	5.327E-13	-1.098E-13	-5.202E-13	1.896E-17	-8.028E-19	-1.894E-17
21.0	1.065E-10	-4.981E-11	-9.277E-11	2.390E-13	-5.053E-14	-2.332E-13	6.229E-18	-2.696E-19	-6.223E-18
22.0	5.797E-11	-2.751E-11	-5.030E-11	1.099E-13	-2.379E-14	-1.071E-13	1.948E-18	-8.812E-20	-1.946E-18
23.0	3.214E-11	-1.546E-11	-2.776E-11	5.171E-14	-1.145E-14	-5.032E-14	7.362E-19	-3.456E-20	-7.353E-19
24.0	1.811E-11	-8.822E-12	-1.558E-11	2.484E-14	-5.618E-15	-2.415E-14	2.447E-19	-1.150E-20	-2.444E-19
25.0	1.036E-11	-5.110E-12	-8.878E-12	1.218E-14	-2.811E-15	-1.182E-14	8.692E-20	-4.228E-21	-8.681E-20

TABLE 7

ABSORPTION COEFFICIENTS FOR $kT = 40$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	1.539E-01	-1.292E-01	-6.614E-03	1.492E-01	-1.165E-01	-6.124E-02	1.255E-01	-5.708E-02	-1.099E-01
1.6	2.294E-01	-2.003E-01	-7.442E-03	2.148E-01	-1.789E-01	-6.999E-02	1.553E-01	-8.121E-02	-1.291E-01
1.7	2.622E-01	-2.376E-01	-6.072E-03	2.463E-01	-2.164E-01	-6.026E-02	1.701E-01	-1.012E-01	-1.318E-01
1.8	2.064E-01	-1.933E-01	-3.162E-03	2.079E-01	-1.907E-01	-3.553E-02	1.651E-01	-1.101E-01	-1.164E-01
1.9	7.907E-02	-7.536E-02	-9.473E-04	1.029E-01	-9.653E-02	-1.270E-02	1.406E-01	-1.032E-01	-8.752E-02
2.0	1.364E-02	-1.101E-02	-7.398E-04	1.844E-02	-1.461E-02	-6.877E-03	1.027E-01	-8.032E-02	-5.522E-02
2.1	2.240E-02	-1.858E-02	-1.042E-03	2.167E-02	-1.652E-02	-9.490E-03	6.230E-02	-4.848E-02	-3.064E-02
2.2	3.283E-02	-2.794E-02	-1.297E-03	3.089E-02	-2.462E-02	-1.185E-02	3.275E-02	-2.119E-02	-2.028E-02
2.3	4.292E-02	-3.741E-02	-1.425E-03	3.982E-02	-3.298E-02	-1.321E-02	2.488E-02	-1.272E-02	-2.081E-02
2.4	4.972E-02	-4.429E-02	-1.373E-03	4.617E-02	-3.955E-02	-1.306E-02	2.810E-02	-1.563E-02	-2.257E-02
2.5	5.031E-02	-4.569E-02	-1.150E-03	4.763E-02	-4.195E-02	-1.138E-02	3.000E-02	-1.805E-02	-2.292E-02
2.6	4.340E-02	-4.003E-02	-8.373E-04	4.291E-02	-3.858E-02	-8.711E-03	3.027E-02	-1.953E-02	-2.182E-02
2.7	3.092E-02	-2.871E-02	-5.582E-04	3.291E-02	-2.990E-02	-6.021E-03	2.884E-02	-1.976E-02	-1.946E-02
2.8	1.835E-02	-1.678E-02	-4.081E-04	2.129E-02	-1.912E-02	-4.228E-03	2.590E-02	-1.859E-02	-1.631E-02
2.9	1.200E-02	-1.052E-02	-3.873E-04	1.324E-02	-1.134E-02	-3.641E-03	2.192E-02	-1.620E-02	-1.295E-02
3.0	1.266E-02	-1.108E-02	-4.074E-04	1.170E-02	-9.767E-03	-3.737E-03	1.752E-02	-1.301E-02	-9.982E-03
3.1	1.421E-02	-1.262E-02	-4.045E-04	1.308E-02	-1.115E-02	-3.779E-03	1.344E-02	-9.705E-03	-7.816E-03
3.2	1.482E-02	-1.333E-02	-3.746E-04	1.381E-02	-1.200E-02	-3.581E-03	1.035E-02	-7.040E-03	-6.574E-03
3.3	1.430E-02	-1.300E-02	-3.251E-04	1.361E-02	-1.201E-02	-3.188E-03	8.619E-03	-5.550E-03	-6.034E-03
3.4	1.273E-02	-1.166E-02	-2.684E-04	1.249E-02	-1.114E-02	-2.692E-03	8.068E-03	-5.219E-03	-5.763E-03
3.5	1.050E-02	-9.639E-03	-2.172E-04	1.068E-02	-9.570E-03	-2.201E-03	7.886E-03	-5.309E-03	-5.405E-03
3.6	8.222E-03	-7.512E-03	-1.806E-04	8.606E-03	-7.691E-03	-1.807E-03	7.489E-03	-5.221E-03	-4.903E-03
3.7	6.505E-03	-5.879E-03	-1.600E-04	6.795E-03	-6.006E-03	-1.552E-03	6.885E-03	-4.929E-03	-4.316E-03
3.8	5.662E-03	-5.075E-03	-1.498E-04	5.635E-03	-4.915E-03	-1.415E-03	6.137E-03	-4.470E-03	-3.712E-03
3.9	5.489E-03	-4.930E-03	-1.415E-04	5.176E-03	-4.500E-03	-1.332E-03	5.325E-03	-3.902E-03	-3.151E-03
4.0	5.424E-03	-4.907E-03	-1.302E-04	5.074E-03	-4.448E-03	-1.243E-03	4.532E-03	-3.303E-03	-2.680E-03
4.1	5.143E-03	-4.681E-03	-1.161E-04	4.899E-03	-4.334E-03	-1.126E-03	3.834E-03	-2.753E-03	-2.315E-03
4.2	4.671E-03	-4.267E-03	-1.014E-04	4.543E-03	-4.044E-03	-9.952E-04	3.282E-03	-2.314E-03	-2.052E-03
4.3	4.094E-03	-3.744E-03	-8.804E-05	4.061E-03	-3.626E-03	-8.672E-04	2.892E-03	-2.016E-03	-1.862E-03
4.4	3.517E-03	-3.211E-03	-7.710E-05	3.534E-03	-3.154E-03	-7.557E-04	2.637E-03	-1.844E-03	-1.709E-03
4.5	3.027E-03	-2.755E-03	-6.885E-05	3.043E-03	-2.707E-03	-6.671E-04	2.454E-03	-1.742E-03	-1.561E-03
4.6	2.675E-03	-2.426E-03	-6.269E-05	2.649E-03	-2.346E-03	-6.003E-04	2.278E-03	-1.643E-03	-1.409E-03
4.7	2.450E-03	-2.221E-03	-5.763E-05	2.372E-03	-2.096E-03	-5.486E-04	2.079E-03	-1.518E-03	-1.255E-03
4.8	2.298E-03	-2.088E-03	-5.280E-05	2.190E-03	-1.937E-03	-5.038E-04	1.868E-03	-1.372E-03	-1.110E-03
4.9	2.153E-03	-1.962E-03	-4.786E-05	2.052E-03	-1.822E-03	-4.599E-04	1.660E-03	-1.220E-03	-9.808E-04
5.0	1.979E-03	-1.808E-03	-4.297E-05	1.909E-03	-1.701E-03	-4.157E-04	1.467E-03	-1.075E-03	-8.698E-04
5.3	1.427E-03	-1.303E-03	-3.119E-05	1.404E-03	-1.254E-03	-3.005E-04	1.044E-03	-7.564E-04	-6.381E-04
5.6	1.082E-03	-9.874E-04	-2.378E-05	1.041E-03	-9.272E-04	-2.270E-04	8.058E-04	-5.937E-04	-4.805E-04
5.9	8.480E-04	-7.761E-04	-1.800E-05	8.190E-04	-7.327E-04	-1.728E-04	6.051E-04	-4.496E-04	-3.532E-04
6.2	6.427E-04	-5.881E-04	-1.368E-05	6.232E-04	-5.580E-04	-1.307E-04	4.495E-04	-3.332E-04	-2.646E-04
6.5	5.027E-04	-4.603E-04	-1.059E-05	4.822E-04	-4.319E-04	-1.009E-04	3.466E-04	-2.587E-04	-2.023E-04
6.8	3.955E-04	-3.626E-04	-8.199E-06	3.804E-04	-3.415E-04	-7.821E-05	2.685E-04	-2.019E-04	-1.541E-04
7.1	3.098E-04	-2.842E-04	-6.399E-06	2.977E-04	-2.674E-04	-6.085E-05	2.062E-04	-1.553E-04	-1.182E-04
7.4	2.465E-04	-2.263E-04	-5.036E-06	2.357E-04	-2.120E-04	-4.782E-05	1.610E-04	-1.217E-04	-9.181E-05
7.7	1.966E-04	-1.806E-04	-3.978E-06	1.881E-04	-1.694E-04	-3.774E-05	1.269E-04	-9.646E-05	-7.157E-05
8.0	1.574E-04	-1.447E-04	-3.162E-06	1.503E-04	-1.354E-04	-2.994E-05	9.984E-05	-7.615E-05	-5.602E-05
8.3	1.270E-04	-1.168E-04	-2.528E-06	1.209E-04	-1.091E-04	-2.391E-05	7.916E-05	-6.056E-05	-4.420E-05
8.6	1.027E-04	-9.457E-05	-2.029E-06	9.780E-05	-8.831E-05	-1.917E-05	6.326E-05	-4.859E-05	-3.505E-05
8.9	8.352E-05	-7.692E-05	-1.637E-06	7.935E-05	-7.171E-05	-1.544E-05	5.067E-05	-3.905E-05	-2.790E-05
9.0	7.804E-05	-7.189E-05	-1.526E-06	7.410E-05	-6.698E-05	-1.438E-05	4.710E-05	-3.633E-05	-2.589E-05
9.5	5.593E-05	-5.156E-05	-1.080E-06	5.299E-05	-4.797E-05	-1.016E-05	3.299E-05	-2.558E-05	-1.796E-05
10.0	4.050E-05	-3.738E-05	-7.727E-07	3.828E-05	-3.470E-05	-7.254E-06	2.336E-05	-1.820E-05	-1.260E-05
10.5	2.962E-05	-2.736E-05	-5.586E-07	2.793E-05	-2.535E-05	-5.234E-06	1.672E-05	-1.309E-05	-8.935E-06
11.0	2.186E-05	-2.021E-05	-4.077E-07	2.057E-05	-1.869E-05	-3.813E-06	1.209E-05	-9.504E-06	-6.402E-06
11.5	1.627E-05	-1.505E-05	-3.002E-07	1.528E-05	-1.390E-05	-2.802E-06	8.821E-06	-6.963E-06	-4.631E-06
12.0	1.220E-05	-1.130E-05	-2.229E-07	1.144E-05	-1.042E-05	-2.077E-06	6.490E-06	-5.143E-06	-3.379E-06
12.5	9.221E-06	-8.543E-06	-1.667E-07	8.625E-06	-7.863E-06	-1.551E-06	4.814E-06	-3.829E-06	-2.486E-06
13.0	7.016E-06	-6.504E-06	-1.256E-07	6.550E-06	-5.978E-06	-1.167E-06	3.597E-06	-2.871E-06	-1.843E-06
13.5	5.373E-06	-4.984E-06	-9.533E-08	5.007E-06	-4.574E-06	-8.839E-07	2.707E-06	-2.168E-06	-1.377E-06
14.0	4.140E-06	-3.843E-06	-7.279E-08	3.851E-06	-3.521E-06	-6.739E-07	2.051E-06	-1.647E-06	-1.035E-06
14.5	3.208E-06	-2.980E-06	-5.592E-08	2.979E-06	-2.727E-06	-5.169E-07	1.563E-06	-1.260E-06	-7.833E-07
15.0	2.500E-06	-2.323E-06	-4.320E-08	2.318E-06	-2.123E-06	-3.987E-07	1.199E-06	-9.687E-07	-5.964E-07
16.0	1.541E-06	-1.434E-06	-2.620E-08	1.424E-06	-1.307E-06	-2.411E-07	7.164E-07	-5.822E-07	-3.517E-07
17.0	9.681E-07	-9.018E-07	-1.621E-08	8.919E-07	-8.195E-07	-1.487E-07	4.369E-07	-3.569E-07	-2.117E-07
18.0	6.186E-07	-5.767E-07	-1.020E-08	5.682E-07	-5.228E-07	-9.338E-08	2.714E-07	-2.227E-07	-1.299E-07
19.0	4.014E-07	-3.746E-07	-6.528E-09	3.677E-07	-3.387E-07	-5.960E-08	1.714E-07	-1.413E-07	-8.107E-08
20.0	2.642E-07	-2.468E-07	-4.240E-09	2.414E-07	-2.226E-07	-3.861E-08	1.099E-07	-9.099E-08	-5.141E-08
21.0	1.762E-07	-1.647E-07	-2.791E-09	1.606E-07	-1.483E-07	-2.536E-08	7.151E-08	-5.942E-08	-3.307E-08
22.0	1.189E-07	-1.113E-07	-1.861E-09	1.081E-07	-9.994E-08	-1.687E-08	4.713E-08	-3.930E-08	-2.157E-08
23.0	8.121E-08	-7.603E-08	-1.256E-09	7.363E-08	-6.814E-08	-1.136E-08	3.144E-08	-2.630E-08	-1.424E-08
24.0	5.602E-08	-5.249E-08	-8.564E-10	5.068E-08	-4.694E-08	-7.728E-09	2.121E-08	-1.780E-08	-9.512E-09
25.0	3.903E-08	-3.659E-08	-5.901E-10	3.523E-08	-3.266E-08	-5.314E-09	1.446E-08	-1.217E-08	-6.423E-09

TABLE 7—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	1.321E-01	-4.136E-02	-1.230E-01	2.482E-01	-2.167E-02	-2.472E-01	2.941E-01	-2.791E-03	-2.941E-01
1.6	8.845E-02	-2.143E-02	-8.369E-02	1.469E-01	-1.400E-02	-1.461E-01	1.771E-01	-1.896E-03	-1.771E-01
1.7	7.436E-02	-1.322E-02	-7.207E-02	8.771E-02	-8.718E-03	-8.722E-02	1.053E-01	-1.258E-03	-1.053E-01
1.8	6.986E-02	-1.084E-02	-6.866E-02	5.497E-02	-5.365E-03	-5.464E-02	6.098E-02	-8.038E-04	-6.098E-02
1.9	6.655E-02	-1.075E-02	-6.561E-02	3.739E-02	-3.369E-03	-3.717E-02	3.589E-02	-5.142E-04	-3.588E-02
2.0	6.161E-02	-1.098E-02	-6.059E-02	2.733E-02	-2.162E-03	-2.719E-02	2.095E-02	-3.208E-04	-2.094E-02
2.1	5.492E-02	-1.081E-02	-5.381E-02	2.195E-02	-1.571E-03	-2.186E-02	1.198E-02	-1.910E-04	-1.198E-02
2.2	4.731E-02	-1.022E-02	-4.615E-02	1.778E-02	-1.140E-03	-1.772E-02	7.407E-03	-1.199E-04	-7.406E-03
2.3	3.957E-02	-9.299E-03	-3.841E-02	1.501E-02	-9.442E-04	-1.497E-02	4.819E-03	-7.718E-05	-4.818E-03
2.4	3.231E-02	-8.184E-03	-3.119E-02	1.262E-02	-7.988E-04	-1.258E-02	3.198E-03	-4.907E-05	-3.197E-03
2.5	2.587E-02	-6.981E-03	-2.482E-02	1.055E-02	-6.899E-04	-1.052E-02	2.214E-03	-3.183E-05	-2.213E-03
2.6	2.044E-02	-5.794E-03	-1.950E-02	8.742E-03	-6.014E-04	-8.720E-03	1.592E-03	-2.118E-05	-1.592E-03
2.7	1.605E-02	-4.702E-03	-1.524E-02	7.179E-03	-5.230E-04	-7.159E-03	1.169E-03	-1.420E-05	-1.169E-03
2.8	1.262E-02	-3.747E-03	-1.194E-02	5.841E-03	-4.511E-04	-5.822E-03	8.729E-04	-9.568E-06	-8.728E-04
2.9	1.001E-02	-2.953E-03	-9.452E-03	4.705E-03	-3.847E-04	-4.688E-03	7.077E-04	-8.055E-06	-7.076E-04
3.0	8.069E-03	-2.322E-03	-7.620E-03	3.768E-03	-3.252E-04	-3.753E-03	5.507E-04	-6.123E-06	-5.507E-04
3.1	6.628E-03	-1.841E-03	-6.276E-03	2.998E-03	-2.720E-04	-2.985E-03	4.303E-04	-4.722E-06	-4.303E-04
3.2	5.555E-03	-1.486E-03	-5.281E-03	2.381E-03	-2.257E-04	-2.369E-03	3.434E-04	-3.969E-06	-3.434E-04
3.3	4.740E-03	-1.233E-03	-4.526E-03	1.882E-03	-1.854E-04	-1.872E-03	2.680E-04	-3.135E-06	-2.680E-04
3.4	4.098E-03	-1.052E-03	-3.925E-03	1.488E-03	-1.513E-04	-1.479E-03	2.113E-04	-2.609E-06	-2.113E-04
3.5	3.567E-03	-9.204E-04	-3.424E-03	1.180E-03	-1.232E-04	-1.173E-03	1.656E-04	-2.143E-06	-1.656E-04
3.6	3.113E-03	-8.193E-04	-2.988E-03	9.393E-04	-9.999E-05	-9.333E-04	1.287E-04	-1.723E-06	-1.287E-04
3.7	2.712E-03	-7.355E-04	-2.599E-03	7.504E-04	-8.094E-05	-7.453E-04	1.004E-04	-1.416E-06	-1.004E-04
3.8	2.354E-03	-6.601E-04	-2.249E-03	6.026E-04	-6.550E-05	-5.984E-04	7.792E-05	-1.146E-06	-7.791E-05
3.9	2.033E-03	-5.892E-04	-1.936E-03	4.869E-04	-5.305E-05	-4.834E-04	6.038E-05	-9.238E-07	-6.037E-05
4.0	1.748E-03	-5.213E-04	-1.658E-03	3.956E-04	-4.303E-05	-3.927E-04	4.685E-05	-7.482E-07	-4.684E-05
4.1	1.498E-03	-4.571E-04	-1.416E-03	3.240E-04	-3.510E-05	-3.216E-04	3.618E-05	-6.017E-07	-3.618E-05
4.2	1.281E-03	-3.976E-04	-1.207E-03	2.679E-04	-2.891E-05	-2.659E-04	2.764E-05	-4.761E-07	-2.764E-05
4.3	1.095E-03	-3.437E-04	-1.029E-03	2.229E-04	-2.399E-05	-2.213E-04	2.140E-05	-3.817E-07	-2.140E-05
4.4	9.373E-04	-2.960E-04	-8.796E-04	1.860E-04	-1.994E-05	-1.846E-04	1.662E-05	-3.063E-07	-1.662E-05
4.5	8.047E-04	-2.544E-04	-7.544E-04	1.558E-04	-1.666E-05	-1.547E-04	1.264E-05	-2.399E-07	-1.263E-05
4.6	6.935E-04	-2.187E-04	-6.499E-04	1.316E-04	-1.414E-05	-1.307E-04	9.884E-06	-1.929E-07	-9.882E-06
4.7	6.003E-04	-1.885E-04	-5.629E-04	1.111E-04	-1.198E-05	-1.103E-04	7.609E-06	-1.521E-07	-7.607E-06
4.8	5.222E-04	-1.632E-04	-4.900E-04	9.416E-05	-1.023E-05	-9.350E-05	5.905E-06	-1.205E-07	-5.903E-06
4.9	4.564E-04	-1.422E-04	-4.287E-04	8.002E-05	-8.800E-06	-7.945E-05	4.605E-06	-9.585E-08	-4.604E-06
5.0	4.006E-04	-1.247E-04	-3.765E-04	6.793E-05	-7.550E-06	-6.745E-05	3.584E-06	-7.573E-08	-3.583E-06
5.3	2.756E-04	-8.732E-05	-2.591E-04	4.199E-05	-4.895E-06	-4.167E-05	1.704E-06	-3.702E-08	-1.704E-06
5.6	1.914E-04	-6.300E-05	-1.792E-04	2.607E-05	-3.189E-06	-2.585E-05	8.721E-07	-1.928E-08	-8.719E-07
5.9	1.329E-04	-4.514E-05	-1.236E-04	1.630E-05	-2.077E-06	-1.615E-05	4.561E-07	-1.011E-08	-4.560E-07
6.2	9.255E-05	-3.190E-05	-8.580E-05	1.031E-05	-1.354E-06	-1.021E-05	2.424E-07	-5.309E-09	-2.423E-07
6.5	6.533E-05	-2.264E-05	-6.051E-05	6.602E-06	-8.861E-07	-6.533E-06	1.383E-07	-3.105E-09	-1.383E-07
6.8	4.688E-05	-1.638E-05	-4.341E-05	4.304E-06	-5.873E-07	-4.258E-06	8.064E-08	-1.890E-09	-8.062E-08
7.1	3.407E-05	-1.210E-05	-3.150E-05	2.847E-06	-3.942E-07	-2.815E-06	4.501E-08	-1.047E-09	-4.500E-08
7.4	2.495E-05	-9.041E-06	-2.298E-05	1.908E-06	-2.685E-07	-1.886E-06	2.709E-08	-6.759E-10	-2.708E-08
7.7	1.834E-05	-6.761E-06	-1.683E-05	1.293E-06	-1.856E-07	-1.278E-06	1.561E-08	-3.928E-10	-1.561E-08
8.0	1.355E-05	-5.052E-06	-1.241E-05	8.852E-07	-1.298E-07	-8.743E-07	9.436E-09	-2.529E-10	-9.432E-09
8.3	1.010E-05	-3.796E-06	-9.231E-06	6.104E-07	-9.157E-08	-6.026E-07	5.530E-09	-1.515E-10	-5.528E-09
8.6	7.588E-06	-2.882E-06	-6.928E-06	4.237E-07	-6.495E-08	-4.181E-07	3.320E-09	-9.406E-11	-3.319E-09
8.9	5.746E-06	-2.210E-06	-5.235E-06	2.962E-07	-4.630E-08	-2.921E-07	2.068E-09	-6.099E-11	-2.067E-09
9.0	5.244E-06	-2.026E-06	-4.774E-06	2.634E-07	-4.146E-08	-2.597E-07	1.739E-09	-5.170E-11	-1.738E-09
9.5	3.346E-06	-1.319E-06	-3.032E-06	1.480E-07	-2.395E-08	-1.458E-07	7.844E-10	-2.420E-11	-7.840E-10
10.0	2.163E-06	-8.655E-07	-1.953E-06	8.494E-08	-1.409E-08	-8.361E-08	3.632E-10	-1.163E-11	-3.629E-10
10.5	1.420E-06	-5.769E-07	-1.278E-06	4.967E-08	-8.435E-09	-4.885E-08	1.630E-10	-5.225E-12	-1.629E-10
11.0	9.445E-07	-3.901E-07	-8.474E-07	2.952E-08	-5.136E-09	-2.901E-08	8.383E-11	-2.844E-12	-8.378E-11
11.5	6.352E-07	-2.662E-07	-5.678E-07	1.781E-08	-3.175E-09	-1.749E-08	3.977E-11	-1.351E-12	-3.974E-11
12.0	4.318E-07	-1.833E-07	-3.849E-07	1.089E-08	-1.987E-09	-1.069E-08	2.103E-11	-7.620E-13	-2.101E-11
12.5	2.969E-07	-1.277E-07	-2.637E-07	6.747E-09	-1.257E-09	-6.614E-09	1.041E-11	-3.706E-13	-1.041E-11
13.0	2.060E-07	-8.978E-08	-1.824E-07	4.232E-09	-8.044E-10	-4.146E-09	5.551E-12	-2.108E-13	-5.547E-12
13.5	1.442E-07	-6.359E-08	-1.273E-07	2.686E-09	-5.204E-10	-2.629E-09	2.972E-12	-1.168E-13	-2.970E-12
14.0	1.018E-07	-4.542E-08	-8.961E-08	1.724E-09	-3.401E-10	-1.686E-09	1.563E-12	-6.171E-14	-1.561E-12
14.5	7.251E-08	-3.270E-08	-6.360E-08	1.118E-09	-2.246E-10	-1.092E-09	8.765E-13	-3.589E-14	-8.758E-13
15.0	5.201E-08	-2.371E-08	-4.548E-08	7.320E-10	-1.497E-10	-7.147E-10	4.530E-13	-1.873E-14	-4.526E-13
16.0	2.734E-08	-1.271E-08	-2.376E-08	3.223E-10	-6.815E-11	-3.142E-10	1.519E-13	-6.669E-15	-1.517E-13
17.0	1.475E-08	-6.984E-09	-1.274E-08	1.468E-10	-3.199E-11	-1.428E-10	4.958E-14	-2.281E-15	-4.952E-14
18.0	8.144E-09	-3.924E-09	-6.999E-09	6.888E-11	-1.545E-11	-6.693E-11	1.728E-14	-8.217E-16	-1.726E-14
19.0	4.595E-09	-2.250E-09	-3.928E-09	3.322E-11	-7.659E-12	-3.223E-11	6.345E-15	-3.127E-16	-6.337E-15
20.0	2.644E-09	-1.315E-09	-2.248E-09	1.643E-11	-3.887E-12	-1.592E-11	2.195E-15	-1.123E-16	-2.191E-15
21.0	1.549E-09	-7.814E-10	-1.310E-09	8.318E-12	-2.016E-12	-8.044E-12	9.075E-16	-4.864E-17	-9.061E-16
22.0	9.231E-10	-4.718E-10	-7.765E-10	4.302E-12	-1.067E-12	-4.154E-12	3.554E-16	-1.985E-17	-3.548E-16
23.0	5.585E-10	-2.891E-10	-4.675E-10	2.269E-12	-5.751E-13	-2.188E-12	1.362E-16	-7.378E-18	-1.360E-16
24.0	3.428E-10	-1.796E-10	-2.855E-10	1.219E-12	-3.154E-13	-1.173E-12	5.351E-17	-3.095E-18	-5.341E-17
25.0	2.132E-10	-1.130E-10	-1.767E-10	6.663E-13	-1.759E-13	-6.404E-13	2.704E-17	-1.706E-18	-2.698E-17

TABLE 8

ABSORPTION COEFFICIENTS FOR $kT = 50$ keV

	$\theta = 89°$			$\theta = 80°$			$\theta = 60°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	2.005E-01	-1.682E-01	-6.941E-03	1.909E-01	-1.520E-01	-6.554E-02	1.484E-01	-7.304E-02	-1.253E-01
1.6	2.427E-01	-2.116E-01	-6.404E-03	2.295E-01	-1.931E-01	-6.235E-02	1.673E-01	-9.354E-02	-1.327E-01
1.7	2.323E-01	-2.098E-01	-4.517E-03	2.255E-01	-1.984E-01	-4.669E-02	1.710E-01	-1.071E-01	-1.250E-01
1.8	1.600E-01	-1.484E-01	-2.335E-03	1.687E-01	-1.533E-01	-2.646E-02	1.584E-01	-1.093E-01	-1.045E-01
1.9	6.351E-02	-5.827E-02	-1.159E-03	8.209E-02	-7.436E-02	-1.296E-02	1.321E-01	-9.793E-02	-7.703E-02
2.0	2.743E-02	-2.212E-02	-1.202E-03	2.923E-02	-2.251E-02	-1.110E-02	9.755E-02	-7.488E-02	-5.076E-02
2.1	3.774E-02	-3.124E-02	-1.427E-03	3.570E-02	-2.779E-02	-1.319E-02	6.321E-02	-4.672E-02	-3.271E-02
2.2	4.722E-02	-4.006E-02	-1.531E-03	4.428E-02	-3.577E-02	-1.434E-02	3.888E-02	-2.417E-02	-2.567E-02
2.3	5.367E-02	-4.657E-02	-1.486E-03	5.041E-02	-4.206E-02	-1.420E-02	3.240E-02	-1.773E-02	-2.588E-02
2.4	5.512E-02	-4.878E-02	-1.307E-03	5.247E-02	-4.497E-02	-1.283E-02	3.456E-02	-2.038E-02	-2.633E-02
2.5	5.070E-02	-4.558E-02	-1.049E-03	4.956E-02	-4.336E-02	-1.061E-02	3.524E-02	-2.221E-02	-2.541E-02
2.6	4.133E-02	-3.749E-02	-7.926E-04	4.209E-02	-3.730E-02	-8.203E-03	3.433E-02	-2.290E-02	-2.328E-02
2.7	3.001E-02	-2.713E-02	-6.068E-04	3.209E-02	-2.843E-02	-6.242E-03	3.194E-02	-2.231E-02	-2.033E-02
2.8	2.093E-02	-1.850E-02	-5.187E-04	2.282E-02	-1.981E-02	-5.104E-03	2.838E-02	-2.047E-02	-1.701E-02
2.9	1.719E-02	-1.485E-02	-4.981E-04	1.741E-02	-1.463E-02	-4.705E-03	2.411E-02	-1.765E-02	-1.384E-02
3.0	1.774E-02	-1.543E-02	-4.857E-04	1.659E-02	-1.389E-02	-4.587E-03	1.972E-02	-1.435E-02	-1.120E-02
3.1	1.825E-02	-1.607E-02	-4.525E-04	1.719E-02	-1.464E-02	-4.345E-03	1.580E-02	-1.117E-02	-9.316E-03
3.2	1.773E-02	-1.578E-02	-4.032E-04	1.696E-02	-1.466E-02	-3.940E-03	1.287E-02	-8.723E-03	-8.172E-03
3.3	1.627E-02	-1.459E-02	-3.476E-04	1.589E-02	-1.388E-02	-3.445E-03	1.116E-02	-7.366E-03	-7.525E-03
3.4	1.418E-02	-1.276E-02	-2.951E-04	1.417E-02	-1.244E-02	-2.945E-03	1.045E-02	-6.983E-03	-7.035E-03
3.5	1.190E-02	-1.069E-02	-2.524E-04	1.212E-02	-1.065E-02	-2.511E-03	1.001E-02	-6.899E-03	-6.468E-03
3.6	9.905E-03	-8.841E-03	-2.221E-04	1.014E-02	-8.865E-03	-2.178E-03	9.362E-03	-6.622E-03	-5.809E-03
3.7	8.513E-03	-7.546E-03	-2.018E-04	8.578E-03	-7.435E-03	-1.948E-03	8.546E-03	-6.155E-03	-5.121E-03
3.8	7.771E-03	-6.873E-03	-1.867E-04	7.587E-03	-6.540E-03	-1.787E-03	7.630E-03	-5.548E-03	-4.462E-03
3.9	7.409E-03	-6.579E-03	-1.719E-04	7.076E-03	-6.110E-03	-1.651E-03	6.693E-03	-4.873E-03	-3.876E-03
4.0	7.039E-03	-6.285E-03	-1.556E-04	6.744E-03	-5.862E-03	-1.509E-03	5.812E-03	-4.206E-03	-3.389E-03
4.1	6.501E-03	-5.827E-03	-1.390E-04	6.317E-03	-5.524E-03	-1.358E-03	5.049E-03	-3.615E-03	-3.003E-03
4.2	5.858E-03	-5.259E-03	-1.234E-04	5.767E-03	-5.061E-03	-1.210E-03	4.441E-03	-3.148E-03	-2.704E-03
4.3	5.196E-03	-4.664E-03	-1.099E-04	5.164E-03	-4.535E-03	-1.076E-03	3.991E-03	-2.819E-03	-2.465E-03
4.4	4.595E-03	-4.117E-03	-9.879E-05	4.577E-03	-4.015E-03	-9.619E-04	3.663E-03	-2.603E-03	-2.255E-03
4.5	4.101E-03	-3.667E-03	-8.970E-05	4.064E-03	-3.556E-03	-8.680E-04	3.400E-03	-2.444E-03	-2.054E-03
4.6	3.727E-03	-3.329E-03	-8.205E-05	3.652E-03	-3.190E-03	-7.905E-04	3.142E-03	-2.284E-03	-1.857E-03
4.7	3.444E-03	-3.079E-03	-7.518E-05	3.338E-03	-2.915E-03	-7.237E-04	2.870E-03	-2.102E-03	-1.668E-03
4.8	3.206E-03	-2.872E-03	-6.868E-05	3.092E-03	-2.706E-03	-6.627E-04	2.596E-03	-1.907E-03	-1.495E-03
4.9	2.970E-03	-2.667E-03	-6.246E-05	2.874E-03	-2.522E-03	-6.047E-04	2.333E-03	-1.714E-03	-1.341E-03
5.0	2.724E-03	-2.448E-03	-5.666E-05	2.654E-03	-2.334E-03	-5.495E-04	2.094E-03	-1.535E-03	-1.209E-03
5.3	2.050E-03	-1.841E-03	-4.284E-05	2.008E-03	-1.767E-03	-4.134E-04	1.559E-03	-1.140E-03	-9.127E-04
5.6	1.605E-03	-1.443E-03	-3.319E-05	1.552E-03	-1.366E-03	-3.193E-04	1.220E-03	-9.037E-04	-6.972E-04
5.9	1.268E-03	-1.142E-03	-2.569E-05	1.231E-03	-1.087E-03	-2.475E-04	9.371E-04	-6.984E-04	-5.286E-04
6.2	9.942E-04	-8.960E-04	-2.007E-05	9.641E-04	-8.519E-04	-1.927E-04	7.209E-04	-5.378E-04	-4.074E-04
6.5	7.946E-04	-7.170E-04	-1.584E-05	7.666E-04	-6.782E-04	-1.519E-04	5.686E-04	-4.269E-04	-3.178E-04
6.8	6.370E-04	-5.754E-04	-1.255E-05	6.152E-04	-5.453E-04	-1.203E-04	4.495E-04	-3.394E-04	-2.482E-04
7.1	5.123E-04	-4.631E-04	-1.002E-05	4.937E-04	-4.380E-04	-9.580E-05	3.551E-04	-2.689E-04	-1.953E-04
7.4	4.160E-04	-3.764E-04	-8.047E-06	3.999E-04	-3.552E-04	-7.687E-05	2.840E-04	-2.160E-04	-1.551E-04
7.7	3.388E-04	-3.068E-04	-6.495E-06	3.256E-04	-2.896E-04	-6.197E-05	2.286E-04	-1.746E-04	-1.236E-04
8.0	2.773E-04	-2.513E-04	-5.272E-06	2.660E-04	-2.368E-04	-5.023E-05	1.843E-04	-1.413E-04	-9.909E-05
8.3	2.283E-04	-2.070E-04	-4.300E-06	2.186E-04	-1.948E-04	-4.092E-05	1.496E-04	-1.150E-04	-7.991E-05
8.6	1.886E-04	-1.712E-04	-3.523E-06	1.804E-04	-1.610E-04	-3.349E-05	1.221E-04	-9.426E-05	-6.474E-05
8.9	1.564E-04	-1.421E-04	-2.899E-06	1.494E-04	-1.335E-04	-2.753E-05	9.999E-05	-7.744E-05	-5.268E-05
9.0	1.471E-04	-1.337E-04	-2.719E-06	1.405E-04	-1.255E-04	-2.581E-05	9.363E-05	-7.258E-05	-4.923E-05
9.5	1.089E-04	-9.910E-05	-1.987E-06	1.038E-04	-9.290E-05	-1.883E-05	6.796E-05	-5.296E-05	-3.535E-05
10.0	8.147E-05	-7.419E-05	-1.468E-06	7.746E-05	-6.943E-05	-1.388E-05	4.983E-05	-3.902E-05	-2.566E-05
10.5	6.147E-05	-5.604E-05	-1.094E-06	5.834E-05	-5.236E-05	-1.033E-05	3.691E-05	-2.903E-05	-1.882E-05
11.0	4.678E-05	-4.268E-05	-8.232E-07	4.431E-05	-3.982E-05	-7.759E-06	2.759E-05	-2.179E-05	-1.394E-05
11.5	3.587E-05	-3.276E-05	-6.243E-07	3.392E-05	-3.052E-05	-5.875E-06	2.079E-05	-1.649E-05	-1.041E-05
12.0	2.771E-05	-2.533E-05	-4.771E-07	2.615E-05	-2.356E-05	-4.484E-06	1.579E-05	-1.257E-05	-7.837E-06
12.5	2.155E-05	-1.972E-05	-3.673E-07	2.030E-05	-1.832E-05	-3.446E-06	1.209E-05	-9.655E-06	-5.946E-06
13.0	1.687E-05	-1.544E-05	-2.846E-07	1.587E-05	-1.433E-05	-2.666E-06	9.312E-06	-7.465E-06	-4.543E-06
13.5	1.328E-05	-1.217E-05	-2.219E-07	1.247E-05	-1.127E-05	-2.076E-06	7.221E-06	-5.808E-06	-3.495E-06
14.0	1.051E-05	-9.642E-06	-1.741E-07	9.859E-06	-8.922E-06	-1.626E-06	5.633E-06	-4.545E-06	-2.705E-06
14.5	8.369E-06	-7.680E-06	-1.373E-07	7.836E-06	-7.098E-06	-1.281E-06	4.420E-06	-3.577E-06	-2.106E-06
15.0	6.695E-06	-6.148E-06	-1.089E-07	6.259E-06	-5.675E-06	-1.015E-06	3.487E-06	-2.830E-06	-1.649E-06
16.0	4.345E-06	-3.995E-06	-6.948E-08	4.051E-06	-3.679E-06	-6.458E-07	2.203E-06	-1.797E-06	-1.027E-06
17.0	2.868E-06	-2.641E-06	-4.514E-08	2.667E-06	-2.426E-06	-4.186E-07	1.418E-06	-1.162E-06	-6.521E-07
18.0	1.923E-06	-1.773E-06	-2.981E-08	1.784E-06	-1.625E-06	-2.758E-07	9.276E-07	-7.640E-07	-4.212E-07
19.0	1.308E-06	-1.207E-06	-1.998E-08	1.210E-06	-1.104E-06	-1.844E-07	6.163E-07	-5.098E-07	-2.763E-07
20.0	9.009E-07	-8.323E-07	-1.358E-08	8.317E-07	-7.599E-07	-1.251E-07	4.152E-07	-3.448E-07	-1.839E-07
21.0	6.281E-07	-5.808E-07	-9.341E-09	5.786E-07	-5.293E-07	-8.587E-08	2.833E-07	-2.361E-07	-1.241E-07
22.0	4.428E-07	-4.098E-07	-6.501E-09	4.070E-07	-3.728E-07	-5.965E-08	1.956E-07	-1.636E-07	-8.474E-08
23.0	3.153E-07	-2.921E-07	-4.574E-09	2.892E-07	-2.652E-07	-4.189E-08	1.365E-07	-1.146E-07	-5.852E-08
24.0	2.267E-07	-2.102E-07	-3.250E-09	2.075E-07	-1.905E-07	-2.971E-08	9.629E-08	-8.106E-08	-4.085E-08
25.0	1.645E-07	-1.526E-07	-2.331E-09	1.503E-07	-1.381E-07	-2.127E-08	6.855E-08	-5.788E-08	-2.880E-08

TABLE 8—*Continued*

	$\theta = 30°$			$\theta = 15°$			$\theta = 5°$		
s	κ	q	v	κ	q	v	κ	q	v
1.5	1.568E-01	-5.100E-02	-1.450E-01	2.706E-01	-2.419E-02	-2.694E-01	3.146E-01	-3.056E-03	-3.146E-01
1.6	1.065E-01	-2.905E-02	-9.943E-02	1.729E-01	-1.697E-02	-1.720E-01	2.044E-01	-2.238E-03	-2.044E-01
1.7	8.479E-02	-1.781E-02	-8.098E-02	1.105E-01	-1.155E-02	-1.098E-01	1.313E-01	-1.606E-03	-1.313E-01
1.8	7.521E-02	-1.312E-02	-7.327E-02	7.238E-02	-7.738E-03	-7.188E-02	8.278E-02	-1.120E-03	-8.277E-02
1.9	6.955E-02	-1.192E-02	-6.834E-02	4.960E-02	-5.188E-03	-4.924E-02	5.260E-02	-7.792E-04	-5.259E-02
2.0	6.398E-02	-1.190E-02	-6.281E-02	3.545E-02	-3.464E-03	-3.520E-02	3.316E-02	-5.320E-04	-3.315E-02
2.1	5.738E-02	-1.174E-02	-5.610E-02	2.744E-02	-2.489E-03	-2.726E-02	2.041E-02	-3.498E-04	-2.041E-02
2.2	5.012E-02	-1.121E-02	-4.877E-02	2.143E-02	-1.743E-03	-2.131E-02	1.320E-02	-2.379E-04	-1.320E-02
2.3	4.280E-02	-1.039E-02	-4.143E-02	1.774E-02	-1.366E-03	-1.765E-02	8.739E-03	-1.629E-04	-8.738E-03
2.4	3.588E-02	-9.364E-03	-3.452E-02	1.479E-02	-1.095E-03	-1.473E-02	5.805E-03	-1.096E-04	-5.804E-03
2.5	2.962E-02	-8.231E-03	-2.832E-02	1.242E-02	-9.094E-04	-1.237E-02	3.950E-03	-7.409E-05	-3.949E-03
2.6	2.418E-02	-7.072E-03	-2.297E-02	1.045E-02	-7.789E-04	-1.041E-02	2.757E-03	-5.039E-05	-2.756E-03
2.7	1.962E-02	-5.957E-03	-1.853E-02	8.775E-03	-6.782E-04	-8.744E-03	1.946E-03	-3.374E-05	-1.945E-03
2.8	1.589E-02	-4.934E-03	-1.493E-02	7.334E-03	-5.930E-04	-7.308E-03	1.376E-03	-2.167E-05	-1.375E-03
2.9	1.291E-02	-4.035E-03	-1.209E-02	6.094E-03	-5.173E-04	-6.070E-03	1.113E-03	-1.763E-05	-1.113E-03
3.0	1.058E-02	-3.275E-03	-9.891E-03	5.043E-03	-4.507E-04	-5.021E-03	8.550E-04	-1.285E-05	-8.549E-04
3.1	8.770E-03	-2.657E-03	-8.206E-03	4.154E-03	-3.911E-04	-4.135E-03	6.543E-04	-9.039E-06	-6.542E-04
3.2	7.371E-03	-2.169E-03	-6.917E-03	3.411E-03	-3.366E-04	-3.393E-03	5.385E-04	-7.734E-06	-5.384E-04
3.3	6.288E-03	-1.798E-03	-5.925E-03	2.790E-03	-2.876E-04	-2.774E-03	4.193E-04	-5.634E-06	-4.193E-04
3.4	5.435E-03	-1.521E-03	-5.143E-03	2.279E-03	-2.443E-04	-2.264E-03	3.444E-04	-4.880E-06	-3.444E-04
3.5	4.744E-03	-1.316E-03	-4.506E-03	1.862E-03	-2.066E-04	-1.849E-03	2.783E-04	-4.018E-06	-2.782E-04
3.6	4.168E-03	-1.164E-03	-3.967E-03	1.522E-03	-1.740E-04	-1.511E-03	2.220E-04	-3.194E-06	-2.220E-04
3.7	3.674E-03	-1.046E-03	-3.497E-03	1.246E-03	-1.460E-04	-1.236E-03	1.812E-04	-2.765E-06	-1.812E-04
3.8	3.239E-03	-9.478E-04	-3.078E-03	1.022E-03	-1.221E-04	-1.013E-03	1.457E-04	-2.271E-06	-1.456E-04
3.9	2.850E-03	-8.605E-04	-2.699E-03	8.406E-04	-1.020E-04	-8.333E-04	1.170E-04	-1.869E-06	-1.170E-04
4.0	2.499E-03	-7.780E-04	-2.357E-03	6.936E-04	-8.500E-05	-6.874E-04	9.482E-05	-1.592E-06	-9.481E-05
4.1	2.184E-03	-6.980E-04	-2.051E-03	5.753E-04	-7.095E-05	-5.699E-04	7.647E-05	-1.340E-06	-7.646E-05
4.2	1.904E-03	-6.213E-04	-1.780E-03	4.803E-04	-5.945E-05	-4.757E-04	6.087E-05	-1.091E-06	-6.086E-05
4.3	1.657E-03	-5.495E-04	-1.545E-03	4.032E-04	-5.001E-05	-3.994E-04	4.904E-05	-9.149E-07	-4.903E-05
4.4	1.443E-03	-4.835E-04	-1.341E-03	3.394E-04	-4.206E-05	-3.361E-04	3.958E-05	-7.677E-07	-3.958E-05
4.5	1.257E-03	-4.238E-04	-1.166E-03	2.868E-04	-3.544E-05	-2.840E-04	3.154E-05	-6.347E-07	-3.153E-05
4.6	1.097E-03	-3.707E-04	-1.016E-03	2.445E-04	-3.024E-05	-2.421E-04	2.547E-05	-5.298E-07	-2.546E-05
4.7	9.605E-04	-3.242E-04	-8.892E-04	2.085E-04	-2.575E-05	-2.065E-04	2.039E-05	-4.360E-07	-2.038E-05
4.8	8.438E-04	-2.840E-04	-7.812E-04	1.787E-04	-2.208E-05	-1.770E-04	1.635E-05	-3.604E-07	-1.635E-05
4.9	7.440E-04	-2.496E-04	-6.893E-04	1.539E-04	-1.910E-05	-1.524E-04	1.319E-05	-2.990E-07	-1.318E-05
5.0	6.585E-04	-2.203E-04	-6.108E-04	1.324E-04	-1.647E-05	-1.311E-04	1.057E-05	-2.460E-07	-1.057E-05
5.3	4.660E-04	-1.570E-04	-4.331E-04	8.606E-05	-1.102E-05	-8.522E-05	5.485E-06	-1.362E-07	-5.483E-06
5.6	3.359E-04	-1.167E-04	-3.112E-04	5.650E-05	-7.521E-06	-5.592E-05	2.966E-06	-7.739E-08	-2.964E-06
5.9	2.430E-04	-8.750E-05	-2.236E-04	3.737E-05	-5.190E-06	-3.696E-05	1.620E-06	-4.366E-08	-1.620E-06
6.2	1.758E-04	-6.462E-05	-1.608E-04	2.490E-05	-3.600E-06	-2.460E-05	8.886E-07	-2.418E-08	-8.882E-07
6.5	1.281E-04	-4.748E-05	-1.170E-04	1.672E-05	-2.497E-06	-1.650E-05	5.194E-07	-1.432E-08	-5.191E-07
6.8	9.468E-05	-3.530E-05	-8.640E-05	1.135E-05	-1.738E-06	-1.120E-05	3.196E-07	-9.105E-09	-3.194E-07
7.1	7.092E-05	-2.677E-05	-6.466E-05	7.800E-06	-1.216E-06	-7.687E-06	1.837E-07	-5.108E-09	-1.837E-07
7.4	5.364E-05	-2.063E-05	-4.875E-05	5.425E-06	-8.583E-07	-5.344E-06	1.185E-07	-3.471E-09	-1.184E-07
7.7	4.078E-05	-1.598E-05	-3.688E-05	3.819E-06	-6.132E-07	-3.760E-06	7.094E-08	-2.036E-09	-7.090E-08
8.0	3.110E-05	-1.235E-05	-2.803E-05	2.717E-06	-4.437E-07	-2.675E-06	4.689E-08	-1.450E-09	-4.687E-08
8.3	2.386E-05	-9.557E-06	-2.146E-05	1.951E-06	-3.247E-07	-1.920E-06	2.866E-08	-8.704E-10	-2.865E-08
8.6	1.844E-05	-7.453E-06	-1.656E-05	1.411E-06	-2.396E-07	-1.387E-06	1.856E-08	-5.923E-10	-1.855E-08
8.9	1.437E-05	-5.872E-06	-1.288E-05	1.026E-06	-1.778E-07	-1.009E-06	1.234E-08	-4.167E-10	-1.234E-08
9.0	1.324E-05	-5.434E-06	-1.186E-05	9.250E-07	-1.614E-07	-9.088E-07	1.061E-08	-3.618E-10	-1.061E-08
9.5	8.865E-06	-3.715E-06	-7.896E-06	5.539E-07	-9.982E-08	-5.435E-07	5.167E-09	-1.805E-10	-5.164E-09
10.0	6.000E-06	-2.553E-06	-5.322E-06	3.373E-07	-6.246E-08	-3.306E-07	2.640E-09	-9.807E-11	-2.638E-09
10.5	4.116E-06	-1.777E-06	-3.640E-06	2.088E-07	-3.958E-08	-2.044E-07	1.295E-09	-4.945E-11	-1.294E-09
11.0	2.862E-06	-1.255E-06	-2.520E-06	1.313E-07	-2.545E-08	-1.285E-07	6.981E-10	-2.763E-11	-6.975E-10
11.5	2.009E-06	-8.940E-07	-1.761E-06	8.382E-08	-1.661E-08	-8.192E-08	3.663E-10	-1.487E-11	-3.659E-10
12.0	1.424E-06	-6.417E-07	-1.244E-06	5.419E-08	-1.099E-08	-5.291E-08	2.052E-10	-8.662E-12	-2.050E-10
12.5	1.020E-06	-4.654E-07	-8.876E-07	3.544E-08	-7.342E-09	-3.456E-08	1.056E-10	-4.354E-12	-1.055E-10
13.0	7.367E-07	-3.405E-07	-6.388E-07	2.343E-08	-4.955E-09	-2.282E-08	6.471E-11	-2.918E-12	-6.463E-11
13.5	5.364E-07	-2.508E-07	-4.634E-07	1.565E-08	-3.375E-09	-1.523E-08	3.600E-11	-1.635E-12	-3.595E-11
14.0	3.936E-07	-1.860E-07	-3.389E-07	1.056E-08	-2.318E-09	-1.027E-08	2.008E-11	-8.955E-13	-2.006E-11
14.5	2.911E-07	-1.391E-07	-2.497E-07	7.195E-09	-1.607E-09	-6.988E-09	1.198E-11	-5.658E-13	-1.197E-11
15.0	2.167E-07	-1.046E-07	-1.853E-07	4.947E-09	-1.124E-09	-4.800E-09	7.133E-12	-3.546E-13	-7.123E-12
16.0	1.224E-07	-6.023E-08	-1.040E-07	2.395E-09	-5.623E-10	-2.320E-09	2.486E-12	-1.240E-13	-2.483E-12
17.0	7.083E-08	-3.547E-08	-5.975E-08	1.195E-09	-2.892E-10	-1.155E-09	1.022E-12	-5.584E-14	-1.020E-12
18.0	4.186E-08	-2.131E-08	-3.508E-08	6.127E-10	-1.524E-10	-5.909E-10	3.592E-13	-1.936E-14	-3.586E-13
19.0	2.522E-08	-1.304E-08	-2.101E-08	3.220E-10	-8.228E-11	-3.100E-10	1.560E-13	-8.946E-15	-1.557E-13
20.0	1.547E-08	-8.114E-09	-1.281E-08	1.731E-10	-4.537E-11	-1.663E-10	6.372E-14	-3.962E-15	-6.358E-14
21.0	9.641E-09	-5.127E-09	-7.935E-09	9.501E-11	-2.549E-11	-9.111E-11	2.896E-14	-1.779E-15	-2.890E-14
22.0	6.101E-09	-3.286E-09	-4.992E-09	5.316E-11	-1.458E-11	-5.088E-11	1.162E-14	-7.177E-16	-1.159E-14
23.0	3.914E-09	-2.134E-09	-3.185E-09	3.028E-11	-8.486E-12	-2.892E-11	4.899E-15	-3.111E-16	-4.888E-15
24.0	2.544E-09	-1.403E-09	-2.059E-09	1.753E-11	-5.012E-12	-1.671E-11	2.677E-15	-1.918E-16	-2.669E-15
25.0	1.674E-09	-9.330E-10	-1.347E-09	1.031E-11	-3.004E-12	-9.807E-12	1.374E-15	-9.976E-17	-1.370E-15

We next use equations (11), (16), and (17) to obtain an analytic approximation to the opacities κ, q, and v in the Stokes formalism by using the above RM formulae for the normal mode opacities $\alpha_{\pm}$, and we compare the results to the accurate numerical opacities in Table 2. From this table one can see that the greatest errors in the analytic opacities occur for $\theta = 30°$. For example, for $kT = 20$ keV and $s = 15$ these opacities deviate from the respective numerical opacities by a factor 2. Furthermore, the analytically derived value for v differs greatly from the numerically derived one for $\theta = 89°$. There are two sources of errors in the analytic opacities. The first is due to those inherent in the RM formulae. These formulae were derived by averaging over the harmonics. Harmonic structure in the opacities is not pronounced when the line width due to Doppler broadening and relativistic effects is larger than ω_c, or for the nth harmonic if $n\mu^{-1/2}(\mu^{-1/2} + \cos\theta) > 1$ assuming that the refractive index is unity (Bornatici et al. 1983). Thus the neglect of the harmonic structure is reasonable at high temperatures and high harmonics. As was pointed out in Paper I, the formulae by RM are also inaccurate for small angles. This explains the differences of the opacities at $\theta = 30°$ as noted in Table 2. The second source of error is in the use of the relation (15). This equation results in $v \neq 0$ even for $\theta = 90°$ where we must have $v = 0$. It also explains the above noted error in the analytically derived value of v for $\theta = 89°$. In order to prevent extreme numerical inaccuracies we find that one should set $v = 0$ for $\theta \geq 88°$.

Overall we can say that the analytic expressions can be used in the regions without strong harmonic structure and at angles $\theta > 30°$. Thereby, one should keep in mind that results from calculations using the analytic formulae should be used cautiously. While they may reflect the qualitative behavior, they may not be accurate enough to support detailed quantitative calculations.

Finally, we present extensive numerical tables of our accurate numerical opacities κ, q, and v. In each table we vary s from 1.5 to 25 and use angles of $\theta = 89°$, 80°, 60°, 30°, and 15°. Note that for $\theta = 0°$ $\kappa = q = v = 0$. In Table 3 we use a temperature of $kT = 5$ keV. In Tables 4, 5, 6, 7, and 8 the temperatures are $kT = 10$, 20, 30, 40, and 50 keV, respectively.

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APPENDIX
POLARIZED RADIATIVE TRANSFER

In equation (1) we gave the transfer equation for polarized radiation using the Stokes parameters. The formal solution to this equation was derived by Pacholczyk (1977). After correcting for some misprints MW derived the solution for the special case when there is no incoming radiation and the matter is in local thermal equilibrium. This solution is

$$I/\mathscr{B} = 1 - (p/2R)(a_1 \cosh \lambda l - a_3 \cos \mu l)e^{-\kappa l}, \tag{A1}$$

$$Q/\mathscr{B} = -(p/2R)(b_1 \sinh \lambda l - b_3 \sin \mu l)e^{-\kappa l}, \tag{A2}$$

$$U/\mathscr{B} = (p/2R)(\cosh \lambda l - \cos \mu l)e^{-\kappa l}, \tag{A3}$$

$$V/\mathscr{B} = -(p/2R)(c_1 \sinh \lambda l - c_3 \sin \mu l)e^{-\kappa l}, \tag{A4}$$

where

$$m = (f^2 + h^2)/2, \quad n = (q^2 + v^2)/2, \quad p = qf - vh, \quad r = qh + vf, \tag{A5}$$

$$R = [(m+n)^2 - p^2]^{1/2}, \quad a_1 = (m + n + R)/p, \quad a_3 = 1/a_1, \tag{A6}$$

$$\lambda = (n - m + R)^{1/2}, \quad \mu = (m - n + R)^{1/2}, \tag{A7}$$

$$b_1 = (f - qa_1)/\lambda, \quad b_3 = (f - qa_3)/\mu, \tag{A8}$$

$$c_1 = -(h + va_1)/\lambda, \quad c_3 = -(h + va_3)/\mu. \tag{A9}$$

These equations further simplify under additional assumptions. In the case of cyclotron absorption one has for sufficiently large frequency ratios (about $s > 5$)

$$q^2 + v^2 \ll h^2 + f^2. \tag{A10}$$

Then one can expand the above equations in terms of n/m. If one further has the condition that

$$(h^2 + f^2)^{1/2} l \gg 2\pi \tag{A11}$$

then the above equations reduce to

$$I/\mathscr{B} = 1 - \exp(-\kappa l)\cosh \lambda' l\,, \tag{A12}$$

$$Q/\mathscr{B} = \mathrm{sgn}(r)[h/(f^2 + h^2)^{1/2}]\exp(-\kappa l)\sinh \lambda' l\,, \tag{A13}$$

$$U/\mathscr{B} = 0\,, \tag{A14}$$

$$V/\mathscr{B} = \mathrm{sgn}(r)[f/(f^2 + h^2)^{1/2}]\exp(-\kappa l)\sinh \lambda' l\,, \tag{A15}$$

where $\lambda' = |vf + qh|/(f^2 + h^2)^{1/2}$ and is derived from λ under the assumption that $n/m \ll 1$ (MW have a wrong sign in eqs. [A13] and [A15]). Hence we obtain equation (18) for the ratio of linear to circular polarization Q/V. When the angle θ between the magnetic field and the line of sight is small then $h \approx 0$. The propagation is called quasi-longitudinal, and one has the situation of large Faraday rotation. Using equation (2) we can write this condition as

$$\frac{\omega_p^2 \omega_c}{\omega^2 c} l \gg 2\pi\,. \tag{A16}$$

When $\theta \approx \pi/2$ then $f \approx 0$, and the propagation is called quasi-transverse. One has the situation of large Faraday pulsation and using equation (3) we get

$$\frac{\omega_p^2 \omega_c^2}{2\omega^3 c} l \gg 2\pi\,. \tag{A17}$$

MW stated that equations (A12)–(A15) follow by only assuming equation (A10). This, however, is incorrect. If it were correct, then the condition of large Faraday rotation and pulsation would not depend on the path length. As a consequence the ratio Q/V would always be given by equation (18) and would be independent of the path length. But this is not the case. We illustrate this in Figures 1 and 2 which compare the calculated ratio Q/V from equations (A2) and (A4) to the theoretical value of Q/V in the case of large Faraday rotation and pulsation. We choose values of temperature kT and angle θ for which MW presented I and the degree of linear and circular polarization figures. Therefore our Figure 1 corresponds to Figure 3 and our Figure 2 corresponds to Figure 4 of MW. As one can see Q/V is strongly dependent on the path length. Only at large path lengths, that is, when equation (A11) is fulfilled, does Q/V obey equation (18), and only in this case do we have large Faraday rotation and pulsation.

Under the assumption of large Faraday rotation and Faraday pulsation the transfer equations for the ordinary and extraordinary mode decouple (Ramaty 1969). One obtains

$$dI_\pm/dl = \alpha_\pm(\mathscr{B}/2 - I_\pm) \tag{A18}$$

with the formal solution (with no incoming radiation)

$$I_\pm = (\mathscr{B}/2)[1 - \exp(-\alpha_\pm l)]\,. \tag{A19}$$

The Stokes parameters are calculated from (Ramaty 1969)

$$I = I_+ + I_-\,, \tag{A20}$$

$$Q = I_+\left(\frac{1 - a_+^2}{1 + a_+^2}\right) + I_-\left(\frac{1 - a_-^2}{1 + a_-^2}\right), \tag{A21}$$

$$U = 0\,, \tag{A22}$$

$$V = I_+\left(\frac{2a_+}{1 + a_+^2}\right) + I_-\left(\frac{2a_-}{1 + a_-^2}\right), \tag{A23}$$

where the functions $a_\pm$ are given in equation (8). One can easily show that equations (A19)–(A23) combine to give equations (A12)–(A15) if

$$\alpha_\pm = \kappa \mp \lambda' = \kappa + \mathrm{sgn}(r)\left(\frac{\mp h}{\sqrt{f^2 + h^2}} q - \frac{\pm f}{\sqrt{f^2 + h^2}} v\right),$$

$$= \kappa - \frac{1 - a_\pm^2}{1 + a_\pm^2} q + \frac{2a_\pm}{1 + a_\pm^2} v\,. \tag{A24}$$

The latter relation follows as $v < 0$ for $\theta < \pi/2$ and $q < 0$ for all θ for cyclotron opacities and therefore sgn $(r) = -1$. Equation (A24) is the same equation that we proved formally in § 2.2.

Now one can also see why equations (A18)–(A23) are insufficient for describing polarized radiative transfer when the magnetic field varies along the line of sight. As one must have $U = 0$ from equation (A22) in order to use the normal mode formalism, one must choose a coordinate system such that the incoming radiation has $U = 0$. However, in this frame the magnetic field will in general not lie in the $y - z$ plane, and therefore $\epsilon_U \neq 0$. From equation (1) it then follows that $U \neq 0$ after integrating across the region, which in turn is contrary to equation (A22).

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