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NUMERICAL METHODS FOR MIE THEORY OF SCATTERING BY A SPHERE

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ABSTRACT

A new procedure for evaluating the basic quantities connected with the Mie theory of scattering by a sphere is presented. Some independent numerical techniques are developed to enable one to achieve the desired accuracy. The method is quite general in the sense that it works for arbitrary but finite values of real, pure imaginary or complex indices of refraction and the size-to-wavelength parameter. Sample calculations are given for a range of size-to-wavelength parameter, for a variety of indices of refraction. The computer program is given in the Appendix.

Key Words: electron scattering—Mie theory—spherical Bessel functions—scattering and absorption efficiencies—albedo—radiation pressure—backscattering

1. Introduction

The theory of scattering of plane electromagnetic waves by a homogeneous, isotropic, and smooth sphere of arbitrary size and index of refraction was originally presented by Mie (1908). Since then, numerous applications of Mie theory have been made in atmospheric sciences, aerosols, colloids, planetary atmospheres, interplanetary and interstellar dust, and many other fields. Some of the readily-available numerical results come from Gumprecht and Sliepcevich (1951), Penndorf (1956), van de Hulst (1957), Denman *et al.* (1966), Deirmendjian (1969), and others. Unfortunately, most work in the literature has been done only on real indices of refraction and sometimes the size-to-wavelength parameter, $x = \frac{2\pi a}{\lambda}$, is chosen at rather large intervals. Besides, the published work on the values of the radiation parameters of the scattered wave are of limited use in practice because of the differences in the values of x and index of refraction, m. Therefore, it need not be emphasized that a suitably accurate, reliable and time-saving method of bringing out the theoretical results from the Mie theory is of prime importance so as to make meaningful comparison with the experiments.

The present computer-oriented numerical methods have been developed with this view in mind. They are useful for arbitrary values of the wavelength (λ), the size of the sphere (a), and index of refraction ($m = m' - im''$). The advantages of the present numerical techniques will be discussed in a later section. A thorough understanding of the Mie theory of scattering by a smooth uniform sphere is presumed. It will be assumed that the scattered beam has the same frequency as the incident one. A special reference is made to van de Hulst's (1957) classic work whose notations have been mainly accepted in the basic formulas that follow.

2. Analytical Results from the Mie Theory of Scattering

The symbols and notations have the following meanings :

λ = the wavelength of the incident plane electromagnetic wave,

a = the radius of the sphere,

$k = \frac{2\pi}{\lambda}$,

$x = ka = \frac{2\pi a}{\lambda}$ = the size-to-wavelength parameter,

$m = m' - im''$ = the complex index of refraction of the material of the sphere,

$z = mx$.

It is customary to express λ and a in microns. The derivatives of the spherical functions with respect to the particular argument are denoted by a prime.

The plane containing the direction of the incident beam of radiation and the direction of observation defines the plane of observation. In the case of natural (i.e. unpolarized) incident beam the intensity of the scattered radiation in the plane of observation is generally expressed by two intensity functions, $I_\perp$ and $I_{||}$, for the two cases of the electric vector vibrating perpendicular and parallel, respectively, to the plane of observation. These intensity functions are given by

$$I_\perp = |T_1(\theta)|^2 \quad (1)$$

and

$$I_{||} = |T_2(\theta)|^2 \quad , \quad (2)$$

where $T_1(\theta)$ and $T_2(\theta)$ are the scattering amplitude functions. The scattering angle, θ, is defined as the angle between the direction of the scattering and the propagation vector of the incident radiation. We have used the letter T in place of S for the amplitude functions in order to avoid confusion with the symbol S_n for the Riccati-Bessel function. Somewhat explicit forms for $T_1(\theta)$ and $T_2(\theta)$ are

$$T_1(\theta) = \sum_{n=1}^{\infty} \frac{(2n+1)}{n(n+1)} \{ a_n \pi_n(\mu) + b_n \tau_n(\mu) \} \quad , \quad (3)$$

$$T_2(\theta) = \sum_{n=1}^{\infty} \frac{(2n+1)}{n(n+1)} \{ b_n \pi_n(\mu) + a_n \tau_n(\mu) \} \quad , \quad (4)$$

where $\mu = \cos\theta$, π_n and τ_n, omitting the argument, μ, are polynomials of real variable μ only; they are, in fact, related to the associated Legendre polynomials and their derivatives. The quantities a_n and b_n are the so-called Mie coefficients (see van de Hulst, p. 123). The functions π_n and τ_n can be evaluated in a straightforward manner from the following recurrence relations

$$\pi_n = \frac{\mu(2n-1)\,\pi_{n-1} - n\pi_{n-2}}{n-1} \quad , \quad (5)$$

$$\tau_n = n\mu\,\pi_n - (n+1)\,\pi_{n-1} \quad , \quad (6)$$

with $\pi_0 = 0.0$ and $\pi_1 = 1.0$.

The amplitude functions $T_1(\theta)$ and $T_2(\theta)$ determine the intensity and state of polarization of the scattered radiation in any direction specified by angle θ. The radiation incident on the sphere may have an arbitrary intensity and state of polarization. Generally, the scattered radiation is elliptically polarized, even if the incident beam has linear polarization, because $T_1(\theta)$ and $T_2(\theta)$ are complex quantities with differing phases. The scattered light is linearly polarized when the plane of observation is parallel or perpendicular to the direction of the electric vector in the primary beam of light. However, Rayleigh scattering ($x << 1$) affords the special case in which the scattered light is linearly polarized for any arbitrary direction of observation in azimuth as well as latitude.

The scattered beam in any direction in the plane of observation has intensity I at a distance r from the scatterer;

$$I = I_0 (I_\perp + I_{||}) / 2k^2 r^2 \quad , \quad (7)$$

where I_0 = intensity of the incident beam of radiation. The degree of polarization of the scattered beam is given by

$$p = \frac{I_\perp - I_{||}}{I_\perp + I_{||}} \quad . \quad (8)$$

The total forward extinction efficiency, Q_{ext}, is defined as the extinction cross section, C_{ext}, per unit geometrical cross section of the sphere,

$$Q_{ext} = \frac{C_{ext}}{\pi a^2} \quad . \quad (9)$$

Using the fundamental extinction formula (van de Hulst, 1957, p. 31), one obtains

$$Q_{ext} = \frac{4}{x^2} \mathrm{Re} \{ T(0^\circ) \} \quad . \quad (10)$$

In the case of homogeneous, isotropic and smooth spheres, the scattering amplitude functions are identical for the forward direction ($\theta = 0^\circ$), i.e. $T_1(0^\circ) = T_2(0^\circ) = T(0^\circ)$. This is the case of the highest symmetry implying that the extinction is independent of the state of polarization of the incident light. Thus we have for $\theta = 0^\circ$

$$T(0^\circ) = \frac{1}{2} \sum_{n=1}^{\infty} (2n+1) \{ a_n + b_n \} \quad . \quad (11)$$

Combining (10) and (11) one obtains

$$Q_{ext} = \frac{2}{x^2} \sum_{n=1}^{\infty} (2n+1) \mathrm{Re} \{ a_n + b_n \} \quad . \quad (12)$$

The total scattering efficiency is given by

$$Q_{sca} = \frac{2}{x^2} \sum_{n=1}^{\infty} (2n+1) \{ |a_n|^2 + |b_n|^2 \} \quad (13)$$

If $m' = 0$, $Q_{ext} = Q_{sca}$ and $Q_{abs} = 0.0$.

Finally, the absorption efficiency, Q_{abs}, obtained from the law of conservation of energy, is given by

$$Q_{abs} = Q_{ext} - Q_{sca} \quad (14)$$

The albedo is simply defined by

$$\text{albedo} = \frac{Q_{sca}}{Q_{ext}} \quad (15)$$

These and other quantities like efficiency for radiation pressure, asymmetry factor, backscattering cross section, Stokes parameters of the scattered radiation, etc., can be computed without difficulty once the Mie coefficients a_n and b_n are made available. One may consult van de Hulst (1957) for further details about these quantities.

3. A Simple Representation of the Mie Coefficients

The numerical evaluation of the Mie coefficients (see van de Hulst, p. 123) can be considerably facilitated if they are represented as follows:

$$a_n = \frac{A_n(z) - m B_n(x)}{A_n(z) G_n(x) - m H_n(x)} \quad (16)$$

$$b_n = \frac{m A_n(z) - B_n(x)}{m A_n(z) G_n(x) - H_n(x)} \quad (17)$$

where

$$A_n(z) = \frac{S'_n(z)}{S_n(z)} \quad (18)$$

$$B_n(x) = \frac{S'_n(x)}{S_n(x)} \quad (19)$$

$$G_n(x) = \frac{\xi_n(x)}{S_n(x)} \quad (20)$$

$$H_n(x) = \frac{\xi'_n(x)}{S_n(x)} \quad (21)$$

and where

$$\xi_n(x) = S_n(x) + i C_n(x) \quad (22)$$

$S_n(x)$ and $C_n(x)$ are the Riccati-Bessel functions defined by

$$S_n(z) = \left(\frac{\pi z}{2}\right)^{\frac{1}{2}} J_{n+\frac{1}{2}}(z) \quad (23)$$

$$C_n(x) = -\left(\frac{\pi x}{2}\right)^{\frac{1}{2}} N_{n+\frac{1}{2}}(x) \quad (24)$$

where $J_{n+\frac{1}{2}}$ and $N_{n+\frac{1}{2}}$ are the spherical Bessel and Neumann functions respectively. Note that n is an integer including zero.

The two logarithmic derivatives, $A_n(z)$ and $B_n(x)$ in equations (18) and (19), and the two ratios in equations (20) and (21) are essentially the four quantities to be evaluated numerically. The first two of these and portions of the last two are determined in a very indirect manner by using the method of continued fractions discussed by Brouwer and Clemence (1961). These authors have shown a method of deriving accurately the higher integral orders of Bessel functions of real argument. It was further extended to complex variable by Shah (1967) in connection with the scattering of EM waves by an infinite circular cylinder at oblique incidence. We have developed here a similar procedure for evaluating the Riccati-Bessel function $S_n(z)$ and simultaneously its logarithmic derivative $A_n(z)$ in just one downward recursion. This holds for $S_n(x)$ and $B_n(x)$ also. Furthermore, if necessary, one can compute the spherical Bessel functions as by-products from the definition (23) without an additional downward recursion.

It may be mentioned that $A_n(z)$ given in equation (18) is a logarithmic derivative first introduced by Infeld (1947) and subsequently used by Aden (1951) to compute its value by upward recursion. Unfortunately, the upward recursion for $A_n(z)$, $S_n(z)$ or $J_{n+\frac{1}{2}}(z)$ could become unstable, especially for $n >> z$. Recently Kattawar and Plass (1967) have chosen almost the same numerical scheme of Aden with the difference that they apply a downward recursion on a logarithmic derivative. However, they seem to obtain another logarithmic derivative [$G_n(x)$ in their notation] by an upward recursion. Now their $G_n(x)$ is a composite function of $S_n(x)$ and $C_n(x)$ both. In practice, the numerical evaluation of these functions is stable if one uses downward recursion on $S_n(x)$ and an upward recursion on $C_n(x)$. Therefore, it is advisable to avoid the use of upward recursion on such composite functions, particularly for large values of n and/or x. Also, Kattawar and Plass perform separately downward and upward recursions on

$J_{n+\frac{1}{2}}(x)$ and $N_{n+\frac{1}{2}}(x)$, respectively. This means unnecessary extra work in the computation of $S_n(x)$.

The present procedure is independently developed and has nothing in common with other methods except for the well-known special functions and their recursions. The objective is to get rid of the inherent truncation errors and avoid indiscrete use of the recursion relations. The function $A_n(z)$ has been obtained as a by-product in the derivation of the higher orders of $S_n(z)$, as explained in the next section. We do not require an additional recursion on $J_{n+\frac{1}{2}}(x)$ at all.

4. Numerical Procedure

The Riccati-Bessel functions, $S_n(x)$ and $C_n(x)$, satisfy the following recurrence relations:

$$S_n(z) = \frac{2n-1}{z} S_{n-1}(z) - S_{n-2}(z) \qquad (25)$$

with

$$S_0(z) = \sin z \quad , \qquad (26a)$$

$$S_1(z) = \frac{\sin z}{z} - \cos z \quad , \qquad (26b)$$

$$S'_n(z) = -\frac{n}{z} S_n(z) + S_{n-1}(z) \quad , \qquad (27)$$

$$C_n(x) = \frac{2n-1}{x} C_{n-1}(x) - C_{n-2}(x) \quad , \qquad (28)$$

with

$$C_0(x) = \cos x \quad , \qquad (29a)$$

$$C_1(x) = \frac{\cos x}{x} + \sin x \quad , \qquad (29b)$$

$$C'_n(x) = -\frac{n}{x} C_n(x) + C_{n-1}(x) \qquad (30)$$

The argument, z, may be either real or complex.

We define a set of coefficients P_n and Q_n in the case of $S_n(z)$ and R_n in the case of $S_n(x)$ as follows:

$$\frac{S_n(z)}{S_{n-1}(z)} = P_n + iQ_n \quad , \qquad (31)$$

$$\frac{S_n(x)}{S_{n-1}(x)} = R_n \quad . \qquad (32)$$

From (25) one obtains

$$\frac{S_n(z)}{S_{n-1}(z)} = \frac{2n-1}{z} - \frac{S_{n-2}(z)}{S_{n-1}(z)} \quad . \qquad (33)$$

Substituting from equation (31) this reduces to

$$\frac{1}{P_{n-1} + iQ_{n-1}} = \frac{2n-1}{z} - (P_n + iQ_n) \quad . \qquad (34)$$

Let $z = y_1 + iy_2$ and $y = |z|^2$, where $y_1 = xm'$ and $y_2 = -xm''$. Define

$$a_n = \frac{(2n-1)y_1}{y} - P_n \quad , \qquad (35)$$

$$\beta_n = \frac{(2n-1)\,y_2}{y} + Q_n \quad . \qquad (36)$$

Now one obtains, after some algebra,

$$P_{n-1} = \frac{a_n}{a_n^2 + \beta_n^2} \quad , \qquad (37)$$

and

$$Q_{n-1} = \frac{\beta_n}{a_n^2 + \beta_n^2} \quad . \qquad (38)$$

Similarly,

$$R_{n-1} = \frac{x}{(2n-1) - xR_n} \quad . \qquad (39)$$

The equations (35-39) are used to carry out downward recursions which provide the coefficients (P_n, Q_n) and R_n of all necessary orders for arguments z and x, respectively. Initially, the starting value N for n is assumed sufficiently large, preferably much larger than the largest z or x anticipated, so that P_N, Q_N and R_N can be set equal to zero in the first instance. Then equations (37, 38 and 39) are used to calculate P_{N-1}, Q_{N-1} and R_{N-1}, respectively. These downward recursions are carried out successively till one obtains P_1, Q_1 and R_1. The coefficients P_n, Q_n, R_n should be stored by treating them as dimensioned variables in the computer program. The initial guess of N, however, may be varied and experimented upon to derive the related Bessel functions of orders greater than zero. The argument of course would have the largest value likely to be encountered in practice. N is raised successively until the desired accuracy is achieved; this happens when raising N higher than a certain value does not affect the accuracy anymore. A comparison with the published tables of Bessel functions may be helpful in the beginning. Thus let us suppose that the coefficients P_n, Q_n and R_n are computed for n = N, N-1, - - - -3, 2, 1. The coefficients P_n, Q_n and R_n may be required to be stored up to orders N_0 (<N). The

manner in which N and N_0 have been selected empirically is explained in the last section.

The higher orders of $S_n(z)$ and $S_n(x)$ are obtained from the definitions of the coefficients themselves as follows :

$$\mathrm{Re}\{s_n(z)\} = P_n \mathrm{Re}\{s_{n-1}(z)\} - Q_n \mathrm{Im}\{s_{n-1}(z)\}, \quad (40)$$

$$\mathrm{Im}\{s_n(z)\} = P_n \mathrm{Im}\{s_{n-1}(z)\} + Q_n \mathrm{Re}\{s_{n-1}(z)\}, \quad (41)$$

$$s_n(x) = R_n s_{n-1}(x) \quad . \quad (42)$$

The starting values of the functions $s_0(z)$ and $s_0(x)$ are adopted according to equation (26a). Fortunately for our purposes, the computations from equations (40) and (41) need not be done at all because the logarithmic derivatives $A_n(z)$ and $B_n(x)$ can be expressed directly in terms of the coefficients P_n and Q_n as follows :

$$A_n(z) = (P_n + iQ_n)^{-1} - \frac{n}{z} \quad , \quad (43)$$

$$B_n(x) = \left(\frac{1}{R_n}\right) - \left(\frac{n}{x}\right) \quad , \quad (44)$$

So far we have shown how to evaluate two of the four quantities essential for the calculation of Mie coefficients. The remaining functions, $G_n(x)$ and $H_n(x)$, are treated in what follows.

From equations (19-22) we have

$$G_n(x) = 1 + i\frac{C_n(x)}{S_n(x)} \quad (45)$$

$$H_n(x) = B_n(x) + i\frac{C'_n(x)}{S_n(x)} \quad (46)$$

Notice that $S_n(x)$ and $B_n(x)$, appearing in equations (45) and (46), have already been made available in equations (42) and (44), respectively, and hence they save some time of computation. It remains to compute $C_n(x)$ and $C'_n(x)$. Here the upward recursion, as in the case of Neumann functions, is found to be stable. The method consists of computing $C_0(x)$ and $C_1(x)$ first from their definitions [equations (29a, b)]. Then the higher orders of $C_n(x)$ and $C'_n(x)$ can be evaluated with the help of equations (28) and (30), respectively. However, some simplification may be accomplished by the following method. Dividing equations (28) and (30) by C_{n-1} we obtain (omitting the argument)

$$\frac{C_n}{C_{n-1}} = \frac{2n-1}{x} - \frac{C_{n-2}}{C_{n-1}} \quad (47)$$

$$\frac{C'_n}{C_{n-1}} = 1 - \frac{n}{x}\left(\frac{C_n}{C_{n-1}}\right) \quad (48)$$

Define : $r_n = \dfrac{C_{n-1}}{C_n}$ (49)

The starting value for $n = 1$ in equation (49) is $r_1 = C_0/C_1$ and can be evaluated easily with the help of equations (29a, b). Equations (47) and (48) reduce to new pairs of recurrence relations,

$$r_n^{-1} = \frac{2n-1}{x} - r_{n-1} \quad (50)$$

$$\frac{C'_n}{C_{n-1}} = 1 - \frac{n}{x}\left(\frac{1}{r_n}\right) \quad (51)$$

The next step is to compute r_2 from equation (50) and then C_2 is obtained from the definition in equation (49). Initially, $C'_n(x)$ is available directly because C_0 and r_1 have been known. Now $C'_2(x)$ can be evaluated from equation (51). The process can be continued up to the desired order, N. It is clear that r_n has been useful in the computation of both C_n and C'_n. The program statements may be suitably arranged to avoid dimension variabes from C_n and C'_n and possibly $S_n(x)$ and $S_n(z)$ as well.

Another method of deriving C_n is to employ the Wronskian relation

$$N_p J_{p+1} - N_{p+1} J_p = \frac{2}{\pi x} \quad (52)$$

Using the definitions of S_n and C_n in terms of $J_{n+\frac{1}{2}}$ and $N_{n+\frac{1}{2}}$, respectively, one obtains

$$C_n = R_n C_{n-1} - \frac{1}{S_{n-1}} \quad (53)$$

where R_n is given by equation (32). It may be recalled that R_n and S_n for all orders ($n \geq 1$) have been calculated previously. Therefore, with C_0 as the only starting function, one can derive C_n for $n \geq 1$ from equation (52). Use is made of equation (30) to obtain C'_n. This apparently elegant method of obtaining C_n with the aid of the Wronskian relation turned out to be somewhat less accurate compared to the one described previously. The difference occurred in the sixth significant digit while working with 8-digit storage of numbers in IBM 1620 IID.

This completes the essentials for the calculations of Mie coefficients.

5. Results and Discussion

The results for extinction, total scattering, absorption and back scattering efficiencies, albedo, asymmetry factor, radiation pressure and angular intensity functions for various indexes of refraction, agree with the available sources in the literature. It has been found that the calculations are correct to at least five significant digits while working with 8-digit precision. An example, for m 1.5 - 0.0*i* and x 23.1 and 23.2, has been given for the extinction efficiency in Table 1. These computations have been done on an IBM 1620 IID computor. The first column represents the precision of the floating point numbers stored in and carried out from the memory core area for evaluating the arithmetic expressions.

Table 1. Test case of extinction by a sphere
Index of Refraction, m 1.5 - 0.0*i*

Precision (Decimal digits)	Extinction Efficiency, Q_{ext} (x)	
	Q_{ext} (x 23.1)	Q_{ext} (x 23.2)
8	2.46226573	2.5184912
10	2.4622683172	2.5184919550
11	2.46226831764	2.51849195584
12	2.462268317172	2.518491959717
16	2.462268317240436	2.518491959261602

Previous calculations (Penndorf, 1956) for m 1.5 −0.0*i*, performed on an IBM 7090 computor, give Q_{ext}=2.462268316 for x=23.1 and Q_{ext}=2.518491911 for x=23.2. These values of Q_{ext} agree up to 10 and 8 significant digits, respectively, with those of Table1. A survey of the literature does not show any comparative results for either a real or complex index of refraction. Therefore, it is difficult to assess the accuracy of the higher precision in Table 1. However, chosing the 16-digit precision as standard, one can find out the correct number of significant digits at lower precision. This is indicated by a flag before which all the digits are believed to be correct. It can be concluded from Table 1 that the computer program MIEHISS, given in Appendices A and B must be operated at a precision of at least three digits higher than the numbr of correct significant digits desired.

Some interesting results on resonance in the extinction due to small metallic particles are shown in Figure 1. A noticeable feature in each of the curves for sodium, potassium, and calcium is the prominent first maximum in Q_{ext}. The minima are much shallower compared to the maxima. The peaks recur at nearly regular intervals, $\Delta x \sim 0.7$ for Na, K and Ca. The mean value of Q_{ext} is far above the case of dielectric dirty ice ($m = 1.33 - 0.05i$) even up to fairly large values of x. The amplitudes of the successive maxima decrease with increase in x and the curves approach the usual extinction efficiency at rather large values of x. A more dramatic size-dependent resonance effect has been plotted in Figure 2. The index of refraction, $m = 0.003535 - 1.41775i$, roughly corresponds to that suggested by Unsöld (1964) in connection with the unidentified diffuse interstellar absorption band at $\lambda 4430$. It may also be mentioned that Q_{ext} tends to zero as $x \to 0$ for all the curves in Figures 1 and 2. We wonder if these and similar size-dependent resonance effects can explain certain structures in the interstellar extinction and polarization.

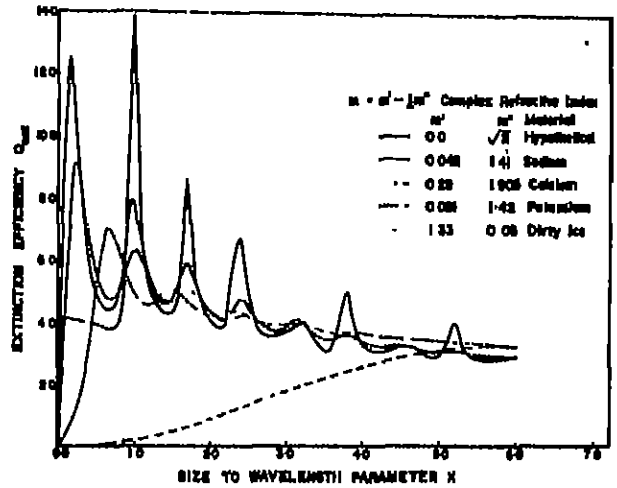

Fig. 1 Theoretical extinction efficiencies, Qext vs. size-to-wavelength parameter, $x = \frac{2\pi a}{\lambda}$, showing size-dependent resonance effect by small metallic particles.

The computer program, MIEHISS (Mie theory of scattering by a homogeneous isotropic smooth sphere), is based on the numerical techniques described in sections 3 and 4. In order to gain some idea about its range of validity we have given some general results on sundry physical quantities in Table 2. They are presented only for selected values of x and m. However, they have an important purpose to serve. The optimization of the program for specific applications in a given m-x domain (s) may render the program more efficient. The author would anticipate that some users might like to make appropriate

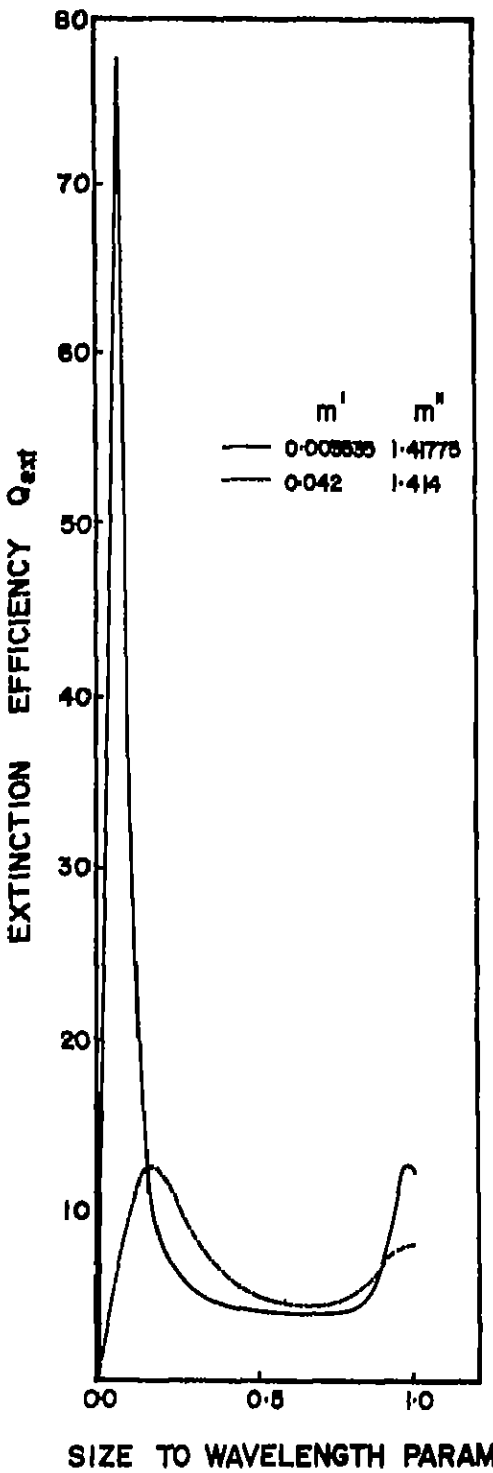

Fig. 2 Comparison of Mie calculations of Q_{ext} for particles of sodium and for a hypothetical material representing the absorption within the unidentified interstellar band at λ4430

changes after preliminary experimentation. Therefore, Table 2 would certainly aid in checking out any modifications one might introduce in the present computer program MIEHISS. The angular scattering functions are also available from the program MIEHISS but we have preferred to omit them here for space saving. Note that all the results in Table 2 have been obtained by employing *single* precision on a CDC-3600 computer. Some indices of refraction in Table 2 have been chosen following the work of van de Hulst (1957) and Deirmendjian (1969). The time taken for the entire calculations in Table 2 is approximately 15 minutes, including compilation, execution, and print output.

Some physical laws of scattering and precision can at once be visualized from Table 2. For instance, Rayleigh's law of scattering, for $m'' \to 0$, shows up in that Q_{ext} varies as the fourth power of x (or size or inverse wavelength) for $x < 1$. An addition of a small imaginary part (m'') reveals that the absorption contributes predominantly to Q_{ext} for $x < 1$, and that Q_{ext} and Q_{abs} are proportional to x as long as x is sufficiently small compared to unity. An interesting feature of the backscattering efficiency, Q_{back}, is that it attains nearly a constant value starting with and beyond sufficiently large x, provided that m'' is non-zero. This happens for $x \simeq 100$ in Table 2. The exact value of x can be found from more extensive calculations. Herman and Battan (1961) have reported that the limiting value of Q_{back} for large values of x can be expressed in terms of the Fresnel reflection coefficient for perpendicular incidence of the electromagnetic wave. Deirmendjian (1969) has verified almost perfect validity of this fact which can be written symbolically as

$$\lim_{x \to \infty} \{ Q_{back}(m,x) \} = \left| \frac{m-1}{m+1} \right|^2 \qquad (54)$$

The present calculations in Table 2 strongly conform to equation (54); though its analytical proof, using Mie coefficients, remains obscure so far.

A closer look at Table 2 further indicates that albedo, asymmetry factor ($< \cos\theta >$), and radiation pressure behave in a fashion similar to the case of Q_{back} for large values of x. Here one may notice that the condition, $m'' \neq 0$, seems to be relaxed to some extent. The asymptotic values of Q_{pr} and $< \cos\theta >$ for real indices of refraction given by Debye (1909) begin to be almost satisfied for $x \gtrsim 100$.

Some unusually large values of the backscattering efficiency, Q_{back}, may be noted for real indices of

refraction (e.g., m = 1.33, 1.5, 1.6, 2.0, 4.0, 5.0, etc.) and certain large values of $x >> 1$. This appears to hold also for weakly absorbing spheres ($m'' << 1$). A maximum value of $Q_{back} \simeq 38$ for $x = 60.0$ and $m = 1.78 - 0.0024i$ (ice spheres illuminated by microwaves) has been reported by Herman and Battan (1961). It is gratifying that the calculations for the same set of parameters, using our program (MIEHISS), gives $Q_{back} = 38.58$; moreover, Q_{back} conforms to equation (54) asymptotically for very large values of x. We feel that the large values of Q_{back} for certain very large values of x and predominantly real m, as are evidenced in Table 2, could speak of an important factor in LIDAR and RADAR backscattering experiments and some physical phenomena.

The extinction efficiency for very large values of x, and index of refraction in the range, $1.0 \lesssim m \lesssim 2$, can be calculated on the basis of the best approximate formula suggested by van de Hulst (1957, p. 264) :

$$Q_{ext} \simeq 2.0 + 1.84 x^{-2/3} + \mathrm{Im}\left[\left\{ \frac{4(\rho + 2x)}{(\rho + 4x)} \right\}^2 e^{i\rho} \right] \quad (55)$$

where $\rho = 2x(m-1)$. Here the contribution due to ripple has been ignored. Sample calculations based on equation (55) have been compared with the Mie theory results in Table 2. It has been found that equation (55) is a reasonable approximation in that it gives errors much less than 1% in most cases. The complex index of refraction seems to be admissible in equation (55). It may be interesting to inquire about the validity of equation (55) in the $(x - \rho)$ plane for a given tolerance of accuracy of Q_{ext}.

6. Conclusion

It may be useful to give some practical hints in conclusion. Normally, one needs the Mie series to be summed up to a certain order N_o which is usually a few percent larger than the particular value of x. For instance, if $x \simeq 2000$, $N_o \simeq 2064$ or less depending on m', m'' and the proposed accuracy. We have set the maximum value of N_o to be $N_{o,max} = 2100$ assuring a safe margin for all values of size to wavelength parameter in the range $x \leq 2000$ irrespective of the order at which downward recursions are started.

Thus we have

$$x \leq 2000.0 \quad ,$$

$$N_{o,max} = 2100 \quad ,$$

$$N_o' = K_1 |z| + K_0 x + K_2 \quad , \quad (56a)$$

$$N_o = \begin{cases} N_o' & \text{if } N_o' \leq N_{o,max} \\ N_{o,max} & \text{if } N_o' > N_{o,max} \end{cases} \quad . \quad (56b)$$

The downward recursions for P_n, Q_n and R_n are started at the highest order given by

$$N = \begin{cases} N_o' + K_3 x + K_4, & \text{if } m'' = 0 \quad (57a) \\ N_o + K_5 x + K_6, & \text{if } m'' \neq 0 \quad (57b) \end{cases}$$

At present the following values have been adopted for various constants in an empirical manner :

$$K_0 \quad \begin{cases} 1 - m' & \text{if } m' < 1 \\ 0 & \text{if } m' \geq 1, \end{cases}$$

$$K_1 = 1.01, \quad K_2 = 60.0, \quad K_3 = 0.75,$$

$$K_4 = 60.0, \quad K_5 = 0.75, \quad K_6 = 60.0.$$

The constants, K_l ($l = 0$ to 6), can be optimized after careful experimentation in order to further economize machine time and storage. The coefficients P_n, Q_n, and R_n would have to be stored from $n = 1$ to N_o; this also applies for the Mie coefficients, a_n and b_n, if one is interested in angular intensity functions.

The combinations of x, m' and m'' should be such that N_o, calculated according to equation (56b), does not exceed the number of memory words provided for each of the dimensioned variables. For example, in Appendix B, the value of N_o, the highest order coefficients stored, must be less than 2100. The value of x can vary typically from 10^{-8} to 2000.0. If $x > 2000$, it is advisable to increase the argument of the dimensioned variables, provided the computer memory does not overflow. Similarly, it would be convenient to reduce the argument of the dimensioned variables if one is concerned with the use of moderate values of $x << 2000$. The program MIEHISS can be operated for any finite value of pure real, pure imaginary or complex index of refraction. However, a similar program can be written down for the perfectly conducting case, $m = \infty$. The starting equations for the corresponding Mie coefficients are far more simplified because they contain the Riccati-Bessel functions and their derivatives of real variable only.

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References

Aden, A. L., 1951, *J. Appl. Phys.*, 22, 601.

Brouwer, D., Clemence, G. M., 1961, *Method of celestial Mechanics*. p. 81. Academic Press, New York.

Debye, P., 1909, *Ann. Physik*, 30, 59.

Deirmendjian, D., 1969, *Electromagnetic scattering on spherical Polydispersions*. American Elsevier Publ. Co., Inc., New York.

Denman, H., Heller, W., Pangonis, W. J., 1966, *Angular scattering functions for spheres*, Wayne State Univ. Press, Detroit.

Gumprecht, R. O., Sliepcevich, C. M., 1951, *Tables of light scattering functions for spherical particles*, Engineering Research Institute, Univ. of Michigan, Ann Arbor.

Herman, B. M., Battan, L. J., 1961, *Quart. J. Roy. Meteorol. Soc.*, 87, 223.

Hulst, H. C., van de, 1957, *Light scattering by small particles*, John Wiley & Sons, New York.

Infeld, L., 1947, *Quart. Appl. Math.*, 5, 113.

Kattawar, G. W., Plass, G. N., 1967, *Appl. Optics*, 6, 1377.

Mie, G., 1908, *Ann. Physik*, 25, 377.

Penndorf, R. B., 1956, *Geophysical Research Papers No. 46*, U.S.A.F. Geophys. Research Directorate, Bedford, Mass.

Shah, G. A., 1967, *Ph. D. Thesis : Models of Interstellar Grains*, Rensselaer Polytechnic Institute, Troy, N. Y.

Unsöld, A., 1964, *Publ. Roy. Obs. Edin.*, 4, 35.

Appendix A

Explanation of some FORTRAN words in the Computer Program MIEHISS

Fortran Word	Equation Number	Meaning or Equivalence in the text
NMAX		Arguments of the dimensioned variables, P_n, Q_n, R_n, a_n and b_n
X		Size-to-wavelength parameter, $x = \frac{2\pi a}{\lambda}$
AMU1		Real part of the index of refraction, m
AMU2		Absolute value of the imaginary part of m. Thus m = AMU1 −/AMU2
NYY	(56a)	N'
NX	(56b)	N_0
N	(57a, b)	N
CX	(29a)	C_0 (x)
C(1)	(29b)	C_1 (x)
SX	(26b)	S_0 (x)
CQ	(49)	$r_1 = C_0(x)/C_1(x)$
QC	(50)	Subsequently QC and CQ are used to accommodate the recursion relation
PJN1		PJN1, QJN1 and RJN1 are the values of the coefficients P_n, Q_n, R_n; and in the first instant they are set to zero fo n = N for starting downward recursions in equations (37), (38) and (39). PJN, QJN, RJN are the same coefficients for one lower order.
QJN1		
RJN 1		
PJN	(37)	
QJN	(38)	
RJN	(39)	
JN		Current order of the coefficients P_n, Q_n and Rn. These coefficients are stored if JN $\leq$ NMAX.
CN = NS		n, current order of the Mie coefficients
S(NS)		$S_n(x)$ } Riccati-Bessel functions.
C(NS)		$C_n(x)$ }
DCX		$C'_n(x)$
ZR1, ZI1	(43)	Real and Imaginary parts of $A_n(z)$
X1	(44)	$B_n(x)$
ZR2, ZI2	(45)	Real and Imaginary parts of $G_n(x)$
ZR3, ZI3	(46)	Real and Imaginary parts of $H_n(x)$
ARNS, AINS	(16)	Real and Imaginary parts of a_n
BRNS, BINS	(17)	Real and Imaginary parts of b_n
TEST		Current contribution to extinction relative to the total extinction
		Quantities following statement Number 20:
QEXT	(12)	Extinction efficiency
QABS	(14)	Absorption efficiency
ALBED	(15)	Albedo

Fortran Word	Equation Number	Meaning or Equivalence in the Text
ASYM	*	Asymmetry factor, $<\cos(\theta)>$.
QPR	*	Radiation pressure.
QBAK	*	Efficiency for back scattering.
NN		Highest order upto which the Mie coefficients have been considered depending on the accuracy prescribed. If TEST $<10^{-11}$ for n - NN, then the Mie series is terminated at n=NN.
THETA		Scattering angle θ in degrees.
SS1, SS2	(1), (2)	Angular intensity functions $I_{\perp}(\theta)$ and $I_{\parallel}(\theta)$, respectively.
SS		Just preceding statement number 150, it represents the average angular intensity function.
POLAR	(8)	Degree of polarization.

* See van de Hulst (1957).

Appendix B

Listing of the Fortran program MIEHISS

```
      PROGRAM MIEHISS(INPUT,OUTPUT)
C     MIE THEORY OF SCATTERING BY HOMOGENEOUS
C     ISOTROPIC SINGLE SMOOTH SPHERES.
      DIMENSION P(2101), Q(2101), R(2101), C(2101), S(2101)
      DIMENSION AR(2101), AI(2101), BR(2101), BI(2101)
      DIMENSION PAR(50)
  500 FORMAT(9X,7(2X,E12.5),1X,I6)
  552 FORMAT(1X,41H----------------------------------------
     1 191H----------------------------------------
     2 217H----------)
  553 FORMAT(22X, 20HINDEX OF REFRACTION, 2X, 10HREAL PART=,
     1F14.10, 6X, 16H-IMAGINARY PART=, F14.10/)
  555 FORMAT(16X,1HX, 12X,4HQEXT, 11X, 4HQABS, 9X, 6HALBEDO,
     1 8X, 4HASYM, 10X, 2HQPR, 11X, 4HQBAK, 8X, 2HNN)
  600 FORMAT(35H KA  TOO  LARGE,  MORE TERMS NEEDED)
  790 FORMAT(1H1,//1X, 4F20.8///)
  801 FORMAT(F20.10, 2F10.7)
      NMAX = 2100
      DO 80 I = 1,15
   80 READ 801, PAR(I)
      PRINT 790
    1 READ 801, AMU1, AMU2
      IF(AMU1) 999, 999, 1000
 1000 CONTINUE
      PRINT 552
      PRINT 553, AMU1, AMU2
      PRINT 552
      PRINT 555
      PRINT 500
      DO 200 IXY = 1,15
      X = PAR(IXY)
      Y1 = X*AMU1
      Y2 = -X*AMU2
      YY = Y1*Y1 + Y2*Y2
      NYY = 1.01*SQRTF(YY) + 50.0
      IF(AMU1 - 1.0) 12, 16, 16
   12 NYY = NYY + X*(1.0-AMU1)
   16 NX = NYY
   27 IF(NYY - NMAX) 29, 29, 28
   28 NX = NMAX
   29 IF(AMU2 - 0.10E-09) 30, 30, 31
   30 N = NYY + 0.75*X + 50.0
      GO TO 32
   31 N = NX + 0.75*X + 50.0
   32 PJN1 = 0.0
      QJN1 = 0.0
      RJN1 = 0.0
      CX = COSF(X)
      SX = SINF(X)
      C(1) = (CX/X) + SX
      CO = CX/C(1)
      JN = N + 1
   35 JN = JN - 1
      XN = 2*JN + 1
      PR = (XN*Y1/YY) - PJN1
      PI = (XN*Y2/YY) + QJN1
      PP = PR*PR + PI*PI
      RJN = X/(XN-X*RJN1)
      PJN = PR/PP
      QJN = PI/PP
      IF(JN - NMAX) 38, 38, 39
   38 P(JN) = PJN
      Q(JN) = QJN
      R(JN) = RJN
   39 PJN1 = PJN
      QJN1 = QJN
      RJN1 = RJN
      IF(JN - 1) 40, 40, 35
   40 CONTINUE
      TXE = 0.0
      SCA = 0.0
      ASO = 0.0
      DO 10 NS = 1,NX
      CN = NS
      IF(NS - 1) 7, 7, 8
    7 S(1) = R(1)*SX
      DCX = CX - C(1)/X
      GO TO 9
    8 S(NS) = R(NS)*S(NS-1)
      XN = 2*NS - 1
      QC = X/(XN - X*CO)
      C(NS) = C(NS-1)/QC
      DCX = C(NS-1) - CN*(C(NS)/X)
      CO = QC
    9 PO = (P(NS)**2) + (Q(NS)**2)
      ZR1 = (P(NS)/PO) - CN*(Y1/YY)
      ZI1 = CN*(Y2/YY) - Q(NS)/PO
      X1 = (1.0/R(NS)) - CN/X
      ZR2 = 1.0
      ZI2 = C(NS)/S(NS)
      ZR3 = X1
      ZI3 = DCX/S(NS)
      ANR = ZR1 - X1*AMU1
      ANI = ZI1 + X1*AMU2
      ADR = ZR1 - ZI1*ZI2 - AMU1*X1 - AMU2*ZI3
      ADI = ZR1*ZI2 + ZI1 - AMU1*ZI3 + AMU2*X1
      BNR = AMU1*ZR1 + AMU2*ZI1 - X1
      BNI = AMU1*ZI1 - AMU2*ZR1
      XR = ZR1 - ZI1*ZI2
      XI = ZR1*ZI2 + ZI1
      BDR = AMU1*XR + AMU2*XI - ZR3
      BDI = AMU1*XI - AMU2*XR - ZI3
      AA = (ADR**2) + (ADI**2)
      ARNS = (ANR*ADR + ANI*ADI)/AA
      AINS = (ANI*ADR - ANR*ADI)/AA
      BB = (BDR**2) + (BDI**2)
      BRNS = (BNR*BDR + BNI*BDI)/BB
      BINS = (BNI*BDR - BNR*BDI)/BB
      AR(NS) = ARNS
      AI(NS) = AINS
      BR(NS) = BRNS
      BI(NS) = BINS
      RN = CN + 0.5
      TXE = TXE + RN*(ARNS + BRNS)
      SCA = SCA + RN*(ARNS**2 + AINS**2 +
     1      BRNS**2 + BINS**2)
      TEST = RN*(ARNS + BRNS)/TXE
      TEST = TEST**2
      IF(NS - 1) 18, 18, 21
   18 VAPISR = 1.5*(BR(1)-AR(1))
      VAPISI = 1.5*(BI(1)-AI(1))
      GO TO 10
   21 FNPV = CN - 1.0
      FNA = FNPV*(CN+1.0) / CN
      FNB = (FNPV + CN) / (FNPV*CN)
      ASO = ASO + (AR(NS-1)*AR(NS) + AI(NS-1)*AI(NS))*FNA
      ASO = ASO + (BR(NS-1)*BR(NS) + BI(NS-1)*BI(NS))*FNA
      ASO = ASO + (AR(NS-1)*BR(NS-1) + AI(NS-1)*BI(NS-1))*FNB
      RN = RN*(-1.0)**NS
      VAPISR = VAPISR + RN*(AR(NS) - BR(NS))
      VAPISI = VAPISI + RN*(AI(NS) - BI(NS))
      IF(TEST - 0.1E-21) 20, 20, 10
   10 CONTINUE
      PRINT 600
   20 XX = 4.0 / (X*X)
      QEXT = XX*TXE
      QSCA = XX*SCA
      QABS = QEXT - QSCA
      ALBED = QSCA/QEXT
      RHO = 2.0*X*(AMU1 - 1.0)
      ASQ = XX*ASO
      ASYM = ASO/QSCA
      QPR = QEXT - ASQ
      QBAK = XX*((VAPISR**2) + (VAPISI**2))
      NN = CN
      PRINT 500, X, QEXT, QABS, ALBED, ASYM, QPR, QBAK, NN
      IF(SENSE SWITCH 4) 120, 100
  120 DO 150 ITH = 1,181
      TH = ITH - 1
      THETA = TH
      TH = TH*0.01745329
      CTH = COSF(TH)
      PI = 0.0
      PI1 = 1.0
      S1R = 1.5*(AR(1) + CTH*BR(1))
      S1I = 1.5*(AI(1) + CTH*BI(1))
      S2R = 1.5*(AR(1)*CTH + BR(1))
      S2I = 1.5*(AI(1)*CTH + BI(1))
      DO 140 M = 2,NN
      FN = M
      FNN = (2.0*FN + 1.0) / (FN*(FN + 1.0))
      PI2 = (CTH*(2.0*FN - 1.0)*PI1 - FN*PI) / (FN - 1.0)
      TAU2 = FN*CTH*PI2 - (FN + 1.0)*PI1
      S1R = S1R + FNN*(AR(M)*PI2 + BR(M)*TAU2)
      S1I = S1I + FNN*(AI(M)*PI2 + BI(M)*TAU2)
      S2R = S2R + FNN*(AR(M)*TAU2 + BR(M)*PI2)
      S2I = S2I + FNN*(AI(M)*TAU2 + BI(M)*PI2)
      PI = PI1
      PI1 = PI2
  140 CONTINUE
      SS1 = (S1R**2) + (S1I**2)
      SS2 = (S2R**2) + (S2I**2)
      SS = SS1 + SS2
      POLAR = (SS1 - SS2) / SS
      SS = 0.5*SS
      PRINT 500, X, THETA, SS1, SS2, SS, POLAR
  150 CONTINUE
  100 CONTINUE
  200 CONTINUE
      GO TO 1
  999 PRINT 552
      CALL EXIT
      END
```

TABLE II

Some general results from the MIEHAS Computer program

INDEX OF REFRACTION: REAL PART= .8400000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.96296E-21	3.61112E-38	1.00000E+00	1.38887E-11	2.96296E-21	4.44444E-21	2
1.00000E-04	2.96296E-17	1.97218E-31	1.00000E+00	1.39288E-09	2.96296E-17	4.44444E-17	2
1.00000E-03	2.96296E-13	3.23117E-27	1.00000E+00	1.39284E-07	2.96296E-13	4.44444E-13	2
1.00000E-02	2.96269E-09	0.	1.00000E+00	1.39288E-05	2.96269E-09	4.44387E-09	3
1.00000E-01	2.93853E-05	2.16846E-19	1.00000E+00	1.39642E-03	2.93143E-05	4.38722E-05	3
1.00000E+00	1.44388E-01	0.	1.00000E+00	1.87309E-01	1.21621E-01	1.36708E-01	8
1.00000E+01	2.21178E+00	1.42109E-14	1.00000E+00	7.17316E-01	6.25138E-01	1.42899E-01	17
1.00000E+02	2.08958E+00	1.42109E-14	1.00000E+00	6.42322E-01	7.08579E-01	1.43088E-01	114
2.50000E+02	2.03842E+00	0.	1.00000E+00	6.24790E-01	7.11021E-01	3.00349E-01	299
5.00000E+02	2.03861E+00	1.42109E-14	1.00000E+00	6.49619E-01	7.14426E-01	1.26490E-01	583
1.00000E+03	2.00600E+00	1.42109E-14	1.00000E+00	6.42744E-01	7.16698E-01	1.30178E-01	1028
1.57080E+03	2.00878E+00	0.	1.00000E+00	6.43008E-01	7.17124E-01	1.43049E-01	1603
1.00000E+03	2.02196E+00	0.	1.00000E+00	6.45600E-01	7.16884E-01	4.93618E-01	1632
1.50000E+03	2.00583E+00	0.	1.00000E+00	6.42192E-01	7.17594E-01	1.46378E-01	1834
2.00000E+03	2.01428E+00	0.	1.00000E+00	6.44347E-01	7.17086E-01	1.45410E-01	2038

INDEX OF REFRACTION: REAL PART= .9990000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.18555E-26	0.	1.00000E+00	1.76404E-11	1.18558E-26	1.77837E-26	2
1.00000E-04	1.18554E-22	7.62316E-37	1.00000E+00	1.59815E-09	1.18558E-22	1.77837E-22	2
1.00000E-03	1.18554E-18	6.14298E-33	1.00000E+00	1.59959E-07	1.18558E-18	1.77837E-18	2
1.00000E-02	1.18553E-14	0.	1.00000E+00	1.59942E-05	1.18551E-14	1.77823E-14	3
1.00000E-01	1.18084E-10	1.68434E-24	1.00000E+00	1.60033E-03	1.17895E-10	1.76417E-10	3
1.00000E+00	8.87782E-07	1.49487E-20	1.00000E+00	1.66894E-01	6.73733E-07	7.58063E-07	8
1.00000E+01	1.93784E-04	8.67382E-19	1.00000E+00	9.71468E-01	5.52988E-06	1.43649E-07	16
1.00000E+02	1.99243E-02	2.22645E-16	1.00000E+00	9.99494E-01	1.00860E-05	9.88230E-06	111
2.50000E+02	1.23136E-01	4.44889E-16	1.00000E+00	9.99964E-01	1.18771E-05	1.01908E-06	264
5.00000E+02	4.72413E-01	0.	1.00000E+00	9.99978E-01	1.32057E-05	1.03305E-06	516
1.00000E+03	1.89892E+00	7.10543E-15	1.00000E+00	9.99991E-01	1.48013E-05	1.04048E-06	1019
1.57080E+03	2.86771E+00	4.26326E-14	1.00000E+00	9.99998E-01	1.53199E-05	1.03417E-06	1592
2.00000E+03	2.88864E+00	1.42109E-14	1.00000E+00	9.99998E-01	1.53527E-05	5.92554E-07	1621
3.00000E+03	3.07396E+00	1.42109E-14	1.00000E+00	9.99999E-01	1.58416E-05	8.62535E-07	1822
4.00000E+03	3.16494E+00	0.	1.00000E+00	9.99999E-01	1.87471E-05	9.83788E-07	2023

INDEX OF REFRACTION: REAL PART= .9990000000 -IMAGINARY PART= .0010000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.66758E-06	2.66758E-06	8.88889E-19	1.79788E-11	2.66758E-06	3.55674E-06	3
1.00000E-04	2.66758E-06	2.66758E-06	8.88889E-16	1.60000E-09	2.66758E-06	3.55674E-06	3
1.00000E-03	2.66758E-06	2.66758E-06	8.88889E-13	1.59944E-07	2.66758E-06	3.55674E-06	3
1.00000E-02	2.66758E-06	2.66758E-06	8.88884E-10	1.59942E-05	2.66758E-06	3.55646E-06	4
1.00000E-01	2.66782E-06	2.66782E-06	8.88324E-07	1.60033E-03	2.66752E-06	3.52835E-06	5
1.00000E+00	2.66802E-03	2.66400E-03	6.06331E-04	1.66949E-01	2.66638E-03	1.81477E-06	8
1.00000E+01	2.66180E-02	2.62366E-02	1.43278E-02	9.71524E-01	2.62475E-02	2.73415E-07	21
1.00000E+02	2.64219E-01	2.30171E-01	1.28863E-01	9.99477E-01	2.30189E-01	1.89877E-07	120
2.50000E+02	4.38807E-01	4.70820E-01	2.63052E-01	9.99891E-01	4.70638E-01	9.80804E-07	276
5.00000E+02	1.15756E+00	7.91666E-01	3.93840E-01	9.99963E-01	7.91683E-01	6.49779E-07	532
1.00000E+03	1.75689E+00	8.84790E-01	4.96389E-01	9.99988E-01	8.84868E-01	5.19132E-07	1039
1.57080E+03	1.97032E+00	9.48295E-01	5.18709E-01	9.99987E-01	9.48309E-01	5.02468E-07	1618
1.60000E+03	1.97436E+00	9.50038E-01	5.18916E-01	9.99987E-01	9.50051E-01	4.98922E-07	1644
1.80000E+03	1.99284E+00	9.59918E-01	5.18317E-01	9.99987E-01	9.59932E-01	5.00637E-07	1846
2.00000E+03	2.00859E+00	9.67109E-01	5.16888E-01	9.99988E-01	9.67121E-01	5.00811E-07	2048

INDEX OF REFRACTION: REAL PART= .9990000000 -IMAGINARY PART= .0100000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.66761E-07	2.66761E-07	4.48900E-18	1.59898E-11	2.66761E-07	1.79624E-24	3
1.00000E-04	2.66761E-06	2.66761E-06	4.48900E-15	1.59939E-09	2.66761E-06	1.79624E-20	3
1.00000E-03	2.66761E-05	2.66761E-05	4.48900E-12	1.59938E-07	2.66761E-05	1.79624E-16	3
1.00000E-02	2.66761E-04	2.66761E-04	4.48882E-09	1.59939E-05	2.66761E-04	1.79609E-12	4
1.00000E-01	2.66757E-03	2.66756E-03	4.47107E-06	1.60039E-03	2.66757E-03	1.78189E-08	5
1.00000E+00	2.65749E-02	2.64958E-02	3.05158E-03	1.67487E-01	2.65493E-02	7.58866E-05	8
1.00000E+01	2.48017E-01	2.31315E-01	6.73428E-02	9.71840E-01	2.31788E-01	1.10778E-05	21
1.00000E+02	1.48788E+00	8.88837E-01	3.78643E-01	9.99181E-01	8.87268E-01	8.44958E-05	121
2.50000E+02	1.85888E+00	9.80897E-01	4.69948E-01	9.99639E-01	9.80919E-01	8.82772E-05	277
5.00000E+02	1.96289E+00	9.96372E-01	4.92751E-01	9.99729E-01	9.96364E-01	8.82747E-05	534
1.00000E+03	1.99146E+00	9.98304E-01	4.99989E-01	9.99732E-01	9.98331E-01	8.82746E-05	1042
1.57080E+03	1.99871E+00	9.98600E-01	5.00828E-01	9.99787E-01	9.98613E-01	8.82746E-05	1619
1.60000E+03	1.99887E+00	9.98684E-01	5.00874E-01	9.99788E-01	9.98499E-01	8.82746E-05	1649
1.80000E+03	1.99974E+00	9.98168E-01	5.00843E-01	9.99791E-01	9.98398E-01	8.82746E-05	1851
2.00000E+03	2.00037E+00	9.98477E-01	5.01032E-01	9.99793E-01	9.98285E-01	8.82746E-05	2052

INDEX OF REFRACTION: REAL PART= 1.0100000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.18119E-24	0.	1.00000E+00	1.69287E-11	1.18119E-24	1.77178E-24	2
1.00000E-04	1.18119E-20	0.	1.00000E+00	1.60615E-09	1.18119E-20	1.77178E-20	2
1.00000E-03	1.18119E-16	7.88861E-31	1.00000E+00	1.60590E-07	1.18119E-16	1.77178E-16	2
1.00000E-02	1.18114E-12	6.44238E-27	1.00000E+00	1.60591E-05	1.18112E-12	1.77164E-12	3
1.00000E-01	1.17660E-08	0.	1.00000E+00	1.60676E-03	1.17471E-08	1.75782E-08	3
1.00000E+00	8.11872E-05	0.	1.00000E+00	1.67302E-01	6.76044E-05	7.60481E-05	5
1.00000E+01	1.98689E-02	1.11022E-16	1.00000E+00	9.71395E-01	5.59774E-04	3.68725E-06	16
1.00000E+02	1.41291E+00	7.10543E-15	1.00000E+00	9.99340E-01	1.06498E-03	4.42375E-05	111
2.50000E+02	2.90994E+00	1.42109E-14	1.00000E+00	9.99582E-01	1.30248E-03	3.84498E-05	265
5.00000E+02	2.31238E+00	0.	1.00000E+00	9.99340E-01	1.82521E-03	3.97489E-06	519
1.00000E+03	1.83713E+00	7.10543E-15	1.00000E+00	9.99000E-01	1.83703E-03	1.27697E-04	1024
1.57080E+03	2.01361E+00	0.	1.00000E+00	9.98926E-01	2.16143E-03	5.66202E-05	1599
1.60000E+03	1.94394E+00	0.	1.00000E+00	9.98879E-01	2.17833E-03	7.30435E-05	1689
1.80000E+03	2.12781E+00	0.	1.00000E+00	9.98920E-01	2.29822E-03	2.94284E-05	1836
2.00000E+03	1.94051E+00	1.42109E-14	1.00000E+00	9.98754E-01	2.41764E-03	6.02154E-04	2031

INDEX OF REFRACTION: REAL PART= 1.0100000000 -IMAGINARY PART= .0500000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.32951E-06	1.32951E-06	2.31260E-17	1.60632E-11	1.32951E-06	4.61199E-23	2
1.00000E-04	1.32951E-05	1.32951E-05	2.31260E-14	1.60581E-09	1.32951E-05	4.61195E-19	3
1.00000E-03	1.32951E-04	1.32951E-04	2.31260E-11	1.60581E-07	1.32951E-04	4.61195E-15	3
1.00000E-02	1.32952E-03	1.32952E-03	2.31281E-08	1.60582E-05	1.32952E-03	4.61184E-11	4
1.00000E-01	1.32965E-02	1.32962E-02	2.30329E-06	1.60599E-03	1.32965E-02	4.57844E-07	5
1.00000E+00	1.31971E-01	1.29932E-01	1.54519E-02	1.64582E-01	1.31628E-01	1.89238E-03	8
1.00000E+01	9.75889E-01	7.32488E-01	2.69414E-01	9.70979E-01	7.39588E-01	4.71438E-04	21
1.00000E+02	1.99903E+00	1.00917E+00	4.92886E-01	9.96636E-01	1.01287E+00	6.43170E-04	122
2.50000E+02	2.01808E+00	9.99680E-01	5.03901E-01	9.97178E-01	1.00288E+00	6.43163E-04	279
5.00000E+02	2.01801E+00	9.92689E-01	5.07353E-01	9.97360E-01	9.96287E-01	6.43151E-04	536
1.00000E+03	2.01187E+00	9.87892E-01	5.08969E-01	9.97443E-01	9.90511E-01	6.43151E-04	1048
1.57080E+03	2.00969E+00	9.85799E-01	5.09477E-01	9.97470E-01	9.88389E-01	6.43151E-04	1622
1.60000E+03	2.00966E+00	9.85728E-01	5.09491E-01	9.97471E-01	9.88317E-01	6.43151E-04	1662
1.80000E+03	2.00907E+00	9.85295E-01	5.09576E-01	9.97476E-01	9.87879E-01	6.43151E-04	1854
2.00000E+03	2.00860E+00	9.84949E-01	5.09639E-01	9.97480E-01	9.87528E-01	6.43151E-04	2055

INDEX OF REFRACTION: REAL PART= 1.0500000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.91067E-23	1.88079E-37	1.00000E+00	1.64847E-11	2.91067E-23	4.36600E-23	2
1.00000E-04	2.91067E-19	0.	1.00000E+00	1.63021E-09	2.91067E-19	4.36600E-19	2
1.00000E-03	2.91067E-15	-1.26218E-29	1.00000E+00	1.63023E-07	2.91067E-15	4.36600E-15	2
1.00000E-02	2.91057E-11	4.13690E-25	1.00000E+00	1.63023E-05	2.91057E-11	4.36868E-11	3
1.00000E-01	2.90058E-07	0.	1.00000E+00	1.63006E-03	2.89988E-07	4.33324E-07	3
1.00000E+00	2.85445E-03	1.38778E-17	1.00000E+00	1.68872E-01	1.78918E-03	1.98533E-03	5
1.00000E+01	4.63529E-01	0.	1.00000E+00	9.69787E-01	1.46478E-02	1.09285E-03	16
1.00000E+02	2.37958E+00	1.42109E-14	1.00000E+00	9.84194E-01	3.28516E-02	1.30681E-03	113
2.50000E+02	2.07198E+00	1.42109E-14	1.00000E+00	9.79983E-01	4.18366E-02	8.93819E-01	267
5.00000E+02	2.05199E+00	0.	1.00000E+00	9.85930E-01	2.85782E-02	2.09607E-01	523
1.00000E+03	2.04046E+00	1.42109E-14	1.00000E+00	9.87084E-01	2.48906E-02	7.34416E-02	1026
1.57080E+03	2.01839E+00	2.84217E-14	1.00000E+00	9.87648E-01	2.48944E-02	3.81744E-01	1604
1.60000E+03	2.01093E+00	1.42109E-14	1.00000E+00	9.87478E-01	2.51876E-02	2.37642E-01	1634
1.80000E+03	2.03188E+00	0.	1.00000E+00	9.88824E-01	2.33662E-02	4.29182E-01	1831
2.00000E+03	2.03064E+00	1.42109E-14	1.00000E+00	9.88442E-01	2.26876E-02	2.04671E-02	2027

INDEX OF REFRACTION: REAL PART= 1.0500000000 -IMAGINARY PART= .0500000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.30963E-06	1.30963E-06	4.44974E-17	1.63485E-11	1.30963E-06	8.74127E-23	2
1.00000E-04	1.30963E-05	1.30963E-05	4.44974E-14	1.62933E-09	1.30963E-05	8.74127E-19	3
1.00000E-03	1.30963E-04	1.30963E-04	4.44973E-11	1.62933E-07	1.30963E-04	8.74127E-15	3
1.00000E-02	1.30964E-03	1.30964E-03	4.44985E-08	1.62934E-05	1.30964E-03	8.74061E-11	4
1.00000E-01	1.31044E-02	1.31044E-02	4.43184E-05	1.63000E-03	1.31044E-02	8.67836E-07	5
1.00000E+00	1.38709E-01	1.31738E-01	2.98639E-02	1.71821E-01	1.38928E-01	3.67842E-03	8
1.00000E+01	1.23348E+00	7.74291E-01	3.72254E-01	9.70534E-01	7.87811E-01	1.29347E-03	21
1.00000E+02	2.05344E+00	1.03844E+00	4.97998E-01	9.95386E-01	1.03886E+00	1.18579E-03	122
2.50000E+02	2.03449E+00	1.00697E+00	5.05844E-01	9.96172E-01	1.01884E+00	1.18978E-03	279
5.00000E+02	2.02379E+00	9.98178E-01	5.08260E-01	9.96364E-01	9.98916E-01	1.18964E-03	537
1.00000E+03	2.01628E+00	9.92823E-01	5.09295E-01	9.96453E-01	9.91849E-01	1.18964E-03	1044
1.57080E+03	2.01286E+00	9.89388E-01	5.09785E-01	9.96481E-01	9.88968E-01	1.18964E-03	1623
1.60000E+03	2.01213E+00	9.88648E-01	5.10440E-01	9.96482E-01	9.88872E-01	1.18964E-03	1658
1.80000E+03	2.01136E+00	9.84688E-01	5.10424E-01	9.96487E-01	9.88291E-01	1.18964E-03	1855
2.00000E+03	2.01061E+00	9.84317E-01	5.10487E-01	9.96491E-01	9.87816E-01	1.18964E-03	2054

INDEX OF REFRACTION= REAL PART= 1.1500000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.51245E-22	0.	1.00000E+00	1.69638E-11	2.51245E-22	3.76868E-22	2
1.00000E-04	2.51245E-18	1.23264E-32	1.00000E+00	1.69611E-09	2.51245E-18	3.76868E-18	2
1.00000E-03	2.51245E-14	1.23974E-26	1.00000E+00	1.69607E-07	2.51245E-14	3.76868E-14	2
1.00000E-02	2.51239E-10	1.65436E-24	1.00000E+00	1.69607E-05	2.51239E-10	3.76843E-10	3
1.00000E-01	2.86639E-06	2.71051E-20	1.00000E+00	1.69617E-03	2.80503E-06	3.74377E-06	3
1.00000E+00	1.09843E-02	1.11022E-16	1.00000E+00	1.73468E-01	1.56912E-02	1.78571E-02	5
1.00000E+01	3.01667E+00	0.	1.00000E+00	9.50871E-01	1.49112E-01	4.71807E-02	14
1.00000E+02	2.23619E+00	1.42109E-14	1.00000E+00	9.40988E-01	1.31963E-01	4.19686E-01	114
2.50000E+02	2.57883E+00	1.42109E-14	1.00000E+00	9.44784E-01	1.14948E-01	2.66686E+00	270
5.00000E+02	2.58143E+00	0.	1.00000E+00	9.44184E-01	1.19400E-01	8.49817E-02	520
1.00000E+03	2.54640E+00	1.42109E-14	1.00000E+00	9.47826E-01	1.07844E-01	9.11639E+00	1027
1.57084E+03	2.51685E+00	0.	1.00000E+00	9.48299E-01	1.04273E-01	4.78409E+00	1599
1.00000E+03	2.51851E+00	1.42109E-14	1.00000E+00	9.48850E-01	1.04858E-01	7.94390E-01	1631
1.00000E+03	2.51384E+00	0.	1.00000E+00	9.53103E-01	9.44427E-02	3.81888E+00	1833
2.00000E+03	2.51279E+00	0.	1.00000E+00	9.52908E-01	9.47908E-02	3.80613E+00	2038

INDEX OF REFRACTION= REAL PART= 1.1500000000 -IMAGINARY PART= .0500000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.25050E-04	1.25050E-04	2.23430E-16	1.69049E-11	1.25050E-04	4.19097E-22	2
1.00000E-04	1.25050E-03	1.25050E-04	2.23430E-12	1.69823E-09	1.25050E-03	4.19097E-18	3
1.00000E-03	1.25050E-04	1.25050E-04	2.23430E-10	1.69517E-07	1.25050E-04	4.19097E-14	3
1.00000E-02	1.25052E-02	1.25052E-03	2.23421E-07	1.69517E-05	1.25052E-03	4.19069E-10	4
1.00000E-01	1.25290E-02	1.25284E-02	2.22448E-04	1.69830E-03	1.25290E-02	4.16313E-06	5
1.00000E+00	1.55674E-01	1.38319E-01	1.30732E-01	1.76295E-01	1.52882E-01	1.84434E-02	8
1.00000E+01	2.49318E+00	8.78193E-01	6.47762E-01	8.69366E-01	9.42298E-01	7.13617E-03	21
1.00000E+02	2.00462E+00	1.02390E+00	5.08833E-01	9.00426E-01	1.03617E+00	5.40617E-03	122
2.50000E+02	2.04888E+00	9.98987E-01	5.15016E-01	9.00184E-01	1.04823E+00	5.40543E-03	261
5.00000E+02	2.02971E+00	9.78143E-01	5.18088E-01	9.89396E-01	9.89294E-01	5.40541E-03	530
1.00000E+03	2.01894E+00	9.71088E-01	5.19288E-01	9.89481E-01	9.82978E-01	5.40541E-03	1047
1.57084E+03	2.01411E+00	9.68270E-01	5.19288E-01	9.89504E-01	9.79247E-01	5.40541E-03	1624
1.00000E+03	2.01398E+00	9.68179E-01	5.19263E-01	9.89589E-01	9.79184E-01	5.40541E-03	1653
1.00000E+03	2.01291E+00	9.67626E-01	5.19291E-01	9.89589E-01	9.78893E-01	5.40541E-03	1855
2.00000E+03	2.01204E+00	9.67178E-01	5.19288E-01	9.89519E-01	9.78139E-01	5.40541E-03	2087

INDEX OF REFRACTION= REAL PART= 1.2120000000 -IMAGINARY PART= .0681000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.45322E-04	1.45322E-04	3.42672E-16	1.73971E-11	1.45322E-04	7.98564E-22	2
1.00000E-04	1.45322E-03	1.45322E-04	3.42672E-13	1.73921E-09	1.45322E-03	7.98564E-18	3
1.00000E-03	1.45322E-04	1.45322E-04	3.42672E-10	1.73922E-07	1.45322E-04	7.98564E-14	3
1.00000E-02	1.45326E-03	1.45326E-03	3.42656E-07	1.73921E-05	1.45326E-03	7.98516E-10	4
1.00000E-01	1.45724E-02	1.45671E-02	3.40993E-04	1.73908E-03	1.45724E-02	7.88723E-06	5
1.00000E+00	2.03284E-01	1.63618E-01	1.95126E-01	1.80348E-01	1.96130E-01	3.89809E-02	8
1.00000E+01	2.79770E+00	1.00649E+00	6.40248E-01	9.46138E-01	1.16299E+00	4.16348E-03	21
1.00000E+02	2.04672E+00	1.00983E+00	5.16968E-01	9.82419E-01	1.02877E+00	9.91678E-03	123
2.50000E+02	2.04762E+00	9.78686E-01	5.22330E-01	9.83181E-01	9.96874E-01	9.91446E-03	261
5.00000E+02	2.03089E+00	9.65942E-01	5.24224E-01	9.83381E-01	9.83651E-01	9.91637E-03	530
1.00000E+03	2.01924E+00	9.59286E-01	5.24928E-01	9.83449E-01	9.76929E-01	9.91636E-03	1047
1.57084E+03	2.01431E+00	9.56679E-01	5.25059E-01	9.83460E-01	9.74172E-01	9.91636E-03	1624
1.00000E+03	2.01414E+00	9.56593E-01	5.25061E-01	9.83460E-01	9.74085E-01	9.91636E-03	1653
1.00000E+03	2.01309E+00	9.56077E-01	5.25069E-01	9.83460E-01	9.73860E-01	9.91636E-03	1855
2.00000E+03	2.01221E+00	9.55666E-01	5.25070E-01	9.83460E-01	9.73138E-01	9.91636E-03	2087

INDEX OF REFRACTION= REAL PART= 1.3150000000 -IMAGINARY PART= .1370000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	3.11119E-04	3.11119E-04	3.91373E-16	1.81128E-11	3.11119E-04	1.82644E-21	2
1.00000E-04	3.11119E-03	3.11119E-04	3.91373E-13	1.81373E-09	3.11119E-03	1.82644E-17	3
1.00000E-03	3.11119E-04	3.11119E-04	3.91373E-10	1.81372E-07	3.11119E-04	1.82644E-13	3
1.00000E-02	3.11131E-03	3.11131E-03	3.91386E-07	1.81371E-05	3.11131E-03	1.82636E-09	4
1.00000E-01	3.12342E-02	3.12221E-02	3.89480E-04	1.81304E-03	3.12342E-02	1.81678E-05	5
1.00000E+00	4.44047E-01	2.61582E-01	2.93779E-01	1.91197E-01	4.36386E-01	8.14033E-02	8
1.00000E+01	2.48216E+00	1.22919E+00	4.84296E-01	9.36180E-01	1.36828E+00	1.98501E-02	21
1.00000E+02	2.08858E+00	9.82623E-01	5.28834E-01	9.68769E-01	1.01707E+00	2.19467E-02	123
2.50000E+02	2.04741E+00	9.53767E-01	5.34189E-01	9.69484E-01	9.87140E-01	2.19463E-02	261
5.00000E+02	2.03024E+00	9.42807E-01	5.35619E-01	9.69629E-01	9.75843E-01	2.19462E-02	530
1.00000E+03	2.01924E+00	9.36803E-01	5.36061E-01	9.69628E-01	9.69479E-01	2.19462E-02	1046
1.57084E+03	2.01431E+00	9.34479E-01	5.36088E-01	9.69604E-01	9.67209E-01	2.19462E-02	1624
1.00000E+03	2.01414E+00	9.34393E-01	5.36084E-01	9.69605E-01	9.67212E-01	2.19462E-02	1653
1.00000E+03	2.01309E+00	9.33932E-01	5.36078E-01	9.69589E-01	9.66741E-01	2.19462E-02	1855
2.00000E+03	2.01221E+00	9.33540E-01	5.36083E-01	9.69591E-01	9.66361E-01	2.19462E-02	2087

INDEX OF REFRACTION: REAL PART= 1.3300000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-06	1.10989E-01	1.08864E-38	1.00000E+00	1.83263E-11	1.10989E-01	1.66483E-01	2
1.00000E-04	1.10989E-17	0.	1.00000E+00	1.83279E-09	1.10989E-17	1.66483E-17	2
1.00000E-03	1.10989E-13	0.	1.00000E+00	1.83279E-07	1.10989E-13	1.66483E-13	2
1.00000E-02	1.10989E-09	1.38349E-33	1.00000E+00	1.83277E-05	1.10986E-09	1.66478E-09	3
1.00000E-01	1.10946E-05	8.42181E-20	1.00000E+00	1.83196E-03	1.10703E-05	1.66023E-05	3
1.00000E+00	9.39845E-02	4.44089E-16	1.00000E+00	1.84517E-01	7.65933E-02	8.44253E-02	5
1.00000E+01	2.20658E+00	1.42109E-14	1.00000E+00	7.12489E-01	6.34473E-01	5.61179E-01	17
1.00000E+02	2.10109E+00	1.42109E-14	1.00000E+00	8.68318E-01	2.76682E-01	2.24893E+00	114
2.50000E+02	2.01482E+00	0.	1.00000E+00	8.77173E-01	2.47398E-01	4.87788E-01	270
5.00000E+02	2.03837E+00	1.42109E-14	1.00000E+00	8.81864E-01	2.40468E-01	1.67188E+00	522
1.00000E+03	2.01484E+00	1.42109E-14	1.00000E+00	8.81893E-01	2.35782E-01	6.76204E-01	1030
1.25000E+03	2.01744E+00	1.42109E-14	1.00000E+00	8.82326E-01	2.37396E-01	1.48874E+01	1403
1.60000E+03	2.01164E+00	0.	1.00000E+00	8.84400E-01	2.32844E-01	2.88808E-01	1634
1.80000E+03	2.01204E+00	1.42109E-14	1.00000E+00	8.83883E-01	2.33637E-01	1.95725E+00	1834
2.00000E+03	2.01825E+00	1.42109E-14	1.00000E+00	8.84243E-01	2.32700E-01	2.94463E+00	2034

INDEX OF REFRACTION: REAL PART= 1.3300000000 -IMAGINARY PART= .0500000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.12367E-06	1.12367E-06	1.01096E-15	1.83278E-11	1.12367E-06	1.70397E-21	2
1.00000E-04	1.12367E-05	1.12367E-05	1.01096E-12	1.83190E-09	1.12367E-05	1.70397E-17	3
1.00000E-03	1.12367E-04	1.12367E-04	1.01096E-09	1.83188E-07	1.12367E-04	1.70397E-13	3
1.00000E-02	1.12371E-03	1.12371E-03	1.01091E-06	1.83187E-05	1.12371E-03	1.70389E-09	4
1.00000E-01	1.12899E-02	1.12786E-02	1.00841E-03	1.83169E-03	1.12899E-02	1.69518E-05	5
1.00000E+00	2.31756E-01	1.39089E-01	3.99847E-01	1.87696E-01	2.14363E-01	8.26055E-02	8
1.00000E+01	2.36486E+00	1.03328E+00	5.62949E-01	4.68185E-01	1.21263E+00	6.34490E-02	21
1.00000E+02	2.09008E+00	9.88899E-01	5.26990E-01	9.78852E-01	1.02103E+00	2.05111E-02	124
2.50000E+02	2.04910E+00	9.58183E-01	5.32388E-01	9.71272E-01	9.89522E-01	2.05108E-02	281
5.00000E+02	2.03104E+00	9.44688E-01	5.33895E-01	9.71419E-01	9.77680E-01	2.05104E-02	538
1.00000E+03	2.01964E+00	9.40403E-01	5.34371E-01	9.71436E-01	9.71231E-01	2.05104E-02	1047
1.25000E+03	2.01457E+00	9.37963E-01	5.34410E-01	9.71418E-01	9.68734E-01	2.05104E-02	1624
1.60000E+03	2.01439E+00	9.37883E-01	5.34409E-01	9.71417E-01	9.68668E-01	2.05104E-02	1653
1.80000E+03	2.01331E+00	9.37401E-01	5.34398E-01	9.71411E-01	9.68166E-01	2.05104E-02	1855
2.00000E+03	2.01241E+00	9.37012E-01	5.34384E-01	9.71406E-01	9.67768E-01	2.05104E-02	2057

INDEX OF REFRACTION: REAL PART= 1.3300000000 -IMAGINARY PART= .1000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.24787E-06	2.24787E-06	5.40288E-16	1.83075E-11	2.24787E-06	1.48164E-21	2
1.00000E-04	2.24787E-05	2.24787E-05	5.40288E-13	1.82918E-09	2.24787E-05	1.48164E-17	3
1.00000E-03	2.24787E-04	2.24787E-04	5.40288E-10	1.82917E-07	2.24787E-04	1.48164E-13	3
1.00000E-02	2.24794E-03	2.24794E-03	5.40230E-07	1.82916E-05	2.24794E-03	1.48154E-09	4
1.00000E-01	2.25743E-02	2.25621E-02	5.37544E-04	1.82841E-03	2.25742E-02	1.48128E-05	5
1.00000E+00	3.68618E-01	2.78037E-01	2.61423E-01	1.96882E-01	3.47409E-01	8.43899E-02	8
1.00000E+01	2.39853E+00	1.21118E+00	4.95034E-01	9.19322E-01	1.36697E+00	2.28767E-02	21
1.00000E+02	2.08788E+00	9.84523E-01	5.28384E-01	9.69021E-01	1.01869E+00	2.18616E-02	123
2.50000E+02	2.04818E+00	9.65912E-01	5.33726E-01	9.69735E-01	9.88097E-01	2.18611E-02	281
5.00000E+02	2.03602E+00	9.43828E-01	5.35201E-01	9.69073E-01	9.76574E-01	2.18611E-02	538
1.00000E+03	2.01942E+00	9.37708E-01	5.35858E-01	9.69882E-01	9.70287E-01	2.18610E-02	1046
1.25000E+03	2.01443E+00	9.35330E-01	5.35688E-01	9.69861E-01	9.67883E-01	2.18610E-02	1624
1.60000E+03	2.01426E+00	9.35258E-01	5.35684E-01	9.69860E-01	9.67773E-01	2.18610E-02	1653
1.80000E+03	2.01319E+00	9.34778E-01	5.35671E-01	9.69854E-01	9.67293E-01	2.18610E-02	1855
2.00000E+03	2.01231E+00	9.34403E-01	5.35656E-01	9.69846E-01	9.66906E-01	2.18610E-02	2057

INDEX OF REFRACTION: REAL PART= 1.3330000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.12828E-21	6.81883E-36	1.00000E+00	1.83499E-11	1.12828E-21	1.69243E-21	2
1.00000E-04	1.12828E-17	0.	1.00000E+00	1.83528E-09	1.12828E-17	1.69243E-17	2
1.00000E-03	1.12828E-13	2.42338E-27	1.00000E+00	1.83528E-07	1.12828E-13	1.69242E-13	2
1.00000E-02	1.12828E-09	0.	1.00000E+00	1.83528E-05	1.12828E-09	1.69234E-09	3
1.00000E-01	1.12747E-05	0.	1.00000E+00	1.83442E-03	1.12541E-05	1.68372E-05	3
1.00000E+00	9.86824E-02	8.88178E-16	1.00000E+00	1.84738E-01	7.79820E-02	8.41358E-02	5
1.00000E+01	2.18766E+00	1.42109E-14	1.00000E+00	7.09560E-01	6.34569E-01	5.42415E-01	17
1.00000E+02	2.11997E+00	1.42109E-14	1.00000E+00	8.78782E-01	2.63338E-01	2.47286E-01	114
2.50000E+02	2.05331E+00	0.	1.00000E+00	8.73423E-01	2.59982E-01	1.11582E+00	270
5.00000E+02	2.03026E+00	1.42109E-14	1.00000E+00	8.79600E-01	2.44443E-01	3.98428E-01	523
1.00000E+03	2.02281E+00	1.42109E-14	1.00000E+00	8.80094E-01	2.42846E-01	3.49449E+00	1028
1.25000E+03	2.01320E+00	1.42109E-14	1.00000E+00	8.82560E-01	2.35940E-01	5.64663E-01	1403
1.60000E+03	2.01570E+00	2.84217E-14	1.00000E+00	8.83178E-01	2.35479E-01	2.69127E-01	1634
1.80000E+03	2.01789E+00	1.42109E-14	1.00000E+00	8.82522E-01	2.37057E-01	5.64656E-01	1838
2.00000E+03	2.01142E+00	0.	1.00000E+00	8.82918E-01	2.35624E-01	2.48647E-02	2038

INDEX OF REFRACTION, REAL PART= 1.3330000000 -IMAGINARY PART= .0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.121446E-06	1.121446E-06	1.029345E-13	1.032000E-11	1.121446E-06	1.731351E-21	2
1.000000E-04	1.121446E-05	1.121446E-05	1.029345E-12	1.032000E-09	1.121446E-05	1.731351E-17	3
1.000000E-03	1.121446E-04	1.121446E-04	1.029345E-09	1.032000E-07	1.121446E-04	1.731351E-13	3
1.000000E-02	1.121446E-03	1.121446E-03	1.029229E-06	1.031999E-05	1.121446E-03	1.731342E-09	4
1.000000E-01	1.126816E-02	1.125866E-02	1.023678E-03	1.031999E-03	1.126816E-02	1.722895E-05	5
1.000000E+00	2.334695E-01	1.391731E-01	4.040633E-01	1.670211E-01	2.197736E-01	8.484795E-02	8
1.000000E+01	2.346411E+00	1.034405E+00	5.991555E-01	8.627811E-01	1.214534E+00	6.284641E-02	21
1.000000E+02	2.898864E+00	9.868982E-01	5.872595E-01	9.702227E-01	1.028677E+00	2.082308E-02	124
2.500000E+02	2.949116E+00	9.978680E-01	5.924316E-01	9.709465E-01	9.893911E-01	2.082308E-02	281
5.000000E+02	2.931076E+00	9.462581E-01	5.941377E-01	9.719098E-01	9.779564E-01	2.082308E-02	938
1.000000E+03	2.819685E+00	9.399264E-01	5.944694E-01	9.711895E-01	9.711245E-01	2.082259E-02	1847
1.978480E+03	2.814877E+00	9.374898E-01	5.944648E-01	9.710871E-01	9.688538E-01	2.082259E-02	1824
1.500000E+03	2.814396E+00	9.374898E-01	5.944644E-01	9.710871E-01	9.688548E-01	2.082259E-02	1693
1.000000E+03	2.813731E+00	9.369248E-01	5.944634E-01	9.710868E-01	9.688957E-01	2.082259E-02	1855
2.000000E+03	2.812441E+00	9.368398E-01	5.944619E-01	9.710748E-01	9.675684E-01	2.082259E-02	2057

INDEX OF REFRACTION, REAL PART= 1.3420000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.184158E-21	0.	1.000000E+00	1.042648E-11	1.184158E-21	1.776238E-21	2
1.000000E-04	1.184158E-17	0.	1.000000E+00	1.042742E-09	1.184158E-17	1.776238E-17	2
1.000000E-03	1.184158E-13	0.877794E-28	1.000000E+00	1.042722E-07	1.184158E-13	1.776238E-13	2
1.000000E-02	1.184414E-09	1.323349E-23	1.000480E+00	1.042718E-05	1.184412E-09	1.776214E-09	3
1.000000E-01	1.163408E-05	1.084206E-19	1.000008E+00	1.041885E-03	1.161222E-05	1.767228E-05	3
1.000000E+00	1.889291E-01	1.332227E-15	1.000000E+00	1.893787E-01	8.221722E-02	9.873668E-02	5
1.000000E+01	2.819377E+00	0.	1.000000E+00	6.698432E-01	6.339346E-01	4.998563E-01	17
1.000000E+02	2.139944E+00	1.421809E-14	1.000000E+00	8.749622E-01	2.670755E-01	2.826609E-01	119
2.500000E+02	2.824137E+00	1.421809E-14	1.000000E+00	8.867695E-01	2.595844E-01	1.619016E+00	358
5.000000E+02	2.838333E+00	0.	1.000000E+00	8.744495E-01	2.849889E-01	8.787946E+00	823
1.000000E+03	2.824595E+00	1.421809E-14	1.000000E+00	8.782564E-01	2.486476E-01	2.474833E+00	1828
1.978480E+03	2.812978E+00	1.421809E-14	1.000000E+00	8.882995E-01	2.489954E-01	1.888196E+00	1692
1.500000E+03	2.889221E+00	0.	1.000000E+00	8.798136E-01	2.438432E-01	1.899432E-01	1634
1.000000E+03	2.813908E+00	1.421809E-14	1.000000E+00	8.798765E-01	2.419188E-01	1.449807E+00	1832
2.000000E+03	2.819718E+00	1.421809E-14	1.000000E+00	8.794158E-01	2.438868E-01	8.464398E-01	2034

INDEX OF REFRACTION, REAL PART= 1.3420000000 -IMAGINARY PART= .1000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	2.229945E-06	2.229945E-06	5.776311E-16	1.033945E-11	2.229945E-06	1.933122E-21	2
1.000000E-04	2.229945E-05	2.229945E-05	5.776311E-13	1.033914E-09	2.229945E-05	1.933122E-17	3
1.000000E-03	2.229945E-04	2.229945E-04	5.776311E-10	1.033912E-07	2.229945E-04	1.933122E-13	3
1.000000E-02	2.230032E-03	2.230032E-03	5.776884E-07	1.033911E-05	2.230032E-03	1.933202E-09	4
1.000000E-01	2.230795E-02	2.230511E-02	5.744077E-04	1.033838E-03	2.230796E-02	1.932244E-05	5
1.000000E+00	3.728473E-01	2.783387E-01	2.741977E-01	1.914268E-01	3.529228E-01	6.894677E-02	8
1.000000E+01	2.374216E+00	1.215232E+00	4.881953E-01	9.168988E-01	1.312248E+00	1.967435E-02	21
1.000000E+02	2.887826E+00	9.825822E-01	5.293758E-01	9.677888E-01	1.016226E+00	2.310662E-02	123
2.500000E+02	2.943636E+00	9.931956E-01	5.346598E-01	9.688443E-01	9.876934E-01	2.310658E-02	281
5.000000E+02	2.930868E+00	9.428108E-01	5.361118E-01	9.688944E-01	9.762812E-01	2.310658E-02	938
1.000000E+03	2.819465E+00	9.359133E-01	5.359322E-01	9.687907E-01	9.699410E-01	2.310658E-02	1846
1.978480E+03	2.814458E+00	9.335458E-01	5.359576E-01	9.687973E-01	9.675156E-01	2.310658E-02	1824
1.500000E+03	2.814127E+00	9.334678E-01	5.359574E-01	9.687971E-01	9.674358E-01	2.310658E-02	1693
1.000000E+03	2.813216E+00	9.329998E-01	5.359561E-01	9.687944E-01	9.669887E-01	2.310658E-02	1855
2.000000E+03	2.812326E+00	9.326822E-01	5.359544E-01	9.687968E-01	9.655771E-01	2.310658E-02	2057

INDEX OF REFRACTION, REAL PART= 1.4480000000 -IMAGINARY PART= 1.9000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	2.357566E-05	2.357566E-05	1.831119E-15	1.124028E-11	2.357566E-05	3.646790E-20	2
1.000000E-04	2.357566E-04	2.357566E-04	1.831119E-12	1.124008E-09	2.357566E-04	3.646790E-16	3
1.000000E-03	2.357566E-03	2.357566E-03	1.831119E-09	1.124006E-07	2.357566E-03	3.646791E-12	3
1.000000E-02	2.357797E-02	2.357797E-02	1.831135E-06	1.124022E-05	2.357797E-02	3.646907E-08	4
1.000000E-01	2.369338E-01	2.366432E-01	1.824841E-03	1.119722E-03	2.369336E-01	3.662366E-04	5
1.000000E+00	3.538885E+00	1.491832E+00	3.747911E-01	1.027174E-01	2.662238E+00	1.091672E-02	8
1.000000E+01	2.953347E+00	9.728832E-01	6.117895E-01	7.497044E-01	1.324535E+00	3.092237E-01	22
1.000000E+02	2.109255E+00	7.031895E-01	6.666452E-01	7.764736E-01	1.217125E+00	2.978895E-01	124
2.500000E+02	2.057336E+00	6.755440E-01	6.718496E-01	7.748011E-01	9.678896E-01	2.978872E-01	281
5.000000E+02	2.039236E+00	6.686106E-01	6.729977E-01	7.723844E-01	9.773596E-01	2.978870E-01	938
1.000000E+03	2.021746E+00	6.603389E-01	6.734482E-01	7.711765E-01	9.716336E-01	2.978869E-01	1847
1.978480E+03	2.015696E+00	6.582190E-01	6.734522E-01	7.708422E-01	9.697511E-01	2.978869E-01	1824
1.500000E+03	2.015078E+00	6.582224E-01	6.734532E-01	7.708428E-01	9.696844E-01	2.978869E-01	1693
1.000000E+03	2.014468E+00	6.578328E-01	6.734448E-01	7.708428E-01	9.691880E-01	2.978869E-01	1855
2.000000E+03	2.013468E+00	6.579117E-01	6.734498E-01	7.708317E-01	9.669599E-01	2.978869E-01	2057

INDEX OF REFRACTION, REAL PART= 1.5000000000 -IMAGINARY PART= .0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	2.333681E-21	0.	1.000000E+00	1.983185E-11	2.333681E-21	3.466211E-21	2
1.000000E-04	2.333681E-17	0.	1.000000E+00	1.983356E-09	2.333681E-17	3.466211E-17	2
1.000000E-03	2.333681E-13	-1.615999E-27	1.000000E+00	1.983332E-07	2.333680E-13	3.466211E-13	2
1.000000E-02	2.333682E-09	1.323499E-23	1.000000E+00	1.983332E-05	2.333674E-09	3.466087E-09	3
1.000000E-01	2.333641E-05	2.166400E-19	1.000000E+00	1.981772E-03	2.333383E-05	3.466129E-05	3
1.000000E+00	2.150498E-01	8.881784E-16	1.000000E+00	1.969424E-01	1.723866E-01	1.865865E-01	9
1.000000E+01	2.862800E+00	0.	1.000000E+00	7.429135E-01	7.429129E-01	1.695866E+00	17
1.000000E+02	2.093439E+00	0.	1.000000E+00	8.182461E-01	3.000002E-01	1.732621E+00	115
2.500000E+02	2.061432E+00	1.421094E-14	1.000000E+00	8.261736E-01	3.583333E-01	3.395821E+00	269
5.000000E+02	2.042605E+00	2.842178E-14	1.000000E+00	8.293965E-01	3.966451E-01	5.565792E-01	522
1.000000E+03	2.013944E+00	1.421094E-14	1.000000E+00	8.276822E-01	3.466316E-01	1.221615E+01	1025
1.978600E+03	2.013933E+00	1.421094E-14	1.000000E+00	8.256134E-01	3.458932E-01	7.052377E+00	1962
1.600000E+03	2.017596E+00	0.	1.000000E+00	8.286736E-01	3.458657E-01	1.937797E+01	1633
1.800000E+03	2.012688E+00	4.263256E-14	1.000000E+00	8.292688E-01	3.463649E-01	1.222336E+01	1832
2.000000E+03	2.008988E+00	0.	1.000000E+00	8.290228E-01	3.458649E-01	1.688899E+01	2034

INDEX OF REFRACTION, REAL PART= 1.5000000000 -IMAGINARY PART= .1000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.992952E-05	1.992952E-05	1.289631E-15	1.978808E-11	1.992952E-05	3.603336E-21	2
1.000000E-04	1.992952E-05	1.992952E-05	1.289631E-12	1.979764E-09	1.992952E-05	3.603336E-17	3
1.000000E-03	1.992952E-04	1.992952E-04	1.289631E-09	1.979795E-07	1.992952E-04	3.603335E-13	3
1.000000E-02	1.992863E-03	1.992863E-03	1.289571E-06	1.979731E-05	1.992863E-03	3.603212E-09	4
1.000000E-01	2.000000E-02	2.000000E-02	1.194311E-03	1.978259E-03	2.000000E-02	3.588760E-05	5
1.000000E+00	4.827709E-01	2.736300E-01	4.327338E-01	2.889907E-01	4.394454E-01	1.760622E-01	8
1.000000E+01	2.459709E+00	1.224685E+00	5.021344E-01	9.223564E-01	1.328564E+00	9.272712E-02	21
1.000000E+02	2.089822E+00	9.576688E-01	5.417377E-01	9.583092E-01	1.813388E+00	4.193448E-02	124
2.500000E+02	2.049206E+00	9.293468E-01	5.464864E-01	9.589442E-01	9.842768E-01	4.193385E-02	281
5.000000E+02	2.031105E+00	9.186242E-01	5.477338E-01	9.589665E-01	9.731778E-01	4.193384E-02	536
1.000000E+03	2.019708E+00	9.127708E-01	5.488672E-01	9.589884E-01	9.671438E-01	4.193366E-02	1048
1.978600E+03	2.011461E+00	9.084988E-01	5.498952E-01	9.590112E-01	9.644810E-01	4.193366E-02	1824
1.600000E+03	2.014436E+00	9.104246E-01	5.488049E-01	9.588872E-01	9.647346E-01	4.193366E-02	1653
1.800000E+03	2.013358E+00	9.099764E-01	5.488248E-01	9.587691E-01	9.642746E-01	4.193356E-02	1858
2.000000E+03	2.012458E+00	9.095614E-01	5.488068E-01	9.587736E-01	9.639036E-01	4.193356E-02	2057

INDEX OF REFRACTION, REAL PART= 1.5250000000 -IMAGINARY PART= .0500000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.333382E-05	1.333382E-05	1.918428-19	2.009678-11	1.333382E-05	3.822232E-21	2
1.000000E-04	1.333382E-05	1.333382E-05	1.918428-12	2.009878-09	1.333382E-05	3.822232E-17	3
1.000000E-03	1.333382E-04	1.333382E-04	1.918428-09	2.009868-07	1.333382E-04	3.822232E-13	3
1.000000E-02	1.333390E-03	1.333390E-03	1.918328-06	2.009548-05	1.333390E-03	3.822089E-09	4
1.000000E-01	1.344158E-02	1.344158E-02	1.897378-03	2.013958-03	1.344158E-02	3.807348E-05	5
1.000000E+00	4.198778E-01	1.983878E-01	5.469668E-01	2.862848E-01	3.728378E-01	1.944348E-01	8
1.000000E+01	2.851138E+00	1.183988E+00	5.476918E-01	9.117738E-01	1.277178E+00	3.868958E-01	21
1.000000E+02	2.090848E+00	9.992448E-01	5.438098E-01	9.483178E-01	1.813928E+00	4.392988E-02	124
2.500000E+02	2.049488E+00	9.268768E-01	5.477488E-01	9.488858E-01	9.842968E-01	4.392888E-02	281
5.000000E+02	2.031258E+00	9.161888E-01	5.489798E-01	9.488868E-01	9.731078E-01	4.392868E-02	538
1.000000E+03	2.019778E+00	9.103838E-01	5.497838E-01	9.487638E-01	9.671498E-01	4.392868E-02	1048
1.978600E+03	2.011468E+00	9.068318E-01	5.498268E-01	9.486678E-01	9.644148E-01	4.392858E-02	1824
1.600000E+03	2.014478E+00	9.079588E-01	5.492838E-01	9.486848E-01	9.647388E-01	4.392858E-02	1653
1.800000E+03	2.013388E+00	9.075088E-01	5.492628E-01	9.486658E-01	9.644768E-01	4.392858E-02	1858
2.000000E+03	2.012468E+00	9.071468E-01	5.492488E-01	9.486488E-01	9.639878E-01	4.392848E-02	2057

INDEX OF REFRACTION, REAL PART= 1.6000000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	3.128096E-21	2.407418-30	1.000000E+00	2.079738-11	3.128096E-21	4.681446E-21	2
1.000000E-04	3.128096E-17	1.972158-31	1.000000E+00	2.081898-09	3.128096E-17	4.681446E-17	2
1.000000E-03	3.128096E-13	1.618898-27	1.000000E+00	2.081858-07	3.128096E-13	4.681446E-13	2
1.000000E-02	3.128101E-09	0.	1.000000E+00	2.081868-05	3.128094E-09	4.681248E-09	3
1.000000E-01	3.128938E-05	0.	1.000000E+00	2.079668-03	3.119038E-05	4.668318E-05	3
1.000000E+00	3.068878E-01	0.	1.000000E+00	2.096858-01	2.824888E-01	2.581938E-01	9
1.000000E+01	2.868778E+00	1.421098E-14	1.000000E+00	7.482768-01	2.451858E-01	1.098878E+01	17
1.000000E+02	2.047178E+00	1.421098E-14	1.000000E+00	7.823448-01	4.458728E-01	5.887488E+00	115
2.500000E+02	2.008268E+00	1.421098E-14	1.000000E+00	7.926888-01	4.276928E-01	5.118338E+00	268
5.000000E+02	2.024388E+00	0.	1.000000E+00	7.978368-01	4.098448E-01	8.421448E+00	522
1.000000E+03	2.021298E+00	1.421098E-14	1.000000E+00	8.013888E-01	3.995988E-01	2.078438E+01	1020
1.978600E+03	2.015828E+00	1.421098E-14	1.000000E+00	8.023338E-01	3.984238E-01	2.638688E+01	1664
1.600000E+03	2.018078E+00	0.	1.000000E+00	8.021928E-01	4.022278E-01	2.717078E+01	1631
1.800000E+03	2.017488E+00	0.	1.000000E+00	8.018308E-01	3.998648E-01	2.489318E+01	1833
2.000000E+03	2.000000E+00	1.421098E-14	1.000000E+00	8.008228E-01	4.042788E-01	3.648888E+01	2034

INDEX OF REFRACTION, REAL PART= 1.6000000000 -IMAGINARY PART= .0000100000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.045722E-10	1.045722E-10	1.690000E-11	2.082490E-11	1.045672E-10	4.681444E-21	2
1.000000E-04	1.045722E-09	1.045722E-09	1.690000E-09	2.082490E-09	1.045672E-09	4.681444E-17	3
1.000000E-03	1.045722E-08	1.045722E-08	1.689987E-08	2.082458E-07	1.045672E-08	4.681444E-13	3
1.000000E-02	1.078004E-07	1.044868E-07	1.661838E-02	2.081956E-05	1.078984E-07	4.681288E-09	4
1.000000E-01	3.311430E-05	1.659888E-06	9.438461E-01	2.079066E-03	3.284934E-05	4.668531E-09	4
1.000000E+00	3.868334E-01	2.917726E-05	9.999185E-01	2.096868E-01	2.425106E-01	2.581911E-01	6
1.000000E+01	2.962790E+00	9.068990E-04	9.999842E-01	7.483322E-01	6.483359E-01	1.893978E+01	18
1.000000E+02	2.847696E+00	4.286611E-03	9.979948E-01	7.829225E-01	4.477931E-01	6.844777E+06	119
2.500000E+02	2.782911E+00	9.682726E-03	9.993186E-01	7.941265E-01	4.323869E-01	9.852145E+06	275
5.000000E+02	2.824788E+00	1.888388E-02	9.981881E-01	7.999021E-01	4.194816E-01	8.344078E+06	533
1.000000E+03	2.821324E+00	3.841248E-02	9.924911E-01	8.066009E-01	4.186916E-01	2.772606E+01	1049
1.570000E+03	2.815896E+00	5.438644E-02	9.738311E-01	8.094295E-01	4.281166E-01	2.360295E+01	1618
1.600000E+03	2.812678E+00	5.822824E-02	9.726699E-01	8.079718E-01	4.319956E-01	2.478822E+01	1646
1.650000E+03	2.817756E+00	6.241838E-02	9.698878E-01	8.104828E-01	4.337815E-01	2.379115E+01	1697
2.000000E+03	2.818412E+00	8.691718E-02	9.597208E-01	8.182822E-01	4.374809E-01	3.179938E+01	2049

INDEX OF REFRACTION, REAL PART= 1.6000000000 -IMAGINARY PART= .0000600000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	9.232356E-07	9.232356E-07	3.484732E-15	2.079015E-11	9.232356E-07	4.715866E-21	2
1.000000E-04	9.232356E-06	9.232356E-06	3.484732E-12	2.080869E-09	9.232356E-06	4.715866E-17	3
1.000000E-03	9.232377E-05	9.232377E-05	3.484732E-09	2.080869E-07	9.232377E-05	4.715866E-13	3
1.000000E-02	9.233815E-04	9.232696E-04	3.484844E-06	2.080867E-05	9.233815E-04	4.714988E-09	4
1.000000E-01	9.329890E-03	9.293615E-03	3.379738E-03	2.078400E-03	9.329822E-03	4.698715E-09	5
1.000000E+00	4.482286E-01	1.417771E-01	6.777943E-01	2.113492E-01	3.764934E-01	2.478115E-01	7
1.000000E+01	2.923922E+00	1.847495E+00	8.849277E-01	8.864268E-01	1.215894E+00	8.969748E-01	21
1.000000E+02	2.898880E+00	9.441898E-01	9.448498E-01	9.399695E-01	1.013021E+00	5.368347E-02	124
2.500000E+02	2.849629E+00	9.162685E-01	9.529681E-01	9.484146E-01	9.837877E-01	5.358347E-02	281
5.000000E+02	2.833137E+00	9.056995E-01	9.541468E-01	9.483722E-01	9.728178E-01	5.360495E-02	538
1.000000E+03	2.819818E+00	8.999128E-01	9.544858E-01	9.482832E-01	9.668851E-01	5.360495E-02	1046
1.570000E+03	2.814686E+00	8.976758E-01	9.544332E-01	9.481358E-01	9.644944E-01	5.360446E-02	1624
1.600000E+03	2.814008E+00	8.976688E-01	9.544308E-01	9.481322E-01	9.644869E-01	5.360446E-02	1653
1.650000E+03	2.813416E+00	8.971898E-01	9.544088E-01	9.481078E-01	9.640158E-01	5.360446E-02	1699
2.000000E+03	2.812898E+00	8.966818E-01	9.543858E-01	9.480886E-01	9.636478E-01	5.360446E-02	2057

INDEX OF REFRACTION, REAL PART= 1.6000000000 -IMAGINARY PART= .1000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	1.045722E-06	1.045722E-06	1.739016E-13	2.078685E-11	1.045672E-06	4.615986E-21	2
1.000000E-04	1.045722E-05	1.045722E-05	1.739016E-12	2.078685E-09	1.045672E-05	4.615986E-17	3
1.000000E-03	1.045722E-04	1.045722E-04	1.739016E-09	2.078685E-07	1.045672E-04	4.615986E-13	3
1.000000E-02	1.045865E-03	1.045844E-03	1.739042E-06	2.077998E-05	1.045865E-03	4.615861E-09	4
1.000000E-01	1.061168E-02	1.057998E-02	1.727958E-03	2.076185E-03	1.061119E-02	4.599268E-09	5
1.000000E+00	5.782480E-01	2.758994E-01	5.166968E-01	2.167448E-01	5.063708E-01	2.418288E-01	8
1.000000E+01	2.485694E+00	1.196218E+00	9.131289E-01	9.152328E-01	1.382965E+00	1.524481E-01	21
1.000000E+02	2.098332E+00	9.426376E-01	9.498944E-01	9.398358E-01	1.012618E+00	5.468478E-02	124
2.500000E+02	2.049852E+00	9.148895E-01	9.553698E-01	9.394768E-01	9.839338E-01	5.468328E-02	281
5.000000E+02	2.033129E+00	9.043366E-01	9.547938E-01	9.394195E-01	9.728512E-01	5.468328E-02	538
1.000000E+03	2.019788E+00	8.985826E-01	9.551868E-01	9.392768E-01	9.666672E-01	5.468298E-02	1046
1.570000E+03	2.014656E+00	8.963147E-01	9.550878E-01	9.391708E-01	9.643758E-01	5.468298E-02	1624
1.600000E+03	2.014448E+00	8.962748E-01	9.550848E-01	9.391668E-01	9.642998E-01	5.468298E-02	1653
1.650000E+03	2.013398E+00	8.958348E-01	9.550628E-01	9.391418E-01	9.638478E-01	5.468298E-02	1699
2.000000E+03	2.012498E+00	8.954778E-01	9.550448E-01	9.391198E-01	9.634828E-01	5.468298E-02	2057

INDEX OF REFRACTION, REAL PART= 1.7000000000 -IMAGINARY PART= .0024000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.000000E-05	3.638222E-06	3.638222E-06	1.222998E-13	2.278776E-11	3.638222E-06	7.848094E-21	2
1.000000E-04	3.638222E-05	3.638222E-05	1.222998E-10	2.278777E-09	3.638222E-05	7.848094E-17	3
1.000000E-03	3.638223E-04	3.638222E-04	1.222998E-07	2.278635E-07	3.638223E-04	7.848094E-13	3
1.000000E-02	3.639902E-03	3.638598E-03	1.228273E-04	2.276433E-05	3.639902E-03	7.848768E-09	4
1.000000E-01	4.341664E-02	3.878098E-02	1.884478E-01	2.273978E-03	4.340859E-02	7.822715E-09	5
1.000000E+00	9.108888E-01	7.132888E-01	9.664948E-01	2.343908E-01	3.928866E-01	3.928344E-01	7
1.000000E+01	2.395694E+00	1.143339E+00	9.522598E-01	6.868278E-01	8.983928E-01	1.083988E+01	20
1.000000E+02	2.116598E+00	8.738114E-01	7.290398E-01	8.455698E-01	8.118228E-01	1.387148E+01	123
2.500000E+02	2.047308E+00	8.339568E-01	8.675888E-01	8.993518E-01	9.287868E-01	3.184918E+00	281
5.000000E+02	2.023818E+00	8.711648E-01	8.718258E-01	9.171868E-01	9.672958E-01	2.972368E-01	538
1.000000E+03	2.019888E+00	8.798138E-01	9.668828E-01	9.193098E-01	9.673678E-01	7.593248E-02	1046
1.570000E+03	2.014708E+00	8.729488E-01	9.667118E-01	9.192888E-01	9.651998E-01	7.871988E-02	1624
1.600000E+03	2.014528E+00	8.728748E-01	9.667088E-01	9.191948E-01	9.651288E-01	7.874718E-02	1653
1.650000E+03	2.013428E+00	8.724418E-01	9.666868E-01	9.191698E-01	9.646868E-01	7.872428E-02	1699
2.000000E+03	2.012528E+00	8.720918E-01	9.666468E-01	9.191228E-01	9.643208E-01	7.872268E-02	2056

INDEX OF REFRACTION, REAL PART= 2.0000000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	6.66667E-21	4.01462E-38	1.00000E+00	2.54531E-11	6.66667E-21	1.00000E-20	2
1.00000E-04	6.66667E-17	3.94430E-31	1.00000E+00	2.54540E-09	6.66667E-17	1.00000E-16	2
1.00000E-03	6.66667E-13	6.46235E-27	1.00000E+00	2.54540E-07	6.66667E-13	1.00000E-12	2
1.00000E-02	6.66693E-09	0.	1.00000E+00	2.54543E-05	6.66676E-09	9.99982E-09	3
1.00000E-01	6.69332E-05	4.33681E-19	1.00000E+00	2.54791E-03	6.67630E-05	9.98179E-05	3
1.00000E+00	7.96838E-01	-7.10543E-15	1.00000E+00	2.76199E-01	5.76747E-01	5.35700E-01	5
1.00000E+01	2.04365E+00	1.42109E-14	1.00000E+00	6.18448E-01	7.79755E-01	6.13179E+00	18
1.00000E+02	2.13622E+00	4.26326E-14	1.00000E+00	6.97749E-01	6.45877E-01	9.98870E+01	114
2.50000E+02	2.08210E+00	1.42109E-14	1.00000E+00	7.09514E-01	6.04022E-01	2.45725E+02	265
5.00000E+02	2.01107E+00	0.	1.00000E+00	7.09595E-01	5.84023E-01	5.20454E+02	524
1.00000E+03	2.01173E+00	1.42109E-14	1.00000E+00	7.11214E-01	5.80044E-01	1.06031E+03	1029
1.57080E+03	2.00946E+00	1.42109E-14	1.00000E+00	7.08949E-01	5.84750E-01	1.65065E+03	1605
1.60000E+03	2.01989E+00	0.	1.00000E+00	7.09805E-01	5.86060E-01	1.71562E+03	1632
1.80000E+03	2.00663E+00	1.42109E-14	1.00000E+00	7.08602E-01	5.90347E-01	1.90920E+03	1834
2.00000E+03	2.01206E+00	1.42109E-14	1.00000E+00	7.12521E-01	5.78606E-01	2.10660E+03	2030

INDEX OF REFRACTION, REAL PART= 2.0000000000 -IMAGINARY PART= .2000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.65475E-06	2.65475E-06	2.61156E-15	2.53181E-11	2.65475E-06	1.03995E-20	2
1.00000E-04	2.65475E-05	2.65475E-05	2.61156E-12	2.53150E-09	2.65475E-05	1.03995E-16	3
1.00000E-03	2.65475E-04	2.65475E-04	2.61155E-09	2.53149E-07	2.65475E-04	1.03995E-12	3
1.00000E-02	2.65505E-03	2.65504E-03	2.61137E-06	2.53146E-05	2.65505E-03	1.03994E-08	4
1.00000E-01	2.69056E-02	2.68360E-02	2.58710E-03	2.52690E-03	2.69054E-02	1.03500E-04	5
1.00000E+00	1.30329E+00	5.68440E-01	5.63841E-01	2.88423E-01	1.00134E+00	4.06749E-01	7
1.00000E+01	2.39432E+00	1.14344E+00	5.22438E-01	8.72044E-01	1.30274E+00	1.32050E-01	22
1.00000E+02	2.09095E+00	8.84129E-01	5.77164E-01	8.92182E-01	1.01425E+00	1.15048E-01	124
2.50000E+02	2.04994E+00	8.57740E-01	5.81575E-01	8.92078E-01	9.86410E-01	1.15045E-01	261
5.00000E+02	2.03160E+00	8.47586E-01	5.82800E-01	8.91702E-01	9.75813E-01	1.15044E-01	536
1.00000E+03	2.01996E+00	8.41960E-01	5.83176E-01	8.91216E-01	9.69994E-01	1.15044E-01	1046
1.57080E+03	2.01470E+00	8.39760E-01	5.83197E-01	8.91097E-01	9.67729E-01	1.15044E-01	1624
1.60000E+03	2.01460E+00	8.39694E-01	5.83195E-01	8.91069E-01	9.67654E-01	1.15044E-01	1653
1.80000E+03	2.01350E+00	8.39250E-01	5.83164E-01	8.91037E-01	9.67207E-01	1.15044E-01	1855
2.00000E+03	2.01250E+00	8.38986E-01	5.83178E-01	8.90953E-01	9.66845E-01	1.15044E-01	2057

INDEX OF REFRACTION, REAL PART= 2.2000000000 -IMAGINARY PART= .2200000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.46019E-06	2.46019E-06	3.51544E-15	2.60259E-11	2.46019E-06	1.30152E-20	2
1.00000E-04	2.46019E-05	2.46019E-05	3.51544E-12	2.60269E-09	2.46019E-05	1.30152E-16	3
1.00000E-03	2.46019E-04	2.46019E-04	3.51544E-09	2.60260E-07	2.46019E-04	1.30151E-12	3
1.00000E-02	2.46052E-03	2.46051E-03	3.51514E-06	2.60256E-05	2.46052E-03	1.30150E-08	4
1.00000E-01	2.50910E-02	2.50046E-02	3.47528E-03	2.60536E-03	2.50916E-02	1.29976E-04	5
1.00000E+00	1.71062E+00	6.95027E-01	5.93223E-01	3.30148E-01	1.36500E+00	5.09130E-01	7
1.00000E+01	2.39806E+00	1.18701E+00	5.30037E-01	8.52633E-01	1.29795E+00	1.27495E-01	22
1.00000E+02	2.09098E+00	8.58479E-01	5.89437E-01	8.71316E-01	1.01708E+00	1.44673E-01	124
2.50000E+02	2.05005E+00	8.32507E-01	5.93908E-01	8.70980E-01	9.89590E-01	1.44669E-01	261
5.00000E+02	2.03169E+00	8.22399E-01	5.95214E-01	8.70472E-01	9.79036E-01	1.44668E-01	536
1.00000E+03	2.02001E+00	8.16766E-01	5.95662E-01	8.69900E-01	9.73200E-01	1.44668E-01	1046
1.57080E+03	2.01482E+00	8.14549E-01	5.95721E-01	8.69723E-01	9.70910E-01	1.44668E-01	1624
1.60000E+03	2.01464E+00	8.14476E-01	5.95721E-01	8.69713E-01	9.70841E-01	1.44668E-01	1653
1.80000E+03	2.01353E+00	8.14036E-01	5.95717E-01	8.69651E-01	9.70389E-01	1.44668E-01	1855
2.00000E+03	2.01262E+00	8.13660E-01	5.95710E-01	8.69594E-01	9.70023E-01	1.44668E-01	2057

INDEX OF REFRACTION, REAL PART= 3.0000000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.41047E-20	0.	1.00000E+00	4.18906E-11	1.41047E-20	2.11570E-20	2
1.00000E-04	1.41047E-16	1.57772E-30	1.00000E+00	4.19049E-09	1.41047E-16	2.11570E-16	2
1.00000E-03	1.41047E-12	6.46235E-27	1.00000E+00	4.19048E-07	1.41047E-12	2.11570E-12	2
1.00000E-02	1.41058E-08	2.64698E-22	1.00000E+00	4.19054E-05	1.41058E-08	2.11567E-08	3
1.00000E-01	1.42129E-04	-6.67368E-19	1.00000E+00	4.19718E-03	1.41533E-04	2.11259E-04	3
1.00000E+00	4.14673E+00	0.	1.00000E+00	2.84490E-01	5.82906E+00	5.27721E+00	5
1.00000E+01	2.65951E+00	0.	1.00000E+00	4.55360E-01	1.46191E+00	2.64898E+00	18
1.00000E+02	2.22865E+00	1.42109E-14	1.00000E+00	5.05330E-01	9.24137E-01	1.26966E+01	115
2.50000E+02	2.11853E+00	0.	1.00000E+00	5.00543E-01	8.71684E-01	3.38792E+01	268
5.00000E+02	1.98682E+00	7.10543E-15	1.00000E+00	5.82625E-01	8.28914E-01	1.55144E+01	523
1.00000E+03	2.04787E+00	1.42109E-14	1.00000E+00	5.90669E-01	8.37947E-01	1.50600E+01	1029
1.57080E+03	1.99152E+00	0.	1.00000E+00	5.81720E-01	8.32996E-01	6.96827E+01	1603
1.60000E+03	2.01379E+00	0.	1.00000E+00	5.91715E-01	8.22199E-01	3.57229E+01	1632
1.80000E+03	2.04361E+00	0.	1.00000E+00	5.96062E-01	8.25492E-01	1.26193E+02	1833
2.00000E+03	1.99859E+00	7.10543E-15	1.00000E+00	5.85799E-01	8.27819E-01	4.76167E+01	2036

INDEX OF REFRACTION, REAL PART= 3.4100000000 -IMAGINARY PART= 1.9400000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NM
1.00000E-05	5.82935E-06	5.82935E-06	3.73162E-15	3.79795E-11	5.82935E-06	3.26294E-20	2
1.00000E-04	5.82935E-05	5.82935E-05	3.73162E-12	3.79786E-09	5.82935E-05	3.26294E-16	3
1.00000E-03	5.82938E-04	5.82938E-04	3.73161E-09	3.79787E-07	5.82938E-04	3.26294E-12	3
1.00000E-02	5.83189E-03	5.83187E-03	3.73038E-06	3.79665E-05	5.83189E-03	3.26300E-08	4
1.00000E-01	6.10519E-02	6.08322E-02	3.59916E-03	3.74891E-03	6.10511E-02	3.26915E-04	5
1.00000E+00	3.31318E+00	1.60794E+00	5.14685E-01	9.23301E-02	3.15974E+00	1.95400E+00	7
1.00000E+01	2.40679E+00	8.30295E-01	6.55020E-01	7.08187E-01	1.29034E+00	3.85636E-01	22
1.00000E+02	2.18641E+00	6.38602E-01	6.96830E-01	7.17822E-01	1.05279E+00	4.12369E-01	123
2.50000E+02	2.05875E+00	6.11059E-01	7.03189E-01	7.15229E-01	1.02332E+00	4.12368E-01	281
5.00000E+02	2.03678E+00	5.99080E-01	7.05869E-01	7.13619E-01	1.01001E+00	4.12366E-01	538
1.00000E+03	2.02282E+00	5.91974E-01	7.07302E-01	7.12404E-01	1.00348E+00	4.12365E-01	1047
1.57000E+03	2.01666E+00	5.89075E-01	7.07699E-01	7.11001E-01	1.00051E+00	4.12365E-01	1624
1.60000E+03	2.01647E+00	5.88970E-01	7.07916E-01	7.11779E-01	1.00041E+00	4.12365E-01	1654
1.80000E+03	2.01518E+00	5.88394E-01	7.08018E-01	7.11645E-01	9.99815E-01	4.12365E-01	1856
2.00000E+03	2.01410E+00	5.87920E-01	7.08099E-01	7.11531E-01	9.99330E-01	4.12365E-01	2057

INDEX OF REFRACTION, REAL PART= 4.0000000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NM
1.00000E-05	1.85185E-20	9.62965E-35	1.00000E+00	6.51424E-11	1.85185E-20	2.77778E-20	2
1.00000E-04	1.85185E-16	0.	1.00000E+00	6.51429E-09	1.85185E-16	2.77778E-16	2
1.00000E-03	1.85185E-12	0.	1.00000E+00	6.51429E-07	1.85185E-12	2.77778E-12	2
1.00000E-02	1.85202E-08	1.05879E-22	1.00000E+00	6.51478E-05	1.85190E-08	2.77766E-08	3
1.00000E-01	1.86931E-04	6.67362E-19	1.00000E+00	6.56185E-03	1.85704E-04	2.76530E-04	3
1.00000E+00	6.86217E+00	5.60434E-14	1.00000E+00	1.48414E-03	6.85318E+00	9.20937E+00	5
1.00000E+01	2.51763E+00	0.	1.00000E+00	4.59970E-01	1.35950E+00	1.69280E+01	17
1.00000E+02	2.06970E+00	0.	1.00000E+00	5.27877E-01	9.77797E-01	3.71331E+01	115
2.50000E+02	2.03606E+00	1.42109E-14	1.00000E+00	5.19259E-01	9.79200E-01	5.00066E+01	269
5.00000E+02	2.01358E+00	1.42109E-14	1.00000E+00	5.26995E-01	9.52431E-01	5.79921E+01	523
1.00000E+03	2.03763E+00	2.84217E-14	1.00000E+00	5.33912E-01	9.49714E-01	1.94659E+02	1029
1.57000E+03	2.01532E+00	1.42109E-14	1.00000E+00	5.31656E-01	9.43860E-01	2.56215E+02	1602
1.60000E+03	2.02226E+00	1.42109E-14	1.00000E+00	5.35095E-01	9.40160E-01	2.40736E+02	1633
1.80000E+03	2.01317E+00	1.42109E-14	1.00000E+00	5.34968E-01	9.36191E-01	3.73746E+02	1835
2.00000E+03	2.00574E+00	0.	1.00000E+00	5.31304E-01	9.40002E-01	3.34113E+02	2034

INDEX OF REFRACTION, REAL PART= 5.0000000000 -IMAGINARY PART= 0.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NM
1.00000E-05	2.10700E-20	3.05186E-34	1.00000E+00	9.50933E-11	2.10700E-20	3.16049E-20	2
1.00000E-04	2.10700E-16	3.94430E-31	1.00000E+00	9.50944E-09	2.10700E-16	3.16049E-16	2
1.00000E-03	2.10700E-12	1.29247E-26	1.00000E+00	9.50945E-07	2.10700E-12	3.16049E-12	2
1.00000E-02	2.10721E-08	0.	1.00000E+00	9.51040E-05	2.10701E-08	3.16019E-08	3
1.00000E-01	2.12889E-04	4.33681E-18	1.00000E+00	9.65731E-03	2.10033E-04	3.12957E-04	3
1.00000E+00	7.44460E-01	3.55271E-15	1.00000E+00	-2.23182E-01	9.10619E-01	9.95767E-01	5
1.00000E+01	2.83833E+00	0.	1.00000E+00	5.96406E-01	1.14553E+00	2.61993E+00	17
1.00000E+02	2.06640E+00	1.42109E-14	1.00000E+00	4.82022E-01	1.07035E+00	1.33992E+01	114
2.50000E+02	2.03947E+00	0.	1.00000E+00	5.02013E-01	1.01400E+00	1.90349E+01	270
5.00000E+02	2.05400E+00	1.42109E-14	1.00000E+00	5.05695E-01	1.00752E+00	1.52795E+01	524
1.00000E+03	2.03014E+00	1.42109E-14	1.00000E+00	5.05802E-01	1.00312E+00	4.74531E+01	1028
1.57000E+03	1.99583E+00	0.	1.00000E+00	4.99469E-01	9.98977E-01	7.71083E+01	1604
1.60000E+03	1.99777E+00	3.55271E-14	1.00000E+00	5.01036E-01	9.95216E-01	7.38764E+01	1633
1.80000E+03	2.00548E+00	1.42109E-14	1.00000E+00	5.04132E-01	9.94494E-01	1.56373E+02	1835
2.00000E+03	2.01219E+00	0.	1.00000E+00	5.06295E-01	9.93430E-01	3.61176E+01	2034

INDEX OF REFRACTION, REAL PART= 5.0000000000 -IMAGINARY PART= .1000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NM
1.00000E-05	1.64505E-07	1.64505E-07	1.28116E-13	9.50087E-11	1.64505E-07	3.16135E-20	2
1.00000E-04	1.64505E-06	1.64505E-06	1.28116E-10	9.50089E-09	1.64505E-06	3.16135E-16	3
1.00000E-03	1.64507E-05	1.64507E-05	1.28114E-07	9.50611E-07	1.64507E-05	3.16135E-12	3
1.00000E-02	1.64681E-04	1.64460E-04	1.27992E-04	9.50753E-05	1.64601E-04	3.16105E-08	4
1.00000E-01	2.01928E-03	1.80633E-03	1.05456E-01	9.65371E-03	2.01722E-03	3.13043E-04	5
1.00000E+00	1.89945E+00	3.79396E-01	8.54021E-01	1.02867E-01	1.23855E+00	9.22532E-01	7
1.00000E+01	2.31000E+00	7.46502E-01	6.77954E-01	6.60647E-01	1.23579E+00	6.01293E-01	22
1.00000E+02	2.07929E+00	6.03546E-01	7.09734E-01	6.99532E-01	1.04690E+00	4.44017E-01	123
2.50000E+02	2.04509E+00	5.84072E-01	7.14515E-01	6.98085E-01	1.02053E+00	4.44001E-01	280
5.00000E+02	2.02992E+00	5.75319E-01	7.16581E-01	6.96000E-01	1.01624E+00	4.44599E-01	537
1.00000E+03	2.01930E+00	5.69847E-01	7.17800E-01	6.95962E-01	1.01005E+00	4.44599E-01	1046
1.57000E+03	2.01443E+00	5.67490E-01	7.18206E-01	6.95464E-01	1.00041E+00	4.44599E-01	1623
1.60000E+03	2.01420E+00	5.67419E-01	7.18302E-01	6.95407E-01	1.00083E+00	4.44599E-01	1653
1.80000E+03	2.01322E+00	5.66928E-01	7.18307E-01	6.95350E-01	1.00753E+00	4.44599E-01	1855
2.00000E+03	2.01234E+00	5.66527E-01	7.18474E-01	6.95265E-01	1.00712E+00	4.44599E-01	2056

INDEX OF REFRACTION, REAL PART= 5.0000000000 -IMAGINARY PART= 2.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.50342E-06	2.50342E-06	6.00009E-15	8.17259E-11	2.50342E-06	3.44456E-20	2
1.00000E-04	2.50342E-05	2.50342E-05	6.00009E-12	8.17258E-09	2.50342E-05	3.44456E-16	3
1.00000E-03	2.50345E-04	2.50345E-04	6.00079E-09	8.17267E-07	2.50345E-04	3.44456E-12	3
1.00000E-02	2.50646E-03	2.50644E-03	8.07940E-06	8.17250E-05	2.50646E-03	3.44350E-08	4
1.00000E-01	2.91983E-02	2.09581E-02	7.95277E-03	8.13509E-03	2.91004E-02	3.42321E-04	5
1.00000E+00	3.00969E+00	1.36010E+00	5.45435E-01	2.03300E-02	2.97630E+00	2.13050E+00	7
1.00000E+01	2.33690E+00	7.06300E-01	6.97760E-01	6.65054E-01	1.25240E+00	4.93035E-01	22
1.00000E+02	2.09430E+00	5.61140E-01	7.32061E-01	6.75543E-01	1.05059E+00	4.99907E-01	123
2.50000E+02	2.05437E+00	5.30755E-01	7.37751E-01	6.73140E-01	1.03413E+00	5.00003E-01	280
5.00000E+02	2.03504E+00	5.28177E-01	7.40450E-01	6.71625E-01	1.02299E+00	5.00001E-01	537
1.00000E+03	2.02222E+00	5.21407E-01	7.42161E-01	6.70460E-01	1.01598E+00	5.00000E-01	1046
1.57000E+03	2.01641E+00	5.18473E-01	7.42873E-01	6.69877E-01	1.01290E+00	5.00000E-01	1624
1.60000E+03	2.01621E+00	5.18373E-01	7.42897E-01	6.69856E-01	1.01287E+00	5.00000E-01	1653
1.80000E+03	2.01497E+00	5.17765E-01	7.43040E-01	6.69729E-01	1.01229E+00	5.00000E-01	1855
2.00000E+03	2.01393E+00	5.17265E-01	7.43157E-01	6.69614E-01	1.01174E+00	5.00000E-01	2057

INDEX OF REFRACTION, REAL PART= 6.0020000000 -IMAGINARY PART= 0.8760000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	1.49979E-06	1.49979E-06	1.64463E-14	1.30340E-10	1.49979E-06	3.70407E-20	2
1.00000E-04	1.49979E-05	1.49979E-05	1.64463E-11	1.30351E-08	1.49979E-05	3.70407E-16	3
1.00000E-03	1.49985E-04	1.49985E-04	1.64678E-08	1.30351E-06	1.49985E-04	3.70406E-12	3
1.00000E-02	1.50528E-03	1.50528E-03	1.64105E-05	1.30340E-04	1.50525E-03	3.70424E-08	4
1.00000E-01	2.10663E-02	2.00164E-02	1.18631E-02	1.36891E-02	2.10629E-02	3.64369E-04	5
1.00000E+00	2.85300E+00	1.06432E+00	6.26940E-01	-3.46903E-02	2.91505E+00	2.00513E+00	6
1.00000E+01	2.28967E+00	5.65709E-01	7.52906E-01	6.20090E-01	1.21060E+00	5.39741E-01	22
1.00000E+02	2.08632E+00	4.60306E-01	7.79372E-01	6.30167E-01	1.06171E+00	6.06557E-01	123
2.50000E+02	2.05180E+00	4.42712E-01	7.84232E-01	6.27679E-01	1.04101E+00	6.06490E-01	280
5.00000E+02	2.03434E+00	4.33623E-01	7.86549E-01	6.26115E-01	1.03211E+00	6.06495E-01	537
1.00000E+03	2.02220E+00	4.27324E-01	7.88692E-01	6.24925E-01	1.02550E+00	6.06494E-01	1046
1.57000E+03	2.01663E+00	4.24409E-01	7.89545E-01	6.24332E-01	1.02256E+00	6.06494E-01	1623
1.60000E+03	2.01643E+00	4.24307E-01	7.89575E-01	6.24310E-01	1.02245E+00	6.06494E-01	1653
1.80000E+03	2.01520E+00	4.23603E-01	7.89757E-01	6.24177E-01	1.02181E+00	6.06494E-01	1855
2.00000E+03	2.01410E+00	4.23160E-01	7.89907E-01	6.24065E-01	1.02128E+00	6.06494E-01	2057

INDEX OF REFRACTION, REAL PART= .0500000000 -IMAGINARY PART= 50.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	9.61543E-11	9.61543E-11	2.77990E-10	-8.32160E-09	9.61543E-11	4.00961E-20	2
1.00000E-04	9.62203E-10	9.62203E-10	2.77000E-07	-8.32164E-07	9.62203E-10	4.00962E-16	3
1.00000E-03	1.02044E-08	1.02017E-08	2.59916E-04	-8.31967E-05	1.02044E-08	4.01029E-12	3
1.00000E-02	7.56974E-07	7.32238E-07	3.52262E-02	-8.12702E-03	7.59191E-07	4.07592E-08	4
1.00000E-01	3.60979E-04	7.31263E-05	7.97422E-01	-2.40916E-01	4.30320E-04	6.39211E-04	5
1.00000E+00	2.12407E+00	2.05203E-04	9.99903E-01	-1.74340E-01	2.49436E+00	3.74642E+00	6
1.00000E+01	2.00927E+00	1.21350E-04	9.99942E-01	4.92522E-01	1.00032E+00	9.05021E-01	19
1.00000E+02	2.02053E+00	1.10477E-04	9.99945E-01	5.03540E-01	1.00317E+00	9.97754E-01	116
2.50000E+02	2.01351E+00	1.09729E-04	9.99946E-01	5.02422E-01	1.00113E+00	9.99004E-01	271
5.00000E+02	2.01033E+00	1.09473E-04	9.99946E-01	5.02326E-01	1.00055E+00	9.99807E-01	525
1.00000E+03	2.00810E+00	1.09347E-04	9.99946E-01	5.01925E-01	1.00020E+00	9.99355E-01	1031
1.57000E+03	2.00714E+00	1.09300E-04	9.99946E-01	5.01713E-01	1.00019E+00	9.99991E-01	1606
1.60000E+03	2.00710E+00	1.09299E-04	9.99946E-01	5.01705E-01	1.00019E+00	9.99541E-01	1636
1.80000E+03	2.00687E+00	1.09290E-04	9.99946E-01	5.01655E-01	1.00017E+00	9.99556E-01	1837
2.00000E+03	2.00667E+00	1.09283E-04	9.99946E-01	5.01613E-01	1.00015E+00	9.99861E-01	2038

INDEX OF REFRACTION, REAL PART= 50.0000000000 -IMAGINARY PART= 50.0000000000

X	QEXT	QABS	ALBEDO	ASYM	QPR	QBAK	NN
1.00000E-05	2.40007E-08	2.40007E-08	1.11100E-12	1.16053E-11	2.40007E-08	4.00000E-20	2
1.00000E-04	2.40667E-07	2.40667E-07	1.10003E-09	1.15673E-09	2.40667E-07	4.00000E-16	3
1.00000E-03	3.06667E-06	3.06667E-06	8.69565E-07	3.73010E-06	3.06667E-06	4.00000E-12	3
1.00000E-02	6.09112E-04	6.09085E-04	3.87125E-05	-7.79710E-04	6.09112E-04	4.00780E-08	4
1.00000E-01	4.05973E-02	4.02921E-02	6.26020E-03	-3.05637E-01	4.06004E-02	7.36320E-04	5
1.00000E+00	2.14029E+00	1.00350E-01	9.53110E-01	-1.72006E-01	2.49255E+00	3.57404E+00	7
1.00000E+01	2.09358E+00	5.60617E-02	9.72076E-01	5.00626E-01	1.07475E+00	6.75461E-01	21
1.00000E+02	2.02192E+00	5.25460E-02	9.74012E-01	5.11922E-01	1.01375E+00	9.59710E-01	121
2.50000E+02	2.01402E+00	5.19416E-02	9.74210E-01	5.11679E-01	1.01124E+00	9.60763E-01	277
5.00000E+02	2.01030E+00	5.16379E-02	9.74313E-01	5.10490E-01	1.01042E+00	9.60793E-01	534
1.00000E+03	2.00769E+00	5.13946E-02	9.74401E-01	5.10012E-01	1.00996E+00	9.60792E-01	1042
1.57000E+03	2.00639E+00	5.12540E-02	9.74455E-01	5.09759E-01	1.00974E+00	9.60792E-01	1616
1.60000E+03	2.00635E+00	5.12465E-02	9.74457E-01	5.09750E-01	1.00974E+00	9.60792E-01	1646
1.80000E+03	2.00605E+00	5.12133E-02	9.74471E-01	5.09091E-01	1.00969E+00	9.60792E-01	1850
2.00000E+03	2.00580E+00	5.11623E-02	9.74483E-01	5.09641E-01	1.00965E+00	9.60792E-01	2051