Interaction Notes

Note 530

July 7, 1997

A Library of the Natural Frequency Responses for Cylindrical Shaped Buried Plastic Mines

Mark C. Worthy
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Abstract

The dielectric mine problem is presented. An approximate approach for finding the natural frequencies of dielectric targets in a dielectric medium is presented. This perturbation approach is shown for the dielectric sphere, infinite slab, infinite cylinder, and finite cylinder. A region where this approach is "accurate" is shown. In the Appendix section a library of dielectric cylindrical shaped mines is presented. The library gives the name, country of origin, countries using, and electromagnetic information about 79 different anti-personnel and anti-tank mines. A method for using this library is presented and demonstrated. If this library proves effective it is suggested that the user input all of the data into software for real time (and easier) manipulation.

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I. Introduction

The problem of detecting buried dielectric land mines has been heavily documented in recent years. Former war zone areas like Bosnia, Iraq, and Afghanistan have demonstrated just how lacking in technology we are in finding buried plastic targets. One common cry from the scientist and military personnel working on this problem has been to establish a library of the natural frequency responses for each and every plastic land mine. With such a library a user could know if what has been detected is of interest.

In 1994 Dr. Carl E. Baum developed a method for using perturbation formulas (much more condensed, yet approximate, mathematical formulas) to find the signatures of dielectric targets in a dielectric medium. He applied this method for the sphere and the infinite slab [Baum, 1994]. In 1996 Dr. George Hanson applied Carl's method for both the infinite and truncated cylinder [Hanson, 1996]. I then used both Carl's and George's equations to compare them with the exact pole locations. I had calculated the exact pole locations for buried dielectric spheres, infinite slabs, and infinite cylinders [Worthy, 1997]. After comparing the results I was able to establish an "effective" region for using the perturbation method. With this effective region one could decide whether or not to use the perturbation formulas by simply entering in their soil conditions (ε and σ) and the radius of the target into an equation and see if the result of this equation falls within an acceptable percent error [Worthy, 1997].

It is the purpose of this paper to supply the radar user with all of the tools needed to quickly find the pole locations of 79 different plastic anti-tank and anti-personnel mines. These are mines that are approximately cylindrical in shape. The names, country of origin, countries known to use, and important electromagnetic information about each of these mines will be provided.

II. Definitions & Equations

Before we look at the perturbed functions its important that we define some necessary terms. The relative dielectric constant, ε_r, will be defined as

$$\varepsilon_r \equiv \frac{target}{medium} = \frac{\varepsilon_2}{\varepsilon_1}$$

The propagation constants for the medium, γ_1, and the target, γ_2, are

$$\gamma_1 = s\sqrt{\mu_o \varepsilon_1}\left[1 + \frac{\sigma_1}{s\varepsilon_1}\right]^{\frac{1}{2}}$$

and

$$\gamma_2 = s\sqrt{\mu_o \varepsilon_2}$$

where $s = \Omega + j\omega \equiv$ the complex frequency.

The ratios of these propagation constants, ξ, will be defined as

$$\xi(s) \equiv \frac{\gamma_1}{\gamma_2} = \varepsilon_r^{-\frac{1}{2}}\left[1+\frac{\sigma_1}{s\varepsilon_1}\right]^{\frac{1}{2}}$$

We will define the natural frequencies as

$$s_\alpha = s_{\alpha,0} + \Delta s_\alpha$$

We will call a either the radius of the sphere, the thickness of the slab, or the radius of the cylinder. We will have a normalization factor T_a such that:

$$T_a = \sqrt{\mu_o \varepsilon_2} a$$

Therefore:

$$s_\alpha T_a = s_{\alpha,0} T_a + \Delta s_\alpha T_a$$

Now we are ready for the perturbation formulas.

III. The Perturbation Method

The general method for the perturbed functions involves solving for two terms $s_{\alpha,0}$, and Δs_α. The $s_{\alpha,0}$ term is found from the exact theoretical equations by applying the limiting case when $\xi \to \infty$. Therefore, for the infinite slab $s_{\alpha,0}$ is found from [Baum, 1994]:

$$\sinh(s_{\alpha,0} T_a) = 0 \text{, or in other words: } \sinh(s_{\alpha,0}\sqrt{\mu_o \varepsilon_2} a) = 0$$

For the dielectric sphere $s_{\alpha,0}$ found from, for the H-modes [Baum, 1994]:

$$i_n(s_{\alpha,0} T_a) = 0 \text{, or in other words: } i_n(s_{\alpha,0}\sqrt{\mu_o \varepsilon_2} a) = 0$$

and for the E-modes:

$$\left[s_{\alpha,0} T_a i_n(s_{\alpha,0} T_a)\right]' = 0 \text{, or in other words: } \left[s_{\alpha,0}\sqrt{\mu_o \varepsilon_2} r i_n(s_{\alpha,0}\sqrt{\mu_o \varepsilon_2} r)\right]' = 0$$

where $i_n(x)$ are modified spherical Bessel functions.

For the infinite cylinder where $s_{\alpha,o} = j\omega_{\alpha,o}$, for the E-modes $s_{\alpha,0}$ can be found from $J_n(\omega_{\alpha,0} T_a) = 0$, and for the H-modes $s_{\alpha,0}$ can be found from $J_n'(\omega_{\alpha,0} T_a) = 0$ [Hanson, 1996].

Next we will look at the Δs_α terms. Notice that the Δs_α terms all have a similar look to them. For the infinite slab [Baum, 1994]:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})$$

As for the sphere Δs_α for the E-modes can be found from [Baum, 1994]:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})\left[\frac{(s_{\alpha,0}T_a)^2}{(s_{\alpha,0}T_a)^2 + n(n+1)}\right]$$

and for the H-modes:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0}).$$

For the infinite cylinder we see a shift from the E to the H modes. Such that now for the H-modes:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})$$

and for the E-modes [Hanson, 1996]:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})\left[\frac{(s_{\alpha,0}T_a)^2}{(s_{\alpha,0}T_a)^2 + n^2}\right]$$

The reason for the difference in the E and H modes for Baum's and Hanson's work is that Baum's equations were with respect to the normal of the sphere's surface where as Hanson's equations were with respect to the z-axis (which runs along the height of the cylinder).

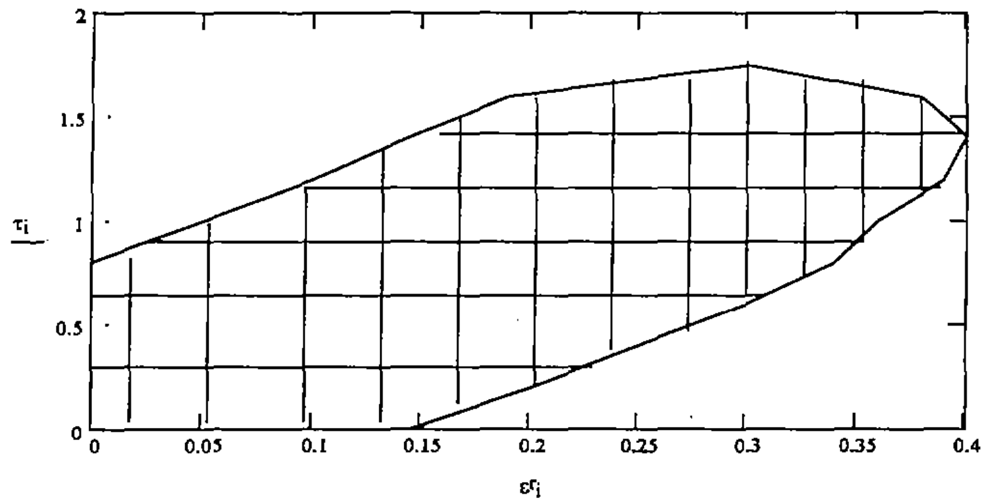
IV. *The Effective Region*

In establishing an effective region for the perturbation functions I found the "exact" pole locations (from the theoretical equations) for the slab, sphere, and infinite cylinder. I investigated 42 different situations (different α, σ_1, ε_1, and ε_2).

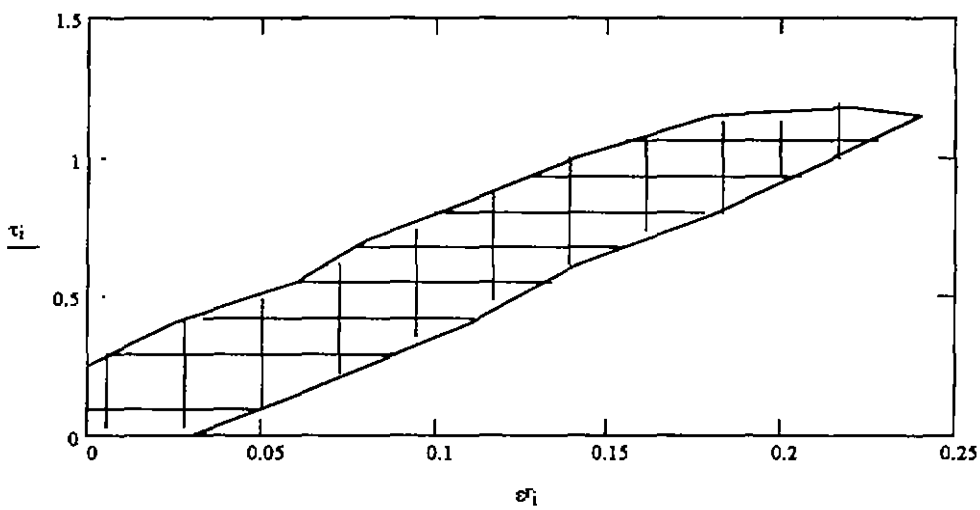
I then condensed all 42 different cases into a graph that establishes an effective region for the perturbation functions. This required two jobs. First I found the percent errors for all 42 cases between the exact versus perturbed poles. Then I established two unit-less parameters, τ and ε_r, for graphing. Where:

$$\tau = \frac{r\sigma_1\sqrt{\mu_o\varepsilon_2}}{\varepsilon_1} \quad \text{and} \quad \varepsilon_r = \frac{\varepsilon_2}{\varepsilon_1}$$

In the following graphs (next page) everything inside the curves represents a "good" region. In the first graph the perturbed functions were less than 6% off for the region inside the curve, and in the second graph the perturbed functions were less than 2% off.



Graph 1: < 6% error for perturbed functions



Graph 2: < 2% error for perturbed functions

Notice from the graphs that there are many cases where some ε_r contains "good" values but for σ_1=0 (τ=0) the percent errors were to large to be considered "good." I noticed when compiling the percent errors that as σ_1 is increased (hence, as τ is increased) the error decreased until it reached some minimum, then the error would begin to increase until it was too large to be considered "good." This explains the reason for the similar shapes of the two graphs ("<6% error," versus "<2% error").

The most important result in establishing these effective regions was that the percent errors were the same for the slab, sphere, and infinite cylinder. This seems to suggest that the effectiveness of the perturbation formulas does not depend upon the geometry of the target.

V. The Finite Cylinder

In 1996 George Hanson applied Carl's method to a more applicable shape; the finite cylinder. It's George's results that will enable us to find the pole locations for the dielectric mine. Where for the E-modes [Hanson, 1996]:

$$s_{\alpha,0}T_a = i\sqrt{x_{n,p}^{\;2} + \left[\frac{q\pi a}{d}\right]^2}$$

Where a is the radius and d is the height of the cylinder. q describes the variation along the height of the cylinder and $x_{n,p}$ is the p-th resonance of the n-th order Bessel function [Hanson, 1996]. Therefore, $x_{n,p}$ is found from $J_n(x_{n,p}) = 0$. Similarly, for the H-modes:

$$s_{\alpha,0}T_a = i\sqrt{x_{n,p}^{\prime\;2} + \left[\frac{q\pi a}{d}\right]^2}$$

where $x'_{n,p}$ is found from $J_n^{'}(x'_{n,p}) = 0$. Note that all of the $s_{\alpha,0}T_a$ values will be <u>imaginary</u>.

The Δs_α values are also a little more complicated for the finite cylinder than the infinite cylinder. Where for the E-modes [Hanson, 1996]:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})\left[1 + \frac{2a}{(1+\delta_{q,0})d}\right]$$

and for the H-modes:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0})\left[\frac{\left(\frac{nq\pi a}{d}\right)^2 + x_{n,p}^{\prime\;4} + \frac{2a}{d}\left(\frac{q\pi a}{d}\right)^2 (x_{n,p}^{\prime\;2} - n^2)}{(s_{\alpha,0}T_a)^2(n^2 - x_{n,p}^{\prime\;2})}\right]$$

where $\delta_{q,0}$ is the Kronecker delta function. n corresponds to the Bessel functions (n = 0,1,2, etc.). As for q, q = 0,1,2, etc. for the E-modes and q = 1,2,3, etc. for the H-modes; however, $q > 2$ corresponds to $a \ll d$ or $a \gg d$.

For the case of the dielectric mine we are only concerned with the dominant poles. So we will only solve for n = 0, 1, and 2. Similarly since a and d are so close (not varying by more than say a factor of 3) we will only need to look at q = 0 and 1 for the dominant poles.

VI. Dielectric Properties of Soils and Mines

Before applying our formulas one must know the dielectric properties of the target and medium. The scattering of electromagnetic waves occur when there is a difference between the dielectric properties of the target and the medium. Dielectric (plastic) targets of interest in the mine problem typically have a permittivity, ε, of about 2.5 ε_o. The earth, unfortunately, is not as predictable.

The dielectric properties of soil not only depend upon the type of soil but also the amount of moisture (and minerals) in the soil. For clays as the water content rises from 0 to 40% ε rises quickly from 3 to $\cong 20\,\varepsilon_o$ [Wang, 1978]. For sandy soils ε rises from 3 to $\cong 30\,\varepsilon_o$ [Wang, 1978]. The conductivity, σ, of the soils rises from ≅.001 to ≅.1 S/m for a rise in water content. Again, you must know the permittivity and conductivity of the soil of interest before you can use this paper.

The effectiveness region established for the perturbation functions would be applicable to many different soils. Where for soils (with plastic targets) τ ranges between 0 and 1 and ε_r ranges between 0.1 and 0.6. The "<6% error" graph shows "good" results for τ ranging (nonlinearally) from 0 to 1.75 and ε_r ranging (nonlinearally) from 0 to 0.4. The **best** results from the perturbed functions correspond to low-moisture soils.

VII. How the library works

A complete library of pole locations of dielectric mines in a dielectric medium would be an impossible task since there are infinite different possible values for σ_1 and ε_1 (even within our soil range and effective region). Therefore, what I've done is compile a library of parameters for each land mine such that the user can quickly calculate the poles for the mine by simply inputting their particular soil conditions.

For the parameters I let

$$CE_q = \left[1 + \frac{2a}{(1+\delta_{q,0})d}\right]$$

for the E-modes, and

$$CH_q = \left[\frac{\left(\frac{nq\pi a}{d}\right)^2 + x'^{\,4}_{n,p} + \frac{2a}{d}\left(\frac{q\pi a}{d}\right)^2 (x'^{\,2}_{n,p} - n^2)}{(s_{\alpha,0}T_a)^2 (n^2 - x'^{\,2}_{n,p})}\right]$$

for the H-modes. Therefore:

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0}) CE_q$$

for the E-modes and

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0}) CH_q$$

for the H-modes.

I've also calculated all of the $s_{\alpha,0}T_a$ values for each mine. Hence, in order to find the pole locations for a particular mine the user will only have to calculate

$$\xi(s_{\alpha,0}) = \varepsilon_r^{-\frac{1}{2}}\left[1 + \frac{\sigma_1}{s_{\alpha,0}\varepsilon_1}\right]^{\frac{1}{2}} .$$

Since, however, this is a repeated calculation (there are 27 s_α values we are solving for) the user might wish to enter the tabulated (library) values in a math software program. This could potentially allow for real time identification (if a user had all of the library data entered in their computer).

VIII. Example

As an example lets say you have radar of a suspected mine field laid by the Polish army. You've eliminated all the metallic mine choices. Unfortunately at this time radar technology can't tell you if the remaining "blips" on the screen are plastic mines or a child's toy. What do you do?

Assuming that you don't already have the library data in your computer, you should first (if you know the soil conditions) go to Appendix A. In Appendix A I have tabulated a list (with the help of a CD-ROM called "Mine Facts") of all the plastic cylindrically shaped anti-personnel and anti-tank mines from all over the world. From this list you can see that the only plastic land mines used by the Polish army are four anti-tank mines: the MPP-B, the PT M1-BA III, the TM-62P, and the TM-62P3.

Next you will want to calculate the natural frequencies of these mines to see if they could possibly be the "blips" on your screen (we will only look at one; the MPP-B). To do this you must first see if the soil conditions will allow you to use the perturbations formulas (i.e. check the effective region). Lets say that the soil in the mine field has a permittivity of $\varepsilon_1 = 12\varepsilon_0$ and a conductivity of $\sigma_1 = 0.05\,\mathrm{S/m}$. From Appendix C we see that the radius of the MPP-B is 0.16m. This means that $\varepsilon r = 0.2083333333$ and $\tau = 0.3971083449$. Upon looking at the "effective region" graph we see that these values do lie within the < 6% error region.

So, lets see what Appendix C says about the MPP-B:

MPP-B

radius a = 0.16 height d = 0.128

	n=0:	n=1:	n=2:
These are the $s_\alpha T_\alpha$ values for the E modes for q = 0:	$sEoT_{0,p}$	$sEoT_{1,p}$	$sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i
These are the $s_\alpha T_\alpha$ values for the E modes for q = 1:	$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
	4.6048279183i	5.4866436371i	6.4649709714i
	6.7744016712i	8.0398855666i	9.2882283614i
	9.5030651827i	10.905079033i	12.265477508i
These are the $s_\alpha T_\alpha$ values for the H modes for q = 1:	$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
	5.4866401453i	4.3371881063i	4.9749008889i
	8.0398820763i	6.6215941699i	7.7713214097i
	10.905069704i	9.3962767104i	10.715016983i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.25$ $CE_q = 3.5$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.76841896882	2.64810666907	2.68533321983
1.35785877665	1.56404114441	1.48064707559
1.19451546663	1.27591313117	1.24340989006

Now, recall the necessary equations:

$$s_\alpha T_a = s_{\alpha,0} T_a + \Delta s_\alpha T_a$$

$$\Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0}) CE_q, \quad \Delta s_\alpha T_a = -\xi^{-1}(s_{\alpha,0}) CH_q$$

$$\xi(s_{\alpha,0}) = \varepsilon_r^{-\frac{1}{2}} \left[1 + \frac{\sigma_1}{s_{\alpha,0}\varepsilon_1} \right]^{\frac{1}{2}}$$

$$T_a = \sqrt{\mu_o \varepsilon_2} a$$

$$s_\alpha = s_{\alpha,0} + \Delta s_\alpha$$

Calculating T_a we find that $T_a = 8.43858 \times 10^{-10}$. Notice that the $s_{\alpha,0} T_a$ values are given (in the Appendix these $s_{\alpha,0} T_a$ values are always imaginary even though the software occasionally cuts off the symbol-i).

Now, in order to solve for s_α we must solve for all of the $\Delta s_\alpha T_a$ values for the E and H modes. This means calculating $-\xi(s_{\alpha,0})^{-1}$ for all 27 $s_{\alpha,0} T_a$ values and multiplying by the corresponding CE and CH values.

Next, add these $\Delta s_\alpha T_a$ values to the corresponding $s_{\alpha,0} T_a$ values, and finally divide all of these numbers by T_a.

Doing so gives the following results:

Poles for the **E-modes**:

q = 0

n = 0:

$s_\alpha = -1.20480 \times 10^9 \pm 2.75099 \times 10^9 i$ Rad/s

$s_\alpha = -1.21465 \times 10^9 \pm 6.49784 \times 10^9 i$ Rad/s

$s_\alpha = -1.21604 \times 10^9 \pm 1.02270 \times 10^{10} i$ Rad/s

n = 1:

$s_\alpha = -1.21214 \times 10^9 \pm 4.47805 \times 10^9 i$ Rad/s.

$s_\alpha = -1.21554 \times 10^9 \pm 8.27933 \times 10^9 i$ Rad/s

$s_\alpha = -1.21631 \times 10^9 \pm 1.20321 \times 10^{10} i$ Rad/s

n = 2:

$s_\alpha = -1.21428 \times 10^9 \pm 6.03900 \times 10^9 i$ Rad/s

$s_\alpha = -1.21599 \times 10^9 \pm 9.94603 \times 10^9 i$ Rad/s

$s_\alpha = -1.21647 \times 10^9 \pm 1.37491 \times 10^{10} i$ Rad/s

q = 1

n = 0:

$s_\alpha = -1.88786 \times 10^9 \pm 5.37562 \times 10^9 i$ Rad/s

$s_\alpha = -1.89068 \times 10^9 \pm 7.97252 \times 10^9 i$ Rad/s

$s_\alpha = -1.89188 \times 10^9 \pm 1.12219 \times 10^{10} i$ Rad/s

n = 1:

$s_\alpha = -1.88941 \times 10^9 \pm 6.43356 \times 10^9 i$ Rad/s

$s_\alpha = -1.89138 \times 10^9 \pm 9.48084 \times 10^9 i$ Rad/s

$s_\alpha = -1.89217 \times 10^9 \pm 1.28884 \times 10^{10} i$ Rad/s

n = 2:

$s_\alpha = -1.89044 \times 10^9 \pm 7.60319 \times 10^9 i$ Rad/s

$s_\alpha = -1.89182 \times 10^9 \pm 1.09664 \times 10^{10} i$ Rad/s

$s_\alpha = -1.89237 \times 10^9 \pm 1.45043 \times 10^{10} i$ Rad/s

Poles for the **H-modes**:

q = 1

n = 0:

$s_\alpha = -9.54650 \times 10^8 \pm 6.46734 \times 10^9 i$ Rad/s

$s_\alpha = -7.33782 \times 10^8 \pm 9.50941 \times 10^9 i$ Rad/s

$s_\alpha = -6.45781 \times 10^8 \pm 1.29111 \times 10^{10} i$ Rad/s

n = 1:

$s_\alpha = -1.42786 \times 10^9 \pm 5.07448 \times 10^9 i$ Rad/s

$s_\alpha = -8.44837 \times 10^8 \pm 7.82149 \times 10^9 i$ Rad/s

$s_\alpha = -6.89668 \times 10^8 \pm 1.11203 \times 10^{10} i$ Rad/s

n = 2:

$s_\alpha = -1.44901 \times 10^9 \pm 5.83768 \times 10^9 i$ Rad/s

$s_\alpha = -8.00086 \times 10^8 \pm 9.18884 \times 10^9 i$ Rad/s

$s_\alpha = -6.72203 \times 10^8 \pm 1.26851 \times 10^{10} i$ Rad/s

IX. Conclusions

The dielectric mine problem was presented. An approximate approach for finding the natural frequencies of dielectric targets in a dielectric medium was presented. This perturbation approach was shown for the dielectric sphere, infinite slab, infinite cylinder, and finite cylinder. A region where this approach is "accurate" was presented.

In the Appendix section a library of dielectric cylindrical shaped mines is presented. The library gives the name, country of origin, countries using, and electromagnetic information about 79 different anti-personnel and anti-tank mines.

A method for using this library is presented and demonstrated. If this library proves effective it is suggested that the user input all of the data into software for real time (and easier) manipulation.

Acknowledgments

I would to recognize Carl E. Baum for his guidance in this project. I would also like to most graciously thank AFOSR and Phillips Laboratory for their sponsorship in this work.

About the Appendices

Appendix A list all of the plastic land mines with an approximate uniform cylindrical shape (which makes them applicable to our perturbation functions). For each mine a list of the country (countries) who manufacture the mine and the countries who use the mine is given.

Appendix B contains all of the $s_{\alpha,0}T_a$, CE, CH, and dimensional values for 36 different plastic anti-personnel mines. These mines are listed in alphabetical order. The $s_{\alpha,0}T_a$ values are in radians (and are all imaginary whether they have the symbol or not). The radius and height values are in meters. The CE and CH values are unit-less.

Appendix C contains all of the $s_{\alpha,0}T_a$, CE, CH, and dimensional values for 38 different plastic anti-tank mines. These mines are listed in alphabetical order. The $s_{\alpha,0}T_a$ values are in radians (and are all imaginary whether they have the symbol or not). The radius and height values are in meters. The CE and CH values are unit-less.

Appendix A: Cylindrical-Plastic-Mines List

A-I. Anti-Personnel Mines

Mine	*Made By*	*Counties Used By*
AP NM M14	India	India
AUPS	Italy	Italy
CP-X.01	Spain	Spain
DM-11	Sweden & Former West Germany	Sweden, Switzerland, Germany, Angola, Zambia, Eritrea, Ethiopia
DM-39	Former West Germany	Former West Germany
FMK-1	Argentina	Argentina, Falkland Islands
LBA Type A&B	Italy	Italy
M14	USA, India, & Vietnam	USA, India, Vietnam, Malawi, Angola, Iraq, Iran, Zambia, Somalia, Eritrea, Ethiopia, Cambodia
MAP II	Chile	Chile
MD-82-B	Vietnam	Vietnam, Cambodia
MGP.30	Peru	Peru
MN-79	Vietnam	Vietnam, Cambodia
NR22C1	France	Netherlands
P5	Spain	Spain
P4 MK1	Pakistan	Pakistan, Somalia, Afghanistan
PATVAG 59	Switzerland	Switzerland, Egypt, Portugal
PATVAG M3	Switzerland	Unknown
PM 79	Bulgaria	Bulgaria
PMA-3	Former Yugoslavia	Former Yugoslavia, Namibia, South Africa, Cambodia
PMP 71	Former East Germany	Germany, Somalia, Ethiopia, Eritrea
PP M1-SR II	Former Czechoslovakia	Afghanistan, Czech & Slovak Republics, Nicaragua, South Africa, Mozambique, Zambia, Somalia, Eritrea, Ethiopia
PPM-2 (variant)	China	China
PRB BAC H-28	Belgium	Belgium
PRB M409	Belgium & Portugal	Belgium, Portugal, Angola, Zambia, Iraq, Namibia, South Africa, Somalia
R2M2	South Africa	South Africa, Namibia, Zimbabwe, Zambia
TM-100	Former Yugoslavia	Former Yugoslavia
TRUPPMINA-10	Sweden	Sweden, Germany, Switzerland, Austria
TYPE 68	China	China
TYPE 72	China & South Africa	Afghanistan, Cambodia, China, Iraq, Pakistan, South Africa, Angola, Zambia, Somalia, Eritrea, Ethiopia
TYPE 72B	China	China, Cambodia
TYPE 72C	China	China
U/I TH AP.1&.2	Thailand	Thailand
(SD/AD)	China	China
VS-MK2-EL	Italy	Unknown

A-II. Anti-Tank Mines

Mine	*Made By*	*Counties Used By*
AT-1A	India	India
B MK1	Egypt & Italy	Egypt, Somalia
BAT/7	Italy	Unknown
K-1	Former East Germany	Former East Germany
L-3	United Kingdom	United Kingdom
M/52	Denmark	Denmark
M453	Portugal	Portugal
MAT F5	Chile	Chile
MAT-62B	Romania	Romania
MAT-87	Romania	Romania
MAT-U-9-10,20,30	Unknown	Romania
MAT/5	Italy	Italy
MATS/2.6	Italy	Italy
MGP.31	Peru	Peru
MPP-B	Poland	Poland
NA-MI-BA	Former Czechoslovakia	Former Czechoslovakia
No. 22	Israel	Israel
P3 MK1	Pakistan	Pakistan, Somalia, Afghanistan
P3 MK2	Pakistan	Pakistan
PT M1-BA III	Former Czechoslovakia	Czech & Slovak Republics, Iraq, Poland, South Africa, Namibia, Mozambique, Angola, Zambia, Somalia, Eritrea, Ethiopia
PTM 80P	Bulgaria	Bulgaria
SACI 54/7	Italy & Egypt	Italy, Egypt, Somalia
SACI 54/9	Italy	Italy
SACI IMAC-10,5,7	Italy	Unknown
SB-81 & 81/AR	Italy & Spain	Italy, Egypt, Somalia
SBMV/1	Italy	Unknown
T.C. 6	Egypt	Egypt, Somalia, Afghanistan
TC/2.4	Italy	Italy, Iraq
TM-62P	Former Soviet Union, Bulgaria, & Poland	Former USSR, Poland, Germany, Egypt, Bulgaria, Zambia, Mozambique, South Africa
TM-62P3	Former USSR & Germany	Former USSR, Poland, Egypt
TMA-1	Former Yugoslavia	Former Yugoslavia
TYPE 69	China	China
TYPE 72	China, South Africa	China, Iraq, Jordan, South Africa, Angola, Zambia
TYPE 81	China	China
U/I TH	Thailand	Thailand
VS-1.6	Italy	Italy, Iraq
VS-HCT	Italy	Italy

Appendix B: Pole Parameters for Anti-Personnel Mines

AP NM M14

radius height
$a = 0.025$ $d = 0.043$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.0198199292i	4.2447768667i	5.4507542514i
5.8144122876i	7.2494573709i	8.6131328993i
8.844383535i	10.3361318183i	11.7625171945i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.2447723533i	2.5934673541i	3.5587232404i
7.2494534999i	5.6356349773i	6.9504178796i
10.3361219757i	8.7295411258i	10.1354063167i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.5813953488$ $CE_q = 2.1627906977$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0301414144	1.4991639946	1.7935798176
1.0103338439	1.0535637056	1.108869402
1.0050834339	1.0210409702	1.0472197369

AUPS

radius height
$a = 0.051$ $d = 0.036$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.0587479679i	5.8727973953i	6.7957590088i
7.0907692705i	8.3082038233i	9.5214325046i
9.7311221713i	11.1043792966i	12.4430072469i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.872794133i	4.8163981889i	5.3977893345i
8.3082004456i	6.9449262196i	8.0485978467i
11.1043701349i	9.6268638125i	10.9177873126i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.4166666667$ $CE_q = 3.8333333333$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.0528996381	2.9838430681	2.9970602793
1.5260930918	1.789370942	1.6582052522
1.2945022872	1.4057525435	1.3465872421

CP-X.01

radius height

$a = 0.0355$ $d = 0.037$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.8560044776i	4.8752014087i	5.9548450891i
6.289423533i	7.6357115123i	8.9406664443i
9.1636552882i	10.6106116267i	12.0044270532i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.8751974789i	3.5320717778i	4.2911501056i
7.6357078371i	6.1245277144i	7.3523987125i
10.6106020386i	9.0528639884i	10.4151773548i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.9594594595$ $CE_q = 2.9189189189$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.3512738104	2.0876433393	2.2040982547
1.1431962322	1.2590434855	1.2520715953
1.0741566571	1.1157870428	1.1188986057

DM-11

radius height
$a = 0.041$ $d = 0.0335$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.5350527002i	5.4282152903i	6.4154588688i
6.7271673711i	8.0001264216i	9.2538342827i
9.4694514468i	10.8757993524i	12.2394526568i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4282117608i	4.2630345419i	4.9103871223i
8.0001229138i	6.5732619138i	7.7301810645i
10.8757899982i	9.3622795758i	10.6852165067i

The C values for the E modes for:
q=0 and q=1
$CE_o = 2.223880597$ $CE_q = 3.447761194$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7263755429	2.5961263851	2.6383501089
1.3344116951	1.5318149128	1.4558023635
1.1809477345	1.2580950811	1.2293927596

DM-39

radius height
$a = 0.05$ $d = 0.04$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6048279183i	5.4866436371i	6.4649709714i
6.7744016712i	8.0398855666i	9.2882283614i
9.5030651827i	10.9050790331i	12.2654775081i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4866401453i	4.3371881063i	4.9749008889i
8.0398820763i	6.6215941699i	7.7713214097i
10.905069704i	9.3962767104i	10.7150169835i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.25$ $CE_q = 3.5$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7684189682	2.6481066907	2.6853321983
1.3578587765	1.5640411441	1.4806470759
1.1945154663	1.2759131317	1.2434098906

FMK-1

radius height

$a = 0.041$ $d = 0.0467$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.6593084775i	4.7211605329i	5.8294037463i
6.1707873387i	7.5382927975i	8.8576116686i
9.0826398279i	10.5407232719i	11.9426980569i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.7211564749i	3.3162175812i	4.1153052415i
7.5382890749i	6.0026333993i	7.2511747207i
10.5407136203i	8.970848031i	10.3439686453i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.8779443255$ $CE_q = 2.755888651$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.257985165	1.9413040445	2.0902341728
1.1011919459	1.1960548861	1.2069913202
1.0517549024	1.0853679189	1.0956753799

LBA Type A & B

radius height

$a = 0.054$ $d = 0.033$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.6754633574i	6.411684846i	7.2665186868i
7.5431400734i	8.6974826294i	9.8629422719i
10.0655199583i	11.3985610005i	12.706234008i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
6.411681858i	5.4605535281i	5.9796390375i
8.6974794029i	7.4062104692i	8.4498450056i
11.3985520753i	9.9647609195i	11.2168637828i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.6363636364$ $CE_q = 4.2727272727$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.4610422637	3.4327626395	3.4304938174
1.793998882	2.1314653113	1.9388465107
1.4622823725	1.6187994288	1.5193125277

M 14

radius *height*
a = 0.028 d = 0.04

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2587251245i	4.4179302485i	5.5866536443i
5.9420002762i	7.3521839752i	8.699772145i
8.9287791521i	10.4084387877i	11.826106197i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.417925912i	2.8681091243i	3.7635738513i
7.3521801583i	5.7671794345i	7.0574985465i
10.4084290135i	8.8150363186i	10.2091350387i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.7$ $CE_q = 2.4$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0991103386	1.6535804361	1.8872668127
1.0357868552	1.0946246765	1.1364649846
1.0178560522	1.0388089922	1.0604929685

MAP II

radius height
a = 0.0565 d = 0.083

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2181666586i	4.3880992338i	5.5630932175i
5.9198542624i	7.3342972676i	8.6846613394i
8.9140565599i	10.3958119069i	11.814994498i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.3880948678i	2.8219420891i	3.7285111425i
7.3342934414i	5.74435948i	7.038863043i
10.3958021207i	8.8001234369i	10.1962613463i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.6807228916 CE_q = 2.3614457831

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0858482808	1.6260007984	1.8696053842
1.030730318	1.0865597691	1.1309912568
1.0152956385	1.0352597398	1.0578331383

MD-82-B

radius height
a = 0.0275 d = 0.055

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
2.8723830491i	4.1411837226i	5.37047427i
5.7392213955i	7.189290935i	8.56255396i
8.7951345692i	10.2940221945i	11.7255312343i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.1411790963i	2.4201952179i	3.4344989559i
7.1892870317i	5.5580260501i	6.8876397029i
10.2940123116i	8.6796405595i	10.0924592237i

The C values for the E modes for:

q=0	and	q=1
$CE_0 = 1.5$		$CE_q = 2$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1	1.4184198822	1.7506969314
1	1.036464075	1.0976272203
1	1.0139142516	1.0419329707

MGP.30

radius $a = 0.045$ height $d = 0.04$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.2748568807i	5.2127938377i	6.2342450108i
6.5545769655i	7.8555535208i	9.1291372696i
9.3476312005i	10.7698983241i	12.1454476943i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.2127901624i	3.9851175469i	4.6711454749i
7.8555499485i	6.3965201902i	7.5804615722i
10.7698888779i	9.2390463367i	10.5774075345i

The C values for the E modes for:

q=0	and	q=1
$CE_0 = 2.125$		$CE_q = 3.25$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.5746115049	2.4015987404	2.4662931118
1.2530239402	1.4180806709	1.3693484067
1.13461466	1.1968339653	1.1814914821

MN-79

radius $a = 0.028$ height $d = 0.04$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2587251245i	4.4179302485i	5.5866536443i
5.9420002762i	7.3521839752i	8.699772145i
8.9287791521i	10.4084387877i	11.826106197i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.417925912i	2.8681091243i	3.7635738513i
7.3521801583i	5.7671794345i	7.0574985465i
10.4084290135i	8.8150363186i	10.2091350387i

The C values for the E modes for:
q=0 and q=1
$CE_o = 1.7$ $CE_q = 2.4$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0991103386	1.6535804361	1.8872668127
1.0357868552	1.0946246765	1.1364649845
1.0178560522	1.0388089922	1.0604929685

NR22Cl

radius $a = 0.031$ height $d = 0.055$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
2.9864055209i	4.2210705015i	5.4323132677i
5.7971282356i	7.2356020967i	8.6014745173i
8.8330303772i	10.3264188611i	11.7539829964i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.2210659627i	2.5544820311i	3.5304130965i
7.2355982184i	5.6178009157i	6.9359652703i
10.3264090092i	8.7180384145i	10.125500814i

The C values for the E modes for:
q=0 and q=1
$CE_o = 1.5636363636$ $CE_q = 2.1272727273$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0223969472	1.4795742385	1.7827140359
1.0076222681	1.0491085388	1.1059222755
1.0037422643	1.0191646898	1.0458252149

P 5

radius height
$a = 0.044$ $d = 0.032$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.9439765474i	5.7742291559i	6.7107610303i
7.0093496094i	8.23882418i	9.4609539708i
9.6719549116i	11.0525658859i	12.3967900057i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.774225838i	4.6957070408i	5.2903783228i
8.2388207739i	6.8617762492i	7.976960599i
11.0525566813i	9.5670517906i	10.8650841185i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.375$ $CE_q = 3.75$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.9793899855	2.8993726318	2.9174252256
1.4810753225	1.730001794	1.6108055354
1.2673115282	1.3706831115	1.3185487844

P4 MK1

radius height
$a = 0.036$ $d = 0.045$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.4784666302i	4.5824173032i	5.7176166014i
6.0652953714i	7.4521842345i	8.7844451182i
9.0113005614i	10.4793147991i	11.8885334858i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.5824131223i	3.1155241307i	3.9553670872i
7.4521804688i	5.8941326156i	7.1616147895i
10.4793050909i	8.8986125862i	10.2813850671i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.8$ $CE_q = 2.6$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.1804855719	1.8088728525	1.9929433577
1.0682439636	1.1455556379	1.1715211996
1.0345116721	1.0617757588	1.0777861539

PATVAG 59

radius height

$a = 0.036$ $d = 0.052$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2424659428i	4.4059509341i	5.5771852124i
5.9330989572i	7.3449918419i	8.693694918i
8.9228578998i	10.4033597434i	11.8216362546i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.4059465857i	2.849622063i	3.7495045122i
7.3449880213i	5.7580078658i	7.0500057934i
10.4033499644i	8.8090386111i	10.2039567909i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.6923076923$ $CE_q = 2.3846153846$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0937230161	1.6424725825	1.880109647
1.0337242677	1.0913397916	1.1342326714
1.0168104096	1.0373601935	1.0594067759

PATVAG M3

radius height

$a = 0.0395$ $d = 0.018$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
7.301446172i	7.8873274591i	8.5966578219i
8.8317152382i	9.835976615i	10.8801591045i
11.0641277972i	12.2893215746i	13.5110552714i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
7.88732503i	7.135676332i	7.5403126527i
9.8359737619i	8.7150551i	9.6176978794i
12.2893132963i	10.9725426436i	12.1209844898i

The C values for the E modes for:

q=0 and q=1

$CE_o = 3.1944444444$ $CE_q = 5.3888888889$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
3.589087811	4.5816877595	4.5835728235
2.6648362869	3.157099353	2.8388887111
2.0664758473	2.3517158227	2.1382356243

PM 79

radius height

a = 0.044 d = 0.048

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.7518518806i	4.7932463715i	5.8879369934i
6.2261119794i	7.583647691i	8.8962429413i
9.1203179903i	10.5732067555i	11.9713779858i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.7932423745i	3.4180627622i	4.1978079079i
7.5836439907i	6.0594935207i	7.2983141088i
10.5731971336i	9.0089937505i	10.377068051i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.9166666667$ $CE_q = 2.8333333333$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.3008033007	2.0099560612	2.1428866957
1.1201670787	1.2246853569	1.2273739069
1.0618199598	1.0990650661	1.106111838

PMA-3

radius height
a = 0.0515 d = 0.036

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.0971778536i	5.9059326372i	6.824414376i
7.1182371355i	8.3316590088i	9.5419058897i
9.751155305i	11.1219391579i	12.4586805247i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.9059293932i	4.85674609i	5.4338219301i
8.3316556406i	6.972968612i	8.0728073412i
11.1219300107i	9.6471134508i	10.9356467971i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.4305555556$ $CE_q = 3.8611111111$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.0777176681	3.0120616565	3.0238209145
1.5415254608	1.8095826064	1.6744366181
1.3038933442	1.4178262294	1.3562678357

PMP 71

radius height
a = 0.0875 d = 0.115

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.3907107349i	4.5161640284i	5.6646561053i
6.015396673i	7.4116286372i	8.750066584i
8.9777907638i	10.4505132816i	11.8631537811i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.5161597862i	3.017230485i	3.8784169431i
7.4116248509i	5.8427723283i	7.1194041593i
10.4505035467i	8.8646768215i	10.2520275111i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.7608695652 CE_q = 2.5217391304

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.14616217	1.7458786375	1.9488791062
1.0542683632	1.1237884837	1.1564419743
1.0272960086	1.0518499223	1.0702960941

PP M1-SR II

radius height

a = 0.051 d = 0.152

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
2.6256966128i	3.9740534654i	5.2426798688i
5.6198185512i	7.0943359429i	8.482984654i
8.717688364i	10.2279319152i	11.6675524875i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
3.9740486445i	2.1215662173i	3.2310186319i
7.0943319873i	5.434643677i	6.7884666162i
10.2279219685i	8.6011544902i	10.0250402245i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.3355263158 CE_q = 1.6710526316

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
0.9768573557	1.3372179888	1.7156862621
0.9927379987	1.0240893035	1.0896960739
0.9965061478	1.0089738092	1.0382962739

PPM-2 (variant)

radius height

a = 0.0625 d = 0.065

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.8611121908i	4.8792423175i	5.9581538125i
6.2925563323i	7.6382921597i	8.9428705283i
9.1658057507i	10.6124688885i	12.0060687027i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.8792383911i	3.5376472212i	4.2957404538i
7.6382884858i	6.1277448171i	7.3550787654i
10.6124593022i	9.0550407626i	10.4170694607i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.9615384615 CE_q = 2.9230769231

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.3538073784	2.0914614939	2.207148699
1.1443706283	1.2607849126	1.253329978
1.0747891995	1.1166425611	1.1195540792

PRB BAC H-28

radius height

a = 0.045 d = 0.028

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.5924471438i	6.3383186493i	7.2018660471i
7.4808784846i	8.6435400632i	9.8154068175i
10.0189456914i	11.3574545395i	12.6693710736i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
6.3383156266i	5.3742186007i	5.9009036387i
8.6435368166i	7.3427879071i	8.3943112495i
11.357445582i	9.9177134924i	11.1750889865i

The C values for the E modes for:

q=0 and q=1

CE_o = 2.6071428571 CE_q = 4.2142857143

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.4050592708	3.3728120473	3.3717801985
1.755543365	2.0834007179	1.8987004744
1.4376037542	1.5877918238	1.4939350038

PRB M409

radius height
$a = 0.041$ $d = 0.028$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.1908500604i	5.9869643888i	6.894659807i
7.1856107741i	8.3892934218i	9.5922713831i
9.8004455031i	11.1651794841i	12.4972966155i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.9869611888i	4.9549656771i	5.5217862189i
8.3892900768i	7.0417322828i	8.1322764738i
11.1651703722i	9.6969325156i	10.9796208109i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.4642857143$ $CE_q = 3.9285714286$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.1386080214	3.0807061747	3.0892264333
1.5798780931	1.859517649	1.7147376049
1.3273832198	1.4479428819	1.3804748816

R2M2

radius height
$a = 0.0345$ $d = 0.057$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.0657541658i	4.2775772171i	5.4763361939i
5.8384010183i	7.2687116033i	8.629344966i
8.8601724766i	10.3496452676i	11.7743936978i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.2775727383i	2.6468111222i	3.5977836652i
7.2687077426i	5.6603814181i	6.9704981817i
10.3496354378i	8.745537403i	10.1491870317i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.6052631579 CE_q = 2.2105263158

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0416006205	1.5270746311	1.8095033219
1.0144072204	1.0602217109	1.1132935397
1.0071063159	1.0238665093	1.0493227608

TM-100

radius a = 0.0165 height d = 0.107

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
2.4531360031	3.8622136778i	5.1584189199i
5.5412953445i	7.0322966388i	8.4311696808i
8.6672766172i	10.184998027i	11.6299344192i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
3.8622087173i	1.9038478829i	3.0924221811i
7.0322926484i	5.3534050325i	6.7236056209i
10.1849880383i	8.5500556788i	9.9812336437i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.1542056075 CE_q = 1.308411215

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
0.9891188063	1.3736399399	1.7337242499
0.9967178823	1.0308005371	1.0940368143
0.9984353148	1.0116939594	1.0403037513

TRUPPMINA-10

radius a = 0.04 height d = 0.0335

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.4558220532i	5.3621980953i	6.3596980804i
6.6740113886i	7.955480497i	9.2152642994i
9.4317632434i	10.8430004487i	12.2103172979i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.3621945224i	4.1786493849i	4.8373080186i
7.9554769695i	6.5188510769i	7.6839668444i
10.8429910662i	9.3241581943i	10.6518307802i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.1940298507$ $CE_q = 3.3880597015$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.6792867297	2.5369981942	2.5853976269
1.3086070294	1.4960811351	1.4284285871
1.1661269378	1.2385707542	1.2140761196

TYPE-68

radius height

$a = 0.0675$ $d = 0.109$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0; $sEoT_{0,p}$	n=1; $sEoT_{1,p}$	n=2; $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.0932316893i	4.2973131753i	5.4917658169i
5.8528762271i	7.2803435393i	8.6391451094i
8.8697175825i	10.3578178611i	11.7815780195i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.2973087171i	2.6785897027i	3.621226447i
7.2803396848i	5.6753106943i	6.9826269111i
10.3578080391i	8.7552074873i	10.1575209123i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.619266055$ $CE_q = 2.2385321101$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.048888649	1.544251203	1.8195446856
1.0170332633	1.0644939952	1.1161439151
1.0084152191	1.0256921624	1.0506833261

TYPE-72, 72B, & 72C

radius $a = 0.03925$ height $d = 0.0385$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.0051296041i	4.9939845203i	6.0524765716i
6.3819386546i	7.71209329i	9.0059874019i
9.2273978377i	10.6657100892i	12.0531556653i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.993980684i	3.6942960977i	4.4256368856i
7.7120896512i	6.2194961483i	7.4316929055i
10.6657005507i	9.1173811485i	10.4713042142i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.0194805195$ $CE_q = 3.038961039$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.4273297747	2.1993163672	2.2948302432
1.1791895717	1.3119798462	1.2905934714
1.0936867337	1.1421227014	1.1391305203

U/I TH (AP.1)

radius $a = 0.05$ height $d = 0.04$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6048279183i	5.4866436371i	6.4649709714i
6.7744016712i	8.0398855666i	9.2882283614i
9.5030651827i	10.9050790331i	12.2654775081i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4866401453i	4.3371881063i	4.9749008889i
8.0398820763i	6.6215941699i	7.7713214097i
10.905069704i	9.3962767104i	10.7150169835i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.25$ $CE_q = 3.5$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7684189682	2.6481066907	2.6853321983
1.3578587765	1.5640411441	1.4806470759
1.1945154663	1.2759131317	1.2434098906

U/I TH (AP.2)

radius height

$a = 0.04$ $d = 0.04$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.9563604085i	4.9549577117i	6.0203153726i
6.3514459399i	7.6868789147i	8.9844050231i
9.2063345253i	10.6474924861i	12.0370380919i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.9549538452i	3.6413662537i	4.381550682i
7.686875264i	6.1882030408i	7.4055238828i
10.6474829313i	9.0960630793i	10.4527477958i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2$ $CE_q = 3$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.4019948777	2.1627593014	2.2647927437
1.1670321525	1.2941974351	1.2775922704
1.0870574296	1.1332011698	1.1322643833

Unidentified (SD/AD)

radius height

$a = 0.0405$ $d = 0.0355$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.3161029382i	5.2466715941i	6.2625996261i
6.5815516726i	7.8780749134i	9.1485239525i
9.3665656611i	10.7863364092i	12.1600264357i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.2466679426i	4.0293306001i	4.7089216674i
7.8780713513i	6.4241586037i	7.6037977925i
10.7863269774i	9.2582028729i	10.5941442964i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.1408450704$ $CE_q = 3.2816901408$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.598093347	2.4324954638	2.4931913566
1.2652749917	1.4354004346	1.382384615
1.1415105981	1.2059945152	1.1886242721

VS-MK2-EL

radius height

$a = 0.04475$ $d = 0.035$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6816096292i	5.5512419298i	6.5198832983i
6.8268255116i	8.0841071546i	9.3265328315i
9.5405071369i	10.9377226734i	12.2945096309i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5512384786i	4.4186230018i	5.0460546387i
8.0841036833i	6.6752181922i	7.8170624288i
10.9377133721i	9.4341424932i	10.7482378798i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2785714286$ $CE_q = 3.5571428571$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8152642982	2.7051998635	2.7373723223
1.384427497	1.6002928832	1.5087684525
1.2100028155	1.2961898462	1.259405124

Appendix C: Pole Parameters for Anti-Tank Mines

AT-1A

radius	*height*
a = 0.14	d = 0.152

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.7624384708i	4.801537409i	5.8946885202i
6.2324971795i	7.5888907631i	8.900712847i
9.1246781289i	10.5769679874i	11.9747000627i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.801533419i	3.4296798333i	4.2072725065i
7.5888870653i	6.0660541079i	7.303762013i
10.5769583689i	9.0134077412i	10.3809003486i

The C values for the E modes for:

q=0	and	q=1
CE_o = 1.9210526316		CE_q = 2.8421052632

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.3058264973	2.0178352359	2.1490184215
1.122427461	1.2280759687	1.2297999305
1.0630250839	1.1007017134	1.1073611715

B MK1

radius	height
a = 0.141	d = 0.205

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2329942489i	4.3989851167i	5.5716838853i
5.9279279398i	7.3408154575i	8.6901667274i
8.919420358i	10.4004115483i	11.819041846i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.3989807615i	2.8388399612i	3.7413166814i
7.3408116347i	5.7526794632i	7.0456545551i
10.4004017665i	8.8055566363i	10.2009509662i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.687804878$ $CE_q = 2.3756097561$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0906281234	1.6360331109	1.87598744
1.0325446011	1.0894580823	1.132955657
1.0162131306	1.0365322143	1.0587863033

BAT/7

radius height

$a = 0.135$ $d = 0.16$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.5790352674i	4.6592179267i	5.7793514298i
6.1235260504i	7.4996542062i	8.8247515196i
9.0505967292i	10.5131252254i	11.9183468564i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.6592138147i	3.2274221845i	4.0440934883i
7.4996504644i	5.9540375073i	7.2109978326i
10.5131155485i	8.9384041812i	10.3158442333i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.84375$ $CE_q = 2.6875$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.2225229135	1.8821747271	2.0460609894
1.0858851294	1.1727267428	1.190525846
1.0437056058	1.0743759082	1.0873261361

K-1

radius height

$a = 0.125$ $d = 0.15$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.5548664146i	4.640678126i	5.7644153849i
6.1094314851i	7.4881503052i	8.8149770937i
9.0410664711i	10.5049218839i	11.9111113491i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.6406739976i	3.2005992779i	4.0227197172i
7.4881465576i	5.9395407582i	7.1990326796i
10.5049121994i	8.9287541733i	10.3074838843i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.8333333333$ $CE_q = 2.6666666667$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.2121699493	1.8644697227	2.0330590592
1.0814886875	1.1659850964	1.1857925232
1.0414057962	1.0712287192	1.0849401209

L-3

radius height

$a = 0.1625$ $d = 0.145$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.2636682062i	5.2036222784i	6.2265781997i
6.5472852709i	7.8494704497i	9.1239033593i
9.3425196967i	10.765462142i	12.1415141114i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.2036185966i	3.9731130219i	4.6609082022i
7.8494668746i	6.3890481111i	7.5741575683i
10.765452692i	9.2338747249i	10.5728905874i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.1206896552$ $CE_q = 3.2413793103$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.5682822093	2.3932145288	2.4590240601
1.2497437637	1.4134304883	1.3658565739
1.1327731873	1.1943850826	1.1795865468

M/52

radius: $a = 0.1495$ height: $d = 0.124$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.4865850446i	5.387788378i	6.381289436i
6.6945890992i	7.9727514153i	9.2301782918i
9.4463354308i	10.8556784183i	12.221576973i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.387784822i	4.2114375068i	4.8656596736i
7.9727478955i	6.5399170144i	7.7018466395i
10.8556690468i	9.3388982875i	10.66473601i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2056451613$ $CE_q = 3.4112903226$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.6974846254	2.5599684741	2.6059047559
1.3185217263	1.5098448854	1.4389500918
1.1718074273	1.2460616565	1.2199472764

M453

radius: $a = 0.116$ height: $d = 0.09$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.7094491486i	5.5747403102i	6.5399022001i
6.8459469125i	8.1002611718i	9.3405383796i
9.5541990242i	10.9496675677i	12.3051375298i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5747368736i	4.4481087886i	5.0718941215i
8.1002577074i	6.6947726232i	7.8337671385i
10.9496582766i	9.4479885238i	10.7603931194i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2888888889$ $CE_q = 3.5777777778$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8323917989	2.7258718384	2.7563222111
1.3942565051	1.6136355735	1.5191637581
1.2157622233	1.303713881	1.265352053

MAT-62B

radius $a = 0.17$ height $d = 0.133$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6805963455i	5.5503874093i	6.519155747i
6.8261306752i	8.0835203913i	9.3260242379i
9.5400099507i	10.9372890018i	12.2941238197i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5503839575i	4.4175493955i	5.0451145524i
8.0835169198i	6.674507573i	7.8164556191i
10.9372797002i	9.4336397012i	10.7477965625i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2781954887$ $CE_q = 3.5563909774$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8146422987	2.7044471646	2.7366833833
1.3840716997	1.599809213	1.5083920749
1.2097946329	1.2959177138	1.2591901496

MAT-87

radius $a = 0.11$ height $d = 0.14$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.4461795288i	4.5579569533i	5.6980314889i
6.0468364613i	7.4371683531i	8.7717101686i
8.9988866564i	10.4686418367i	11.8791267225i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.55795275i	3.0794340156i	3.9270029337i
7.4371645798i	5.8751359591i	7.14598836i
10.4686321186i	8.8860412562i	10.2705064211i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.7857142857$ $CE_q = 2.5714285714$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.1675912569	1.7855746652	1.9764681329
1.0629471702	1.1373324799	1.1658086944
1.0317695541	1.0580077285	1.0749400638

MAT/5

radius height

$a = 0.145$ $d = 0.108$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.8552741175i	5.6984651442i	6.6456825277i
6.9470687776i	8.1859029143i	9.4149048159i
9.6269151064i	11.0131737168i	12.3616821307i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.6984617821i	4.6022219924i	5.2075796156i
8.1858994862i	6.7981435663i	7.9222902656i
11.0131644792i	9.5215157731i	10.8250097254i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.3425925926$ $CE_q = 3.6851851852$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.9232527109	2.8338901277	2.8562103916
1.4474072898	1.6851809681	1.5753042639
1.2471790283	1.3446062519	1.2977793533

MATS/1.4

radius a = 0.11   height d = 0.09

	n=0:	n=1:	n=2:
These are the $s_o T_a$ values for the E modes for q = 0:	$sEoT_{0,p}$	$sEoT_{1,p}$	$sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i
These are the $s_o T_a$ values for the E modes for q = 1:	$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
	4.5306364231i	5.4245262136i	6.4123377876i
	6.7241909732i	7.9976237825i	9.2516707861i
	9.4673372238i	10.8739585689i	12.2378169926i
These are the $s_o T_a$ values for the H modes for q = 1:	$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
	5.4245226817i	4.2583361669i	4.9063087036i
	7.9976202736i	6.5702157949i	7.727591002i
	10.8739492131i	9.3601411453i	10.683342885i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2222222222$ $CE_q = 3.4444444444$

These are the C values for the H modes for q=1:	$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
	1.7237321754	2.5928334327	2.6353870955
	1.3329502763	1.5297987842	1.4542529583
	1.1801052361	1.2569869288	1.2285222146

MATS/2.6

radius a = 0.13   height d = 0.09

	n=0:	n=1:	n=2:
These are the $s_o T_a$ values for the E modes for q = 0:	$sEoT_{0,p}$	$sEoT_{1,p}$	$sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i
These are the $s_o T_a$ values for the E modes for q = 1:	$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
	5.1356908842i	5.9392035747i	6.8532277331i
	7.145865847i	8.3552762148i	9.5625345382i
	9.7713422091i	11.1396422482i	12.4744867311i
These are the $s_o T_a$ values for the H modes for q = 1:	$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
	5.9392003489i	4.8971503316i	5.4699652243i
	8.3552728562i	7.0011706201i	8.0971795802i
	11.1396331156i	9.667517609i	10.9536509739i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.4444444444$ $CE_q = 3.8888888889$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.1026860786	3.0403082941	3.0506830429
1.5571685175	1.8299998664	1.6908807087
1.3134484077	1.4300910832	1.3661158282

MGP.31

radius height

$a = 0.16$ $d = 0.13$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.553415196i	5.4435657607i	6.4284523372i
6.7395599109i	8.0105499009i	9.2628470723i
9.4782592103i	10.8834690475i	12.2462683415i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4435622412i	4.2825635382i	4.9273510778i
8.0105463977i	6.5859440584i	7.7409680431i
10.8834596999i	9.3711880682i	10.6930229004i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2307692308$ $CE_q = 3.4615384615$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7373893635	2.6098144745	2.6506839398
1.3405171378	1.5402281343	1.4622742712
1.1844715122	1.2627277556	1.2330336632

MPP-B

radius height

$a = 0.16$ $d = 0.128$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6048279183i	5.4866436371i	6.4649709714i
6.7744016712i	8.0398855666i	9.2882283614i
9.5030651827i	10.9050790331i	12.2654775081i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4866401453i	4.3371881063i	4.9749008889i
8.0398820763i	6.6215941699i	7.7713214097i
10.905069704i	9.3962767104i	10.7150169835i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.25$ $CE_q = 3.5$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7684189682	2.6481066907	2.6853321983
1.3578587765	1.5640411441	1.4806470759
1.1945154663	1.2759131317	1.2434098906

NA-MI-BA

radius height

$a = 0.098$ $d = 0.247$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
2.7086621154i	4.0293509029i	5.2847194778i
5.6590571919i	7.1254592991i	8.5090302851i
8.7430348372i	10.2495443321i	11.6865028473i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.0293461482i	2.2234232542i	3.2987951062i
7.1254553608i	5.4752095529i	6.8209857611i
10.2495344063i	8.6268433576i	10.0470890936i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.3967611336$ $CE_q = 1.7935222672$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
0.9802411321	1.3535285147	1.7212174031
0.9936816167	1.025762943	1.0907321781
0.9969463241	1.0096037542	1.038754994

NO.22

radius height
a = 0.1525 d = 0.114

These are the $s_o T_a$ values for the E modes for q = 0:

	n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

	$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
	4.8419800174i	5.6871424048i	6.6359761898i
	6.9377841083i	8.1780248383i	9.4080559323i
	9.6202171596i	11.0073193398i	12.3564666808i

These are the $s_o T_a$ values for the H modes for q = 1:

	$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
	5.687139036i	4.5881947431i	5.1951871175i
	8.1780214069i	6.7886552189i	7.9141497828i
	11.0073100974i	9.5147436303i	10.8190535302i

The C values for the E modes for:

q=0 and q=1

CE_o = 2.3377192982 CE_q = 3.6754385965

These are the C values for the H modes for q=1:

	$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
	1.9148935226	2.8240613475	2.8470636846
	1.4424475147	1.6785464389	1.5700705428
	1.2442282192	1.3407759734	1.2947345058

P3 MK1

radius height
a = 0.153 d = 0.117

These are the $s_o T_a$ values for the E modes for q = 0:

	n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

	$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
	4.760335157i	5.6177939665i	6.5766405034i
	6.8810514205i	8.1299514497i	9.3662979209i
	9.5793840364i	10.9716498015i	12.3247023961i

These are the $s_o T_a$ values for the H modes for q = 1:

	$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
	5.6177905562i	4.5019497241i	5.1191785966i
	8.129947998i	6.7306656431i	7.864463561i
	10.971640529i	9.4734558989i	10.7827612237i

The C values for the E modes for:

q=0 and q=1

$CE_0 = 2.3076923077$ $CE_q = 3.6153846154$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8638846128	2.763615812	2.7910632011
1.4124879733	1.6382898619	1.5384343567
1.226487212	1.3177017871	1.2764243329

PT M1-BA III

radius height

$a = 0.165$ $d = 0.107$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.408556198i	6.1766737319i	7.0600205135i
7.3444235984i	8.5257140413i	9.7118085897i
9.9174738647i	11.2680428073i	12.5892803008i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
6.1766706301i	5.1825901496i	5.726925776i
8.5257107498i	7.2037177443i	8.2729363858i
11.2680337787i	9.815195159i	11.084206284i

The C values for the E modes for:

q=0 and q=1

$CE_0 = 2.5420560748$ $CE_q = 4.0841121495$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.282071592	3.2394932089	3.2420416992
1.6729146372	1.9790214326	1.8122910364
1.3852342424	1.5216330989	1.4400511089

PTM 80P

radius height

$a = 0.16$ $d = 0.128$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6048279183i	5.4866436371i	6.4649709714i
6.7744016712i	8.0398855666i	9.2882283614i
9.5030651827i	10.9050790331i	12.2654775081i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4866401453i	4.3371881063i	4.9749008889i
8.0398820763i	6.6215941699i	7.7713214097i
10.905069704i	9.3962767104i	10.7150169835i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.25$ $CE_q = 3.5$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7684189682	2.6481066907	2.6853321983
1.3578587765	1.5640411441	1.4806470759
1.1945154663	1.2759131317	1.2434098906

SACI 54/7

radius height

$a = 0.141$ $d = 0.205$

n=0: n=1: n=2:

These are the $s_o T_a$ values for the E modes for q = 0:

$sEoT_{0,p}$	$sEoT_{1,p}$	$sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.2329942489i	4.3989851167i	5.5716838853i
5.9279279398i	7.3408154575i	8.6901667274i
8.919420358i	10.4004115483i	11.819041846i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.3989807615i	2.8388399612i	3.7413166814i
7.3408116347i	5.7526794632i	7.0456545551i
10.4004017665i	8.8055566363i	10.2009509662i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.687804878$ $CE_q = 2.3756097561$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.0906281234	1.6360331109	1.87598744
1.0325446011	1.0894580823	1.132955657
1.0162131306	1.0365322143	1.0587863033

SACI 54/9

radius height
a = 0.141 d = 0.191

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.3409291986i	4.4789090361i	5.6349993269i
5.9874774117i	7.3889869182i	8.7308965088i
8.9591079701i	10.4344677138i	11.8490213205i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.4789047586i	2.9611768643i	3.8349715262i
7.3889831203i	5.8140241746i	7.0958300576i
10.4344579639i	8.8457551273i	10.2356707992i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.7382198953$ $CE_q = 2.4764397906$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.1277425573	1.7106672216	1.9249397845
1.0469364147	1.1122739176	1.1485219544
1.0235363695	1.0466641107	1.0663924182

SACI IMAC-10

radius height
a = 0.145 d = 0.16

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.7267923777i	4.7736568446i	5.8720005901i
6.211043332i	7.5712813443i	8.8857035379i
9.110037823i	10.5643404899i	11.9635479592i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.7736528312i	3.3905371165i	4.1754257416i
7.5712776378i	6.0440094821i	7.2854634528i
10.5643308599i	8.998586405i	10.3680340579i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.90625$ $CE_q = 2.8125$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.2890130755	1.9913242696	2.1284583717
1.1148896245	1.2167529299	1.2217080778
1.0590112978	1.0952479596	1.1031999296

SACI IMAC-5

radius height

$a = 0.1375$ $d = 0.13$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.1017603787i	5.0718099775i	6.116849492i
6.443020724i	7.7627158889i	9.0493747928i
9.2697489672i	10.7023710814i	12.0856086545i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.07180062i	3.7988417598i	4.5132734131i
7.7627122739i	6.2821578615i	7.48421235i
10.7023615756i	9.1602409393i	10.5086434426i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.0576923077$ $CE_q = 3.1153846154$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.4787599209	2.2717963839	2.3552853164
1.2043695123	1.348514944	1.3174895798
1.1075186613	1.1606815477	1.1534522036

SACI IMAC-7

radius height

$a = 0.145$ $d = 0.13$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.2499163234i	5.1923604458i	6.2171696341i
6.5383382141i	7.8420092147i	9.1174851079i
9.3362517354i	10.7600231095i	12.1366917692i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.1923567561i	3.9583518373i	4.6483316849i
7.8420056362i	6.3798791485i	7.5664248527i
10.7600136546i	9.2275329649i	10.5673524383i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.1153846154$ $CE_q = 3.2307692308$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.5605271162	2.3829080143	2.4501063169
1.2457374659	1.4077434047	1.3615909336
1.1305269021	1.1913963133	1.1772627244

SB-81

radius height

$a = 0.115$ $d = 0.09$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6794705671i	5.5494380824i	6.5183475123i
6.8253587915i	8.0828685845i	9.3254592769i
9.5394576626i	10.936807274i	12.2936952595i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5494346301i	4.4163565639i	5.0440701308i
8.0828651127i	6.6737181526i	7.8157815402i
10.9367979719i	9.4330811853i	10.747306341i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2777777778$ $CE_q = 3.5555555556$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8139513607	2.7036108769	2.7359180239
1.3836765628	1.5992720084	1.5079740757
1.2095634569	1.2956155114	1.2589514306

SB-81/AR

radius	height
a = 0.116	d = 0.09

These are the $s_o T_a$ values for the E modes for q = 0:

	n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
	2.404825i	3.83171i	5.13562i
	5.520078i	7.01559i	8.41724i
	8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.7094491486i	5.5747403102i	6.5399022001i
6.8459469125i	8.1002611718i	9.3405383796i
9.5541990242i	10.9496675677i	12.3051375298i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5747368736i	4.4481087886i	5.0718941215i
8.1002577074i	6.6947726232i	7.8337671385i
10.9496582766i	9.4479885238i	10.7603931194i

The C values for the E modes for:

q=0 and q=1

CE_o = 2.2888888889 CE_q = 3.5777777778

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8323917989	2.7258718384	2.7563222111
1.3942565051	1.6136355735	1.5191637581
1.2157622233	1.303713881	1.265352053

SBMV/1

radius	height
a = 0.118	d = 0.113

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.0676193738i	5.0442388538i	6.0940082765i
6.4213398303i	7.7447302818i	9.0339511459i
9.2546925978i	10.6893328104i	12.0740641755i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.0442350557i	3.7619526688i	4.4822679602i
7.7447266584i	6.2599198528i	7.4655558177i
10.689323293i	9.1450042773i	10.4953645087i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.0442477876$ $CE_q = 3.0884955752$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.4604080506	2.2461845553	2.3337900402
1.1953085933	1.3354123111	1.3078158637
1.1025257881	1.1539908914	1.1482832141

T.C. 6

radius height

$a = 0.135$ $d = 0.185$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.3224692165i	4.4651562053i	5.6240742525i
5.9771966288i	7.3806586062i	8.7238493586i
8.9522404684i	10.4285718224i	11.8438296188i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.4651519146i	2.9403336896i	3.8189004165i
7.3806548041i	5.8034361276i	7.0871572574i
10.428562067i	8.838799554i	10.2296603313i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.7297297297$ $CE_q = 2.4594594595$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.1211151704	1.6977242857	1.9162717758
1.0443283162	1.1081610125	1.1457030606
1.022203537	1.0448232159	1.0650083366

TC/2.4

radius height

$a = 0.102$ $d = 0.108$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.8192442593i	4.8461783867i	5.9311075033i
6.2669533713i	7.6172138266i	8.924873817i
9.1482476148i	10.5973079257i	11.9926696385i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.8461744334i	3.4919030949i	4.2581481197i
7.6172101425i	6.1014503116i	7.3331864158i
10.5972983257i	9.0372674285i	10.401623696i

The C values for the E modes for:

q=0 and q=1

CE_o = 1.9444444444 CE_q = 2.8888888889

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.3331976819	2.0601843818	2.182274165
1.1348677715	1.2466646491	1.2431445125
1.0696802555	1.1097275492	1.1142595257

TM-62P & TM-62P3

radius	height
a = 0.16	d = 0.125

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.6854608238i	5.5544901994i	6.5226492037i
6.8294671078i	8.0863380401i	9.3284665979i
9.5423975416i	10.9393716315i	12.2959766378i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.5544867502i	4.4227032054i	5.0496278901i
8.0863345698i	6.6779197603i	7.8193695032i
10.9393623316i	9.4360542068i	10.7499159035i

The C values for the E modes for:

q=0 and q=1

CE_o = 2.28 CE_q = 3.56

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.8176292372	2.7080604638	2.7399912871
1.3857810321	1.6021324384	1.5102002276
1.2107949822	1.2972252463	1.2602231258

TMA-1

radius height
$a = 0.1575$ $d = 0.1$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
5.5014516901i	6.2581777653i	7.1314360547i
7.4130997932i	8.5849455715i	9.7638474299i
9.9684391159i	11.3129253183i	12.6294682803i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
6.2581747039i	5.2794631555i	5.8147372593i
8.5849423027i	7.2737225608i	8.3339646624i
11.3129163256i	9.8666887333i	11.1298301648i

The C values for the E modes for:
q=0 and q=1
$CE_o = 2.575$ $CE_q = 4.15$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
2.3440145056	3.3069320825	3.3075195403
1.7142077527	2.0313787982	1.8554994823
1.4112919143	1.5546143721	1.4668677197

TYPE 69, 72, & 81

radius height
$a = 0.135$ $d = 0.1$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.8755037998i	5.7157112895i	6.6604764698i
6.9612222452i	8.1979178496i	9.4253532156i
9.6371336512i	11.0221071426i	12.3696416943i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.7157079376i	4.6235589986i	5.2264458285i
8.1979144265i	6.8126064391i	7.93470438i
11.0220979125i	9.5318473112i	10.8340983059i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.35$ $CE_q = 3.7$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.9360006401	2.8488392973	2.8701433134
1.4549979526	1.6953187053	1.5833122323
1.2517025842	1.3504739037	1.3024467263

U/I TH

radius height

$a = 0.115$ $d = 0.13$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
3.6751308446i	4.733434796i	5.8393489559i
6.1801832149i	7.5459861179i	8.8641600088i
9.0890260443i	10.5462265899i	11.9475556107i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
4.7334307485i	3.3336687353i	4.1293807552i
7.5459823991i	6.0122920686i	7.2591723372i
10.5462169433i	8.9773137734i	10.3495765867i

The C values for the E modes for:

q=0 and q=1

$CE_o = 1.8846153846$ $CE_q = 2.7692307692$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.2651632381	1.9530094568	2.0991108614
1.1043359064	1.2008199488	1.2103706274
1.0534160743	1.0876320845	1.0973981222

VS-1.6

radius height

$a = 0.11$ $d = 0.09$

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.5306364231i	5.4245262136i	6.4123377876i
6.7241909732i	7.9976237825i	9.2516707861i
9.4673372238i	10.8739585689i	12.2378169926i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.4245226817i	4.2583361669i	4.9063087036i
7.9976202736i	6.5702157949i	7.727591002i
10.8739492131i	9.3601411453i	10.683342885i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.2222222222$ $CE_q = 3.4444444444$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.7237321754	2.5928334327	2.6353870955
1.3329502763	1.5297987842	1.4542529583
1.1801052361	1.2569869288	1.2285222145

VS-HCT

radius height

a = 0.111 d = 0.104

These are the $s_o T_a$ values for the E modes for q = 0:

n=0: $sEoT_{0,p}$	n=1: $sEoT_{1,p}$	n=2: $sEoT_{2,p}$
2.404825i	3.83171i	5.13562i
5.520078i	7.01559i	8.41724i
8.653727i	10.17347i	11.61984i

These are the $s_o T_a$ values for the E modes for q = 1:

$sET_{0,p}$	$sET_{1,p}$	$sET_{2,p}$
4.1262695978i	5.0916518967i	6.1333115279i
6.4586514567i	7.7756942173i	9.0605102909i
9.2806200495i	10.711788336i	12.0939488646i

These are the $s_o T_a$ values for the H modes for q = 1:

$sHT_{0,p}$	$sHT_{1,p}$	$sHT_{2,p}$
5.091648134i	3.8252923164i	4.5355594463i
7.7756906084i	6.2981878336i	7.4976727783i
10.7117788385i	9.1712418274i	10.5182341481i

The C values for the E modes for:

q=0 and q=1

$CE_o = 2.0673076923$ $CE_q = 3.1346153846$

These are the C values for the H modes for q=1:

$CH_{0,p}$	$CH_{1,p}$	$CH_{2,p}$
1.492051914	2.2901828895	2.3708029769
1.2109841102	1.3580495873	1.3245482404
1.111174324	1.1655743741	1.1572363467

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The information about the names of, country made in, countries used by, and dimensions of the mines in the Appendices came from "Mine Facts," a CD-ROM developed by the Essex Corporation for the Department of Defense in 1996.