ECH Parallel Stratification, B(x)$\hat{x}$

Open Additional files:

Get dispersion routines by evaluating Plasma_Dispersion.np
Get plotting and printing routines by evaluating PlotPack.nb
Set Parameters by opening a Parameter Window

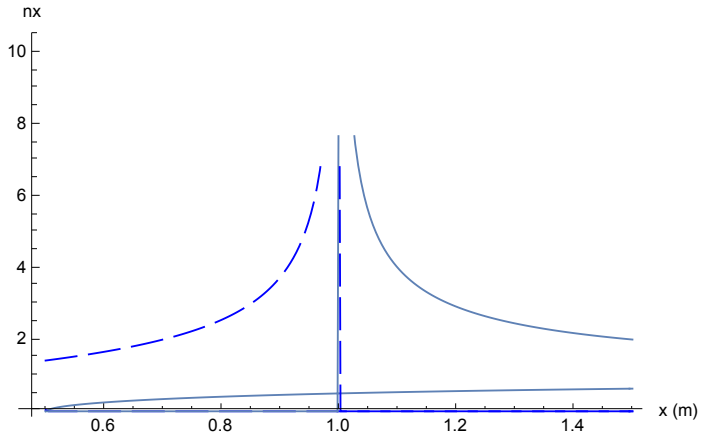
Note: Slab profile models defined in initialization cells at the bottom of this notebook.

Plot Real and Imaginary parts of n_x from 4nd order
cold plasma dispersion relation (Fast and Slow roots)
N.B. Here n_z is perpendicular to B. But in nzColdDisFS n_z is parallel to B. So think of it as exchanging $n_z \longleftrightarrow n_x$.

α = 1.5, nx = 0.

In[776]:=
```
nParallelFS[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzColdDisFS[freq, ne, b, nz, etaList]];
ntFS = Table[Flatten[{x, nParallelFS[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nx"];
g2 = PPComplexListPlot[nS, "x (m)", "nx"];
Show[{g1, g2}, PlotRange → {0., 10.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[782]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=1.46×10^{19}

nXmax=1.46×10^{19}

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

xmax=1.5

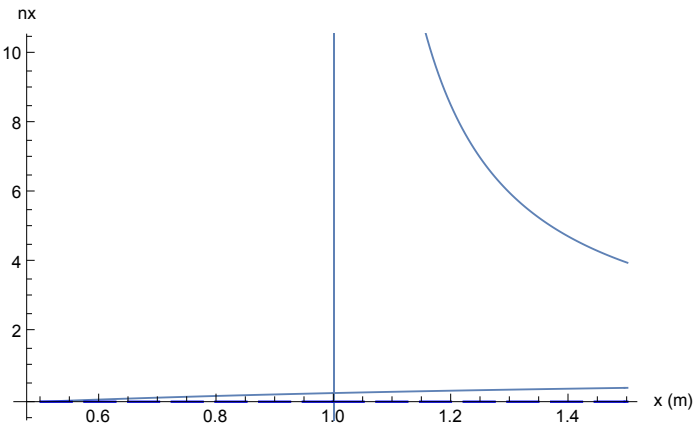
Plot Real and Imaginary parts of n_x^2 from 4nd order cold plasma dispersion relation (Fast and Slow roots)

N.B. Here n_z is perpendicular to B. But in nzColdDisFS n_z is parallel to B. So think of it as exchanging $n_z \longleftrightarrow n_x$.

$\alpha = 1.5$, nx = 0.

In[784]:=
```
nParallel2FS[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzSqColdDisFS[freq, ne, b, nz, etaList]];
ntFS = Table[Flatten[{x, nParallel2FS[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nx"];
g2 = PPComplexListPlot[nS, "x (m)", "nx"];
Show[{g1, g2}, PlotRange → {0., 10.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[790]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=1.46×10^{19}

nXmax=1.46×10^{19}

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

xmax=1.5

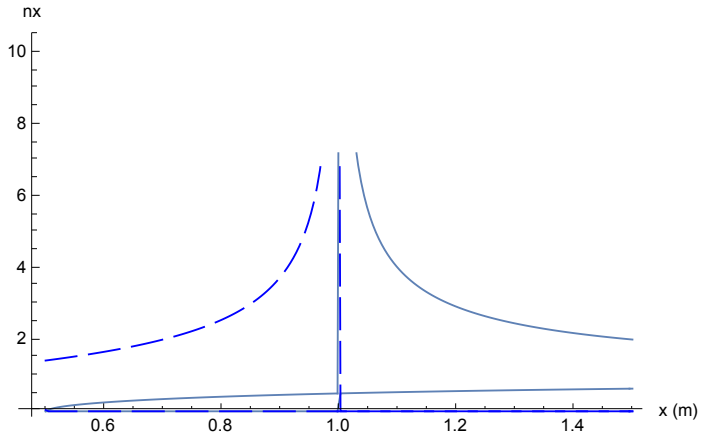
Plot Real and Imaginary parts of n_x from 4nd order

cold plasma dispersion relation (Plus and Minus roots)
N.B. Here n_z is perpendicular to B. But in nzColdDisPM n_z is parallel to B. So think of it as exchanging $n_z \longleftrightarrow n_x$.

$\alpha = 1.5,\ \text{nx} = 0.$

In[792]:=
```
nParallelPM[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzColdDisPM[freq, ne, b, nz, etaList]];
ntFS = Table[Flatten[{x, nParallelPM[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nx"];
g2 = PPComplexListPlot[nS, "x (m)", "nx"];
Show[{g1, g2}, PlotRange → {0., 10.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[798]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=1.46×10^{19}

nXmax=1.46×10^{19}

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

xmax=1.5

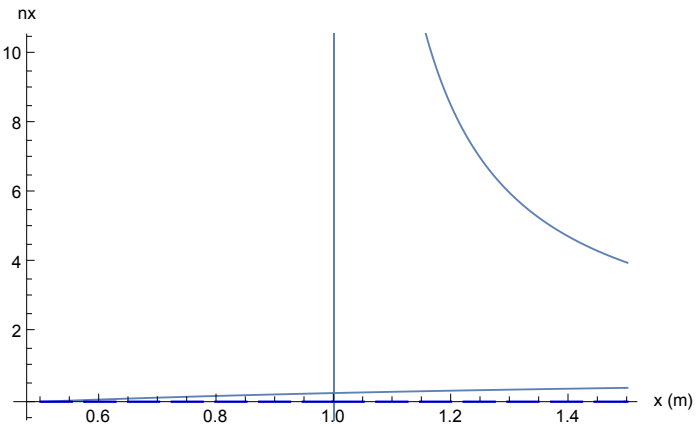
Plot Real and Imaginary parts of n_x^2 from 4nd order cold plasma dispersion relation (Plus and Minus roots)

N.B. Here n_z is perpendicular to B. But in nzColdDisPM n_z is parallel to B. So think of it as exchanging $n_z \longleftrightarrow n_x$.

$\alpha = 1.5,\ \text{nx} = 0.$

In[800]:=
```
nParallel2PM[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzSqColdDisPM[freq, ne, b, nz, etaList]];
ntFS = Table[Flatten[{x, nParallel2FS[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[ntFS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nx"];
g2 = PPComplexListPlot[nS, "x (m)", "nx"];
Show[{g1, g2}, PlotRange → {0., 10.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[806]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=1.46×10^{19}

nXmax=1.46×10^{19}

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

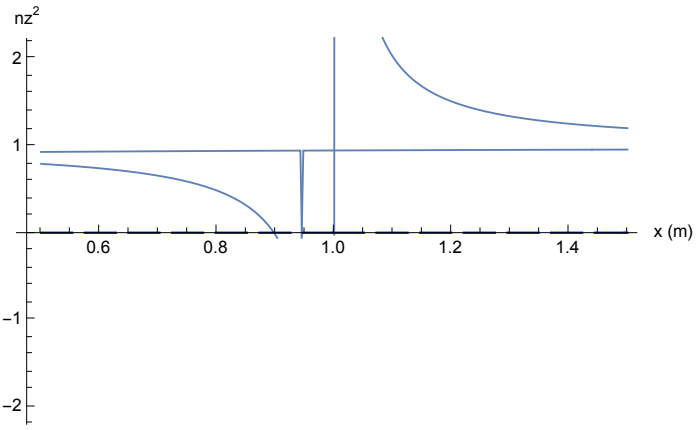
xmax=1.5

Plot Real and Imaginary parts of n_z from 4nd order cold plasma dispersion relation (Fast and Slow roots)

$\alpha = 0.1,\ \text{nx} = 0.$

In[752]:=
```
nParallel2FS[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzSqColdDisFS[freq, ne, b, nz, etaList]];
nt2FS = Table[Flatten[{x, nParallel2FS[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[nt2FS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[nt2FS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nz^2"];
g2 = PPComplexListPlot[nS, "x (m)", "nz^2"];
Show[{g1, g2}, PlotRange → {-2., 2.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[758]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=$1. \times 10^{18}$

nXmax=$1. \times 10^{18}$

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

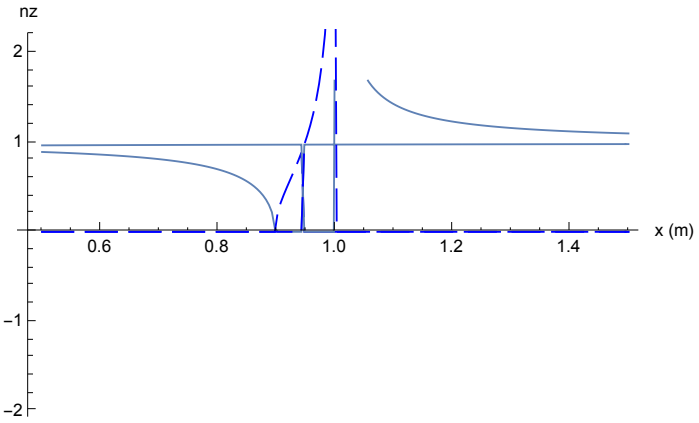
xmax=1.5

Plot Real and Imaginary parts of n_z from 4nd order cold plasma dispersion relation (Fast and Slow roots)

$\alpha = 0.1,\ \text{nx} = 0.$

In[736]:=
```
nParallelFS[x_] := Module[{ne, b, x0}, x0 = x;
    ne = nprof[x0];
    b = bprof[x0];
 nzColdDisFS[freq, ne, b, nz, etaList]];
nt2FS = Table[Flatten[{x, nParallelFS[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nF = Transpose[{Transpose[nt2FS][[1]], Transpose[nt2FS][[2]]}];
nS = Transpose[{Transpose[nt2FS][[1]], Transpose[nt2FS][[3]]}];
g1 = PPComplexListPlot[nF, "x (m)", "nz"];
g2 = PPComplexListPlot[nS, "x (m)", "nz"];
Show[{g1, g2}, PlotRange → {-2., 2.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
    nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmax}];
```

Out[742]=



dataSet=Parallel Stratification 28HHz

xProfileMin=0.5

xProfileMax=1.5

nXmin=$1. \times 10^{18}$

nXmax=$1. \times 10^{18}$

BXmin=0.5

BXmax=1.5

freq=28 000.

nz=0.

etaList={0., 1., 0., 0., 0.}

xmin=0.5

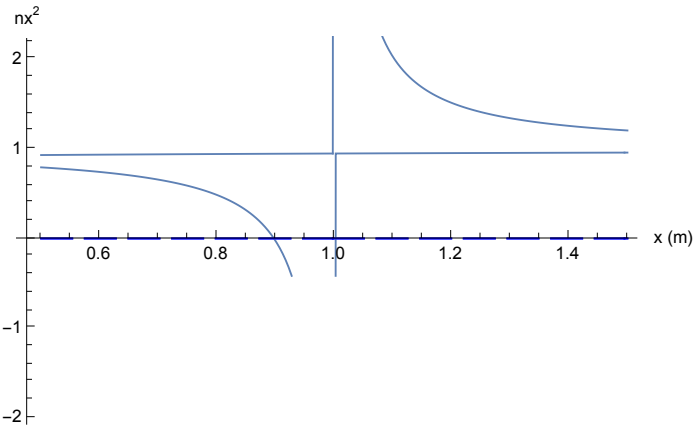
xmax=1.5

Plot Real and Imaginary parts of n_z^2 from 4nd order cold plasma dispersion relation (Plus and Minus roots)

$\alpha = 0.1,\ \text{nx} = 0.$

In[744]:=
```
nPerp2PM[x_] := Module[{ne, b, x0}, x0 = x;
  ne = nprof[x0];
  b = bprof[x0];
       nzSqColdDisPM[freq, ne, b, nz, etaList]]
nt2PM = Table[Flatten[{x, nPerp2PM[x]}], {x, xmin, xmax, (xmax - xmin)/(nPoints - 1)}];
nP = Transpose[{Transpose[nt2PM][[1]], Transpose[nt2PM][[2]]}];
nM = Transpose[{Transpose[nt2PM][[1]], Transpose[nt2PM][[3]]}];
g1 = PPComplexListPlot[nP, "x (m)", "nx^2"];
g2 = PPComplexListPlot[nM, "x (m)", "nx^2"];
Show[{g1, g2}, PlotRange → {-2., 2.}]
paramPrint[{dataSet, xProfileMin, xProfileMax,
   nXmin, nXmax, BXmin, BXmax, freq, nz, etaList, xmin, xmin}];
```

Out[750]=

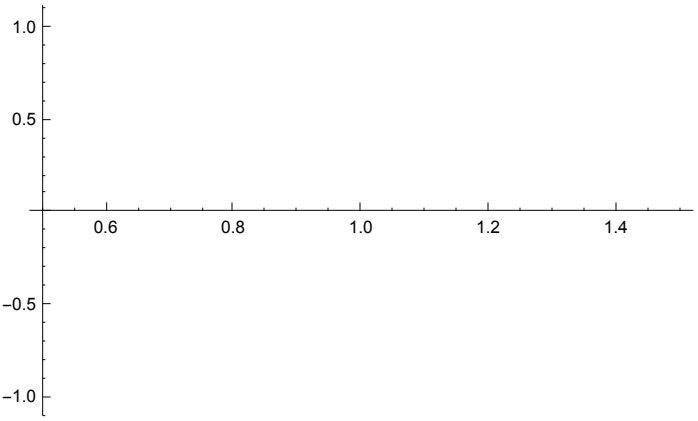



```
dataSet=Parallel Stratification 28HHz
xProfileMin=0.5
xProfileMax=1.5
nXmin=1. × 10^18
nXmax=1. × 10^18
BXmin=0.5
BXmax=1.5
freq=28 000.
nz=0.
etaList={0., 1., 0., 0., 0.}
xmin=0.5
xmin=0.5
```

Plot Profiles

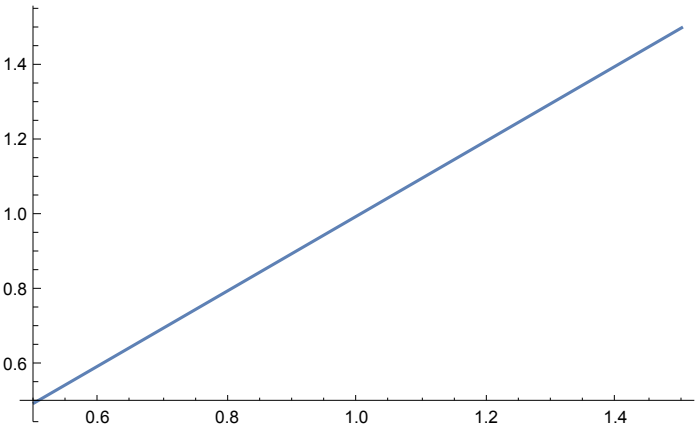
In[515]:=
```
Plot[nprof[x], {x, xmin, xmax}]
```

Out[515]=



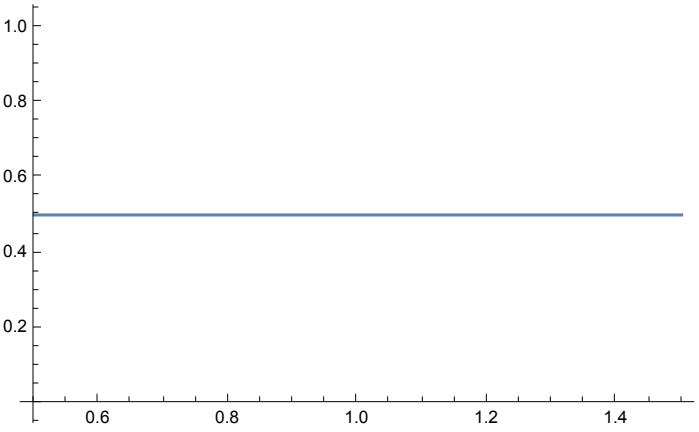
In[516]:=
```
Plot[bprof[x], {x, xmin, xmax}]
```

Out[516]=



In[517]:=
```
Plot[tprof[x], {x, xmin, xmax}]
```

Out[517]=



In[518]:=
```
αHcut[BXmax, freq, nz, 1]
```

Out[518]=
```
1.00015
```

Initialization

Magnetic field,Density and Temperature Profiles

In[519]:=
```
bprof[x_] := If[Abs[(BXmax - BXmin) / BXmax] > 10^-6,
   BXmin + (x - xProfileMin) / (xProfileMax - xProfileMin) (BXmax - BXmin), BXmin];
```

In[520]:=
```
nprof[x_] := If[Abs[(nXmax - nXmin) / nXmax] > 10^-6,
   nXmin + (x - xProfileMin) / (xProfileMax - xProfileMin) (nXmax - nXmin), nXmin];
```

In[521]:=
```
tprof[x_] := If[Abs[(TXmax - TXmin) / TXmax] > 10^-6,
   TXmin + (x - xProfileMin) / (xProfileMax - xProfileMin) (TXmax - TXmin), TXmin];
```

In[522]:=
```
αHcut[B_, freq_, nz_, sgn_] := (1 - nz^2) × (1 + sgn * 2.79926 B / freq)
```