

# Package ‘zoeppritz’

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**Type** Package

**Title** Seismic Reflection and Scattering Coefficients

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**Description** Calculate and plot scattering matrix coefficients for plane waves at interface.

**License** GPL (>= 2)

**NeedsCompilation** no

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zoeppritz-package	<i>Zoeppritz Equations</i>
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## Description

Calculate and plot scattering matrix coefficients for plane waves at interface.

## Author(s)

Jonathan M. Lees<jonathan.lees@unc.edu> Maintainer: Jonathan M. Lees<jonathan.lees@unc.edu>

## References

Young, G.B., Braile, L. W. 1976. A computer program for the application of Zoeppritz's amplitude equations and Knott's energy equations, *Bulletin of the Seismological Society of America*, vol.66, no.6,1881-1885.

K. Aki and P.G. Richards. *Quantitative seismology*. University Science Books, Sausalito, Calif., 2nd edition, 2002.

## Examples

```
##### demo(ZOEP)

##### Incident wave in Low velocity layer
alpha1 = 4.98
  beta1 = 2.9
  rho1 = 2.667

alpha2 = 8.0
  beta2 = 4.6
  rho2 = 3.38

App = pzoeppritz( "Amplitude" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "P", "ALL");
App = pzoeppritz( "Amplitude" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "S", "ALL");
App = pzoeppritz( "Energy" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "P", "ALL");
App = pzoeppritz( "Potential" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "P", "ALL");

##### Incident wave in high velocity layer
alpha1 = 8.0
  beta1 = 4.6
  rho1 = 3.38

alpha2 = 4.98
  beta2 = 2.9
  rho2 = 2.667

App = pzoeppritz( "Amplitude" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "P", "ALL");
App = pzoeppritz( "Amplitude" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "S", "ALL");
```

**Description**

Adds a small diagram showing two layers and labeled scattered ray paths.

**Usage**

```
piczoeppritz(LL = list(x = c(0, 1), y = c(0, 1)), chincw = "P")
```

**Arguments**

LL	Bounds of Box for plotting
chincw	character for incident wave

**Details**

This code simply adds a small cartoon showing incoming and outgoing waves in scattering matrix.

**Value**

Graphical side effect.

**Author(s)**

Jonathan M. Lees<jonathan.lees@unc.edu>

**See Also**

pzoeppritz

**Examples**

```
plot(c(0,1), c(0,1), type='n')
piczoeppritz(LL = list(x = c(0.5, 0.75), y = c(0.5, 0.75)), chincw = "P")
```

---

plotzoeppritz

*Plot Scattering (Zoeppritz) Coefficients*

---

**Description**

Plot Scattering (Zoeppritz) Coefficients

**Usage**

```
plotzoeppritz(A, zoepcols = c("red", "green", "blue", "purple"), zoeppty = c(1, 1, 1, 1))
```

**Arguments**

A	list output of pzoeppritz or zoeppritz
zoepcols	vector of 4 colors
zoeply	vector of 4 line types

**Details**

Used to plot the matrix of scattering coefficients with different colors and/or line types.

**Value**

Graphical side effects.

**Author(s)**

Jonathan M. Lees<jonathan.lees@unc.edu>

**See Also**

zoeppritz, pzoeppritz, piczoeppritz

**Examples**

```
alpha1 = 4.98
beta1 = 2.9
rho1 = 2.667

alpha2 = 8.0
beta2 = 4.6
rho2 = 3.38
##### create the scattering matrix:
App = pzoeppritz( "Amplitude" , alpha1, alpha2, beta1, beta2, rho1 ,rho2, "P", "NONE");

##### plot
plotzoeppritz(App)
```

---

pzoeppritz

*Plot Scattering (Zoeppritz) Coefficients*

---

**Description**

Calculate and plot the P and S-wave scattering amplitudes for a plane wave at an interface.

**Usage**

```
pzoeppritz(chtype = "Amplitude", alpha1, alpha2,
  beta1, beta2, rho1, rho2, chincw = "P",
  choutkind = "ALL")
```

**Arguments**

chtype	character, type of output, one of: Amplitude, Potential, Energy
alpha1	P-wave Velocity of Upper Layer, km/s
alpha2	P-wave Velocity of Lower Layer, km/s
beta1	S-wave Velocity of Upper Layer, km/s
beta2	S-wave Velocity of Lower Layer, km/s
rho1	Density of Upper Layer, kg/m <sup>3</sup>
rho2	Density of Lower Layer, kg/m <sup>3</sup>
chincw	Incident Wave: P, S
choutkind	character, type of out put one of: P, S, ALL, NONE

**Details**

Front end for zoeppritz program.

**Value**

List output of zoeppritz call:

angle	Incident angles, degrees
rmat	Matrix of 4 by n reflection coefficients for each angle
rra	Matrix of 4 by n real part of scattering matrix
rra	Matrix of 4 by n imaginary part of scattering matrix
ang	Matrix of 4 by n phase angle
incw	integer, from input parameter
icoef	integer, from input parameter
alphacrit	critical angle

**Note**

This front end is easier to call because it is more verbose. Creates a plot of the coefficients versus incident angle. If coefficients are complex, they are replaced with NA and they are thus not plotted.

**Author(s)**

Jonathan M. Lees<jonathan.lees@unc.edu>

## References

Young, G.B., Braile, L. W. 1976. A computer program for the application of Zoeppritz's amplitude equations and Knott's energy equations, *Bulletin of the Seismological Society of America*, vol.66, no.6,1881-1885.

K. Aki and P. G. Richards. *Quantitative seismology*. University Science Books, Sausalito, Calif., 2nd edition, 2002.

## See Also

zoeppritz, pzoeppritz, piczoeppritz

## Examples

```
##### Incident wave in Low velocity layer

alpha1 = 4.98
beta1 = 2.9
rho1 = 2.667

alpha2 = 8.0
beta2 = 4.6
rho2 = 3.38

App = pzoeppritz( "Amplitude" , alpha1, alpha2,
beta1, beta2, rho1 ,rho2, "P", "ALL");

App = pzoeppritz( "Amplitude" , alpha1, alpha2,
beta1, beta2, rho1 ,rho2, "S", "ALL");

##### Incident wave in high velocity layer

alpha1 = 8.0
beta1 = 4.6
rho1 = 3.38

alpha2 = 4.98
beta2 = 2.9
rho2 = 2.667

App = pzoeppritz( "Amplitude" , alpha1, alpha2,
beta1, beta2, rho1 ,rho2, "P", "ALL");

App = pzoeppritz( "Amplitude" , alpha1, alpha2,
beta1, beta2, rho1 ,rho2, "S", "ALL");
```

zoeppritz

*Zoeppritz Equations***Description**

Calculate the P and S-wave scattering amplitudes for a plane wave at an interface.

**Usage**

```
zoeppritz(icoef, vp1, vp2, vs1, vs2, rho1, rho2, incw)
```

**Arguments**

icoef	type of out put Amplitude=1, Potential=2, Energy=3
vp1	P-wave Velocity of Upper Layer, km/s
vp2	P-wave Velocity of Lower Layer, km/s
vs1	S-wave Velocity of Upper Layer, km/s
vs2	S-wave Velocity of Lower Layer, km/s
rho1	Density of Upper Layer, kg/m <sup>3</sup>
rho2	Density of Lower Layer, kg/m <sup>3</sup>
incw	integer, Incident Wave: P=1, S=2

**Details**

Coefficients are calculated at angles from 0-90 degrees. Zero is returned where coefficients are imaginary.

**Value**

List:

angle	Incident angles (degrees)
rmat	Matrix of 4 by n reflection coefficients for each angle
rra	Matrix of 4 by n real part of scattering matrix
ria	Matrix of 4 by n imaginary part of scattering matrix
ang	Matrix of 4 by n phase angle
incw	integer, from input parameter
icoef	integer, from input parameter

**Note**

Based on the fortran algorithm in Young and Braille. Uses a linear approximation by Aki and Richards.

**Author(s)**

Jonathan M. Lees<jonathan.lees@unc.edu>

**References**

Young, G.B., Braille, L. W. 1976. A computer program for the application of Zoeppritz's amplitude equations and Knott's energy equations, *Bulletin of the Seismological Society of America*, vol.66, no.6,1881-1885.

K. Aki and P.G. Richards.*Quantitative seismology*. University Science Books, Sausalito, Calif., 2nd edition, 2002.

**See Also**

pzoeppritz, plotzoeppritz

**Examples**

```
##### set up 2-layer model

alpha1 = 4.98
beta1 = 2.9
rho1 = 2.667

alpha2 = 8.0
beta2 = 4.6
rho2 = 3.38
##### P-wave incident = 1
incw=1;
icoef=1

A = zoeppritz(icoef, alpha1, alpha2, beta1, beta2, rho1,rho2, incw)

plot(A$angle, A$rmat[,1], xlab="Incident Angle", ylab="Ratio of Amplitudes",
main="P-wave incident/P-wave Reflected" )

plot(A$angle, A$rmat[,2], xlab="Incident Angle", ylab="Ratio of Amplitudes",
main="P-wave incident/S-wave Reflected" )

plot(A$angle, A$rmat[,3], xlab="Incident Angle", ylab="Ratio of Amplitudes",
main="P-wave incident/P-wave Refracted" )

plot(A$angle, A$rmat[,4], xlab="Incident Angle", ylab="Ratio of Amplitudes",
main="P-wave incident/S-wave Refracted" )

##### S-wave incident = 2
incw=2
icoef=1

A = zoeppritz(icoef, alpha1, alpha2, beta1, beta2, rho1,rho2, incw)
```



```
plot(A$angle, A$rmat[,1], xlab="Incident Angle", ylab="Ratio of Amplitudes",  
main="S-wave incident/P-wave Reflected" )
```

```
plot(A$angle, A$rmat[,2], xlab="Incident Angle", ylab="Ratio of Amplitudes",  
main="S-wave incident/S-wave Reflected" )
```

```
plot(A$angle, A$rmat[,3], xlab="Incident Angle", ylab="Ratio of Amplitudes",  
main="S-wave incident/P-wave Refracted" )
```

```
plot(A$angle, A$rmat[,4], xlab="Incident Angle", ylab="Ratio of Amplitudes",  
main="S-wave incident/S-wave Refracted" )
```

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