

Package ‘tetrascatt’

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Type Package

Title Acoustic Scattering for Complex Shapes by Using the DWBA

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Description Uses the Distorted Wave Born Approximation (DWBA) to compute the acoustic backward scattering, the geometry of the object is formed by a volumetric mesh, composed of tetrahedrons. This computation is done efficiently through an analytical 3D integration that allows for a solution which is expressed in terms of elementary functions for each tetrahedron. It is important to note that this method is only valid for objects whose acoustic properties, such as density and sound speed, do not vary significantly compared to the surrounding medium. (See Lavia, Cascallares and Gonzalez, J. D. (2023). TetraScatt model: Born approximation for the estimation of acoustic dispersion of fluid-like objects of arbitrary geometries. arXiv preprint <arXiv:2312.16721>).

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License GPL (>= 2)

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read_mesh	<i>read_mesh</i>
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Description

This function reads the mesh from a file .mesh (extension)

Usage

```
read_mesh(meshfile)
```

Arguments

meshfile	a string with the name of the file that contains the volumetric mesh in GMF format (Gamma Mesh Format), conventionally, an ASCII file with ".mesh" extension.
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Value

a list representing the mesh, it should include

- vertex: a data frame with the vertices of the tetrahedra, each vertex must have three coordinates
- tetra: a data frame containing the four vertex-index of each tetrahedron

Examples

```
# Generates a pseudofile that has the mesh of
# a cube with edges one metre in length, centered at the origin.

pseudofile=c("MeshVersionFormatted 2",
  "", "Dimension 3", "", "Vertices", "8", "-0.5 -0.5 0.5 6 ",
  "-0.5 -0.5 -0.5 7 ", "-0.5 0.5 0.5 9 ", "-0.5 0.5 -0.5 11 ",
  "0.5 -0.5 0.5 16 ", "0.5 -0.5 -0.5 17 ", "0.5 0.5 0.5 19 ",
  "0.5 0.5 -0.5 21 ", "", "Edges", "12", "2 1 5 ", "1 3 8 ",
  "4 3 10 ", "2 4 12 ", "6 5 15 ", "5 7 18 ", "8 7 20 ", "6 8 22 ",
  "2 6 25 ", "1 5 26 ", "4 8 29 ", "3 7 30 ", "", "Triangles",
  "12", "2 1 3 3 ", "3 4 2 3 ", "5 6 8 13 ", "8 7 5 13 ",
  "2 6 5 23 ", "5 1 2 23 ", "8 4 3 27 ", "3 7 8 27 ", "2 4 8 31 ",
  "8 6 2 31 ", "3 1 5 33 ", "5 7 3 33 ", "", "Tetrahedra",
  "5", "5 2 1 3 1 ", "4 2 8 3 1 ", "8 5 7 3 1 ", "8 2 6 5 1 ",
  "3 2 8 5 1 ", "", "End", "" )

# creating an empty temporary mesh file
temp_mesh_file=tempfile(fileext = ".mesh")
```

```

# loading the file with data.
writeLines(pseudofile,temp_mesh_file)
# reading the mesh
my_mesh=read_mesh( meshfile=temp_mesh_file)

# see the bounding box of the volumetric mesh.
lapply(my_mesh$vertex,range)

# unlinking the temporary file.
unlink(temp_mesh_file)

```

tetrascatt

tetrascatt

Description

This function computes the volumetric backscattering from a mesh of tetrahedrons.

Usage

```
tetrascatt(parameters, freq, mesh, kversor)
```

Arguments

parameters	a list including the parameters model, it must include <ul style="list-style-type: none"> • cw: sound speed in the water in m/s • g: g density contrast value, i.e $g = \rho_1 / \rho_w$, where ρ_1 and ρ_w are the density values of the scatterer and the media (sea water) respectively. • h: h density sound speed contrast value, that is $h = c_1 / cw$ where c_1 is the sound speed of the scatterer.
freq	an array of frequencies where the scattering is computed.
mesh	a list representing the mesh, it must include <ul style="list-style-type: none"> • vertex: a data.frame with the vertex of the tetrahedra, each vertex has to have three coordinates. • tetra: a data.frame containing the four index of each tetrahedra.
kversor	A three component vector that indicates the direction of the incident plane wave.

Value

List containing the frequencies, freq, and their corresponding Target Strength values, ts .

See Also

[read_mesh](#) to get this kind of list from a .mesh file.

Examples

```
#####
### Set the Frequency range #####
#####
fmin=12
fmax=400
freqs= seq(fmin,fmax, by=1)
# for tetrascatt freq unities should be in Hz.
freq=freqs*1000
#####
##### Set properties of media and scatterer #####
#####
cw <- 1477.4 #soundspeed surrounding fluid (m/s)
rho <- 1026.8 #density surrounding fluid (kg/m^3)
g <- 1028.9/rho #density contrast
h <- 1480.3/cw #soundspeed contrast
my_parameters=list(cw=cw,g=g,h=h)

#####
### Set the incident direction of the plane wave #####
#####
kvector=c(1,0,0)

#####
### Set the scatterer geometry #####
#####
# generates a pseudofile that has the mesh of cube of one meter
# side
pseudofile=c("MeshVersionFormatted 2",
  "", "Dimension 3", "", "Vertices", "8", "-0.5 -0.5 0.5 6 ",
  "-0.5 -0.5 -0.5 7 ", "-0.5 0.5 0.5 9 ", "-0.5 0.5 -0.5 11 ",
  "0.5 -0.5 0.5 16 ", "0.5 -0.5 -0.5 17 ", "0.5 0.5 0.5 19 ",
  "0.5 0.5 -0.5 21 ", "", "Edges", "12", "2 1 5 ", "1 3 8 ",
  "4 3 10 ", "2 4 12 ", "6 5 15 ", "5 7 18 ", "8 7 20 ", "6 8 22 ",
  "2 6 25 ", "1 5 26 ", "4 8 29 ", "3 7 30 ", "", "Triangles",
  "12", "2 1 3 3 ", "3 4 2 3 ", "5 6 8 13 ", "8 7 5 13 ",
  "2 6 5 23 ", "5 1 2 23 ", "8 4 3 27 ", "3 7 8 27 ", "2 4 8 31 ",
  "8 6 2 31 ", "3 1 5 33 ", "5 7 3 33 ", "", "Tetrahedra",
  "5", "5 2 1 3 1 ", "4 2 8 3 1 ", "8 5 7 3 1 ", "8 2 6 5 1 ",
  "3 2 8 5 1 ", "", "End", "" )

# creating an empty temporary mesh file
temp_mesh_file=tempfile(fileext = ".mesh")
# loading the file with data.
writeLines(pseudofile,temp_mesh_file)

#reading the mesh
my_mesh=read_mesh( meshfile=temp_mesh_file)
```

```

# Computing the scattering
output= tetrascatt(parameters=my_parameters,freq,
                  mesh=my_mesh,kversor)

plot(output$freq,output$ts)

# unlinking the temporary file.
unlink(temp_mesh_file)

```

tetrascatt_c

tetrascatt_c

Description

Computes scattering from a volumetric mesh efficiently, it is an auxiliary function called by tetrascatt function.

Usage

```
tetrascatt_c(cw, g, h, freq, Tet, Ver, kversor)
```

Arguments

cw	sound speed in the water in m/s
g	density contrast value, i.e $g = \rho_0 / \rho_w$, where ρ_0 and ρ_w are the density values of the scatterer and the unbounded medium respectively
h	density sound speed contrast value i.e $h = c_0 / cw$, where c_0 is the sound speed of the scatterer
freq	an array of frequencies, where the scattering is computed.
Tet	a matrix containing the four index of each tetrahedron.
Ver	a matrix with the vertex of the tetrahedra, each vertex has to have three coordinates.
kversor	three component vector that indicates the direction of the incident plane wave.

Value

A complex number array which contains the backward differential far-field scattering cross-section (f infinity) values at each frequency.

See Also

[tetrascatt](#)

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