# フリーソフトウェア **FreeFEM** による境界要素法のデモンストレーション

Small demo of BEM in FreeFEM

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松本安弘 (Yasuhiro Matsumoto)
東京科学大学 情報基盤センター
(Center for Information Infrastructure, Institute of Science Tokyo)

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# Content

The materials are taken from the github repository
"freefem_bem_lecture" (GPLv3)
`https://github.com/ya-mat/freefem_bem_lecture`

Demos for BVPs of the Helmholtz equation

- Exterior Dirichlet problem in 2D (with Burton-Miller formulation)
- Exterior Neumann problem in 2D
- Exterior Dirichelt problem in 3D
- Exterior Neumann problem in 2D with multiple scatteres
- Transmission problem in 2D

# FreeFEM

- FreeFEM is the DSL (domain specific langage) for FEM
  - `https://freefem.org/`
  - We can compute the FEM solution only to write down some scripts and weak forms of PDE
- Moreover, FreeFEM has a module for BEM
  - Laplace, Helmholtz, Maxwell in 2D and 3D
  - BemTool by X. Claeys in `https://github.com/xclaeys/bemtool`
  - Only Galerkin discretization is available

Other BEM tool or library: Bempp, Bembel, NiHu

# How to use?

To install FreeFEM, see the official reference:
https://doc.freefem.org/introduction/installation.html#installation-guide

Copy scripts in your computer

```
1  git clone git@github.com:ya-mat/
       freefem_bem_lecture.git
2  cd freefem_bem_lecture
```

or

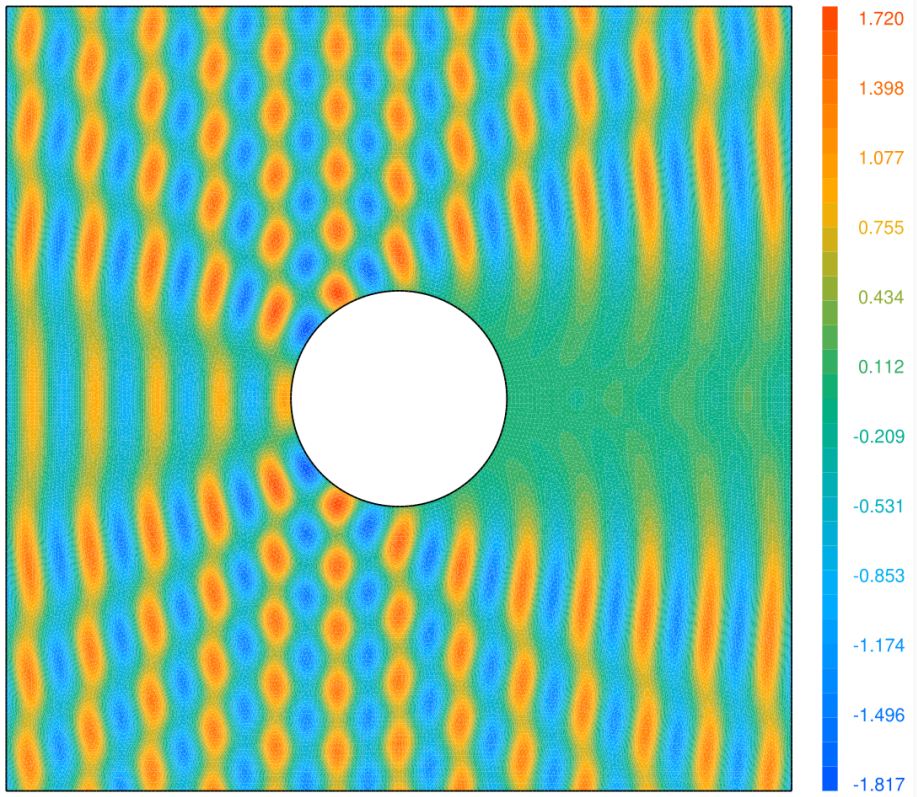
```
1  git clone https://github.com/ya-mat/
       freefem_bem_lecture.git
2  cd freefem_bem_lecture
```

File extension: .edp (équation aux dérivées partielles)

# Exterior Dirichlet problem in 2D

Fine name: 1_Hel2D_circle_BM_Dirichlet.edp

```
1   ff-mpirun -np 1 1_Hel2D_circle_BM_Dirichlet.
        edp -wg
```




Real part of solution

- Number of nodes on circle: 200
- $L_2$ relative error: 0.000594837

# Some scripts

## Exterior Neumann problem in 2D

Fine name: 2_Hel2D_circle_BM_Neumann.edp

```
1    ff-mpirun -np 1 2_Hel2D_circle_BM_Neumann.
         edp -wg
```

## Exterior Dirichelt problem in 3D

Fine name: 3_Hel3D_BM_Dirichlet.edp

```
1    ff-mpirun -np 1 3_Hel3D_BM_Dirichlet.edp -wg
```

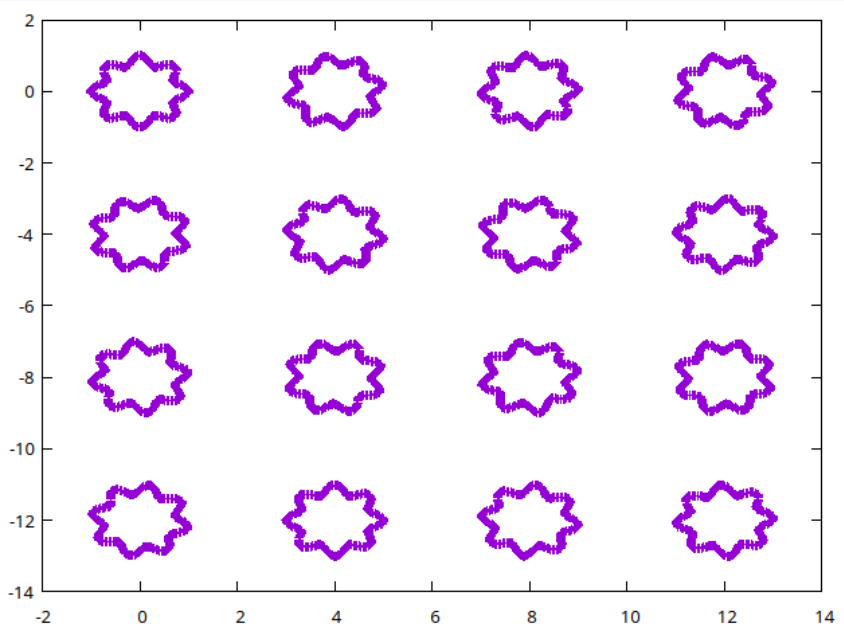
# Exterior Neumann problem in 2D with multiple scatterers

File name: 4_Hel2D_multiple_BM_Neumann.edp

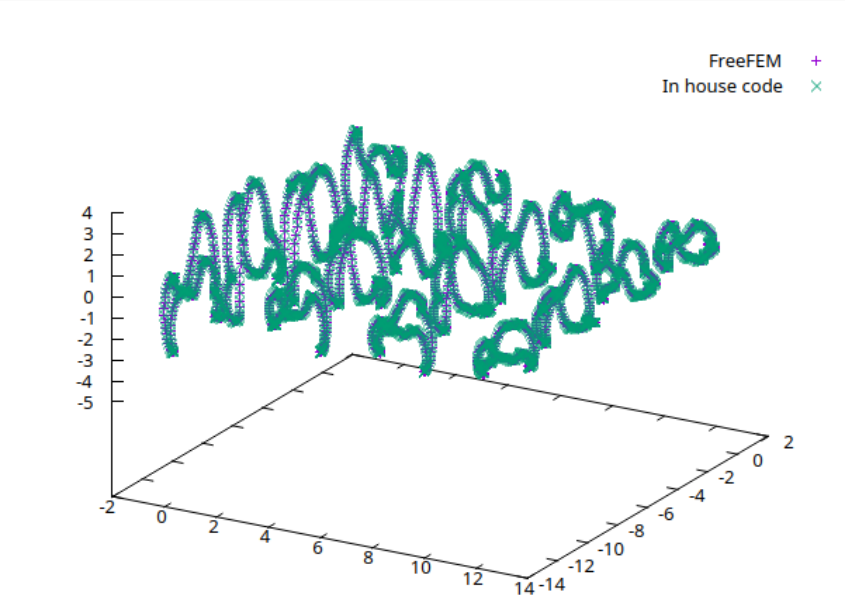
```
1    ff-mpirun -np 1 4_Hel2D_multiple_BM_Neumann.
         edp -wg
```

Output: u_boundary_4_Hel2D_multiple_BM_Neumann.txt

Reference: zeta_correction_BIEM_16_star_k3_Neumann_BM.txt (In house)




Multiple scatterers




Obtained boundary value (Re($u$))

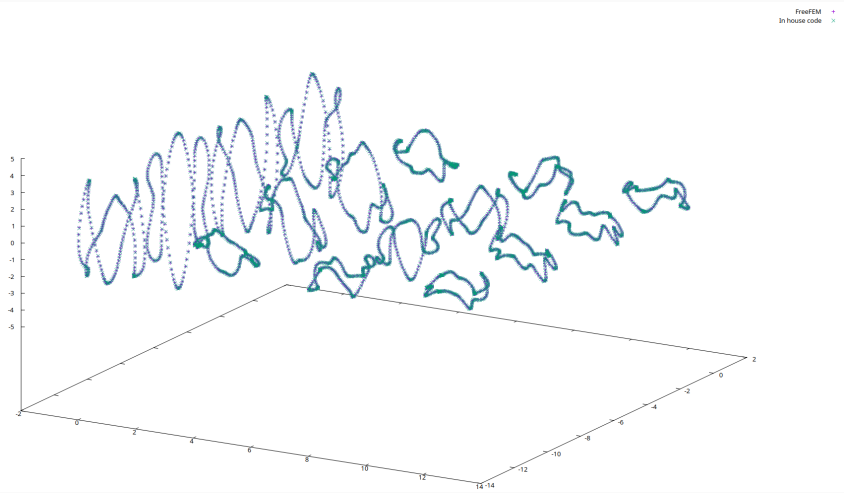
# Transmission problem in 2D

Fine name: 5_Hel2D_multiple_transmission.edp

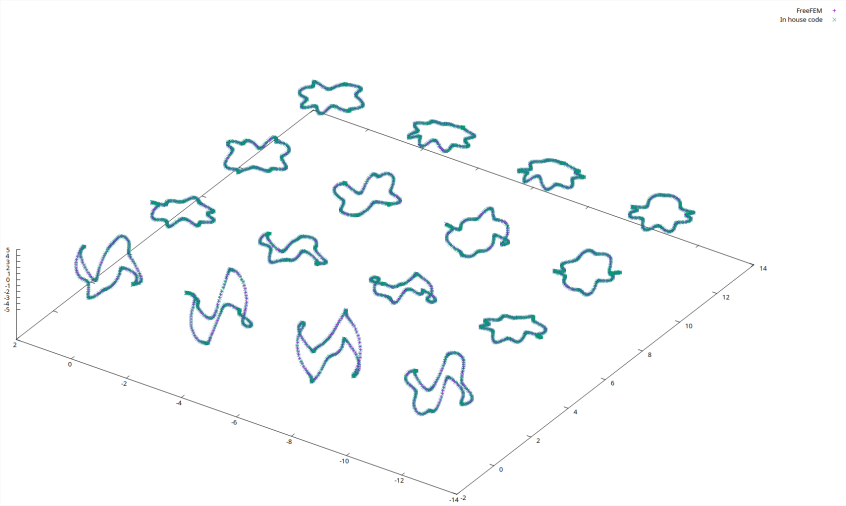
```
ff-mpirun -np 1 5
    _Hel2D_multiple_transmission.edp -wg
```

Output: u_boundary_5_Hel2D_multiple_transmission.txt

Reference: zeta_correction_BIEM_16_star_o3_d1k3_d4k6_transmission.txt (In house)




Obtained boundary value (Re($u$))




Obtained boundary value (Re($u$))

# Some demonstration with screen sharing

- Explanation of syntax etc.