SBG_exmapleREADME

The SBG is a script batch generator for micromagnetic simulation package MuMax3. As an instance, here we show how to get the script that describe a classic magnonic crystal problem [1], and at the same time, introduce the way to sweep the parameters and get scripts in batch.

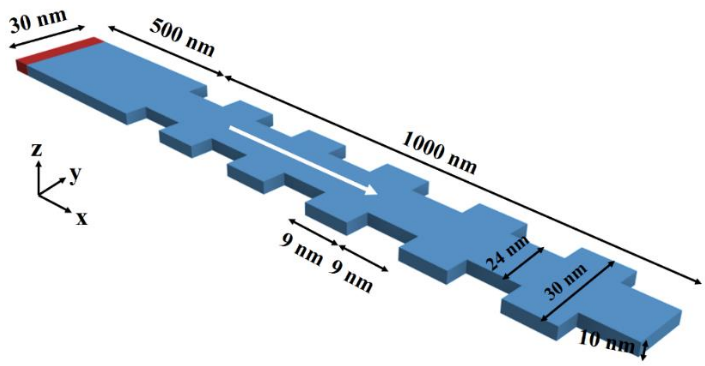

Figure 1. Schematic of the magnonic crystal instance. The direction of the initial magnetization is +x, as indicated by the white arrow. A sinc function field with B_0 = 1.0 T is applied along the y direction only to the local area of 1.5×30×10 nm^3, indicated by red color.

1. Example description

Fig 1. Show the schematic of the magnonic crystal. The cell size is set to 1.5×1.5×10 nm^3. The material used here is Permalloy (Py), the chosen material parameters are as follows: the saturation magnetization M_s = 8.6×10^5 A/m, exchange constant A_{ex} = 1.3×10^{-11} J/m, Gilbert damping α = 0.01. A "sine cardinal (sinc)" function field $B_y(t) = B_0 \frac{\sin(2\pi f_H(t+t_0))}{2\pi f_H(t+t_0)}$ with B_0 = 1.0 T, f_H = 100 GHz and t_0 = 0.1 ps is applied along the y direction only to the local area of 1.5×30×10 nm^3, indicated by color red in Fig 1.

2. Script creation example

2.1. Run "SBG.py".

2.2. Input the desired name into the 'Name' entry, e.g. "e". Input the directory, in which the script files generated, into the 'Dir' entry. For users of Windows system, please use "/" or "\\" instead of "\".

2.3. Click 'Mesh & Geometry' button to define the simulation mesh size and the geometry of the magnonic crystal.

(a) First, define the mesh size. For the purpose of introducing the way of parameter sweeping. Here, click the 'sweep' tab to enable the "sweep mode". Then, assign the values of "1500e-9", "1560e-9" and "15e-9" to the three entries in the 'X (m)' row,

respectively. This will result in the generation of series scripts in which the mesh size in x-direction increase from 1500e-9 to 1560e-9 by 15e-9. Next assign the values of "30e-9", "30e-9" and "1" to the 'Y (m)' row. Finally, assign the values of "10e-9", "30e-9" and "10e-9" to the 'Z (m)' row. It is similar to the definition in 'X (m)' row.
(b) Define the cell size and periodic boundary condition in the 'Cell size & PBC' frame. Key in "1.5e-9", "1.5e-9" and "10e-9" to the 'cell_x/y/z (m)' entries. Key in three "0" to the 'PBC_x/y/z' entries.
(c) Click 'Add This Mesh' button to add the mesh to the edit window.
(d) Next, define the geometry of the magnonic crystal. This is the most complex step of the whole coding process due to the shape of the model is periodical. Select "Cuboid" shape from 'Shape' menu, click 'Add shape' button to add this geometry to the edit window. Similarly, select "Cuboid" shape, then choose "Transl" method from 'Method' menu, click 'Add shape' button two times. The first Cuboid "a" is the main body of the magnonic waveguide, whereas "b" and "c" are used to create notches along the long-axis of the waveguide by periodically substrating them from "a".

```
a:=Cuboid(x,y,z)
b:=Cuboid(9e-9,3e-9).Transl(-245.5e-9,13.5e-9,0)
c:=Cuboid(9e-9,3e-9).Transl(-245.5e-9,-13.5e-9,0)

i_start1 := 1
i_limit1 := 57
i_step1 := 1
for i:=i_start1; i<i_limit1; i+=i_step1{
a=a.Sub(b).Sub(c)
b=b.Transl(18e-9,0,0)
c=c.Transl(18e-9,0,0)
}

SetGeom(a)
EdgeSmooth=0
```

Figure 2. The geometry definition of the example.

(e) From 'Loop' menu, select 'one cycle', click 'Add shape' button.
(f) Click 'Add This Geom' button to add the 'SetGeom' item.
(g) Move the cursor into the loop body, key in the content as shown in Fig 2. Then assign all parameters as depicted in Fig 2. Note that the second parameter of "Transl" method for "c" is "-13.5e-9".
(h) Click 'Confirm & Quit' button.

```
DefRegion(1,XRange(-750e-9, -747e-9))
DefRegion(2,XRange(-747e-9,744e-9))
DefRegion(3,XRange(744e-9,750e-9))
```

Figure 3. The region definition of the example.

2.4. Click 'Define Regions' button to define the regions used in the simulation.
(a) Choose "XRange" from 'Shape' menu, click 'Add shape' button, then click 'Add This Region' button. Repeat these two operations three times in total, since we need to

define three regions which are excitation region, waveguide body region and high damping region. Finally, key in the space range as shown in Fig 3. For Region 1, “XRange(-750e-9, -747e-9)”; for Region 2, “XRange(-747e-9,744e-9)”; for Region 3, “XRange(744e-9,750e-9)”.
(b) Click ‘Confirm & Quit’ button.

2.5 Click ‘Parameters & Initial m’ button to define magnetic parameters.
(a) Select “Uniform” from ‘Initial m’ menu. Then click ‘Add Initial m’ button.
(b) From ‘Parameters’ menu, select “Alpha”, input “0.01” into the ‘Function’ entry, select “SetRegion” from ‘Method’ menu and click ‘Add This Para’ button two times to assign the same parameter to both region 1 and region 2. Then change the value of ‘Function’ entry from “0.01” to “0.5”, click ‘Add This Para’ button to assign the parameter to region 3.
(c) Select “Msat” from ‘Parameters’ menu, assign “8.6e5” to ‘Function’ entry and select “None” from ‘Method’ menu. Click ‘Add This Para’ button.
(d) Select “Aex” from ‘Parameters’ menu, assign “1.3e-11” to ‘Function’ entry and choose “None” from ‘Method’. Click ‘Add This Para’ button.
(e) Key in “1,0.0001,0” as the parameter of “Uniform” initial magnetization defined at step (a).
(f) Click ‘Confirm & Quit’ button.

```
m=Uniform(1,0.0001,0)
alpha.SetRegion(1,0.01)
alpha.SetRegion(2,0.01)
alpha.SetRegion(3,0.5)
Msat=8.6e5
Aex=1.3e-11
```

Figure 4. The parameter definition of the example.

2.6 Click ‘Running & Output’ to relax the sample.
(a) Choose “Relax” from ‘Running’ menu.
(b) Click ‘Add This Run’ button and ‘Confirm & Quit’ button.

2.7 Click ‘Excitations’ button to define the excitation.
(a) Input “vector(0,amp*sin(f*t+1e-13)/(f*t+1e-13),0)” into the ‘Function’ entry of ‘B_ext’ frame, and select “SetRegion” from ‘Method’ menu.
(b) Click ‘Sweep’ tab, assign “0.5”, “1” and “0.1” to the three entries in ‘amp’ row. This will result in the generation of series scripts in which the amplitude of the magnetic field increases from 0.5 to 1 by 0.1.
(c) Input “100e9”, “100e9” and “1” to the three entries in ‘f’ row. Set the cut-off frequency of the excitation field to 100 GHz.
(d) Click ‘Add This B_ext’ button, and ‘Confirm & Quit’ button.

2.7 Click ‘Running & Output’ button to define the running method and output quantity.
(a) If user want to use MFA processing the data, choose “OVF2_TEXT” from ‘Export

Format' menu.
(b) Select "AutoSave" from 'Output Type' menu, and "m" from 'Quantities' menu. Then click 'Add This Output' button.
(c) Select "Run" from 'Running' menu, and click 'Add This Run' button.
(d) Assign ",2e-12" to "AutoSave", and assign "5e-9" to "Run". Set the total simulation time to 5 ns and set the sampling interval to 2 ps as depicted in Fig 5.
(e) Click 'Confirm & Quit' button.

```
OutputFormat = OVF2_TEXT
AutoSave(m,2e-12)
Run(5e-9)
```

Figure 5. The output definition of the example.

2.8 Click 'OK' button to generate the scripts.
After the execution of the program, 90 .txt files will be created in the specified folder. The simulation script used in the article is "e_1000_20_1_1.0e+00_1.0e+11.txt".

The complete code as following:

```
//#SetMesh X1000--1040Y20--20Z1--3x1.5e-09y1.5e-09z1e-08i0j0k0#by10by666666667by1#//

a:= Cuboid(x,y,z)
b:= Cuboid(9e-9,3e-9,10e-9).Transl(-245.5e-9,13.5e-9,0)
c:= Cuboid(9e-9,3e-9,10e-9).Transl(-245.5e-9,-13.5e-9,0)

i_start1 := 1
i_limit1 := 57
i_step1 := 1
for i:=i_start1; i<i_limit1; i+=i_step1{
a = a.Sub(b).Sub(c)
b = b.Transl(18e-9,0,0)
c = c.Transl(18e-9,0,0)
}

SetGeom(a)
EdgeSmooth=0

DefRegion(1,XRange(-750e-9,-747e-9))
DefRegion(2,XRange(-747e-9,744e-9))
DefRegion(3,XRange(744e-9,750e-9))

m=Uniform(1,0.0001,0)
alpha.SetRegion(1,0.01)
```

```
alpha.SetRegion(2,0.01)
alpha.SetRegion(3,0.5)
Msat=8.6e5
Aex=1.3e-11
Relax()

//#amp_B := #0.5--1 by amp0.1#
//#f_B := #100e9--100e9 by f1#//
B_ext.SetRegion(1,vector(0,amp_B*sin(f_B*t+1e-13)/(f_B*t+1e-13),0))

OutputFormat = OVF2_TEXT
AutoSave(m,2e-12)
Run(5e-9)
```

Reference:

[1] K. S. Lee, D. S. Han, S. K. Kim, Phys. Rev. Lett. 102 (2009) 127202.