DEMO_0007_Multi_Morph_Spherical_Coordinates

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This is a demo for:

- Building geometry for multi-morphology TPMS structures (gyroid and diamond) in spherical coordinates, with transition in different directions.

This example contains # Case-1: TPMS in spherical coordinates, cylindrical transition. # Case-2: TPMS in spherical coordinates, spherical transition. # Case-3: TPMS in spherical coordinates, linear transition.

Name

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```
Change log:
2023/11/15 MV Created
2024/02/2 MV Added cases 1-3
--------------------------------------------------------------------------

clear; close all; clc;
```

Plot settings

```
fontSize=20;
faceAlpha1=0.8;
markerSize=10;
lineWidth1=3;
lineWidth2=4;
markerSize1=25;
```

Control parameters

```
res=150; %Resolution

R=1; %Outter radius
```

```
r=0.5; % Inner radius (for spherical shape r=0)
tranR=0.7; %Transition radius

transType= 1;  % 1:cylindrical, 2: spherical, 3:linear
```

Setting-up input parameters for individual lattices

```
inputStruct_A.L=[2 2 2]; % characteristic length
inputStruct_A.Ns=res; % number of sampling points
inputStruct_A.isocap=1; %Option to cap the isosurface
inputStruct_A.surfaceCase='g'; %Surface type

inputStruct_B = inputStruct_A;

% Set parameters for individual gyroid
inputStruct_A.numPeriods=[10 10 10]; %Number of periods in each direction
inputStruct_A.levelset=0.75; %Isosurface level
inputStruct_A.gradiantF=0; %Gradiant Factor
levelset_A=inputStruct_A.levelset;

inputStruct_B.numPeriods=[10 10 10];
inputStruct_B.levelset=0.6;
inputStruct_B.gradiantF=0 ; %Gradiant Factor
levelset_B=inputStruct_B.levelset;
inputStruct_B.surfaceCase='d';
```

Compute individual gyroids

```
[~,~,~,S_A,X,Y,Z]=SphericalTPMS (inputStruct_A);
[~,~,~,S_B,~,~,~]=SphericalTPMS (inputStruct_B);
```

Transition lengthScale and shape

kappa controls the lengthscale of transition between TPMS Higher kappa => faster transition Lower kappa => slower transition G controls the shape of transition between TPMS

```
switch transType
    case 1 % Figure-7(a)
        % Cylindrical transition boundary across x-axis
        G=X.^2 + Y.^2 -(tranR^2);
        kappa = 20;

    case 2 % Figure-7(b)
        % Spherical transition boundary across x-axis
        G=X.^2 + Y.^2 + Z.^2 -(tranR^2);
        kappa = 15;

    case 3 % Figure-7(c)
        % linear transition boundary across x-axis
        G = X;
```

```
        G = G/max(G(:));
        %  G = G-(max(G(:))/2);
        kappa = 20;
end
```

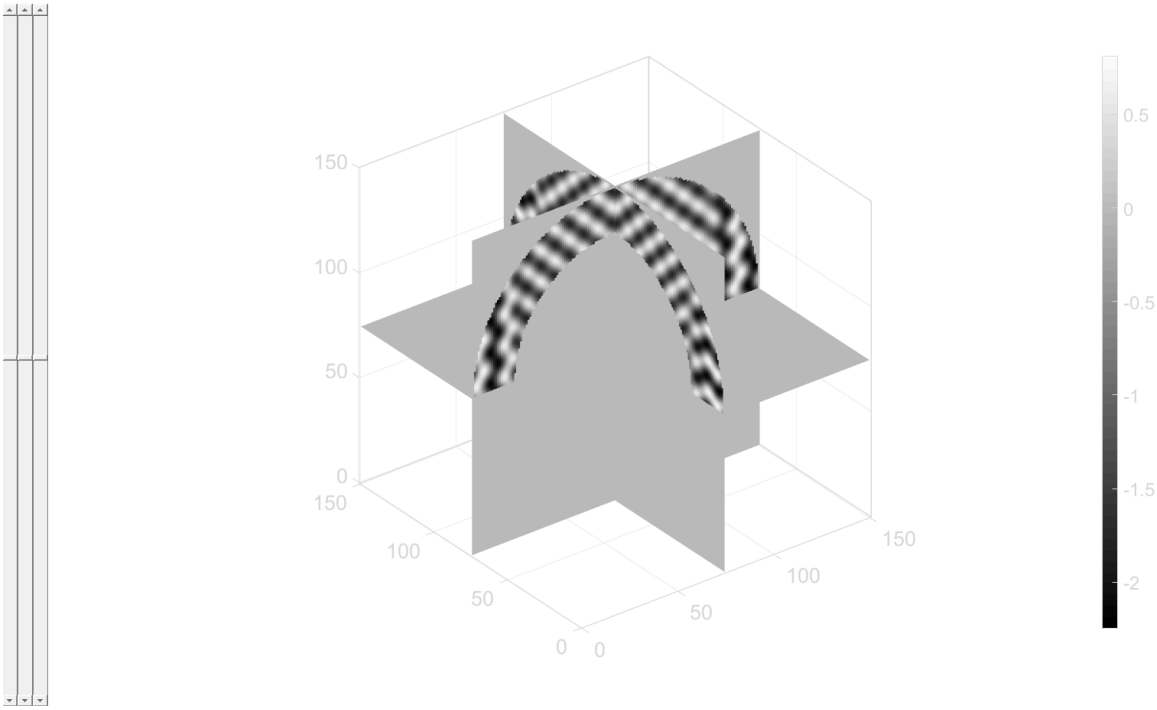
Compute the weitgh functions

```
weights_A = 1/(1+exp(-kappa * G));
weights_B = (1-weights_A);

% Interpolating using the above weights
graded_S =  weights_A .* (S_A - levelset_A) ...
            + (1-weights_A).* (S_B - levelset_B);
```

Trimming the domain to spherical or shell

```
switch transType

    case 1 %cylindrical transition
        % Outter Surface
        Ind_out=find(((X.^2 + Y.^2 + Z.^2) < R) & ...
            ( 0 <Z & Z<(sqrt(R^2-(X.^2 + Y.^2))))); % -0.5<Z<Outter Shell
        % Inner surface
        Ind_in=find((X.^2 + Y.^2 + Z.^2) < r);

    case 2 %spherical transition
        r = 0; % Inner radius (for spherical case r=0)
        % Outter Surface
        Ind_out=find(((X.^2 + Y.^2 + Z.^2) < R) & ...
            ( -0.5 <Z & Z<(sqrt(R^2-(X.^2 + Y.^2))))); % -0.5<Z<Outter Shell
        % Inner surface
        Ind_in=find((X.^2 + Y.^2 + Z.^2) < r);

    case 3 %linear transition
        % Outter Surface
        Ind_out=find(((X.^2 + Y.^2 + Z.^2) < R) & ...
            ( 0 <Z & Z<(sqrt(R^2-(X.^2 + Y.^2))))); % 0<Z<Outter Shell
        % Inner surface
        Ind_in=find((X.^2 + Y.^2 + Z.^2) < r);

end

% Trimm outter and inner points
Logic_out= ismember(1:size(X(:)) , Ind_out);
Logic_out=reshape(Logic_out,size(X));

Logic_in= ismember(1:size(X(:)) , Ind_in);
Logic_in=reshape(Logic_in,size(X));

keepLogic=and(Logic_out, ~Logic_in);
Sn=double(keepLogic);
Sn(keepLogic)=graded_S(keepLogic);
```

```
% Visualize trimmed field
sv3(Sn);
```

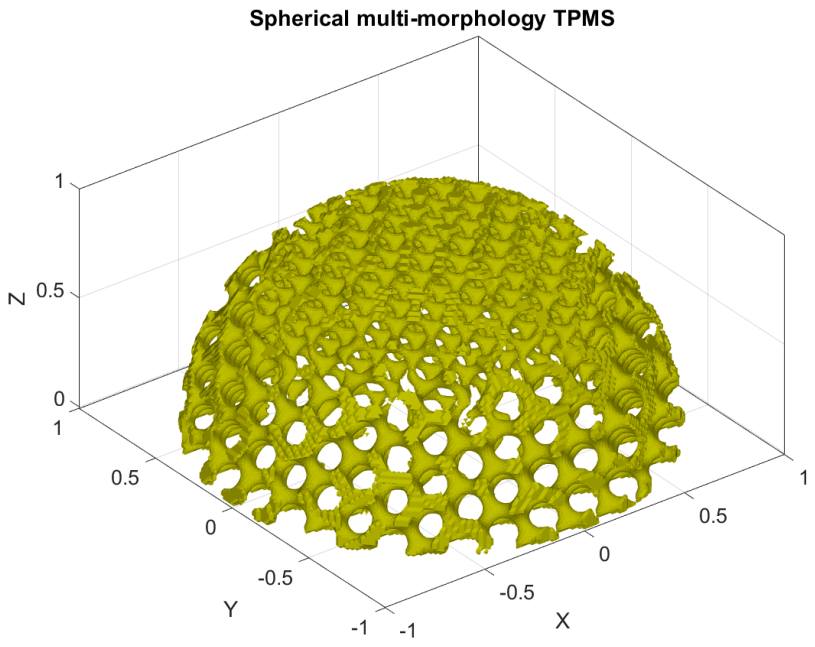


graded surface

```
graded_levelset=0;

% isosurface over the spherical shell
[F,V]=isosurface(X,Y,Z,Sn,graded_levelset);
C=zeros(size(F,1),1);

% Using grouping to keep only largest group
groupOptStruct.outputType='label';
[G,~,groupSize]=tesgroup(F,groupOptStruct); %Group connected faces
[~,indKeep]=max(groupSize); %Index of largest group

% Keep only largest group
F=F(G==indKeep,:); %Trim faces
C=C(G==indKeep,:); %Trim color data
[F,V]=patchCleanUnused(F,V); %Remove unused nodes
```

Visualizing geometry

```
cFigure; hold on;
title('Spherical multi-morphology TPMS','FontSize', fontSize)
gpatch(F,V,[0.75, 0.75, 0],'none', 1);
axisGeom(gca,fontSize); axis on;
camlight headlight;
drawnow;
```



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