

## Exploring meshes

□—pMesh —

Playing with mesh creation. Notice that the functions calls are in pGrid and pTGrid. The others are only for arrange the data. Try to change  $uo$  and  $vo$ .

Targets are 3: 1. For visualization, get the best view with less matrix size.  
2. For solving PDE's, get the best mesh for the algorithm.  
3. For the 3D printer, get the faster path for the printer head.

□—peaks —

$$\text{peaks}(x, y) := 3 \cdot \frac{(1-x)^2}{e^{x^2 + (y+1)^2}} - 10 \cdot \frac{\frac{x}{5} - x^3 - y^5}{e^{x^2 + y^2}} - \frac{1}{3 \cdot e^{(x+1)^2 + y^2}}$$

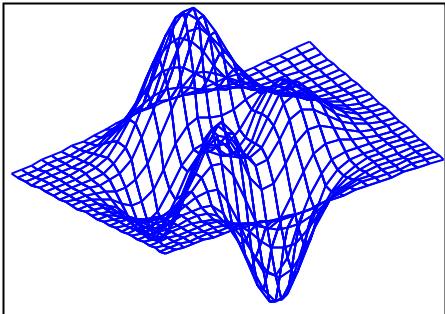
$U := pR(-3, 3, 25)$   
 $V := pR(-3, 3, 25)$   
 $G := pGrid(peaks, U, V)$   
 $z := [3 2 1]$

□—pMesh —

$$\begin{cases} uo := [0 0 1 1 0] \\ vo := [0 1 1 0 0] \\ S := pMesh(G, uo, vo) \\ S_1 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_1) = 3725$$

Viacheslav original mesh

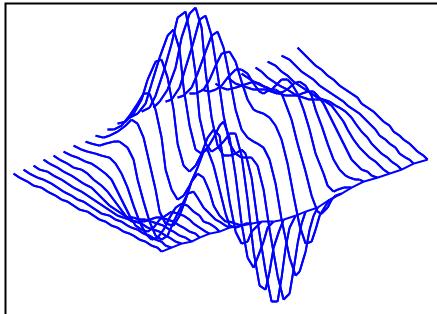


$$S_1 \cdot \gamma$$

$$\begin{cases} uo := [0 0] \\ vo := [1 1] \\ S := pMesh(G, uo, vo) \\ S_2 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_2) = 1850$$

waterfall along x

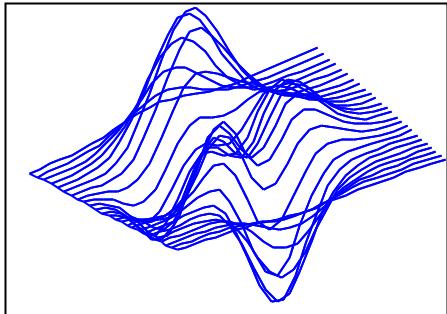


$$S_2 \cdot \gamma$$

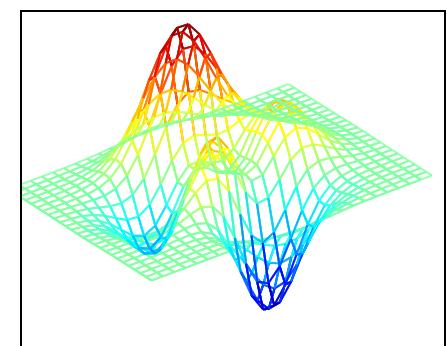
$$\begin{cases} uo := [0 0] \\ vo := [1 1] \\ S := pMesh(G^T, uo, vo) \\ S_3 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_3) = 1850$$

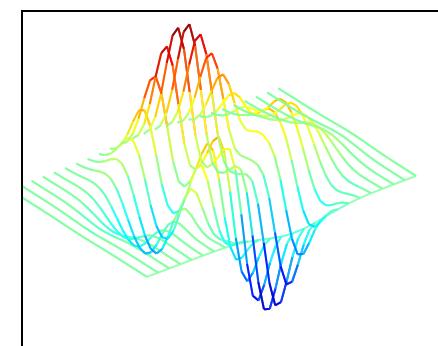
waterfall along y



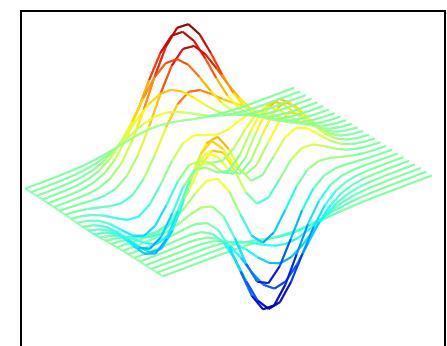
$$S_3 \cdot \gamma$$



$$pMeshShow(S_1, CM, \gamma)$$



$$pMeshShow(S_2, CM, \gamma)$$



$$pMeshShow(S_3, CM, \gamma)$$

$$\begin{cases} uo := [1 0] \\ vo := [0 1] \\ S := pMesh(G, uo, vo) \\ S_1 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_1) = 1850$$

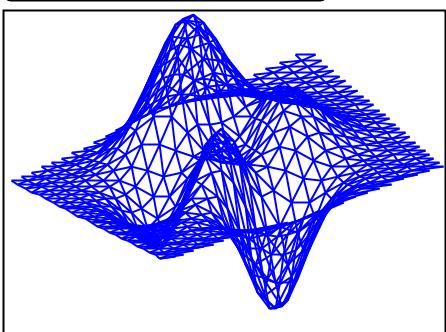
$$\begin{cases} uo := [0 0 1] \\ vo := [0 1 1] \\ S := pMesh(G, uo, vo) \\ S_2 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_2) = 2475$$

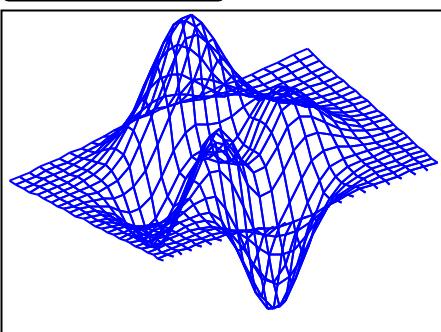
$$\begin{cases} uo := [0 0 1 0 1] \\ vo := [0 1 1 0 0] \\ S := pMesh(G, uo, vo) \\ S_3 := pZoom(S, z) \end{cases}$$

$$\text{rows}(S_3) = 3725$$

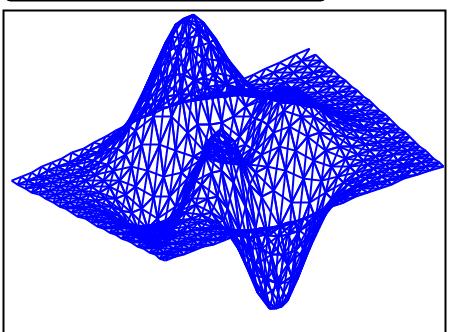
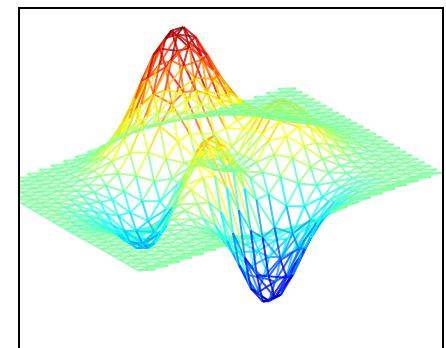
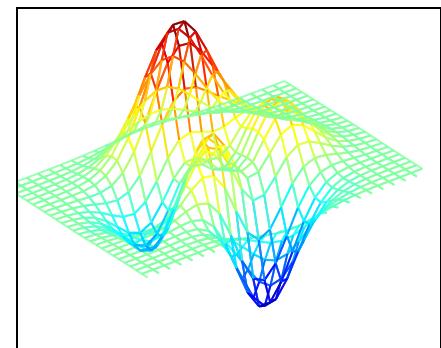
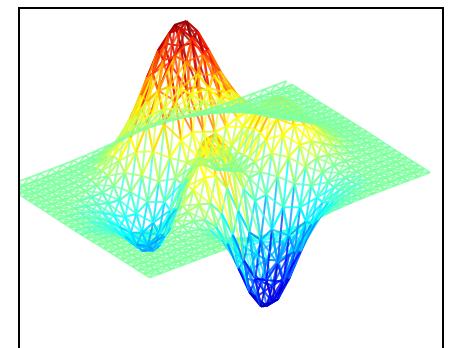
fake but fast trimesh

 $S_1 \cdot Y$ 

something else

 $S_2 \cdot Y$ 

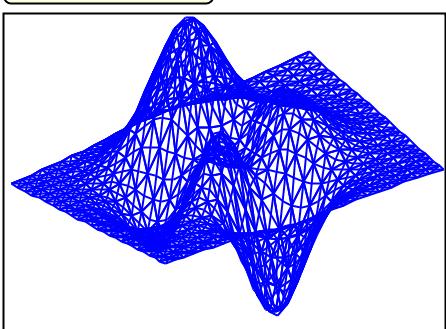
fake but nice trimesh

 $S_3 \cdot Y$  $pMeshShow(S_1, CM, Y)$  $pMeshShow(S_2, CM, Y)$  $pMeshShow(S_3, CM, Y)$ 

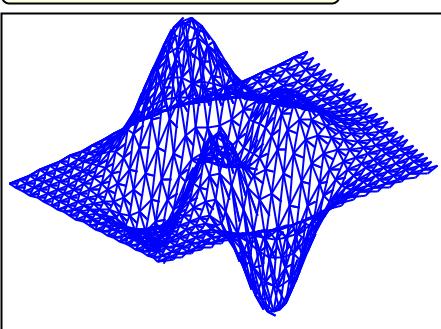
## □—Trimesh —————

**Trimesh** $TG := pTGrid(peaks, U, V)$ 
 $uo := [0\ 0\ 1\ 0\ 1]$   
 $vo := [0\ 1\ 1\ 0\ 0]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_1 := pZoom(S, z)$ 
 $\text{rows}(S_1) = 4525$ 
 $uo := [0\ 1\ 0]$   
 $vo := [0\ 1\ 1]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_2 := pZoom(S, z)$ 
 $\text{rows}(S_2) = 3225$ 
 $uo := [0\ 1]$   
 $vo := [0\ 1]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_3 := pZoom(S, z)$ 
 $\text{rows}(S_3) = 2575$ 

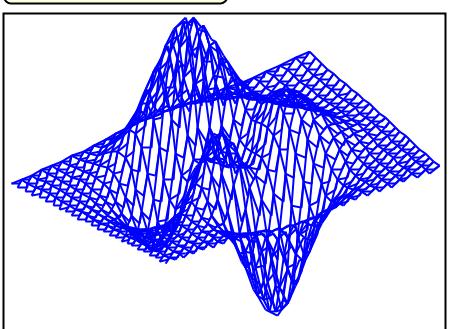
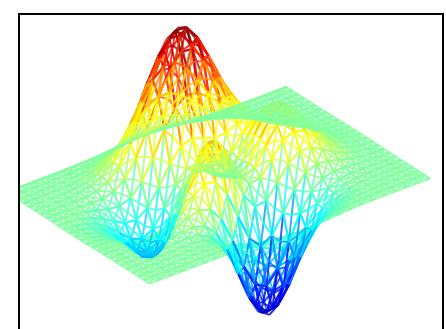
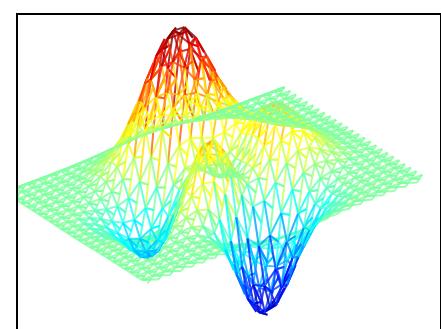
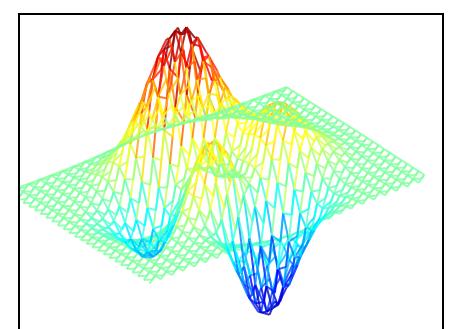
true tri mesh

 $S_1 \cdot Y$ 

intermediate variation

 $S_2 \cdot Y$ 

fast variation

 $S_3 \cdot Y$  $pMeshShow(S_1, CM, Y)$  $pMeshShow(S_2, CM, Y)$  $pMeshShow(S_3, CM, Y)$

torus

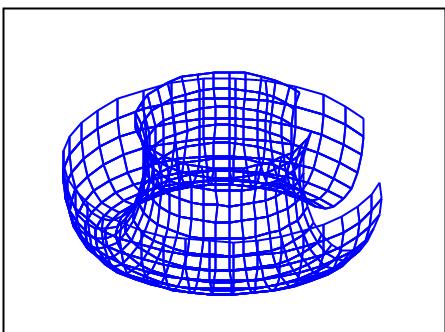
$$\begin{aligned} & [R := 6 \ r := 2] \\ & torus(u, v) := \begin{pmatrix} (R + r \cdot \cos(u)) \cdot \cos(v) \\ (R + r \cdot \cos(u)) \cdot \sin(v) \\ r \cdot \sin(u) \end{pmatrix} \\ & U := pR(-1.25 \cdot \pi, 0, 16) \\ & V := pR(0, 1.75 \cdot \pi, 32) \\ & G := pGrid(torus, U, V) \\ & z := [1 \ 1 \ 2] \end{aligned}$$

— pMesh —

$$\begin{array}{l} uo := [ \begin{array}{ccccc} 0 & 0 & 1 & 1 & 0 \end{array} ] \\ vo := [ \begin{array}{ccccc} 0 & 1 & 1 & 0 & 0 \end{array} ] \\ S := pMesh(G, uo, vo) \\ S_1 := pZoom(S, z) \end{array} \quad \boxed{\begin{array}{l} uo := [ \begin{array}{cc} 0 & 0 \end{array} ] \\ vo := [ \begin{array}{cc} 1 & 1 \end{array} ] \\ S := pMesh(G, uo, vo) \\ S_2 := pZoom(S, z) \end{array}} \quad \boxed{\begin{array}{l} uo := [ \begin{array}{cc} 0 & 0 \end{array} ] \\ vo := [ \begin{array}{cc} 1 & 1 \end{array} ] \\ S := pMesh(G^T, uo, vo) \\ S_3 := pZoom(S, z) \end{array}}$$

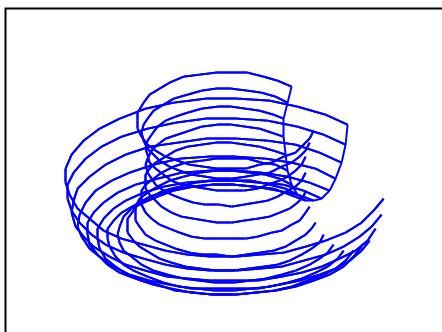
$$\text{rows}(S_1) = 3056 \quad \text{rows}(S_2) = 1520 \quad \text{rows}(S_3) = 1504$$

Viacheslav original mesh



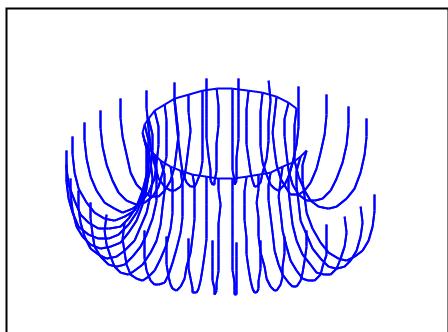
$$S_1 \cdot Y$$

waterfall along x

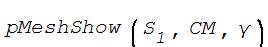


$$S_2 \cdot \gamma$$

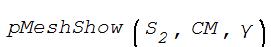
waterfall along y



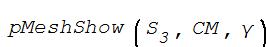
$$S_3 \cdot Y$$



A complex, multi-colored, helical or spiral-shaped curve plotted in 3D space. The curve is composed of numerous thin, curved segments in various colors, including red, orange, yellow, green, blue, and purple. It forms a dense, twisted structure that spirals around a central axis, resembling a DNA helix or a complex mathematical function like a helicoid.



A 3D plot of a hyperboloid of two sheets, represented by the equation  $x^2 + y^2 - z^2 = 1$ . The surface features two distinct bowl-shaped lobes opening along the z-axis. A grid of curves, colored red and blue, is overlaid on the surface to illustrate its geometry and the coordinate axes.



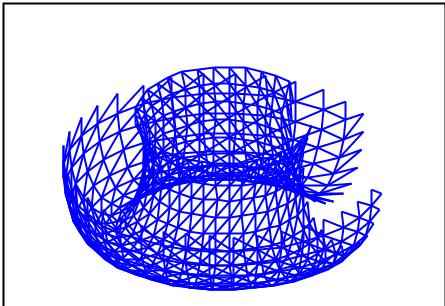
```

|  $uo := [ \begin{smallmatrix} 1 & 0 \end{smallmatrix} ]$ 
|  $vo := [ \begin{smallmatrix} 0 & 1 \end{smallmatrix} ]$ 
|  $S := pMesh(G, uo, vo)$ 
|  $S_1 := pZoom(S, z)$ 

```

$$\text{rows } \left( S_1 \right) = 1520$$

fake but fast trimesh



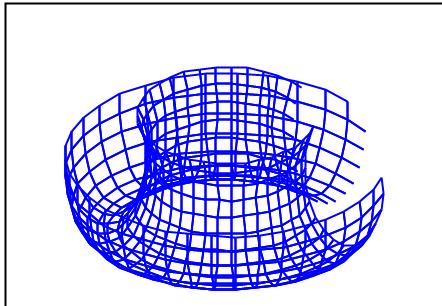
```

|  $uo := [ \begin{smallmatrix} 0 & 0 & 1 \end{smallmatrix} ]$ 
|  $vo := [ \begin{smallmatrix} 0 & 1 & 1 \end{smallmatrix} ]$ 
|  $S := pMesh ( G , \ uo , \ vo )$ 
|  $S_2 := pZoom ( S , \ z )$ 

```

$$\text{rows } \left( S_2 \right) = 2032$$

something else



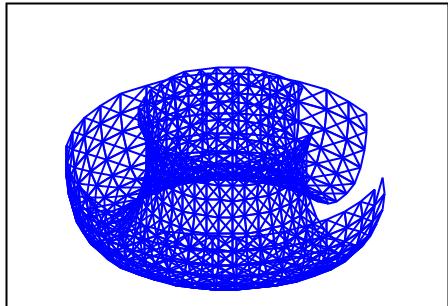
```

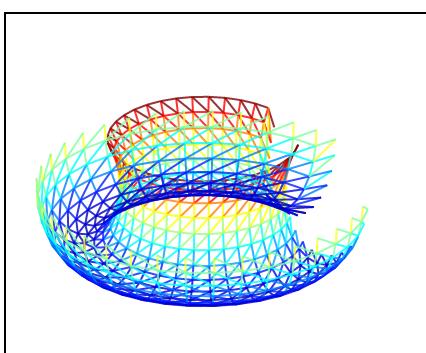
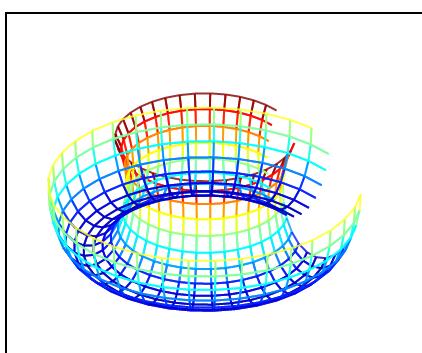
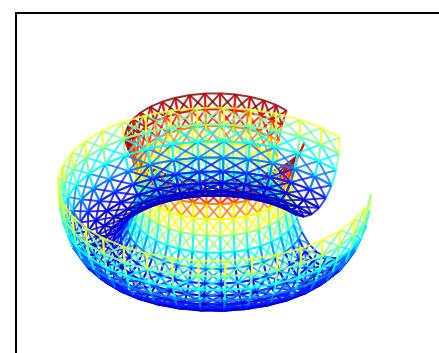
uo := [ 0 0 1 0 1 ]
vo := [ 0 1 1 0 0 ]
S := pMesh ( G , uo , vo )
S3 := pZoom ( S , z )

```

$$\text{rows}(S_3) = 3056$$

fake but nice trimesh



$S_1 \cdot \gamma$  $pMeshShow(S_1, CM, \gamma)$  $S_2 \cdot \gamma$  $pMeshShow(S_2, CM, \gamma)$  $S_3 \cdot \gamma$  $pMeshShow(S_3, CM, \gamma)$ 

## □—Trimesh —

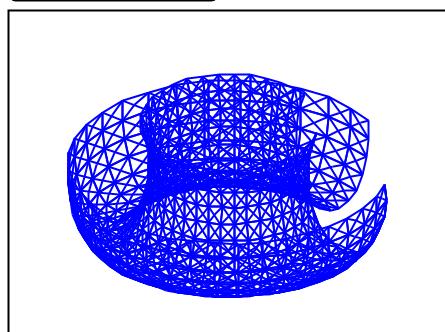
**Trimesh** $TG := pTGrid(torus, U, V)$ 

$$\begin{cases} uo := [0 0 1 0 1] \\ vo := [0 1 1 0 0] \\ S := pTMesh(G, TG, uo, vo) \\ S_1 := pZoom(S, z) \end{cases}$$
 $\text{rows}(S_1) = 3680$ 

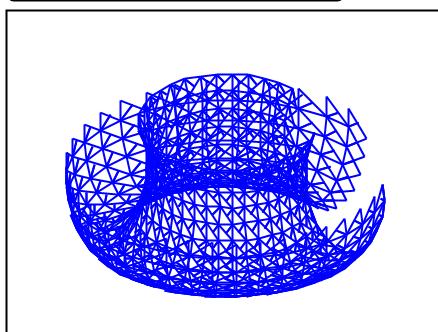
$$\begin{cases} uo := [0 1 0] \\ vo := [0 1 1] \\ S := pTMesh(G, TG, uo, vo) \\ S_2 := pZoom(S, z) \end{cases}$$
 $\text{rows}(S_2) = 2624$ 

$$\begin{cases} uo := [0 1] \\ vo := [0 1] \\ S := pTMesh(G, TG, uo, vo) \\ S_3 := pZoom(S, z) \end{cases}$$
 $\text{rows}(S_3) = 2096$ 

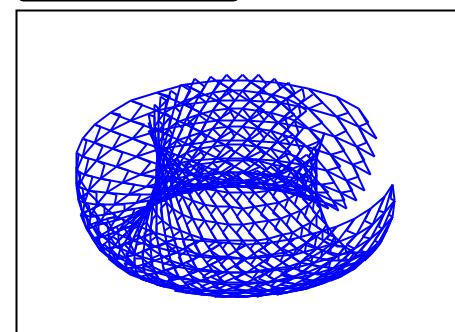
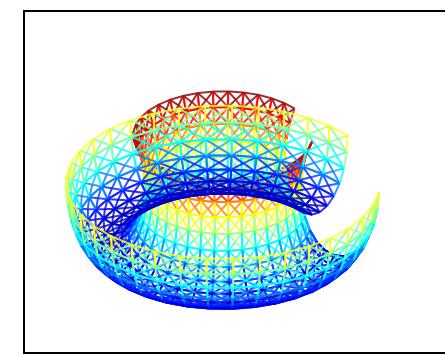
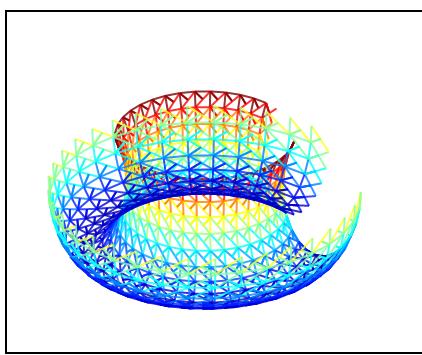
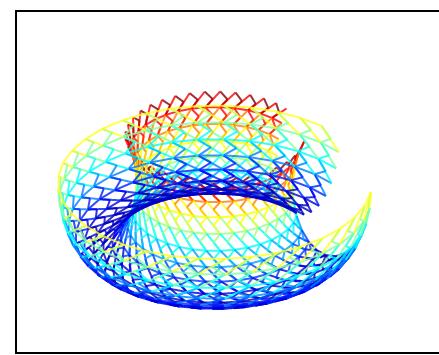
true tri mesh

 $S_1 \cdot \gamma$ 

intermediate variation

 $S_2 \cdot \gamma$ 

fast variation

 $S_3 \cdot \gamma$  $pMeshShow(S_1, CM, \gamma)$  $pMeshShow(S_2, CM, \gamma)$  $pMeshShow(S_3, CM, \gamma)$ 

## □—wave —

$$\begin{cases} f(r) := 0.5 \cdot \cos(4 \cdot r) \\ wave(r, \theta) := cyl2xyz([r \ \theta \ f(r)]) \end{cases}$$

$$\begin{cases} U := pR(0, 5, 20) \\ V := pR(0, 1.5 \cdot \pi, 30) \\ G := pGrid(wave, U, V) \\ z := [2 \ 2 \ 2] \end{cases}$$

## □—pMesh —

 $uo := [0 0 1 1 0 1]$  $uo := [0 0 1]$  $uo := [0 0 1]$

17 nov 2021 20:01:41 - C:\Users\ALVARO\Desktop\pWMesh.pdf

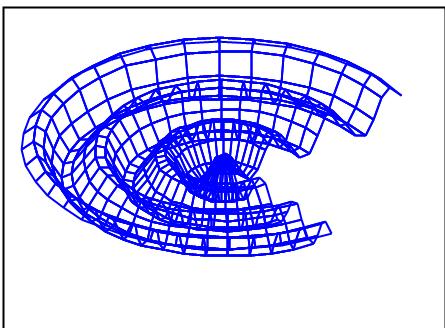
```

vo := [ 0 1 1 0 0 ]
S := pMesh ( G , uo , vo )
S1 := pZoom ( S , z )

```

$$\text{rows}(S_1) = 3580$$

Viacheslav original mesh



$S_1 \cdot Y$

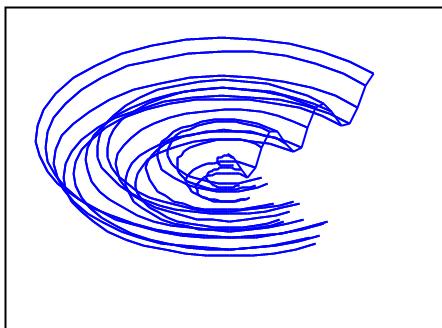
```

vo := [ 1 1 ]
S := pMesh ( G , uo , vo )
S2 := pZoom ( S , z )

```

$$\text{rows}(S_2) = 1780$$

waterfall along x



$S_2 \cdot Y$

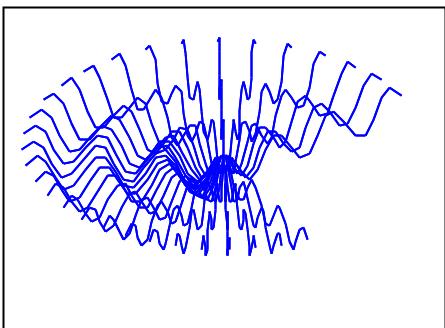
```

vo := [ 1 1 ]
S := pMesh ( GT , uo , vo )
S3 := pZoom ( S , z )

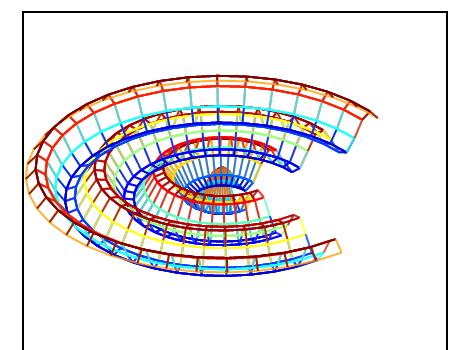
```

$$\text{rows}(S_3) = 1770$$

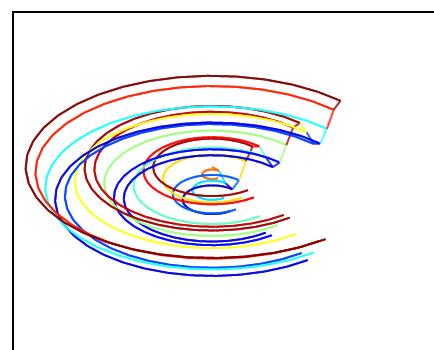
waterfall along y



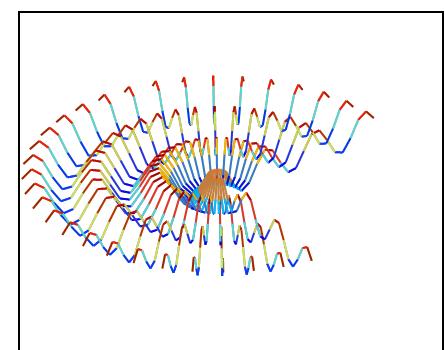
$S_3 \cdot Y$



pMeshShow ( S<sub>1</sub> , CM , Y )



pMeshShow ( S<sub>2</sub> , CM , Y )



pMeshShow ( S<sub>3</sub> , CM , Y )

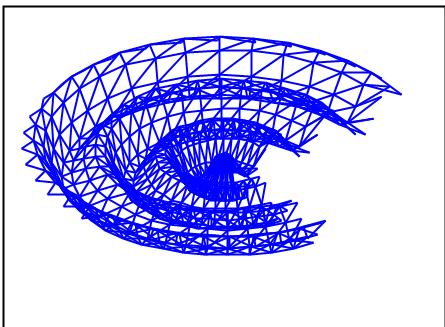
```

uo := [ 1 0 ]
vo := [ 0 1 ]
S := pMesh ( G , uo , vo )
S1 := pZoom ( S , z )

```

$$\text{rows}(S_1) = 1780$$

fake but fast trimesh



$S_1 \cdot Y$

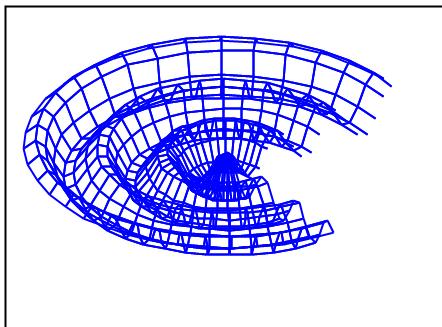
```

uo := [ 0 0 1 ]
vo := [ 0 1 1 ]
S := pMesh ( G , uo , vo )
S2 := pZoom ( S , z )

```

$$\text{rows}(S_2) = 2380$$

something else



$S_2 \cdot Y$

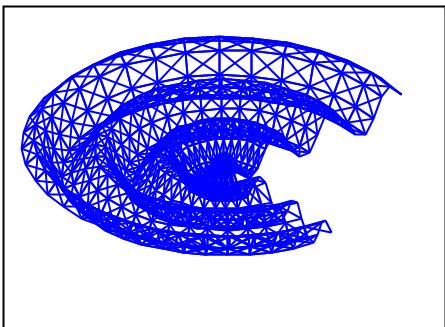
```

uo := [ 0 0 1 0 1 ]
vo := [ 0 1 1 0 0 ]
S := pMesh ( G , uo , vo )
S3 := pZoom ( S , z )

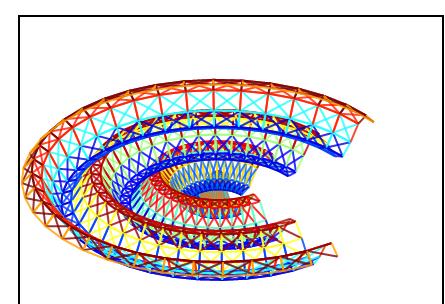
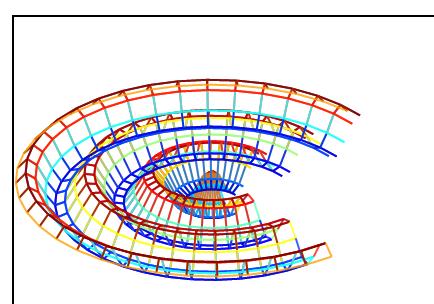
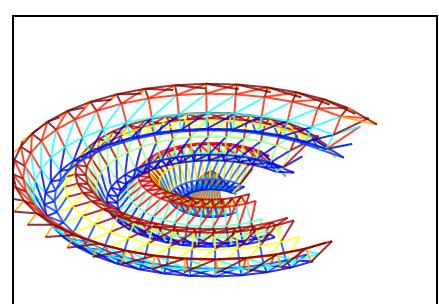
```

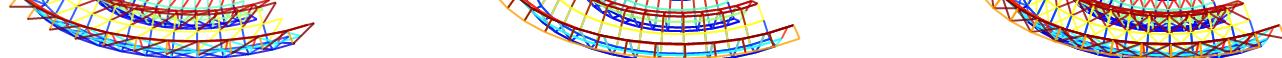
$$\text{rows}(S_3) = 3580$$

fake but nice trimesh



$S_3 \cdot Y$





17 nov 2021 20:01:41 - C:\Users\ALVARO\Desktop\pWMesh.pdf

$pMeshShow(S_1, CM, Y)$

$pMeshShow(S_2, CM, Y)$

$pMeshShow(S_3, CM, Y)$

■—Trimesh

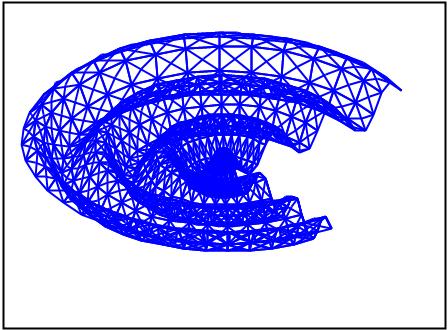
**Trimesh**

$TG := pTGrid(wave, U, V)$

$uo := [0 \ 0 \ 1 \ 0 \ 1]$   
 $vo := [0 \ 1 \ 1 \ 0 \ 0]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_1 := pZoom(S, z)$

$\text{rows}(S_1) = 4320$

true tri mesh

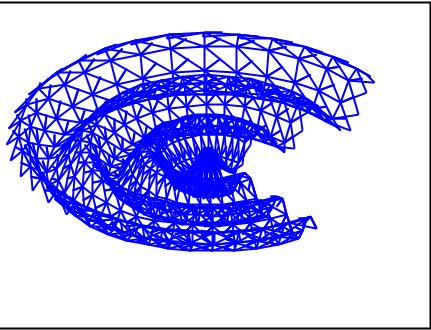


$S_1 \cdot Y$

$uo := [0 \ 1 \ 0]$   
 $vo := [0 \ 1 \ 1]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_2 := pZoom(S, z)$

$\text{rows}(S_2) = 3080$

intermediate variation

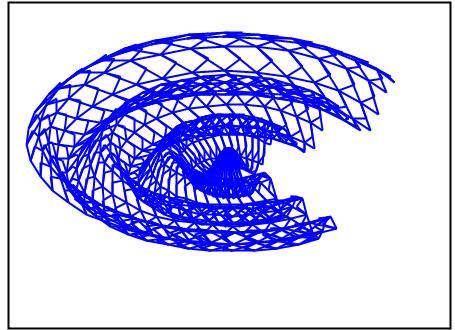


$S_2 \cdot Y$

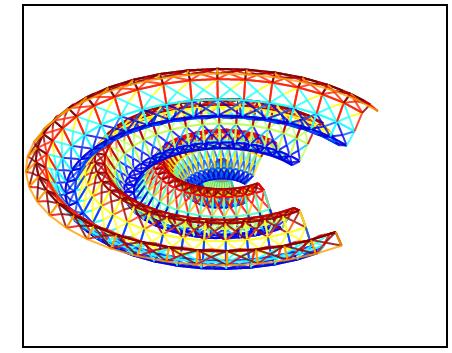
$uo := [0 \ 1]$   
 $vo := [0 \ 1]$   
 $S := pTMesh(G, TG, uo, vo)$   
 $S_3 := pZoom(S, z)$

$\text{rows}(S_3) = 2460$

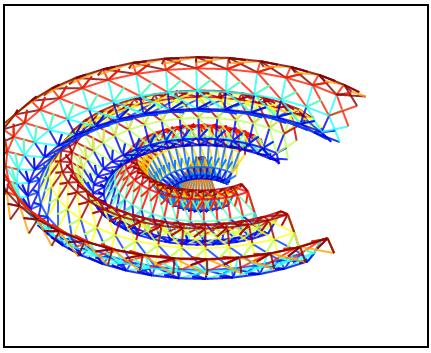
fast variation



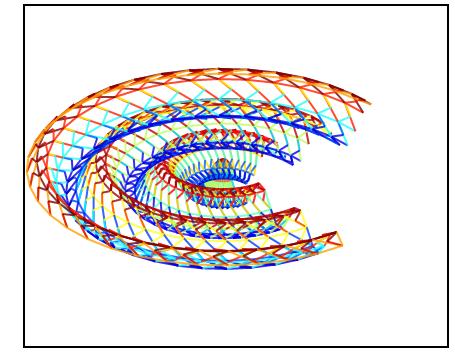
$S_3 \cdot Y$



$pMeshShow(S_1, CM, Y)$



$pMeshShow(S_2, CM, Y)$



$pMeshShow(S_3, CM, Y)$

Alvaro