# Simulation and Analysis of Mechanical Properties for Euplectella sp. Skeleton

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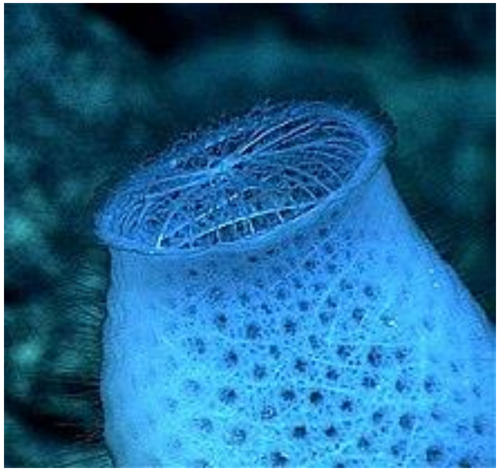
# Outline

- **What is *Euplectella* sp. Skeleton?**
- **Research methods**
- **Simulation**
- **Future work**
- **Reference**

# Euplectella sp. Skeleton

- ***Euplectella* sp. Skeleton** is a marine-sponge-derived biomaterials.
- Structure： 6~32cm long , 40~70 $\mu$ m in diameter.
- Material: hydrated silica ($SiO_2 \bullet nH_2O$) (n=2~5).



Venus flower basket Venus flower basket ,*Euplectella* sp.,skeketon

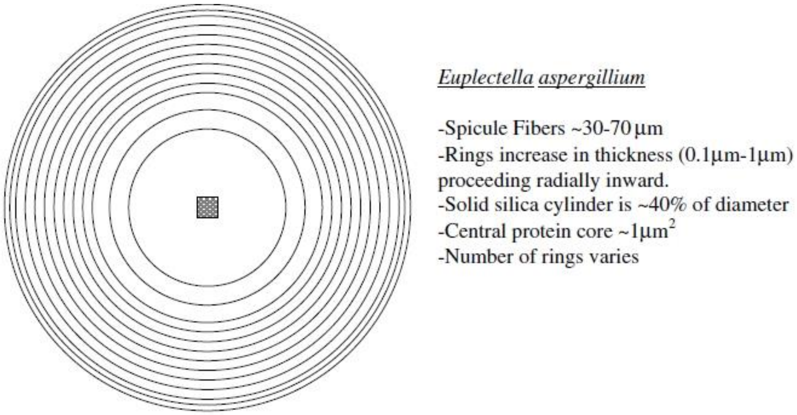



Fig. 4. Schematic drawing of *E. aspergillium* spicule. Note: drawing is not to scale.

# Research methods

- Coarse-grained modeling
- Lattice  spring modeling (LSM)
- Tool:

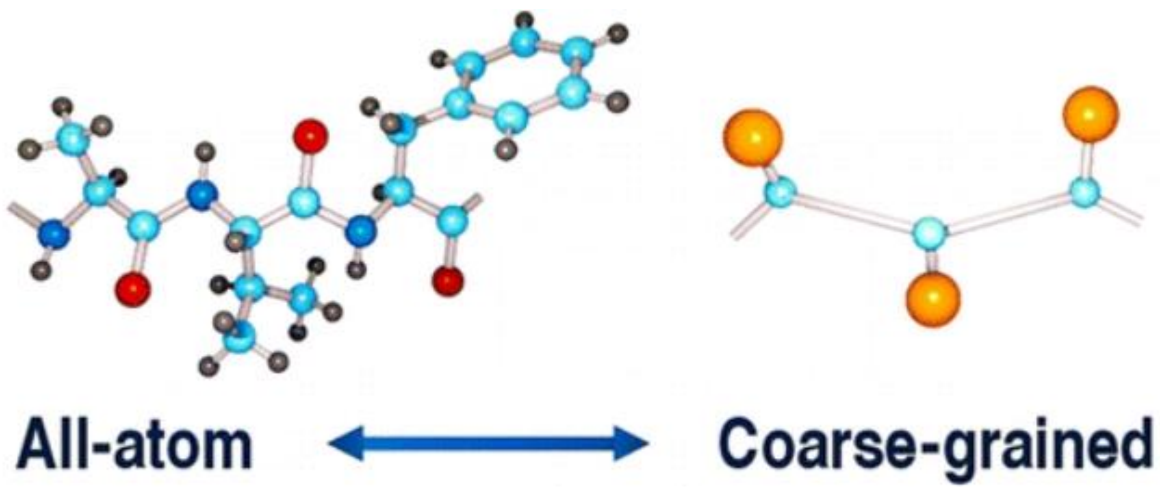
◆MATLAB

◆Lammps

◆OVITO

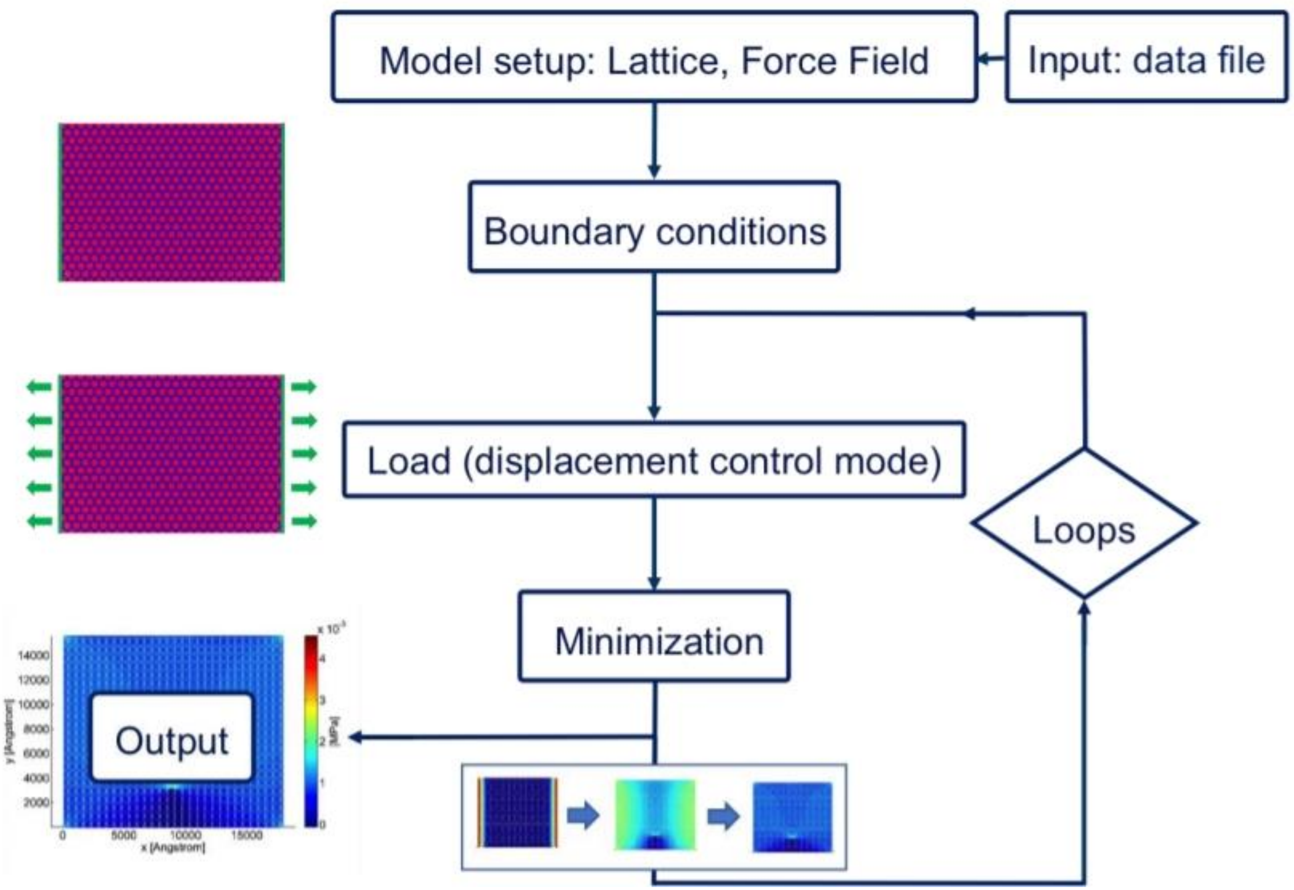
# Coarse-grained modeling

- **Coarse-grained modeling, aim at simulating the behavior of complex systems using their coarse-grained (simplified) representation.**



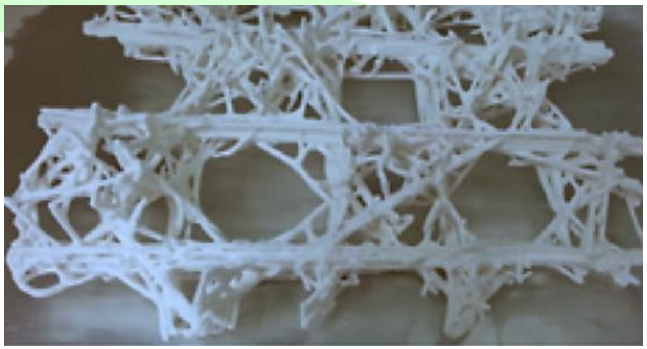
# Lattice Spring Modeling (LSM)

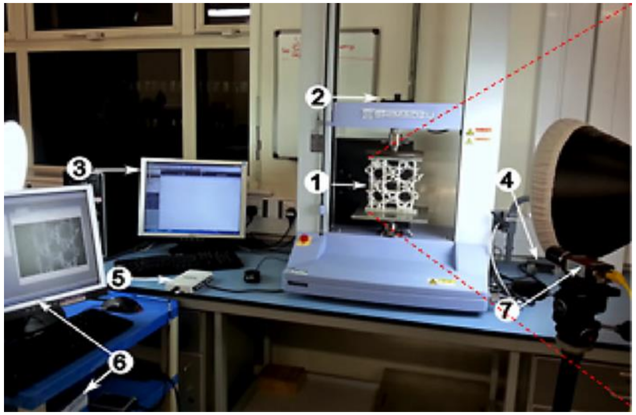
Lammps MATLAB

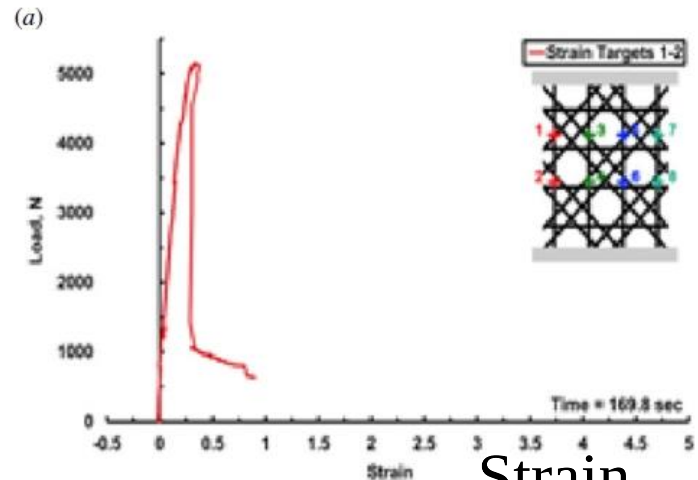



MATLAB
OVITO

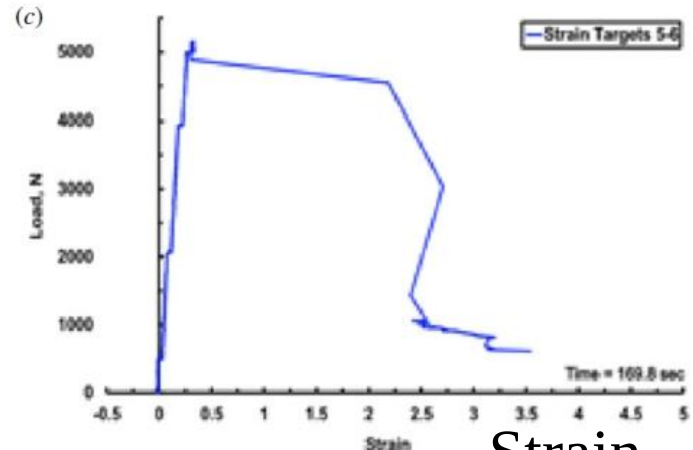
# Experimental reference





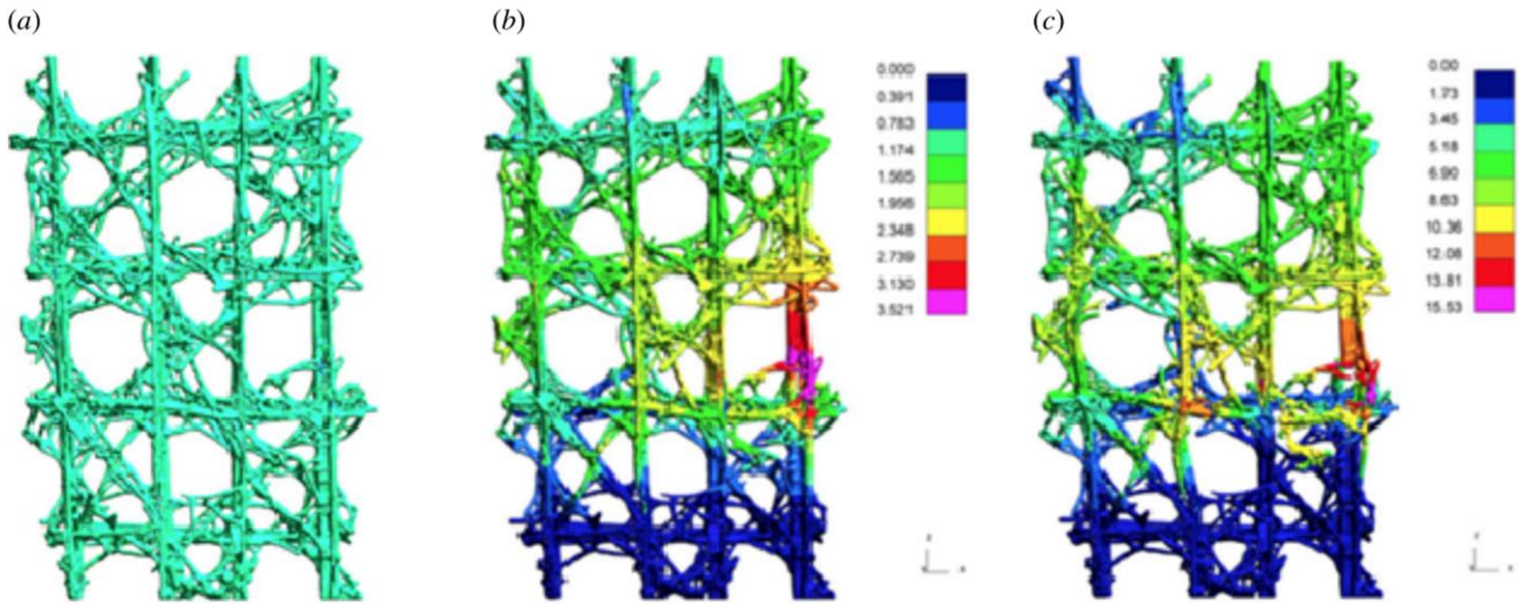




Strain




Strain

# Experimental reference

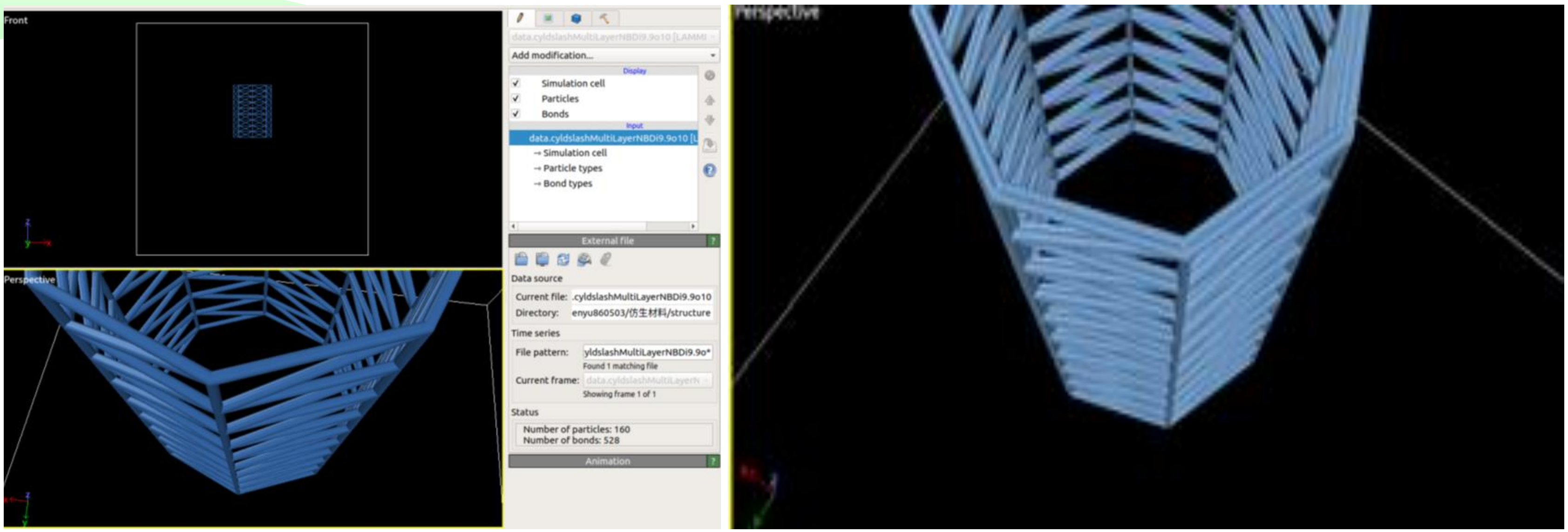



- The team believes that the construction of multi-layer interweaving of nodes improves the ability of local energy absorption.

# Simulation

- Structure
  - ➢Structure coefficient
  - ➢Structure model
- Simulation setting
- Data

# Structure




| | Real | Robsonbrow2019 | My simulation |
|---|---|---|---|
| Height | 6~32(cm) | 25(cm) | 40(cm) |
| Diameter | 1.5~5(cm) | 2.5~4.25±0.94(cm) | 10(cm) |
| Thickness | 0.1~1( $\mu$ m) | 350±60( $\mu$ m) | - |
| Section | - | 2*2(cm) | 3(cm)*3(cm) |

# Simulation setting

- **Environmental conditions: NPT**
- **Force field:**

➢ **Bond Potential: Harmonic bond**

**E = K (r - r0)^2**

- **r0 is the equilibrium bond distance**

➢ **Intermolecular force: Lennard-Jones potential**

$$V_{\mathrm{LJ}} = 4\varepsilon\left[\left(\frac{\sigma}{r}\right)^{12} - \left(\frac{\sigma}{r}\right)^{6}\right]$$

- $\sigma$ is the finite distance at which the inter-particle potential is zero
- $\varepsilon$ is the depth of the potential well

# Future work

- **Imitate the compression test done by Robinson team, and improve the structure of the next stage.**
- **Build different layer structure and adjust geometric shape ratio. Observe shape ratio and tensile strength relationship.**

# 謝謝聆聽！

# Thanks!

# Reference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