MSRI
Mathematical Sciences Research Institute

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NOTETAKER CHECKLIST FORM

(Complete one for each talk.)

Name: Malgorzata Marciniak **Email/Phone:** mmarciniak@lagcc.cuny.edu 5734620411

Speaker's Name: Vincenzo Vitelli

Talk Title: Topology protects equilibrium structures in a classical system of interacting lines

Date: 10 / 05 / 2018 **Time:** 2 : 00 am / pm (circle one)

Please summarize the lecture in 5 or fewer sentences:
Construction of topologically protected states that arise from the combination of strong interactions and thermal fluctuations inherent to soft matter. Consideration of fluctuating lines under tension, subject to a class of spatially modulated substrate potentials. At equilibrium, the lines acquire a collective tilt proportional to an integer topological invariant called the Chern number.

CHECK LIST

(This is **NOT** optional, we will **not pay** for **incomplete** forms)

☑ Introduce yourself to the speaker prior to the talk. Tell them that you will be the note taker, and that you will need to make copies of their notes and materials, if any.

☑ Obtain ALL presentation materials from speaker. This can be done before the talk is to begin or after the talk; please make arrangements with the speaker as to when you can do this. You may scan and send materials as a .pdf to yourself using the scanner on the 3rd floor.

- **Computer Presentations**: Obtain a copy of their presentation
- **Overhead**: Obtain a copy or use the originals and scan them
- **Blackboard**: Take blackboard notes in black or blue **PEN**. We will **NOT** accept notes in pencil or in colored ink other than black or blue.
- **Handouts**: Obtain copies of and scan all handouts

☑ For each talk, all materials must be saved in a single .pdf and named according to the naming convention on the "Materials Received" check list. To do this, compile all materials for a specific talk into one stack with this completed sheet on top and insert face up into the tray on the top of the scanner. Proceed to scan and email the file to yourself. Do this for the materials from each talk.

☑ When you have emailed all files to yourself, please save and re-name each file according to the naming convention listed below the talk title on the "Materials Received" check list. (*YYYY.MM.DD.TIME.SpeakerLastName*)

☑ Email the re-named files to notes@msri.org with the workshop name and your name in the subject line.

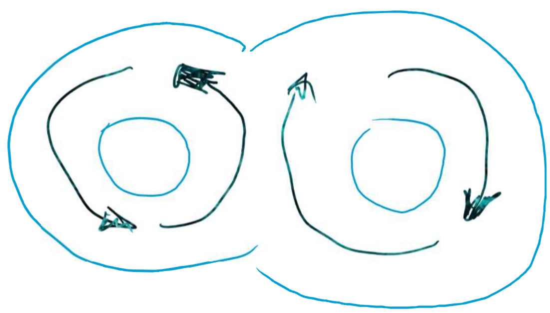
Speaker: Vincenzo Vitelli

Title: **Topology protects equilibrium structures in a classical system of interacting lines**

(Topological mechanics: from metamaterial to soft and active matter)

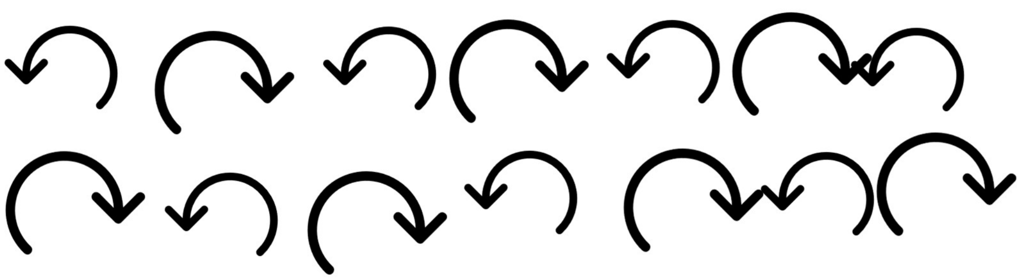
Note taker: Malgorzata Marciniak

Active topological metamaterials: fluid within particles, continuous motion. Chirality of flow transmitted to density waves? How does the sound move through the net of those?



Counterclockwise rotation clockwise rotation

Robust unidirectional sound waveguides: no back-scattering and the wave goes around the obstacles (Souslov, van Zuiden, Bartolo, Vitelli *Nature Physics* 2017). Excite a wave in appropriate frequency and it will go around the boundary and around obstacles. Never enters the interior of the net.



Chern number:

$$C_n = \frac{1}{2\pi} \int_{BZ} \nabla \times A_n(q) dq$$

Berry connection

$$A_n(q) = i(u_q^n)^+ \cdot (\nabla_q u_q^n)$$

Topological gyroscopic metamaterials: Experiment with gyroscopes shows the same property that the wave (obtained by poking one of the gyroscopes) goes along the edge only and goes around places if gyroscopes are removed.

Movies from the webpage: http://home.uchicago.edu/~vitelli/videos.html

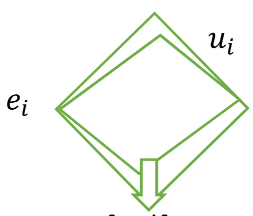
Topological mechanical metamaterials I: the flipper shows a movable structure that appears entirely rigid at first but can be moved locally. The local softness property can be moved to other vertices.

In **topological Maxwell lattices** the rigidity and the softness can be placed in a particular place within the lattice.

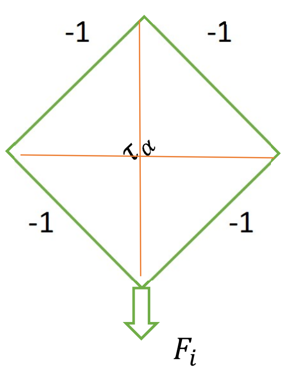
Response to adding topological defects? Placing two topological defects in the structural feature in the medium. Is the entire structure rigid or not? At the position of the two defects the reaction of the medium is different (soft or rigid), depending on the topological polarization (quantity that is +1 or -1). If this number is positive, then the reis a zero mode. When it is negative then there is no motion and possibility of stress (state of self-stress).

Topological band theory of "Phonons"

-zero mode $0 = e_i = R_{ij}u_i$



-state of self-stress $0 = F_i = R_{i\alpha}^T \tau_\alpha$



# of degrees of freedom-#of constrains=$n_{zm} - n_{ss}$==flux polarization(the difference of the numbers of zero modes in the matrices)

Winding numbers:

$$n_i = \frac{1}{2\pi} \int_{C_i} \mathrm{d}\mathbf{k} \cdot \nabla_{\mathbf{k}} \phi(\mathbf{k})$$

Topological control of material failure: use the state of self-stress (the entire line of it). 3d design by stacking layers and creating the entire self-stress region. The 3D printed mode shows the localized buckling response.

Topological patterning of interacting polymers: polymers are fluctuating line that are interacting with each other, study the mechanical problem in the presence of strong fluctuation, mathematically this is summing over a mini path. Here are interactions of many polymers. Polymer lines have a tilt (rational number), which is proportional to Chern number (integer). When the noise becomes large then the Chern number jumps.