# INT WORKSHOP INT-23-85W

# Interplay of Nuclear, Neutrino and BSM Physics at Low-energies

## April 17, 2023 - April 21, 2023

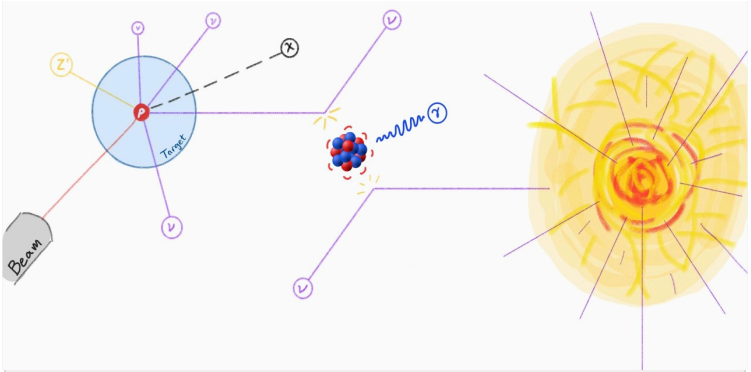



Image credit: Jayden Newstead, University of Melbourne

Welcome

Glad you're here!

**Bhaskar Dutta, Jayden Newstead, Vishvas Pandey**

Texas A&M University 1876

The University of Melbourne

Fermilab

# INT Code of Conduct

https://www.int.washington.edu/index.php/visitors/int-code-conduct

INT **faculty, scientific personnel, and visitors** shall carry out their scientific research with integrity and the highest standards, and shall not commit scientific misconduct, defined as fabrication, falsification, or plagiarism. Scientific error or incorrect interpretation of research data that may occur as part of the scientific process does not constitute scientific misconduct.

INT **faculty, scientific personnel and visitors** shall avoid those detrimental research practices that are clear violations of the fundamental tenets of research. They should be fair and objective peer reviewers, maintain confidentiality when requested, promptly move to correct the literature when errors in their own work are detected, include all deserving authors on publications, and give appropriate credit to prior work in citations.

INT **faculty, scientific personnel and visitors** shall treat all individuals in the scientific enterprise collegially and with respect, including supervisors, colleagues, students and other early-career colleagues, technical and clerical staff, and interested members of the public. They must refrain from all forms of discrimination, harassment, and bullying in their professional encounters, as these behaviors have adverse impacts on the careers of scientists and the proper conduct of science.

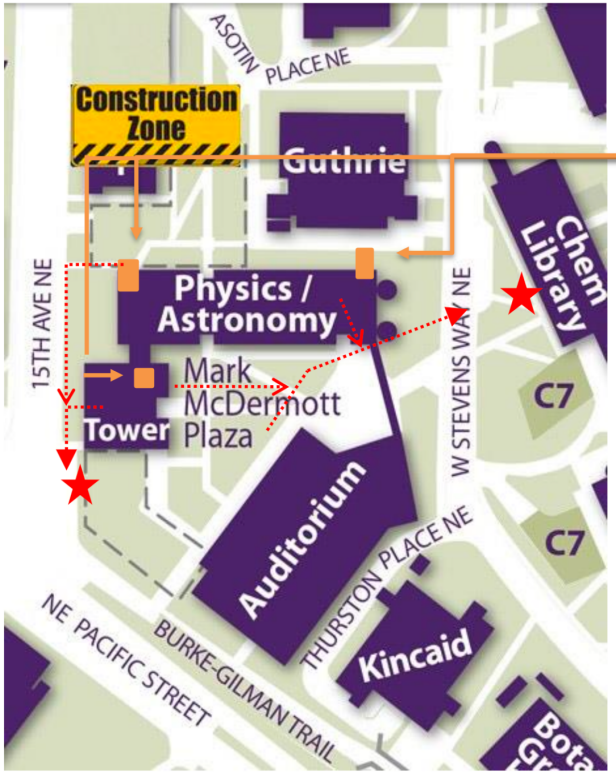
INT **faculty, scientific personnel and visitors** shall not represent any position as being that of the INT unless it has the approval of the **INT director**.

INT **faculty, scientific personnel and visitors** are expected to adhere to their employers' codes of conduct or ethics.

# Emergency Exit

**Fire:** If alarm is activated (whooping sound and flashing lights), immediately leave the building via the nearest stairwell & close doors behind you. Do not use the elevators. Go to the bottom of the stairs, then exit the building. Do not remain in the Plaza area, instead head toward the sidewalks for safety.

**Earthquake:** Take cover next to (not under) a reasonably elevated and sturdy piece of furniture like an office desk (or better yet, lie down between two), in a corner away from windows and heavy objects that may fall, or in a structurally strong location such as a hall by a pillar. Do not stand in open office doorways as swinging doors may cause injury. Wait until all shaking stops before leaving the building. Do not use the elevators. Take the stairs to the bottom and exit the building, being careful to watch for falling debris.




Stairwells

Evacuation routes

Assembly locations

**Do Not** remain in the Mark McDermott Plaza with the sculpture or just north of the building. They are potentially dangerous locations due to **possible collapse into the basement/laboratory areas** below.

# More Practical Info …

**Internet:**

Network: University of Washington

Temporary UW NetID: event0985

Password: r4E9; a2N5; g3E4 Expires: 04/24/2023

**Uploading your talks:**

Please email a .pdf or .ppt file of your presentation to intmail@uw.edu.
Be sure to include your last name in the file name.

# Workshop Dinner

Mamma Melina
RISTORANTE + PIZZERIA

**Thursday, April 20, 6:30 PM**

***Address: 5101 25th Ave NE,***

***Seattle, WA 98105***

https://www.mammamelina.com/

**We have made a reservation for a family style menu (+1s, +2s are welcome) it will be $36 per person (not covered by INT, we pay ourselves).**





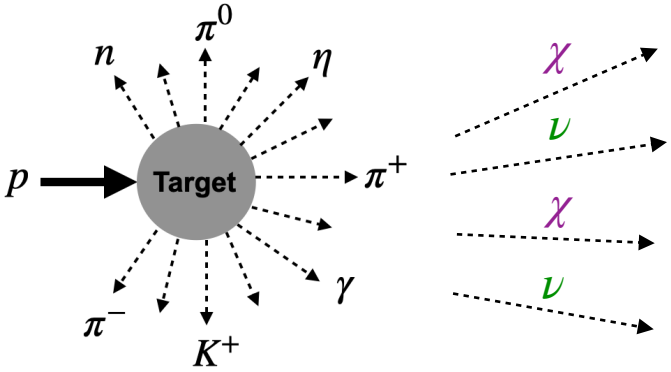







# Scope of the Workshop

**Accelerator Neutrino Facilities**




***ORNL, LANL, FNAL (PIP-II BD), JPARC, ….***

*Please note that this workshop primarily focuses on "low-energy" neutrinos and dark sector candidates at spallation-neutron-sources/decay-at-rest/beam-dump type facilities but similar physics and interplay is applicable for decay-in-flight/GeV-scale neutrino facilities*

# Scope of the Workshop

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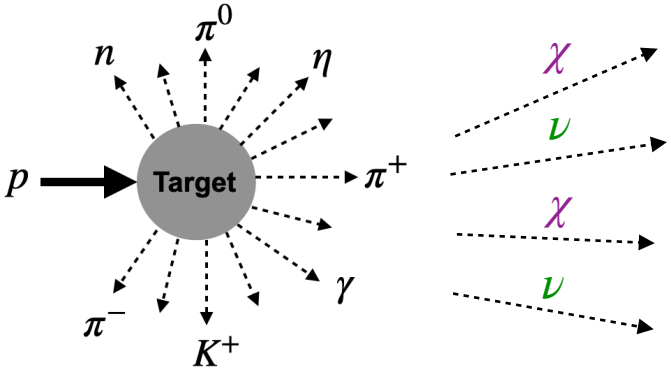


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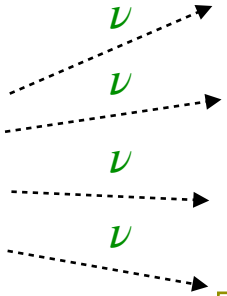
**Supernova**

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# Scope of the Workshop

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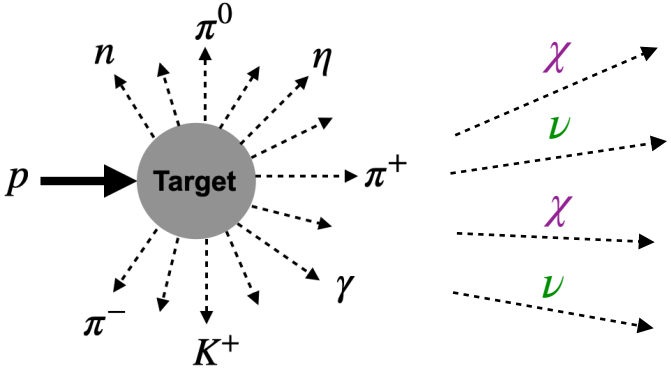
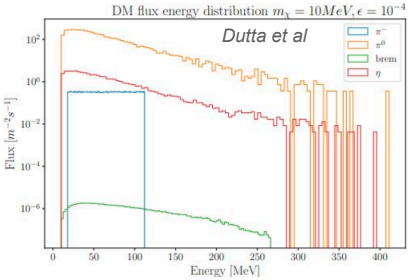
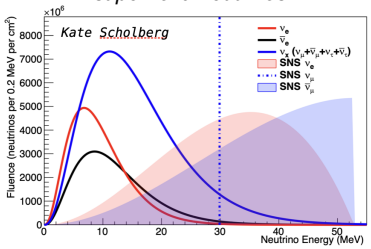



*pion decay at rest and supernova neutrinos*

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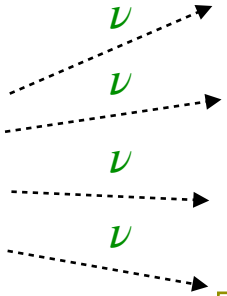


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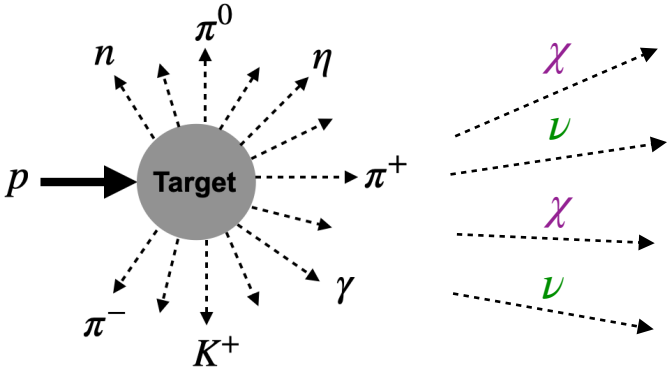


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## Supernova

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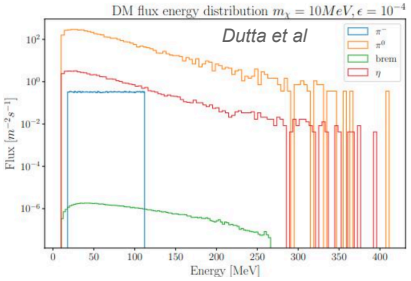


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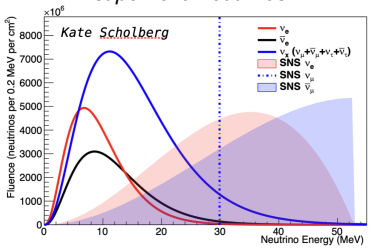
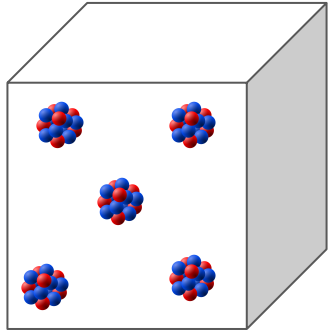



$\chi$ $\nu$ $\chi$ $\nu$

**Low-threshold, highly capable detectors**



***Nuclear Target***

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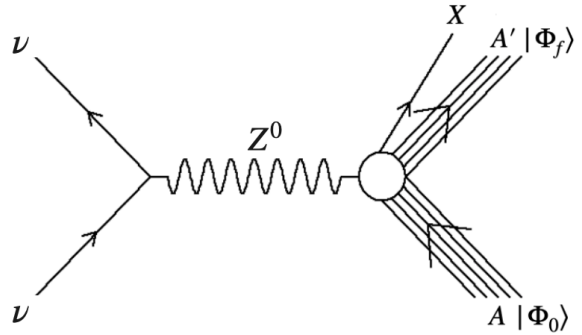
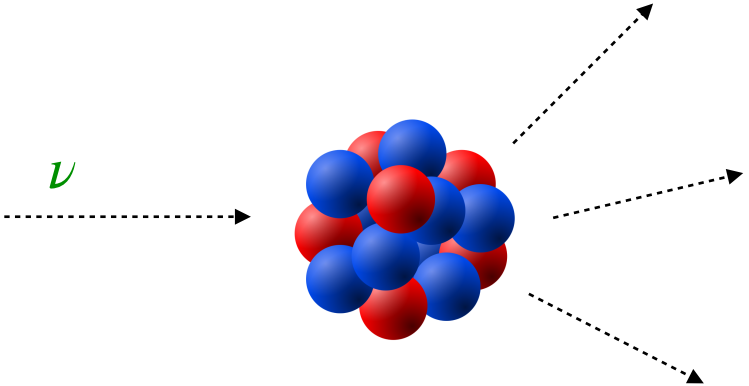
# Scope of the Workshop

**(NC) Neutrino Scattering off Nuclei**



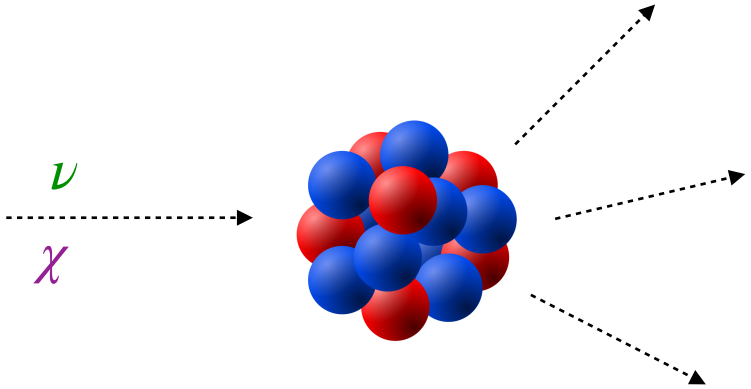




*Nuclear Effects*

- *Nucleons bound in the nucleus in a potential*
- *Pauli blocking*
- *Collective excitations*
- *Nucleon-nucleon correlations (short- and long-range)*
- *……*

*(X is signal in our detectors)*

# Scope of the Workshop

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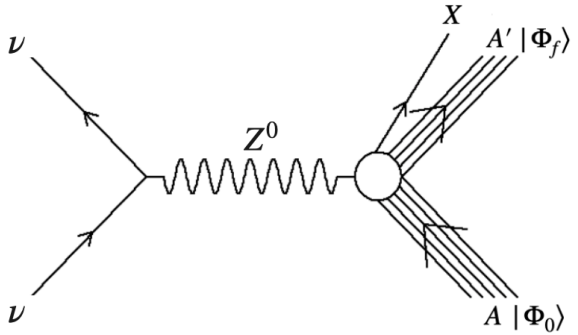
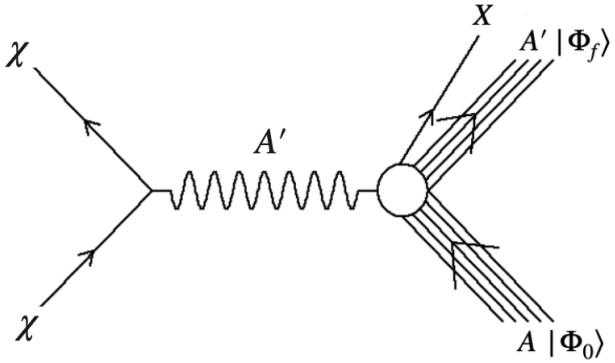



**Dark Matter Scattering off Nuclei**




*(X is signal in our detectors)*

# Scope of the Workshop

✦ We need:

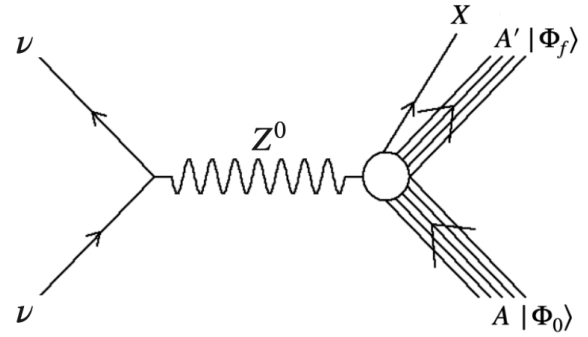
accurate theory predictions

precise experimental measurements

of scattering rates (/cross section) of these process for both neutrino- and dark matter-nucleus scattering.

✦ To fully allow us to disentangle any potential BSM physics signals from the SM signals at these facilities.

**(NC) Neutrino Scattering off Nuclei**

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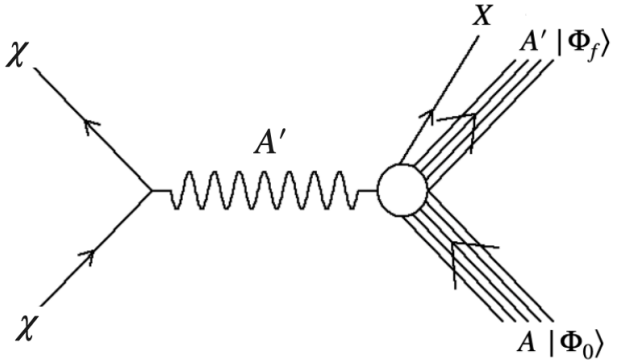


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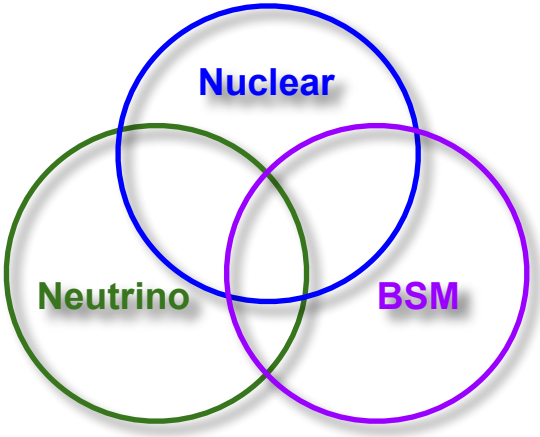
# Scope of the Workshop

✦ Interplay of Nuclear, Neutrino and BSM Physics at Low-energies

- Exploring complementarity between neutrino-nuclear interactions and various BSM candidate nuclear interactions, e.g., DM-nucleus scattering, ALP-nuclear scattering
- To advance efforts to identify and characterize the interplay between nuclear, neutrino, and beyond the standard model (BSM) physics signatures (at the tens of MeV scale)
- Bring together experts from the nuclear, neutrino, and BSM community, both theorists and experimentalists, who have the common goal of understanding interplay of this physics.
- The workshop aims to provide an environment stimulating discussion and collaboration.
- We hope that the workshop will provide a forum to enable future advances in both theoretical and experimental aspects of our understanding of this interplay of nuclear, neutrino, and BSM physics and would lead to new collaborations across fields.



# Workshop Agenda

Full agenda on the workshop website: https://www.int.washington.edu/programs-and-workshops/23-85w

| | Mon, Apr 17 | Tue, Apr 18 | Wed, Apr 19 |
|---|---|---|---|
| 09:00 - 09:45 | Check-in, Meet and Greet<br>**Bhaskar, Jayden, Vishvas:** Workshop Introduction | **Wei-Chih Huang:** Inelastic nuclear scattering from neutrinos and dark matter | **Jayden Newstead:** CEvNS with reactor neutrinos |
| 09:45 - 10:30 | **Natalie Jachowicz:** Elastic and Inelastic neutrino-nucleus scattering in the 10s of MeV energy range | **Joanna Sobczyk:** CEvNS and inelastic cross sections within coupled-cluster theory | **Charles Horowitz:** PVES experiments to constrain weak form factor for CEvNS physics |
| 10:30 - 11:00 | **Coffee Break** | **Coffee Break** | **Coffee Break** |
| 11:00 - 11:45 | **Calvin Johnson:** Shell model calculations | **Steven Gardiner:** Simulating supernova neutrino interactions in argon: status and challenges | **Oleksandr Tomalak:** Radiative corrections to low-energy neutral-current neutrino scattering and DAR sources |
| 11:45 - 12:30 | **Baishan Hu:** Ab initio nuclear calculations for dark matter detection and CEvNS | **Samuel Hedges:** Recent results from COHERENT's inelastic neutrino-nucleus scattering detectors | **Wouter Dekens:** Light sterile neutrinos and neutrinoless double beta decay |
| 12:30 - 02:00 | **Lunch** | **Lunch** | **Lunch** |
| 02:00 - 02:45 | **Discussion**<br><br>**(Moderators: Jayden Newstead, Oleksandr Tomalak)** | **Aaron Meyer:** Neutrino cross sections from Lattice QCD | |
| 02:45 - 03:30 | | | |
| 03:30 - 04:00 | **Coffee Break** | **Coffee Break** | |
| 04:00 - 05:00 | | **Discussion**<br><br>**(Moderators: Bhaskar Dutta, Vishvas Pandey)** | |

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| | Thu, Apr 20 | Fri, Apr 21 |
|---|---|---|
| 09:00 - 09:45 | **Louis Strigari:** New directions in CEvNS searches: flavor separation and directionality | **David McKeen:** TBD |
| 09:45 - 10:30 | **Yen-Hsun Lin:** Searching for afterglow: Light dark matter boosted by supernova neutrinos | **Dipangkar Dutta:** Searching for "heavy light": what can electron scattering tell us about the Atomki X(17) anomaly |
| 10:30 - 11:00 | **Coffee Break** | **Coffee Break** |
| 11:00 - 11:45 | **Kate Scholberg:** COHERENT Second Target Station Opportunities | **Jacob Zettlemoyer:** Searching for New Physics with a Stopped Pion Facility at an Upgraded Fermilab Accelerator Complex |
| 11:45 - 12:30 | **Richard Van de Water:** Dark sector searches at the Coherent Captain-Mills (CCM) experiment | **Yu-Dai Tsai:** Neutrino Properties and BSM at Existing & Near-Future Neutrino Experiments |
| 12:30 - 02:00 | **Lunch** | **Lunch** |
| 02:00 - 02:45 | **Ryan Plestid:** Coulomb physics and MeV neutrinos | |
| 02:45 - 03:30 | **Alexis Nikolakopoulous:** Kaon decay-at-rest neutrino-nucleus scattering cross section | |
| 03:30 - 04:00 | **Coffee Break** | |
| 04:00 - 05:00 | **Discussion**<br><br>**(Moderators: Louis Strigari, Matt Toups)** | |

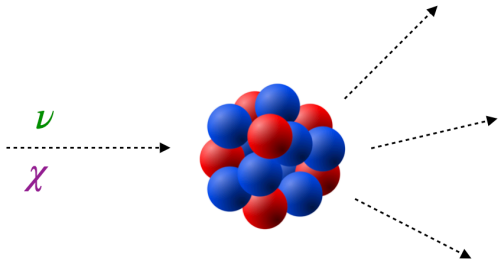
**Workshop Dinner**

*** Workshop Report/White Paper:**

- It would be great to summarize all the exciting things we will discuss this week into a report/ white paper.

- What do people think?

- If yes, we will follow up shortly after the workshop, soliciting your contributions.




# Thank you!

# Let’s get started!