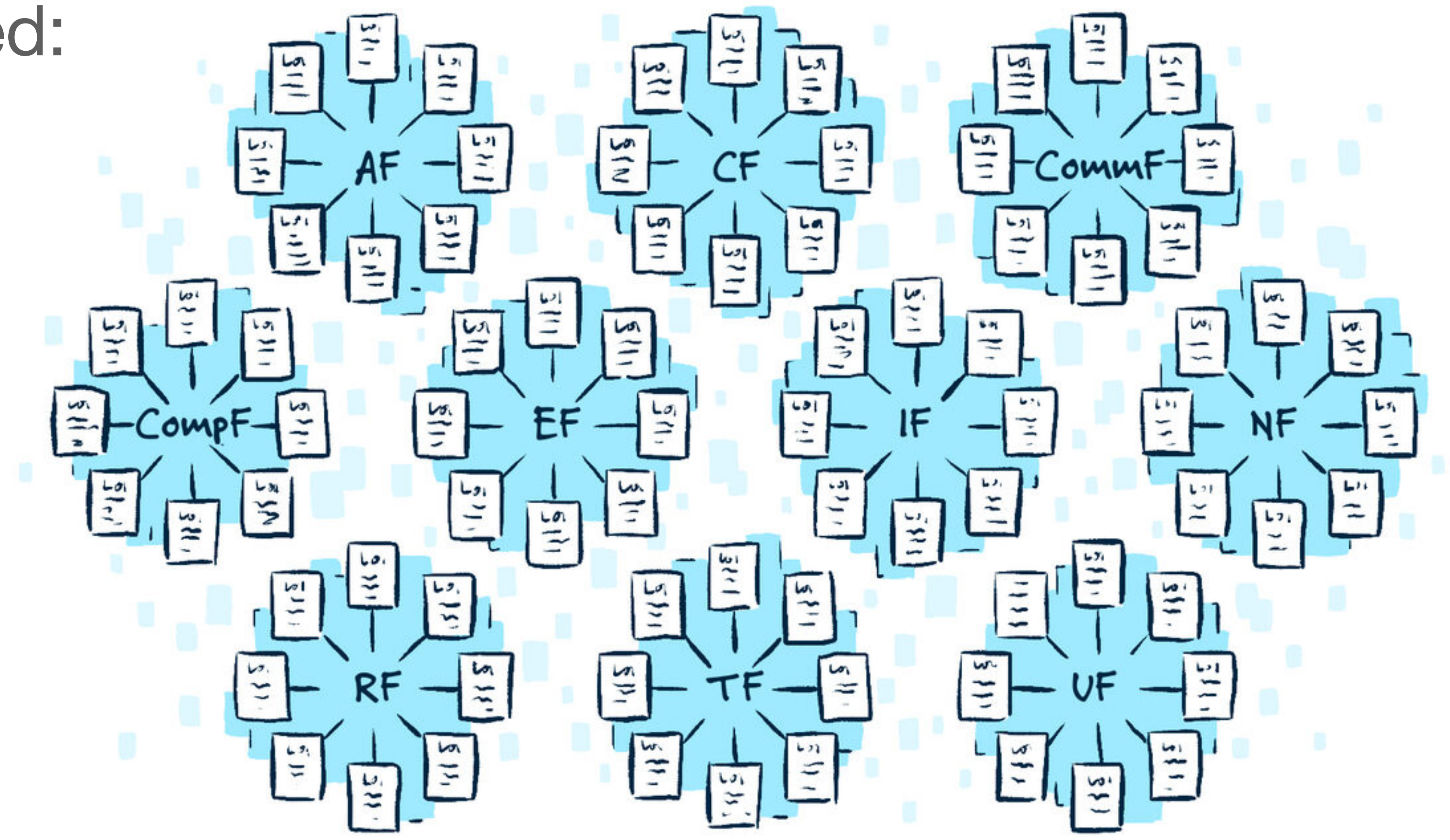
SNOWMASS

- Every several years (~ 7 years), the US particle physics community works together to identify the most exciting questions for the field and map out the tools and resources they'll need to address them
- The "Snowmass" process, named after its original venue and organized by the Division of Particles and Fields of the American Physical Society, consists of a series of meetings and workshops.
- Guides P5 subpanel of the High Energy Physics Advisory Panel -> final set of recommendations presented to US funding agencies
- 10 "frontiers" of physics, dubbed:
  - energy,
  - neutrino,
  - rare processes & precision,
  - cosmic, theory,
  - accelerator,
  - instrumentation,
  - computation,
  - underground facilities,
  - community engagement
- First time that organizers requested short Letters of Interest, LOIs, from any scientists who wanted to share their ideas.
- Informal starting point for the community to organize its efforts, forming groups with common interests and goals to more efficiently tackle the next steps in the process
- The goal is to have a more cohesive community and make sure that everyone's voices are heard.



symmetry follow
topics

Illustration by Sandbox Studio, Chicago with Steve Shanabruch

Physicists submit avalanche of ideas to 'Snowmass' process

01/26/21 | By Ali Sundermier

Scientists wrote more than 1500 letters of interest to share ideas about what they hope the next decade of particle physics will bring.

SNOWMASS

- By the deadline, they had received about 1560 unique LOIs
- One area that generated a lot of interest is long-lived particles
- Guides P5 subpanel of the High Energy Physics Advisory Panel -> final set of recommendations presented to US funding agencies

https://gordonwatts.github.io/snowmass-loi-words/

Snowmass 2021 LOIs

Exploring the Snowmass 2021 LOI's graphically

View the Project on GitHub gordonwatts/snowmass-loi-words

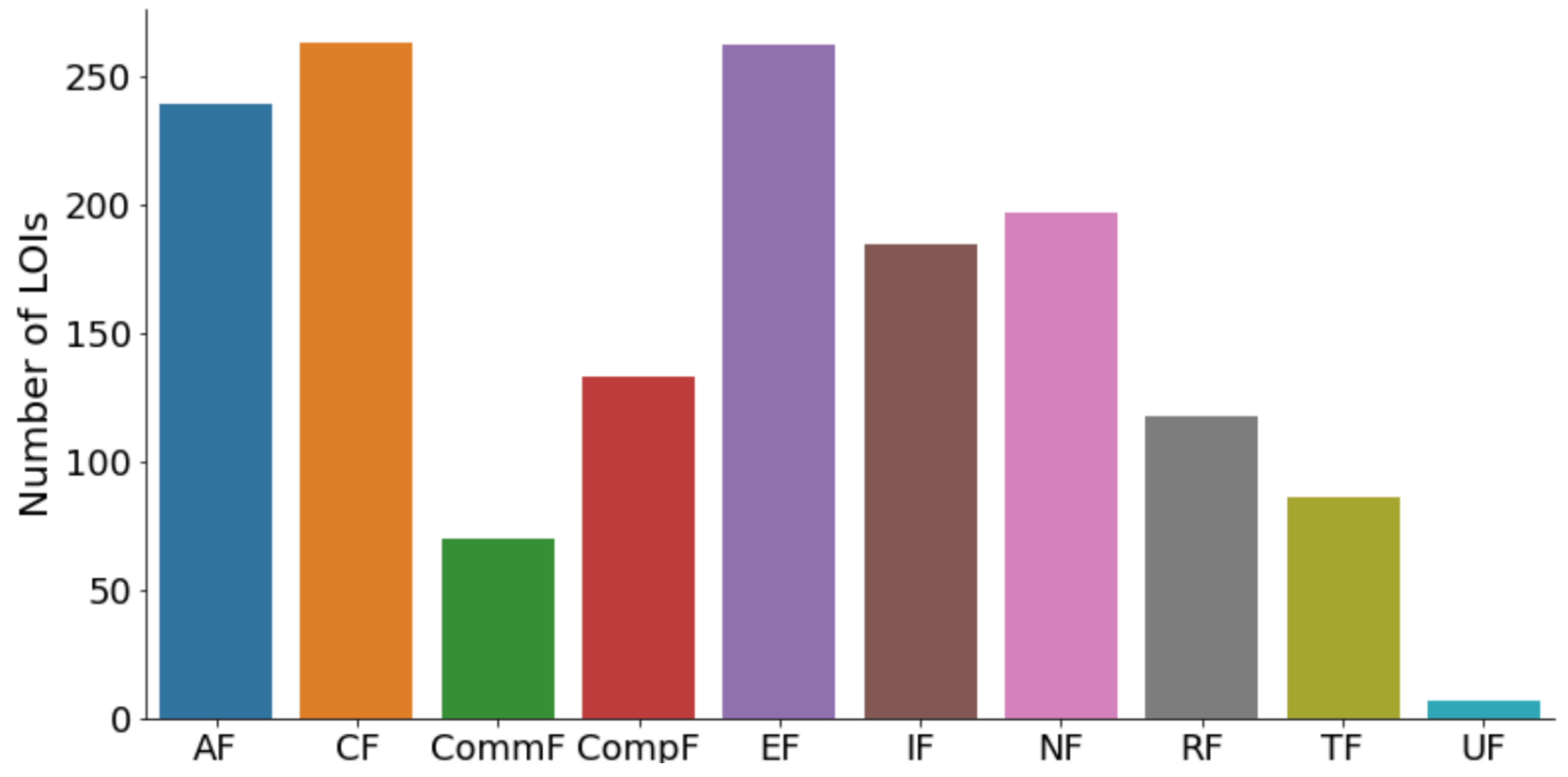
Snowmass Letters of Interest

This site contains 1560 LOI's that have been submitted to the Snowmass 2021 process. At the University of Washington we are hard at work getting ready for the summer meeting (COVID allowing…) - and I wanted to take a look at all the incoming LOI's. The large number was unexpected - I did not think that many would show up!

The official repository can be found from the main website. The snapshot in this data was taking just as the LOI process closed. All analysis can be found in this github repository. Feel free to submit pull requests!

LOI's by frontier

The number of LOI's per frontier (as declared by the submitter):



APS physics Division of Particles & Fields

Town Hall Meeting @ DPF 21

July 14, 2021
Tao Han
University of Pittsburgh
On behalf of the DPF Executive Committee
& the Snowmass Steering Group

Snowmass 2020 activity

Snowmass Community Planning Meeting
Oct. 5-8, 2020 (FNAL, virtual)

- ~ 3,000 people registered !
- 63 submissions to the "Voices from the Community"
- 25 Plenary speakers; 5 "Future Facilities" panelists
- 101 Breakout sessions

Contributed ("white") Papers (new deadline: March 15, 2022)
– Specific scientific areas, technical articles presenting new results on relevant physics topics, and reasoned expressions of physics priorities, including those related to community involvement.
– Part of Snowmass proceedings. Remain part of the permanent record of Snowmass 2021, all on aiXiv
– Submission instructions: https://snowmass21.org/submissions/.

Were heading to Community Summer Study (CSS): Snowmass 2021 in July 2021, UW-Seattle, but …

The need for Snowmass 2021

Snowmass Goals:

– To define the most important questions for the field of particle physics
– To identify promising opportunities to address them

Snowmass 2021 organization

Steering Group 2021

Chair: Tao Han
Chair-elect: Joel Butler
Vice Chair: Sekhar Chivukula
Past Chair: Young-Kee Kim
Ex Officio: Prisca Cushman

DPB: Sergei Nagaitsev
DNP: Yury Kolomensky
DAP: Glennys Farrar
DGRAV: Nicolas Yunes

Advisory Group 2021

- DPF Executive Committee
  - Secretary/Treasurer: Mirjam Cvetic
  - Councilor: Elizabeth Simmons
  - Member-at-Large: Natalia Toro
  - Member-at-Large: Andre de Gouvea
  - Member-at-Large: Mary Bishai
  - Member-at-Large: Lauren Tompkins
  - Member-at-Large: Mayly Sanchez
  - Member-at-Large: Gordon Watts
  - Early Career Member: Julia Gonski
- Editor and Communication
  - Editor – Michael Peskin
  - Communication – Bob Bernstein
- Representatives from the Int. Community
  - Africa / Middle East
    Azwinndini Muronga, Nelson Mandela Metropolitan Univ, South Africa
  - Asia / Pacific
    Atsuko Ichikawa, Kyoto University, Japan
    Xinchou Lou, IHEP, China
  - Canada
    Heather Logan, Carleton University
  - Europe / Russia
    Val Gibson, Cavendish Laboratory, UK
    Berrie Giebels, CNRS, France
  - Latin America
    Claudio Dib, Universidad Tecnica Federico Santa Maria, Chile

SNOWMASS

- Snowmass Frontiers
  - Energy Frontier
  - Neutrino Physics Frontier
  - Rare Processes and Precision
  - Cosmic Frontier
  - Theory Frontier
  - Accelerator Frontier
  - Instrumentation Frontier
  - Computational Frontier
  - Underground Facilities
  - Community Engagement
  - Snowmass Liaisons

Description

The Cosmic frontier includes probes of the fundamental nature of dark matter and dark energy, and opportunities using astrophysical and cosmological data to learn about fundamental physics.

COSMIC FRONTIER

Conveners

Name	Institution	Email
Aaron Chou	Fermi National Accelerator Laboratory	achou[at]fnal.gov
Marcelle Soares-Santos	University of Michigan	mssantos[at]umich.edu
Tim M.P. Tait	University of California, Irvine	ttait[at]uci.edu

Topical Group Pages

- CF1. Dark Matter: Particle-like
- CF2. Dark Matter: Wave-like
- CF3. Dark Matter: Cosmic Probes
- CF4. Dark Energy and Cosmic Acceleration: The Modern Universe
- CF5. Dark Energy and Cosmic Acceleration: Cosmic Dawn and Before
- CF6. Dark Energy and Cosmic Acceleration: Complementarity of Probes and New Facilities
- CF7. Cosmic Probes of Fundamental Physics

Submissions

- **Letters of Interest** are due by August 31, 2020 and can be submitted by following the instructions here. We ask you to use the Cosmic Frontier template provided below:
  - Cosmic Frontier LOI LaTeX Template on Overleaf
  - Cosmic Frontier LOI Google Doc Template
- **Contributed Papers** are due March 15, 2022. Instructions can be found here. Contributed papers are not required to use any official template, but we provide one for convenience.
  - CF Coordinated White Paper Planning Document
  - Cosmic Frontier Contributed Paper Template on Overleaf

Cosmic Frontier

Co-Conveners

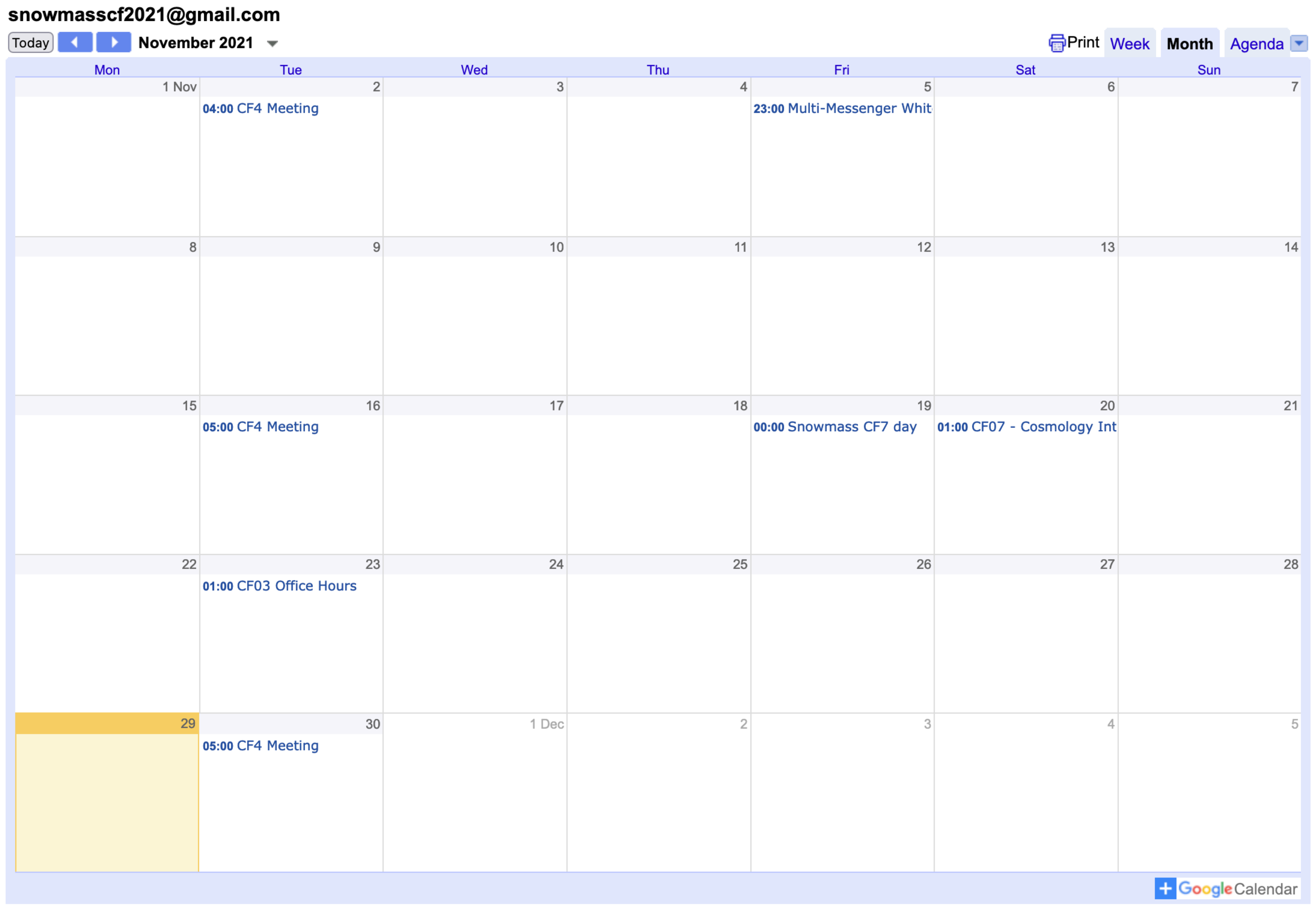
Aaron Chou (Fermilab)

Marcelle Soares-Santos (U.Michigan)

Tim Tait (UC Irvine)

Topical Group		Topical Group co-Conveners				
CF01	Particle DM	Jodi Cooley (SMU)	Tongyan Lin (UCSD)	Hugh Lippincott (UCSB)	Tracy Slatyer (MIT)	
CF02	Wavelike DM	Joerg Jaeckel (Heidelberg)	Gray Rybka (UW)	Lindley Winslow (MIT)		
CF03	DM Astro Probes	Alex Drlica-Wagner (FNAL)	Chanda Prescod-Weinstein (NH)	Haibo Yu (Riverside)		
CF04	DE & CA The Modern Universe	Jeff Newman (Pittsburgh)		Anze Slosar (BNL)		
CF05	DE & CA Cosmic Dawn & Before	Clarence Chang (ANL)	Deirdre Shoemaker (Georgia Tech.)	Laura Newburgh (Yale)		
CF06	Dark Energy complementarity	David Schlegel (LBNL)	Brenna Flaugher (FNAL)			
CF07	Cosmic Probes	Luis Anchordoqui (CUNY)	B.S. Sathyaprakash (Penn State)	Rana Adhikari (CalTech)	Ke Fang (Wisconsin)	Kirsten Tollefson (MSU)

Cosmic Frontier is on a pause till late August (CF03 started meetings).



CF2 Community Kick-Off Meeting

Jul 15, 2020, 9:00 PM → Jul 16, 2020, 1:00 AM Australia/Perth

WEDNESDAY, 15 JULY

9:00 PM → 9:20 PM **Town Hall Meeting**

Snowmass_CF2_15...

Cosmic Frontier: Wave-Like Dark Matter

Joerg Jaeckel
University of Heidelberg

Gray Rybka
University of Washington

Lindley Winslow
Massachusetts Institute of Technology

Lindley Winslow
Wave Dark Matter: Community Talks - Friday
To: SNOWMASS-CF-02-DM-WAVE@fnal.gov <SNOWMASS-CF-02-DM-WAVE@FNAL.GOV>

This message is from a mailing list.

Hi all,

The first day of community talks is tomorrow/Friday 12-2PM eastern. The next one will be Wednesday.

An Indico is here:
https://indico.fnal.gov/event/51365/

We have plenty of space, so please add yourself to future dates:
https://docs.google.com/document/d/1ZKMLHxdi87hnjDORrmEeaXXU0NC0NUvgT1h6jai6IDg/edit?usp=sharing

Please invite your friends!

Zoom Info Below,
Lindley

Lindley Winslow
Associate Professor of Physics
Undergraduate Faculty Coordinator
Laboratory for Nuclear Science
Pronouns: She/Her

Lindley Winslow is inviting you to a scheduled Zoom meeting.

Topic: Snowmass

CF2 Re-Start Meeting

Thursday Sep 16, 2021, 12:00 AM → 1:00 AM Australia/Perth
Zoom
Gray Rybka (University of Washington), Joerg Jaeckel, Lindley Winslow (MIT)

Wave Dark Matter: Community Talks 2 of 6

Saturday Oct 9, 2021, 12:00 AM → 2:00 AM Australia/Perth

12:00 AM → 2:00 AM **Wave Dark Matter: Community Talks 2 of 6**

12:00 AM **CAPP Short and Long Term Experiments** — 10m
Speaker: Yannis Semertzidis (IBS-CAPP and KAIST)
YkS_wave_dark_ma...

12:10 AM **RADES** — 10m
Speaker: Jose María García Barceló

12:20 AM **ORGAN** — 10m
Speaker: Ben McAllister (ARC Centre of Excellence for Engineered Quantum Systems, School of Physics, University of Western Australia)
Snowmass.pdf

12:30 AM **MADMAX** — 10m
Speaker: Stefan Knirck (Fermi National Accelerator Laboratory)
knirck_stefan_mad...

12:40 AM **BREAD** — 10m
Speaker: Jesse Liu (University of Chicago)
BREAD-CF2-8-Oct-2...

12:50 AM **Plasma Haloscopes** — 10m
Speaker: Alexander Millar (Stockholm University)

1:00 AM **LAMPOST** — 10m
Speaker: Jeffrey Chiles (NIST)

Wave Dark Matter: Community Talks 3 of 6

Thursday Oct 14, 2021, 12:00 AM → 2:00 AM Australia/Perth

12:00 AM → 2:00 AM **Wave Dark Matter: Community Talks 3 of 6**

12:00 AM **UPLOAD**
Speaker: Michael Tobar (The University of Western Australia)
UPLOADUpdate_Sn...

12:10 AM **ADMX-EFR**
Speaker: Chelsea Bartram (University of Washington)

12:20 AM **ARIADNE**
Speaker: Andrew Geraci (Northwestern University)

12:30 AM **Resonant Mechanical Sensors for the Dark Sector**
Speaker: Swati Singh (University of Delaware)

Wave Dark Matter: Community Talks 5 of 6

Friday Oct 22, 2021, 12:00 AM → 2:00 AM Australia/Perth

12:00 AM → 2:00 AM **Wave Dark Matter: Community Talks 5 of 6**

12:00 AM **SHAFT**
Speaker: Alexander Sushkov (Boston University)

12:10 AM **Poynting vector analysis of DC axion haloscopes and the sensitivity of low-mass experiments in the classical quasi-static regime**
Speaker: Michael Tobar (The University of Western Australia)
PoyntingVectorAxio...

12:20 AM **Atomic and nuclear clocks for ultralight dark matter detection**
Speaker: Marianna Safronova (University of Delaware)
2021 Snowmass-Sa...

12:30 AM **CMB and large-scale structure probes of ultra-light axions**
Speaker: Keir Kwame Rogers

12:40 AM **Near-field cosmology and ultra-light axions**
Speaker: Ethan Nadler (Stanford/KIPAC)
Near-field_ULA_Nad...

12:50 AM **CMB-HD: Constraining wave-like dark matter with small-scale CMB lensing**
Speaker: Neelima Sehgal (Stony Brook University)
CMB-HD-DM.pdf

1:00 AM **Searching for Ultralight Dark Matter with Optical Cavities**
Speaker: Tejas Deshpande

Snowmass2021 - Letter of Interest

The Oscillating Resonant Group AxioN (ORGAN) Experiment

Thematic Areas: (check all that apply □/■)

■ (CF2) Dark Matter: Wavelike
■ (IF1) Quantum Sensors
■ (IF2) Photon Detectors

Contact Information:
Ben T. McAllister (University of Western Australia) [ben.mcallister@uwa.edu.au]
Michael E. Tobar (University of Western Australia) [michael.tobar@uwa.edu.au]
Collaboration: ARC Centre of Excellence for Engineered Quantum Systems and ARC Centre of Excellence for Dark Matter Particle Physics

Authors: Ben T. McAllister (University of Western Australia), Maxim Goryachev, Graeme R. Flower, Aaron P. Quiskamp, William M. Campbell, Catriona A. Thomson, Cindy Zhao, Eugene N. Ivanov, Gilberto A. Umana-Membreno, Paul Altin (Australian National University), Tom Stace (University of Queensland), Gray Rybka (University of Washington), Gianpaolo Carosi (Lawrence Livermore National Laboratory), Michael E. Tobar (University of Western Australia)

Abstract: The ORGAN Experiment is a high mass, (Sikivie-style) axion haloscope hosted at the University of Western Australia nodes of the ARC Centre of Excellence for Engineered Quantum Systems (EQUS), and the ARC Centre of Excellence for Dark Matter Particle Physics. The experiment will run for 7 years, from 2020 - 2026, as funded by the ARC, continuing the work which has already been done with the ORGAN pathfinding project. The ORGAN axion mass range of interest is ~60-200 μeV, corresponding to roughly 15-50 GHz in photon frequency. To overcome the significant technical challenges associated with operating a traditional resonant cavity haloscope, we pursue four avenues of research and development. Firstly, we consider novel resonator designs based on higher order modes in resonant cavities and dielectric materials, to increase form factors and volumes at high frequency. Secondly, we investigate novel schemes for combining multiple resonators, such as cross-correlation, to increase effective detector volume. Thirdly, we consider high critical field superconducting coatings to increase quality factors of resonators. Finally, we propose to implement promising single photon counting technologies, and/or sub-quantum limited linear amplification. The experiment will consist of 2 phases, each broken down into stages. Phase 1 will consist of two targeted scans at 15 - 16 GHz and 26.1 - 27.1 GHz, whereas Phase 2 will consist of the entire 15-50 GHz region, broken down into 5 GHz stages.

External with UWA LOIs

- SNOWMASS21-CF2_CF0_David_Tanner-205.pdf
- SNOWMASS21-CF2_CF0-IF1_IF9_Gianpaolo_Carosi-252.pdf
- slic.pdf
- SNOWMASS21-CF2_CF0_Gray_Rybka-160.pdf
- PrecisionCurrent.pdf
- Snowmass2021_LOI_Freque...ed_Axion_Haloscopes_v2.pdf
- Snomass2021_LOI____Frequ...lexed_Axion_Haloscopes.pdf
- Duffy_ADMX_highresolution.pdf
- snowmass2021_loi_cosmic_...MAX_general_v20200826.pdf
- DAW_SNOWMASS_LOI.pdf
- ADMX_2_4_GHz_Snowmass_LOI_DRAFT.pdf
- RC_LOI.pdf

Snowmass2021 - Letter of Interest

UP-conversion Loop Oscillator Axion Detectors (UPLOAD)

Thematic Areas: (check all that apply □/■)
■ (CF2) Dark Matter: Wavelike
■ (IF1) Quantum Sensors

Contact Information: Michael E Tobar (University of Western Australia) [michael.tobar@uwa.edu.au]:

Authors: Michael E Tobar[1], Maxim Goryachev[1], Eugene Ivanov[1], Ben McAllister[1], Catriona Thomson[1], Chunnong Zhao[1], Paul Altin[2], Alexander Romanenko[3], Anna Grassellino[3], Sam Posen[3], Mohamed Awida[3], Andrew Sonnenschein[3], Yanbei Chen[4], Rana Adhikari[4], Chelsea Bartram[5], Gianpaolo Carosi[6]

[1]ARC Centre of Excellence for Engineered Quantum Systems and ARC Centre of Excellence for Dark Matter Particle Physics, Department of Physics, University of Western Australia, Crawley WA 6009, Australia
[2]ARC Centre of Excellence For Engineered Quantum Systems, Department of Quantum Science, Research School of Physics, Australian National University College of Science, ACT, Canberra, Australia.
[3]Fermi National Accelerator Laboratory, Batavia, IL 60510, USA
[4]Caltech, The Division of Physics, Mathematics and Astronomy, Pasadena CA 91125, USA
[5]University of Washington (UW), Seattle, WA 98195, USA
[6]Lawrence Livermore National Laboratory, Livermore, CA 94550, USA

Abstract: (maximum 200 words)

Special configurations of dual-mode resonator-oscillators have been shown to be sensitive to low mass axions through the principle of upconversion and precision frequency metrology [1;2]. The signal sensitivity is derived from the two-photon axion process given by $a+\gamma_1+\gamma_2 \rightarrow a+\gamma_1'+\gamma_2'$, which does not destroy the axion, but causes frequency modulation of the photon frequencies inside the resonator. This is effectively an axion non-demolition technique with enhanced sensitivity by searching the spectrum of frequency fluctuations of one of the oscillators. A first simple table-top demonstration has been achieved, placing exclusion limits of 5×10^{-7} 1/GeV in the range of 7.44 - 19.38 neV after a measurement time of only 2.5 hours[2]. In the future, a frequency-stabilized cryogenic version of this technique will achieve best limits in an axion mass range of less than $1\mu eV$, and it is possible that an optical version will place competitive limits in the $50-400\mu$eV range. These group of projects will continue in concurrent stages: 1) Frequency stabilized oscillators[3–5] based on an invar silver plated microwave cavity operating in vacuum, will start operation by 2021, with the ability to test ALP Cogenesis[6] in the mass range less than $10neV$: 2) A cryogenic version of the experiment based on high-Q superconducting Tesla cavities designed by Fermilab[7], with a proof of principle experiment to begin in 2020. This will be followed up with a properly designed system able to test QCD axions below $10^{-11}eV$ and conventional alignment mechanisms below $10^{-8}eV$, tentatively scheduled to begin in 2022 after the necessary R&D. 3) In parallel, due to the lessons learnt at microwaves, we have started to design a dual mode optical cavity with a similar enhanced sensitivity. The goal of this experiment will be to search at a difference frequency compatible with the $50-400\mu$ eV range, where the necessary size of the microwave cavities become problematic to attain QCD sensitivity. This work will be undertaken with researches from the LIGO collaboration at the University of Western Australia (UWA) and Caltech.

Snowmass2021 - Letter of Interest

Low-Mass Broadband Electrical Action Sensing Techniques (BEAST)

Thematic Areas: (check all that apply □/■)
■ (CF2) Dark Matter: Wavelike

Contact Information: Michael E Tobar (University of Western Australia) [michael.tobar@uwa.edu.au]:

Authors: Michael E Tobar[1], Paul Altin[2], William M. Campbell[1], Maxim Goryachev[1], Eugene Ivanov[1], Ben McAllister[1]

[1]ARC Centre of Excellence for Engineered Quantum Systems and ARC Centre of Excellence for Dark Matter Particle Physics, Department of Physics, University of Western Australia, Crawley WA 6009, Australia
[2]ARC Centre of Excellence For Engineered Quantum Systems, Department of Quantum Science, Research School of Physics, Australian National University College of Science, ACT, Canberra, Australia.

Abstract: When axions, $a(t)$, mix with an applied photonic degree of freedom (γ), a photon of different frequency will be produced via a second photonic degree of freedom (γ') through the inverse Primakoff effect, given by $\gamma+a\rightarrow\gamma'$. From the view point of the second photon degree of freedom, γ', this is a non-conservative electrodynamical process due to the creation of photons from an external non-electromagnetic source (namely the first photonic degree of freedom mixing with the axion). If the first photonic degree of freedom is an applied DC $\vec{B}$-field, the modified axion electrodynamical equations become similar to the electrodynamics of an AC voltage source, producing an AC electromagnetic action (or emf, $\mathcal{E}_a(t)$) oscillating at the Compton frequency of the axion. As in standard electrodynamics, $\mathcal{E}_a(t)$ may be modelled as an oscillating effective impressed magnetic current boundary source. This boundary source is present in the axion-photon electrodynamical equations [1;2], however, the relevant term is usually approximated to equal zero, so only a derivative axion-photon coupling remains, consistent with a zero total derivative. In the low-mass limit where the Compton wavelength of the axion is greater than the dimensions of the experiment (quasi-static limit) this approximation is no longer valid and the boundary source terms are the dominant effect. The end result is the realisation of new Broadband Electrical Action Sensing Techniques (BEAST) with a sensitivity linearly proportional to the axion photon coupling [1–3]. Contrary to what has been published by others [4–6], we have subsequently shown our sensitivity calculations are consistent, and calculate that the electric field produced by the axion current in the low-mass limit is suppressed. *Our technique does not detect this suppressed axion induced electric field, $\vec{E}_a(t)$, but directly detects $\mathcal{E}_a(t)$ from the non-conservative process.* This is a much more sensitive technique because it is not suppressed by the mass of the axion and puts axion-photon coupling low-mass experiments on a similar footing to axion-gluon coupling experiments [7;8] such as the CASPEr [9;10] and Sussex-RAL-ILL nEDM experiments [11], which are not suppressed by the axion mass and have also been projected to be sensitive enough to detect QCD axions at low mass ranges below $10^{-8}eV$. This result may be considered controversial, but no one has yet shown how this calculation is wrong! To fully consider this effect in axion electrodynamics, the electrodynamics of standard impressed sources that convert external energy to electromagnetic must be fully understood [12–15].

The ORGAN experiment: An axion haloscope above 15 GHz

Authors Ben T McAllister, Graeme Flower, Eugene N Ivanov, Maxim Goryachev, Jeremy Bourhill, Michael E Tobar

Publication date 2017/12/1

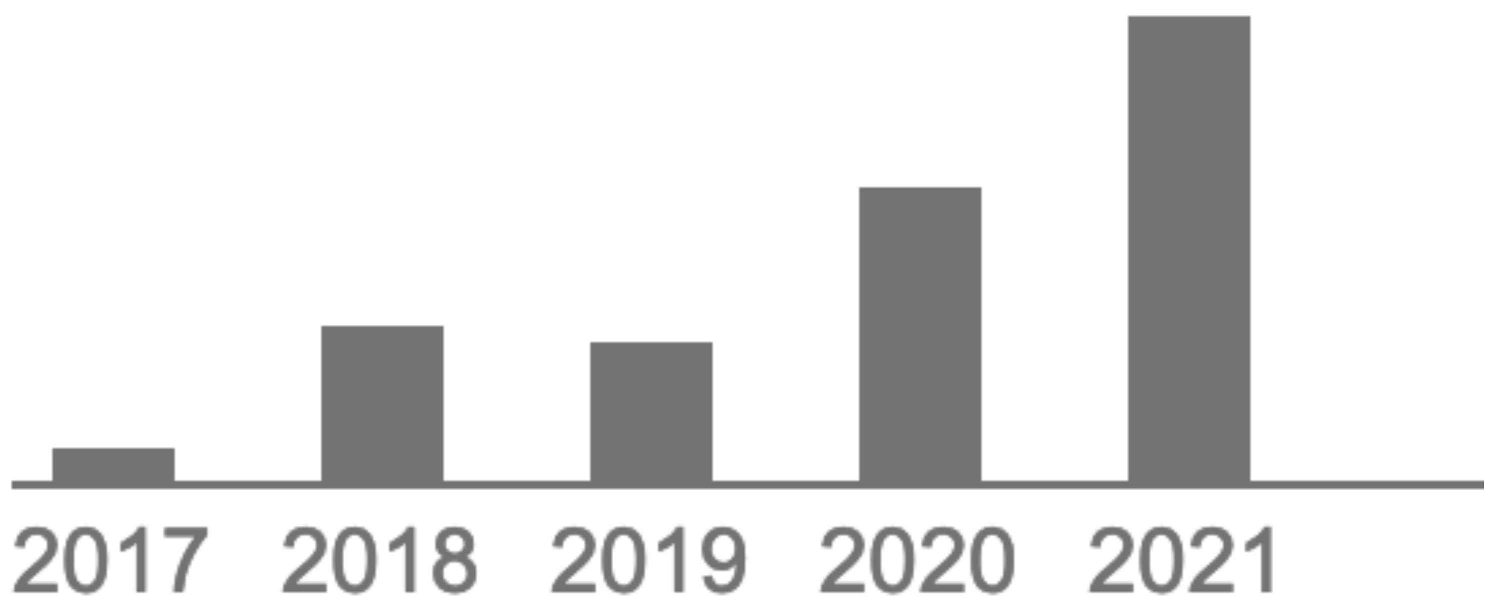
Journal Physics of the dark universe

Volume 18

Pages 67-72

Publisher Elsevier

Description We present first results and future plans for the Oscillating Resonant Group AxioN (ORGAN) experiment, a microwave cavity axion haloscope situated in Perth, Western Australia designed to probe for high mass axions motivated by several theoretical models. The first stage focuses around 26.6 GHz in order to directly test a claimed result, which suggests axions exist at the corresponding mass of 110 μ eV. Later stages will move to a wider scan range of 15–50 GHz (62–207 μ eV). We present the results of the pathfinding run, which sets a limit on g a γ γ of 2. 02× 1 0− 12 eV− 1 at 26.531 GHz, or 110 μ eV, in a span of 2.5 neV (shaped by the Lorentzian resonance) with 90% confidence. Furthermore, we outline the current design and future strategies to eventually attain the sensitivity to search for well known axion models over the wider mass range.



Snowmass Timelines