

IceCube Management and Operations

Jim Madsen
UW-Madison

NSF Mid-Term Review
29 April 2024



Presenter Background

- Involved with IceCube and Predecessor AMANDA Since 1998
- Current
 - Interim Director and Executive Director of WIPAC
 - IceCube Associate Director for Education and Outreach
 - Cosmic Ray Research and Polar-Themed Virtual Reality Experiences
- Prior to moving to UW-Madison was Professor at UW-River Falls

Outline

- Overview
- Extended, Intensive Activities
- High Exposure Public Events
- Partnering with Artists
- New/Updated Resources
- Communications Metrics
- Summary

Overview

- WIPAC leverages M&O funds to support vibrant local, national and international IceCube Education & Outreach and Communication efforts
 - Ellen Bechtol---Outreach Specialist & Diversity, Equity, Inclusion and Disability Working Group Lead
 - Jean DeMerit---Web Resources/Technical Editing
 - Alexandria Fleagle---Event Coordination
 - Alisa King-Klemperer---Communications Manager
 - Alexa Nelson---Graphic Artist

Extended, Intensive Activities

- IceCube Masterclasses
 - Day-long events held at IceCube institutions for science motivated high school students
 - Web resources for two activities (Astrophysical Neutrinos and Cosmic Ray Flux) in English, French, Spanish, German and Japanese
 - Usually includes South Pole Webcast
 - ~20 IceCube Institutions participate annually with ~10 to ~100 students each



Extended, Intensive Activities

- WIPAC IceCube Afterschool Program
 - 10 weekly ~2 hour meetings for Madison area high school students
 - ~25 participants hear career/research talks each week while learning skills to complete a project
- Grandparents University
 - Annual UW-Madison Alumni Association 2-day program for alums and their grandchildren
 - Learn about IceCube and earn a “degree”



Extended, Intensive Activities

- UW-River Falls Upward Bound
 - 2-week summer residential science enrichment program for high school students from low-income families
 - Tie in IceCube/Antarctic research with accessible activities that illustrate science/engineering process
 - Over 500 students in 15 years
- Mann/Sánchez Scholars visit
 - Underrepresented students who show potential for academic achievement but face significant economic and personal challenges
 - UW-Madison PSL tour and talks at WIPAC



Extended, Intensive Activities

- Annual Davis Bahcall Scholars visits
- Around the world in 24 Hours Webcasts
- ThaisCube ---Thailand-UW program with Chiang Mai University with support from Her Royal Highness Princess Maha Chakri Sirindhorn
 - 2 students, faculty member and postdoc spend summers at UW-Madison
 - Multiple visits and presentations by WIPAC members in Thailand



High Exposure Public Events

- Annual UW-Madison Wisconsin Science Expeditions and Physics Fair (spring) and Science Festival (fall)
- Science in the Park and Juneteenth Celebration
- [IceCube Display](#) at the Madison Holiday Fantasy of Lights the last 3 years, ~80,000 vehicles each year!



Partnering with Artists

- [Aganta Kairos](#) with Laurent Mulot.
 - 2021 ICRC Proceeding: *Completing Aganta Kairos: Capturing Metaphysical Time on the Seventh Continent*, Jim Madsen, Laurent Mulot, Christian Spiering
<https://arxiv.org/abs/2108.01687v1>
- *Tidal Disruption with Mark-David Hosale*
 - Fall 2022 event at Madison Olbrich Gardens drew tens of thousands of visitors
 - 2023 ICRC Proceeding: *Tidal Disruption: An Unforgettable Encounter with a Black Hole*, Mark-David Hosale, Jim Madsen, Vedant Basu
<https://doi.org/10.48550/arXiv.2308.11623>
- Workshop and evening public event with rapper [Consensus](#) at spring 2024 Munster IceCube meeting



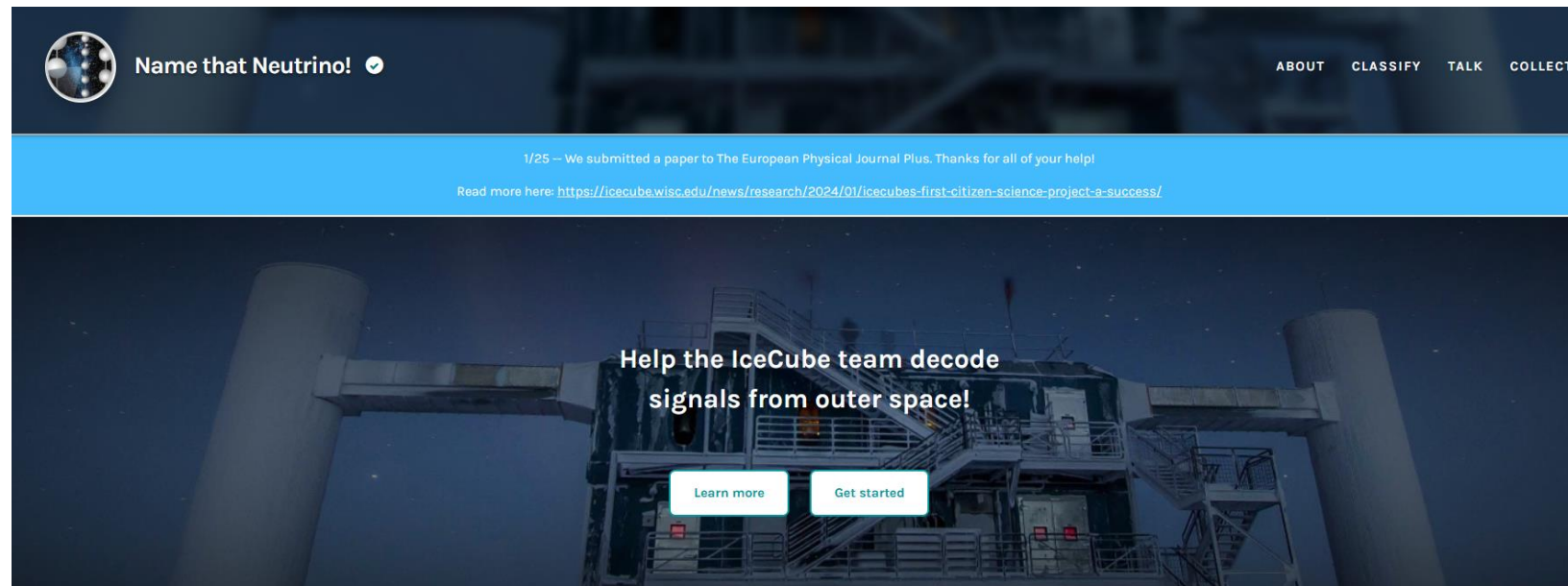
Partnering with Artists

- Ice lens images with [Tristan Duke](#)
 - Week-long residency supported by Francis Halzen's UW-Madison funds in July 2023
 - Pop-up gallery show in Madison in July 2023 and one night event at SCAR AAA meeting in Svalbard in September 2023
 - Second visit in April 2024 to UW-Madison just completed



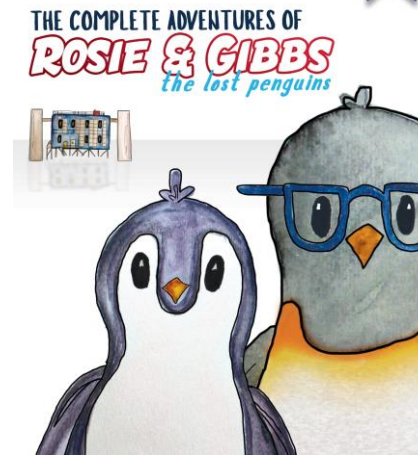
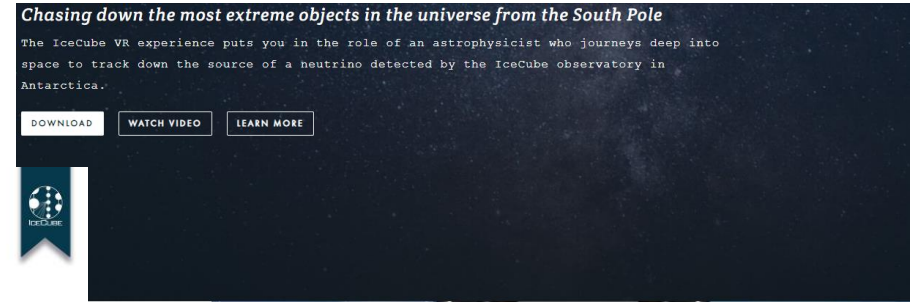
New/Updated Resources

- IceCube Citizen Science project launched, [Name that Neutrino](#), thanks to team at Drexel University led by Christy Love
 - *Citizen Science for IceCube: Name that Neutrino*, IceCube Collaboration author list, accepted for publication in European Physics Journal Plus, [2401.11994.pdf \(arxiv.org\)](#)
 - ~2,200 volunteer data analyzers have categorized almost 165,000 events



Updated/New Resources

- Virtual reality experience, [Discover IceCube](#), available in English, Spanish and Thai
- [Rosie-Gibbs comics](#) connect with younger kids, available in up to 11 languages
 - Plans for new edition celebrating 75th anniversary of founding NSF
- IceCube educational game for middle school students [effort underway](#)
 - Collaboration with UW-Madison's Field Day group
 - Anticipate tens of thousands of students will play based on prior outcomes.
- [IceCubeAR](#) provides real-time alerts and engaging event viewer



Librarians, Teachers, Game Developers, Astrophysicists Collaborate to Enhance Science-Based Learning

Tuesday, April 9, 2024



NSF 2024 Mid-Term Review



ICECuBEAR 4+

Find Your Neutrinos

Lu Lu

Designed for iPad

★★★★★ 5.0 • 6 Ratings

Free



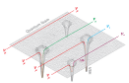
Communications

- Responsible for all media interactions---Social, Print, On-Line, and Monthly Newsletter *[Below the Ice](#)*
 - Facebook, Instagram, X presence
 - Produces accessible [summaries of high-impact research](#) and [awards](#)
 - Communication Manager assisted by others on the E&O team, the collaboration and by UW student workers
- Weekly summary of on-ice activities, [Life at the Pole](#), on IceCube web page
- Communications manager organizes press events
- Communications manager also part of the Education and Outreach Team

Research

[IceCube search for neutrino decoherence from quantum gravity](#)

Posted on March 26, 2024 by [Alisa King-Klemperer](#)



The unification of quantum theory and gravitation remains one of the most outstanding challenges in fundamental physics today. One mystery is the quantum nature of spacetime—a fusion of the three dimensions of space and the fourth dimension of time—and whether it is subject to the randomness seen in other quantum theories, resulting in fluctuations at [...]

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Awards

[Sanjib Kumar Agarwalla receives prestigious 2021-2022 Rajib Goyal Prize](#)

Posted on March 26, 2024 by [Alisa King-Klemperer](#)



Sanjib Kumar Agarwalla was recently awarded the 2021-2022 Rajib Goyal Prize in Physical Sciences, which "honors Indian scientists who have made a mark in basic and applied sciences research." The Goyal Prizes were instituted by the late philanthropist Ram S. Goyal to honor Indian scientists and social activists working towards the service of India. Agarwalla [...]

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Life at the Pole

[Week 15 at the Pole](#)

Posted on April 19, 2024 by [Jean DeMerit](#)



The sun officially sets as it wafts in the work on the IceAC

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Posted in [Life at the Pole](#)

[Week 14 at the Pole](#)

Posted on April 12, 2024 by [Jean DeMerit](#)



What better way to lounge chair on a opportunities to [...]

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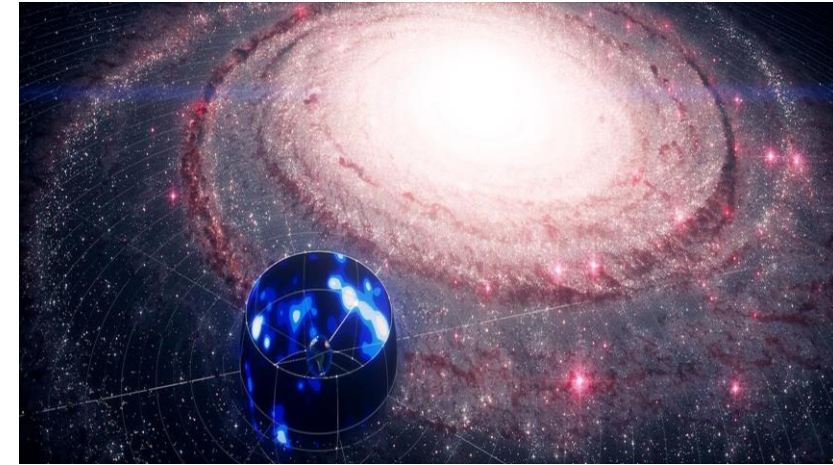
Posted in [Life at the Pole](#)



Galactic Plane Press Release

Press impact highlights

[Running list, click here](#)



585,362 impressions



37,700 reach



9,400 reach



1,687 concurrent views/25,000 total views

YouTube comment: "Just wanted to tell you that this live chat question answering is one of the best things I've seen for a large scale announcement. It makes us virtual participants feel seen. TYSM!"



Social Media Metrics



X, formerly Twitter 18,046 followers (up 5%)

@uw_icecube

- Winterover applications are now OPEN!
- Gold alert 11/3
- Winterover applications are still open



Facebook 12,963 followers (up 2%)

@icecubeneutrino

- Farewell to our winterovers, Marc and Hrvoje!
- Winterover applications are now OPEN!
- Winterover applications are still open



Instagram 7,988 followers (up 5%)

@icecube_neutrino

- Winterover applications are still open
- Winterover applications are now OPEN!
- Valentine's Day

- Follower numbers reflect growth since October 2023

- Top 3 popular posts for each platform are ranked according to the number of impressions/reach

New Cross Fold Brochure

Science

IceCube's science program extends from the study of Earth's core to the edge of the Universe. In 2012, two years after full operations began, IceCube detected the first high-energy neutrinos from beyond our solar system, with energies more than a million times those of neutrinos produced at accelerator laboratories. We have identified supermassive black holes at the centers of active galaxies as sites where neutrinos originate as well as the first neutrino reactions on Earth ever, on May 22. The high-statistics sample of 100,000 atmospheric neutrinos detected each year are used to determine neutrino properties and probe for new physics.

OUR RESEARCH AREAS INCLUDE:

- ASTROPHYSICS
- EARTH SCIENCES
- NEUTRINO PROPERTIES
- NEW AND FUNDAMENTAL PHYSICS

Data

1 Atmospheric neutrino (cosmic ray) 100 billion per year

2 Atmospheric neutrino (cosmic ray) 100,000 per year

3 Astrophysical neutrino 100+ per year

IceCube records ~2,600 events every second, which are more neutrinos produced in the Earth's atmosphere (1). For every million events, we identify a neutrino, also originating in cosmic ray interactions in the atmosphere (2).

For every 100,000 neutrinos detected, we identify one that reaches us from beyond the solar system (3). They open a new window on the Universe. IceCube has an IceCube system of more than 92%.

Enhancements

IceCube-Gen2 Radio, IceCube-Gen2 Optical, IceCube, IceCube Upgrade

The IceCube Upgrade will add 7 more densely instrumented strings in the 2022-26 season to improve the detector low-energy performance, enhance the understanding of low-probability critical to accurate event reconstruction, and advance astrophysical R&D.

IceCube-Gen2 is proposing to install 100 more densely spaced strings to instrument a larger volume and a larger range away from the detector. This will allow us to know where and how high-energy neutrinos are produced.

Milestones

- 1986: Idea of the IceCube
- 2000: Approved Concept
- 2001: Approved Concept
- 2003: Approved Concept
- 2008: Approved Concept
- 2011: Approved Concept
- 2013: Approved Concept
- 2018: Approved Concept
- 2021: Approved Concept
- 2022: Approved Concept
- 2023: Approved Concept

The idea to build a cubic kilometer scale array in water for detecting neutrinos was first introduced in 1990. Francis Halzen later proposed using ice as both the detector medium and the detector itself.

IceCube was finished in 2011, on time, on budget, and exceeding performance requirements. It spans a 10 orders of magnitude in energy, telling us even more about the Universe than ever imagined.

Collaboration

A group of about 500 scientists, engineers, and technicians from 12 countries are working together to build and operate the IceCube Neutrino Observatory. The observatory is located at the South Pole and is the largest neutrino detector ever built.

IceCube: NEUTRINO OBSERVATORY

CRACKING THE HIGH-ENERGY CODE WITH NEUTRINOS

TO LEARN MORE, SCAN THE QR CODE OR VISIT OUR WEBSITE AT ICECUBE.WISC.EDU

@ICECUBENEUTRINO @UW_ICCUBE @ICECUBE_NEUTRINO @ICECUBENEUTRINO

Detector

IceCube has a 3 km³ detector of 86 strings of 5,161 optical modules (OMs) each. The OMs are arranged in a grid that covers an area of 1.3 km² and is 2.5 km deep. The detector is designed to detect neutrinos with energies from 10 GeV to 10¹¹ GeV.

EIFFEL TOWER 324 M

IceCube is the largest neutrino detector ever built. It is the size of the Eiffel Tower and is located at the South Pole.



Summary

- Reaching out beyond the research community is an important and rewarding part of IceCube
- There is engagement throughout the collaboration that leverages M&O efforts
- We continue to actively seek new partnerships and opportunities to engage all audiences

