# Canadian Institute of Nuclear Physics
# Institut canadien de physique nucléaire

**Newsletter #17, November 2020**

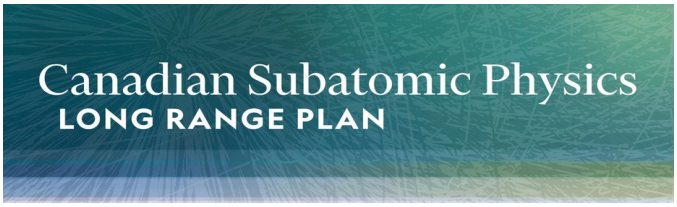
*The Canadian Institute of Nuclear Physics (CINP) is a formal organization of the Canadian nuclear physics research community to promote excellence in nuclear research and education, and to advocate the interests and goals of the community both domestically and abroad.*

## 1. CINP Board of Directors (2020-21)

The CINP Institutional Members had their annual meeting via teleconference on May 11, 2020. One of the agenda items was to elect two new Board members. There were no changes in Board membership, as both Michael Gericke and Jeff Martin were re-elected to new 3 year terms.

The Board is listed below, along with their assigned responsibilities.

| Name | Institution | Role | E-mail | Term Ends |
|---|---|---|---|---|
| Michael Gericke | University of Manitoba | | mgericke @ physics.umanitoba.ca | June, 2023 |
| Gwen Grinyer | University of Regina | | gwen.grinyer @ uregina.ca | June, 2021 |
| Sangyong Jeon | McGill University | Secretary | jeon @ physics.mcgill.ca | June, 2022 |
| Rituparna Kanungo | Saint Mary's University | President | ritu @ triumf.ca | June, 2022 |
| Jeffery Martin | University of Winnipeg | Vice-President | j.martin @ uwinnipeg.ca | June, 2023 |
| Chris Ruiz | TRIUMF | | ruiz @ triumf.ca | June, 2021 |




## 2. Canadian Subatomic Physics Long Range Plan

General information about the Canadian Subatomic Physics Long Range Planning process can be found at http://www.SubatomicPhysics.ca

The Long Range Plan Committee (LRPC) has prepared a community-wide survey that will be circulated to you shortly. The goal of this survey is to collect information directly from the community to assist in preparing the Long Range Plan report. We would like all active members of the SAP community, including research associates and graduate students, to complete this survey, and will ask for your help to disseminate the survey link to all members of your research group. We thank you in advance for taking the time to participate in this important exercise.

Moving forward, the community data from this survey and the IPP and CINP Briefs to be submitted to the LRPC in December, will inform a series of virtual, topical, mini-town hall meetings to be organized early in the new year. More information about these meetings will be communicated to you in the coming weeks, and we look forward to your participation. A comprehensive community town hall meeting will follow in spring 2021.

Should you have any questions or comments, please feel free to contact us directly at mailto:LRPC@SubatomicPhysics.ca

Adam Ritz (Uvic) Brigitte Vachon (McGill)
Co-chairs, Canadian SAP LRPC

## 3. Grad classes offered by TRIUMF
(submitted by Marcello Pavan, TRIUMF)

TRIUMF is once again offering specialized graduate-level courses to students across Canada via video-conference.

### WINTER 2021 SESSION:

#### UBC Physics 505: Introduction to Nuclear Physics

Instructors: Barry Davids and John Behr, TRIUMF

Syllabus:

- Nucleons and their structure, hadrons and isospin, two-nucleon systems, the *NN* interaction;
- Bulk properties of nuclei, nuclear excitations and radioactivity, nuclear models;
- Strong and electromagnetic decay, symmetries and weak interaction;
- Nuclear reactions, nuclear astrophysics.

Prerequisites:

PHYS 500 QM I or equivalent

Textbook:

Samuel S.M. Wong, *Introductory Nuclear Physics*

Website: https://phas.ubc.ca/~behr/phys505/

#### UBC Physics 528: Elementary Particle Physics

Instructor: David Morrissey, TRIUMF Theory

This course will cover the underlying theory of the Standard Model (SM) of particle physics. Starting from Feynman diagrams and quantum electrodynamics (QED), we will build up the other elements of the SM including the strong and weak forces and the Higgs mechanism. We will also connect the SM to experimental observations at high energy colliders and beyond.

Prerequisite: Familiarity with QED at the level of tree-level Feynman rules.

Website: https://particletheory.triumf.ca/PHYS528/

#### UBC Physics 560: Physics and Engineering of Particle Accelerators

Instructors: Oliver Kester, Tobias Junginger, and others from TRIUMF Accelerator Div

The course will provide an introduction to the physics and technology of particle accelerators with focus on proton and ion accelerator technology. The course will include a survey of existing accelerator types and an introduction to transverse and longitudinal beam optics. The course will also include an introduction to the physics and technology of ion sources, will give an overview of radioactive ion beam production, of accelerator radio-frequency principles and more detailed aspects of room temperature and superconducting linear accelerators, as well as high energy circular machines. The course should appeal to students of Accelerator Physics, as well as to students of Experimental Nuclear and Particle Physics and other students interested in Particle Accelerators.

Prerequisites: Classical Mechanics, Classical Electro-dynamics

### FALL 2021 SESSION: TBA

### WINTER 2022 SESSION:

#### UBC Physics 527: Topics in Nuclear Physics

Instructor: Reiner Kruecken (and others).

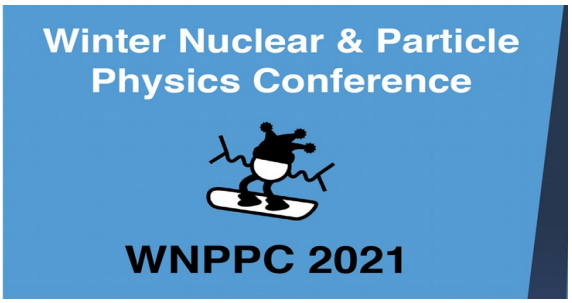
This is the followup course to 505.

#### UBC Physics 528: Elementary Particle Physics

Could be offered if there is sufficient demand.

#### UBC Physics 560: Physics and Engineering of Particle Accelerators

**For more information on any of these courses, please contact the TRIUMF Academic Committee at trac@triumf.ca**




## 4. Winter Nuclear and Particle Physics Conference (WNPPC 2021)

(submitted by Thomas Brunner, McGill)

The 58th annual Winter Nuclear and Particle Physics Conference (WNPPC) will take place from February 9 – 12, 2021. The WNPPC invites junior researchers (students, postdocs) to present their research in a stimulating and engaging environment for everyone interested in subatomic physics research in Canada.

All talks will be given in a virtual format. Topics include:

- Electroweak and Higgs Physics
- QCD and Hadrons
- Nuclear Structure
- Neutrino Properties
- Physics beyond the Standard Model
- Nuclear and Particle Astrophysics

We are excited that we could get the following invited speakers:

- Nahee Park, Queen's University
- Joseph Bramante, Queen's University
- Matthias Danninger, SFU
- Dennis Muecher, Guelph University
- Erica Caden, SNOLAB
- Juan Pablo Yanez, University of Alberta

Additional information can be found on the conference website: http://wnppc.triumf.ca/2021/

**Important:** Registration (free for students and PDFs) opens Nov 23. Registration deadline is Dec 18, 2020.

## 5. Canadian Undergraduate Physics Conference (CUPC 2020)

CUPC was organized this year by the University of Western Ontario, and was held virtually on Nov 5-8. Due to the COVID-19 travel restrictions, we did not have a CINP Student Travel Award program to assist undergraduates supervised by CINP members in presenting their research work at the conference.

Instead, CINP supported the CUPC through a platinum-level sponsorship, with a named CINP prize awarded to the best research presentation in nuclear physics. Dixin Chen from McGill University received the award. Ms. Chen was previously the recipient of a CINP Undergraduate Research Scholarship in 2018.

## 6. NSERC Support for CINP

The CINP gratefully acknowledges support from NSERC in the form of a Subatomic Physics Major Resources Support (SAP-MRS) grant. This grant supports the CINP's external conference support program, the undergraduate research scholarship program, expenses for the Long Range Plan, and other initiatives.

The CINP MRS grant was renewed for 5 years in the 2020 competition. The installment for 2020-21 is $85,000. The substantial increase in support will allow an expansion of some CINP programs.

## 7. Representation and Input to Various Agencies

The CINP is an advocate and representative of the Canadian nuclear physics community and is asked to attend various meetings or make presentations on its behalf. Some recent and forthcoming activities include:

- The CINP White Paper *"The 2022-2036 Horizon for Nuclear Physics in Canada – From the Core of Matter to the Fuel of Stars"* is in the process of being finalized and will be submitted to the LRPC on Dec 1. We had a successful virtual Town Hall Meeting #2 on Oct 26, where we received much useful feedback and suggestions for improvement. We thank everyone who participated. The final LRP White Paper, as well as past documents, will be available at: https://cinp.ca/subatomic-physics-long-range-plan

- The *New Digital Research Infrastructure Organization (NDRIO) announced a Call for White Papers* as part of a nation-wide exercise to assess the needs of Canada's Digital Research Infrastructure. As reminder, NDRIO will replace Compute Canada as the organization to coordinate research computing, data and software. The IPP/CINP community has organized a group to prepare a response to the call including: Alexandros Gezerlis, Doug Gingrich, Chris Jillings, Randy Lewis, Pekka Sinervo, Randall Sobie (Chair) and Reda Tafirout together with Garth Huber (CINP) and Mike Roney (IPP). **The draft white paper for your comment will be distributed separately, with the final report due to NDRIO by Dec 4.**

- CINP and IPP presented the joint document on *The Context and Environment of Canadian Subatomic Physics Research at Canadian Universities* to the Subatomic Physics Evaluation Section (SAPES) at their Nov 5 fall orientation meeting. This document is needed because many SAPES members are not very familiar with the Canadian research funding process and the research environment at Canadian universities. The document can be downloaded from: https://cinp.ca/cinp-white-papers

- Garth Huber represents CINP on the Carleton-Victoria-Winnipeg MRS Resource Planning Board. There is an openness to support projects from CINP members. Please visit https://cinp.ca/subatomic-physics-major-resources-support-facilities or contact GH for more information (contact info at end of Newsletter).

- The CINP Executive Director is asked to suggest new members of the NSERC Subatomic Physics Evaluation Section (SAPES), to replace the specific expertise of outgoing members. **Please let us know if you have any suggestions for the 2021-22 committee**. Your suggestions can be either international or domestic, from any subatomic physics sub-discipline, keeping in mind the Tri-Council conflict of interest guidelines, which stipulate that committee members cannot be applicants in that competition.

- We anticipate that CINP will be asked to make a short presentation on The Breadth of Canadian Nuclear Physics Research at SAPES Large Projects Day in February. **Please send information on your significant 2020-21 research highlights, new research capabilities, or honours received to Garth Huber by February 1.**

- The Advisory Committee on TRIUMF (ACOT) meets and reports to the NRC twice a year. Garth Huber represents the CINP as a "community observer". ACOT met Nov 19-21, and will next meet Apr 22-24, 2021. **Please let us know if you have specific information that would be useful to CINP's input.**

**To provide input to any of these matters, or request further information, please see the Executive Director contact information at the end of the newsletter.**

***Two research highlights were submitted after our Nov 2 request for announcements, milestones, etc. for the newsletter. Reports from other CINP members are always welcome.***

## 8. Landmark ALPHA result garners editor's pick among 15 years of Nature Physics (submitted by Makoto Fujiwara, TRIUMF)

The 2011 paper *Confinement of antihydrogen for 1000 seconds*, published by the ALPHA group has been tapped as a *Nature Physics* editor's favorite admist a 15-year round-up of top papers.

In *Sweet Fifteen*, the publication's fifteen-year anniversary special edition, *Nature Physics* editors share a nod to ALPHA's achievement of trapping and containing more than 300 atoms of anti-hydrogen atoms for a record-breaking 16 minutes - the world's first prolonged look at the elusive substance.

Since antimatter annihilates upon contact with matter, learning how to confine and store antimatter in our matter world was a necessary first step for the collaboration's endeavours in experimental antimatter research. Building from *Confinement of antihydrogen for 1000 seconds,* the ALPHA collaboration has since published a number of important papers describing the physical properties of antimatter, including several increasingly precise spectroscopic and charge measurements.

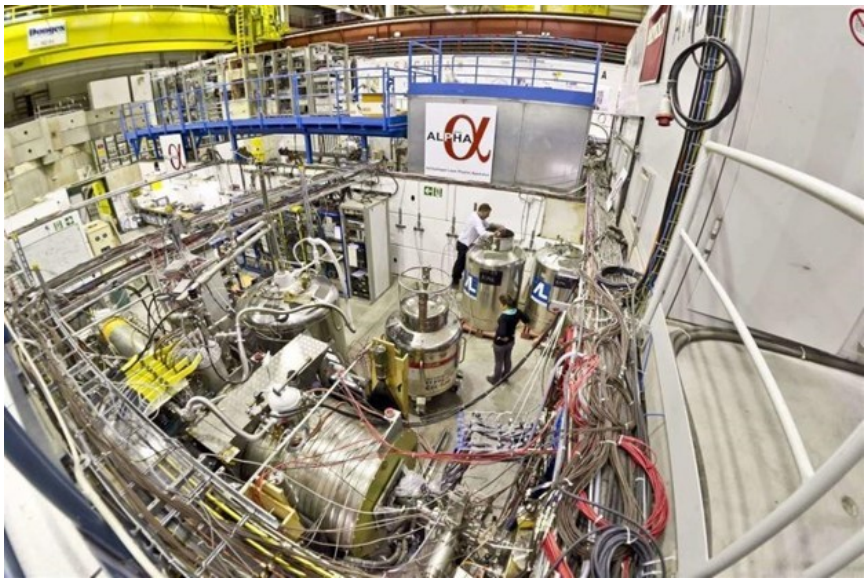
"I would have been happy to trap antimatter atoms for a few milli-seconds, since you could already do a lot in that time. But the 1000 seconds was a total game changer," says Makoto Fujiwara, a TRIUMF scientist and both the ALPHA-Canada lead and the principal author of the *Confinement* paper.

The *Confinement* paper remains a persistent source of pride for ALPHA-Canada and the wider international team, even as the ALPHA Collaboration looks to its future experiments, which include a measurement on how antimatter responds to the force of gravity with the new ALPHA-g apparatus.

"The confinement of antimatter was a critical first step. However, no one has directly measured the effect of gravity on antimatter — but we hope to do just that with the ALPHA-g experiment" said Chukman So, who has joined TRIUMF as a TRIUMF Research Associate to lead the design of the ALPHA-g superconducting magnetic trap.

Andrea Capra, a TRIUMF Research Associate who leads the ALPHA-g detector project, added: "Our recent analysis suggests the trapping lifetimes is 60 hours or even longer. We're on the brink of some very interesting opportunities in the studies of antimatter."

The ALPHA-Canada team comprises about one-third of the international ALPHA collaboration, and includes researchers and students from five Canadian institutions (TRIUMF, UBC, SFU, University of Calgary, and York University). The Canadian cohort plays a leading role in both the development of the trapping apparatus and the antimatter detection apparatus.



## 9. Searching for Shape Coexistence with $^{80}$Ge (submitted by F.H. Garcia and C. Andreoiu, SFU)

Shape coexistence is now known be a wide spread phenomenon in the chart of nuclides. Located around areas near the islands of inversion, and near the canonical shell closures far from stability, it manifests as the presence of intruder $0^+$ states with different deformations in a narrow energy range to the spherical configuration.

A recent experiment by the ALTO collaboration [PRL 116(18) 182501, 2016] investigated the existence of excited $0^+$ states in $^{80}$Ge. The neighbouring Ge isotopes and the N=48 isotones show evidence of these intruders, but no information was available for this type of state $^{80}$Ge, until the ALTO experiment.

They observed an excited $0^+$ level located at 639 keV, below the $2_1^+$ 659-keV state. This pointed to shape coexistence in this nucleus. However, this experiment was unable to observe a deformed band built upon this state, or a γ-ray transition between this $0^+$ excited state and the $(2^+)$ 1573-keV state. Though not mentioned, this lack of key spectroscopic data was likely due to the low statistics of this experiment.

The GRIFFIN array at TRIUMF, consisting of up to 16 Compton supressed HPGe clover detectors, can be coupled to the PACES array for conversion electron spectroscopy, making for a powerful experimental set-up to search for low energy shape coexistence. In an effort to expand the knowledge of $^{80}$Ge and find the missing states and transitions, a complementary β-decay experiment was performed using GRIFFIN and PACES.

The lack of evidence for the 639-keV $0_2^+$ state, as observed by PACES, is shown in Figure 1. The ALTO conversion electron spectrum, on the left, shows a peak at 628 keV (the K-electron binding energy in $^{80}$Ge is 11 keV). The PACES conversion electron spectrum on the right, however, shows no evidence for this peak, despite the observation of much weaker peaks like the $^{80}$Ge L-line and $^{80}$Kr K-line (present in the beam due to isobaric contamination).

The GRIFFIN experiment, benefiting from higher statistics and an increased detector number, was unable to detect the signature 628-keV conversion electron peak observed by ALTO.

The absence of this state was further confirmed by detailed γ-ray coincidences obtained with GRIFFIN, isomeric component determination and theoretical calculations. The large-scale shell model calculations performed show that, though a $0_2^+$ state is expected, it appears at around 2 MeV, a value which is in line with the energies of the $0_2^+$ states observed in the $^{78,82}$Ge neighbouring isotopes. The non-observation of these key data is therefore evidence that there is no low-energy shape coexistence in $^{80}$Ge.

The comprehensive spectroscopy of this nucleus, including the search for the $0_2^+$ candidate level near 2 MeV, is still under review. The findings here presented are encapsulated in a recently published article [PRL 125, 172501, 2020].

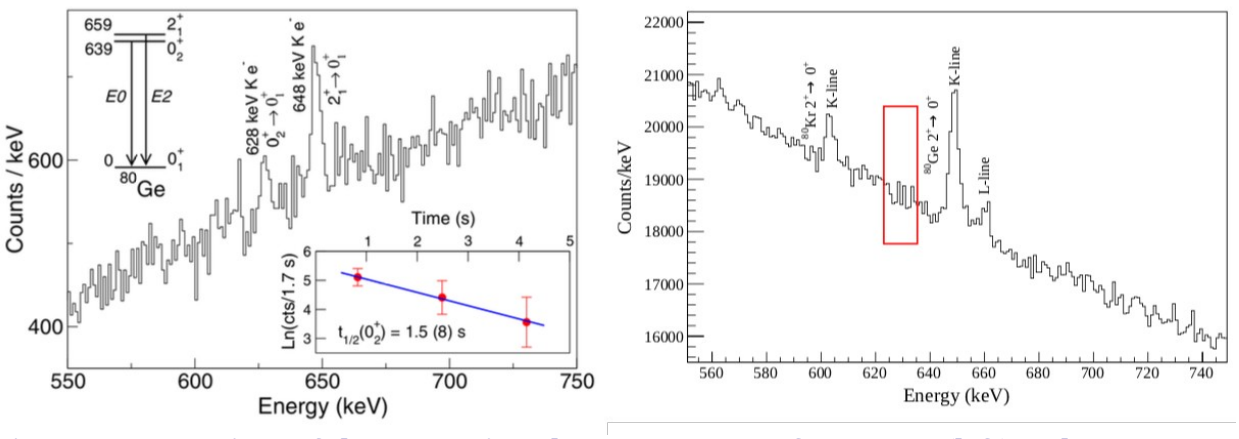



***Figure 1: Comparison of the conversion electron spectrum from ALTO (left) and PACES (right). The red box shows where the 682-keV electron peak should appear.***

## 10. COVID-19 Impacts on CINP Programs

Due to the COVID-19 travel restrictions, most conferences and workshops have either moved to a virtual format, or been delayed. This has had a significant impact upon our various travel support programs, such as:

- CUPC Student Travel Awards
- WNPPC Student Travel Awards
- Junior Scientist (JSci) Travel Support Program https://cinp.ca/junior-scientist-travel-support-program-jsci
- Conference Support Program https://cinp.ca/conference-support

**Please rest assured that if you have received approval for a JSci or Conference Support award, you will not lose your allocation if your event was delayed until 2021 or later.** In this case, simply please let us know, so we can make sure the award is saved for you. Also, if you are planning a future event but are still uncertain on its timing, we are willing to guarantee support once the nature and scope of your conference/workshop are decided. Application forms are available at the above links.

The Undergraduate Research Scholarship (URS) Program has not been much impacted, with one student electing to defer their award until fall 2020 and the others proceeding as planned in the summer. Of course, we will be running the URS program again in summer 2021, as it is one of our most successful programs.

## 11. CINP Sessions at the CAP 2021 Congress

The Canadian Association of Physicists will be held virtually in 2021, as it was in 2020. We plan to have a full slate of CINP activities, including:

- CINP Individual Members AGM
- CINP+IPP Joint Session

We will announce more details closer to the event.

## 12. Thanks to Scientific Working Group

## Chairs

*Nuclear Structure:* Adam Garnsworthy (TRIUMF)
*Nuclear Astrophysics:* Iris Dillmann (TRIUMF)
*Fundamental Symmetries:*
Gerald Gwinner(Manitoba)
*Hadron Structure/QCD:*
Svetlana Barkanova (Memorial)
*Nuclear Education and Training:*
Juliette Mammei (Manitoba)

**We thank the SWG Chairs for their hard work this summer putting together the CINP Long Range Plan White Paper.** This is an extremely important volunteer responsibility that our entire community benefits from. Once the SWG Chairs have had a chance to rest from these activities, our next planned activity is to post selected highlights to the CINP website.

## 13. CINP Contact Information

### CINP Executive Director:

If you require information about any CINP programs, please do not hesitate to contact:

Garth Huber, Ph.D.
CINP Executive Director
c/o University of Regina
306-585-4240
huberg@cinp.ca

### CINP Treasurer:

Greg Hackman
TRIUMF
hackman@triumf.ca

*This Newsletter was edited by Garth Huber. Email regarding the content of this newsletter, or suggestions for content in future CINP newsletters should be sent to huberg@cinp.ca*