

Abstracts 101

Cat and David

How do you convince someone
to **care** about your research?

Or convince someone to **care** about you *talking* about your
research?

Outline

- What we're going to do in the workshop
- Bad abstract (exaggerated)
- purpose of abstract
- How to frame your abstract (conference, thesis, paper).
 - Abstract for two different conferences
- description of ideal abstract
- outline the content of an abstract
- Show abstract that we really like
- Exercise

Workshop breakdown

- Look at some questionable abstracts
- Understand the purpose of an abstract
- Key ingredients
- Knowing your audience
- More abstracts
- Apply what you have learned!

Let's look at some abstract examples

LoLX: Light-only Liquid Xenon experiment for R&D studies towards next-generation neutrino-less double beta decay experiments

The light-only liquid xenon (LoLX) experiment is an R&D detector designed to perform studies of light emission, transport and detection in liquid xenon (LXe) detectors using silicon photomultipliers (SiPMs). LoLX aims to study the properties of xenon scintillation light and Cherenkov radiation, which will be used to refine existing simulation models, and provide input to the planned neutrinoless double beta decay ($0\nu\beta\beta$) experiment nEXO [1]. nEXO will employ 5 tonnes of enriched Xe-136, and is expected to reach a $0\nu\beta\beta$ half-life sensitivity of $>10^{28}$ years in the planned configuration, covering the parameter space associated with the inverted neutrino mass ordering [1].

The nEXO experiment will use SiPMs to detect LXe scintillation light, and segmented anode tiles for charge readout in a single-phase TPC configuration. LoLX employs 96 Hamamatsu VUV4 SiPMs for xenon scintillation light detection, which peaks at ~ 175 nm, and uses wavelength filters to isolate scintillation light from broad-band Cherenkov radiation. In this presentation, we will give an overview of the LoLX experiment, discuss the status of the program and outline current and future upgrades to the detector. These upgrades include improvements to the data acquisition system, now capable of reading 3 GSPS, which will enable detailed timing studies of LXe scintillation.

References:

1. nEXO Collaboration, nEXO: neutrinoless double beta decay search beyond 1028 year half-life sensitivity, Journal of Physics G: Nuclear and Particle Physics, 2021, DOI: 10.1088/1361-6471/ac3631

Line shape analysis of the resonant eigenstates in a quantum corral by means of tunneling spectroscopy and non contact AFM

Back in 1993 Crommie et al. [1] arranged 48 Fe adatoms on a Cu(111) surface in a circle with a diameter of 14.26 nm. This quantum corral confines surface electrons in a circular potential well. Past investigations with scanning tunneling microscopy and tunneling spectroscopy revealed energetically discrete eigenstates that spatially appear as Bessel functions of the enclosed electrons. But these studies on the Fe quantum corral showed unwanted movement of the corral walls during spectroscopic measurements. [1] Instead of Fe, we used CO molecules to provide the corral with more stable walls (see Figure 1A). This permitted us to access a larger voltage window and allowed for a detailed line shape analysis of the corrals eigenenergy levels. Surprisingly, we discovered a large Gaussian broadening of the eigenstates. We also acquired nc-AFM data of the corral. As we have previously done, we determined the occupation of electronic states that cross the Fermi level [2]. Similar to our previous work, we observed that the presence of the probe tip shifts the energy of the electronic states under study. In this work, we show that we can also use the AFM data to estimate the lifetime (i.e. the spectral width) of these states.

Ferroelectricity on oxide perovskite surfaces

In many bulk materials transition to the ferroelectric phase can be triggered by the ion displacement from its equilibrium position in the matrix. For example, in barium titanate, BaTiO_3 , the Ti^{4+} ion rests in a double-well potential landscape, resulting in a switchable polarization [1]. If this potential barrier in a well is low, which is in the case of potassium tantalate, KTaO_3 , ferroelectric state can be reached by the application of a small stimuli, e.g. stress, doping or external fields, causing the material to be incipient-ferroelectric (quantum paraelectric). In this talk, I will present the similarities and differences between two representative perovskite oxide surfaces – $\text{KTaO}_3(100)$ and $\text{BaTiO}_3(100)$, showcasing the manifestation of the (incipient-) ferroelectricity on the atomic and electronic structure. Both surfaces were prepared by cleaving single crystals in situ and characterized by means of qPlus nc-AFM at temperatures ranging from 4K to 100K. $\text{BaTiO}_3(100)$, a model ferroelectric perovskite, cooled down to 4K adopts a rhombohedral crystal structure, where titanium atoms can easily break a symmetry causing a spontaneous polarization. I will present that a biased tip placed a few nanometers above the surface allows for reversible manipulation of individual atoms on the surface, writing and erasing polarized ferroelectric domains (as demonstrated in Fig. 1a,b). For a similar experimental conditions, incipient-ferroelectric KTaO_3 remain paraelectric, hence tip-induced electric fields influence it via different mechanisms. Excess charges injected from the AFM tip form quasiparticles called polarons (charges coupled with lattice distortions) which can be further shaped into 1D or 2D structures by intrinsic surface electric fields, emerging from two alternating domains of KO and TaO₂, developed to compensate the surface polarity [2]. Careful analysis of the frequency shift signal enables tracing single injections (Fig. 1c inset), whereas Kelvin Probe Force Microscopy mapping reveals the 1D or 2D shape of charged domains (Fig. 1c)

Floating Hole Multiplier – a novel concept for dual-phase noble liquid detectors

We describe a novel concept for dual-phase noble liquid detectors, the Floating Hole Multiplier (FHM). It consists of a perforated electrode freely floating on the surface of the liquid. The concept has been validated with a Thick Gas Electron Multiplier (THGEM) on the surface of liquid xenon. First experimental results will be reported showing that the electrons, liberated in liquid xenon due to ionization by alpha-particles, are focused into the THGEM holes, extracted under the electric field from liquid to gas and generate electroluminescence of the gas in the hole and its vicinity. Both primary scintillation of the liquid and secondary scintillation in the gas were measured with a quartz window photomultiplier thus showing the potentiality of operation of this configuration in the regime used in the noble liquid dual-phase time projection chambers for low background experiments such as WIMP search and neutrino physics. The advantages of the new concept of floating electrodes will be discussed in view of its application in both liquid xenon and liquid argon detectors, among which are the complete absence of the electrode sagging (critical for large detectors), no need for a fine tilt and liquid level control, significant reduction of surface mechanical and electrical instabilities, reduction of single electron noise from the surface.

A versatile cryogenic system for liquid argon detectors

Detectors for direct dark matter search using noble gases in liquid phases as detection medium need to be coupled to liquifying, purifying and recirculation systems.

In the framework of the DarkSide experiment the Proto-0 system, a double phase liquid Argon TPC as reduced scale prototype version of the DarkSide-20k detector, has been built with the aim of the study of the position of the scintillation and ionization signals detected by a large SiPM's arrays.

The detector is connected to a dedicated cryogenic system to liquefy and purify the gaseous argon used as the scintillator.

The cryogenic system is mainly composed of double wall cryostat hosting the TPC, a purification stage to reduce the impurities below the parts per billion level, a condenser to liquefy the argon, a recirculation gas panel connected to the TPC cryostat equipped with a custom gas pump.

The system has been built and has been operated at the INFN-Laboratory of the Naples since October 2021.

Main features of the cryogenic system will be presented. Performances, long term operations and stability in terms of the most relevant thermodynamic parameters will be reported. Future plans and upgrades will be discussed.

Purpose of the abstract

- Summarize what you will talk about in your conference/paper/thesis
- Convince people to come hear you talk / read your paper/thesis

SELL YOUR IDEA

How to convince someone to **care** about you *talking* about your research?

Ingredients for an abstract (6 sentence method)

1. **Intro**: What's the topic?
2. State the **problem**: what's your research question?
3. Why has no one solved this problem, i.e. what's the **literature**?
4. What's your **big idea** to solve this issue?
5. What's your **methodology** that helped you ___ this big idea?
6. What is the key **impact** of your research?

(1) In widgetology, it's long been understood that you have to glomp the widgets before you can squiffle them. (2) But there is still no known general method to determine when they've been sufficiently glomped. (3) The literature describes several specialist techniques that measure how wizzled or how whomped the widgets have become during glomping, but all of these involve slowing down the glomping, and thus risking a fracturing of the widgets. (4) In this thesis, we introduce a new glomping technique, which we call googa-glomping, that allows direct measurement of whiffalization, a superior metric for assessing squiffle-readiness. (5) We describe a series of experiments on each of the five major types of widget, and show that in each case, googa-glomping runs faster than competing techniques, and produces glomped widgets that are perfect for squiffing. (6) We expect this new approach to dramatically reduce the cost of squiffled widgets without any loss of quality, and hence make mass production viable.

A few tips and tricks for conference abstracts

- Be **concise**, avoid filler words! I.e. don't be too wordy
- Make an **outline**
- Word count < **200** (if you have 2 paragraphs you're doing something **wrong**)
- Make sure your first and last sentences are **impactful**
- Avoid long (boring) titles
 - **BAD**: Oscillatory behaviour of dissipation energy in hydration layers at the interface between a nanometer-thin water film and a KBr(100) surface observed by frequency modulation atomic force microscopy
 - **GOOD**: Measuring the change in reactivity of a single molecule: Does the bottom effect the top?
- **Specific enough** so that people know what you will be talking about, **general enough** so that readers will want to come hear you talk.
- Know your **audience**!

Framing your abstract to your audience

Conference	Paper	Thesis
Convincing people to come hear you talk (I swear I have something interesting to say, come hear more about it).	Convincing people to read your paper (what's so cool about your results?).	(a lot) Longer, more of a summary of your thesis

Framing your abstract to your audience

Conference
Convincing people to come hear you talk (I swear I have something interesting to say, come hear more about it).

General	Specific Topic
Different backgrounds, concentrate on the <i>why we care</i> aspect.	Alter your abstract to more heavily talk about this abstract

Undergrads	Undergrads/Grads	Grads, Post-Docs, Profs	People from Industry
Stick with easier, general concepts	Mix of general and specific.	Can be more technical	How does your research relate to that industry?

Quantum Imaging of Single Electron Transfers in Metalloenzymes

Enzymes have been of great interest due to their fascinating redox properties and their use in green energy production. Specifically, metalloenzymes have great potential in clean H₂ utilization and CO₂ reduction by means of carbon scrubbing. It is thus imperative to understand the structural properties of metalloenzymes, and their internal redox and electron transfer rates since these properties support catalytic activity. To do so, we can map quantum energetics to electron transfer rates of metalloenzymes through quantum imaging. Specifically, our home-built low-temperature atomic force microscope (LT-AFM) will be used to image single-electron transfers of metalloenzymes. By monitoring the frequency shift and dissipation of our oscillating conductive cantilever, we induce electron tunneling events and determine quantum dot density of states, measure single electron tunneling rates, and observe transitions between quantized nuclear vibronic states at the single-molecule level. With this method, we will be able to determine Franck-Condon factors associated with redox transitions, measuring energetic offsets, and mapping electronic coupling between redox centers. This will allow us to understand and engineer the catalytic activity of metalloenzymes in an effort to develop sustainable energy solutions.

CONFÉTI (CONFérence ÉTudiante de l'INTRIQ)

Conference, general/specific topic (quantum), undergrads/grads

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NC AFM (Non-Contact Atomic Force Microscopy)

Conference, specific topic (nc AFM), grads + post docs + profs + industry

Single Electron Spectroscopy on Metalloenzymes

Single-electron electrostatic force microscopy (e-EFM) has been a useful method for probing nanoscale systems and extracting quantum properties. With this AFM technique, we can mobilize and probe single-electron transfers in structures with discrete electronic states. By monitoring the frequency shift and dissipation of our oscillating conductive cantilever, we induce electron tunneling events and determine quantum dot density of states, measure single electron tunneling rates, and observe transitions between quantized nuclear vibronic states at the single-molecule level [1-3]. Recently, e-EFM has been of great interest to understand redox energetics and electron transfer rates of metalloenzymes, two fundamentally quantum derived processes that underpin catalytic activity. Specifically, we would like to use our home-built low-temperature atomic force microscope (LT-AFM) to image single-electron transfers in single- and multi-redox site metalloenzymes. With e-EFM, we will be able to determine Franck-Condon factors associated with redox transitions, measure energetic offsets, and map electronic coupling between redox centers [3,4]. This will allow us to understand and engineer the catalytic activity of metalloenzymes in an effort to develop sustainable energy solutions [5].

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Let's look at some nice abstracts

Some nice abstracts

“The varied nature of Iron Age religious sites in Scandinavia has been the cause of much scholarly debate, particularly in terms of their continuity and centralization - or otherwise. Little focus, however, has been paid to the general patterns of specialization displayed by these sites in the wider pre-Christian landscape. As such, this article seeks to examine the social spaces engendered with sacral value by pre-Christian Scandinavians. Drawing on a range of evidence, including toponymic, textual, and archaeological corpora, a model is proposed whereby despite the ongoing physical changes in such religious sites during the Iron Age, an underlying continuity may be found in the non-physical characteristics of their spaces. It is concluded that different manifestations of liminality – geographic, temporal, and dimensional – lay at the heart of these late Iron Age sacral spaces.”

Structure discovery in AFM imaging of ice

The interaction of water with surfaces is crucially important in a wide range of natural and technological settings. In particular, at low temperatures, unveiling the atomistic structure of adsorbed water clusters would provide valuable data for understanding the ice nucleation process. Using high-resolution Atomic Force Microscopy (AFM) and Scanning Tunneling Microscopy, several studies have demonstrated the presence of water pentamers, hexamers, heptamers (and of their combinations) on a variety of metallic surfaces [1 – 4], as well the initial stages of 2D ice growth on an insulating surface [5]. However, in all these cases, the observed structures were completely flat, providing a relatively straightforward path to interpretation. Here, we present high-resolution AFM measurements of several new water clusters on Cu(111), whose understanding presents significant challenges, due to both their highly 3D configuration and to their large size. For each of them, we use a combination of machine learning, atomistic modelling and statistical sampling to propose an underlying atomic structure, comparing the experimental images with simulated AFM from Density Functional Theory. These results provide new insights into the early phases of ice formation, which is a ubiquitous phenomenon ranging from biology to astrophysics.

Where to get help

- Ask your colleagues and group members
- Talk to your supervisor
- Keep an eye out for emails from McGill Writing Centre and Graphos courses
- LLM Tools like ChatGPT can be very helpful co-writers

Playing with ChatGPT

Here's my outline for a conference abstract in particle physics, can you help me write the abstract from this?

- nEXO will search for $0\nu\beta\beta$ at 10^{28} year sensitivity
- nEXO and other future RES experiments will use SiPMs for VUV light detection
- Understanding the device performance over long periods of time with large statistics in detector conditions is critical for success
- LoLX is a multi-disciplinary R&D collaboration, which will study the performance of SiPMs in a LXe environment
- To enable long-term testing, a series of upgrades were carried out to the detector systems, including a new cooling system
- Using this new cooling system we will enable long-term testing of 80 SiPMs in LXe for week-month time-scales with a benchmark measurement against a VUV-sensitive PMT
- Overview of hardware improvements and status of long-term testing will be shown

Playing with ChatGPT

Title: Long-term Testing of SiPMs in a LXe Environment for nEXO and Future RES Experiments

Abstract:

The search for neutrinoless double beta decay (0vBB) is of paramount importance in particle physics. The next-generation Enriched Xenon Observatory (nEXO) aims to achieve unprecedented sensitivity to 0vBB with an anticipated reach of 10^{28} years. To meet this ambitious goal, nEXO and other future Rare Event Search (RES) experiments rely on Silicon Photomultipliers (SiPMs) for Vacuum Ultraviolet (VUV) light detection.

A crucial aspect for the success of these experiments is a comprehensive understanding of SiPM performance over long periods of time, within the demanding detector conditions. To address this, the LoLX (Long-term Testing of SiPMs in LXe) collaboration has been established as a multi-disciplinary research and development effort.

In this work, we present the recent advancements made in the LoLX project. To facilitate extended testing of SiPMs, a series of detector system upgrades have been implemented. Notably, a new cooling system has been incorporated, enabling long-term testing of 80 SiPMs in Liquid Xenon (LXe) for week to month time-scales.

To validate the performance of SiPMs, a benchmark measurement is conducted by comparing the SiPMs against a VUV-sensitive Photomultiplier Tube (PMT). The usage of the new cooling system, combined with this benchmark measurement, provides valuable insights into the long-term behavior and stability of SiPMs in a LXe environment.

In this abstract, we offer an overview of the hardware improvements implemented in the LoLX project and present the current status of the long-term testing campaign. The results obtained from this study will contribute to the optimization of SiPM-based VUV light detection systems, ensuring their reliability and effectiveness for nEXO and future RES experiments.

Keywords: neutrinoless double beta decay, SiPMs, VUV light detection, nEXO, RES experiments, long-term testing, LXe environment, LoLX collaboration.

Now you try!

Ingredients for an abstract (6 sentence method)

1. **Intro**: What's the topic?
2. State the **problem**: what's your research question?
3. Why has no one solved this problem, i.e. what's the **literature**?
4. What's your **big idea** to solve this issue?
5. What's your **methodology** that helped you achieve this big idea?
6. What is the key **impact** of your research?

Resources

- <http://www.easterbrook.ca/steve/2010/01/how-to-write-a-scientific-abstract-in-six-easy-steps/>
- <https://openai.com/> -> ChatGPT
- <https://www.mcgill.ca/graphos/conferences>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3136027/>