

DMUK

Report of Contributions

Contribution ID: **1**

Type: **not specified**

Welcome

Thursday 22 September 2022 10:00 (10 minutes)

Author: ARAUJO, Henrique

Presenter: ARAUJO, Henrique

Session Classification: Session 1 (morning)

Contribution ID: 2

Type: **not specified**

Boulby Underground Laboratory: plans for development of facilities and science

Thursday 22 September 2022 10:10 (20 minutes)

An overview of work underway to develop Boulby Underground Laboratory facilities to host future UK and international underground science project.

Presenter: PALING, Sean

Session Classification: Session 1 (morning)

Contribution ID: 3

Type: **not specified**

Direct Dark Matter searches with the DarkSide-20k experiment

Thursday 22 September 2022 10:30 (20 minutes)

DarkSide-20k is a next-generation direct dark matter search experiment under construction at the Gran Sasso National Laboratory (LNGS) in Italy. The core of the detector is a two-phase liquid argon time projection chamber designed to probe WIMP interactions down to the neutrino floor, with an exposure goal of ~ 200 tonne-years in expectation of a WIMP-nucleon cross section of 10^{-47} cm² for a WIMP mass of 1 TeV/c² during a 10-year run. In order to ensure zero instrumental backgrounds, low-radioactivity underground argon (depleted in ³⁹Ar) is used as the detector medium. This reduces the internal background, while a 25 cm² Silicon Photo Multiplier (SiPM) modules capable of resolving single photoelectrons are developed and will be installed in both the active detector volume and the veto system. An overview of the DarkSide experimental program and the DarkSide-20k detector will be presented with a focus on the SiPM construction and testing procedures.

Presenters: MANTHOS, Ioannis; Dr MANTHOS, Ioannis (University of Birmingham (GB))

Session Classification: Session 1 (morning)

Contribution ID: 4

Type: **not specified**

Update on dark matter searches using NaI from the COSINE-100 experiment

Thursday 22 September 2022 10:50 (20 minutes)

COSINE-100 is a NaI dark matter detection experiment located at the Yangyang Underground Laboratory in South Korea, designed with the main goal of testing the controversial, positive dark matter signal from the DAMA experiments using the same target material. COSINE-100 has been operational for almost six years and in that time has been the first NaI experiment to exclude the DAMA signal in certain dark matter models, as well as publishing multiple annual modulation search results which provide a model-independent check on the DAMA signal. This talk, an overview of the COSINE-100 detector will be given, with particular focus on recent and upcoming results, including newly published three years of annual modulation search data, an investigation of DAMA's analysis method using COSINE-100 data, and upcoming searches with five years of annual modulation data.

Presenter: NEAL, Robert (Sheffield University)

Session Classification: Session 1 (morning)

Contribution ID: 5

Type: **not specified**

Recent physics results from NEWS-G

Thursday 22 September 2022 11:10 (20 minutes)

The NEWS-G collaboration is searching for light dark matter using spherical proportional counters. Access to the mass range from 50 MeV to 10 GeV is enabled by the combination of low energy threshold, light gaseous targets (H, He, Ne), and highly radio-pure detector construction. The NEWS-G collaboration has constructed a new, 140 cm in diameter, spherical proportional counter at LSM using 4N copper with 500 um electroplated inner layer. Prior to shipping the detector to SNOLAB, a short data-taking campaign was undertaken at LSM using methane. New physics results from this run, leading to world-leading spin-dependent sensitivity will be presented.

Presenter: KNIGHTS, Patrick (Birmingham University)

Session Classification: Session 1 (morning)

Contribution ID: 6

Type: **not specified**

First Results and Status of the LUX-ZEPLIN (LZ) Experiment

Thursday 22 September 2022 11:30 (30 minutes)

The LUX-ZEPLIN (LZ) direct dark matter detection experiment is currently operating at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. LZ recently set new limits on WIMP-nucleus interactions above 9 GeV/c² with its first science run (SR1). This talk will detail these results, the status and outlook of the project.

Presenter: COTTLE, Amy**Session Classification:** Session 1 (morning)

Contribution ID: 7

Type: **not specified**

An update on Quantum Sensing for the Hidden Sector

Thursday 22 September 2022 13:00 (20 minutes)

I present an update on the work of the Quantum Sensing for the Hidden Sector collaboration, who are designing and building detectors for wave-like dark matter, particularly axions in the first instance, in the UK.

Presenter: DAW, Ed**Session Classification:** Session 2 (early pm)

Contribution ID: 8

Type: **not specified**

A new search for dark matter axions using quantum technologies

Thursday 22 September 2022 13:20 (20 minutes)

The toolkit of quantum technologies developed in atomic, molecular and optical physics are ideally suited to enhance the search for dark matter axions with masses above $\sim 40 \mu\text{eV}$. I will present an overview of a new experimental effort at Imperial College, developing technologies to initially target an axion mass range 120-250 μeV . We will use a large mode area Fabry-Perot cavity to efficiently convert axions into microwave photons. Compared to other geometries, the Fabry-Perot cavity can have a large volume factor, high Q and can be easily tuned. To detect the microwaves, we plan to use an electron in a Penning trap as a single photon counter. Individual microwave absorption events will change the cyclotron state of the electron, causing measurable shifts in the trapped particle's oscillation frequencies. This versatile device will also open up other possible detection routes for alternative dark matter candidates.

Presenter: DEVLIN, Jack (Imperial College London)**Session Classification:** Session 2 (early pm)

Contribution ID: 9

Type: **not specified**

QUEST-DMC: Simulation studies for the detection of sub-GeV dark matter with a superfluid ^3He calorimeter.

Thursday 22 September 2022 13:40 (20 minutes)

Several independent observations suggest that there is more mass in the Universe than has been directly observed. Dark matter is a hypothetical new form of matter that does not interact with the electromagnetic field and has a very weak interaction with ordinary baryonic matter. WIMPs (weakly interacting massive particles) are a dark matter candidate currently widely investigated in experiments, but most experiments are constrained to spin-independent interactions in the 10–100 GeV/ c^2 mass range. QUEST-DMC will use superfluid ^3He as a dark matter collision target, aiming to reach the world-leading sensitivity to spin-dependent interactions of 0.1–1 GeV/ c^2 mass dark matter candidates. Here we discuss a simulation of the superfluid ^3He bolometer's impact energy sensitivity, and argue that recoil energy of <10 eV can be detected using nanomechanical resonators. We also investigate the sources of radioactive background at and above this region and their relative importance using the Geant4 particle physics simulations toolkit. We aim to report on the development of a dark matter bolometer based on these studies and present the preliminary sensitivity results.

Presenter: FRANCHINI, Paolo (RHUL & Lancaster University)

Session Classification: Session 2 (early pm)

Contribution ID: 10

Type: **not specified**

BREAD: Broadband Reflector Experiment for Axion Detection

Thursday 22 September 2022 14:00 (20 minutes)

The BREAD Collaboration proposes a novel dish antenna programme for broadband searches of terahertz axion dark matter. Its hallmark is a cylindrical metal barrel converting axions to photons that are focused by a parabolic reflector onto ultralow-noise quantum sensors. We present the BREAD conceptual design and science program from dark photon pilot planned at Fermilab to large-scale experiment. BREAD is projected to open multiple decades of unexplored coupling sensitivity across meV to eV masses that has long eluded existing resonant-cavity haloscopes. Based on Phys. Rev. Lett. 128 (2022) 131801

Presenter: LIU, Jesse (University of Cambridge)

Session Classification: Session 2 (early pm)

Contribution ID: 11

Type: **not specified**

AION: the Atom Interferometer Observatory and Network

Thursday 22 September 2022 14:20 (20 minutes)

I introduce the Atom Interferometer Observatory and Network (AION), an experimental programme which aims to use cold strontium atoms to search for ultra-light dark matter and to explore gravitational waves. I outline the experimental concept of AION, and its place within the landscape of ultra-light dark matter detectors. Finally, I give progress update for the AION project in the UK, which is entering its 2nd year.

Presenter: HOBSON, Richard**Session Classification:** Session 2 (early pm)

Contribution ID: 12

Type: **not specified**

Dark matter searches using levitated optomechanics

Thursday 22 September 2022 14:40 (20 minutes)

Levitated optomechanics provides a novel platform to test fundamental physics. One such application provides a unique directional dark matter direct detection technique to explore alternative parameter space to that being investigated by large scale experiments deployed underground. We detail our experiment, capable of resolving collisions in all three dimensions, utilising nanoparticles (10^{-18} kg) for composite dark matter searches in the 10 MeV – 10 GeV mass range. We detail the theoretical calculations, experimental apparatus, data analysis framework and statistical inference that we aim to use to obtain results competitive with world-leading dark matter constraints. We present sensitivity projections for our experiment, informed by an initial characterisation of relevant backgrounds. We also discuss planned future work to explore alternative dark matter models using this experiment and complimentary approaches.

Presenter: JAMES, Robert S**Session Classification:** Session 2 (early pm)

Contribution ID: 13

Type: **not specified**

Migdal effect: New insights and updated predictions

Thursday 22 September 2022 15:30 (20 minutes)

Previous calculations of the Migdal effect assumed small values of the nuclear recoil velocity and were limited to the ionisation of single electrons. I will discuss new calculations of the Migdal effect that are robust for any conceivable value of the nuclear recoil velocity and allow for the ionisation of multiple electrons. Our results enable robust predictions of the Migdal effect scattering rate in experiments using neutron sources, and in dark matter direct detection experiments.

Presenter: Dr MCCABE, Christopher (King's College London)

Session Classification: Session 3 (late pm)

Contribution ID: 14

Type: **not specified**

The MIGDAL experiment at the NILE facility of the Rutherford Appleton Laboratory

Thursday 22 September 2022 15:50 (20 minutes)

I will report on the status of the construction of the experiment and analysis of preliminary data from detector commissioning.

Presenter: Dr MAJEWSKI, Pawel (STFC/Rutherford Appleton Laboratory)

Session Classification: Session 3 (late pm)

Contribution ID: 15

Type: **not specified**

Maximising sensitivity to low mass dark matter with the Migdal effect and exploring non-standard models including isospin violation in liquid noble direct detection experiments

Thursday 22 September 2022 16:10 (20 minutes)

Liquid noble direct dark matter detection experiments aim to detect galactic dark matter scattering off nuclei in highly sensitive detectors in underground laboratories. As positive signals of dark matter in the lab are elusive, it is crucial that current and future experiments broaden the reach and scope of dark matter models which are explored. In this presentation I will report on work exploring sensitivity to low mass dark matter exploiting the Migdal effect: this will include presentation of recently-released DarkSide-50 results, reinterpretation of existing Xenon-1T data, and future sensitivity projections for next generation argon and xenon detectors. I will also present new studies of the sensitivity of existing and future argon- and xenon-based detectors to isospin violating dark matter, demonstrate the complementarity of different target materials in the search for dark matter, and the importance of nuclear form factor models for properly characterising any discovery.

Presenter: SANDFORD, Ellen**Session Classification:** Session 3 (late pm)

Contribution ID: 16

Type: **not specified**

Constraining Dark Matter Spikes with OJ287

Thursday 22 September 2022 16:30 (20 minutes)

We use the extreme black hole binary system OJ287 to place constraints on dark matter spikes expected outside supermassive black holes as predicted by theory.

Presenter: Prof. FAIRBAIRN, Malcolm (Physics, King's College London)

Session Classification: Session 3 (late pm)

Contribution ID: 17

Type: **not specified**

Signatures of Non-thermal Dark Matter with Kination and Early Matter Domination: Gravitational Waves versus Laboratory Searches

Thursday 22 September 2022 16:50 (20 minutes)

The non-thermal production of dark matter (DM) usually requires very tiny couplings of the dark sector with the visible sector and therefore is notoriously challenging to hunt in laboratory experiments. Here we propose a novel pathway to test such a production in the context of a non-standard cosmological history, using both gravitational wave (GW) and laboratory searches. We investigate the formation of DM from the decay of a scalar field that we dub as the reheaton, as it also reheats the Universe when it decays. We consider the possibility that the Universe undergoes a phase of kination ($w_{\text{kin}} > 1/3$) before the reheaton dominates the energy density of the Universe and eventually decays into Standard Model and DM particles. We then study how first-order tensor perturbations generated during inflation, the amplitude of which may get amplified during the kination era and lead to detectable signals at the GW detectors such as LISA, ET, u-DECIGO, BBO, etc. Demanding that the reheaton produces the observed DM relic density, we show that the reheaton's lifetime and branching fractions are dictated by the cosmological scenario we show that it is long-lived and can be searched in DUNE, FASER, FASER-II, MATHUSLA, SHiP, etc. experiments and identify the parameter space where one may complement with the detectable GW signals. In particular we find that a kination-like period with an equation-of-state parameter $w_{\text{kin}} \sim 0.5$ and a reheaton mass $O(0.5-5)$ GeV and a DM mass of $O(10-100)$ keV may lead to sizeable imprints in both kinds of searches satisfying Big Bang Nucleosynthesis (BBN) constraints.

Presenter: Dr HEURTIER, Lucien (IPPP, Durham, England)

Session Classification: Session 3 (late pm)

Contribution ID: **18**Type: **not specified**

Dark Matter reaching out

Thursday 22 September 2022 17:10 (20 minutes)

A brief discussion on outreach in our community.

Presenters: ANGELIDES, Nicolas (Imperial College London); ANGELIDES, Nicolas

Session Classification: Session 3 (late pm)