T 54: Axion like particles I

Time: Wednesday 16:30–19:00 Location: H-HS XV

T 54.1 Wed 16:30 H-HS XV

Power boost optimisation for the MADMAX dielectric haloscope — •Lolian Shtembari for the MADMAX-Collaboration — Max Planck Institute for Physics, Munich, Germany

The MADMAX experiment is aimed to directly detect dark matter axions with masses between 40μeV and 400μeV by means of a dielectric haloscope.

Such a setup promotes the conversion of axions to photons at boundaries between materials of different dielectric constants under a strong magnetic field in order to produce an electromagnetic signal.

Combining many such surfaces, the conversion and the power of the emitted signal can be significantly enhanced using constructive interference and resonances.

In the highly dimensional phase space defined by the relative position of such surfaces with respect to each other, we investigate the distribution of the power boost and we look for the largest possible enhancement by means of global optimisation algorithms.

T 54.2 Wed 16:45 H-HS XV

Development of components for the MADMAX prototype booster system — •Christoph Krieger for the MADMAX-Collaboration — Universität Hamburg

The axion, a low-mass particle arising from an elegant solution to the strong CP problem, is a viable and natural candidate for (cold) dark matter. Due to a linear relation between the axion mass and its coupling, for low axion masses, detection becomes non-trivial.

Especially, the range of 40 to 400 μeV, favored in one of the well motivated scenarios, cannot be accessed with the standard haloscope approach. Therefore, for the **MA**gentized **D**isc and **M**irror **A**xion e**X**periment the dielectric haloscope approach will be used, utilizing the axion photon conversion at dielectric surfaces in a strong magnetic field. By combining many surfaces, the conversion can be boosted significantly using constructive interference and resonances.

To prototype the MADMAX booster system a small booster with twenty dielectric discs of 300 mm diameter is foreseen which have to be (re-)positioned in situ with micrometer precision inside a large magnetic field and a cryogenic environment. The prototype system will be commissioned in a dedicated cryostat at the University of Hamburg and later, possibly, operated at CERN in the MORPURGO magnet for a first axion search with a dielectric haloscope.

In this presentation, the concept of the MADMAX prototype and especially the development of the booster will be presented, showing the recent status of the production of tiled discs as well as studies on the drive system.

T 54.3 Wed 17:00 H-HS XV

Search for Axion-Like Particles at BESIII — •Julian Walter, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Axions or axion-like particles (ALPs) are hypothetical elementary particles proposed by theoretical approaches to extend the Standard Model of particle physics. While initially postulated as a solution to the strong CP problem of Quantum Chromodynamics, the existence of such a particle a could contribute to our understanding of other unsolved problems of modern particle physics. One such example is the anomalous magnetic moment of the muon a_μ, where the experimentally measured value deviates from the theoretical prediction by $3-4\sigma$. Furthermore, ALPs are considered promising candidates for cold Dark Matter.

The BESIII experiment at the BEPCII e^+e^- collider in Beijing, China, offers a great opportunity to investigate the possible production of ALPs in two-photon fusion reactions, assuming a subsequent decay $a \to \gamma\gamma$. This contribution will present a feasibility study of such investigations — Supported by DFG SFB 1044.

T 54.4 Wed 17:15 H-HS XV

Search for Axion-Like Particles in early Belle II data — •Michael De Nuccio for the Belle II-Collaboration — DESY, Hamburg, Germany

The Belle II experiment, located at the asymmetric e^+e^- collider SuperKEKB in Tsukuba, Japan, is a second-generation B factory. A first commissioning run took place in Spring 2018. The main physics data taking began in early 2019. Thanks to the very clean environment and dedicated triggers, Belle II is suited to perform searches for dark-sector particles.

Axion-Like Particles (ALPs) are light, neutral pseudoscalars interacting predominantly with Standard Model photons, and have been proposed both as candidate dark matter particles or as portal particles to the dark sector. The Belle II sensitivity to ALPs produced in association with a recoil photon from e^+e^- collisions, and decaying promptly into two photons, is competitive with the small commissioning collisions dataset collected in 2018. This talk will present the results of this search, and will show the new limits that the Belle II experiment is able to set for this process.

T 54.5 Wed 17:30 H-HS XV

A Ray Tracer for Axions at CAST — Klaus Desch[1], •Johanna von Oy[1], Jochen Kaminski[1], Sebastian Schmidt[1], Tobias Schiffer[1], and Arshia Ruina[2] — [1]Physikalisches Institut, Uni Bonn — [2]DPNC, Université de Genève, CH-1211 Genève 4, Switzerland

The CAST (CERN Axion Solar Telescope) experiment has primarily been searching for solar axions and other dark matter candidates since 2003. In 2017 and 2018 data has been taken at CAST with an InGrid detector (a MicroMegas like gaseous detector) behind a purpose-built X-ray telescope. To calculate the expected flux arriving at the detector, a ray tracer has been developed.

In this case, the ray tracer tracks the path of thousands of axions from the sun, through the CAST magnet, where they are converted to X-ray photons. Those are then traced through the X-ray telescope to the detector.

It takes into account the production probability of axions for each radius of the sun and for each energy of the axion, which is calculated after choosing an axion model as well as a solar model. Following this, the path of the axion - and after conversion in the magnet, the photon - is constricted by the dimensions of the setup. Especially the Wolter I X-ray telescope is looked upon precisely as the reflection needs to be calculated and its transmission probability depends on the incoming angle and the energy of the X-ray.

The ray tracing of solar axions at CAST will be presented step by step.

T 54.6 Wed 17:45 H-HS XV

KWISP - Hunting Chameleons at the CAST Experiment at CERN — •Justin Baier, Horst Fischer, and Marc Schumann — Albert-Ludwigs-Universität Freiburg

The KWISP (Kinetic Weakly Interacting Slim Particle) detector is part of the CAST experiment at CERN exploring the dark sector. It utilizes an ultra-sensitive opto-mechanical force sensor for the search for solar chameleons. Chameleons are hypothetical scalar particles postulated as dark energy candidates, which have a direct coupling to matter depending on the local density. Considering these characteristics a flux of solar chameleons hitting a solid surface at grazing incidence will, under certain conditions, reflect and exert the equivalent of a radiation pressure. To exploit this trait the KWISP sensor consists of a thin and rigid dielectric membrane placed inside a resonant optical cavity. First results have been published and will be presented in this talk. Meanwhile, various detector upgrades have been implemented, which will be discussed as well.

T 54.7 Wed 18:00 H-HS XV

Method to search for axion-like particles (ALPs) in storage rings, demonstrated at COSY — •Swathi Karanth — Instititute of Physics, Jagiellonian University, Cracow, Poland

The axion was originally proposed to explain the small size of CP violation in quantum chromodynamics. It would be light in weight and weakly coupled to nucleons. If sufficiently abundant, it might be a candidate for dark-matter in the universe. Axions or axion-like particles (ALPs), when coupled with gluons, induce an oscillating Electric Dipole Moment (EDM) along the nucleon's spin direction. This can be used in an experiment to search for axions or ALPs using charged particles in a storage ring.

In spring of 2019, at the Cooler Synchrotron (COSY) in Jülich, we

performed a first test experiment to search for ALPs using an in-plane polarized deuteron beam with a momentum of 0.97 GeV/c. If the EDM oscillation due to ALPs is in resonance with the spin precession frequency of the beam, then there is an accumulation of vertical polarization. The experiment involved the development of a beam with four bunches, each with different polarization direction and a long polarization lifetime. This allows the ALP to be detected despite ignorance about the oscillating EDM phase. We scanned a frequency window of 1kHz around the spin precession frequency of 121 kHz. I will talk about the experiment and present the preliminary results.

T 54.8 Wed 18:15 H-HS XV

A Two-Higgs-Doublet Variant of the Standard*Model*Axion *Seesaw*Higgs-Portal-Inflation Model — •Michael Matlis and Andreas Ringwald — Deutsches Elektronen-Synchrotron DESY, Theory Group, D-22603 Hamburg, Germany

The Standard Model (SM) suffers from five shortcomings: Dark Matter, Neutrino masses and mixing, Baryon asymmetry, Strong CP-Problem and Inflation. The latter is regarded as the seeds for structure formation. In this contribution, we introduce the 2hdSMASH (Two-Higgs-Doublet SM*Axion*Seesaw*Higgs-Portal-Inflation) model which aims at giving a complete and unified picture of the universe evolution from the inflationary epoch to today.

T 54.9 Wed 18:30 H-HS XV

The search for axion-like particles within A2 — •Daniel Maurer, Achim Denig, and Lena Heijkenskjöld for the A2-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

A special type of hypothetical pseudo-scalar particles has been postulated in Standard Model extensions to solve the strong CP problem, the so-called axion-like particle (ALP). Additionally, they might be a solution for the puzzle of the anomalous magnetic moment of the muon, as well as a candidate for cold dark matter. By considering ALPs to be dominantly coupling to photons, they can be produced in Primakoff production off a nuclear target, in t-channel photon exchange, and can be searched for in two photon final states.

In this presentation, we discuss a feasibility study of the possibility to detect ALPs within the CB/TAPS setup of the A2 collaboration at MAMI. The experiment uses a Bremstrahlung distributed photon beam with $E_{max} = 1492$ MeV impinging on a fixed target, along with a system of detectors that nearly covers the full solid angle for high precision nuclear experiments. A simulation of the fixed-target particle interaction $\gamma p \to ap \to \gamma\gamma p$ is performed, accounting for a Bremsstrahlung distribution of the incident photon beam together with the Primakoff doubly-differential cross section. The resulting kinematical distributions of the final state particles are investigated to determine the acceptance of the CB/TAPS detector system.

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T 54.10 Wed 18:45 H-HS XV

Searching for ALPs in light-by-light scattering in pp collisions using AFP proton tagging with the ATLAS detector — •Patrick Odagiu[1] and André Sopczak[2] — [1]EPFL Lausanne — [2]IEAP CTU in Prague

The search for an Axion-Like-Particle (ALP) is being performed using about $20\,\mathrm{fb}^{-1}$ data recorded with the ATLAS experiment and the ATLAS Forward Proton (AFP) detector in 2017. The AFP detector is positioned symmetrically at approximately 220 m about the interaction point near the beam pipe and is used to measure the kinematics of surviving protons. The high-mass diphoton spectrum is studied for the search for an ALP mediated by light-by-light scattering. At the current stage of the analysis, the focus is on a 1 TeV ALP with coupling $g = 0.001\,\mathrm{GeV}^{-1}$. Data containing photon information and AFP containers were prepared. The blinding strategy was established, along with the next steps in this search.