New Instruments for Neutrino Relics and Mass

Report of Contributions

https://indico.cern.ch/e/42884

Contribution ID: **0** Type: **not specified**

Coherent target effects for atomic neutrino mass spectroscopy and detection of relic neutrino

Monday 8 December 2008 15:45 (30 minutes)

New experimental method using isolated atoms and molecules
implanted in sold matrix is explained, whose goal is to measure all 3 neutrino masses and the unknown mixing angle along with determination of Majorana or Dirac particle. If the method works, it
is expected to detect the cosmic relic neutrino, too.

Presenter: YOSHIMURA, Motohiko (Okayama University)

Session Classification: Relic Detection

Contribution ID: **1** Type: **not specified**

The electron endpoint from accelerated ions - a new route to the neutrino mass scale?

Monday 8 December 2008 14:00 (25 minutes)

We introduce the possibility of determining the neutrino mass scale from monitoring the decays of a crystalised beam. Through the careful control of the beam momentum, one can perform a 'cut' on the electron spectrum with only electrons near the endpoint traveling backwards in the laboratory frame. The idea is introduced with the results from preliminary simulations presented.

Primary author: ORME, Christopher (Durham University)

Presenter: ORME, Christopher (Durham University)

Session Classification: Theory and Cosmology

Contribution ID: **2** Type: **not specified**

Welcome

Monday 8 December 2008 08:45 (15 minutes)

Welcome and suggest goals for the workshop

Presenter: Dr MCELRATH, Bob (CERN)

Session Classification: Welcome

Contribution ID: **3** Type: **not specified**

Oscillations of Moessbauer neutrinos

Monday 8 December 2008 09:00 (25 minutes)

We discuss the phenomenology of the Mössbauer neutrino experiment
proposed recently by Raghavan. In particular, we will show that Mössbauer neutrinos do oscillate, in
spite of their extremely small energy uncertainty. Using a quantum field theoretical approach, we will compute the combined rate of Mössbauer neutrino production, oscillation and detection, and discuss the arising coherence and localization conditions.

Presenter: Mr KOPP, Joachim (Max Planck Institute for Nuclear Physics)

Session Classification: Experimental Techniques

Contribution ID: **4** Type: **not specified**

One-dimensional ordering in high-energy ion beams

Monday 8 December 2008 09:25 (25 minutes)

A sudden reduction of momentum spread, and under certain conditions also of Schottky-noise power, has been observed with electron-cooled beams at a few ion storage rings. This has been interpreted as an effect of one-dimensional ordering of the beams, such that the ions line up after one another in the ring. A brief overview of subject of beam crystallization or beam ordering is given, and results from observations and measurements of beam ordering at CRYRING in Stockholm are given together with a model of the ordered beam.

Presenter: Dr DANARED, Håkan (Manne Siegbahn Laboratory)

Session Classification: Experimental Techniques

Contribution ID: **5** Type: **not specified**

Contribution of Penning trap mass spectrometry to neutrino physics

Monday 8 December 2008 09:50 (25 minutes)

Penning traps provide nowadays highest sensitivity, precision and accuracy for atomic mass spectrometry [1]. In the combined strong magnetic field and weak electric field of a Penning trap a charged particle can be stored and observed for long time thus frequency comparisons well below ppb can be performed. Different techniques such as non-destructive detection with single ion sensitivity or destructive time-of-flight resonance techniques are available to measure with high resolution the motional frequencies in the trap, yielding the free space cyclotron frequency which is inversely proportional to the charged particles mass.

References
1. K. Blaum, Phys. Rep. 425, 1-78 (2006)
2. Sz. Nagy et al., Europhys. Lett. 74, 404?410 (2006)
3 G. Douysset et al., Phys. Rev. Lett. 86, 4259 - 4262 (2001)
4. M. Suhonen et al., JINST 2, P06003 (2007)
5. M. Redshaw et al., Phys. Rev. Lett. 98, 053003 (2007)

A number of important mass measurements with remarkable precision have been performed for applications in neutrino physics experiments studying beta-decay or searching for neutrinoless double-beta-decay (0nBB) or radiative neutrinoless double electron capture (0n2EC) processes, where the atomic mass of the initial and final state nuclei or the mass difference are a much needed input.

The mass measurement principle will be introduced and the different detection techniques will be compared. The latest advances shall be summarized, new ideas and upcoming experiments will be presented. The talk will cover some of the recent highlights such as the measurement of the 3H-3He mass difference giving the endpoint of the tritium beta-decay with 1.2 eV precision [2], the 76Ge-76Se Q-value of 2039.006(50) keV [3,4] and the 136Xe-136Ba Q-value 2457.83(37) [5].

Presenter: Dr NAGY, Szilard (MPI-K)

Session Classification: Experimental Techniques

Contribution ID: **6** Type: **not specified**

Bounds on sterile neutrinos using full kinematic reconstruction of radioactive decays

Monday 8 December 2008 10:15 (25 minutes)

Current bounds on mixing angles for light (several keV range) sterile neutrinos are rather weak, though theoretically it is a very interesting region. An interesting experimental technique for analysing such neutrinos is full kinematic reconstruction of the nuclear beta decay. This method, in principle, allows an event by event measurement of the neutrino mass, compared to large statistical noise of the kink search in the usual electron spectrum. I'll discuss advantages and problems of this approach.

Presenter: Mr BEZRUKOV, Fedor (MPI fur Kernphysik)

Session Classification: Experimental Techniques

Contribution ID: **7** Type: **not specified**

The MARE project: the calorimetric approach potential

Monday 8 December 2008 11:10 (30 minutes)

The international project "Microcalorimeter Arrays for a Rhenium Experiment" (MARE) aims at a direct and calorimetric measurement of the electron antineutrino mass with sub-electronvolt sensitivity.

The experimental strategy consists in analysing the beta spectrum of 187Re near the end-point looking for the spectral distortion expected for a finite antineutrino mass. In these experiments the detectors are thermal calorimeters with absorbers made of rhenium or of one of its compounds. Therefore the beta decay source is internal to the sensitive detector removing the most severe systematic uncertainties which have plagued the traditional and, so far, more sensitive spectrometers. In the final experimental phase, large arrays with as many as 10000 detectors each will be realized. At least five arrays will be then deployed to collect the statistics required to probe the antineutrino mass with a sensitivity of at least 0.2 eV, comparable to the one expected for the Katrin experiment.

In this talk I would like to give an update on the status of the MARE experimental activity and their prospects. I will then discuss the results of a detailed study of the sensitivity achievable with the calorimetric approach.

Presenter: NUCCIOTTI, Angelo (INFN Milano-Bicocca / Dip. di Fisica U. di Milano-Bicocca)

Session Classification: Existing Experiments

Contribution ID: **8** Type: **not specified**

Orbital electron capture decay of hydrogen-like ions (GSI)

Monday 8 December 2008 11:40 (30 minutes)

At GSI Darmstadt, we have studied the decay of highly-charged heavy ions, stored and cooled in the experimental storage ring, ESR, by means of time-resolved Schottky-noise mass spectroscopy. The Fast Fourier Transform, FFT, of the Schottky noise is a non-destructive, non-instantaneous detection method, sensitive to a single heavy ion circulating in the ring. We have focused our interest on the two-body orbital electron capture decay of hydrogen-like ions, and have developed a method that allows us to identify unambiguously the decay channel and the decay time by observing both the parent and the daughter ions. We have investigated the decay of small numbers of particles stored and cooled in the ring, and we have observed deviations from the expected exponential decay of 140 Pr and 142 Pm ions [1]. In this contribution, I will concentrate on the motivation, on the method, and on the experimental findings of these studies.

Presenter: Dr KOZHUHAROV, Christophor (GSI)

Session Classification: Existing Experiments

Contribution ID: **9** Type: **not specified**

The Karlsruhe Tritium Neutrino Experiment KATRIN

Monday 8 December 2008 12:10 (30 minutes)

The KArlsruher TRItium Neutrino experiment KATRIN is going to search for the neutrino mass from the endpoint region of the tritium beta decay spectrum with one order of magnitude higher sensitivity of 0.2 eV/c2 compared to previous direct neutrino mass experiments. This sensitvity will allow to distinguish between hierarchical and quasi-degenerate neutrino mass scenarios as well as to investigate the whole cosmological relevant neutrino mass range.

The KATRIN experiment is currently being set up at Forschungszentrum Karlsruhe/Germany by an international collaboration. The key elements of KATRIN are a windowless gaseous molecular tritium source with an ultra-high luminosity and which minimizes systematic uncertainties, a very effective tritium retention and electron guiding system, the 23m long and 10m diameter main spectrometer of MAC-E-Filter type, and an electron detector. This setup allows to measure the tritium beta spectrum with unprecedented signal rate and energy resolution of 0.93eV. The scientific context, the present status of KATRIN, its technical challenges and a discussion on KATRIN`s systematics and sensitivity will be presented.

Presenter: Prof. WEINHEIMER, Christian (University of Münster, Germany)

Session Classification: Existing Experiments

Contribution ID: **10** Type: **not specified**

Measuring the neutrino mass from large scale structure

Monday 8 December 2008 14:25 (25 minutes)

Future large scale structure surveys provide one of the most promising techniques for probing the neutrino mass. I will present results from detailed N-body simulations of structure formation in models with neutrino mass. Such simulations are necessary for the next generation of surveys such as the LSST

Presenter: Prof. HANNESTAD, Steen (University of Aarhus)

Session Classification: Theory and Cosmology

Contribution ID: **11** Type: **not specified**

The GSI anomaly and neutrino mixing

Monday 8 December 2008 14:50 (25 minutes)

It will be shown why the GSI anomaly can in principle not be due to neutrino mixing.

Presenter: Prof. LINDNER, Manfred (Max Planck Institut fuer Kernphysik)

Session Classification: Theory and Cosmology

Contribution ID: **12** Type: **not specified**

Relic neutrino detection using beta decaying nuclei

Monday 8 December 2008 16:40 (25 minutes)

We present a study on the interaction of low energy electron neutrinos on nuclei that undergo both beta decay and electron capture. We show that, due to the absence of an energy threshold and to the relatively high value of the cross section, these processes are the only ones to date having a realistic chance to unambiguously detect the yet undiscovered cosmological relic neutrino background.

Presenter: Dr COCCO, Alfredo Giuseppe (Istituto Nazionale di Fisica Nucleare)

Session Classification: Relic Detection

Contribution ID: **13** Type: **not specified**

Experimental challenges towards the detection of relic neutrinos with unstable nuclei

Monday 8 December 2008 17:05 (25 minutes)

In this talk I will review the experimental challenges towards the detection of relic neutrinos. The talk is based on a paper where the idea of detecting relic neutrinos with instable nucli is renewed. Different target nucli and experimental approaches are considered and, the advantage and the difficulties of different experimental techniques are discussed.

Presenter: Dr MESSINA, Marcello (University of Bern)

Session Classification: Relic Detection

Contribution ID: **14** Type: **not specified**

Emergent Electroweak Gravity

Monday 8 December 2008 16:15 (25 minutes)

We show that the cosmic neutrino background is a superfluid today, and the quantum numbers of the order parameter give a goldstone graviton, with a coupling numerically similar to the actual Newton's constant.

Presenter: Dr MCELRATH, Bob (CERN)

Session Classification: Relic Detection