XIIth Rencontres du Vietnam

Quy Nhon, Vietnam

July 31st - August 7th 2016

High Sensitivity Experiments Beyond the Standard Model

PRACTICAL INFORMATION

GENERAL INFORMATION

Registration

The registration for all participants will take place at 14:30 on Sunday July 31st at Seagull Hotel. Please register as soon as you arrive at the hotel, fill in an ARRIVAL FORM and hand it to the conference secretaries.

All payments must be completed by Tuesday evening. The accommodation will be paid to the conference secretariat and not directly to the hotel. Our conference secretariat office is located at ICISE, open from 8:15 to 12:30 and from 13:30 to 17:30.

Welcome Cocktail

All participants, their families and guests are invited to a welcome drink at 19:00 on Sunday July 31st at Seagull Hotel followed by a buffet dinner at 19:30.

Khách Sạn Hải Âu - Seagull Hotel
489 An Dương Vương
Quy Nhơn, Bình Định
Phone: +84 563 846 377

Meals

• All meals are served either at Seagull hotel or at ICISE Center. **You will need the daily coupon provided to you at registration time.**

• For the beverage, if you wish order alcoholic or soft drinks, it will be charged to your hotel account. If you are sharing a room, please find an arrangement with your room mate for both your telephone and beverage bills.

• ***Breakfast*** will be served at Seagull hotel.

• ***Lunch*** for the participants will be served at ICISE. For accompanying persons, lunch will be served at **Seagull hotel from 12:30 to 13:00. Please note that lunch service will end at 13:15**. If you wish to have lunch at Seagull hotel, please inform us one day before.

• Dinner: all participants and their families take the dinner at Seagull hotel at 19:00, with a few exceptions to be announced.

• Please let us know your preference (vegetarian, vegan ...) so that we can inform the hotel and please mention it to the waiters at the restaurant.

• In any case, **please bring along with you your meal coupons**, provided to you at registration time.

The conference center

The conference center is located at ICISE (International Center for Interdisciplinary Science and Education):

Trung tâm quốc tế Khoa học và Giáo dục liên ngành (ICISE)

Address: Quốc lộ 1 D, Khu vực 2, phường Ghềnh Ráng, Thành phố Quy Nhơn, tỉnh Bình Định, Việt Nam

Phone Nummber: (+84) 563 354 0099

Bus shuttle from/to Hotel or ICISE

There is shuttle bus between Seagull hotel and the conference center

- *From Hotel to ICISE:*

  The first bus departure from Seagull hotel to ICISE is at 7:30. The last one is at 8:00.

- *From ICISE to Seagull hotel:*

  The first bus back to hotel is at 17:30 and the last one is at 18:30.

Conference banquet

Will be held at 7:00 pm on Thursday 04 August 2016 at ICISE. Bus from hotel to ICISE for accompanying persons at 18:15.

USEFUL INFORMATION

• *Internet:* WIFI is available at the hotel as well as ICISE. Password is ICISE20130812 for guests.

• *Beach time:* There will be sufficient time for swimming during lunch time so bring along your towel and bathing suit if you want to swim.

• *Telephone:* If you share a room, please keep track of your calls because there is only one telephone per room and the billing is done for each room. Telephone bills should be settled before you leave.

• *Wifi on street:* If it happens that you need internet on street somewhere, you can go to any small cafe for a cup of coffee and ask for wifi password.

• *Prepaid Mobile phone and 3G internet SIM card:* Prepaid sim card for phone and internet data is relative cheap in Vietnam. Vina-phone, Mobilfone and Viettel are three phone and internet providers who provide the Tourist SIM which cost around 200000 VND or 10 USD. These tourist SIM offers you around 50 minutes international call, 100 minutes domestical call, free text messages, 3G internet connection (depending on the provider).

These SIM cards can be bought at the airport, electronic or phone shops.

Please check the detail here:

http://www.mobifone.com.vn/wps/portal/public/goi-cuoc/theo-doi-tuong/happy-tourist

http://www.vietteltelecom.vn/mobile.php/chi-tiet-dich-vu/tourist-goi-cuoc-danh-cho-khach-du-lich

http://www.3gvinaphone.pro.vn/2016/07/tourist-sim-vinaphone.html

• *Banking facilities* Exchange currency service is available at the hotel reception, local bank branches or any jewellery shops. ATM machines can be found next to the Seagull hotel.

• *Pick-up from the airport on Sunday July 31st*: For the arrival in Quy nhon on Sunday July 31st, there will be a transfer by bus from the airport to Seagull hotel for the participants and their families for registration. There will be a welcome team at the airport at the arrival of all flights from HCM and Hanoi. A desk with ICISE staff members is planned in the luggage arrival room. The luggage arrival room is very small so you will not miss it. Please try to find the table with ICISE name tag.

• *Drop-off to the airport on Saturday August 06th*: For the departure from Seagull hotel to the airport on Saturday August 6th, there will be a transfer by bus.

Please contact the conference secretaries for a taxi transfer. The transfer cost will be at your charge.

DON'T FORGET TO GET BACK YOUR PASSPORT AT THE HOTEL RECEPTION DESK BEFORE YOU LEAVE!

• ***Special announcements:*** A paperboard will be at the Secretaries office in ICISE. For accompanying persons, a paper board will be at the hotel reception hall. Please check it regularly. Information about entertainement and sight-seeing for accompanying people is displayed on this board.

Urgent and emergency contacts

You can call us any time if you have any emergency request including pick up, medical help...

Betty Binh: +84 9473 175 27

Thao Ly: +84 1683 063 008

Seagull Hotel: +84 563 846 377

GENERAL PROGRAM

Sunday July 31St	Registration Seagull Hotel	15h00-19h00
	Welcome drink Seagull hotel	19h00
Monday Aug. 1st		
Welcome		***9h-9h15***
Josh Long	The search for exotic sub-millimeter range forces	9h15-10h15
break		***10h15-10h30***
Yoshio Kamiya	Fifth force search with neutron scattering	10h30-11h15
Guillaume Pignol	Probing Dark Energy Models with Neutrons	11h15-12h00
Lunch		***12h30-14h***
Eberhard Widmann	Prospects of in-flight hyperfine spectroscopy of (anti)hydrogen for tests of CPT symmetry	14h-15H00
Sebastian Gerber	Antimatter Gravity Measurement with Cold Antihydrogen The AEGIS Experiment	14h45-15h30
Shabana Nisar	Forward-backward asymmetry in top production through z' bosons	15h30-16h15
break		***16h15 - 16h30***
Nicolas Leroy	First detection of a black hole merger with gravitational wave	16h30 - 17h30
Tuesday Aug. 2nd		
Anna Hayes-Sterbenz	The Neutrino Anomalies	9H-10h00
Luca Stanco	Sterile Neutrino searches: a challenge forehead the Standard Model.	10h00-10h45
break		***10h30-10h45***
Benoit Guillon	Status of the SOLID Experiment	10h45-11h30
Jacob Lamblin	The Stereo experiment: search for a sterile neutrino.	11h30-12h15
Lunch		***12h15-14h***
Takatochi Aoki	Light shifts induced by atomic parity nonconserving transitions in ultracold Fr for probing physics beyond the Standard Model	14h-14h45
Stephanie Roccia	EDM and Radioactive Nuclei	14h45-15h30
break		***15h30-15h45***
Aiko Uchiyama	EDM Francium	15h45-16h30
Malika Denis	eEDM with Molecules	16h30-17h15
Wednesday Aug. 3rd		
Peter Geltenbort	Research with very cold and ultra-cold neutrons at the Institut Laue Langevin in Grenoble	9h-10h
break		***10h00-10H30***
Philipp Schmidt-Wellenburg	Search for the neutron electric dipole moment using ultra cold neutrons at PSI	10h30-11h15
Takeyasu Ito	Fundamental physics with Ultracold Neutrons in the U.S.	11h15-12h00
EXCURSION	TBA	14h00
Thursday Aug. 4th		
Niels Gresnigt	Applications of quantum groups to standard model phenomenology	***9h-9h45***
Dominique Durand	Double beta decay and the SuperNEMO project	9h45-10h30
break		***10h30-10h45***
Angela Romano	Search for K+->pi+nunu and exotics at NA62	10h45-11h30
Makoto Miura	Nucleon Decay Searches in Super-Kamiokande	11h30-12h15
Lunch		***12h15-14h***
Sotahro Kanda	Muonium	14h-14h45
Kim Siang Khaw	Muon Anomalous Magnetic Moment	14h45-15h30
break		***15h30-15h45***
Benjamin Krikler	Comet	15h45-16h30
Michael Hasinoff	TREK	16h30 17h15
CONFERENCE DINER	ICISE	19H00
Friday Aug.5th		
Oscar Naviliat-Cuncic	Measurements of beta energy spectra in nuclear beta decay	9h-10h00
Leendert Hayen	Beta Spectrum	10h00-10h45
break		***10h45-11h00***
John Hardy	Super Allowed Nuclear Beta Decay Testing CVC and CKM	11h00-12h00
Pierre Delahaye	D correlation measurement in the b decay of trapped and polarized ions	12h00-12h45
Lunch		***12h45-14h***
Dan Melconian	Probing fundamental symmetries via precision correlation measurements of beta decay	14h00-14h45
Phillipe Velten	Measurement of the β Asymmetry Parameter in 35Ar Decay with a Laser Polarized Beam	14h45-15h30
Oscar Naviliat-Cuncic	Concluding remarks	15h30-16h15

MONDAY AUGUST 1ST, 2016
Gravity, Fifth Forces, Anti Matter

9h15-10h15 **Pr. Josh Long,** *Indiana University Physics Department, Bloomington, Indiana, USA.*

The search for exotic sub-millimeter range forces.

Many theoretical models of the most profound unexplained phenomena in the universe predict modifications to the inverse square law of gravity at sub-millimeter length scales, yet this law has not been tested below 50 microns and there could be forces of nature millions of times stronger than gravity acting at this range. Following a general introduction, I describe a series of experiments sensitive to both mass-coupled and spin-coupled forces in the sub-millimeter range, with emphasis on experiments using macroscopic test masses. The sensitivity of these experiments is projected to cover much of the parameter space for predictions of forces beyond gravity and electromagnetism in the range of interest.

10h15-10h30 ***Coffee Break***

10h30-11h15 **Dr. Yoshio Kamiya,** *International Center for Elementary Particle Physicsand Department of Physics, Komamiya-group, The University of Tokyo, Japan.*

We report on new experimental constraints on gravity-like fifth forces by measuring the angular distribution of cold neutrons scattering off atomic xenon gas. The results improve previous upper limits on Yukawa-type parametrization space in the 4 to 0.04 nm range by a factor of up to 10, which was published in PRL 114, 161101 (2015). In this presentation, we also discuss about our new plans of experiments to test the equiv. principle at shot ranges.

11h15-12h00 **Pr. Guillaume Pignol,** *Laboratoire de Physique Corpusculaire et de Cosmologie, Université Grenoble Alpes, Grenoble, France.*

Probing Dark Energy Models with Neutrons.

The accelerating expansion of the universe has been recently discovered and confirmed. It is one of the most puzzling observation of modern cosmology: 70% of the energy budget of the Universe today has to be attributed to a completely unknown type of Dark Energy. One theoretical route to address this problem is to assume the existence of a cosmological scalar field, the quintessence, with nontrivial dynamics. If this quintessence field is coupled to ordinary matter particles, it would also mediate a fifth fundamental force displaying very unusual properties.
In particular, the force between macroscopic bodies is screened: this is the chameleon mechanism. Experiments with neutrons can alleviate the chameleon mechanism and reveal the new scalar field. I will discuss two experimental ways to probe the chameleon with neutrons :

(i) neutron interferometry: a recent experiment performed with a neutron interferometer at the Institut Laue Langevin that sets already interesting constraints.
(ii) bouncing ultracold neutrons: chameleons can be probed by measuring the quantum states of neutrons bouncing over a mirror. I will present the status of the GRANIT experiment at the ILL.

12h00-14h00 ***Lunch***

14h00-15h00 **Pr. Eberhard Widmann,** *Stefan Meyer Institute for Subatomic Physics, Austrian Academy of Sciences, Vienna, Austria.*

Prospects of in-flight hyperfine spectroscopy of (anti)hydrogen for tests of CPT symmetry.

A measurement of the ground-state hyperfine structure (GS-HFS) of antihydrogen can become one of the most sensitive tests of CPT symmetry on an absolute scale due to the fact that it is a small quantity on the energy scale and can be measured to very high precision. For this reason the ASACUSA collaboration at the Antiproton Decelerator of CERN has chosen to perform a measurement of GS-HFS using a polarized antihydrogen beam. A major mile stone towards a hyperfine measurement was the first observation of a beam of antihydrogen atoms produced ina so-called CUSP trap in a field-free region by ASACUSA.

Similar arguments regarding the absolute sensitivity of CPT tests have been brought forward by A. Kostelecky et al. within their Standard Model Extension (SME). Their model is based on Lorentz-invariance violation and also has consequences for the GS-HFS of ordinary hydrogen, notably sidereal and annual variations, which have been tested using hydrogen masers to high precision. In a recent extension to the non-minimal SME, further coefficients are found that depend on the orientation of the applied static magnetic field in the laboratory for some of the observable HFS transitions.
ASACUSA has used the hyperfine spectrometer line originally developed for antihydrogen spectroscopy with a source of cold polarized hydrogen atoms and measured the (F=1, M=0) to (0,0) transition to few ppb and plans to extend the measurements to the (F=1, M=1) to (0,0) transition which - within the SME - is sensitive to Lorentz and CPT violation. This talk discusses the results and prospects of in-beam GS-HFS measurements using the ASACUSA apparatus in both hydrogen and antihydrogen.

14h45-15h30 **Dr. Sebastian Gerber,** *CERN, Geneva, Switzerland.*

Antimatter Gravity Measurement with Cold Antihydrogen The AEGIS Experiment.

Antimatter experiments conducted at the Antiproton Decelerator (AD) at CERN address the fundamental questions why primordial antimatter is not observed in the present universe. The AEgIS collaboration aims at performing tests of the weak equivalent principle (WEP) by measuring the gravitational acceleration of antihydrogen atoms in the Earth's gravitational field that are horizontally emitted from a Penning trap. The antihydrogen atoms will be produced via resonant charge exchange of Rydberg positronium and antiprotons at temperatures potentially determined by the recoil limit of the constituents. To prepare an ensemble of cold antihydrogen with a narrow velocity spread we plan to extend the existing electron cooling mechanism of antiprotons by laser-cooling techniques of negative C2- molecules in a Penning trap in order to sympathetically cool antiprotons to the mK regime. The generation of cold antihydrogen atoms can ultimately also be used for precision spectroscopy experiments of electromagnetic interaction as a test of CPT symmetry.
In this presentation the status of the AEgIS experiment and the feasibility of sympathetic cooling using C2- molecules will be reviewed.

15h30-16h15 **Dr. Shabana Nisar,** *COMSATS Institute of Information Technology, Lahore, Pakistan.*

There are only a few experimental hints towards deviation from standard model and one such example is top quark's asymmetry that can lead us to physics beyond Standard Model. We consider one phenomenological model containing an extra neutral boson to characterize the new physics that may be responsible for this deviation. We estimate the amount of this asymmetry in this model. this model capture some generic effects of alarge number of theories such as Technicolor and Little Higgs Mode.

16h15-16h30 ***Break***

16h30-17h30 **Dr. Nicolas Leroy,** *Laboratoire de l'accélérateur linéaire d'Orsay, Orsay, France*.

First detection of a black hole merger with gravitational wave.

On September 14 2015 the two LIGO detectors registered at almost the same time an event consistent with gravitational wave emission by the merger of two black holes. The reconstructed waveform of the signal shows that the system was located at a distance of approximately 400 Mpc, with constituent masses of 36 and 29 M_sun. The final object is consistent with a mass of 62 M_sun and then revealed that an estimated 3 M_sun was radiated in gravitational wave emission.
This detection, 100 years after its theoretical prediction and after 50 years of experimental quest, opens a new way to observe powerful astrophysical sources. In this talk I will describe shortly the detectors and the main information we obtain from this observation.

TUESDAY AUGUST 2ND, 2016
A. Neutrinos

9h00-10h00 **Dr. Anna Hayes-Sterbenz,** *Los Alamos National Laboratory, Los Alamos, New Mexico, USA.*

The Neutrino Anomalies.

The neutrino anomalies generally refer to the hints from appearance and disappearance experiments for eV-scale neutrinos. In the 1990s, the LSND experiment reported a neutrino appearance oscillation signal that, when viewed together with the solar and atmospheric neutrino oscillation experiments, is in conflict with the Standard Model expectation of three neutrino flavors. The follow-on experiment to LSND, MiniBooNE, reported inexplicable excess events at low energies, but not at high energies. More recently, two additional low-energy neutrino disappearance anomalies have been reported. These are the Reactor anomaly, in which the number of observed reactor antineutrinos is fewer than expected in all short-baseline experiments, and the Gallium anomaly, in which the number of neutrinos from radioactive sources detected in gallium detectors is fewer than expected. If these anomalies are neutrino oscillation phenomena, they require the existence of ~1eV sterile neutrinos that do not interact via the normal Standard Model electroweak interaction. In this talk I review the current neutrino anomalies. I discuss the uncertainties involved and possible standard model explanations, with an emphasis on the Reactor anomaly. Finally, I will briefly summarize the needs for and the planned new very short-baseline experiments designed to confirm or refute the existence of sterile neutrinos.

10h00-10h45 **Dr. Luca Stanco,** *INFN Padova, Padova, Italy.*

Sterile Neutrino searches: a challenge forehead the Standard Model.

Despite a long history the sterile neutrino issue is still currently a very open issue. On top of the incredible window it could be open by its discovery, it constitutes a demanding part for the assessment of a neutrino global picture. Through the presentation of the different results collected so far, in particular at the eV mass scale, a critical illustration of what has to be expected in the near future is given.

10h30-10h45 ***Coffee Break***

10h45-11h30 **Pr. Benoit Guillon For the SOLID Collaboration,** *Laboratoire de Physique Corpusculaire de Caen, Caen, France.*

Status of the SOLID Experiment.

The aim of the SoLid experiment is to provide the precise measurement of the anti-neutrino energy spectrum from a highly enriched uranium reactor, and then,

perform sensitive search for short baseline neutrino oscillation. The objectives are to resolve the reactor neutrino anomaly and to test in fine the light sterile neutrino hypothesis. For this purpose, the SoLid collaboration are using a novel, highly segmented, composite scintillator detector design to measure the anti-neutrino energy spectrum between 5 and 10 m from a compact reactor core. This project is driven by an international collaboration gathering 11 institutes and about 55 physicists. These measurements will be performed over the next five years at the BR2 reactor at SCK-CEN in Mol, Belgium. The collaboration already built and deployed a small 288 kg module of the detector at the BR2 reactor. Its purpose was to demonstrate the effectiveness of using the detector's novel design in selecting the inverse beta decay events from the high rate of backgrounds events. The detector module was operational during the February 2015 BR2 reactor cycle. After a short review of the detector design, this talk will present the preliminary results of this successful data taking. It will ended with the presentation of the SoLid Phase I scheduled to begin at the end of this year.

11h30-12h15 **Dr. Jacob Lamblin,** *Laboratoire de Physique Corpusculaire et de Cosmologie, Université Grenoble Alpes, Grenoble, France.*

The Stereo experiment: search for a sterile neutrino.

Past experiments have observed deficits of neutrinos that could be explained by the existence of a sterile neutrino. The Stereo experiment will search for an oscillation at short distance from the reactor of the Institut Laue-Langevin in France. After introducing the motivations and the experiment, the first results of the detector characterization will be presented. The sensitivity to the sterile neutrino will be then discussed.

12h15-14h00 ***Lunch***

B. Parity Violation, EDMs

14h00-14h45 **Dr. Aoki Takatochi,** *The University of Tokyo Institute of Physics Tokyo, Japan.*

Light shifts induced by atomic parity nonconserving transitions in ultracold Fr for probing physics beyond the Standard Model.

The two sources of parity nonconservation (PNC) in atomic systems are the neutral current weak (NCW) interactions due to the exchange of the Z boson between the nucleus and the electrons and the nuclear anapole moment. The NCW interactions can give rise to nuclear spin independent (NSI) as well as nuclear spin dependent (NSD) PNC, while the interaction of the nuclear anapole moment with the electrons results in PNC of only the NSD kind. NSI PNC is a probe of new physics beyond the Standard Model and NSD PNC from the nuclear anapole moment provides important information about PNC in nuclei.

We report precise calculations of NSI and NSD PNC transition amplitudes of Fr atom, and the detection scheme of this effect as light shifts induced by E2 and PNC-E1 transitions using ultracold Fr atom [2]. We consider the light shifts for all the magnetic sublevels, which are determined by angular factors for E2 and PNC E1 transitions [3]. These light shifts will be useful to experimentally study the NSI PNC in Frin CYRIC, Tohoku University in the near future to probe new physics beyond the Standard Model.

[1] C. S. Wood, S. C. Bennett, D. Cho, B. P. Masterson, J. L. Roberts, C. E. Tanner, and C. E. Wieman, Science 275, 1759 (1997).
[2] B. K. Sahoo, T. Aoki, B. P. Das, and Y. Sakemi, Phys. Rev. A 93, 032520 (2016).
[3] T. Aoki et al., to be submitted.

14h45-15h30 **Pr. Stephanie Roccia,** *Centre de Sciences Nucléaires et de Sciences de la Matière Orsay, France.*

EDM and Radioactive Nuclei.

Many systems are used to search for a non-zero electric dipole moment such as atoms, molecules or neutron. The existence of static T-odd and P-odd moments of a nucleus can arise from T and P violating nucleon-nucleon interactions. Measuring the EDM of an atom, the sensitivity on those interactions depends on the nuclear structure. In particular pear-shaped nuclei are predicted to be good candidates.

15h30-15h45 ***Coffee Break***

15h45-16h30 **M. Aiko Uchiyama,** *Cyclotron and Radioisotope Center (CYRIC), Tohoku University Sendai, Myagi, Japan.*

Permanent electric dipole moments (EDMs) of elementary particles are good candidates to search for the combined charge conjugation and parity symmetry (CP) violation. At the Cyclotron and Radioisotope Center at Tohoku University, an experiment to search for the EDM of the electron using francium (Fr) atoms is promoted. The progress and the present status of the facility will be presented.

16h30-17h15 **Ms. Malika Denis,** *Laboratoire de Chimie et Physique Quantiques, Université Paul Sabatier, Toulouse, France.*

Polar diatomic molecules such as ThO and ThF+ are promising systems in the search of the electron Electric Dipole Moment, a possible probe of new physics beyond the Standard Model.
We employ a relativistic 4-component Configuration Interaction approach to obtain the theoretical input needed by the eEDM
experiment (Eeff) as well as other P and T- odd properties and the hyperfine interaction constant A|| calculated as expectation values over the wavefunction of the 3Δ1 state of the eEDM molecules.

WEDNESDAY AUGUST 3RD, 2016
Neutron EDM

9h00-10h **Dr. Peter Geltenbort,** *Institut Laue Langevin, Grenoble, France.*

Research with very cold and ultra-cold neutrons at the Institut Laue Langevin in Grenoble.

Due to their outstanding property to be storable and hence observable for long periods of time (several hundreds of seconds) in suitable material or magnetic traps, ultra-cold neutrons (UCN) with energies around 100 neV are an unique tool to study fundamental properties of the free neutron, like its beta-decay lifetime, its electric dipole moment and its wave properties. The search for the electric dipole moment (EDM) of the neutron plays a prominent role in particle physics because of its direct bearing on CP and T violation: a non-zero value of the neutron EDM would be evidence of CP and T violation. Precision measurements of the neutron lifetime provide stringent tests of the standard electroweak model as well as crucial inputs for tests of Big-Bang nucleosynthesis. Neutron lifetime can be related to CKM Matrix unitarity. Neutron lifetime also dominates the uncertainty in theoretical calculation of primordial 4He. After the observation of quantum states of UCN in the gravitational potential of the Earth, a new powerful resonance spectroscopy technique has been established. It allows precision experiments as tests of the equivalence principle and Newton's gravity law at the micrometre scale. In this talk, the ILL will be briefly introduced before recent ILL experiments linked to these fundamental questions are presented and a brief outlook is given.

About the speaker :
Peter W.H. Geltenbort received a Ph D from the University of Tuebingen, Germany, in 1983. He joined the Nuclear and Particle Physics (NPP) College at the ILL in 1983 responsible for a fission fragment spectrometer. From 1989 to 1993 he held the position of Head of the Detector Group. In 1993 he reintegrated into the NPP College responsible for the Ultra-Cold Neutron/Very Cold Neutron facilities at the ILL. His current research interests are the fundamental properties of the neutron

10h-10H30 ***Coffee Break***

10h30-11h15 **Dr. Philipp Schmidt-Wellenburg,** *Paul Scherrer Institut, Villigen, Switzerland.*

Search for the neutron electric dipole moment using ultra cold neutrons at PSI.

Why is there so much matter and so little anti-matter observed in our Universe? One necessary condition to create a matter/antimatter asymmetric universe from symmetric starting conditions is a sufficient strong source of charge/parity violation (CPV) in the fundamental physics describing the early universe. A discovery of a nEDM value larger than the SM prediction (≤1E-31 *e*cm) would be the indication for a yet unknown source of CPV and might help to explain the matter/anitmatter asymmetry of the Universe, or shed light on to the strong CP problem.

At the Paul Scherrer Institute (PSI) in Switzerland a collaboration of 14 institutions is searching for the nEDM using ultracold neutrons (UCN). We intend to improve the current upper limit by the RAL/Sussex/ILL collaboration, d_n< 3E-26 *e*cm @90% C.L. [J.M. Pendlebury *et al*. PRD 92, 092003 (2015)], by using the same but improved and upgraded spectrometer connected to the solid-deuterium-based UCN source. In my talk I will present the current status of data-taking and will discuss the most relevant challenges on the path to a new limit.

11h15-12h00 **Dr. Takeyasu It,** *Los Alamos National Laboratory, Los Alamos, New Mexico, USA.*

Fundamental physics with Ultracold Neutrons in the U.S.A.

Ultracold neutrons (UCNs) are defined operationally to be neutrons of sufficiently low kinetic energies that they can be confined in a material bottle, corresponding to kinetic energies below about 340 neV. UCNs are playing increasingly important roles in the studies of fundamental physical interactions. There is an active research program of research using UCNs in the US. In this talk, I will give an overview of the fundamental physics with Ultracold Neutrons in the U.S.

12h00 ***Lunch***

14h00 ***Excursion***

THURSDAY AUGUST 4th 2016
A. Neutrinos

9h-9h45 **Dr. Niels Gresnigt,** *Xi'an Jiaotong-Liverpool University, Suzhou, Jiangsu, China.*

Applications of quantum groups to standard model phenomenology.

Replacing the classical groups in the Standard Model (SM) by their quantum group counterparts is motivated from the consideration of both Lie and Hopf type (quantisation) deformations. A quantisation deformation deforms the universal enveloping algebra of a Lie algebra into a quantum group.

Taking the quantum group SUq(3) as a flavor symmetry, including second order symmetry breaking and considering electromagnetic contributions, we derive q-deformed octet and decuplet baryon mass relations accurate to 0.02% and 0.08% respectively as well as a new relation between the octet and decuplet masses accurate to within 1.0%.

As gauge groups, quantum groups introduce additional degrees of freedom suggestive of non-locality, forming the basis of a soliton theory of massive particles. A similar approach in the literature where particles are described as braids has led to the idea that the SM is emergent from quantum spacetime.

Further applications of quantum groups to Cabibbo mixing, and neutrino oscillations are discussed.

9h45-10h30 **Dr. Dominique Durand,** *Laboratoire de Physique Corpusculaire de Caen, Caen, France.*

Double beta decay and the SuperNEMO project.

The talk is an introduction to the study of double beta decay. It will discuss the present status of the dedicated experiments and will briefly introduce the SuperNEMO project.

10h30-10h45 ***Coffee Break***

B. Rare Decays, Precision Muon Experiments

10h45-11h30 **Dr. Angela Romano,** *School of Physics and Astronomy, University of Birmingham Edgbaston, Birmingham, United Kingdom.*

Search for K+->pi+nunu and exotics at NA62.

The K+->pi+nunu decay is one of the theoretically cleanest meson decay where to look for indirect effects of new physics complementary to LHC searches. The new experimental setup used by the NA62 experiment at CERN SPS since 2014 is designed to measure the branching ratio of this decay with 10% precision. NA62 took data with the new setup in 2014, 2015 and 2016. The quality of data acquired in view of the final measurement will be presented. Prospects for other rare and forbidden decays and exotic processes will also be reviewed.

11h30-12h15 **Pr. Makoto Miura,** *Kamioka Observatory, ICRR, University of Tokyo, Hida, Japan.*

Nucleon Decay Searches in Super-Kamiokande.

One of general feature of Grand Unified Theories (GUTs) is their prediction of the instability of nucleons by baryon number violating decays. Therefore, nucleon decay search is one of keys to open new door beyond the Standard Model.The Super-Kamiokande detector is the best detector to search for nucleon decays. In this talk, I'll report the latest results from Super-Kamiokande.

12h15-14h00 ***Lunch***

14h-14h45 **M. Sotahro Kanda,** *The University of Tokyo,Tokyo, Japan.*

Muonium is a hydrogen-like atom consisting of a positive muon and an electron. Precision spectroscopy of its ground state hyperfine splitting (HFS) is the most rigorous test of bound-state QED and the most precise determination of the muon mass. At J-PARC, MuSEUM collaboration intends to improve the precision of muonium HFS by one order of magnitude relatively to the most recent experiment. In this talk, experimental overview and preliminary result of the first physics-run are to be reported

---

14h45-15h30 **Dr. Kim Siang Khaw,** *Physic Department, Physics and Astronomy, University of Washington, Seattle, USA.*

The new Muon g-2 experiment (E989) at Fermilab aims to measure the anomalous magnetic moment of muon, a_μ, to an unprecedented precision of 140 parts per billion. The basic principles of the experiment are to store a muon beam in a ring magnet and to detect the decay positrons with calorimeters installed around the ring. Two key values needed for the extraction of a_μ are the anomalous precession frequency of muon ω_a in the magnet and the average magnetic field experienced by the muon beam. An overview of how we measure these two values will be presented.

15h30-15h45 ***Coffee Break***

15h45-16h30 **M. Benjamin Krikler,** *Imperial College London, London, United Kingdom.*

Observing Charged Lepton Flavour Violation would be a clear sign of physics Beyond the Standard Model. The COMET experiment is one of a handful hoping to measure such a process with an intense muon beam. COMET will search for COherent Muon to Electron Transitions, where a muon converts to an electron in the presence of an atomic nucleus without neutrino emission.

Currently under construction at J-PARC, Japan, Phase-I is set to start data-taking in JFY 2018 and should improve the current limits on mu-e conversion by two orders of magnitude. Phase-II should then follow in the early 2020s and push the sensitivity by a further two orders of magnitude. In this talk I present an overview of the experiment design and the current status of preparations for Phase-I running.

16h30 17h15 **Pr. Michael Hasinoff,** *Dept of Physics & Astronomy University of British Columbia Vancouver, Canada.*

The TREK (E36) collaboration has performed a precision measurement of the branching ratio, RK = Γ(K+ → e+ + νe)/Γ(K+ → μ+ + νμ) to test lepton universality and search for new physics beyond the Standard Model(SM). The SM prediction is extremely precise, (2.477 ± 0.001) × 10−5, and any deviation from this value would clearly indicate the existence of New Physics beyond the SM. A recent SUSY calculation allows a shift from the SM value up to the % level.

19h00 ***Conference Diner***

FRIDAY AUGUST 5th, 2016
Beta Decay

9h-10h00 **Pr. Oscar Naviliat-Cuncic,** *National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East-Lansing, Michigan, USA.*

Measurements of beta energy spectra in nuclear beta decay.

Precision measurements in neutron and nuclear decays have played a crucial role in the development of the vector-axial-vector (V-A) theory of the weak interactions, which is contained today in the standard electroweak model (SM). Experiments in nuclear beta decay offer today a sensitive window to search for physics beyond the SM which is complementary to direct searches carried out at high energy colliders. The focus of many precision experiments in nuclear beta decay today is to measure the shape of the beta particle energy spectrum in Gamow-Teller decays, in order to extract the Fierz interference term. Such an observable is sensitive to contributions of so-called exotic tensor interactions which could arise by the presence of new interaction bosons. The Fierz term is attractive since it is linear in those exotic couplings. In this presentation I will describe new efforts in nuclear beta decay to reach new levels of sensitivity by using a new technique that eliminates the instrumental effect of backscattering of electron on the detectors. I will illustrate the first application of the technique in 6He and 20F decays and present the status of the data analysis.

10h00-10h45 **M. Leendert Hayen,** *KU Leuven, Instituut voor Kern- en Stralingsfysica, Heverlee, Belgium.*

A precise understanding of the beta spectrum shape proves an indispensable tool in the pursuit of Beyond Standard Model (BSM) physics. It opens up possibilities for scalar and tensor current searches and allows a study of nuclear structure dependent effects through the weak magnetism interaction [N. Severijns et al. Rev. Mod. Phys. 78, 991-1040 (2006)]. The latter is a contamination of the strong interaction, and forms an essential component in the analysis of the reactor antineutrino anomaly [P. Huber PRC 84, 024617 (2011)]. To this end, high precision measurements are being taken at Los Alamos National Laboratory with a 4 pi magnetic spectrometer using high performance, position sensitive silicon detectors. Further, it employs ultra-thin source foils, thereby minimising harmful scattering effects. Combined with precise timing, it enables full reconstruction of backscattered events including energy and angular distributions. Theoretical investigations have been performed to analytically describe all known correction factors on the beta spectrum shape to below the per mille level, including atomic and molecular effects. This allows for the most precise extraction of (B)SM physics from the beta spectrum shape to date. Preliminary results will be presented.

10h45-11h00 ***Coffee Break***

11h00-12h00 **Pr. John Hardy,** *Cyclotron Institute Texas A&M University, College Station, USA.*

Testing CVC and CKM unitarity via superallowed nuclear beta decay

Very precise measurements in nuclei can offer demanding tests of the Standard Model. In particular, superallowed nuclear beta-decay between 0+ analogue states is a sensitive probe of the vector part of the weak interaction, with the established strength – or F t value – of each such transition being a direct measure of the vector coupling constant, GV. Each transition's F t value depends on the half-life of the parent nucleus as well as on the Q-value and branching ratio for the transition of interest. It also depends on small (~1%) transition-dependent theoretical corrections, of which the most sensitive accounts for isospin symmetry breaking. The most recent survey of world superallowed-decay data [1] includes 222 individual measurements of comparable precision obtained from 177 published references; it establishes the F t values of 14 separate superallowed transitions to a precision of order 0.1% or better. These results, which cover a wide range of parent nuclei from 10C to 74Rb, constitute a very robust data set. Excellent consistency among the average F t-values for all 14 transitions – an expected consequence of the conservation of vector current (CVC) – confirms the validity of the correction terms; and recent measurements [2], which closely compare pairs of mirror superallowed transitions with A = 26, 34 and 38, further support that validity. With CVC upheld, the average result for GV in turn yields the value of Vud, the up-down quark mixing element of the Cabibbo-Kobayashi-Maskawa (CKM) matrix. Not only is this the most precise determination of Vud, it is the most precise result for any element in the CKM matrix. The CKM matrix is a central pillar of the Standard Model and, although the model does not predict values for the matrix elements, it demands that the matrix itself be unitary. The experimental value for Vud obtained from superallowed beta-decay leads to the most demanding test available of CKM unitarity. Neutron beta decay can also be used to determine Vud, but experimental problems have so far limited the precision that can be attributed to averages obtained from neutron world data. Though substantially less precise, neutron data yield a value for Vud that is statistically consistent with the value from superallowed decays. Prospects for future improvements to Vud will be discussed. [1] J.C. Hardy and I.S. Towner, Phys. Rev. C 91, 025501 (2015). [2] H.I. Park et al., Phys. Rev. Lett. 112, 102502 (2014); and to be published.

12h00-12h45 **Dr. Pierre Delahaye,** Grand Accélérateur National d'Ions Lourds, GANIL, Caen, France.

D correlation measurement in the β decay of trapped and polarized ions.

In this talk we discuss the potentials of a new technique of optical orientation of radioactive ions trapped in an open Paul trap, permitting to reach a very high degree of polarization, for β decay experiments.

More precisely, laser polarization of the alkali-earth ions $^{23}Mg^{+}$ and $^{39}Ca^{+}$ in a Paul trap and detection of the emitted electron and recoil ion shall enable the

measurement of the so-called *D* correlation. *D* is a triple correlation of the form $\langle \mathbf{J} \rangle (\mathbf{p}_e \times \mathbf{p}_\nu)$ with $\mathbf{p}_e$ and $\mathbf{p}_\nu$ being respectively the momenta of the electron and the neutrino, and **J** the nuclear spin. The *D* correlation violates Time reversal. While such violation is predicted to occur in the Standard Model via the quark mixing mechanism, experimental constraints are 5 to 10 orders of magnitude lower [1].There is a large window in which *D*, *R* correlations and neutron EDM searches can contribute to the search for other sources of CP violation at a much higher level, which could explain for example the large matter-antimatter asymmetry observed in the Universe. The best constraints so far on *D* arise from the neutron decay and are of the order of 2×10^{-4} on coupling constants of interactions violating T [2]. Lower constraints have been obtained from hyperon, Kaon, and nuclear decays. The latter were derived from the decay of ^{19}Ne yielding a constraint of 6×10^{-4}, limited by statistics [3]. With the expected rates from the upgraded SPIRAL facility at GANIL, an experiment aiming at *D*-correlation measurement with an unprecedented sensitivity of the below 10^{-4} can be conceived. It is envisaged to perform a proof-of-principle of the laser polarization method using the laser systems of IGISOL at JYFL [4], together with an optimized trapping setup inspired by the one of LPCTrap [5].

[1]: P. Herczeg and I.B. Khriplovich, Phys. Rev. D56 (1997) 80.
[2]: T. E. Chupp et al., Phys. Rev. C 86 (2012) 035505.
[3]: F. P. Calaprice, Hyp. Interact. 22 (1985) 83
[4]: I. D. Moore et al., Nucl. Instrum. Meth. B, 317(2013)208.
[5] : E. Liénard et al., Hyperfine Interact. 236 (2015) 1 and references therein.

12h45-14h00 ***Lunch***

14h00-14h45 **Pr. Dan Melconian,** *Cyclotron Institute Texas A&M University, College Station, USA.*

Probing fundamental symmetries via precision correlation measurements of β decay.

Nuclear β decay has a long-standing history of shaping and testing the standard model of particle physics, and it continues to this day with elegant, ultra-precise low-energy nuclear measurements. Experiments observing the angular correlations between the electron, neutrino and recoil momenta following nuclear β decay can be used to search for exotic currents contributing to the dominant (V − A) structure of the weak interaction. Precision measurements of the correlation parameters to would be $\lesssim$ sensitive to 0.1% (or meaningfully constrain) new physics, complementing other searches at large-scale facilities like the LHC. A summary of the correlation experiments in progress will be presented, with an emphasis on the atom- and ion-trap programs at Triumf and the Cyclotron Institute at Texas A&M University respectively.

14h45-15h30 **Dr. Phillipe Velten,** *KU Leuven, Instituut voor Kern- en Stralingsfysica, Heverlee, Belgium.*

Measurement of the β Asymmetry Parameter in 35Ar Decay with a Laser Polarized Beam.

Over the years, a large set of measurements and theoretical calculations have been performed, leading to the corrected Ft-values for the superallowed pure Fermi transitions. The weighted mean from these values leads to a high precision value for the Vud quark mixing matrix element, i.e. Vud = 0.97425(22) [1]. In combination with significant advances in the determination of the Vus matrix element from Kaon decay [2], this has led to a very high precision test of the unitarity of this matrix and subsequently to strong limits on several types of new physics beyond the Standard Model [3, 4].

Another source to address Vud is provided by the mirror transitions between isospin T=1/2 states [5]. Here, similar to the Fermi -transitions, one has to determine the Ft-value [6] but one has also to measure the ratio between the Fermi and the Gamow-Teller strengths, by e.g. performing a β-ν correlation or β asymmetry measurement. Using data readily available in the literature from experiments that were not originally performed for this purpose, a value of Vud = 0.9717(17) was obtained [5]. Dedicated studies of these mirror-decays can significantly improve the precision on this value, and at the same time contribute to the ongoing study of the isospin symmetry breaking corrections, which are often larger for the mirror-transitions.

Recently, a critical survey [7] has shown that the measurement of the

Some years ago asymmetry parameter, A, in the mirror decay of 35Ar to the 35Cl ground state (gs.) is the most sensitive among all β-ν correlation and β asymmetry parameter measurements for the mirror decays. Indeed, a measurement of the asymmetry parameter A in the gs. to gs. positron decay of 35Ar, with a relative precision of 0.5%, would yield a highly competitive value for Vud which will be the most precise among mirror transitions.

This talk will present the ongoing preparations for an accepted experiment at ISOLDE, CERN (IS601, [8]) aiming at measuring A(35Ar) at this level of precision.

The laser polarized beam will be provided by the new VITO beam line [9] that will be commissioned in September 2016 and which will provide both the required intensity and purity to achieve the 0.5% precision on A during a physics run planned at a later stage.

The talk will also detail the experimental technique used to extract the asymmetry parameter consisting in the implantation of the polarized beam into a cooled crystal host surrounded by a holding magnetic field and followed by the simultaneous measurement of both the 35Ar transition to the g.s. and to the first excited state of 35Cl through a β-γ coincidence detection setup.

[1] Hardy JC, Towner IS. Phys. Rev. C 79 055502 (2009)
[2] Beringer J, et al. (Particle Data Group). Phys. Rev. D 86 010001 (2012)
[3] Towner IS, Hardy JC. Phys. Rev. C 82 065501 (2010)
[4] Bazavov A, et al. Phys. Rev. Lett. 112 112001 (2014)
[5] Naviliat-Cuncic O, Severijns N. Phys. Rev. Lett. 102 142302 (2009)
[6] Severijns N, Tandecki M, Phalet T, Towner IS. Phys. Rev. C 78 055501 (2008)
[7] Severijns N, Naviliat-Cuncic O. Phys. Scr. T 152 014018 (2013)
[8] Velten P., et al., Tech. Rep. CERN-INTC-2014-062. INTC-P-426
[9] M. Stachura, et. al., Nucl. Instr. Meth. Phys. Res. B 376 (2016) 369-373

Concluding Remarks

15h30-16h00 **Pr. Oscar Naviliat-Cuncic,** *NSCL-MSU, East Lansing, USA.*

Participants

Family Name	Given Name	Institutional Affiliation	Country
Aoki	Takatoshi	The University of Tokyo	Japan
Ban	Gilles	Laboratoire de Physique Corpusculaire de Caen	France
Delahaye	Pierre	GANIL	France
Denis	Malika	Laboratoire de Chimie et Physique Quantiques	France
Durand	Dominique	LPC Caen	France
Geltenbort	Peter	Institut Laue Langevin (ILL)	France
Gerber	Sebastian	CERN	Switzerland
Guillon	Benoit	LPC CAEN	France
Hardy	John	Texas A&M University	USA
Hasinoff	Michael	University of British Columbia	Canada
Hayen	Leendert	Instituut voor Kern- en Stralingsfysica	Belgium
Hayes-Sterbenz	Anna	Los Alamos National Laboratory	USA
Hussain	Sadiq	National Institute of Sciences and Technology	Pakistan
Ito	Takeyasu	Los Alamos National Laboratory	USA
Kamiya	Yoshio	The University of Tokyo	Japan
Kanda	Sohtaro	The University of Tokyo	Japan
Khaw	Kim Siang	University of Washington	USA
Krikler	Benjamin	Imperial College London	United Kingdom
Lamblin	Jacob	LPSC	France
Leroy	Nicolas	Laboratoire de l'Accélérateur Linéaire d'Orsay	France
Long	Joshua	Indiana University	USA
Mekki	Awadallah	University of Khartoum	Sudan
Melconian	Dan	Texas A&M University	USA
Melconian	Dan	Cyclotron Institute Texas A&M University	USA
Miura	Makoto	Kamioka Observatory, ICRR, University of Tokyo	Japan
Naviliat-Cuncic	Oscar	Michigan State University	USA
Nisar	Shabana	COMSATS Institute of Information Technology	Pakistan
Pignol	Guillaume	LPSC	France
Romano	Angela	University of Birmingham	United Kingdom
Schmidt-Wellenburg	Philipp	Paul Scherrer Insitute	Switzerland
Soramel	Francesca	University of Padua	Italy
Stanco	Luca	INFN - Padova	Italy
Uchiyama	Aiko	Cyclotron and Radioisotope Center (CYRIC)	Japan
Velten	Philippe	Instituut voor Kern- en Stralingsfysica	Belgium
Widmann	Eberhard	Stefan Meyer Institute	Österreich

Presentations

PDFs presentations will be available here : https://indico.in2p3.fr/event/13430/


Chine
Ha Giang
Cao Bang
HANOÏ
Son La
Nam Dinh
Haiphong
Thanh Hoa
Laos
Vinh
Dong Hoi
Archipel Hoang Sa (Vietnam)
Huê
Da Nang
Thaïlande
Pleiku
Quy Nhon
Cambodge
Loc Ninh
Da Lat
Cam Ranh
Dak Nong
Ho Chi Minh-ville
Phan Thiet
Vung Tau
Archipel Truong Sa (Spratley-Vietnam)
Bac Liêu
200 km