TAM2013 - Venice

Monday 04 March 2013 - Friday 08 March 2013

Venice

Book of Abstracts

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Matter and Gravity / 31

Black holes, TeV-scale gravity and the LHC

Elizabeth Winstanley[1]

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Over the past 15 years models with large extra space-time dimensions have been extensively studied. We have learned from these models that the energy scale of quantum gravity may be many orders of magnitude smaller than the conventional value of 10^19 GeV. This raises the tantalizing prospect of probing quantum gravity effects at the LHC. Of the possible quantum gravity processes at the LHC, the formation and subsequent evaporation of microscopic black holes is one of the most spectacular. In this talk we give an overview of some of the fundamental ideas in black hole physics, the large extra dimensions scenarios, and black hole processes at the LHC. We also discuss recent experimental searches for these events.

The Origins of Mass - Higgs Boson / 26

CMS Observation of a new boson at the LHC and its implications for the origin of mass

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The following points will be discussed:

- Evidence for a Higgs particle in CMS
- Is it Peter´s Higgs or just a Higgs?
- What it has to do with the "origin of mass" in the universe?
- What is the Higgs boson good for?
- What is so special about the observed Higgs particle?

Dark Matter and Dark Energy / 15

Casimir effect as an explanation of dark energy

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It is known that the simply evaluated value of the zero point energy of quantum fields is extremely deviated from the observed value of dark energy density. In this study, it is shown that Casimir energy, which is the zero point energy brought from boundary conditions, can explain dark energy by using proper renormalization method and considering the finite temperature Casimir effect of the particles in the compacted extra dimensions.

Evolution of Time / 24

Direct observation of time-reversal violation in B0 decays

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The B factories have established with great accuracy the violation of the CP symmetry in the B system. However, no direct observation of time-reversal violation had been performed prior to the work, recently published by the BABAR Collaboration, discussed in the present talk. The quantum entanglement of B-Bbar pairs produced in the decay of the Y(4S) resonance at the PEP-II asymmetric B Factory is exploited to perform an unambiguous t-transformation (inversion of the sign of t and exchange of the in" andout" states). The comparison of the decay rates of reference and t-transformed states as a function of the decay time difference allows us to establish for the first time T violation in the B system with a significance of 14 sigma, independently from assumptions on the CPT symmetry.

Dark Matter and Dark Energy / 29

Discovering Dark Matter

Subir Sarkar[1]

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Much effort has been devoted to the study of weak scale particles, e.g. supersymmeteric neutralinos, which have a relic abundance from thermal equilibrium in the early universe of order what is inferred for dark matter. This does not however provide any connection to the comparable abundance of baryonic matter, which must have a non-thermal origin. Interestingly "dark baryons" of mass ~5 GeV from a hidden strongly interacting sector could naturally provide the dark matter and are consistent with putative (controversial) signals in experiments such as CoGeNT, CRESST and DAMA. Searches for monojet signals at the LHC provide a complementary probe of such particles.

The Origins of Mass - Higgs Boson / 6

Heavy Quarks, the Origin of Mass, and CP Violation for the Universe

George Wei-Shu Hou[1]

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A Higgs-like new boson with mass around 126 GeV is discovered during 2012. However, it could still be the dilaton of scale-invariance violation, which can only be ruled out after the LHC restarts with the 13 TeV run in 2015, by observing the vector boson fusion or Higgsstrahlung production processes. With the existence of already three generations of chiral quarks, i.e. left and right-handed components carry different electroweak charges, if a 4th generation of quarks exist, the LHC has pushed the mass limits beyond 700 GeV, which is considerably beyond the nominal unitarity bound, hence the associated Yukawa coupling is in the nonperturbative domain. This would not be easily compatible with a 126 GeV Higgs boson. We argue, however, that a scale-invariant "gap equation" can be constructed, where massless input is guaranteed by gauge invariance. A nontrivial numerical solution is found for Yukawa coupling above 4pi or so, hence dynamical electroweak symmetry breaking can be achieved by strong Yukawa coupling. In turn, because the gap equation is scale invariant, this strong coupling solution is compatible with a 126 GeV dilaton, which would be a true

messenger from energies much higher than the electroweak scale. We note that extending from 3 to 4 generations, the quark sector may have enough CP violation for generating the matter dominance of the Universe. This is seen most easily through the so-called Jarlskog invariant. We offer some speculation on the possible phenomena pertaining to heavy chiral quarks as massive as a couple of TeV.

The Origins of Mass - Higgs Boson / 18

Higgs boson cross sections at LHC and open issues

Damiano Tommasini[1]

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I briefly review the theoretical status on the different production and decay channels of a Standard Model Higgs boson at the LHC. After this overview, I focus on the most important channels that are the gluon-gluon fusion, for the production, and on the Electro-Weak channels for the decay. When combined they represent the most important ones for the Higgs boson searches at the LHC. Some excess of events in the gamma-gamma decay channel have been observed. I discuss some issues related to this channel and the important impact of the background estimation.

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In quest of sterile neutrinos, an experimental review

Maximiliano Sioli[1]

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The possibility of mixing between standard active neutrinos and neutrino fields which are singlets under the gauge symmetries of the Standard Model is a natural consequence of neutrino non-zero masses. The discovery of a sterile neutrino state would have profound impact on our understating of particle physics and on the evolution of the Universe. Recent tensions between world-wide experimental data renewed the possibility of at least a sterile neutrino state with mass around 1 eV to explain the observations. Here we provide an updated review of the rapidly evolving experimental scenario which provides at the same time hints in favor of and in contradiction to the sterile neutrino hypothesis. Finally we discuss the current planned experimental activities aiming at definitively unravel this longstanding issue.

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Interacting Ricci Dark Energy with power-law and logarithmic corrections

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Motivated by the holographic principle, it has been suggested that the dark energy density may be inversely proportional to the area A of the event horizon of the universe. However, such a model

would have a causality problem. In this work, we consider the entropy-corrected version of the holographic dark energy model in the non-flat FRW universe and we propose to replace the future event horizon area with the inverse of the Ricci scalar curvature. We consider both the power law and the logarithmic corrections. We obtain the equation of state (EoS) parameter, the deceleration parameter q and the evolution of the energy density parameter in the presence of interaction between Dark Energy (DE) and Dark Matter (DM). Moreover, we reconstruct the potential and the dynamics of the tachyon, K-essence, dilaton and quintessence scalar field models according to the evolutionary behavior of the interacting entropy-corrected holographic dark energy model.

Precision Time Measurements / 22

Measurement of the neutrino velocity with the OPERA detector in the CNGS beam

Gabriele Sirri[1]

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The OPERA neutrino experiment located in the underground Gran Sasso Laboratory measured the velocity of neutrinos composing the CERN CNGS beam over a baseline of about 730 km. Dedicated upgrades of the CNGS timing system and of the OPERA detector, as well as a high precision geodesy campaign for the measurement of the neutrino baseline, allowed to set a limit on the muon neutrino velocity with respect to the speed of light of −1.8 × 10-6 < (vν− c) / c < 2.3 × 10-6 at 90% C.L.

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Micro Black Hole Formation and Evaporation

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It has been conjectured that Micro Black Holes(MBH) may be formed in the presence of large extra dimensions. These MBHs have very small mass and they decay almost instantaneously. Taking into consideration quantum effects, they should Howking radiate mainly to Standard Model particles, this radiation then gets modified by the non trivial geometry around the MBHs; the so called grey-body factors which filter the Hawking radiation. To test the validity of MBH models, one needs to investigate it experimentally. A primary tool in this investigation is simulation of the MBH formation and evaporation, including all theoretical work that has been performed up to now. BlackMax and CHARYBDIS2, are the most modern and realistic simulators currently available. However they still suffer from the lack of important parameters. In this talk I will explain the primary work that we have done to study the possible changes that can be implemented in the simulations.

Matter and Gravity / 34

NA61/SHINE experiment at the CERN SPS

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The aim of this project is to explore the QCD phase diagram within the range of thermodynamical variables (like e.g. temperature and baryon chemical potential) accessible at the SPS. In addition it provides precise hadro-production measurements to characterize the neutrino beam of the T2K experiment at J-PARC and to simulate cosmic-ray showers for the Pierre Auger Observatory, KASCADE-Grande and KASCADE experiments.
The main physics goals of the NA61/SHINE ion program are the study of the properties of the onset of deconfinement and the search for signatures of the critical point of strongly interacting matter by performing an energy (beam momentum 13A-158A GeV/c) and system size (p+p, p+Pb, Be+Be, Ar+Ca, Xe+La) scan.
The architecture and performance of the detector will be discussed. Moreover, an overview of NA61/SHINE status, results and plans will be presented.

Opening / 36

Opening Address

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Quantum Geometry and the Holometer Experiment

Chris Stoughton[1]

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Fermilab is conducting an experiment sensitive to effects of quantum gravity at the Planck scale. Inspired by the Holographic Principle, we calculate the "holographic noise" when measuring location, defined by position in two non-degenerate directions.
We use power recycled Michelson interferometers to measure the location of the beam splitter. I will discuss the experimental strategy and progress of construction and commissioning.

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TBA

Peter Higgs[1]

[1] *The University of Edinburgh*

TBA

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The Fate of the Quantum

Gerard 't Hooft[1]

[1] *Institute for Theoretical Physics, Universiteit Utrecht*

Although the suspicion that quantum mechanics is emergent has been lingering for a long time, only now we begin to understand how a bridge between classical and quantum mechanics can be squared with Bell's inequalities and other conceptual obstacles. It is helpful to have some good model examples such as string theory.

The Origins of Mass - Higgs Boson / 38

The Higgs Boson discovery and the Road Ahead

James Wells[1]

[1] *CERN*

The Origins of Mass - Higgs Boson / 27

The Higgs Hunt with ATLAS at LHC

Marko Mikuz[1]

[1] *Josef Stefan Institute/ATLAS*

Results on measurements the Higgs-like boson, discovered at a mass around 125 GeV, with the ATLAS detector are presented. The proton-proton collision data were collected at 7 TeV in 2011 representing an integrated luminosity close to 5/fb, and at 8 TeV in 2012 with results reported on integrated luminosity up to the full collected luminosity of 21/fb. Discovery of a new, Higgs-like boson can be claimed in two distinct decay channels: H-> gg and H->ZZ*->4l. In these decays the boson mass can be fully reconstructed. ATLAS went beyond discovery in measuring the Higgs-like boson properties, like couplings, production mechanisms and spin.

The Origins of Mass - Higgs Boson / 17

The Higgs boson and extra dimensions

James Wells[1]

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One of the main motivations for low-scale or warped extra dimensions was to lower the scale of potentially dangerous quadratic divergences to the Higgs sector from quantum gravity. Now that the Higgs boson has been discovered at the LHC, and extra dimensions so far have not, we take a critical look at the status of extra dimensions' ability to explain the weak scale.

Precision Time Measurements / 21

The Measurement of Time

Thomas Udem[1]

[1] *Max-Planck Inst.*

Time can be measured with the best accuracy of all physical quantities and forms the basis of all precision measurements. Usually this is accomplished by determining the period of an atomic oscillator. To measure means to compare. Measuring time essentially means to compare the number of cycles of different oscillators. I will elaborate on how this has been done in the past, what the state of the art is and dwell a bit on the scientific applications.

The Origins of Mass - Higgs Boson / 13

The Pierre Auger Observatory: results on the highest energy particles

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Co-author(s): Ruben Conceição [2]

[1] *The Pierre Auger Observatory*

[2] *LIP*

The Pierre Auger Observatory has been designed to investigate the most energetic particles known, the ultra high energy cosmic rays.
The observatory, covering an area of 3000 km^2, combines two different detection techniques to study the huge particle showers created by the interaction of the primary cosmic ray with the atmosphere. The analysis of the showers allows to extract information on the nature of the primary cosmic rays as well as their origin. Moreover, the study of the interaction of these particles with the atmosphere offers an unique window to study particle physics at an energy more than one order of magnitude above the current highest energy man-made accelerator.

In this contribution, selected results are presented with focus on the primary mass composition, on the determination of the number of muons, which is very sensitive to the shower hadronic interactions, and on the measurement of the proton-air cross-section at $\sqrt{s} = 57$ TeV. For the last topic, a link with the proton-proton cross-section measurements, done at accelerators, will be shown.
Results on the cosmic ray energy spectrum and on the searches for ultra high energy photons and neutrinos, will also be addressed.

The Origins of Mass - Higgs Boson / 28

The next ten years of dark energy research

Luca Amendola[1]

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In the next few years new data from ground and space will push the limit of cosmological observations to new frontiers. Combining CMB, weak lensing, redshift clustering and supernovae data, we will be able to constrain the properties of dark energy and its interactions from the background to the non-linear level. In this talk I
discuss these methods and the future expected constraints on the most general model of dark energy and modified gravity.

Philosophical Perspectives / **33**

Time and Fermions: General Covariance vs. Ockham's Razor for Spinors

J. Brian Pitts[1]

[1] *University of Cambridge*

Supposedly it is trivial to implement formal general covariance for any physical theory; just use tensor calculus. It is also widely believed, going back to Weyl in 1929, that spinors as such cannot exist in coordinates in curved space-time; one needs an orthonormal tetrad with 6 extra fields and extra local O(1,3) gauge group. These (incompatible) claims are both false. In 1965 Ogievetsky and Polubarinov defined spinors as part of a nonlinear representation (up to a sign, near the identity) of general coordinate transformations. But as Bilyalov in effect showed in the 1990s, with an indefinite metric sometimes one must reorder the coordinates to admit 'arbitrary' coordinates, a feature with no analog for bosons. This fact relates to theorems about the non-existence of a suitable square root of matrices with negative eigenvalues. Hence spinors in coordinates in curved space-time exist and are more economical than in the tetrad formalism, as Ockham's razor commends. But the cost is mild trimming of formal general covariance. For fermions time is not quite so much like or mixed with space in GR as has been thought.

Philosophical Perspectives / **32**

Time's Arrow in Cosmology

Chris Smeenk[1]

[1] *University of Western Ontario*

The problem of time's arrow arises due to the conflict between the time-reversal invariance of dynamical laws and temporal asymmetry of phenomena. In the late 19th century, Boltzmann proposed to avoid this conflict with speculative cosmological proposals, including the suggestion that the universe began in a low entropy initial state. Contemporary neo-Boltzmannians hold that this idea, called the Past Hypothesis," is essential to solving the problem of time's arrow. I will first review the recent debates in the philosophy of physics literature regarding this view. The second part of the talk turns to inflationary cosmology and other speculative cosmological scenarios. In particular, I consider the apparent conflict between the Past Hypothesis and the idea that inflation works forgeneric" initial conditions. I then criticize proposals that offer modern versions of another idea originally due to Boltzmann, namely that we should treat the observed universe as a fluctuation from an overall equilibrium state.

Evolution of Time / **23**

Time-reversal violation and the origin of matter in the Universe

Antonio Masiero[1]

[1] *Universita' di Padova*

In the plasma of particles of the primordial Universe it is expected that matter and antimatter were present in equal amount. To dynamically develop a matter-antimatter asymmetry starting from such a symmetrical situation, a necessary condition is that CP is violated. In local quantum field theories CP violation is always accompanied by the same amount of time-reversal violation. Interestingly

enough, the amount of CP violation (and, hence, of time-reversal violation) present if the Standard Model of particle physics is not enough to give rise to all the matter present in the Universe. Thus, some new physics has to produce a substantial violation of the time-reversal symmetry.

Philosophical Perspectives / 37

Visualizing some aspects of unifying Theories

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The Quantum Cinema 3D animated geometry depiction model is based on the idea that geometry must not remain restricted to the plane 2-D page but the invention of digital media makes the appropriate outlook of higher mathematics possible and animated 3-D graphics are the new medium for a new geometry which is introduced here.
The basic discrete geometric model obeys the rules of the algebraic number field
and allows a continuous evolvement up to higher dimensions of space: The discrete space grid Z5 – comparable to the ontological significance of the „quintessence" or „ether – enables to join electromagnetic phenomena such as light as turbulence in 5D space, the principles of relativity and the notion of time, the 4D behaviour of "space time" are embedded in 6D. The electric and magnetic forces as well as gravity find analogue geometrical entities. A 5D space cell performs permutations of algebraic elements.
(http://shorts.quantumlah.org/from-the-pentagon-inequality-to-the-poincare-universe)

Summary:

This digital geometry framework allows to visualize the wellknown mathematically accomplished unification theories by most of all Theodor Kaluza ‚s unification in 5D, Roger Penrose‘s Twistor theory, String Theories and Garret Lisis‘E8 theory.
3D animated geometry enables the visualization of the imaginary (numbers) and finally provides a continuum of symmetries. A kaleidoscopic movie which gives new insights and
physical interpretations for a commensurate recognition of so far abstract concepts.