Andrea Addazi

Quantum Gravity in Lab

Abstract: We will show how several quantum gravity bottom-up models can be tested from searches of Pauli Exclusion Principle violations in underground experiments such as BOREXINO, DAMA and VIP. In particular, we will discuss non-commutative space-time, generalised uncertainty principle (GUP). and prospectives.

Ignatios Antoniadis

Swampland Program, Extra Dimensions and Supersymmetry Breaking

Abstract: I will discuss the possibility that the smallness of some physical parameters signals a universe at a large distance corner in the string landscape of vacua. Such parameters can be the scales of dark energy and supersymmetry breaking, which should then be tied to a large 'dark' dimension at the micron scale, as dictated by the large distance swampland conjecture.

Rita Bernabei:

i) Recent efforts in the DAMA project; ii) summary: The features and the results of DAMA/LIBRA–phase2 experiment at Gran Sasso are presented. DAMA/LIBRA–phase2, with improved experimental configuration and lower software energy threshold with respect to the phase1, confirms a signal that meets all the requirements of the model independent Dark Matter annual modulation signature, at high C.L. The model independent DM annual modulation result is compatible with a wide set of DM candidates. A new configuration of DAMA/LIBRA–phase2 is now running: the empowered one, with a further lowered energy threshold. The perspectives are outlined.

Arnab Chaudhuri

Dark Matter Production from Two Evaporating PBH Distributions

Abstract: Particulate Dark Matter (DM), completely isolated from the Standard Model particle sector, can be produced in the early universe from Primordial Black Hole (PBH) evaporation. However, Big Bang Nucleosynthesis (BBN) observations put an upper bound on the initial mass of PBH requiring the PBH to evaporate completely before the advent of BBN. DM particles in the mass range $\tilde{(}110^{9})$ GeV can not explain the observed relic abundance for an early matter dominated universe due to this BBN constraint. However, this assumes the presence of only one monochromatic PBH mass distribution in the early universe. In this work, we explore the simple possibility of achieving the observed relic with DM masses from the above mentioned range for an early matter dominated era with two monochromatic evaporating PBH mass distributions and demonstrate that the BBN constraints can be alleviated to a good degree.

Sourav Roy Chowdhury

The stochastical gravitational wave background

Abstract: The superposition of independent astrophysical objects can serve as candidates causing the stochastical gravitational wave background. We already know that the maximum contribution of this background is sourced by several physical processes that happened in the primordial universe. In addition, objects like binary black holes, binary neutron star mergers, supernovae explosions, and magnetars can also contribute to the background. It is possible to make significant astrophysical and cosmological conclusions about the stochastic background based on direct or indirect (setting the upper limit in particular frequency bands) observations. In this article, we have studied the nature of the background produced by different sources. We determine how well our model can reconstruct frequency-amplitude images of the emission modes and show how well we can determine the parameters of the signal. We show how the parameters of our signal model may allow us to place constraints on the amplitude. We also study how the star formation rate controls the amplitude of the gravitational wave spectrums.

Elia Dmitrieff

Some Informational Aspects of Fundamental Particle Modeling

Abstract: We consider a model of a physical vacuum based on a grid of discrete nodes arranged periodically. These can be, for example, vacuum domains formed during a phase transition.

As a degree of freedom, we assume that for each node, there are exactly two options for the electric charge associated with it (+1/6 or -1/6 of the electron charge), and the node does not carry any more information.

In such a model, vacuum corresponds to some background pattern of alternation, in which positive and negative charges are compensated, and discrete deviations from this pattern, or defects, correspond to particles.

With this approach, it becomes possible to represent the processes of propagation, decay and interaction of particles in the form of the movement of defects that occur according to certain rules, similar to those operating in cellular automata.

Due to the fact that information about which nodes are defective is not directly available for observation, in such a model, uncertainty effects arise, which can be the cause of known quantum effects.

We consider here several cases in which understanding the details of storing and moving information is, in our opinion, important.

The first case relates to the realization of what exactly can be called information and how the realism of the model correlates with its computability. We believe that if we limit ourselves to only computable models, we must accept the need to respect the principle of locality: the state of a node (domain) can only depend on the state of the nodes that are its immediate neighbors.

The second example is the juxtaposition of information presented as a sequence of symbols and information presented in more complex geometric forms. In our opinion, coding by a linear sequence is in principle not suitable for representing color information in quantum chromodynamics. Such a result leads to a reasonable doubt about the possibility of an accurate calculation of the strong interaction on conventional computers, and also allows us to imagine what kind of calculation architecture is required for this.

The third situation is the consideration of the phenomenon of observation, the entangled state of particles and the Einstein-Podolsky-Rosen paradox. In our opinion, the unusual behavior of quantum particles is a consequence of the fact that they actually carry less information than it appears from the classical point of view. In this case, the principle of locality is preserved, but the principle of realism, as a rule, is violated: the measurement result is necessarily mixed with additional information that is not related to the particle under study. In some cases, the measurement result may be completely independent of the object of observation.

The fourth case is a situation of branching when a defect propagates in a discrete environment, in which it becomes necessary to choose one of several equally possible options. This situation formally corresponds to a decrease in entropy, which leads to reasonable doubts about the fundamental realism of discrete models. On the basis of computational experiments, we came to the conclusion that the need for choice is apparent, and this effect can be eliminated. In particular, the source of data for selection can be the situation inverse to branching, i.e., the merging of possible trajectories. The mechanism for transmitting data under conditions of locality constraints can be compactification or twisting of one dimension. Such a mechanism can only work in a certain range of possible angles, which causes the appearance of propagation cones.

In general, we find the modeling of the physical vacuum and particles using discrete binary information distributed in a special way very productive, consistent and promising.

Anish Ghosal

Sky Meets Laboratory via RGE: Axions, Peccei-Quinn Phase Transitions and Gravitational Waves

Abstract: As a solution to the SM hierarchy problem, we will discuss model-building with classical scale invariance in 4-dimensional QFT satisfying Total Asymptotic Freedom (TAF): the theory holds up to infinite energy, where all coupling constants flow to zero and is devoid of any Landau poles. Such principles if beyond the reach of LHC (TeV scale) can be tested via Gravitational Waves (GW) in LIGO, etc. As an example, we will discuss a QCD axion in the TAF scenario, with strong first order Peccei-Quinn phase transitions and produces GW.

Thus we will conclude by promoting RGE as a novel connection to complement laboratory searches of BSM with cosmological observables as probes of BSM models.

Shu-Yuan Guo

Footprints of Axion-Like Particle in Pulsar Timing Array Data and JWST Observations

Abstract: Very recently Pulsar Timing Array (PTA) collaborations have independently reported the evidence for a stochastic gravitational-wave background (SGWB), which can unveil the formation of primordial seeds of inhomogeneities in the early universe. With the SGWB parameters inferred from PTAs data, we can make a prediction of the Primordial Black Hole (PBH) clusters from the domain walls of axion-like particles (ALPs). These primordial seeds can naturally provide a solution to the early Active Galactic Nuclei (AGN) formation indicated by James Webb Space Telescope (JWST). Besides, the mass of ALP is also constrained, ma10151014 eV, within the reach of upcoming cavity experiments.

Albino Hernández-Galeana

Fermion masses and mixing within a gauged SU(3) family symmetry model

Abstract: Within a gauged SU(3) family symmetry model, we address the problem of mass generation for the ordinary fermions, including neutrinos in a 3+5 scenario.

This BSM introduces new particles: scalars, gauge bosons, right handed neutrinos to cancel anomalies, and a set of $SU(2)_L$ weak singlets vector-like fermions U,D,E,N, with N a neutral lepton. These vector-like fermions allows the implementation of See-saw mechanisms at tree level to generate the masses of the top and bottom quarks and the tau lepton. Light fermions obtain masses from loop corrections mediated by the massive SU(3) gauge bosons.

We update and show the parameter space region solutions for quark and lepton masses and mixing.

Ulrich Jentschura

1. Ultra-relativistic tachyonic and tardyonic wavepackets on cosmic scales

(J. Nicasio, Ulrich Jentschura)

Abstract: A famous "early" arrival of a neutrino burst from the supernova SN1987A (before the light burst) was observed in a detector under Mont Blanc, as reported in [V. L. Dadykin et al., JETP Lett. 45, 593 (1987)]. This event still provides some grounds for speculations about a possible tachyonic (faster-than-light) nature of at least some of the known neutrino species. It is well known that quantum mechanical wave packets describing massive particles disperse while propagating on cosmic dis- tance scales, in contrast to the deterministic trajectories of classical particles. This applies both to tachyonic (superluminal) and tardyonic (subluminal) massive rela- tivistic wave packets. Hence, on the basis of the dispersion of quantum-mechanical wave packets, it is interesting to ask to which extent quantum dispersion of the wave packets could contribute to the uncertainties of arrival times of cosmic rays consisting of massive particles on Earth, possibly even "mimicking" superluminal propagation, purely due to dispersion of the wave packet. In our investigations [J. Nicasio and U. D. Jentschura, Symmetry 14, 2596 (2022)], we investigate the free-particle propagation of tardyonic (subluminal) and tachyonic (superluminal) wave packets composed of a Gaussian weight function multiplying positive-energy, negative-helicity solutions of the free ordinary Dirac equation, and of the free tachyonic Dirac equation. In particular, we investigate the dispersion of the wave packets with time, an effect which translates into a posi- tional uncertainty. Considering cosmic scales, in the ultrarelativistic limit, we find a unified result for both tachyons as well as tardyons,

$$\sigma_x(t) = \frac{m^2 c^3 \sigma_p}{p_0^3} t$$

This result describes the uncertainty in the detection position $\sigma_x(t)$, where σ_p is the initial momentum spread of the wave packet in statu nascendi, m is the particle mass, c is the speed of light, p_0 is the expectation value of the momentum, and t is the propagation time.

2. Quantum Electrodynamics: A Few Additions to a Jewel of Theoretical Physics

Abstract: The purpose of this talk is to introduce a few new results recently presented in [U. D. Jentschura and G. S. Adkins, Quantum Electrodynamics: Atoms, Lasers and Gravity (World Scientific, Singapore, 2022)]. The development of quantum electrodynamics started when Bethe, Feynman and Schwinger, and Tomonaga, de- veloped the concept of renormalized quantum field theory, to deal with the infinities that arose in perturbative calculations of scattering processes. The characteristic element of the calculations was the emergence of so-called loop corrections, which describe the self-interaction of the quantum fields. The application of the formal- ism to bound states is marred with additional difficulties, due to the presence of two distinct energy scales, which have to be matched at the end of any precise calculation. Nevertheless, the theory has enabled theorists to calculate transition energies in simple atomic systems like hydrogen and helium to unprecendented ac- curacy, approaching 13 or 14 decimals. This talk describes some aspects of the recently available treatise (mentioned above, published in 2022). As an example of higher-order calculations which could further enhance our understanding of bound systems, the eighth-order Foldy–Wouthuysen transformation will be described. Our talk also focuses on searches for physics beyond the Standard Model (proton radius puzzle, X17 boson) which have an overlap with current precision atomic physics. In particular, prospects for a definitive resolution of the proton radius puzzle will be discussed.

Norma Susana Mankoč Borštnik

1. How far can we understand nature with the spin-charge-family theory, describing the internal spaces of fermions and bosons with the Clifford algebra?

Abstract: I have demonstrated in a long series of works, together with the collaborators, that the it spin-charge-family theory offers the explanation for all in the standard model assumed properties of quarks and leptons, of boson gauge fields, of scalar higgs, as well as for many of the so far observed cosmological phenomena. The theory assumes a simple starting action in d= (13+1), with massless fermions carrying only spins and interacting with massless gravity field only.

This talk presents the so far achievements of this theory in **a.** explaining the assumptions of the electroweak *standard model* for quarks and leptons and antiquarks and antileptons, with the appearance of families included and for vector gauge fields and the scalar fields, **b.** expaining the cosmological observations, **c.** making predictions, **d.** explaining the second quantization postulates for fermion and boson fields, **e.** offering explanation for assuming the Fadeev-Popov ghosts, **f.** offering the possibility to replace the two kinds of the *spin connection fields* with the new fields, the internal space of which is described by the Clifford even algebra.

The detailed discussions on subjects **d., e., f.** are offered in separate talks.

2. How Clifford algebra helps understand second quantized quarks and leptons and corresponding vector and scalar boson fields, *opening a new step beyond the standard model*

Abstract: This talk presents the description of the internal spaces of fermion and boson fields in d-dimensional spaces, with the odd and even "basis vectors" which are the superposition of odd and even products of operators γ^a. While the Clifford odd "basis vectors" manifest properties of fermion fields, appearing in families, the Clifford even "ba-

sis vectors" demonstrate properties of the corresponding gauge fields. In $d \geq (13+1)$ the corresponding creation operators manifest in $d = (3+1)$ the properties of all the observed quarks and leptons, with the families included, and of their gauge boson fields, with the scalar fields included, making several predictions.

The properties of the creation and annihilation operators for fermion and boson fields are illustrated on the case $d = (5+1)$, when $SO(5,1)$ demonstrates the symmetry of $SU(3) \times U(1)$.

3. Clifford odd and even objects in even and odd dimensional spaces describing internal spaces of fermion and boson fields

Abstract: The main topic of this talk is the analyse of the properties of the internal spaces of the fermion and boson fields in odd dimensional spaces, $d = (2n+1)$, described again by the Clifford odd and even objects, respectively. It namely turns out that the properties of fermion and boson fields differ essentially from their properties in even dimensional spaces, resembling the ghosts needed when looking for final solutions with Feynman diagrams. Detailed illustrations will be made on d=(2+1) and d=(4+1).

4. Can the Clifford even algebra, used to describe internal spaces of boson fields, which are the gauge fields of fermion fields described by the Clifford odd algebra, bring a new understanding into second quantization of (gravity) fields?

Norma Susana Mankoč Borštnik, Holger Bech Nielsen

Abstract: The starting action of the *spin-charge-family* theory assumes massless fermions interacting with the gravity only. The higher dimensions than $d = (3+1)$ determine the internal spaces of fermion and boson fields so that for $d = (13+1)$ they offer the explanation for all the assumptions of the *standard model*: For fermion and boson fields.

There are two kinds of the spin connection fields; offering explanation for the observed boson gauge fields, and for scalars which give masses to fermions and to some of the boson fields. The spin connections fields of both kinds, $\omega_{st\alpha}$ and $\tilde{\omega}_{st\alpha}$, $(s,t) = (5,6,,)$, representing higher dimensions, manifest the gauge invariance of boson fields.

When describing the internal spaces of fermions and bosons with the Clifford algebra, the Clifford odd algebra for describing the internal space of fermions and the Clifford even algebra for describing the internal space of bosons, the spin connection fields, $S^{ab}\omega_{st\alpha}$ and $\tilde{S}^{ab}\tilde{\omega}_{st\alpha}$ are expected to be replaced by the superposition of the two kinds of the Clifford even "basis vectors", ${}^{I}\hat{\mathcal{A}}^{m}_{f}{}^{I}\mathcal{C}^{m}_{f}$ and ${}^{II}\hat{\mathcal{A}}^{m}_{f}{}^{II}\mathcal{C}^{m}_{f}$; the first transforming Clifford odd "basis vectors" within each family, the second transforming Clifford odd "basis vectors" of particular member to the same member of another family. This offers the possibility to replace the covariant derivative $p_{0\alpha}$

$$p_{0\alpha} = p_\alpha - \frac{1}{2} S^{ab}\omega_{ab\alpha} - \frac{1}{2}\tilde{S}^{ab}\tilde{\omega}_{ab\alpha}$$

with

$$p_{0\alpha} = p_\alpha - \sum_{mf} {}^{I}\hat{\mathcal{A}}^{m\dagger}_{f}{}^{I}\mathcal{C}^{m}_{f\alpha} - \sum_{mf} {}^{I}\hat{\tilde{\mathcal{A}}}^{m\dagger}_{f}\,{}^{II}\tilde{\mathcal{C}}^{m}_{f\alpha}\,.$$

The Clifford even "basis vectors", ${}^{I,II}\hat{\mathcal{A}}^{m\dagger}_{f}{}^{I,II}\mathcal{C}^{m}_{f\alpha}$ demonstrate gauge invariance.

Dmitry Kalashnikov

Influence of three-body recombination on formation of dark atoms.

Abstract: Nowadays dark matter models with thier own dark interaction becom more popular. They may solve a number of problems of cold dark matter model (CDM). The simplest viable model of self-interacting dark matter (SIDM) involves dark Coulomb-like interaction (with dark photon "y" as carrier) and two species of particles: dark electron (e_y) and dark proton (p_y). In present work, parameter space of the model was investigated, in which three-particle recombination makes a significant contribution to the number density of relic neutral atoms.

Maxim Yu. Khlopov

Recent advances of Beyond the Standard model cosmology

Abstract: The Standard Lambda CDM cosmology involves BSM physics. Development of any BSM model inevitably leads to model dependent deviations of the Standard scenario. I discuss the hints for dark atoms, for antimatter objects in baryon asymmetrical Universe and for primordial nonlinear structures, leading to early galaxy formation and Stochastic Gravitational Wave Background. The nontrivial dark atom, axion-like-particle and nonhomogeneous baryosynthesis scenarios are discussed. Model dependent fine tuning in the interpretation of the experimental data is considered as determination of classes of BSM models and their parameters with 'astronomical accuracy'. Type / to insert files and more

Maxim Yu. Khlopov, Orchidea Maria Lecian

(Speaker: Orchidea Maria Lecian)

Properties of Fractons

Abstract: The theoretical origin of fractionally-charged particles, as well as the pertinent experimental verifications, are exposed. So-called fractons are fractionally-charged-particles which arise in several models. The different types of fractons can be Hadronic-matter fractons, which be resulting in the description of new-long-range interactions, and leptonic fractons, which can be obtained after several kinds of super-symmetric theories. The attestation of the existence of fractons is looked for in Early Cosmology, Cosmology and Astrophysics. The postulation of the existence of fractons after the description of new long-range forces is recalled. Group-theoretical examinations are scrutinised. Particle-recombination modes are analysed. Experimental searches are enumerated.

Polina Korshunova

The search for dark matter space distribution facilitating explanation of the positron anomaly in cosmic rays

Abstract: The work is devoted to studying the influence of the spatial distribution of dark matter on the positron flux in cosmic rays. In particular, optimal parameters were found for describing the positron anomaly within the framework of the dark matter model with a small annihilating component distributed in the form of two thin rings around the center of the Galaxy.

Maxim Krasnov

Multidimensional f(R)-gravity as the source of primordial black holes

Abstract: The work is devoted to consideration of the quadratic f(R)-gravity with tensor corrections. It is shown that one of cosmological manifestations of modified gravity can be the formation of primordial black holes (PBHs). Properties of the domain walls generated in the considered model are described. The fact that these walls are supercritical leads to a modification of the mass spectrum of the emerging black holes, with respect to the case of subcritical walls. The final result of the work is the black hole mass spectra taking into account both the accretion of dust-like matter and radiation.

Euich Miztani

A Transformation Groupoid and Its Representation — A Theory of Dimensionality

Abstract: In higher dimensional physics there are usually two ways of dimensional reduction. One is by Kaluza-Klein theory and another by braneworld. In this talk we would like to discuss a third way of dimensional reduction. It is remarkably succinct, integrated by the groupoid and represented by the operation. Additionally, since it has a symmetry, it suggests an unknown conservation law based on Noether's theorem.

Pravin Natwariya

In Search of Global 21-cm Signal Using Artificial Neural Network in Light of EDGES and ARCADE 2

Abstract: Understanding the astrophysical nature of the first stars still remains an unsolved problem in cosmology. The redshifted global 21-cm signal and power spectrum act as a treasure trove to probe the Cosmic Dawn era when the first stars formed. Many experiments, like SARAS 3, SKA, EDGES, DARE, etc., have been proposed to probe the cosmic dawn era. However, extracting the faint cosmological signal buried inside the brighter foregrounds $O(10^4)$ remains challenging. However, we can construct the signal using Artificial Neural Network. In this talk, I will present how to reconstruct the 21 cm signal and estimate parameters related to the first stars formation from data containing foreground and noise.

Holger Bech Nielsen

1. Dark Matter with Macroscopic Particles Developed

(H. B. Nielsen, C. D. Froggatt)

Abstract: We continue the development of our dark matter model consisting in dark matter being macroscopic pearls based on a second type of vacuum. E.g. the mystery that contrary to DAMA-LIBRA the only somewhat less deep similar experiment Anais do not "see" the dark matter, is explained by our pearls running so fast untill the reach the depth like that of DAMA-LIBRA, that the emission of electrons from the above excited pearls gets so weak in Anais, that they are not noticed. But in the deeper DAMA-LIBRA the pearls move slower and have better time to radiate their excitation energy so as to be observed. In the underground experiments based on liquid xenon our pearls by gravity fall through rather quickly and there is little time for radiating the electrons, so they neither "see" the dark matter. We make detailed studies of the 3.5 keV X-ray supposedly

from dark matter. Connected to this dark matter is rather low tension domaine walls, which may allow us to consider a cosmology with walls largely replacing the cosmological constant in the standard cosmology. This may allow for a recontracting universe.

2. A Point of View of Gravity as Needed Spontaneous Breaking of Local General Linear Group
Abstract: We take as starting point geometry having locally - i.e. for the tangent space - general linear symmetry, as e.g. a total reparametrization invariant manifold, or a projective space time. Such a symmetry would allow us to use the derivation by Astri Kleppe and H.B.N. of locality of the theory with this symmetry imposed and obeying some mild analyticity assumption. But you get superlocallity and no propagation unless you somehow break the symmetry spontaneously, say. The needed breaking means really introduction of a gravitational $g^{\mu\nu}$ field with upper indices having a non-zero value even in "vacuum". Thus we need gravity to get propagation.

A seperate point is that find a slight evidence in the CMB-data favouring a projective space.

D. Sopin
Balancing baryon and dark matter excess
Abstract: Effect of the electroweak non-conservation of the baryon number could be a key ingredient to explain the ratio of dark and baryonic densities. The cosmological consequences of sphaleron transitions was considered for the minimal walking technicolor (WTC) model. The realization of multi-component dark atom scenario is possible because the electric charges of new fermions are not fixed. In particular cases the limits for the masses of techniparticles could be found. The obtained results can be applied to wider class of models, including Norma's stable 5th generation.

Konstantin Stepanyantz
The gauge coupling unification in Grand Unified Theories based on the group E_8
Abstract: We consider a theory with the gauge group E_8 assuming that the gauge symmetry breaking pattern is $E_8 \to E_7 \times U_1 \to E_6 \times U_1 \to SO_{10} \times U_1 \to SU_5 \times U_1 \to SU_3 \times SU_2 \times U_1$ and vacuum expectation values are acquired only by components of the representations 248. It is demonstrated that in this case there are several options for the relations between the gauge couplings of the resulting theory, but only one of them gives $\alpha_3 = \alpha_2$ and $\sin^2\theta_W = 3/8$. Also, it is the only option for which the resulting theory can include all MSSM superfields.

Valerija Vakulenko
Possibility of formation of antimeteorites in a globular cluster of antistars
Abstract: We analyze a possibility to form antimeteorites from an isolated globular cluster of antistars in our Galaxy. Assuming symmetry in production of light elements in Big Bang Nucleosynthesis antimatter solids should be the result of stellar nucleosynthesis. We show that heavy elements produced within the antimatter globular cluster dominantly leave this region, annihilate in the Galaxy and cannot form significant amount of antimatter molecules. The incoming anti-nuclei originated from similar clusters in other

galaxies cannot provide anti-molecule formation too. We consider Big Bang Nucleosynthesis in the antimatter domains with enhanced antibaryon density as an opportunity for the formation of heavy elements in antimatter domain.

K. Zioutas :

Clean energy from the dark Universe?

(K. Zioutas, V. Anastassopoulos, A. Argyriou, G. Cantatore, S. Cetin, A. Gardikiotis, H. Haralambous, M. Karuza, A. Kryemadhi, M. Maroudas, C. Oikonomou, K. Ozbozduman).

Abstract: The dark matter (DM) in the Universe is about 5 times more abundant than ordinary matter. The question is whether the stuff the dark Universe is made of, can be utilized as energy source, even though the widely assumed DM-flux could only provide some 10 Watt / m 2 . The recently introduced "planetary signatures" for the dark Universe, widely dubbed as invisible, can occasionally strongly enhance the DM flux due to planetary gravitational focusing, which is possible for the slow DM constituents of about 300 km/s. The estimated flux enhancements due to gravitational focusing can be occasionally several orders of magnitude, which could be utilized , in order to reach or even surpass energy fluxes at the level of the solar irradiation at Earth's position. Therefore, the already derived peaking planetary relationships for the upper atmosphere, i.e., Stratosphere and Ionosphere, can point at the spatiotemporal conditions which could optimize the utilization of energy from the dark sector. At the conference, an update of the progress made for the realization of this scheme will be presented.