Preface in English and Slovenian Language

Let us shortly overview the history of our workshops "What Comes Beyond the Standard Models?":
This year was 28^{th} time that our series of workshops on "What Comes Beyond the Standard Models?" took place. The series started in 1998 with the idea of organising a workshop where participants would spend most of the time in discussions, confronting different approaches and ideas. The picturesque town of Bled by the lake of the same name, surrounded by beautiful mountains and offering pleasant walks, was chosen to stimulate the discussions.
The idea was successful and has developed into an annual workshop, which is taking place every year since 1998. Very open-minded and fruitful discussions have become the trademark of our workshops, producing several published works. It took place in the house of Plemelj, which belongs to the Society of Mathematicians, Physicists and Astronomers of Slovenia.
We have been trying, and we are still trying to understand whether the laws of nature, the laws of our universe (of all the universes if there are many universes) are complicated and need many assumptions when we try to make predictions and comment on the experiments and observations, and whether we really have so many different constituents, or whether the law is simple, and there are only two kinds of the elementary constituents: anti-commuting fermions and commuting bosons, and all the anti-commuting fermions can be treated equivalently, and all the commuting bosons can be treated equivalently, while even these two elementary kinds of fields can be treated equivalently.
It is only when many interacting constituents are involved, that the approximate laws start to be needed when we look for the confirmation with the experiments and cosmological observations. And we will be forced also in future, even if we succeed in proving that the laws of nature are simple and the elementary fields are simple, even if the computers will be much more capable, to invent approximate constituents and approximate laws to be able to make predictions.
We will have to show that all the basic fermionic and bosonic fields, as we recognise them today, follow from simple equivalent building blocks of two types of fields. Although these two type of fields are so different, their mutual relation is very simple.
Although in these twenty-eight years, the technology of experiments, as well as astronomical observations, has advanced incredibly, it is still true that we are only guessing how our universe started and why it is expanding exponentially, and then reheated. Why do we experience only three space dimensions and one time, why most of the matter is almost unobservable in direct measurements, what forces our universe to expand faster than expected; many other open questions remain unanswered.
We improve our knowledge in small steps. But there were also large steps like the special theory of relativity, the general theory of gravity, the quantum theory of groups of constituents (in the first quantisation models), the second quantisation of bosons and fermions, the electroweak *standard model*, the *cosmological models*.

What seems trustworthy this year is that there are two kinds of the second quantised fields, commuting and anti-commuting, and that all the fields, fermions and bosons are second-quantised fields. At least some of the members of the organising committee, we are sure. Why the law of nature would make a difference between gravity and the rest of the boson fields.
In the Bled workshops "What comes beyond the standard models", the laws of nature among elementary second quantized fermion and boson fields, which should explain the born and the history of our universe, has been discussed and developed from the very beginning.
This year almost half of the contributions discuss the gravity in the content of the unification with the gauge boson fields.
The two contributions treating fermion and boson second quantized fields in a comparable way, use to describe the internal spaces of fermion and boson fields, the "basis vectors" which are products of nilpotents and projectors, and are the eigenvectors of the Cartan subalgebra members. The "basis vectors" with the odd number of nilpotents, appear in families, and offer in even-dimensional spaces, as it is d = (13 + 1), the unique description of all the properties of the observed fermion fields (with quarks and leptons and antiquarks and antileptons appearing in the same family). The "basis vectors" with the even number of nilpotents offer the description of the observed boson fields (gravitons have two nilpotents in the part $SO(3,1)$, photons (have only projectors), weak bosons (have two nilpotents in the part $SO(4)$), gluons (have two nilpotents in the part $SO(6)$) and scalars), providing that all the fields have non zero momenta only in $d = (3+1)$ of the ordinary space-time. Bosons have the space index α (which is for tensors and vectors $\mu = (0,1,2,3)$ and for scalars $\sigma \geq 5$). The two papers overviews the theory, presents new achievements, discuss the open problems of this theory, the second one with respect to the Feynman diagrams.
One contribution discusses the possibility that the gravitational field in $d = (3+1)$, as well as the quantum gravity emerges from the spontaneus break of the de Sitter $SO(1,4)$or anti-de Sitter $SO(3,2)$ group, formulated on a manifold without a metric structure. The author constructs t he Lagrangian densities using the Levi-Civita symbol. The spontaneus break of the starting symmetry reduces to the Lorentz group $SO(1,3)$ and dynamically generates a space-time metric. The analyse brings the observed Planck mass and the small cosmological constant, the massless graviton and massive scalar.
The author analyses the new anomalies arising from the attempt to develop an extension of the *standard model* with a general theory of gravity, and attempts to eliminate them. Fermions, which have the opposite chirality (chirality) in the left sector than the fermions of the right sector, interact with their own gauge fields with the symmetry $SU(3)$ and $U(1)$. The vector field $SU(2)$ and the metric are common to both sectors. The author assumes that the left sector describes the *standard model* coupled to gravity, and that the right sector describes dark matter consisting of quantum fermions and bosons that interact weakly with gravity and the weak force, and that interact with the bosons and fermions of the Standard Model.

One of the authors observes that the spectral action principle within the noncommutative geometry offers the derivation of the actions of the *standard model* and the *the general relativity* and discusses their phenomenological aspects.
One of the papers analyzes the usefulness of extended phase space for quantizing gravity.
There is an excellent pioneer DAMA project, which measured the presence of the dark matter by annual modulation of signals deep underground in Gran Sasso. It was decommissioned by the end of September 2024. Experiments have been running since 1990, developing several very low background measurement methods for measuring dark matter, as well as for many other rare events. The team presents an overview of the development of the DAMA experiment over the past 30 years.

There are papers which study the early universe.

One paper proposes that the $T \rightarrow 0$ vacuum naturally organizes into proton-scale. Suggesting the model, the author derives the Planck surface, the minimal coherent length, the density of the vacuum and the maximal velocity c.
One contribution investigates numerically spontaneous particle production by a pseudo-Nambu-Goldstone boson for small angles.
Another contribution study baryogenesis and the problem of matter-antimatter asymmetry in the early universe. They assume the existence of isolated antimatter domains that survive until the era of first star formation (Z approximately 20).
The author investigate how primordial black holes can catalyze the first-order phase transitions in the early universe, modifying the resulting gravitational wave signals.
The authors attempt to explain the excess of positrons measured by the Pamela experiment by measuring gamma rays. They hypothesize that the cause of this excess is dark matter with a large mass.
The dark atom hypothesis XHe offers with a neutral, atom-like configuration, an explanation for the dark matter. They try to show that their model can explain the existence of dark matter in the universe, anomalies in DAMA/LIBRA measurements.
The authors study the possible Lorentz invariance breaking in the unexplored weak sector. They propose experiments to measure this breaking at the LHC.
The author presents a very precise calculation of the fine structure constants, which is based on the connection between various physical phenomena and their associated logarithms of energy scales and an imagined lattice associated with the quantum oscillations of the phenomena under consideration. This connection provides him with a linear relationship from which he deduces, in the limit of unification, incredibly precise values of the energy scales.
The author discusses the geometric special relativity and its new Lie group in real space.
The author studies the properties of almost democratic matrices by considering the CP-violation, in particular the Jarlskog invariant-strains and finds the interdependence of quark masses.

The relativistic equations with The negative-energy and tachyonic solutions of the relativistic equations for higher spins are studied, bringing the paradoxical conclusions.
The author presents recent results of all-loop renormalization for supersymmetric theories. For some supersymmetric theories $\mathcal{N} = 1$ he shows how to construct expressions that have no quantum corrections at all orders. For the minimal supersymmetric extension of the *Standard Model*, the author checks the dependence of the results on the chosen scheme using three loops.
Maybe next year, we shall report on physically realistic cellular automaton used to offer several illustrations in elementary particle physics. This year, we only received the a short overview.

The workshops at Bled changed a lot after the COVID pandemic: For three years, the workshop became almost virtual and correspondingly less open-minded. The discussions, which asked the speaker to explain and prove each step, can not be done so easily virtually. However, many questions still interrupt the presentations, so the speakers must often continue their talks several times in the following days. Also, this year, the talks were presented virtually.

This year, the organisers are again asking the University of Ljubljana for the help in arranging the DOI number.
Although the *Society of Mathematicians, Physicists and Astronomers of Slovenia* remain our organiser, for which we are very grateful, yet the Faculty of Mathematics and Physics starts to be our publisher together with the University of Ljubljana. The technical procedure is now different, and the possibility that the participants send the contributions "the last moment" is less available.
Several participants have not managed to submit their contributions in time. We have several suggestions for solving the open problems, which have not succeeded to be prepared in time for the discussion section.
The organisers are grateful to all the participants for the lively presentations and discussions and an excellent working atmosphere, although most participants appeared virtually, led by Maxim Khlopov.
The reader can find all the talks and soon also the whole Proceedings on the official website of the Workshop: http://bsm.fmf.uni-lj.si/bled2025bsm/presentations.html, and on the Cosmovia Forum https://bit.ly/bled2025bsm ..

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