Description of the project's outline and work break down structure

The detailed research plan is divided into two interrelated **work packages** (WPs). Scientific collaboration between the packages as well as external to the project Bulgarian and international researchers is anticipated.

a). **WP1** entitled "Symmetry aspects of the project: Lie (super)algebras, $Z_2 \times Z_2$-graded algebras, quantum groups. Representation theory." N. Stoilova, S. Stoimenov, J. Van der Jeugt, R. Oste

Symmetry aspects of quantum statistics and models of quantum systems used in the second package require the expertise of group theoretical methods and algebraic techniques. The objective of this package is to develop the mathematical tools for this. We will study and contribute to the theory of Lie (super)algebras, $Z_2 \times Z_2$-graded algebras, quantum groups and their representation theory. We will:

- construct explicitly a class of unitary irreducible representations of the Lie superalgebra $B(\infty|\infty)$ using its subalgebra $gl(\infty|\infty)$, its covariant representations and certain Clebsch-Gordan coefficients.
- define the $Z_2 \times Z_2$-graded analogues of the basic classical Lie superalgebras $A(m|n)$, $C(n)$, $D(m|n)$, unravel their subalgebra structure and root space decomposition.
- investigate specific representations of 2D conformal algebra in terms of time-space variables different from the light cone coordinates u=t+ir and u'=t-ir, defined recently as representations of the meta-conformal algebra **mconf(1,1)** in (1+1) time-space dimensions. Next, possible generalizations to **mconf(1,d)** (especially for d=2) will be considered.
- develop an algebraic technique to apply local scale invariance to non-equilibrium statistical models with a dynamical exponent z≠1,2, which require finding new

representations of spin-l conformal Galilean algebras, known also as generalized Schrödinger algebra.

b). **WP2** entitled “Generalized quantum statistics. Quantum systems”. N. Minkov, N. Stoilova, J. Van der Jeugt

We will:

- consider a mixed system of infinite number of parabosons and infinite number of parafermions with relative paraboson commutation relations. Fock space of the system will be constructed and as a result this will allow to investigate the physical properties of such mixed systems of paraparticles and in particular of paraparticles corresponding to order of statistics p=2, which are candidates for particles of dark matter and energy.
- consider a mixed system of infinite number of parabosons and infinite number of parafermions with relative parafermion commutation relations. Fock space of the system will be constructed and as a result this will allow to investigate the physical properties of such mixed systems of paraparticles.
- classify the generalized quantum statistics associated with the $Z_2 \times Z_2$-graded analogues of the basic classical Lie superalgebras.
- apply the highest weight proxy SU(3) irreps obtained from the U(N)⊃SU(3) reduction algorithm to explore the dependence of nuclear quadrupole deformation on the nuclear shell structure with emphasis on neutron rich and superheavy nuclei. Within this scheme we shall examine the possible regions of shape coexistence.
- apply the Vector Boson Model Hamiltonian with the highest weight proxy SU(3) irreps in wide ranges of heavy deformed nuclei. Predictions for the spectra and electromagnetic transition rates in neutron rich and superheavy nuclei will be made.