The most significant 20 papers:

[1] A.A.Raduta, A.Sandulescu, Microscopic theory of two phonon quadrupole-octupole vibrations in spherical nuclei, Nucl.Phys.A.181 (1972) 153.

The papers, authored by A. A. Raduta, regarding the microscopic description of the quadrupole-octupole double phonon states were the first in literature. Besides the solution proposed in the above mentioned paper some additional solutions were proposed in several publications: Nucl. Phys. A 149(1970) 11,Phys.Rev. C8 (1973) 1525, Progr. Th. Phys.3, 52 (1974), Ann of Phys. 100 (1976) 94.
One method used to describe the negative parity quintuplet is that of the boson expansion, which first expresses the microscopic Hamiltonian as a polynomial of quadrupole and octupole RPA (random phase approximation) phonon operators. To diagonalize such a Hamiltonian one has to calculate the degeneracy of the irreducible representations of the R(7) symmetry group. For this quantity A. A. Raduta provided an analytical solution. Results in this field are quoted in review papers by several authors like P. Vogel , V.G. Soloviov , S.D. Rohozinski, P. Butler, P. Nazarewic.

[2] A.A.Raduta, V. Ceausescu, A.Gheorghe, M.S.Popa, Semiclassical treatment of the interaction between individual and quadrupole collective degrees of freedom, Nucl. Phys. A 427 (1984) 1.

In this paper one studies the semiclassical behavior of a set of nucleons and a collective core described by a quadrupole coherent state. Using a time dependent variational principle one obtains the classical equations of motion for the phase space coordinates. The BCS and RPA approximations are succesively adopted to solve the classical equations. In this way the classical origin of the well known approaches called BCS and RPA was proved. The problem of the SU(2) classical quasi-spin algebra and its quantisation was also

treated.

Besides the Holstein-Primakoff and Dyson boson representations for the quasispin algebra a new one is obtained. This result is quoted in the review paper of A. Klein and E.R. Marshalek (Rev. Mod. Phys.63 (1991)516)

[3] A.Gheorghe, A.A.Raduta, V.Ceausescu, On the exact solution of the harmonic quadrupole collective Hamiltonian, Nucl. Phys. A 296 (1978) 228.

In 1953 A. Bohr and B. Mottelson proposed the liquid drop model to describe the quadrupole oscilations around a spherical nuclear shape. In the intrinsic frame the wave function, which describes the mentioned oscillations, depends on the dynamic variables beta and gamma as well as on the Euler angles which define the relative position of the intrinsic and the laboratory frames. The gamma dependence of these functions was unknown for about 25 years. Based on the theory of harmonic functions in five variables we constructed an original basis which corresponds to the group reduction chain SU(5)† O(5)† O(3) † O(2) and labeled by the following quantum numbers: the number of bosons N, the seniority v, the missing quantum number l, the angular momentum J and its projection on Z axis, M. There are another two basis on the market proposed by the groups of Moshinski and Williams, about the same year. The three basis are distinct from each other. Our basis has the advantage of providing very compact matrix elements for boson monomials (see AA. Raduta et al., Nucl. Phys. A 311 (1978) 118). It is used by many groups and quoted by experts in their publications and books.

[4] A.A.Raduta, V.Ceausescu, A.Gheorghe, R.M.Dreizler, Phenomenological description of three interacting bands, Nucl. Phys. A 381 (1982) 253.

The proposed model is called the Coherent State Model (CSM) and treats an effective quadrupole boson Hamiltonian in a[8] A.

A. Raduta, C. M. Raduta, Amand Faessler, The CSM extension to the odd-even octupole deformed nuclei, Phys. Rev. C 80, 044327 (2009). restricted collective space, defined through angular momentum projection from an axially symmetric coherent state and two orthogonal elementary excitations of it. The formalism is aimed at describing, in a realistic fashion, the excitation energies for states with high and very high spins as well as the interband and intraband E2 transitions in ground, beta and gamma bands. The model works very well for transitional and well deformed nuclei, for low and high spin states. The quoted paper was the starting point for several signi[8] A. A. Raduta, C. M. Raduta, Amand Faessler, The CSM extension to the odd-even octupole deformed nuclei, Phys. Rev. C 80, 044327 (2009).ficant improvements. This paper is quoted in books (see the book of P. Ring and P. Shuck) and important review papers. In the publication from Rev. Mod. Phys. 63 (1991) 375 signed by A. Klein and E. P. Marshalek the CSM is considered as one of the important achievements in the field of collective models.

Also, in Prog. Th. Phys. 70(1983) 176, Huruo Ui and Gyo Takeda consider that our formalism is the only one which correctly interpret the rotational states as a consequense of a spontaneous symmetry breaking. Our procedure is in detail described in the book of W. Greiner about collective models.

**[5] A. A. Raduta, R. Budaca, A. Faessler, Analytical description of the coherent state model for near vibrational and well deformed nuclei,
Ann Phys [NY] 327 (2012) 671.**

In Ref.[8] A. A. Raduta, C. M. Raduta, Amand Faessler, The

CSM extension to the odd-even octupole deformed nuclei, Phys. Rev. C 80, 044327 (2009). Jour. Phys. G: Nucl. Part. Phys. 37 (2010) 085108 (A. A. Raduta at al.), based on a semiclassical description, we arived at a compact formula for the ground band energies, which generalizes the famous equation of Holmberg-Lipas. Moreover, exploiting the rotational symmetry we found out that the classical potential energy leads to the so called Davidson potential. This result encouraged us to generalize it to the CSM model. Thus, using Taylor expansions for the matrix elements in the extreme cases of small and large deformations we obtained compact formulas for the excitation energies in the ground, beta and gamma bands as well as for the reduced probabilities of inter and intra-bands E2 transitions . A least square fit of the involved parameters have been used to describe the existent data for nuclei belonging to different shape symmetries. Applications for 44 nuclei showed a very good agreement with the experimental data.

[6] A.A.Raduta, A.Faessler, V.Ceausescu, Description of the K? = 1+ magnetic states within a generalised coherent state model, Phys. Rev. C36 (1987) 2111.

The CSM was generalized by considering also the isospin degrees of freedom. Concretly, we consider distinct bosons for protons and neutrons, respectively. The model is aimed at describing the magnetic collective states in medium and heavy nuclei. It provides a consistent quantitative description of the properties: 1) the excitation energy for the scissors mode; 2) The B(M1;0+-->1+) valu[8] A. A. Raduta, C. M. Raduta, Amand Faessler, The CSM extension to the odd-even octupole deformed nuclei, Phys. Rev. C 80, 044327 (2009).e;3) The M1 form factor for the (e,e') process.; 4) The description of M3 states; 5) We did'nt describe the state 1^+ in isolation but simultaneously considered 6 bands including the ground, beta and gamma bands. 6) We have

analytically proved that the M1 strength is proportional to the nuclear deformation squared and by this the collective nature of the scissors mode. 7) The model generalizes both the two drops and the two rotors models. We extended the GCSM to the even-odd nuclei (A. A. Raduta et al., Z. f. Phys. A 334 (1989) 403; A.A. Raduta et al., Nucl. Phys. A 513 (1990) 11). Our predictions for 155Gd and 163Dy have been experimentally confirmed, as shown in Ref. U. Kneissl et al., Prog. Part Nucl Phys. 37 (1996) 349. Within a particle-core formlism, with the core described by the GCSM, an elegant treatment of the chiral symmetries in the even-even nuclei was possible (see J. Phys. G: Nucl. Part. Phys 41 (2014) 035105).

[7] A. A. Raduta, Al. H. Raduta and C. M. Raduta, Simultaneous description of four positive and four negative parity bands, Phys. Rev. C74 (2006) 044312.

The CSM has been extended to the negative parity states by replacing the quadrupole boson coherent state with the product of a quadrupole and an octupole boson coherent state with axial symmetry. Thus, the intrinsic ground state breaks not only the rotation symmetry but also the space reflection symmetry.Therefore, an additional symmetry projection, that of parity, is necessary. To the major bands, ground, beta and gamma, three parity partner bands denoted by g-, b-, g- respectively, correspond. Additionally, two dipole bands of opposite parities are defined. The E2, E1 and E3 properties are systematically studied. Signatures for static octupole deformation in ground and excited bands are pointed out by means of the energy displacement functions of first and second order. For ground, beta and gamma bands one finds out that from a critical angular momentum the angular momenta carried by the quadrupole and the octupole bosons are orthogonal onto each other. The dipole bands are of different nature. While in the dipole positive band the magnetic properties prevail, the negative parity band is of an electric nature.

[8] A. A. Raduta, C. M. Raduta, Amand Faessler, The CSM extension to the odd-even octupole deformed nuclei, Phys. Rev. C 80, 044327 (2009).

A particle-core model is formulated to describe the positive and negative parity bands in even-odd nuclei. The phenomenological core is associated to the description presented at [5]. The nucleons may move in two states of positive and one state of negative parity. By angular momentum projection from the particle core deformed and parity mixed basis, one obtains six sets of model states for describing three bands of positive and three bands of negative parity. As mentioned above the states describing the phenomenological core have the property that starting with a critical total spin, the angular momenta carried by the quadrupole and the octupole bosons respectively, are mutually orthogonal. For the bands with K=5/2 we pointed out that the three components of the composite system may achieve a configuration exhibiting a chiral symmetry.

[9] A. A. Raduta and E. Moya de Guerra, Isospin and particle number projection with generalized nucleon-nucleon pairing, Ann. Phys. N. Y., 284 (2000) 1.

The gound state of a pairing correlated system of protons and neutrons is described by a generalized BCS wave function. Only the pairs with T=1 are considered. Of course this wave function breaks the rotation symmetry in the isospin space.
We derived the expression of the state obtained by boson number, isospin and its third component projections from the generalized BCS ground state. In the space of projected states an isospin invariant Hamiltonian has been considered. The effect of projection on energies and transition probabilities has been quantitatively studied for a single j case, where the Hamiltonian is solvable. One concludes that the projection affects both energies and transition probability. For the single j case the result for energies provided by the projected

states coincide with the exact one. This is in fact an indirect prove that the projected states are just the irreducible representation of the O(5) group.   In the near future we intend to generalize the proposed formalism to the situation where both the T=1 and T=0 pairing interactions are included.

[10] A. A. Raduta, L. Zamick, E. Moya de Guerra, A. Faessler and P. Sarriguren, Description of Single and Double analog States in the f7/2 shell:the Ti Isotopes, Phys. Rev. C, 68 (2003) 044317.

The excitation energies of single analog states in even-odd Ti isotopes and double analog states in even-even Ti isotopes are microscopically described in a single j-shell formalism. A projection procedure for generalized BCS states has been used. As an alternative description a particle-core formalism is proposed. The later picture provides a two parameter expression for excitation energies, which describes fairly well the data in four odd and three even isotopes of Ti.

[11] A.A.Raduta, A.Faessler, S.Stoica, The 2nbb decay rate within a boson expansion formalism, Nucl.Phys.A 534 (1991) 149.

We estimated the higher pnQRPA effects, through a boson expansion technic, on the Gamow-Teller transition amplitude of the 2nbb process. It was shown that including the higher pnQRPA contribution, the value of the particle-particle channel strength for which the pnQRPA breaks down is shifted to an
unphysical region. Moreover, some processes which are forbidden within the
pnQRPA, are allowed in a higher pnQRPA picture. An example is the double beta transition to an excited final state. Thus, we were the first who calculated the transition rate of the decay $0^+\to 2^+$. One should mention that in order to satisfy the boson expansion

requirements we had to use not only a dipole charge non-conserving boson but also a quadrupole charge conserving one. It is worth mentioning that after our papers appeared several groups have investigated the higher RPA effects on the Gamow-Teller transition amplitude by using similar approaches.

[12] A.A.Raduta, D.S.Delion and N. Lo Iudice, A projected single particle basis for deformed nuclei, Nucl.Phys. A551 (1993) 73.

A spherical projected single particle basis was obtained in above quoted paper.This basis depends on a parameter which simulates the nuclear deformation. When the deformation goes to zero one obtains the spherical shell model basis, while when the deformation is diferent from zero the corresponding energies are close to those of Nilsson scheme. The mathematical properties of this basis were in extenso studied. The usefulness of such a basis consists in that it allows for an unitary description of spherical and deformed nuclei. Thus, the RPA states obtained with this single particle basis, have good angular momentum. By contrast, the many body theories using deformed single particle basis should be supplemented by a tedious projection formalism for angular momentum. This basis was succesfully used for the description of the orbital and spin-flip modes (up to 10 MeV) in Sm isotopes (see Ref: A.A. Raduta et al., Phys. Rev. C 65 (2002) 0243121). Another application concerns the infuence of nuclear deformation on the Gamow-Teller amplitude for the 2nbb decay.

[13] A. A. Raduta, C. M. Raduta and A. Escuderos, New results for the two neutrino double beta decay in deformed nuclei with angular momentum projected basis, Phys. Rev. C 71 (2005) 034317.

Using an angular momentum projected single particle basis, a pnQRPA approach is used to study the 2nbb properties of ten isotopes,

exhibiting various quadrupole deformations. The mother and daughter nuclei exhibit different quadrupole deformations. Since the projected basis enables a unified description of deformed and spherical nuclei, situations where the nuclei involved in the double beta decay process are both spherical, both deformed or one spherical and another deformed, can be treated through a sole formalism. Dependence of single b- and b+ strength distribution on atomic mass number and nuclear deformation is analyzed. For the double beta decay process, the Gamow-Teller transition amplitudes and half lives are calculated. Results are compared with the experimental data as well as with the predictions of other theoretical approaches. The agreement between the present results and experimental data is fairly good.

[14] C. M. Raduta, A. A. Raduta, I. I. Ursu, New teoretical results for 2nbb decay within a fully renormalized proton-neutron random phase approximation approach with the gauge symmetry resored, Phys. Rev. C 84, 064322 (2011).

A many body Hamiltonian involving the mean field for a projected spherical single particle basis, the pairing interactions for alike nucleons and the dipole-dipole proton-neutron interactions in the particle-hole (ph) and particle-particle (pp) channels is treated by a gauge restored and a fully renormalized proton-neutron quasiparticle random phase approximation (GRFRpnQRPA) formalism. The resulting wave functions and energies for the mother and the daughter nuclei are used to calculate the 2nbb decay rate and the process half life for the emitters:
48Ca, 76Ge, 82Se and 96Zr. The results are in good agreement with the corresponding experimental data. Also we compared our results with those obtained by other traditional methods. The Ikeda sum rule (ISR) is obeyed. The gauge projection makes the pp interaction inefficient. This is the first higher pnQRPA procedure which satisfies (ISR).

[15] A. A. Raduta, R. Budaca, Al. H. Raduta, Colective dipole excitations in sodium clusters, Phys. Rev. A.79, 023202 (2009).

Recently, a new model for describing the deformed clusters was proposed [A.A. Raduta et al., Phys. Rev. B 59 (1999) 8209]. The mass abundence, the shapes of Na clusters are realistically described. Several features which cannot be described within the Clemenger model are consistently explained by the present approach. Also the super-shell effects are reasonably well reproduced. Recently, several features [A. A. Raduta et al., Eur. Phys. Jour. D 15 (2001) 65.] like skin effect, static polarizability, plasmon oscillations, halo structure for Na clusters have been investigated. In this paper we calculated the collective dipole excitations in light and medium Na clusters. Comparison with experimental data is made in terms of photo-absorbtion cross section. A good agreement with the data is obtained.
Besides the collective excitations of a surface nature we pointed out also volume like excitations around the energy of 6 eV. The formalism used in our paper is that of a particle-hole RPA using a projected spherical single particle basis. Using the RPA wave functions we calculated the number of the spilled-out electrons which is furter used to calculate the system polarizability. Again, a good agreement with the corresponding data is obtained.

[16] A. A. Raduta and R. Budaca, Semi-microscopic description of the backbending phenomena in some deformed even-even nuclei, Phys. Rev. C 84 (2011) 044323.

The mechanism of backbending is semi-phenomenologically investigated based on the hybridization of two rotational bands. These bands are defined by treating a model Hamiltonian describing two interacting subsystems: a set of particles moving in a deformed mean field and interacting among themselves through an effective pairing force and

a phenomenological deformed core whose intrinsic ground state is an axially symmetric coherent boson state. The two components interact with each other by a quadrupole-quadrupole and a spin-spin interaction. The total Hamiltonian is considered in the space of states with good angular momentum, projected from a quadrupole deformed product function. The single-particle factor function defines the nature of the rotational bands, one corresponding to the ground band in which all particles are paired and another one built upon a i13/2 neutron broken pair. The formalism is applied to six deformed even-even nuclei, known as being good backbenders. Agreement between theory and experiment is quite good.
Recently (R. Budaca, A. A. Raduta, Jour. Phys. G: Nucl. Part. Phys, 40 (2013))the formalism was extended as to simultaneously describe the double backbending phenomena. The second backbending is caused by breaking a proton pair in the orbital h11/2 and the band crossing of two neutron quasiparticle band with a four quasiparticle, 2nqp +2pqp, band.

[17] A. A. Raduta and C. M. Raduta, Interplay of classical and quantal features within the coherent-state model, Phys. Rev. C 86 (2012) 054307.

The CSM (coherent state model) describes the ground band states by wave functions obtained through angular momentum projection from an axially symmetric coherent state. The unprojected state is associated to the nuclear system in the intrinsic reference frame and describes a classical behavior reflected by the fact that the uncertainty relations for the quadrupole coordinate and the corresponding
conjugate momentum reach the minimum values. Symmetry restoration favor the quantal behavior. A measure for the departure from the classical limit is the deviation of the variances product from the classical value. We considered two pairs of conjugate variables: a)

the quadrupole coordinate and the conjugate momentum;

b) The number of quadrupole bosons and the conjugate phase. In the competition of the two sets of features, classical and quantal, an important role is played by the nuclear deformation. For small deformation the quantal behavior is dominant while for large deformation the classical aspects prevail over the classical ones.

[18] M. I. Krivoruchenko, A. A. Raduta and Amand Faessler, Quantum deformation of the Dirac bracket, Phys. Rev. D 73, 029905 (2006).

Constrained systems are classified by the Hamiltonian formalism as systems with constraint of class II. In this paper it was proved that any system of point like particles with holonome constraints exhibits a hidden gauge symmetry which allows the quantisation in the original phase space, as a system with costraints of the class I. The method was applied to the case of a particle moving on a (n-1) dimensional sphere. Also its analouge from the field theory, the non-linear O(n) sigma model has been considered. The quantum deformation of the Poisson bracket is the Moyal bracket. The quantum deformation of the Dirac bracket for systems which admit global symplectic bases for the constraints functions, has been constructed. Equivalently, the Moyal brackets were extended for systems having second clasThe phase transitions from U(5) to O(6) and from U(5) to SU(3) are achieved bypassing through critical points which correscpond at their turn to the symmetries E(5) and X(5) respectively. In the case of X(5) the wave function depending on the variable gamma is not periodic and moreover is normalized to unity on an unbound interval. Moreover the scalar product is defined with respect to an integration measure which is different from that used by the liquid drop model. Also the Hamiltonian in gamma is not hermitian as it should be.These drawbacks of the previous publications were removed in the quoted paper. Indeed, the Hamiltonian in gamma is an differential operator which has as eigenfunctions the spheroidal functions of prolate type, which are periodic and moreover normalized to unity with the standard measure proposed by the liquid drop model. We have proved that in the asymptotic region the X(5) model is recovered. Numerical application to Sm152, Nd150, Gd154 and Os192 shows a very good agreement with the experimental data for both the excitation energies in the ground, beta and gamma bands and the E2 inter and intraband transitions (Phys. Lett. B 648 (2007) 171-175).

s constraints. The same is valid also for systems which become of second class after fixing the gauge (International Journal of Modern Physics A, vol. 22, nr. 4 (2007) 787-833, Phys. Lett B. 608 (2005) 164).

[19] A. A. Raduta, A. D. Aaron and I. I. Ursu, Semiclassical description of a sixth order quadrupole boson Hamiltonian, Nucl. Phys. A, A 772 (2006)20-54.

In several publications(Nucl. Phys. A, A 772 (2006)20-54, Phys. Rev. C 67 (2003) 014301,Jour. Phys. G. 34 (2007) 2053-2061,Jour. Phys. G. 36 (2009) 055101)

the solvable boson Hamiltonians have been studied from both classical andquantum mecanical point of view. Dequantizing the chosen Hamiltonian one obtains classical equations of motion of Hamilton type. The number of the degrees of freedom and of prime integrals are equal to each other, and therefore the correspondin

Hamiltonians are fully solvable. The classical solutions are elliptic periodic functions. These trajectories are quantized by the standard restrictions on the classical action. The potential energy of one of the studied Hamiltonians have two minima, one of them corresponing to a spherical nuclear shape. Trajectories in the two wells have specific properties. When the energy approaches the the pick of the potential barrier, the period tends to infinity. As a matter of fact this is a nice example where a phase transition takes place in an excited state. Another boson Hamiltonian studied in Ref. is of sixth

order and leads to an analytical semi-classical spectrum involving only 4 free parameters. This energy formula has been used to describe the multiplets 0+ and 2+. The most interesting case seems to be that of Er168 where 105 energies are available, 26 for 0+ and 79 for 2+. It is worth mentioning that all these data have been quantitatively described with a good accuracy.

[20] A. A. Raduta, A. C. Gheorghe, P. Buganu and A. Faessler, A solvable model which has X(5) as a limiting symmetry and removes some inherent drawbacks, Nucl. Phys. A. 819 (2009) 46-78.

The phase transitions from U(5) to O(6) and from U(5) to SU(3) are achieved bypassing through critical points which correscpond at their turn to the symmetries E(5) and X(5) respectively. In the case of X(5) the wave function depending on the variable gamma is not periodic and moreover is normalized to unity on an unbound interval. Moreover the scalar product is defined with respect to an integration measure which is different from that used by the liquid drop model. Also the Hamiltonian in gamma is not hermitian as it should be.These drawbacks of the previous publications were removed in the quoted paper. Indeed, the Hamiltonian in gamma is an differential operator which has as eigenfunctions the spheroidal functions of prolate type, which are periodic and moreover normalized to unity with the standard measure proposed by the liquid drop model. We have proved that in the asymptotic region the X(5) model is recovered. Numerical application to Sm152, Nd150, Gd154 and Os192 shows a very good agreement with the experimental data for both the excitation energies in the ground, beta and gamma bands and the E2 inter and intraband transitions (Phys. Lett. B 648 (2007) 171-175).