Nuclear structure theory studies in Poland

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The purpose of the present note is to summarize the activity of Polish physicists in recent nuclear structure theory (NST) studies. My scope is limited by two defining factors, i.e., I consider only the physicists who: (i) in 1999 have been employed in Poland, and (ii) in years 1996-1999 have published in journals paper(s) on the NST. The first (geographic) factor is relatively easy to implement. We are fairly small a community, and therefore, it is not too difficult to enumerate all colleagues who qualify as the nuclear structure theoreticians. However, in order not to omit anybody, in the beginning of November 1999 I have asked colleagues from several institutions to provide me with lists of their closest collaborators.

These lists constituted the baseline for taking into account the second (thematic) factor. To this end, I have collected the 1996-1999 lists of publications of all the physicists who fulfill the geographic criterion. This has been done by using the automated searches within the INSPEC 1996-1999 data base. The data base was up-to-date including the 45th week of 1999, and started with the complete year of 1996, so effectively it spanned over about three and a half year. The beginning of the data base does not exactly correspond to the beginning of the calendar year 1996; some papers from the beginning of 1996 are missing (they are accounted for in the 1995 data base) while, on the other hand, some papers from 1995 are included. Similarly, some of the papers published in the second half of 1999 are also missing. Fortunately, these small shifts and omissions are not very significant for the global picture.

I have taken all possible precautions to account for misspelled names or non-standard initials, appearing sometimes on the author lists, especially for popular names [e.g. L.A. Baran (1 paper) or T. Werner (1 paper)].

In what follows, only those papers which have been published in refereed journals are taken into account. Within this restriction, I have found 188 references, of which 71 were marked in the data base as the "conference papers" (all of them published in journals). By scanning their titles and abstracts I have selected those papers which I personally consider as belonging to the domain of the NST. This is, of course, a very vague definition and a fair amount of arbitrariness is involved in making decisions for a few of these papers, However, I have no doubt that most of my colleagues would have made a very similar selection. Finally, I have kept 160 papers in the NST set, of which 63 were marked as the "conference papers".

I have also attempted to estimate possible errors in the performed data base searches. To this end, for papers originating from my own Institute I have compared the obtained list with that which I had already at my disposal, and I have found no differences. This gave me the confidence that the collected data are reasonably complete.

Physicist who signed the 160 papers are affiliated with six different institutions. Five of them are the Polish scientific institutes, while the sixth one, the University of Tennessee, is included in the analyses below because of the special position of Witek Nazarewicz, who is employed both by the University of Tennessee and by the Warsaw University.

Finally, the list of 29 physicists employed in 1999 in Poland, who in years 1996-1999 have published at least one journal paper on the NST, is as follows. For each institution I have also included the lists of the current PhD students.

I. IFT: Institute of Theoretical Physics, Warsaw University, Warsaw

Staff members:

1. Jacek Dobaczewski
2. Witold Nazarewicz
3. Stanisław G. Rohoziński
4. Wojciech Satuła
5. Zdzisław Szymański[a]
6. Tomasz Werner

PhD students:

1. Rainald Kirchner
2. Przemysław Olbratowski
3. Elżbieta Perlińska

[a]Deceased on September 5, 1999

II. UT: Department of Physics and Astronomy, University of Tennessee, Knoxville

Staff members:

1. Witold Nazarewicz

PhD students:

1. Mladen Matev

III. PW: Faculty of Physics, Warsaw Institute of Technology, Warsaw

Staff members:

1. Stefan Ćwiok
2. Piotr Magierski

PhD students:

1. Rafał Nowakowski

IV. IPJ: Soltan Institute of Nuclear Studies, Warsaw

Staff members:

1. Zygmunt Patyk
2. Janusz Skalski
3. Robert Smolańczuk
4. Adam Sobiczewski
5. Sławomir Wycech

PhD students:

1. Igor Muntian

V. UMCS: Institute of Physics, Maria Curie-Skłodowska University, Lublin

Staff members:

1. Andrzej Baran
2. Waldemar Berej
3. Andrzej Bobyk
4. Andrzej Góźdź
5. Wiesław Kamiński
6. Zdzisław Łojewski
7. Bożena Nerlo-Pomorska
8. Krzysztof Pomorski
9. Leszek Próchniak
10. Piotr Rozmej
11. Andrzej Staszczak
12. Stanisław Szpikowski[a]
13. Michał Warda
14. Krystyna Zając

PhD students:

1. Małgorzata Kleban
2. Michał Kowal
3. Dariusz Nuzka
4. Marek Pietrow
5. Daniel Rosły
6. Paweł Rutkowski
7. Agnieszka Surowiec
8. Marian Turek
9. Paweł Zaręba

[a]Professor Emeritus

VI. IFJ: Niewodniczański Institute of Nuclear Physics, Cracow

Staff members:

1. Stanisław Drożdż
2. Jacek Okołowicz

PhD students:

Table 1 summarizes the numbers of 1999 staff members, PhD students, and the NST papers published in 1996-1999 in journals. One should note that the quoted numbers papers pertain only to the activity in the NST research. On the other hand, some of the groups, especially from UMCS and IFJ, devote a substantial fraction of their activity to research in other branches of science.

The total numbers of papers (the last column) are smaller than sums of numbers given in the first columns. This is so, because many papers have been prepared in collaboration between two or more institutions.

Table 1:

Institution	IFT	UT	PW	IPJ	UMCS	IFJ	TOTAL
Number of staff members	*6*	*1*	*2*	*5*	*14*	*2*	*29*
Number of PhD students	*3*	*1*	*1*	*1*	*9*	*0*	*15*
Number of non-conference papers in journals	44	30	8	19	22	4	97
Number of conference papers in journals	17	12	4	19	18	3	63
Total number of papers in journals	61	42	12	38	40	7	160

Table 2:

Institution	IFT	UT	PW	IPJ	UMCS	IFJ	
IFT:	61	23	5	3	5	-	*51%*
UT:		42	5	1	-	-	*62%*
PW:			12	1	-	-	*67%*
IPJ:				38	2	-	*13%*
UMCS:					40	-	*13%*
IFJ:						7	*0%*

In order to visualize the pattern of the collaboration, Table 2 supplements the numbers of papers published in each institution (the main diagonal) by the numbers of papers prepared in collaboration between pairs of institutions (the off-diagonal boxes). In addition, 5 papers have been prepared in collaboration between three institutions (3 papers for the IFT+UT+PW collaboration, and 2 papers for the IFT+IPJ+UMCS collaboration) The right most column gives for every institution the percentage of papers published in collaboration with other institutions. It turns out that IFT, UT, and PW constitute a very closely collaborating set of institutions, with over 50% of papers published in collaboration with other institutions. These three institutions have very strong connections, and in fact, since many years they collaborate under common research grants.

Table 2 also allows to obtain the total numbers of papers published by groups of institutions. In particular, IFT and UT have published together 80 papers (61+42−23). Similarly, the strongly collaborating team IFT+UT+PW has published 85 papers, and the weakly collaborating team IPJ+UMCS+IFJ has published 83 papers, with 8 papers being common publications of both teams.

Table 3:

Themes	**Numbers of papers**	
Nuclei far from stability	10	
Densities and halos	10	
Masses	11	
Radii	3	
r-process	2	
Neutron matter	1	**37**
Superdeformation	17	
High-spin phenomena	17	**34**
Superheavy elements	19	
Fission	3	**22**
Quadrupole collective states	9	
Electromagnetic transitions	4	
Shape coexistence	2	
Octupole shapes	1	**16**
Pairing	3	
Proton-neutron pairing	4	**7**
β decay and double-β decay	6	**6**
Proton and two-proton emitters	4	**4**
Giant resonances	4	**4**
Algebraic and supersymmetric models	4	**4**
Shell model and continuum shell model	3	**3**
Chaos	2	**2**
Theoretical methods	8	**8**
Other	13	**13**
Total	160	**160**

Table 3 shows the distribution of the published papers among the main themes of investigation. Every paper has been attributed to one of the listed categories. Of course, this constitutes a fairly schematic classification, because in most papers several aspects have been considered simultaneously. Nevertheless, in the Table one can easily distinguish the main directions of the recent NST studies in Poland.

Three subjects carry the most thrust: (i) nuclei far from stability, with special emphasis on the neutron-rich nuclei and their density distributions, halos, masses, and radii (37 papers), (ii) high-spin phenomena with a particular emphasis on the structure of superdeformed nuclei (34 papers), and (ii) the superheavy elements with their fission and other decay modes (22 papers). Study of the quadrupole and other collective excitations (16 papers) also remains one of the main research directions. Pairing (7) and β-decay phenomena (6) belong to the set of more diversified subjects, followed by studies of proton emitters (4) and giant resonances (4). Two of the selected themes use specific theoretical tools, i.e., the algebraic models (4) and the shell model (3). It is interesting that a relatively small number of studies (8) dealt with developing new theoretical methods; most of the effort has in fact been devoted to the study of specific physical phenomena. Finally, 13 remaining papers could not be easily fit into the above classification scheme.

In order to complete the census of the recent NST studies in Poland, let me present below the list of main research results achieved in 1996-1999. The selection is not at all meant to give an objective opinion, which in fact I do not believe to be possible. It only reflects my purely personal and highly biased opinion. Table 4 lists such main research achievements together with the corresponding bibliography references.

Table 4:

No.	Year	Research achievement in 1996-1999	References
1.	1996	Identification of deformed intruder configurations in heavy isotopes around N=28	.... [1]
2.	1996	Quantitative classification of the occurrence of identical superdeformed bands	.... [2]
3.	1996	Analysis of pairing properties of neutron-rich nuclei	.... [3]
4.	1996	Review of phenomena related to octupole deformations in nuclei	.... [4]
5.	1996	Description of evaporation of light particles from hot deformed rotating nuclei	.... [5]
6.	1996-9	Polarization-direction and polarization-polarization correlations between γ rays emitted in rotational cascades	.... [6, 7, 8]
7.	1996-8	Neutron and proton densities at large distances studied by the antiproton annihilation	..... [9, 10]
8.	1996	Additivity of nuclear quadrupole moments in rotating superdeformed nuclei	.... [11]
9.	1996	Self-consistent description of superheavy nuclei and the prediction of the Z=126 magic gap.	.... [12]
10.	1997	Systematic description of spherical proton emitters	.... [13]
11.	1997	Analysis of halo structures in heavy deformed nuclei	.... [14]
12.	1997	Comparison of deformation properties within various mean-field approaches	.... [15]
13.	1998	Proton emission from superdeformed band in ^{58}Cu and the superdeformed band in doubly magic ^{56}Ni	.....[16, 17]
14.	1998	New approach to the relationship between the odd-even mass staggering and pairing	.... [18]
15.	1999	Predictions of cold fusion reactions to synthesize superheavy nuclei	.....[19, 20]
16.	1999	Successful no-free-parameters description of collective quadrupole states	.... [21]

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