Women In Physics: The Yugoslav Experience

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Abstract
In this paper we have tried to follow the careers of women - physicists in Yugoslavia in two periods that differed nearly in every aspect of political, economical and social life. It was the period of the seventies and the eighties, a period of relative political and economical stability, and the period of the nineties, when the country disintegrated, wars and economic sanctions brought social and economic chaos, and a great number of young mostly highly educated people left the country. Were the careers of women - physicists affected by these events more than the careers of their male colleagues, do women - physicists generally act more passively in answering to the new economic and social demands or maybe, they got a new chance?

Women In Physics: Overcoming The Obstacles
It was only after the II World War that women shyly opened the doors of physics. The few women - founders of modern Atomic and Nuclear Physics, Maria and Irene Curie, Lisa Meitner, seemed to be nothing but exceptions of the general truth that physics is a task for men (Miller, 1996). Therefore, in the early fifties, among the sixty students of physics in the Cavendish Laboratory, there were only three young women. Two would leave their research careers after the marriage and only one, Joan Freeman would stay till the end (Freeman, 1993).

However, the number of women that enrolled and graduated in natural and technical sciences and made their professional careers in research laboratories and universities over the world was increasing from the early seventies till the nineties, when the general world wide trend of decreased interest for natural sciences changed the situation. In spite of the differences among the countries and specific scientific research areas, there are some common indicators reflecting the situation on the global level. The numbers of male and female students in biology, chemistry, applied and interdisciplinary sciences as biochemistry, molecular biology, pharmacology and chemical technology are nearly equal, and women even dominate in some of the areas, biology for instance (AIPS Report, 1997). But hard sciences as mathematics and physics appear still to be closed for women, even for those educated in science. The development in computing and information technology opened new perspectives for those women educated in mathematics, but they are still employed mainly as technical stuff, for routine jobs like data input and processing, while analysis and data proceeding are still reserved for their male colleagues, as it was the case in astronomy till the middle of the 20th century (Langford, 1990).

As for physics, it even more emphasises the gendered relations between education, science and society, especially in some research areas Quantum Mechanics, Relativity Theory or High Energy Physics. Therefore, even women that have passed all the obstacles of the traditional rules within their families, schools and society in general, and entered the space of the masculine scientific domination, are still out of the reach of the heights of pure science these areas represent. These are the facts that came into the focus of interest of the feminist and education theoreticians and psychologists only recently, mainly in the USA and the Western European countries (S.Harding, 1991; EUPEN Report, 1997). But the results of the studies on this matter are often controversial.

The claims that gender differences for interest in natural sciences could be recognised even at the age of nine, when boys gain the advantages girls can not overcome afterwards (J.Harding, 1998), could lead to dangerous implications that boys are biologically (whatever it does mean) more skilled in abstract thought, and girls in love and care. However, some kind of gender related science anxiety seems to exist and not to be correlated with social background and/or nationality (Mallow, 1994). It is rather
interesting that in economically less developed parts of Europe and in South America, the percentage of women studying physics is higher than in USA or in Western Europe (Table 1), but the question remains what happens to them after the studies. Do they generally go in for teaching at secondary and high schools or for research, as at that point their traditional roles start to conflict with their personal interests. Generally, in the economically highly developed European countries, for years the percentage of women at universities and research institutes has been between 8-12% (Svenska Institute Fact Sheets, 1997).

Table 1.
Women Enrolling In Physics (Harding, J.,1998)

<table>
<thead>
<tr>
<th>Country</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>England, Swiss, Germany, Austria, USA, Canada, Japan, Taiwan, India</td>
<td>2-19%</td>
</tr>
<tr>
<td>France, Denmark, Finland, Poland, Italy, Spain, Turkey, Russia, Israel</td>
<td>20-35%</td>
</tr>
<tr>
<td>Ireland, Portugal, Czech Republic, Hungary, Philippine</td>
<td>40-57%</td>
</tr>
</tbody>
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Those and similar results from different studies dealing with justification and enrolment in physics and mathematics opened a debate on the need for introducing single sex classes in the age of 11-16 as a tool for promoting girls interest in sciences (McDonald, 1998), but this question is out of the scope of this paper. The question of what determines and encourages the scientific curiosity, in general and concerning the gender differences, still remains open. Some psychologists and physicist involved in education research claim that the higher degree of scientific curiosity is found among emotionally more mature girls and less emotionally developed boys as girls take science as a serious job, and boys as a game. Putting science within the social context makes the girls more interested, while boys just do not care (Mallow, 1994; Harding,J, 1998). In general, the differences in the interest for different subjects among girls and boys on high school level are mirror symmetrical. The data on the choice of majors in high schools in USA and Denmark (Mallow, 1994) show that girls' interest in majors is decreasing from languages (80%), biology, chemistry and history (45-50%) down to physics and computers (20%), while it is quite the opposite for the boys: they are poorly interested in languages (20%), moderately in biology, chemistry and history (45-50%) and highly in physics and computers (80%).

In high schools in Yugoslavia (gymnasiums), due to the specific organisational structure - the departments for mathematics and sciences and the departments for humanities and languages are separated, the differences are even more emphasised: in some classes in humanities department there are only 2-4 boys among 40 scholars, while in the department for sciences and maths, the percentage of girls goes up to 25%. Professionaly oriented high school are highly gendered: girls generally enrol in medical schools, boys in technical schools. That is the pattern they continue to follow afterwards, on university too. Even more, boys often go for science and technology even if they were not successful in those subjects at secondary or high school, while girls enrol in physics and mathematics and other natural sciences only if they were highly successful in those subjects during secondary education. It is probably due to the messages coming from the social and family environment, sharply separating male and female professions. During studies, girls seem to find it more difficult to follow the social codes of the scientific community (Hernion, 1997). Some anthropological studies (Hasse, 1998) indicate that the female students rarely manage to get the proper position to actively participate into the transfer of knowledge and often remain only passive observers outside the groups that will create professional and scientific carriers afterwards. To gain the proper positions boys have only to use talent or skill, while girls are often forced to act aggressively or to give up. According to the percentage of women in physics, it seems that they generally give up.

Women - Physicists In Former Yugoslavia: Reality Comes After Graduation

Former Yugoslavia had a relatively high percentage of women enrolling in physics and other natural sciences, as it was generally the case in all ex-socialist countries in Central and Eastern Europe and former Soviet Union. The social, institutional and political equality between women and man was officially
proclaimed and women were encouraged to take the active part in social life, although it strongly conflicted their traditional role in the society, and that role is in many aspects still unchanged. The climax was reached during the seventies and the eighties, in the period of relative social, political and economic stability and prosperity. There was a strong institutional and governmental support to women education and active participation in professional life. Girls were largely encouraged to study technical and natural sciences. For years the percentage of girls enrolling and graduating at the University of Belgrade, including those graduating in pure mathematics and other natural sciences was equal to the percentage of boys. Actually, the number of girls graduating in natural sciences was slowly but steadily increasing from 52% in the early sixties to 60% in the late eighties (Blagojevic, 1991). But, contrary to molecular biology and biochemistry, the number of girls enrolling in physics in the period from the sixties to the early nineties was rather constant, not exceeding 30-35% (Popovic, 1998).

The situation after the graduation was rather different. The study on the careers of educated women in the eighties (Blagojevic, 1991; 1992) showed a clear delay in their professional life: women, even those with significantly higher scores during the studies, usually obtained their MA, MSc or PhD degree one to three years later than their male colleagues. But, thanks to biology, chemistry and medicine, in that period women still represented about a third of the scientific population in the country (Table 2).

Table 2.
Women MSc & PhD degree graduates, 1989 (Blagojevic, 1991)

<table>
<thead>
<tr>
<th>MSc,MA degree</th>
<th>PhD degree</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>34%</td>
<td>28%</td>
<td>32-44%</td>
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According to some studies concerned with the same period of time, women in Western Europe relatively more easily made their careers within academic institutions, universities, etc. than within research institutes, industry, management or government institutions (Harding, 1986; 1991). It seemed to be the true for women - scientists in Yugoslavia, too, (Blagojevic, 1991, 1992), but it was hardly true for physics. Since the 2nd World War there was no woman Master of the Faculty of Physics, no woman Dean of the Belgrade University, no woman within the Department of Natural Sciences at the Serbian Academy of Science and Art. Only one woman Director General of the Institute for Nuclear Sciences Vinca, hardly made the difference.

Once a part of the University staff, women still encountered obstacles, specially if not willing to give up marriage and children. As it can be seen from the Table 3, only a half of women that started their career as university assistants managed to obtain their PhD degree and get a position of a full professorship, while the percentage of their male colleagues was generally above 80% (Popovic, 1998).

Table 3.
Women at Belgrade University 1986/87 (Blagojevic, 1991)

<table>
<thead>
<tr>
<th></th>
<th>maths&amp;natural sci</th>
<th>medicine</th>
<th>humanities</th>
<th>art</th>
</tr>
</thead>
<tbody>
<tr>
<td>prof</td>
<td>22%</td>
<td>26%</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>assist</td>
<td>44%</td>
<td>45%</td>
<td>48%</td>
<td>49%</td>
</tr>
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The closer view of the physicists community gives an even gloomier picture. In the seventies, the percentage of women assistants on the Faculty of Physics was less than 10%, and there was only one women full professor. Women were much less involved in publishing scientific papers and managing
scientific projects in physics and related disciplines (5-10%): generally, women participated in projects on experimental and applied physics, biophysics, medical physics or radiology, while only 1-2% of them participated in projects on theoretical or quantum physics. Women physicists obtained scholarships far less often than their male colleagues (and still do), they were only seldom members of international scientific associations, presidents of national scientific associations or editors-in-chief of scientific journals. The mechanism of gender inequalities and male majorization if not before, was definitely switched on after the graduation. Therefore, contrary to general social climate that was rather inclining to women active participation in professional life, physics remained male science.

The Chaos Of The Nineties: A New Chance For Women In Physics?
A general decrease in the enrolment in natural sciences and technology at the end of the eighties, was an echo of the world wide trend of the decreased interest in natural and technical sciences, coming from the West with a certain delay (Milic, 1992). It has alarmed scientific, administrative and educational community in the West World and forced it to consider the problem within the projects on both national and international level, proposing different solutions (Musilek, 1998; EUPEN Report, 1997), but mainly within the two general concepts: putting physics in a broader social context and introducing new interdisciplinary courses into the physics university curricula.In Yugoslavia, that trend coincidental with the disintegration of the former Yugoslavia, war and dramatic changes in the political, social and economic situation in the country. Due to the war and large unemployment, a high percentage of university graduates left the country. They were mainly professionals in technical and natural sciences, engineers and physicians, and mainly man. That considerably changed gender relations in some of the highly specialised professions and within some of the university departments and research institutes. Some professions that has been dominated by men for years suddenly seemed to become open for women. Although there are still no systematic studies and reliable official data on the matter, some facts are evident. At the Faculty of Veterinary Medicine in Belgrade,for example, in 1975 only two women were the head of department among the 30 departments and women made less than 25% of the educational stuff. In 2000, women make 40-45% of the educational stuff of the Faculty, ten of them (40%) head the departments, but not the clinics. The Master is also a woman, second in the history of the Faculty.

From 1994-1997 nearly 60% of the students enrolling in physics at the University of Belgrade were girls, and 47 girls were also among the 97 post-graduates that obtained the MSc degree in physics. Still, 22 of them got MSc degree in experimental physics, 10 in physics education and 15 in theoretical physics, among them there were only two degrees in quantum physics. It was quite the opposite with the MSc degrees obtained by the male post-graduate students in the same period: their scientific interest was generally in theoretical physics, definitely not in physics education or methodology (Popovic, 1998).

The gender relation among the researchers in the institutes of physics changed, too (Table 4). Does it mean that women physicists got a new chance, or that the traditional mechanisms of gender discrimination lost power? Unfortunately not. Women in physics in Yugoslavia today only entered the empty space their male colleagues left for different and numerous reasons (Blagojevic, 1992; Finch, 1983; Polity Reader, 1992). And, it is very unlikely that the situation will change in the near future. Sciences, especially physics has lost their prestige: marketing, trade, management and information technology are in the focus of interest of the young people nowadays over the world. Why should anyone bother to study physics? It is hard, demanding and poorly paid. In the countries in transition, and Yugoslavia is in the very beginning of the process, science is on the edge of the social interest and care and it will continue to be so for some time. As schools and education system only amplify the values of the society, women are obviously once again going in for poorly paid and socially poorly valued professions.

Table 4.
Staff in Institute of Nuclear Sciences "Vinca",1997 (Popovic, 1998)

<table>
<thead>
<tr>
<th>title</th>
<th>female</th>
<th>male</th>
</tr>
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"Boys In The Lab": Women In Physics In Yugoslavia Today

Our study included a hundred women researchers, assistants and professors working at the University and in the scientific institutes in Belgrade. They all have MSc or PhD degrees in physics. Due to the age and the title, the group was divided in the three sub-groups: group I - professors and seniors scientists born in 1940/50; group II researchers and assistant professors, born in 1954/65; and group III research assistants, born in 1965/75. In fact, only two groups were planned, the I and the III group, while the II group formed by itself during the study.

Those women were educated and entered into their profession in different periods and worked in different social and political environment. Besides interviews, the study was performed through the analysis of the scientific structure of the papers the interviewers have published in scientific publications on the national and international level (Popovic, 1998; YRPA Bibliography, 1994).

Women in the I group (34) were university professors and senior scientists. Majority of them were born in Belgrade, they are married and have children (90%). About 25% among their parents, mainly fathers made their careers in the same profession or even in the same research area; 50% among their husbands are in the same profession, too. Only 20% of them work in pure physics, other find their research interest in multidisciplinary areas of biochemistry, biophysics, and biomedicine.

The II group (30) included women - assistant professors, PhD applicants and scientific assistants in the institutes. About 50% of them are born in Belgrade, about 50% are married and with children, about 30% of their husbands or life partners are in the same profession. Women from this group mainly work in the institutes (70%), due to the generation change that happened at one moment within the scientific community. Nearly 70% of them got their PhD degree in theoretical physics, but their scientific work is now within the framework of the experimental physics and other related applied or interdisciplinary areas.

In the III group (28) there were women working as research and teaching assistants. Less than 40% of them are born in Belgrade, about 65% is not yet married and have no children. About 30% of them have a mother within the interviewers in the I group, working in the same or close scientific area of research. As for the scientific work, majority of them are engaged in theoretical work.

The interviews showed the differences in the social background and in the apparent interest for theoretical or experimental research among the groups. The interest for theoretical work among women in the III group is in fact due to the economic situation (lack of instrumentation) and not to the true scientific motivation. Still, only a small percentage of these women, less than 10%, chose or plan to change institution, laboratory, position or even country in order to follow their personal scientific interest, while their male colleagues from the control group (30) under the same economic conditions, seem to be far more active, searching for better working environment and fulfilling their scientific interest.

It is also highly interesting that, in spite of the fact that women from the III group generally had higher marks during the studies than those from the I and the II group, and in spite of their claims that they have chosen science only due to their personal interest, more than 60% of them are highly unsatisfied by their professional choice and would be only happy to change it. On the other hand, women from the I and from
the II group, although also generally unsatisfied with the present state in science in the country, all firmly claimed they would make the same professional choice today.

Universities appeared not to be more friendly surrounding for women than research institutes or other scientific institutions: the percentage of women scientists, from research assistants to seniors scientists, is in fact higher in the institutes than on the Belgrade University (Table 5), and women scientists are more often head of departments or projects managers in the institutes than on the Belgrade University. Still, in the latest publication of the Serbian Academy of Sciences and Art dealing with the lives and work of the 150 Serbian natural scientists in the 19th and 20th century, there is not a single women (SANU Report, 1998).

Table 5.
Women Scientists (%) on the Belgrade University and in the Institute Vinca, 1998 (Popovic,1998)

<table>
<thead>
<tr>
<th></th>
<th>Prof.(Seniors)</th>
<th>Assis.prof.(Resear.)</th>
<th>Assistants</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>27</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Institute</td>
<td>34</td>
<td>38</td>
<td>39</td>
</tr>
</tbody>
</table>

Generally, women scientists in Yugoslavia still publish less, only 16-25% of scientific papers are published by women in different research areas and only 4 -6% among single authors and invited lecturers on scientific meeting are women (Popovic, 1998). Women are seldom members of scientific boards and committees of scientific meetings, even more seldom members of organising committees, but among the technical staff at the desk, one usually finds only women, doing technical and administration work. Do they consider themselves professionally equal? Generally, they seem not to care. Perhaps they should?

Conclusion
Although a number of women within the scientific community in former Yugoslavia was significant, women were actually as far away from the real centres of power as their female colleagues elsewhere. Natural sciences as science in general, appeared to be inhibited by the values divisioned by gender and traditional power structure that function continuously during education, but especially after the graduation. The increase in the number of women in natural sciences, including physics, in the last decade is not the result of the new opening of science for female scientists, but it is unfortunately due to the world wide decreaseamet in the interest for natural sciences, with some specificity due to the political and social context in our country. Women are once again only allowed to go in for the professions men had left as poorly paid and unperspective.

References