

## SYLLABUS

### 1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University
1.2 Faculty	of Physics
1.3 Department	Doctoral School of Physics
1.4 Field of study	Physics
1.5 Study cycle	PhD
1.6 Study programme / Qualification	Physics

### 2. Information regarding the discipline

2.1 Name of the discipline	Advanced methods in Atomic and Molecular Physics						
2.2 Course coordinator	Prof dr David Leontin, Prof dr Damian Grigore, Assoc Prof dr habil Baia Monica, Prof dr habil Pinzaru Simona, Assoc Prof dr habil Leopold Nicolae						
2.3 Seminar coordinator	Prof dr David Leontin, Prof dr Damian Grigore, Assoc Prof dr habil Baia Monica, Prof dr habil Pinzaru Simona, Assoc Prof dr habil Leopold Nicolae						
2.4. Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Type of discipline	DO

### 3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					42
Additional documentation (in libraries, on electronic platforms, field documentation)					14
Preparation for seminars/labs, homework, papers, portfolios and essays					22
Tutorship					20
Evaluations					10
Other activities: .....					-
3.7 Total individual study hours	108				
3.8 Total hours per semester	160				
3.9 Number of ECTS credits	10				

### 4. Prerequisites (if necessary)

4.1. curriculum	
4.2. competencies	

### 5. Conditions (if necessary)

5.1. for the course	<ul style="list-style-type: none"> <li>• Course hall with blackboard, projector and software</li> </ul>
5.2. for the seminar /lab activities	<ul style="list-style-type: none"> <li>• Course hall with blackboard, projector, internet access and software</li> </ul>

## 6. Specific competencies acquired

<b>Professional competencies</b>	<ul style="list-style-type: none"> <li>- The ability to formulate hypothesis and evaluate experimental data specific to the advanced methods applied in atomic and molecular physics</li> <li>- Practical skills to operate high performance equipments</li> <li>- -The capacity to obtain and evaluate experimental data in correlation with the state-of-the -art in the research field</li> <li>- The capacity to summarise the scientific results and to elaborate manuscripts based on the obtained results.</li> <li>- Planning and organising skills. Interdisciplinary mindset.</li> </ul>
<b>Transversal competencies</b>	<ul style="list-style-type: none"> <li>- Fulfilling the professional tasks in an efficient and responsible way in accordance with the law and specific professional ethics</li> <li>- Respecting, in accordance with the law, of intellectual property rights (including the technological transfer), product certification methodology, principles, norms and values of professional ethics in the framework of the own rigorous, efficient and responsible strategy of work.</li> <li>- Effective work in multidisciplinary team on different hierarchical levels, fulfilling specific roles within a team, showing initiative and entrepreneurial leadership based on dialogue, cooperation positive attitudes, mutual respect, diversity and multiculturalism and continuous improvement of the own activities.</li> <li>- Effective use of information sources and communication resources and training assistance, both in Romanian and in a foreign language.</li> </ul>

## 7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	<ol style="list-style-type: none"> <li>1. Acquiring advanced theoretical knowledge about advanced methods applied in atomic and molecular physics</li> <li>2. Acquiring advanced experimental and theoretical methodologies for characterizing atomic and molecular systems</li> </ol>
7.2 Specific objective of the discipline	<ol style="list-style-type: none"> <li>1. Increasing the PhD student ability to identify new methods applied for the atom and molecule study</li> <li>2. Knowledge of the advanced research methods and techniques available within the Doctoral School to better organise and develop the research topic.</li> <li>3. Knowledge of metal – molecule charge transfer processes and of the electronic mechanism of surface-enhanced Raman scattering (SERS)</li> <li>4. Knowledge of the modern magnetic resonance methods (ESR and NMR) and the magneto-structural analysis of the coupled paramagnetic systems.</li> <li>5. Advanced concepts of the techniques and methods of electron paramagnetic resonance (EPR)</li> <li>6. Knowledge of the optical spectroscopy theory and practical use of analytical tools for different interdisciplinary applications (physics-chemistry-pharmacy-medicine-biology)</li> </ol>

## 8. Content

8.1 Course	Teaching methods	Remarks
Molecular magnetism molecular		3 hours
Magnetic resonance methods (ESR and NMR)		2,5 hours
The influence of the ionising radiation and oxidizing agents effect on the biopharmaceutical and food compounds		3 hours
The use of spin traps and spin markers in the study of biological systems and antioxidative processes.		2.5 hours
Surface-enhanced Raman spetroscopy- a versatile tool for various applications- theoretical considerations		3 hours
Applications of SERS in various fields: pharmaceutical, medical, environmental, etc.		2.5 hours
Electron transfer at metal-molecule interfaces		3 hours
Study of halide ion adsorption to metal nanoparticles		3 hours
The study of the structure and vibrational properties of some molecules of biologic, medical and environmental interest		3 hours
Developing multidisciplinary applications of detection, monitoring and/or biosensing based on optical spectroscopy techniques (Raman, IR, UV-VIS, SERS, resonant Raman, SERRS)		2.5 hours
<b>Bibliography</b>		
1. E.C. Le Ru, P.G. Etchegoin, Principles of Surface-Enhanced Raman Spectroscopy and Related Plasmonic Effects, Elsevier, Amsterdam, Boston, 2009		
2. S.A. Maier, Plasmonics: Fundamentals And Applications, Springer, 2007		
5. M. Baia, S. Astilean, T. Iliescu, <b>Raman and SERS investigations of pharmaceuticals</b> , Springer-Verlag GmbH, Berlin/Heidelberg, Germany, pp 214, 2008.		
6. Alula, M. T.; Mengesha, Z. T.; Mwenesongole, E., <b>Advances in surface-enhanced Raman spectroscopy for analysis of pharmaceuticals: A review</b> . <i>Vibrational Spectroscopy</i> <b>2018</b> , <i>98</i> , 50-63.		
7. Traian Iliescu, Simona Pinzaru, <b>Spectroscopia Raman si SERS cu aplicatii in biologie si medicina</b> , Ed. Casa Cartii de Stiinta, Cluj-Napoca, 2011;		
8. SC Pînzaru, A Fălămaș, CA Dehelean, <b>Raman Spectroscopy: A Key Analytical Tool for New Drugs Research and Development-</b> Studies in Natural Products Chemistry, 2018;		
9. Toporski, Jan, Dieing, Thomas, Hollricher, Olaf, <b>Confocal Raman Microscopy</b> , Springer Series in Surface Sciences, 2018		
10. Rita Kakkar, <b>Atomic and Molecular Spectroscopy; Basic Concepts and Applications</b> , Cambridge University Press, 2015.		
11. G.Damian, V.Miclauş, Radicali Nitroxidici, Ed. EFES, Cluj-Napoca 2001		
12. Spin Labeling. Theory and Applications, Academic Press, 1976, ed. L.J.Berliner		
13. D.J. Schreirer, J.H.Freed, Spin Labelling theory and Applications, în Biological Magnetic Resonance, vol.8, L.J.Berliner, J.Ruben, eds. Plenum press, New York, 1989		
14. Garry R. Buettner, Ronald P. Mason, Spin-Trapping Methods for Detecting Superoxide and Hydroxyl Free Radicals In Vitro and In Vivo, in Critical Reviews of Oxidative Stress and Aging: Advances in Basic Science, Diagnostics and Intervention. (2003) Ed Richard G. Cutler and Henry Rodriguez. World Scientific, Volume I. Chapter 2		
8.2 Seminar / laboratory	Teaching methods	Remarks
Magneto-structural investigation of some coupled	Presentations.	2 hour

paramagnetic systems	Correlations between experimental results and theoretical models. Discussions	
Identification of the physico-chemical characteristics of nitrons and their use in the study of the structure and dynamics of biomolecular systems by means of ionising radiations		3 hours
Vibrational analysis (Raman, IR, SERS) of some pharmaceutical compounds		3 hour
Specific adsorption to metal surface and SERS detection of anionic and cationic molecules		3 hour
SERS in biomedical and environmental research		3 hours
<b>Bibliography</b>		
<ol style="list-style-type: none"> <li>1. E.C. Le Ru, P.G. Etchegoin, Principles of Surface-Enhanced Raman Spectroscopy and Related Plasmonic Effects, Elsevier, Amsterdam, Boston, 2009</li> <li>2. S.A. Maier, Plasmonics: Fundamentals And Applications, Springer, 2007</li> <li>3. Alula, M. T.; Mengesha, Z. T.; Mwenesongole, E., <b>Advances in surface-enhanced Raman spectroscopy for analysis of pharmaceuticals: A review.</b> <i>Vibrational Spectroscopy</i> <b>2018</b>, <i>98</i>, 50-63</li> <li>4. SC Pînzaru, A Fălămaș, CA Dehelean, <b>Raman Spectroscopy: A Key Analytical Tool for New Drugs Research and Development-</b> Studies in Natural Products Chemistry, 2018;</li> </ol>		

**9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program**

The content of the discipline is in accordance with the subjects which are studied in the same field in Romanian and foreign universities and with the specific demands of research institutes, economy and labour market.

**10. Evaluation**

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Acquired knowledge	exam	50 %
10.5 Seminar/lab activities		Oral presentation	50%
10.6 Minimum performance standards			
<ul style="list-style-type: none"> <li>➤ Identification of the advanced experimental methods for the atom and molecule study</li> <li>➤ Identification of the specific information derived by using these methods</li> </ul>			

Signature of course coordinator  
Prof.dr. Leontin David

Signature of seminar coordinator  
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Prof.dr. Grigore Damian

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Leopold

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Date of approval

21.09.2020

Signature of the head of department

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