Subject content

1. Program information

1.1 University	West University of Timisoara
1.2 Faculty	Physics
1.3 Department	Physics
1.4 Study direction	Physics
1.5 Study cycle	Master
1.6 Study program	Physics and technology of advanced materials

2. Subject matter information

2.1 Subject matter				Condensed Matter Spectroscopy			
2.2 Subject teacher				Associate Professor dr. Calin Avram			
2.3 Subject applications teacher				Associate Professor dr. Calin Avram			
2.4 Study year	2	2.5 Semester	3	2.6 Assessment type	Ex	2.7 Subject type	Ob. **PTAM2302**

3. Study time distribution

3.1 Nr. of hours/week	3	In which: 3.2 course	2	3.3 seminar	1
3.4 Total hours in educational plan	42	In which: 3.5 course	28	3.6 seminar	14
Time distribution:					**hours**
Study after lecture notes, bibliography or notes					31
Additional documentation in the library, electronic specialty platforms/ field					10
Seminar / laboratory preparations, homework, portfolio and essays					10
Tutoring					4
Exams					3
Other activities……					

3.7 Total number of personal study hour	**42**
3.8 Total number of hours in semester	**100**
3.9 Number of credits	**6**

4. Preconditions (where appropriate)

4.1 curriculum	•
4.2 skills	•

5. Conditions (where appropriate)

5.1 for course	• Physics of Atoms and Molecules; Quantum Mechanics; Solid State Physics;
5.2 for seminar/lab	• Physics of Atoms and Molecules; Quantum Mechanics; Solid State Physics;

6. Specific skills gained

Professional skills	- Thorough knowledge and understanding of physical phenomena underlying the spectral methods to investigate condensed matter ; -Getting new deepening of professional skills closely related areas of undergraduate studies, and development capacity for scientific research in a world of knowledge. -Capacity of understanding, analyzing and description of the structure and basic interactions in condensed matter ; -Capacity of using models for transitional and rare-earth ions in crystals, ceramics and glasses; -Skills of standalone analysis and synthesis of complex systems and interactions between them; - Interpretation and correlations of the personal results with that of related professionals; - Skills on interpretation condensed state spectroscopy methods.
Transversal skills	• Skills in research ethics • Skills in research project management • Team work in a research activity. • Efficient use of informational and communication resources in English language. • Improving investigation references;

7. Course Objectives

7.1 Main Objective	• The main objective of this course is obtaining of new knowledge in the field of spectroscopy and use them to investigate condensed matter (undoped and doped crystals, nanocrystals, glasses, ceramics, etc.).

7.2 Specific objectives	• Study interactions of the electromagnetic radiation with condensed matter in order to obtain information about structure and basic interactions in such systems; • Modeling and simulation of spectral properties of systems with complex structure, forecasting this way of properties designated for the studied systems, especially for laser crystals doped with various impurity ions • Use knowledge and skills acquired by graduates of this university master's program in order to access and continue their studies in the next cycle of initial training at the doctoral program;

8. Table of content

8.1 Course	Teaching methods	Observations
1. Spectroscopy of condensed matter. Introduction.	Exposition, demonstration, heuristic conversation	Course support and bibliographic materials will be sent to students by e-mail
2. Spectra of many electron atoms	Exposition, demonstration, heuristic conversation	
3. Symmetry in condensed matter physics. Symmetry operations.	Exposition, demonstration, heuristic conversation	
4. Symmetry groups.	Exposition, demonstration, heuristic conversation	
5. Ions in anisotropic environment.	Exposition, demonstration, heuristic conversation	
6. Single d-electron in a cubic field. 3d transition ions in crystal field.	Exposition, demonstration, heuristic conversation	
7. General structure of a Hamiltonian of an ion in a crystal field.	Exposition, demonstration, heuristic conversation	
8. Many d-electrons in a crystal field and Tanabe-Sugano diagram.	Exposition, demonstration, heuristic conversation	
9. Estimations of the crystal field strength Dq and Racah parameters B, C from the experimental absorption spectra. Nephelauxetic effect.	Exposition, demonstration, heuristic conversation	
10. Exchange charge model and superposition model of crystal field.	Exposition, demonstration, heuristic conversation	
11. Adiabatic approximation and configurational coordinate model.	Exposition, demonstration, heuristic conversation	
12. General picture of the Jahn-Teller effect.	Exposition, demonstration, heuristic conversation	
13. Spectroscopy of rare-earth ions doped in crystals.	Exposition, demonstration, heuristic conversation	
14. Ab initio and DFT methods in condensed matter spectroscopy.	Exposition, demonstration, heuristic conversation	

Bibliography

1. B. Henderson, R.H. Bartram, "*Crystal-Field Engineering of Solid-State Laser Materials*", Cambridge University Press, Cambridge, 2000;
2. M.G. Brik, I. Sildos, V. Kiisk, "*Introduction in Spectroscopy of Atomic, Molecular and Crystals*", Tartu, 2008
3. H. Kuzmany, *"Solid-State Spectroscopy", Springer, Berlin, 1998*
4. D.R. Vij, *"Handbook of Applied Solid State Spectroscopy, Springer, "Heidelberg, 2006.*
5. Feng Duan, Jin Goujun, *"Introduction to Condensed Matter Physics", Vol.1, World Scientific Publishing Co., Singapore, 2005*

8.2 Seminar / labs	**Teaching methods**	**Observations**
1. Introduction. Spectra of condensed matter.	Conversation, investigation, case study.	
2. Terms of many electron free atoms. Classifications.	Conversation, investigation, case study.	
3. Symmetry elements of molecules. Point group of symmetry.	Conversation, investigation, case study.	
4. Symmetry of the crystals(I): Space group .	Conversation, investigation, case study.	
5. Symmetry of the crystals(II): Site symmetry group.	Conversation, investigation, case study.	
6. Classification of the electronic state using symmetry.	Conversation, investigation, case study.	
7. Calculation of Racah Parameters from absorption spectra	Conversation, investigation, case study.	
8. Modeling the crystal field parameters for Cr^{3+}:LiCaAlF6.	Conversation, investigation, case study.	
9. Simulation of energy levels for Ni2+:MgGa2O4.	Conversation, investigation, case study.	
10. Jahn-Teller effect in $^4T_{2g}$ excited states of V^{2+}:CsCaF3.	Conversation, investigation, case study.	
11. Calculations of energy levels with CASSCF and NEVPT2 .	Conversation, investigation, case study.	
12. Modeling spin-Hamiltonian parameters in crystal field parameters.	Conversation, investigation, case study.	
13 Modeling spin-Hamiltonian parameters	Conversation, investigation, case study.	
14. Modeling spin-Hamiltonian parameters with DFT methods.	Dialogue	
Bibliography		

1. N.M. Avram, C.N. Avram, *"Nivelele energetice ale ionilor în cristale"*, Editura Mirton, Timişoara, 2001
2. M.G. Brik, N.M. Avram and C.N. Avram, *„Exchange charge model of crystal field for 3d ions "* in N.M. Avram and M.G. Brik (Eds), *"Optical Properties of 3d-Ions in Crystals. Spectroscopy and Crystal Field Analysis"*, Tsinghua University Press, Beijing and Springer-Verlag, Berlin, Heidelberg, 2013.
3. D.R. Vij, *"Handbook of Applied Solid State Spectroscopy"*, Springer,"Heidelberg, 2006.
4. Publised papers by C.N. Avram.

9. Relation between subject content and the expectations of employers

Condensed Matter Spectroscopy gives work skills in domain topics and related topics in which the future graduate could work. Mainly are related to physics, chemistry, material science, etc.

10. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment method	10.3 Percent in final mark
10.4 Course	The assimilation level of knowledge gained	Oral examination	60%
10.5 Seminar / labs	Capacity of solving specific problem	Written test	40%
10.6 Minimum performance standards			
-To know the basic terminology -To correct address three topics, even if they cannot develop completely; -Do not make major mistakes.			

Data completării:
16.09.2022

Titular de disciplină:
Conf. dr. Avram Călin

Data avizării în department:

Director de departament:
Conf. dr. Marin Cătălin