



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Zlom simetrije
Course title:	Symmetry breaking

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		1. ali 2.	1., 2. ali 4.
PHYSICS		1. or 2.	1., 2. or 4.

Vrsta predmeta / Course type

Izbirni za vse module

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
15					165	6

Nosilec predmeta / Lecturer:

Samo Kralj

Jeziki /

Languages:

Predavanja /

Lectures:

Vaje / Tutorial:

slovenski/Slovenian in/and angleški s slovenskim prevodom/English with translation in Slovenian

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Predznanje iz klasične in moderne fizike in iz matematične fizike.

Prerequisites:

Pre-knowledge of classical physics, modern physics, and mathematical methods in physics.

Vsebina:

- 1) Landau-ova teorija faznih prehodov
- 2) Značilne razdalje in časovne skale
- 3) Zlom zvezne simetrije in topološki defekti
- 4) Statika in dinamiko topoloških defektov
- 5) Interakcija med nanodelci, koloidi in topološkimi defekti; samoorganizacija

Content (Syllabus outline):

- 1) Landau theory of phase transitions
- 2) Characteristic length and time scales
- 3) Symmetry breaking and topological defects
- 4) Statics and dynamics of topological defects

- 6) Topološki defekti v bioloških membranah
- 7) Topološki defekti kot občutljivi detektorji

- 5) Interaction between nanoparticles, colloids, topological defects; selforganisation
- 6) Topological defects in biological membranes
- 7) Topological defects as sensitive detectors

Temeljni literatura in viri / Readings:

- 1) M. Kleman, O.D. Lavrentovich, *Soft Matter Physics*, Springer-Verlag, New York, 2003.
- 2) P. M. Chaikin, T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge University Press, Cambridge, 1995.
- 3) K.F. Riley, M.P. Hobson, S.J. Bence, *Mathematical Methods for Physics and Engineering*, 3rd edition, Cambridge University Press, Cambridge, 2006
- 4) A. Leach, *Molecular modelling: Principles and applications*, Pearson, 2001.
- 5) J.C. Taylor, *Hidden Unity in Natural Laws*, Cambridge University Press, Cambridge, 2001.

Cilji in kompetence:

Študenti poglobijo znanje s področja modeliranja v fiziki mehkih sistemov in povezavo z drugimi področji v fiziki.

Objectives and competences:

Students acquire advanced knowledge on modeling in physics of soft systems and universalities.

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje ključnih procesov v naravi, ki so povezani z zlomom simetrije.

Prenosljive/ključne spretnosti in drugi atributi:
Rešitev problemov z matematičnimi orodji, numeričnimi metodami, univerzalnosti v fiziki in celosten pristop k reševanju problemov.

Intended learning outcomes:

Knowledge and understanding:
Understanding of key processes in nature based on symmetry breaking.

Transferable/Key Skills and other attributes:
Solving of problems with mathematical tools, numerical methods, universalities in physics and gained global approach on solving problems.

Metode poučevanja in učenja:

Predavanja in reševanje zastavljenih problemov.

Learning and teaching methods:

Lectures and solving of defined problems.

Načini ocenjevanja:

Delež (v %) /

Weight (in %)

Assessment:

Način (pisni izpit, ustno izpraševanje, naloge, projekt)	Delež (v %) / Weight (in %)	Type (examination, oral, coursework, project):
2 seminarja	65 %	2 Seminars
Ustni izpit	35 %	Oral exam

Reference nosilca / Lecturer's references:

1. DUBTSOV, Alexander, PASECHNIK, Sergey V., SHMELIOVA, Dina V., KRALJ, Samo. Light and phospholipid driven structural transitions in nematic microdroplets. *Applied physics letters*, ISSN 0003-6951. [Print ed.], 2014, vol. 105, no. 15, str. 151606-1-151606-4, doi: [10.1063/1.4898335](https://doi.org/10.1063/1.4898335). [COBISS.SI-ID [20904200](#)]
2. RANJKESH SIAHKAL, Amid, AMBROŽIČ, Milan, KRALJ, Samo, SLUCKIN, T. J. Computational studies of history dependence in nematic liquid crystals in random environments. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2014, vol. 89, iss. 2, str. 022504-1-022504-14, doi: [10.1103/PhysRevE.89.022504](https://doi.org/10.1103/PhysRevE.89.022504). [COBISS.SI-ID [20347912](#)]
3. TRČEK, Maja, CORDOYIANNIS, George, TZITZIOS, Vassilios, KRALJ, Samo, NOUNESIS, George, LELIDIS, Ioannis, KUTNJAK, Zdravko. Nanoparticle-induced twist-grain boundary phase. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2014, vol. 90, issue 3, str. 032501 -1-032501 -8, doi: [10.1103/PhysRevE.90.032501](https://doi.org/10.1103/PhysRevE.90.032501). [COBISS.SI-ID [27908903](#)]
4. RANJKESH SIAHKAL, Amid, AMBROŽIČ, Milan, CORDOYIANNIS, George, KUTNJAK, Zdravko, KRALJ, Samo. History-dependent patterns in randomly perturbed nematic liquid crystals. *Advances in condensed matter physics*, ISSN 1687-8108, 2013, vol. 2013, str. 505219-1-505219-10, doi: [10.1155/2013/505219](https://doi.org/10.1155/2013/505219). [COBISS.SI-ID [26806567](#)]
5. POVŠE JESENEK, Dalija, PERUTKOVÁ, Šárka, GÓZDŽ, Wojciech, KRALJ-IGLIČ, Veronika, IGLIČ, Aleš, KRALJ, Samo. Vesiculation of biological membrane driven by curvature induced frustrations in membrane orientational ordering. *International journal of nanomedicine*, ISSN 1178-2013. [Online ed.], 2013, vol. 8, no. 1, str. 677-687, ilustr. http://www.dovepress.com/articles.php?article_id=12253. [COBISS.SI-ID [4516971](#)]
6. REPNIK, Robert, RANJKESH SIAHKAL, Amid, ŠIMONKA, Vito, AMBROŽIČ, Milan, BRADAČ, Zlatko, KRALJ, Samo. Symmetry breaking in nematic liquid crystals: analogy with cosmology and magnetism. *Journal of physics, Condensed matter*, ISSN 0953-8984, 2013, vol. 25, no. 40, str. 404201-1-404201-10, doi: [10.1088/0953-8984/25/40/404201](https://doi.org/10.1088/0953-8984/25/40/404201). [COBISS.SI-ID [20050952](#)]