



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, 3. stopnja | | 1. ali 2. | 1., 2. ali 4. |
| PHYSICS, 3 rd cycle | | 1. or 2. | 1., 2. or 4. |

Vrsta predmeta / Course type

Izbirni za vse module/ Optional for all modules

Univerzitetna koda predmeta / University course code:

| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | Klinične vaje work | Druge oblike študija | Samost. delo Individ. work | ECTS |
|------------------------|--------------------|------------------|-----------------------|-------------------------|----------------------------------|------|
| 15 | | | | | 165 | 6 |

Nosilec predmeta / Lecturer:

Samo Kralj

Jeziki /

Languages:

Predavanja /

Lectures:

Vaje / Tutorial:

slovenski/Slovenian

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

Pogojev ni.

Priporočljiva znanja so: predznanje iz klasične in moderne fizike in iz matematične fizike.

Prerequisites:

None.

Recommended is preknowledge of classical physics, modern physics, and mathematical methods in physics.

Vsebina:

Content (Syllabus outline):

- 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) Opis narave s polji
- 6) Interakcija med nanodelci, koloidi in topološkimi defekti; samoorganizacija
- 7) Topološki defekti v bioloških membranah
Topološki defekti kot občutljivi detektorji

- 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
- 5) Field presentation of nature.
- 6) Interaction between nanoparticles, colloids, topological defects; selforganisation
- 7) Topological defects in biological membranes
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. Hobson, There are no particles, there are only fields, *Am. J. Phys.* **81** (3), 211-243 (2013).
- 5) J.C. Taylor, *Hidden Unity in Natural Laws*, Cambridge University Press, Cambridge, 2001.

Cilji in kompetence:

Študenti poglobijo znanje s področja zloma simetrije. Spoznajo možnost modeliranja narave s »polji«, kjer »osnovni delci« nastopajo kot topološko stabilizirana lokalizirana stanja polj.

Objectives and competences:

Students acquire advanced knowledge on symmetry breaking. A "field" perspective of nature is presented, where "fields" represent fundamental entity of nature. In this respect "fundamental particles" are emergent.

Predvideni študijski rezultati:

Znanje in razumevanje:

Poglobljeno razumevanje ključnih procesov v naravi, ki so povezani z zlomom simetrije. Spoznanje uporabnost zloma simetrije za številne aplikacije v nanotehnologiji.

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. Usefulness of symmetry breaking in emergent nanotechnology is understood.

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:

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|---|
| Predavanja in reševanje zastavljenih problemov. |
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Learning and teaching methods:

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| Lectures and solving of defined problems. |
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Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

| | | |
|--------------------------|--------------|------------------------|
| Seminar. Ustni izpit. | 50 % 50 % | Seminar. Oral exam. |
|--------------------------|--------------|------------------------|

Reference nosilca / Lecturer's references:

NATH, Nibedita, CHAKROBORTY, Subhendu, PAL, Kaushik, BARIK, Arundhati, MISHRA, Nilima Priyadarsini, KRALJ, Samo. Recent advances in plasmonic enhanced nanocatalyst for oxidation of alcohol. Topics in catalysis. 2023, 11 str., ilustr. ISSN 1022-5528. DOI: 10.1007/s11244-023-01839-y. [COBISS.SI-ID 163018499]

MESAREC, Luka, IGLIČ, Aleš, KRALJ, Samo. Spatial manipulation of topological defects in nematic shells. The European physical journal. E, Soft matter. Jul. 2022, iss. 7, art. no. 62, 1-7 str., ilustr. ISSN 1292-8941. <https://link.springer.com/article/10.1140/epje/s10189-022-00216-z>, DOI: 10.1140/epje/s10189-022-00216-z. [COBISS.SI-ID 117006851]

POLANŠEK, Juš, HÖLBL, Arbresha, STARZONEK, Szymon, DROZD-RZOSKA, Aleksandra, RZOSKA, Sylwester, KRALJ, Samo. History-dependent phase transition character. The European physical journal. E, Soft matter. Sep. 2022, vol. 45, iss. 9, 1-14 str. ISSN 1292-8941. DOI: 10.1140/epje/s10189-022-00221-2. [COBISS.SI-ID 120603395]