Univerza v Mariboru

Fakulteta za naravoslovje in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Koloidne interakcije**
Course title:	**Colloidal interactions**

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
FIZIKA		**1**. ali 2.	**1., 2. ali 3.**
PHYSICS		1. or 2.	**1., 2. or 3.**

Vrsta predmeta / Course type

Izbirni za modula Biofizika 3 in Fizika 1, 2, 3

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Mentorstvo Mentorship	Samost. delo Individ. work	ECTS
7	**3**				**290**	**10**

Nosilec predmeta / Lecturer: **Jure Dobnikar**

Jeziki / Languages:	**Predavanja / Lectures:**	slovenski/Slovenian
	Vaje / Tutorial:	/

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

Osnove klasične in moderne fizike, termodinamike in numeričnih metod.

Prerequisits:

Fundamentals of classical and modern physics, thermodynamics and numerical methods.

Vsebina:

Content (Syllabus outline):

Pri predmetu Koloidne interakcije se bomo posvetili interakcijam v koloidnih raztopinah, kot so:
• sterična,
• elektrostatska,
• hidrodinamska,
• termična in
• disperzijska interakcija.
Podrobneje bomo obravnavali izvor in modele opisa steričnih interakcij med koloidi ter ektrostatske interakcije med električno nabitimi makroioni v raztopini, ki se prenašajo preko velikega števila mikroionov v raztopini. V tej zvezi bomo obdelali potenciale s trdo sredico, potenciale z mehko sredico, privlačne interakcije med koloidi in tvorbo skupkov, Poisson-Boltzmann-ovo enačbo, teorijo DLVO, koncept efektivnih parskih interakcij ter mnogodelčne interakcije.
Posvetili se bomo povezavi med lastnostmi interakcij med koloidi na mikroskopskem in faznim lastnostmi koloidnih raztopin na makroskopskem nivoju. Opisali bomo tudi eksperimentalne metode za preučevanje koloidov, kot so rentgensko sipanje, laserska pinceta, videomikroskopija, ter kako pristopimo k opisu koloidnih raztopin s pomočjo numeričnih simulacij.

At *Colloidal Interactions* we will study the interactions that are present among colloids:
• steric,
• electrostatic,
• hydrodynamic,
• thermic,
• dispersion.
The emphasis will be on steric interactions (the origin and modelling) and electrostatics, which is mediated by a large number of microions in suspension. In this respect we will examine closely the properties of hard-core interactions, soft-core interactions, attractive interactions, aggregation properties, Poisson-Boltzmann equation, DLVO theory, the concept of the effective pair interactions and manybody interactions. We will further focus on the interplay between the interaction properties and the phase behavior of the system. We will study the state of the art experimental methods like light scattering, laser tweezers and videomicroscopy. Finally, also the numerical simulations of colloidal suspensions will be presented in detail.

Temeljni literatura in viri / Readings:

1) W.B. Russel, D.A. Saville and W.R. Scholwater, **Colloidal Dispersions**, Cambridge University Press, 1989
2) D.F. Evans and H. Wennerström, **The Colloidal Domain: where Physics, Chemistry, Biology and Technology meet**, VCH, 1994
3) R.J. Hunter, **Foundations of Colloidal Science**, Oxford University Press, 2005 (2nd ed.)
4) D. Frenkel, B.J.Smit, **Understanding Molecular Simulation**,Elsevier, 2002
5) Članki v znanstvenih revijah / Papers in scientific publications

Cilji in kompetence:

• Obvladati področje koloidnih interakcij na nivoju raziskovalnega dela

• Pridobiti znanje o aktualnih eksperimentalnih metodah, teoretičnih modelih in moderni

Objectives and competences:

• State of the art knowledge about colloidal interactions

• State of the art knowledge about experimental methods, theoretical models and applications of

uporabi koloidov • Razumeti komlpeksnost elektrostatskih interakcij v raztopinah • Obvladati numerične metode za simulacijo koloidov • Zmožnost samostojnega raziskovalnega dela na področju predmeta • Predstavitev seminarja	colloids • Understanding of complexity of electrostatics in media • Mastering numerical methods used to simulate colloidal systems • Capability of independent research in the area covered by the subject • Presenting a seminar

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: • interakcije med koloidnimi delci, • elektrostatika v raztopinah, • sterične interakcije, • mnogodelcne interakcije, • numerične simulacije koloidnih raztopin • fazne lastnosti koloidnih raztopin Prenesljive/ključne spretnosti in drugi atributi: • uporaba modelskih interakcij za izračun faznih lastnosti snovi • teoretični opis mnogodelcnih sistemov, • numerično reševanje parcialnih diferencialnih enačb, • obvladovanje metod numerične simulacije in njihova uporaba v koloidnih sistemih • znanje o eksperimentalnih metodah • samostojno pregledovanje znanstvene literature in predstavitev seminarja	Knowledge and understanding: • interactions among colloids, • electrostatics in suspension, • steric interactions • many-body interactions, • numerical simulations of colloidal suspensions • phase properties of colloidal suspensions Transferable/Key Skills and other attributes: • applying the model interactions to derive the phase space properties of matter • theoretical description of many-body systems, • numerical methods for solving partial differential equations, • Mastering the methods of numerical simulations and applying them to colloids • knowledge about experimental methods • Independent literature search and presentation of seminars

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, seminarji, projektne naloge.	Lectures, seminars, project work.

Delež (v %) /

Načini ocenjevanja:	Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
Ustni izpit	**50%**	Oral examination
Seminar	**30%**	Seminar
Naloge	**20%**	Coursework

Reference nosilca / Lecturer's references:

1. MÜLLER, Kathrin, OSTERMAN, Natan, BABIČ, Dušan, LIKOS, Christos N., DOBNIKAR, Jure, NIKOUBASHMAN, Arash. Pattern formation and coarse-graining in two-dimensional colloids driven by multiaxial magnetic fields. *Langmuir*, ISSN 0743-7463, 2014, vol. 30, issue 18, str. 5088-5096, ilustr. http://pubs.acs.org/doi/abs/10.1021/la500896e, doi: 10.1021/la500896e. [COBISS.SI-ID 2674532]

2. CURK, Tine, MARENDUZZO, Davide, DOBNIKAR, Jure. Chemotactic sensing towards ambient and secreted attractant drives collective behaviour of E. coli. *PloS one*, ISSN 1932-6203, 2013, vol. 8, no. 10, str. e4878-1-e4878-9. http://www.plosone.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.pone.0074878&representation=PDF, doi: 10.1371/journal.pone.0074878. [COBISS.SI-ID 27381799]

3. EL SHAWISH, Samir, DOBNIKAR, Jure, TRIZAC, Emmanuel. Colloidal ionic complexes on periodic substrates : ground-state configurations and pattern switching. *Physical review. E, Statistical, nonlinear, and soft matter physics*, ISSN 1539-3755, 2011, vol. 83, no. 4, str. 041403-1-041403-10. [COBISS.SI-ID 24653095]

4. TRIZAC, Emmanuel, EL SHAWISH, Samir, DOBNIKAR, Jure. Dimeric and dipolar ground state orders in colloidal molecular crystals. V: *Proceedings of the IUTAM Symposium on Swelling and Shrinking of Porous Materials: From Colloid Science to Pro-Mechanics, Petrópolis, Brazil, August 6 - August 10, 2007*, (Anais da academia Brasileira de ciencias, vol. 82, no. 1, 2010). Rio de Janeiro: Academia Brasileira de Ciencias, 2010, vol. 82, no. 1, str. 87-94. [COBISS.SI-ID 23483687]
tipologija 1.08 -> 1.01

5. MATTHÄUS, Franziska, JAGODIČ, Marko, DOBNIKAR, Jure. E. coli superdiffusion and chemotaxis-search strategy, precision, and motility. *Biophysical journal*, ISSN 0006-3495, 2009, vol. 97, no. 4, str. 946-957. http://dx.doi.org/10.1016/j.bpj.2009.04.065. [COBISS.SI-ID 22872103]