

MATEMAATIKA-LOODUSTEADUSKONNA FÜÜSIKAINSTITUUDI TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2011

1. Instituudi struktuur

Instituudi direktor Pavel Suurvarik

- Rakendusfüüsika õppetool , Chair of Applied Physics, Jüri Krustok
- Teoreetilise füüsika õppetool , Chair of Theoretical Physics, Rein-Karl Loide

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! punktid 2.1- 2.6 täidab struktuuriüksus)

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

2.1.1 teadustöö kirjeldus (*inglise keeles*);

2.1.2 aruandeaastal saadud tähtsamad teadustulemused (*inglise keeles*).

Chair of Applied Physics

Research topics in the Chair of Applied Physics are mainly related to semiconductor physics. Most studies involve optical and electrical characterization of absorber materials for solar cells. Low temperature photoluminescence spectroscopy, Raman spectroscopy, capacitance spectroscopy and modulation spectroscopy are the main experimental methods. Studied materials include CuInS₂ , AgGaTe₂, ZnO, Cu₂ZnSn(Se_xS_{1-x})₄ and CdTe.

Main results in 2011 involve a detection of exciton emission in Cu₂ZnSnSe₄. A low temperature photoreflectance spectroscopy was implemented to study valence band splitting in AgGaTe₂. Raman and photoluminescence studies of Cu₂ZnSn(Se_xS_{1-x})₄ solid solutions were also completed in 2011. In addition admittance spectroscopy studies were performed in Cu₂ZnSnS₄ solar cells and a defect state at 120 meV was found.

Selected publications:

- F. Luckert, D. I. Hamilton, M. V. Yakushev, N. S. Beattie, G. Zoppi, M. Moynihan, I. Forbes, A. V. Karotki, A. V. Mudryi, M. Grossberg, J. Krustok, and R. W. Martin. Optical properties of high quality Cu₂ZnSnSe₄ thin films. Appl. Phys. Lett. 99, 062104 (2011).
- M. Grossberg, J. Krustok, J. Raudoja, K. Timmo, M. Altosaar, T. Raadik. Photoluminescence and Raman study of Cu₂ZnSn(Se_xS_{1-x})₄ monograins for photovoltaic applications, Thin Solid Films, v. 519, pp. 7403-7406 (2011).

- E. Kask, T. Raadik, M. Grossberg, R. Josepson, and J. Krustok. Deep defects in Cu₂ZnSnS₄ monograin solar cells. Energy Procedia 10 (2011) 261 – 265.

Chair of Theoretical Physics

Topics:

Solid state theory. A method of performing the MD simulations of the local dynamics of 3-D nonlinear crystal lattices based on the nonlinear integral equations of the atomic motions in the site representation has been developed. Performed an analytic and numerical study of nonlinear dynamics of Ni and Nb. It is founded that intrinsic localized modes may exist in these metals with frequencies above the top of the phonon bands. Intrinsic localized mode in Ni or in Nb may have a rather small amplitude and hence a small energy of formation. In the Cu and Al ILM's not exists.

Quantum field theory. Relativic wave equations for arbitrary spin (superspin) fields and superfields, projection operators, Lie algebras and superalgebras. Zero mass limit of massive half-odd spin particles is analysed. The possible content of masses of a given massless equation in the massive case is given. It appears that these additional states are playing important role when interactions with other fields are treated.

Physics of stochastic processes. Influence of memory time on system described by the generalized Langevin equation and under the influence of outer periodical force is analysed. Outer fluctuating media is modeled with the help of dihotomic noise and additive Mittag-Leffler noise. The longtime behaviour of outer parameters is analysed and also the possibility of existence of resonance-like effects.

Binary stars, photogrammetric investigation of Moon's surace. Modelling the light curves of precataclysmic binary systems is continued. The influence of parameters of precataclysmic binaries on their light curves is analysed.

Photogrammetric mapping of the Apollo 11 landing site was continued. Camera stations, locations of artifacts left on the lunar surface (instruments etc) and landscape features (boulders, craters) were found with high accuracy. Identifications of objects in photographs made during EVA by the crew of the Lunar Module were performed using LRO orbital images. The results are prepared for publishing in Acta Astronautica (with Apollo Lunar Surface Journal editor as the co-author) and are published in the web site of NASA Headquarters.

Photogrammetric studies of Apollo 12 landing site were initiated. 73 camera stations have been found, they will serve as a photogrammetric basis for further positioning of other cameras and objects.

2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

Chair of Applied Physics

- F. Luckert, D. I. Hamilton, M. V. Yakushev, N. S. Beattie, G. Zoppi, M. Moynihan, I. Forbes, A. V. Karotki, A. V. Mudryi, M. Grossberg, J. Krustok, and R. W. Martin. Optical properties of high quality Cu₂ZnSnSe₄ thin films. Appl. Phys. Lett. 99, 062104 (2011).
- E. Kask, T. Raadik, M. Grossberg, R. Josepson, and J. Krustok. Deep defects in Cu₂ZnSnS₄ monograin solar cells. Energy Procedia 10 (2011) 261 – 265.

Chair of Theoretical Physics

- Haas, M.; Hizhnyakov, V.; Shelkan, A.; Klopov, M.; Sievers, A. J. (2011). Prediction of high-frequency intrinsic localized modes in Ni and Nb. Physical Review B, 84(144303), 144303-1 - 144303-8.
- Laas, Katrin; Mankin, Romi; Reiter, Eerik (2011). Influence of memory time on the resonant behavior of an oscillatory system described by a generalized Langevin equation. INTERNATIONAL JOURNAL OF MATHEMATICAL MODELS AND METHODS IN APPLIED SCIENCES, 5(2), 280 - 289.
- Pustynski, V.-V.; Pustylnik, I. (2011). On the Influence of Parameters of Precataclysmic Binaries on Their Light Curves. Ученые записки Казанского университета (126 - 131). Казанский (Приволжский) Федеральный Университет

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

2.4 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

Nende loetelu on antud punktis 2.7.

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

- 14th International Density Functional Theory Conference (DFT11) Athens (Greece) "DEMOCRITOS" National Scientific Research Center, from 29.08.11 to 02.09.11, M. Klopov
- 3rd Impedance Spectroscopy School, toimumiskoht: Universitat Jaume I, Castelló, Spain, 14-15 Juuli 2011, Raavo Josepson.

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused (*Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel*)

- Haridus- ja Teadusministeerium
sihtfinantseeritavad teemad:
baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
riiklikud programmid:

Päikesepatareide ja nende materjalide elektriliste omaduste mõõtmisüsteemi ehitamine (BYF)
Raavo Josepson

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:
- Uuriija-professori rahastamine:
- SA Eesti Teadusfond
grandid:
 - ETF7906, Ab-initio, molekulaardünaamika ja Monte-Carlo meetodite kasutamine kristallide mittelineaarsete dünaamika- ja elastsusomaduste arvutamiseks lõplikul temperatuuril, Klopov Mihhail

ühisgrandid välisriigiga:
järel doktorite grandid (SA ETF ja Mobilitas):
tippteadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA
eeluuringud:
arendustoetused:

- SA Archimedesega sõlmitud lepingud
infrastruktuur (nn „mini-infra“, „asutuse infra“):
Eesti tippkeskused:
riiklikud programmid:
muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

Valgusreostuse pikaajaliste muutuste uurimine Tallinnas ja valgusreostuse hetkeseisu määramine Eestis KIK11064 SA Keskkonnainvesteeringute Keskus toetus 27.06.11 - 31.12.12 Mario Mars

- Siseriiklikud lepingud:
- EL Raamprogrammi projektid:
- Välisriiklikud lepingud:

2.8 _Struktuuriüksuse töötajate poolt avaldatud sihtfinantseeritava teadusteema taotlemisel arvestatavad eelretsenseeritavad teaduspublikatsioonid (*ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1*).

1.1

Kask, E.; Raadik, T.; Grossberg, M.; Josepson, R.; Krustok, J. (2011). Deep defects in Cu₂ZnSnS₄ monograin solar cells. Energy Procedia, 10, 261 - 265.

Tõnsuaadu, K.; Kaljuvee, T.; Petkova, V.; Traksmäa, R.; Kirsimäe, K.; Bender, V. (2011). Impact of mechanical activation on physical and chemical properties of phosphorite concentrates. International Journal of Mineral Processing, 100(3-4), 104 - 109.

Klimova, I.; Kaljuvee, T.; Türn, L.; Bender, V.; Trikkel, A.; Kuusik, R. (2011). Interactions of ammonium nitrate with different additives: thermodynamic analysis. Journal of Thermal Analysis and Calorimetry, 105(1), 13 - 26.

Luckert, F.; Hamilton, D. I.; Yakushev, M. V.; Beattie, N. S.; Zoppi, G.; Moynihan, M.; Forbes, I.; Karotki, A. V.; Mudryi, A. V.; Grossberg, M.; Krustok, J.; Martin, R. W. (2011). Optical properties of high quality Cu₂ZnSnSe₄ thin films. Applied Physics Letters, 99, 062104

Haas, M.; Hizhnyakov, V.; Shelkan, A.; Klopov, M.; Sievers, A. J. (2011). Prediction of high-frequency intrinsic localized modes in Ni and Nb. Physical Review B, 84(144303), 144303-1 - 144303-8.

1.2

Laas, Katrin; Mankin, Romi; Reiter, Eerik (2011). Influence of memory time on the resonant behavior of an oscillatory system described by a generalized Langevin equation. INTERNATIONAL JOURNAL OF MATHEMATICAL MODELS AND METHODS IN APPLIED SCIENCES, 5(2), 280 – 289.

Pustynski, V.-V.; Pustynnik, I. (2011). Mass-loss Rate in EHB Binary Progenitors. Astronomical

and Astrophysical Transactions, 27(3), 355 - 356. [ilmumas]

1.3

2.1

2.2

3.1

3.2

Pustynski, V.-V.; Pustynnik, I. (2011). On the Influence of Parameters of Precataclysmic Binaries on Their Light Curves. Ученые записки Казанского университета (126 - 131).Казанский (Приволжский) Федеральный Университет

3.3

4.1

5.1

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu (*NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu*)

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu (*ETIS-e kaudu esitatud taotluste alusel*)

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

3. Struktuuriüksuse infrastruktuuri uuendamise loetelu