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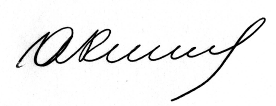
Eessõna

Lõppenud tööaasta oli sisuliselt väga mitmekülgne. Lisaks kolmele jätkuvale sihtfinantseeritavale teadusteemale uurisime Eesti teaduse rahavusvahelistumise programmi raames võimalusi liitumiseks Eesti Teaduse infrastruktuuri teekaardile kantud Euroopa Lõunaobservatooriumiga (ESO). Tõsi on, et vaatamata suurele poolehoiule ametnike poolt ja samuti olulisusele meie astronoomide jaoks, on see kokkuvõttes praegu veel liiga kallis, kuid töö suurema integreerituse suunas rahvusvaheliste erialaorganisatsioonidega läheb edasi. Koos Tartu Ülikooli ja Tallinna Tehnikaülikooliga nõustame Majandus- ja Kommunikatsiooniminiteeriumi ning Keskkonnaministeeriumi Euroopa Kosmoseagentuuriga (ESA) liitumise ettevalmistamisel ning keskkonna jälgimise ja turvalisuse süsteemide kasutuselevõtmisel (EL Copernicus programm). Käivitasime koos partneritega viis uut tüüpi tegevust keskkonnakaitse ja -tehnoloogia teadus- ja arendustegevuse raames Eesti Keskkonnaobservatooriumi loomiseks, veekeskkonna, metsanduslike ning maapinna kaugseirerakenduste arendamiseks ning kliimamuutuste ja polaaralade uuringuteks. Oleme suutnud olla neis EL struktuuritoetuste fondi kaudu rahastatavates projektides edukad vaatamata kiirelt paisuvale bürokraatiale. Tänuväärsed tulemused meie teadusaparatuuri ja infrastruktuuri kaasajastamisel on andnud nii rikkalikult kogemusi kui ka kindlustunnet, et oleme õigel teel.

Eriti hea meel on, et observatooriumi teadlaste tööd on märgatud ja tunnustatud nii kodu- kui välismaal. Akadeemik Jaan Einasto pälvis Armeenia Teaduste Akadeemia poolt välja antava akadeemik Viktor Ambartsumjani rahvusvahelise preemia. Tippkeskuse "Tumeaine ja (astro) osakeste füüsika ja kosmoloogia" teadustöö koos Keemilise ja Bioloogilise Füüsika Instituudiga on kindlasti väärikas J. Einasto ideede edasiviija. Tunnustused Mart Noormale teaduse populariseerimise auhindadena ei ole ju tegelikult üllatus, sest tema entusiasmi ja kirglikkust Eesti esimese satelliidi loomisel jagavad sajad tudengid, kolleegid ja sõbrad. Presidendilt saadud Valgetähe V klassi teenetemärk on sellele kinnituseks. Doktorant Tiina Liimets valiti väga tulemusliku rahvusvahelise teadustöö ja ladusa suhtlejana 500 andeka noorteadlase hulka üle maailma, kes osalesid traditsioonilisel Lindau kohtumisel noorteadlaste ja nobelistide vahel. Meie täielikult renoveeritud tööruumidega peahoone koos uue kosmosetehnoloogia laborikompleksi ja külastuskeskusega sai valmis! 22. oktoobril 2012 andis ehitaja AS YIT Ehitus uuenenud hooned üle. Moodsa töökeskkonna saavad nüüd ligi 90 teadlast, inseneri ja üliõpilast ning avaneb võimalus kutsuda tööle ka ka rahvusvaheliselt tunnustatud tippteadlasi. Juba praegu töötab meil välisteadlasi Saksamaalt, Soomest, Lätist, Bulgaariast, Tšehhist ja Venemaalt. Uuenenud maja sisustamine nii mööbli kui ka sisulise tegevusega kestab veel mõnda aega ja arvata on, et päris valmis ei saa see kunagi: ikka tulevad uued ideed, uued inimesed, uued võimalused.



Anu Reinart
Direktor

Tõraveres
veebruar 2013

Renoveeritud peahooone ees lindi läbi lõikamine. Paremalt: Eesti Teadusagentuuri juhatuse esimees Andres Koppel, Tartu Observatooriumi direktor Anu Reinart ja AS YIT Ehitus juhatuse liige/ehitusdirektor Toomas Rapp.

Foreword

As usual, we worked in different directions in 2012, too. In addition to the three ongoing target financed research topics we explored our possibilities for larger international collaboration with European Southern Observatory (ESO) through the internationalization of science programme. Despite of the support from officials and of great importance for our astronomers, the participation is yet just too expensive! But developing the collaboration with different international organizations continues. In collaboration with the University of Tartu and the Tallinn University of Technology we also contribute to the Ministry of Economic Affairs and Communications and the Ministry of the Environment with research and advice in order to be ready to become a full member of European Space Agency (ESA) and to prepare the EU Copernicus programme on environmental monitoring and security systems. New types of activities have been developed with associates through the Research and Development programme for Environmental Protection and Technologies for the creation of Estonian Environmental Observatory, for aquatic environment, forestry and landscape remote sensing, for polar regions and climate change research. These projects, being financed by European Structural Funds, have also been a matter of concern due to ever-increasing need of managing commands and strict bureaucratic regulations. Nevertheless, modernization of our equipment and infrastructure (10 projects in 2012) has proven very effective and it had given experience as well as assurance that we are on the right track.

It is particularly pleasing that the work and efforts of our scientists have been acknowledged and appreciated in Estonia as well as abroad. Academician Jaan Einasto received the Academician Viktor Ambartsumjan prize from the Armenian Academy of Sciences. Research in the Centre of Excellence "Dark Matter and (Astro)particle Physics and Cosmology" together with the Institute of Chemical and Biological Physics respectably represent and develop EinastoŠs ideas. Recognition of Mart Noorma for science popularization is not all that surprising, because his enthusiasm and passion toward the creation of EstoniaŠs first satellite is shared by hundreds of students, colleagues and friends. For the recognition of this work, Noorma received a Fifth Class Order of the White Star from the President. Doctoral student Tiina Liimets was selected for her productive research and excellent communication skills as one of 500 talented young scientists from all over the globe to take part in a traditional meeting of young scientists and nobelists in Lindau. Our fully renovated main building with the brand new space technology laboratories and visitors center was finally presented to the public on the 22nd of October, 2012 by the builders YIT Ehitus Inc. Over 90 scientists, engineers and students will have the modern working environment. It will be also possible to recruit highly qualified top scientists from all over the world. Currently, we have visiting researchers from Germany, Finland, Latvia, Bulgaria, Czech Republic and Russia. The purchase of the furniture as well as some activities connected with building are still not quite finished in the new building and progress will take a while. Hopefully, this process will never really end, so there is always room for new ideas, new people, new opportunities.

Anu Reinart
Director

Tõravere
February 2013

1 Ülevaade

1.1 Uurimisteemad ja grandid

1.1.1 Sihtfinantseeritavad teadusteemad

2012. aastal jätkus Tartu Observatooriumis (TO) kolme sihtfinantseeritava teadusteema täitmine.

- Tumeenergia, tumeaine ja struktuuri teke Universumis (teema juht E. Saar) – 235 910 EUR.
- Evolutsiooni hilisfaasis tähtede ja nende ümbriste vaatluslik ja teoreetiline uurimine (teema juht T. Kipper) – 280 520 EUR.
- Taimkatte kvantitatiivne kaugseire (teema juht A. Kuusk) – 80 150 EUR.

1.1.2 Eesti Teadusagentuuri grandid

Eesti Teadusagentuuri kaudu rahastastati 7 endist Eesti Teadusfondi granti:

- Grant 7725: A. Kuusk – Metsa peegeldusindikatriss – 16 382 EUR.
- Grant 7765: U. Haud – Nähtav ja varjatud aine galaktikates – 8 933 EUR.
- Grant 8005: E. Saar – Valguskoonused: kosmiliste struktuuride areng – 15 290 EUR.
- Grant 8290: M. Lang – Kaugseire, metsanduslike andmebaaside ning metsakasvu ja -heleduse mudeli lõimimine pideva metsakorralduse süsteemi poolboreaalsete metsade jaoks – 10 271 EUR.
- Grant 8906: L. Leedjärv – Täheassotsiatsioonide heledaimate tähtede muutlikkuse uuring – 9 200 EUR.
- Grant 8970: J. Kuusk – Optiliste kaugseiremõõtmiste täpsust mõjutavad metroloogilised faktorid – 6 000 EUR.
- Grant 9428: A. Tamm – Galaktiliste ketaste ja sferoidide osakaal Universumis – 7 080 EUR.

Need grandisummad ei sisalda asutuse üldkululõivu. Viimane (20% grantide summast) eraldati otse observatooriumi eelarvesse.

Eesti Teadusagentuur rahastas ka kolme järeldoktori- ja mobiilsusgranti:

- ETF järeldoktori grant JD 189: E. Jakobson – Atmosfääri optiliste omaduste muutlikkus Läänemere regioonis kaugseire rakenduste seisukohalt – 24 926 EUR.
- Mobiilsusgrant ERMOS-32: J. Pisek – Taimkatte grupeerumisindeksi määramine satelliidisensori MERIS mitme vaatesuuna mõõtmisandmetest – 22 395 EUR.
- Mobiilsusgrant ERMOS-35: G. Hütsi – Kosmiline suuremastaabiline struktuur: efektiivne vahend fundamentaalfüüsika kontrolliks – 22 395 EUR.

1.1.3 Euroopa Liidu 7. raamprogrammi projektid

- EL 7. raamlepingu projekt GA 251527 (WaterS) "Täiustatud vee kvaliteedi parameetrite määramine optilisest signatuurist strateegilise partnerluse abil" (01.06.2010–31.05.2014): TO koordinaator A. Reinart – 50 895 EUR.
- EL 7. raamprogrammi projekt GA 262733 (ESAIL) "Elektrilise päikesepurje tehnoloogia" (01.12.2010–30.11.2013): TO koordinaator M. Noorma – 70 743 EUR.
- EL 7. raamprogrammi projekt GA 311970 (FORMIT) "Metsade majandamisvõimalused Euroopas kliimamuutuste mõju leevendusvõimekuse tõstmiseks" (01.10.2012–30.09.2016): TO koordinaator M. Lang – 711 EUR.

Lepingud on sõlmitud lisaks veel kahe Euroopa Liidu 7. raamprogrammi projekti täitmiseks:

- EL 7. raamprogrammi projekt GA 313256 (GLASS) "Sentinel satelliitide teenused järvede uuringuteks" (01.03.2012–28.02.2016): TO koordinaator A. Reinart – 246 400 EUR (TO kogumaksumus).
- EL 7. raamprogrammi projekt GA 313116 (NANOSAT) "Utilizing the potential of NANOSATellites for the implementation of European Space Policy and space innovation (24 kuud): TO koordinaator M. Noorma – 85 855 EUR (TO kogumaksumus).
- J. Kuusk osaleb põhitäitjana EMÜ projektis 8-2/T11062PKTF "Kliimamuutuste uuringute infrastruktuuri INCREASE rahvusvaheline kasutus", projekti vastutav täitja L. Hallik, EMÜ.

1.1.4 Euroopa kosmoseagentuuri Euroopa koostööriikide programmi projektid

- Projekt ORAQUA "Teenuspõhised optilise radimeetria rakendused veekeskkonna jaoks (01.12.2011–31.12.2013): A. Reinart – 176 062 EUR.
- Projekt GAIA "Emissioonijoontega tähtede klassifitseerimine Gaia kataloogis" (01.01.2011–31.12.2013): L. Leedjärv – 60 456 EUR.
- Tartu Observatoorium osaleb koostööpartnerina AS Regio ESA PECS projekti "Improving the Quality of Greenhouse Gas Inventory in Estonia – Estimating Forest and Wetland Emissions, Removals and Carbon Stocks" täitmisel: T. Nilson — 21 600 EUR

1.1.5 Euroopa Liidu struktuuritoetused

- Projekt (3.2.0201.10–0013) "Tartu Observatooriumi infrastruktuuri arendusprojekt" (01.06.2008–31.12.2014): A. Reinart – 2 865 977 EUR.

- Teaduse tippkeskuste arendamise projekt (3.2.0101.11–0031) ”Dark matter in (Astro)particle Physics and Cosmology” (2011–2015): TO koordinaator E. Saar, projektijuht A. Tamm – 169 759 EUR.
- Keskkonnakaitse ja -tehnoloogia teadus- ja arendustegevuse (KESTA) projekt (3.2.0802.11-0043) ”Eesti veekeskkonna observatoorium (VeeOBS)” (01.01.2012–31.12.2014): Juhtpartner Eesti Maaülikool, TO koordinaator A. Reinart, projektijuht K. Uudeberg – 57 942 EUR.
- Keskkonnakaitse ja -tehnoloogia teadus- ja arendustegevuse (KESTA) projekt (3.2.0802.11-0043) ”Eesti Keskkonnaobservatooriumi biosfääri ja atmosfääri alane teadus- ja arendustegevus (BioAtmos)” (01.01.2012–31.12.2014): Juhtpartner Tartu Ülikool, TO koordinaator A. Reinart, projektijuht J. Kuusk – 43 282 EUR.
- Riikliku tähtsusega teaduse infrastruktuuri kaasajastamise projekt (3.2.0304.11-0395) ”Eesti Keskkonnaobservatoorium” (01.01.2012–31.12.2012): Juhtpartner Tartu Ülikool, TO projektijuht A. Kuusk – 87 000 EUR.
- Keskkonnatehnoloogia teadus- ja arendustegevuse toetamise projekt (3.2.0801.11-0012) ”Aeglaselt kulgevate nähtuste tuvastamise kaugseiremeetodite täiustamine”(23.03.2012–31.12.2014): U. Peterson – 30 005 EUR.
- Keskkonnatehnoloogia teadus- ja arendustegevuse toetamise projekt (3.2.0801.11-0041) ”Eesti kiirguskliima” (23.03.2012–31.08.2015): K. Eerme – 26 786 EUR.
- E. Jakobson osaleb põhitäitjana TÜ projektis SLOOM12073T ”Polaaraalade kliima- ja keskkonnamuutused seotuna globaalsete muutustega ning nende mõju Põhja-Euroopa kliima kõikumistele”, projekti vastutav täitja J. Jaagus, TÜ.
- Kõrgkoolide ning teadus- ja arendusasutuste õppe- ja töökeskkonna projekt (3.2.0902.11-0003) ”Tartu Observatooriumi teleskoobi tornide tuleohutusnõuetega kooskõlla viimine ja juurdepääsetavuse suurendamine” (01.10.2011– 31.12.2012): E. Ruusalepp, D. Toots – 113 272 EUR.
- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.10-0143) ”1,5 meetrise teleskoobi juhtimissüsteemi moderniseerimine” (01.03.2010– 31.03.2012): K. Annuk – 11 486 EUR.
- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.10-0144) ”Kaugseire etalonide komplekslabor” (01.01.2010–30.04.2012): A. Reinart, A. Kuusk – 68 666 EUR.
- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.11-0290) ”Kosmosetehnoloogia labor” (01.07.2011–06.07.2013): M. Noorma – 69 497 EUR.
- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.11-0292) ”Satelliidimaajaam” (01.07.2011–06.07.2013): S. Lätt – 30 310 EUR.

- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.12-0427) ”Kaugseireaparatuuri testimiskompleks” (01.11.2011–17.12.2013): M. Noorma.
- Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamise projekt (3.2.0302.12-0428) ”Astronoomiliste vaatluste efektiivsuse tõstmine” (01.11.2011– 17.12.2013): K. Annuk – 3 885 EUR.
- Väikesemahulise teaduse infrastruktuuri kaasajastamine teadusteema (3.2.0301.10-0236) ”Evolutsiooni hilisfaasides tähtede ja nende ümbriste vaatluslik ja teoreetiline uurimine” (10.03.2011–31.12.2012): L. Leedjärv – 11 227 EUR.
- Väikesemahulise teaduse infrastruktuuri kaasajastamise teadusteema (3.2.0301.11-0376) ”Tumeenergia, tumeaine ja struktuuri teke Universumis” (06.03.2012– 31.12.2013): E. Saar – 63 000 EUR.
- Väikesemahulise teaduse infrastruktuuri kaasajastamise teadusteema (3.2.0301.11-0377) ”Taimkatte kvantitatiivne kaugseire” (06.03.2012–31.12.2013): A. Kuusk – 39 000 EUR.
- Programmi Teaduse rahvusvahelistumine projekt (3.2.0601.11-0001) ”Eesti osalus Euroopa Kosmoseagentuuris - Kosmoseteaduse ja -tehnoloogia koostöövõrgustik GEOKOSMOS” (01.08.2010–31.08.2015): A. Reinart, M. Noorma, S. Lätt – 21 136 EUR.
- Programmi Teaduse rahvusvahelistumine projekt (3.2.0601.11-0001) ”Eesti osalus Euroopa Lõunaobservatooriumis” (01.08.2010–31.08.2015): L. Leedjärv, P. Tenjes, A. Tamm, I. Kolka – 7 208 EUR.

1.1.6 COST projektid

- COST projekt FP0703 ”Prognoositav kliimamuutus ja selle mõju Euroopa metsandusele 2009–2012”: TO koordinaator – M. Lang.
- Spektrimõõtmiste vahendid taimkatte biofüüsikaliste parameetrite ning voomõõtmistornide andmete jaoks Euroopas. COST projekt ES0903 (2009–2013): TO koordinaator – M. Lang.

1.1.7 Muud projektid ja lepingud

- Eesti Terminoloogiaühingu (ETER) toetus kosmoseterminoloogia korrastamiseks: U. Veismann – 800 EUR.
- Satelliidifotode töötlemine, põldude niitmise analüüs ja fotode täpsuse kirjeldus Põllumajanduse Registrite ja Informatsiooni Ameti (PRIA) tellimusel: K. Voormantsik – 1 000 EUR.
- Riikliku keskkonnaseire programmi allprogramm ”Eesti maastike kaugseire 2012 aastal”. Keskkonnaministeerium: U. Peterson – 9 640 EUR.

- Satelliidifotode töötlemine 2012. aasta kaugseire alades Põllumajanduse Registrite ja Informatsiooni Ameti (PRIA) tellimusel: U. Peterson – 2 556 EUR.
- SA Eesti Teadusagentuuri teaduse populariseerimise konkursi toetus Eesti tudengisatelliidi programmi elluviimiseks (01.04.2012–31.03.2013): M. Noorma – 15 000 EUR.
- Tehniline tugi Stockholmi Ülikooli ESA/ESRIN projektis MERIS toodete valideerimisel Rootsis Vänerni järvel ja Balti mere loodeosa rannikuvetes (01.03.2012–30.11.2012): K. Alikas – 9 130 EUR.

Nende teemade ja projektide raames tehtust leidub põhjalikum ülevaade peatükkides 3–5.

1.2 Töötajad

Observatooriumi töötajaskonnas toimusid mitmed muutused:

- 1. jaanuaril alustasid 0,2 koormusega tööd nooremteadurid Andris Slavinskis ja Kārlis Zālite ja 0,5 koormusega nooremteadur Riho Vendt. Riho Vendt'i töökoormus suurenes juulist 0,8-ni.
- 1. veebruarist alustas 0,7 koormusega tööd teadur Ivar Suisalu.
- 1. märtsist asusid tööle IT spetsialist Urmas Sellis ja 0,4 koormusega tarkvara insener Reikko Randoja. Samal päeval asusid tööle 0,2 koormusega teadur Kersti Kangro ja 0,4 koormusega insener Elar Asuküll.
- 1. maist asus teaduri ametikohale tööle Boris Zhivkov Deshev.
- 20. maist siirdus pensionile kauaaegne apraadiehitaja ja aktinometrist Madis Sulev.
- 31. maist lõppesid Matti Mõttuse ja Vladislav Pustõnski töölepingud.
- 1. juunist töötab Margit Aun 0,2 koormusega nooremteaduri ametikohal, Merlin Juur 0,4 koormusega projektijuhi abina ja Olga Tihhonova 0,2 koormusega tehniku ametikohal.
- 16. juunist lahkus töölt IT spetsialist Urmas Sellis.
- 1. augustist töötab IT spetsialistina Tõnu Veeranna.
- 1. septembrist töötab juhtivteadurina Olaf Krüger.
- 17. septembrist töötab 0,25 koormusega nooremteaduri ametikohal Jaan Laur.
- 24. septembrist töötab teadurina Philipp Grötsch.
- 30. septembril lõppesid peainsener Rein Kalbergi ja sisekujundaja Taisi Kadariku töölepingud.
- 1. oktoobrist töötavad teaduritena Jukka Nevalainen ja Heidi Lietzen.

2012. aastal kaitses tähefüüsika töörühma teadur Taavi Tuvikene Brüsselis (Vrije Universiteit Brussel) edukalt oma doktoriväitekirja (17.08.2012).

Kõigi muutuste tulemusena oli 31. detsembril 2012 Tartu Observatooriumis tööl 95 inimest, neist 62 teadustöötajat ja 10 teadustööd tegevat inseneri ja tehnikut.

1.3 Tunnustused

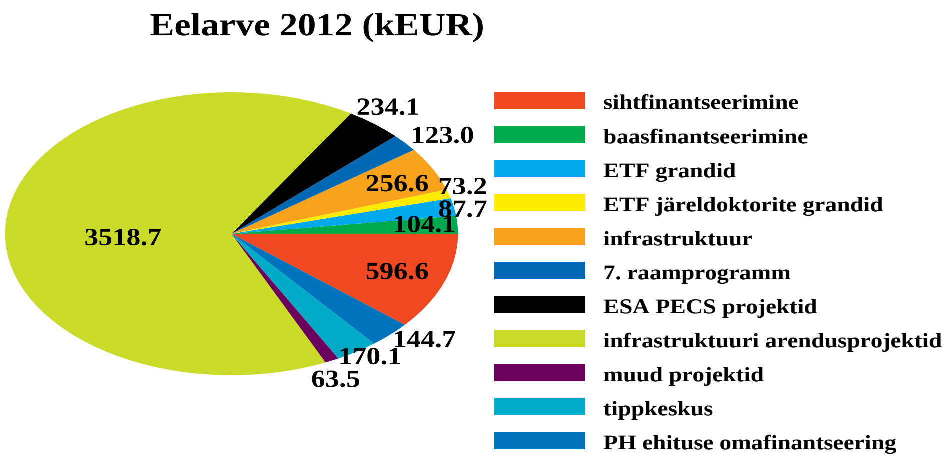
- Armeenia Teaduste Akadeemia poolt välja antava rahvusvahelise akadeemik Viktor Ambartsumjani preemia said akadeemik Jaan Einasto (Eesti) ja professor Igor Novikov (Venemaa). Auhind anti kätte 18. septembril Jerevanis, Armeenia Teaduste Akadeemias toimunud pidulikul üritusel.
- Galaktikate füüsika töörühma vanemteadur Peeter Tenjes valiti Tartu Ülikooli astrofüüsika professoriks.
- Mart Noorma sai Valgetähe V klassi teenetemärgi.
- M. Noorma sai Eesti teaduse populariseerimise auhinna peapreemia kategoorias "Parim uus algatus teaduse ja tehnoloogia populariseerimisel" (koolinoorte teaduspõhise töömaleva Teadusmalev algatamise eest).
- M. Noorma sai Eesti teaduse populariseerimise auhinna peapreemia kategoorias "Teaduse ja tehnoloogia populariseerimine audio-visuaalse ja elektroonilise meedia abil" (saatesarja Rakett 69 loomingulise kollektiivi koosseisus).
- Doktorant Tiina Liimets osales 62. Lindau noorteadlaste ja nobelistide teadusfoorumil. Igal aastal, alates 1951. a. kohtuvad Lindaus paarkümmend Nobeli preemia laureaati ja 500 andekat noorteadlast üle kogu maailma. Noorteadlastel on suurepärane võimalus kuulata nobelistide loenguid, suhelda nobelistidega vabas õhkkonnas, arutada teadusprojekte ning luua teaduslikke sidemeid tulevikuks. 2012. aastal oli kohtumise teemaks füüsika ja seotud erialad. Eesti Teaduste Akadeemia ja teadusfoorumi korraldajate poolt valiti Eestist osalema 2 noorteadlast: meie doktorant Tiina Liimets ning Keemilise ja Bioloogilise Füüsika Instituudi teadur Kristjan Kannike.

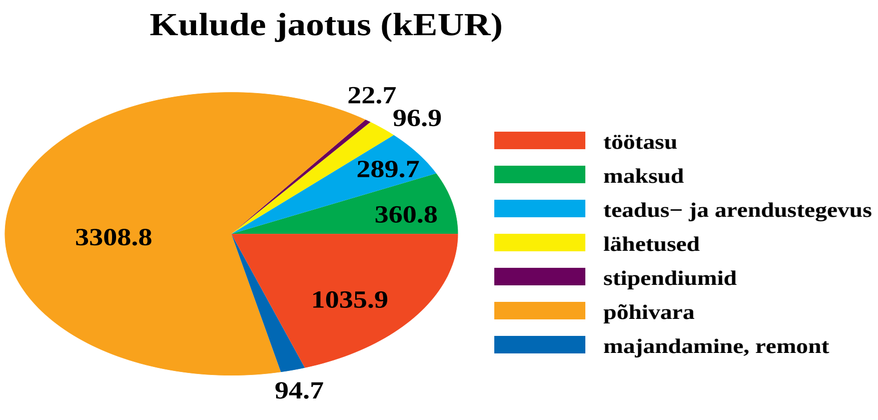
Reisil Lindau saarele: nobelist 2011 Brian P. Schmidt ja Tiina Liimets.

1.4 Eelarve

Riigieelarvest eraldati Tartu Observatooriumile 2012. aastal 1 264,636 kEUR. Lisaks laekus *ca* 4 771,5 kEUR mitmesugustest koostööprojektidest ja lepingutest, mida on nimetatud osades 1.1.3–1.1.7, ning observatooriumi infrastruktuuri renoveerimise projekti arvelt.

Tulud ja kulud jagunesid järgnevalt:





Observatooriumi teadlaste keskmine töötasu 2012. a lõpul oli 1 420 EUR kuus.

1.5 Aparatuur ja seadmed

Euroopa Liidu struktuuritoetuste "Majanduskeskkonna arendamise rakenduskava" alameetmest "Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamine" rahastati Tartu Observatooriumi mitut projekti:

- TAP13-1. 1,5 m teleskoobi juhtimissüsteemi moderniseerimine. 2012. aastal lõpetati 1,5-meetrise teleskoobi juhtimissüsteemi moderniseerimine. Tööd teostas ABB AS. Lisaks soetati sama projekti raames eraldi tarkvara teleskoobi külge uue aparatuuri kinnitamise ja teleskoobi enda hoolduse juures vajaminevate mehaanikadetailide projekteerimiseks, komponentide tugevusarvutuste teostamiseks ja nende kokkusobivuse simulatsioonideks olemasoleva mehaanikaga,
- TAP13-2. Kaugseire etalonide komplekslabor. 2012. aasta jooksul suurendati kaugseire etalonide komplekslabori tehnoloogilist võimekust viie seadmekomplekti soetamisega:
  1. Spektraalse kirkuse peegeldusetalonide komplekti täiendati juhtarvuti ja välitöödeks vajaliku päikese käes loetava lisaekraaniga.
  2. Monokromaatori seadmete komplekti osteti kalibreeritud fotoelektronkordisti ning kahekordne võremonokromaator Bentham koos lisaseadmetega lainepikkustele 250–500 nm, GBIP-USB üleminekud arvutiga ühendamiseks, v-lambda filter, fotodiood.
  3. Komplekteeriti optikaeksperimentide baaskomplekt, mis sisaldab optilisi laudu, optikaeksperimentide läbiviimiseks vajalikke tarvikuid, tööriistu ja hooldusvahendeid. Hangiti erinevad eksperimentideks tarvilikud manuaalsed ning motoriseeritud aktuaatorid (pöördlaud, lineaartranslaator, elektrooniline katik jne) ja aktuaatorite juhtimiseks sobiv kontroller, samuti juhtsüsteemide valmistamise komponendid (mootorid, elektroonikadetailid).
  4. Etalonkiirgurite komplektis soetati stabiilse energiaga pooljuhtlaserid, fiiberoptiline lamp, erineval lainepikkusel kiirgavad pooljuhtdioodid ning fotodioodid kiirgurite stabiliseerimiseks vajaliku tagasisideahela konstrueerimise tarbeks.
  5. Termoelektrilise kiirgusmõõtja seadmetest hangiti laiaribaline lainepikkusest sõltumatu energiamõõtja RS-5900 koos komplekti juurde kuuluvate tarvikutega.
- TAP21-1. Kosmosetehnoloogia labor. 2012. aastal alustati seadmete soetamisega kosmosetehnoloogia laborisse. Elektriliste parameetrite täppismõõtesüsteemi seadmete komplektist osteti ostsilloskoobid ning temperatuuri arendusjaama seadmetest jootekolvid, mikroskoobid, toiteallikad, täppiskaalud ning laborisisustus.
- TAP21-2. Satelliidi maajaam. 2012. aastal soetati satelliitside vastuvõtu ja monitooringu süsteemi seadmed ning viidi läbi hange tugisageduse genereerimise ja jaotamise süsteemi soetamiseks.

- TAP 37-1. Kaugseireaparatuuri testimiskompleks. 2012. aastal viidi läbi hanked termovaakumseadme ja elektromagneetilise emissiooni mõõtesüsteemi soetamiseks.
- TAP 37-2. Astronoomiliste vaatluste efektiivsuse tõstmine. 2012. aastal alustati ettevalmistusi astronoomiliste vaatlusandmete arhiveerimise ja töötlussüsteemi soetamiseks ning suure teleskoobi peeglite aluminiseerimiseks.

Teaduse väikemahulise infrastruktuuri kaasajastamiseks:

- täiendati ja rakendati tähefüüsika sihtfinantseeritava teema raames töösse täisautomatiseeritud robotteleskoobi kuppel, CCD kaamera ja ilmajaam.
- lisati kosmoloogia sihtfinantseeritava teema raames koostöös KBFI-ga arvutusvõimsust arvutusserveritele.
- Hangiti ning sisustati väikebuss Mercedes Benz Vito baasil mobiilne labor kaugseire välitööde jaoks.

Riikliku tähtsusega teaduse infrastruktuuri kaasajastamise projekti Eesti Keskkonnaobservatoorium raames soetati kaks spektromeetrit.

Tartu Observatooriumi infrastruktuuri arendusprojekti raames soetati renoveeritud peahoonesse uued arvutivõrgu aktiivseadmed ning uuendati telekommunikatsiooni välisühendus (optiline kaabel Tõraverest Tartusse).

1.6 Teadusnõukogu töö

Alates 25. aprillist 2012 töötab Tartu Observatooriumi teadusnõukogu järgmises koosseisus:

Anu Reinart – Tartu Observatooriumi direktor, teadusnõukogu esimees,
Gert Hütsi – järeldoktor, teadustöötajate valitud liige,
Rein Kaarli – Haridus- ja Teadusministeeriumi teadusosakonna nõunik,
Marco Kirm – Tartu Ülikooli Füüsika Instituudi direktor (alates augustist TÜ teadusprorektor),
Andres Kuusk – vanemteadur, teadustöötajate valitud liige,
Laurits Leedjärv – vanemteadur, teadustöötajate valitud liige,
Mart Noorma – vanemteadur, teadustöötajate valitud liige,
Tiina Nõges – Eesti Maaülikooli põllumajandus- ja keskkonnainstituudi uurija-professor,
Martti Raidal – Keemilise ja Bioloogilise Füüsika Instituudi uurija-professor,
Enn Saar – juhtivteadur, teadustöötajate valitud liige,
Antti Tamm – teadur, teadustöötajate valitud liige,
Elmo Tempel – teadur, teadustöötajate valitud liige,
Peeter Tenjes – vanemteadur, teadustöötajate valitud liige.

Teadusnõukogu pidas 7 koosolekut.

09. jaanuari koosolekul otsustati, et SA Eesti Teadusagentuuri hindamiskomisjoni nõukogusse esitame Tõnu Viigi kandidatuuri, kuid toetame ka Tartu Ülikooli kandidaate Ergo Nõmmistet ja Tiit Kutserit. Teaduse arendamise siseriiklikus töörühmas, mis peab ette valmistana dokumente Euroopa Liidu vastavale komisjonile, esindavad observatooriumi Anu Reinart ja Antti Tamm. Peeti läbirääkimisi ka observatooriumi struktuuri muutmiseks eesmärgiga luua atmosfääri osakonna alusel kaks osakonda: kaugseire osakond ja kosmosetehnoloogia osakond. Endiselt jätkavad tähefüüsika osakond ja kosmoloogia osakond. Otsustati esitada kaks keskmise infrastruktuuri rahastamise taotlust:

1. 1,5m teleskoobi peeglite aluminiseerimine – K. Annuk.
2. Termovaakuumseade kosmosetehnoloogia laboratooriumi jaoks – M. Noorma.

13. veebruari koosolekul toimus arutelu teadustöötajate konkursi teemal ja otsustati esitada akadeemik Jaan Einasto kandidatuur taotlemaks Armeenia Teaduste Akadeemia poolt välja antavat Viktor Ambartsumjani preemiat.

16. aprilli koosolekul esitas direktor Anu Reinart ülevaate peahoone renoveerimisest. See kulgeb plaanipäraselt. Tehti ettepanek haridus- ja teadusministrile, et teadusnõukogu senini puuduvaks liikmeks määratakse Tiina Nõges Eesti Maaülikoolist. 25. aprilli 2012 käskkirjaga nr. 215 nimetabki minister Tartu Observatooriumi teadusnõukogu uuteks liikmeteks Tiina Nõgese ja ministeeriumi esindajana Rein Kaarli senini nõukogusse kuulunud Ene Kadastiku asemele, kes asus tööle Brüsselisse.

30. aprilli koosolekul toimus konkurss teadustöötajate ametikohtadele. Konkursi tulemusena valiti juhtivteaduriks kosmoloogia erialal Enn Saar ja juhtivteaduriks astrofüüsika erialal Jaan Pelt. Vanemteaduriks galaktikate füüsika erialal valiti Urmas Haud, vanemteaduriks astrofüüsika erialal Laurits Leedjärv ning vanemteaduriks kaugseire erialal Joel Kuusk. Teaduriks galaktikate füüsika erialal valiti Antti Tamm ja teaduriks astrofüüsika erialal Tõnis Eenmäe.

11. juuni koosolekul kinnitati Tartu Observatooriumi põhimääruse muudatused, arutati tulevase raamatukogu seisu, võimalikku ühinemist EL-NET'iga. Otsustati, et kosmosetehnoloogia üliõpilastele hakatakse välja andma Ch. Villmanni nimelist stipendiumi.

1. oktoobri koosolekul määrati juba traditsioonilised E.J. Öpiku ja J. Rossi nimelised stipendiumid ning esmakordselt Ch. Villmanni nimeline stipendium Tartu Ülikooli doktorantidele.

Ettekannetega esinesid:

Rain Kipper: Galaktikate modelleerimine (E.J. Öpiku nimelise stipendiumi taotleja),

Evelin Kangro: MERIS/ENVISAT vee kvaliteedi tulemite valideerimine järvede näitel (J. Rossi nimelise stipendiumi taotleja) ja
Urmas Kvell: Eesti esimene satelliit – ESTCube-1. (Ch. Villmanni nimelise stipendiumi taotleja).
Toimus ka sihtfinantseeritavate teadusteemade jätkutaotluste arutelu ja kinnitamine.

12. novembri koosolekul toimus Tartu Observatooriumi arengukava arutelu, kus erilise tähelepanu all oli tehnoloogilise baasi areng.
Lühiettekannetega esinesid:
   1. K. Annuk: 1,5m teleskoobi juhtimissüsteemi renoveerimine.
   2. T. Eenmäe: Robotteleskoobi ja Zeissi teleskoobi olukord.
   3. J. Kuusk: Optikalaboratooriumite ja ISO 8 puhasruumide olukord.
   4. R. Vendt: Kosmosetehnoloogia laboratooriumite olukord.
   5. T. Veeranna: Multimeedia võimalused uuenenud observatooriumis.

1.7 Suhted avalikkusega

2011/2012 koolide õppeaasta oli kuulutatud Teadusaastaks, milles osalesid ka Tartu Observatooriumi teadlased. Vanemteadur M. Noorma oli nimetatud aasta kõneisik. Teadusaasta saadikuteks olid A. Reinart, T. Liimets ja T. Sepp.

M. Noorma kuulus populaarse noorte teadusvõistluse Rakett 69 kohtunike kogusse. Saatesari oli Eesti Televisiooni eetris igal laupäeval kogu 2012. aasta kevadhooaja.

M. Noorma kuulus Euroopa Komisjoni poolt korraldatud Galileo joonistustevõistluse Eesti vooru žüriisse. Võistluse võitis Kohtla-Järve koolitüdruk Milena Kaznatšejeva ning seega saab üks Euroopa Liidu Galileo positsioneerimissüsteemi satelliitidest nimeks "Milena". Noor kosmosekunstnik valmistas 2012. aasta suvel ette kosmoseteemalise kunstinäituse, mis avati pidulikult Tartu Observatooriumis 22. oktoobril.

Tartu Observatooriumi poolt koordineeritud Teadusmalev tõi suvel TO kosmosetehnoloogia laboritesse 5 aktiivset koolinoort, kes lõid kaasa ESTCube-1 ehituses. See tegevus pälvis Eesti Teadusagentuuri poolt korraldataval teaduse populariseerimise auhinna konkursil peapreemia uue algatuse kategoorias.

2012. aastal jätkus Tartu Observatooriumi peahoone kapitaalne renoveerimine ja tööruumidena olid kasutusel ka 1,5m teleskoobi tornis asuvad Stellaariumi ruumid. Samal ajal renoveeriti ka 1,5m teleskoobi kuplialune ruum ja trepikojad. Huvilisi saime piiratud hulgal vastu võtta õhtusel ajal, et teaduslikke töötajaid nende töös mitte häirida.

Vaatamata nendele häirivatele teguritele käis Tõraveres 100 gruppi ligikaudu 2 400 huvilisega. Populariseerimine jätkus ka veebipõhiselt saidi *www.astronoomia.ee* kaudu. Pidevalt ilmus sinna uusi artikleid, uudiseid, juhtnööre, mida vaadelda jne. Autorid on observatooriumi noored teadlased ja kogu lehekülge haldab/hooldab Taavi Tuvikene.

Eesti Astronoomia Seltsi egiidi all korraldasid Tartu Observatooriumi noored astronoomid (T. Liimets, T. Tuvikene ja T. Eenmäe) 09.–13. augustini traditsioonilise astronoomiahuviliste XVII üle-Eestilise kokkutuleku Võrumaal, Lüllemäel. Astronoomiahuvilised – kelle hulgas on nii kooliõpilasi, üliõpilasi, töötajaid kui ka pensionäre – kogunevad traditsiooniliselt augustikuus perseiidide meteoorivoolu ajal. Kuulatakse professionaalsete astronoomide loenguid, selgetel öödel loendatakse perseiide, käiakse eksursioonil, kuulatakse muusikat jne. Pikema loo nimetatud kokkutulekust kirjutas kokkutuleku üks organiseerija Taavi Tuvikene ja see on avaldatud *Tähetorni Kalendris 2013*.

Observatooriumi teadlaste arvukad populaarteaduslikud kirjutised on üksikasjaliselt ära toodud lk. 88 avalikud loengud ja intervjuud lk. 112.

Ilmus Tähetorni Kalender 2013 (89. aastakäik) ja juba traditsiooniline Tähistaeva Kalender 2013. Kalendrite kalendaariumi osa arvutused tegi Alar Puss.

1.8 Tänuavaldused

Meie teadlased on saanud rahalist või muud toetust paljudelt asutustelt üle maailma. Oleme tänulikud kõigile toetajatele, nende nimed leiate ingliskeelsest osast leheküljel 34.

2 Summary

2.1 Research projects and grants

2.1.1 Target financed projects

In 2012, research in the framework of three target financed projects was continued:

- Dark Energy, Dark Matter, and the formation of structure in the Universe (principal investigator E. Saar) – 235 910 EUR.
- Observational and theoretical investigation of stars and their envelopes during advanced evolutionary phases (principal investigator T. Kipper) – 280 520 EUR.
- Quantitative remote sensing of vegetation covers (principal investigator A. Kuusk) – 80 150 EUR.

2.1.2 Estonian Research Council grants

The Estonian Research Council financed 7 former Estonian Science Foundation grant projects from our Observatory:

- Grant 7725: A. Kuusk – Angular distribution of forest reflectance – 16 382 EUR.
- Grant 7765: U. Haud – Visible and dark matter in galaxies – 8 933 EUR.
- Grant 8005: E. Saar – Light cones: evolution of cosmic structures – 15 290 EUR.
- Grant 8290: M. Lang – Integration of remote sensing, forest growth and reflectance models with existing databases into continuous inventory systems of hemi-boreal forests – 10 271 EUR.
- Grant 8906: L. Leedjärv – Time-resolved survey of the most luminous stars in stellar associations – 9 200 EUR.
- Grant 8970: J. Kuusk – Study of metrological factors limiting complex optical measurements in remote sensing and atmospheric research – 6 000 EUR.
- Grant 9428: A. Tamm – Share of galactic discs and spheroids in the Universe – 7 080 EUR.

Those amounts do not contain institutional overheads. The latter (20% of each grant) was transferred separately to the budget of the Observatory.

The Estonian Research Council also financed one post-doc grant and two mobility grants:

- Post-doc grant JD 189: E. Jakobson – Variability of optical properties of the atmosphere in the Baltic Sea region for remote sensing purpose – 24 926 EUR.

- Mobility grant ERMOS-35: G. Hütsi – Large-scale structure of the Universe – a powerful probe of fundamental physics – 22 395 EUR.
- Mobility grant ERMOS-32: J. Pisek – Retrieving foliage clumping index from multi-angle MISR measurements – 22 395 EUR.

2.1.3 The European Commission 7th Framework Programme projects

- FP7 project GA 251527 ”Strategic partnership for improved basin-scale Water quality parameter retrieval from optical Signatures (WaterS)” (01.06.2010–31.05.2014) continued: Consortium coordinator A. Reinart – 50 895 EUR to TO.
- FP7 project GA 262733 (ESAIL) ”Electric sail propulsion technology” (01.12.2010–30.11.2013) continued: M. Noorma – 70 743 EUR.
- FP 7 project GA 311970 (FORMIT) ”FORest management stategies to enhance the MITigation potentials of European forests”(01.10.2012–30.09.2016): TO partner M. Lang – 711 EUR.
- FP 7 project GA 313116 (GLASS) ”Global Lakes Sentinel Services” (01.03.2012–28.02.2016): TO partner A. Reinart – Full cost for TO 246 400 EUR.
- FP 7 project GA 313116 (NANOSAT) ”Utilizing the potential of NANOSATellites for the implementation of European Space Policy and space innovation” 24 months: TO partner M. Noorma – Full cost for TO 85 855 EUR.
- J. Kuusk participates in the project 8-2/T11062PKTF An integrated network on climate change research activities on shrubland ecosystems (INCREASE) agreement for transnational access (Estonian University of Life Sciences), PI L. Hallik, EULS

2.1.4 European Space Agency Programme for European Cooperating States

- Project ORAQUA ”Services based on optical radiometry applications for aquatic environment” (01.01.2011–31.12.2013): A. Reinart – 176 062 EUR.
- Project GAIA ”Emission Line Star Classification in the Gaia Catalogue” (01.01.2011–31.12.2013): L. Leedjärv – 60 456 EUR.
- Tartu Observatory is a partner in the AS Regio ESA PECS project ”Improving the Quality of Greenhouse Gas Inventory in Estonia – Estimating Forest and Wetland Emissions, Removals and Carbon Stocks”: T. Nilson – 21 600 EUR.

2.1.5 Financing from the EU Structural Funds

- Project (3.2.0210.10–0013) ”Renovation and development of Tartu Observatory infrastructure” (01.06.2008–31.12.2014): A. Reinart – 2 865 977 EUR.
- Programme for Centres of Excellence in Research project (3.2.0101.11–0031) ”Dark matter in (Astro)particle Physics and Cosmology” (2011–2015): TO koordinaator E. Saar, project leader A. Tamm – 169 759 EUR.
- Environmental Conservation and Environmental Technology R&D (KESTA) project (3.2.0802.11-0043) ”Estonian observatory of water environment (VeeOBS)” (01.01.2012– 31.12.2014): Leading partner Estonina University of Life Sciences, TO coordinator A. Reinart, project leader K. Uudeberg – 57 942 EUR.
- Environmental Conservation and Environmental Technology R&D (KESTA) project (3.2.0802.11-0043) ”Biosphere and atmosphere related R&D in the Estonian Environmental Observatory (BioAtmos)” (01.01.2012–31.12.2014): Leading partner University of Tartu, TO coordinator A. Reinart, project leader J. Kuusk – 43 282 EUR.
- Estonian Research Infrastructures Roadmap project (3.2.0304.11-0395) ”Estonian Environmental Observatory” (01.01.2012–31.12.2012): Leading partner University of Tartu, TO project leader A. Kuusk – 87 000 EUR.
- Environmental technology R&D project (3.2.0801.11-0012) ”Improving methods for remote sensing of slowly proceeding phenomena” (23.03.2012–31.12.2014): U. Peterson – 30 005 EUR.
- Project (3.2.0801.11-0041) ”Estonian radiation climate”financed from the European Regional Development Fund and coordinated by the University of Tartu. Partners Tartu Observatory and Estonian Meteorological and Hydrological Institute: K. Eerme (project manager) – 26 786 EUR.
- Project (3.2.0902.11–0003) ”Improvement of accessibility to telescope buildings and pavilions of Tartu Observatory” (01.10.2011–31.12.2012): E. Ruusalepp, D. Toots – 113 272 EUR.
- Research equipment and facilities project (3.2.0302.10-0143) ”Modernization of the control system of the 1.5 metre telescope” (01.03.2010–31.03.2012): K. Annuk – 11 486 EUR.
- Research equipment and facilities project (3.2.0302.10-0144) ”Multipurpose laboratory of remote sensing etalons”(01.01.2010–30.04.2012): A. Reinart, A. Kuusk – 68 666 EUR.
- Research equipment and facilities project (3.2.0302.11–0290) ”Space Technology Laboratory” (01.07.2011–06.06.2013): M. Noorma – 69 497 EUR.

- Research equipment and facilities project (3.2.0302.11–0272) ”Satellite Ground Station” (01.07.2011–06.06.2013): S. Lätt – 30 310 EUR.
- Research equipment and facilities project (3.2.0302.12-0427) ”Test facilities for remote sensing equipment” (01.11.2011–17.12.2013): M. Noorma.
- Research equipment and facilities project (3.2.0302.12-0428) ”Increasing effectiveness of astronomical observations” (01.11.2011–17.12.2013): K. Annuk – 3 885 EUR.
- Small equipment to the research topic ”Observational and theoretical investigation of stars and their envelopes in advanced evolutionary phases"(3.2.0301.10-0236) (10.03.2011–31.12.2012): L. Leedjärv – 11 227 EUR.
- Small equipment to the research topic "Dark Energy, Dark Matter and formation of structure in the Universe"(3.2.0301.11-0376) (06.03.2012–31.12.2013): E. Saar – 63 000 EUR.
- Small equipment to the research topic "Quantitative remote sensing of vegetation covers"(3.2.0301.11-0377) (06.03.2012–31.12.2013): A. Kuusk – 39 000 EUR.
- Internationalization of research project (3.2.0601.11-0001) ”Participation of Estonia in the European Space Agency – network for space science and technology GEOKOSMOS” (01.08.2011–31.08.2015): A. Reinart, M. Noorma, S. Lätt – 21 136 EUR.
- Internationalization of research project (3.2.0601.11-0001) ”Participation of Estonia in the European Southern Observatory – ESTO-ESO” (01.11.2011–31.08.2015): L. Leedjärv, P. Tenjes, A. Tamm, I. Kolka – 7 208 EUR.

2.1.6 COST projects

- COST project FP0703 ”Expected Climate Change and Options for European Silviculture (ECHOES) COST Action 2009–2012”: TO coordinator M. Lang.
- COST project ES0903 ”Spectral Sampling Tools for Vegetation Biophysical Parameters and Flux Measurements in Europe” (2009–2013): TO coordinator M. Lang.

2.1.7 Some other projects and contracts

- Development of (Estonian) space terminology: U. Veismann – 800 EUR.
- Review of declared agricultural parcels with remote sensing methods, Estonian Agricultural Registers and Information Board: K. Voormansik – 1 000 EUR.

- National programme of environmental monitoring, subprogramme ”Studies on change of Estonian landscapes and remote sensing”, Ministry of the Environment: U. Peterson, 9 640 EUR.
- Review of declared agricultural parcels with remote sensing methods: U. Peterson – 2 556 EUR.
- Estonian Research Council’s science popularization grant to support the Estonian student satellite EstCube-1 (01.04.2012–31.03.2012): M. Noorma – 15 000 EUR.
- Technical support to the University of Stockholm ESA/ESRIN project ”Validation of MERIS products for the Lake Vänern and coastal waters of the Nort-West Baltic Sea” (01.03.2012–30.11.2012): K. Alikas – 9 130 EUR.
- E. Jakobson was a main investigator in the University of Tartu project SLOOM12073T ”Climate and environment changes in polar regions and their relations to global changes and climate variability in Northern Europe”, project leader J. Jaagus, UT.

A scientific report about the activities within these projects and topics will be given in Chapters 3–5.

2.2 Staff

Some changes in the staff of the Observatory took place:

- From January 1, Andris Slavinskis and Kārlis Zālite are working as junior research associates (0.2 workload), and Riho Vendt as research associate (0.5, starting from July 0.8 workload).
- From February 1, Ivar Suisalu is working as research associate (0.7 workload).
- From March 1 IT specialist Urmas Sellis and software engineer Reikko Randoja (0.4 workload) were employed as well as research associate (0,2) Kersti Kangro and engineer (0.4) Elar Asuküll.
- From May 1, Boris Zhivkov Deshev is working as research associate
- On May 20, Madis Sulev, an engineer and actinometrist of long service, retired.
- On May 31, the contracts of Matti Mõttus and Vladislav Pustõnski ended.
- From June 1, Margit Aun is working as junior research associate (0.2), Merlin Juur as assistant project manager (0.4), and Olga Tihhonova as technician (0.2).
- On June 16, IT specialist Urmas Sellis left the Observatory.
- From August 1, Tõnu Veeranna is working as IT specialist.
- From September 1, Olaf Krüger is working as leading research associate.

- From September 17, Jaan Laur is working as junior research associate (0.25).
- From September 24, Philipp Grötsch is working as research associate.
- On September 30, the contracts of Rein Kalberg and Taisi Kadarik ended.
- From October 1, Jukka Nevalainen and Heidi Lietzen are working as research associates.

On August 17, 2012 the research associate of the group of stellar physics Taavi Tuvikene successfully defended his Ph.D. thesis in the Vrije Universiteit Brussel.

As a result of all the changes, the number of people employed by the Tartu Observatory was 95 on December 31, 2012. Of them, 62 are on the position of researchers and 10 on that of research engineers.

2.3 Awards

- National Academy of Sciences of Armenia awarded a very prestigious International Viktor Ambartsumian Prize to professor Jaan Einasto (Estonia) and to professor Igor Novikov (Russia). The award ceremony took place on September 18 in Yerevan.

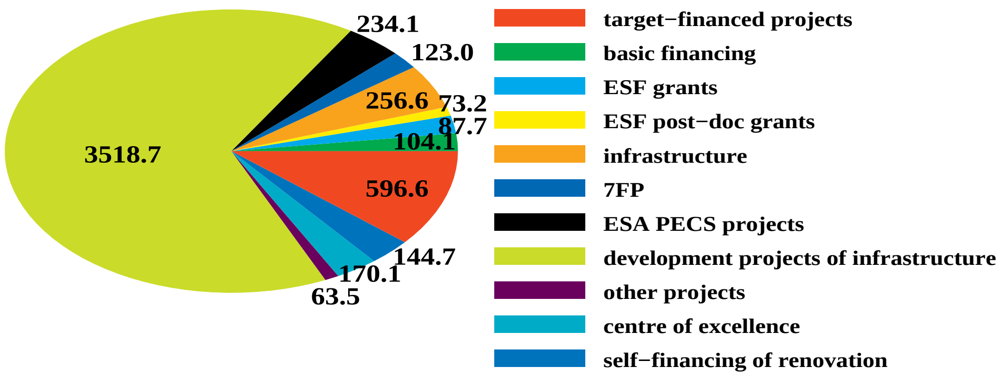
Viktor Ambartsumjani nimelise preemia üleandmine Jaan Einastole. Vasakult: Jaan Einasto, Armeenia president Serž Sargsjan ja Armeenia Teaduste Akadeemia president prof. Radik Martirosjan. Areg Mikaeljani foto From left: Jaan Einasto, President of the Republic of Armenia Serž Sargsjan, President of the Armenian Academy of Sciences professor Radik Martirosjan.

- Mart Noorma was awarded the Order of the White Star, class V.
- Senior research associate of the group of physics of galaxies Peeter Tenjes was elected the Professor of Astrophysics at the University of Tartu.
- Organizing a science summer camp (coordinated by M. Noorma) was awarded the Main award of the Estonian Research Council on popularization of science in the category of new initiatives.
- M. Noorma was awarded a prize as a member of the jury of the popular youth scientific competition ”Rakett 69” broadcasted by the Estonian National TV every Saturday in the spring session 2012.
- ”62nd Lindau Nobel Laureate Meeting”. Every year since 1951 about 25 Nobel laureates and 500 talented young researchers from all over the world meet in Lindau. Young researchers have an excellent opportunity to listen talks by Nobel laureates, discuss science with them and built international networks. The 2012 meeting was dedicated to physics and related topics. Estonia was presented by our Ph.D. student Tiina Liimets and young researcher Kristjan Kannike (National Institute of Chemical Physics and Biophysics) chosen by Estonian Academy of Sciences and the organizers of the meeting.

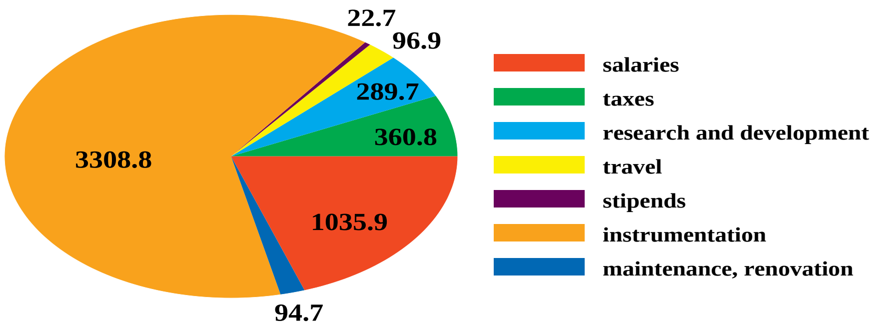
2.4 Budget

The total amount allocated from the state budget directly to the Observatory was 1 264.636 kEUR. In addition, about 4 771.5 kEUR from contracts with several organizations, for renovation of the infrastructure etc. were allocated to the Observatory.

Budget 2012 (kEUR)



Expenditure (kEUR)



The mean monthly salary of researchers was approximately 1 420 EUR by the end of 2012.

2.5 Instruments and facilities

Tartu Observatory was successful in obtaining financing for several projects from the subprogramme ”Modernization of the research apparatus and equipment” of the implementation plan of the European Union structural funds "Development of the economic environment":

- TAP13-1. Modernization of the control system of the 1.5 m telescope. In 2012, this project was finished by the ABB AS. In addition, a special software for mechanical calculations and designing was purchased.
- TAP13-2. Multipurpose laboratory of remote sensing etalons. In 2012:
    1. The set of etalons for spectral reflectance was supplemented with the control computer and a special display for measurements in sunny conditions.
    2. The set of Monochromator was supplemented with a calibrated photoelectric multiplier and a double grating monochromator Bentham for the wavelength region 250–500 nm, GBIP-USB connections, v-lambda filter, and a photodiode.
    3. A basic complex for optical experiments was compiled containing various optical benches, instruments, maintenance devices etc.
    4. The complex of etalon radiators was supplemented with a stable energy semiconductor laser, fiber-optical lamp, semiconductor diodes for different wavelength regions, and photodiodes for creating feedback chains.
    5. A wavelength independent measuring device RS-5900 for thermoelectrical measurements was purchased.
- TAP21-1. Laboratory for space technology. Purchase of some smaller equipment was started in 2012: oscsilloscopes, microscopes, precision scales, power supplies etc.
- TAP21-2. Satellite ground station. In 2012, equipment for receiving and monitoring satellite communication was purchased and the procurement of the device for generating and distributing reference frequency was started.
- TAP 37-1. Test facilities for remote sensing equipment. The procurement procedures for thermovacuum equipment and measurement system for electromagnetic emission were started in 2012.
- TAP 37-2. Increasing effectiveness of astronomical observations. Preparations for purchasing of the archiving and processing system were started in 2012.

In the framework of the small equipment programme related to the target financed topics the following items were purchased:

- A mobile field-work laboratory on the basis of the minibus Mercedes Benz Vito.

- The dome, weather station and CCD camera for the fully automatic robotic telescope.
- The server of the cosmology group.

In the framework of the Estonian Environmental Observatory two new spectrometers were obtained.

New active devices for the computer network were obtained and external communications on the basis of the optical fiber were implemented in relation to the renovation of the main building of the Observatory.

2.6 Scientific Council

Membership of the Scientific Council of Tartu Observatory was appointed in 2012 as follows:

Anu Reinart – director, Chair of the Council,
Gert Hütsi – postdoc, elected by researchers,
Rein Kaarli – adviser in the Ministry of Education and Research,
Marco Kirm – director of the Institute of Physics, University of Tartu, from August 2012 vice-rector of the University of Tartu
Andres Kuusk – senior research associate, elected by researchers,
Laurits Leedjärv – senior research associate, elected by researchers,
Mart Noorma – senior research associate, elected by researchers,
Tiina Nõges – Estonian University of Life Sciences, research professor,
Martti Raidal – senior research associate of the National Institute of Chemical Physics and Biophysics,
Enn Saar – leading research associate, elected by researchers,
Antti Tamm – research associate, elected by researchers,
Elmo Tempel – research associate, elected by researchers,
Peeter Tenjes – senior research associate, elected by researchers.

Scientific Council had 7 meetings in 2012.

On January 9, Tõnu Viik was presented as a candidate to the evaluation committee of the Estonian Research Council, and the candidatures of Ergo Nõmmiste and Tiit Kutser (University of Tartu) were supported. A change in the structure of Observatory was discussed and proposed: there would be four scientific departments: stellar physics, cosmology, remote sensing and space technology. Two proposals for purchasing and renovating research infrastructures were approved:

1. Increasing effectiveness of astronomical observations (including aluminization of the mirror of the 1.5m telescope – K. Annuk.
2. Thermovacuum equipment for the space technology laboratory – M. Noorma.

On February 13, discussions were held on the forthcoming public contest for the posts of researchers. The candidature of professor Jaan Einasto was presented to the International Viktor Ambartsumian Prize.

On April 16, the director Anu Reinart gave an overview on the renovation of the main building of the Observatory. A proposal was made to nominate Tiina Nõges and Rein Kaarli to the members of the Scientific Council. The minister of education and research confirmed the new Council in his order of April 25, 2012.

On April 30, the contest on the posts of researchers took place. Following persons were elected: Enn Saar to leading research associate in cosmology, Jaan Pelt – leading research associate in astrophysics, Urmas Haud – senior research associate in physics of galaxies, Laurits Leedjärv – senior research associate in astrophysics, Joel Kuusk – senior research associate in remote sensing, Antti Tamm – research associate in physics of galaxies, and Tõnis Eenmäe – research associate in astrophysics.

On June 11, changes in the statute of Tartu Observatory were approved. Some questions on the library were discussed. A decision was made to start to issue the Charles Villmann fellowship to the students of space technology.

On October 1, the traditional fellowships of Ernst Julius Öpik and Juhan Ross as well as a new Charles Villmann fellowship were awarded. The awardees made short reports:
Rain Kipper: Modelling of galaxies (E.J. Öpik fellowship),
Evelin Kangro: Validation of MERIS/ENVISAT on the water quality in the example of lakes (J. Ross fellowship),
Urmas Kvell: On the ESTCube-I project (Ch. Villmann fellowship).
Proposals for continuation of three target-financed projects were also approved.

On November 12, the development plan of Tartu Observatory was discussed, with special emphasis on the development of technology. Following short reports were presented:

1. Annuk K.: Renovation of the control system of the 1.5m telescope.
2. Eenmäe T.: On the robotic telescope and the Zeiss-600 telescope.
3. Kuusk J.: On the optical laboratories and the ISO 8 cleanrooms.
4. Vendt R.: On the space technology laboratories.
5. Veeranna T.: On the multimedia devices in the Observatory.

2.7 Public relations

The study year 2011/2012 was declared the a Year of Science in Estonia. Researchers from Tartu Observatory participated actively in the events of this year, with M. Noorma being the Spokesperson of the year, and A. Reinart, T. Liimets and T. Sepp as ambassadors of the year.

M. Noorma belonged to the jury of the popular youth scientific competition "Rakett 69" broadcasted by the Estonian National TV every Saturday in the spring session 2012.

M. Noorma belonged to the Estonian jury of the drawing competition arranged by the European Commission on the topic of the European navigation and positioning system Galileo. Milena Kaznatšejeva from Kohtla-Järve won the competition, and one of the Galileo satellites will be named Milena. On October 22, an exhibition of her space-related drawings was opened in the renovated main building of Tartu Observatory.

As a new initiative, a science summer camp for 5 school students was coordinated by Tartu Observatory. Those young people participated in building of the ESTCube-1 student satellite. The initiative deserved a prize on popularization of science.

Renovation of the main building of Tartu Observatory was continued in 2012, as well as some reconstruction works in the building of the 1.5-meter telescope. This made very difficult to receive groups of visitors at Tõravere. The excursions were possible mostly in late evening hours and on the weekends, in order not to disturb researchers who were working in the premises of the telescope. In spite of all difficulties, about 2400 visitors in about 100 groups were still received in 2012.

Popularization of astronomy in internet was also active. The website *www.astronoomia.ee* was continuously upgraded by young researchers of the Observatory, under the supervision of Taavi Tuvikene.

A traditional all-Estonian meeting of amateur astronomers was organized by T. Liimets, T. Tuvikene and T. Eenmäe under the auspices of Estonian Astronomical Society. The event took place from August 9 to 13 at Lüllemäe, southern Estonia.

Numerous popular-scientific articles by our scientists are presented on the page 88, public lectures and interviews on the page 112.

The 89th issue of the Calendar of the Observatory was published as well as traditional Calendar of the Starry Sky.

2.8 Acknowledgements

Many associates were supported by various institutions throughout the world. Herewith we cordially thank:

- Archimedes Foundation
- ASTRONET (EC FP7 project)
- Astronomical Institute of the Academy of Sciences of the Czech Republic

- Astrophysikalisches Institut Potsdam
- Enterprise Estonia
- Estonian Academy of Sciences
- Estonian Ministry of Education and Research
- Estonian Ministry of Environment
- Estonian Ministry of Finance
- Estonian Research Council
- Enterprise Estonia
- Euro–Asian Astronomical Society
- European Astronomical Society
- European Commission
- European Space Agency
- Foundation Lindau Nobelprizewinners Meeting at Lake Constance
- Helsinki University
- Instituto de Astrofisica de Canarias
- International Astronomical Union
- Institute of Physics, University of Tartu
- National Astronomical Observatories, China
- Nordic Forest Research Co-operation Committee (SNS)
- Nordic Optical Telescope
- Observatori Astronomic, Universitat de València
- Ondřejov Observatory
- Pakker Avio
- Tuorla Observatory, University of Turku
- University of Tartu

3 Dark Energy, Dark Matter and formation of structure in the Universe Tumeenergia, tumeaine ja struktuuri teke Universumis

Juba mitukümmend aastat on teada fakt, et Universumis domineerib tumeaine, mida on pea viis korda rohkem kui tavalist ainet. Astronoomilistest vaatlustest on teada paljud tumeaine omadused, kuid selle päritolust ei ole füüsikutel mingit informatsiooni. Tumeaine jälgi on elementaarosakestefüüsika ja kosmoloogia eksperimentides otsitud kümneid aastaid, kahjuks edutult. E. Tempel koostöös Martti Raidali ja Andi Hektoriga KBFIst analüüsisid kosmoseteleskoop Fermi andmeid ning leidsid sealt esimesi vihjeid tumeaine päritolu kohta. Fermi andmetes avastati 2012. aasta kevadel Linnutee tsentrit ümbritsevast piirkonnast üks "veider" signaal: üldiselt siledas kosmilise gammakiirguse spektris on nähtav suhteliselt terav maksimum. Sellist teravat maksimumi, mille energia on umbes 130 GeV, on tavaliste astrofüüsikaliste objektidega väga raske seletada, kuid saab seletada tumeaine annihilatsiooniga. E. Tempel, M. Raidal ja A. Hektor näitasid, et gamma-joone signaal tuleneb üsna täpselt Galaktika keskmest ning ei ole seotud ühegi varem teadaoleva astronoomilise objektiga nagu näiteks "Fermi mullid". Lisaks Galaktika keskmele leidsid autorid samasuguse signaali lähedastest galaktikaparvedest. Kui vaadata gamma-joone morfoloogiat lähemalt, siis on näha, et lisaks tugevale 130 GeV joonele on olemas natuke nõrgem 110 GeV joon. Kuna täpselt samasugune joonte dublett on nähtav nii Galaktika keskmes, kui ka galaktikaparvedes, siis on signaal väga suure tõenäosusega pärit tumeainest. Kui tumeaine päritolu uurimine on meie temaatikas uus, siis Universumi suuremastaabilise struktuuri (galaktikate superparvede, filamentide, parvede ja gruppide) uurimine jätkub sama hooga kui ennegi. M. Einasto koos J. Venniku, E. Templi, P. Nurmi, A. Ahvensalmi, E. Saare, L.J. Liivamäe, E. Tago, J. Einasto, M. Gramanni, P. Heinämäe ja teistega uurisid SDSS galaktikate andmete põhjal koostatud galaktikaparvede kataloogi, kasutades rikaste galaktikaparvede ehitust. Kasutati andmeid 109 parve kohta ja uuriti, kas galaktikaparvedes on alamstruktuure. Leiti, et enam kui 80% galaktikaparvedest koosnevad mitmest komponendist, ja ligi pooltel parvedel on peagalaktikate omakiirused suured. See näitab, et suur osa galaktikaparvi ei ole veel dünaamilises tasakaalus, vaid alles moodustumas. Lisaks uuriti galaktikaparvede omaduste seoseid neid ümbritseva keskkonna omadustega. Leidsime kõikide parvede korral need superparved, milles nad paiknevad (kokku 50 superparve) ja uurisime, kas superparvede morfoloogia on seotud neis paiknevate galaktikaparvede omadustega. Superparvi on kaht põhilist morfoloogilist tüüpi – filamendid ja ämblikud. Osutus, et ämblik-tüüpi superparvedes asuvatel galaktikaparvedel on rohkem komponente ning nende peagalaktikate omakiirused on suuremad kui filament-tüüpi superparvedes asuvatel galaktikaparvedel. Heidi Lietzen, Pekka Heinämäki ja Pasi Nurmi Tuorla Observatooriumist koos E. Tempeli, E. Saare ja M. Einastoga võrdlesid erinevas suureskaalalises ümbruses paiknevate galaktikagruppide galaktilist koostist ning näitasid, et ühesuguse rikkusega, kuid erinevas ümbruses asuvate gruppide koostis on erinev: sama rikkuse juures on suure tihedusega ümbruses (superparvedes) paiknevad grupid suurema heledusega ning nad sisaldavad suhteliselt rohkem passiivseid, elliptilisi galaktikaid kui hõredamas ümbruses paiknevad sama rikkusega grupid. Tuorla ja Tartu kosmoloogid Pasi Nurmi juhtimisel jätkasid tumeaine halode ja galaktikagruppide omaduste võrdlemist aru saamaks, kas vaatlustest leitud galaktikagruppe võib pidada ühise tumeaine haloga objektideks. Selle töö esimeseks osaks on galaktikagruppide ja simulatsioonidest leitud tumeaine halode statistiliste omaduste võrdlemine. See uurimus näitas, et halode ja gruppide omadused on paljuski sarnased, kuid leiti ka terve rida huvitavaid erinevusi. Jätkasime BAO kerakihtide, kõige suuremate siiani teada olevate kosmoloogiliste struktuuride uurimist. Parandasime otsingualgoritmi ja otsisime BAO kerasid galaktikate jaotuses. Leidsime neid mitu, parimaks näiteks on M. Einasto kera, mille tsentris asub Bootese superparve kõige rikkam parv. L.J. Liivamägi uuris BAO kihte moodustavate galaktikate ning galaktikasüsteemide omadusi.

Mõistmaks galaktikate arengut uurisid E. Tempel ja E. Saar koostöös Radu Stoicaga Prantsusmaalt, Lille'i Ülikoolist, kuidas Universumi kärgstruktuur mõjutab galaktikate arengut. Galaktikad on koondunud parvedesse, mida omavahel ühendavad galaktikate ahelad ehk filamendid, mille mõõtmed ulatuvad kuni kümnete megaparsekiteni. Me kaardistasime SDSS valimi filamendid ja määrasime galaktikate pöörlemisteljed. Leidsime, et spiraalgalaktikate pöörlemisteljed on enamasti paralleelsed filamentidega, aga elliptiliste galaktikate pöörlemisteljed) on filamentidega risti. Antud tulemused sobituvad üsna hästi hiljutistest N-keha simulatsioonidest saadud tulemustega – spiraalgalaktikad tekivad rahuliku arengu käigus, kus gaas langeb galaktikatesse risti filamendiga, ja galaktikate pöörlemisteljed on piki filamenti. Elliptilised galaktikad seevastu tekivad galaktikate põrgete tulemusel, mis peamiselt toimuvad piki filamenti, ja nende pöörlemisteljed on risti filamendiga. Jätkasime ka galaktikagruppide uurimist. E. Tempel, E. Tago ja L.J. Liivamägi uuendasid Sloani digitaalse taevaülevaate (SDSS) alusel saadud galaktikagruppide kataloogi, kasutades uut SDSS versiooni (DR8). paljude Selle kataloogi alusel on koostatud superparvede kataloog, uuritud superparvede omadusi, leitud suuremastaabiline tihedusväli, uuritud parvede ja gruppide omadusi. Analoogiline grupikataloog koostati ka pikalainelises kiirguses vaadeldud 2MASS ülevaate galaktikate põhjal. See kataloog sisaldab detailset teavet lähedaste superparvede kohta.

J. Vennik ja T. Kuutma jätkasid galaktikate fotomeetrilisi uuringuid lähedastes galaktikagruppides, eesmärgiga hinnata tähetekkeprotsesside iseärasusi grupikeskkonnas. Nad leidsid, et grupi tihedamas siseosas paiknevates ketasgalaktikates on näha gaasikadu ja tähetekke nõrgenemist ketta välisosades, kuid grupi välisosas paiknevates ketasgalaktikates toimub intensiivne täheteke eelkõige gaasirikkas väliskettas.

Jätkasime ka üksikgalaktikate uurimist. Boris Deshev uuris külma gaasi omaduste sõltuvust galaktikate lähimast ümbrusest, kasutades raadiovaatluste andmeid ja SDSS kataloogi. Koos kolleegidega IAC-st (Hispaania) töötab ta ka M33 gaasijaotuse uurimisel, ja alustas uut programmi uurimaks galaktikate kinemaatikat põrkuvates galaktikaparvedes.

A. Tamm, E. Tempel, P. Tenjes, O. Tihhonova ja T. Tuvikene määrasid detailse tähelise ja tumeaine jaotuse Andromeeda galaktikas, kasutades SDSS ning kosmoseteleskoop Spitzeri andmeid. Modelleeriti igas pikslis olev spektraalne energia jaotus, kasutades sünteetilisi tähtede populatsioonide mudeleid ja saadi kahemõõtmeline täheaine massi jaotus Andromeedas. Rakendades sellele tuumast, mõhnast, kettast, noorte tähtede rõngast ja tähelisest halost koosnevat mudelit, tuletati nähtava aine kolmemõõtmeline jaotus Andromeeda galaktikas. Galaktika massijaotus määrab galaktika pöörlemiskõvera. Kui täheliste komponentide juurde lisada gaas ja tumeaine, saab modelleeritud dünaamikat vaatlustega võrrelda ning tumeaine omadusi määrata. Selleks kasutati neutraalse vesiniku ning satelliitgalaktikate, täheliste voolude ja kerasparvede dünaamikast saadud ringkiirusi. Gaasi massijaotust lähendati noorte tähtede rõngaga, tumeaine halo puhul kasutati aga mitut mudelit. Leiti, et praegu ei õnnestu veel fikseerida tumeaine jaotust. Samas on galaktika viriaalmass aga hästi piiritletud. Tumeaine tihedus galaktika tsentris on sarnane suurtel punanihetel olevate galaktikate omadega. Meie Galaktika puhul uuriti selle gaasisisaldust ja tähtede omadusi. U. Haud jätkas tööd neutraalse vesiniku kitsajoonelise kiirgusega (NHIE) pilvede uurimisel ja alustas uute Parkesi lõunataeva vesinikuvaatluste (GASS) töötlemist. Praeguseks on lõpetatud kogu GASS andmestiku esmane Gaussi komponentideks lahutamine, tulemuste alusel on koostatud probleemsete profiilide nimekirjad. V. Malyuto jätkas tähepopulatsioonide klassifikatsioonimeetodite arendamist.

3.1 Search for invisible matter

There are several kinds of unseen matter in the Universe. The best known is dark matter that comprises about 27% of they energy content of the Universe; another example is the unseen baryonic matter that is supposed to be located in galaxy filaments as the warm-hot intergalactic gas and with mass as large as that of the luminous matter. We are searching for both of them.

3.1.1 Search for dark matter

Firm evidence for DM is given by various gravitational effects in astrophysics and cosmology. Unfortunately, direct and indirect searches for DM particles have all given either negative or contradictory results. A notable exception to this result is the recent evidence for the gamma-ray excess with the of energy 130 GeV in the Fermi Large Area Telescope (LAT) data. This excess originates predominately from a small region in the Galactic centre and may have a double peak spectral structure.

E. Tempel together with M. Raidal and A. Hektor from KBFI analysed the publicly available Fermi-LAT high-energy gamma-ray data and discovered/confirmed the existence of a clear spectral feature peaked at E_γ = 130 GeV. Scanning over the Galaxy they identified several disconnected regions where the observed excess originates from. The best optimized fit is obtained for the central region of the Galaxy with a clear peak at 130 GeV with a local statistical significance of 4.5σ. The observed excess is not correlated with Fermi bubbles. They computed photon spectra induced by dark matter annihilations into two and four standard model particles, the latter via two light intermediate states, and fit the spectra with data. Since the resulted fits indicate a sharper and higher signal peak than in the previous works, the data favours dark matter direct two-body annihilation channels into photons or other channels giving only line-like spectra. If the Einasto halo profile correctly predicts the central cusp of the Galaxy, the dark matter annihilation cross-section to two photons is of order of ten percent of the standard thermal freeze-out cross-section. The large dark matter two-body annihilation cross-section to photons may signal a new resonance that should be searched for at the CERN LHC experiments.

E. Tempel together with M. Raidal and A. Hektor from KBFI searched also for spectral features in the Fermi-LAT gamma-ray data from regions corresponding to nearby galaxy clusters, selected by high signal line-of-sight integrals (J-factors). They observed a double peak-like excess at the photon energies of 110 GeV and 130 GeV over the diffuse power-law background with a global statistical significance up to 3.6σ, confirming independently the earlier claims of excess from the Galactic centre. Interpreting this result as a signal of

DM annihilations into two channels with monochromatic final-state photons, and fixing the annihilation cross section from the Galactic centre data, they determined the annihilation boost factor due to galaxy cluster subhaloes.

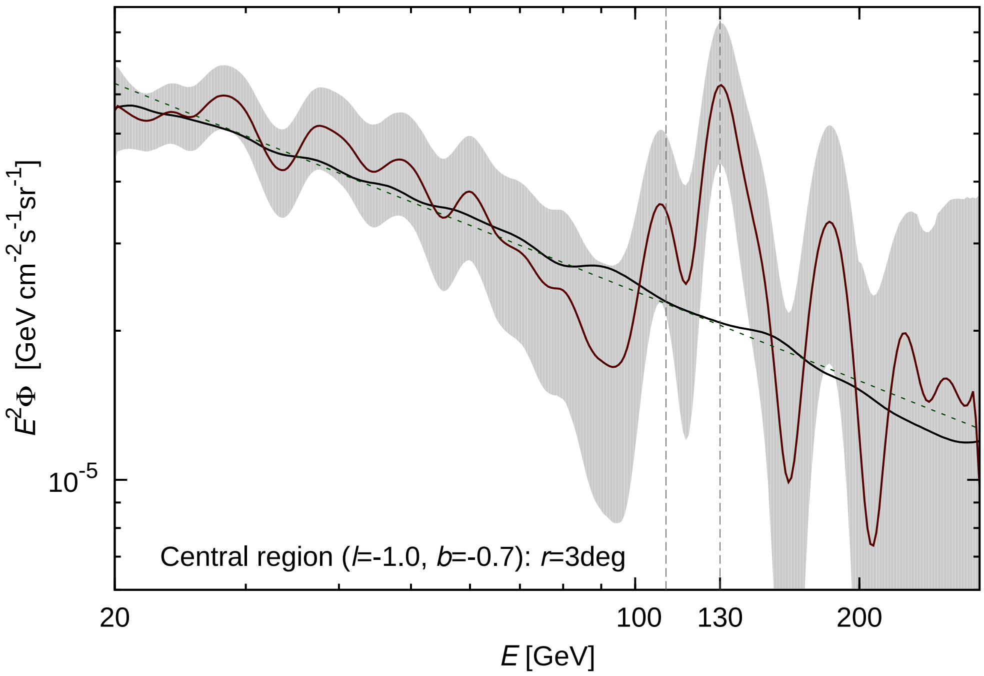


Figure 3.1: The updated energy distribution from the Galactic centre together with the 95% CL error band, using the 218 week data and improved Fermi-LAT energy resolution. The background fitted from the data is also shown (black solid line), and the power-law spectrum with the exponent of 2.6 is plotted for comparison (dotted line). Vertical lines mark the 110GeV and 130GeV energies. Energia jaotus Galaktika keskmest tulevas signaalis koos 95% veapiiridega, 218 nädala andmete põhjal, kasutades parendatud spektraallahutust. Võrdluseks on näidatud ka vaatlustest leitud foon (tume joon) ja astmespekter astendajaga 2.6 (punktiirjoon). Vertikaaljooned märgivad 110GeV and 130GeV energiaid.

3.1.2 Search for warm-hot intergalactic gas

E. Saar and L.J. Liivamägi, together with Pekka Heinämäki (Tuorla, Finland), Ricardo Tanausu Genova Santos and José Alberto Rubino Martin (IAC, Spain) and other members of WG5 of the Planck mission tried to find the diffuse SZ signal from the warm-hot gas in galaxy filaments, comparing the Planck satellite maps and the galaxy luminosity maps produced from the SDSS and 2MASS catalogues. The results were inconclusive, mainly due to the fact that the errors of the SZ maps produced from the Planck data are about two orders of magnitude larger than the expected signal. We here have finally arrived to the conclusion that most of the diffuse SZ signal should come from larger distances that our galaxy samples do not cover, and the search for warm-hot gas should concentrate on an approximately constant SZ signal over the whole sky; correlations with observed filamentary structure should be a second-order, unmeasurable effect. We have yet to convince our collaborators in that.

3.2 Studies of the structure in the Universe

The properties of the structure of the Universe reflect both the initial conditions (the structure seeds) and the processes that lead to its formation and evolution. These depend on the background cosmology, and so the properties of the present structure give us information on the overall properties and evolution of the Universe. As the main processes which influence the formation of structure are different at different scales, it is customary to study them in different scale ranges. The BAO shells have the largest sizes, with diameters around 300 Mpc, the typical sizes of superclustes of galaxies are about 30–100 Mpc, clusters of galaxies fit into 2 Mpc, and galaxy groups are yet smaller.

3.2.1 Probing the large scale structure of the Universe

In order to map the large-scale structure of the Universe, we have to measure distances to galaxies. These distances are usually found from the redshifts of spectral lines in optical spectra, but in some sources no lines are visible. G. Hütsi together with M. Gilfanov and R. Sunyaev (MPA, Garching) investigated the possibility of performing large-scale structure tomography with the iron 6.4 keV fluorescence line – a remarkably strong spectral feature in the X-ray energy band, providing up to $\sim 5-10\%$ of the cosmic X-ray background spectral intensity at $\sim 2-6$ keV energy range. It turns out that with current or upcoming X-ray instruments like XMM or eROSITA the tomographic signal is in principle only weakly detectable, while the proposed X-ray missions with an order of magnitude larger effective area like WFXT or ATHENA should achieve a clear ($\sim 20-40\sigma$) detection, thus providing us a new probe for studying the 3D matter distribution in the Universe.

E. Saar together with Vicent Martínez and Pablo Arnalte-Mur (OAUV, Valencia) refined their wavelet technique for discovering and characterising baryonic (BAO) shells – remnants from the recombination era. These shells are huge, with diameters of 300 Mpc, but with small densities. They had found these shells in the present galaxy distribution a couple of years before, using a specially designed wavelet. In this first attempt, they ignored edge effects that are present in all galaxy redshift samples. As the BAO shells are huge, this forced them to use only a small subset of the data – galaxies that lie far away from the sample edges. This year they devised a method to account for edge effects, and as the result, they could use full data samples (the SDSS DR8 main sample).

Another improvement they made was to expand the BAO shell centre candidate sample. They had used LRG's (Large Red Galaxies) as defined by the SDSS team. As these galaxies are meant for cosmological studies, they are absent in nearby regions. Enn Saar used now a subsample of bright red galaxies there that are similar to LRG's. This was also crucial for using the full SDSS DR8 sample in the analysis, and lead to a much larger number of shell centre candidates.

As a result, they confirmed the existence of the BAO feature with a much better significance. They also found an interesting signal that may be interpreted as coming from twice larger shells. This is not predicted by theory and may be an artefact of our wavelet method; the issue is being clarified.

As the BAO shells are features that should be seen in galaxy maps, M. Einasto, L.J. Liivamägi, E. Saar, and V. Martínez started the search of BAO shell candidates and the study of the galaxies and clusters of galaxies which determine the BAO shells.

3.2.2 Superclusters

L.J. Liivamägi together with E. Saar and E. Tempel, compiled and published a definitive catalogue of superclusters of galaxies, based on the SDSS data. These superclusters have already been studied in detail by our cosmology group. As M. Einasto has shown, superclusters can be divided into two main morphological types – spiders with a large number of filaments connecting galaxy groups and clusters in them, and filaments, in which groups and clusters are located along a rich filament (which may be multi-branching).

E. Saar and E. Tempel together R. Stoica (University of Lille) and V. Martínez (OAUV, Valencia) worked on developing algorithms for finding galaxy filaments. Galaxy filaments are prominent features in the observed galaxy distribution, but there are yet no concordant algorithms to find them. They discussed how to apply object point process algorithms to observational data samples, and how to create and present catalogues of galaxy filaments. E. Tempel has already written a program to do that and has applied it to the SDSS data. The results are promising and the filament catalogues will be published in 2013.

E. Saar worked also on developing methods for describing the morphology of cosmic structures – calculating Minkowski functionals of single superclusters. We had used an integral geometry based (grid) method for that before, to find these functionals for a general galaxy density field, and had shown that the method works well. Applying the method for single superclusters the results depend slightly on the mutual orientation of the supercluster and the grid. Enn Saar examined this dependence and found the characteristics of the distribution of the values of the functionals for random rotations. This work will be extended by comparing our method with the SURFGEN algorithm developed by Prof. Varun Sahni and his collaborators in Pune, India in a joint research project.

3.2.3 Rich clusters of galaxies.

M. Einasto together with her colleagues J. Vennik, E. Tempel, E. Saar, L.J. Liivamägi, E. Tago, M. Gramann and J. Einasto from Tartu Observatory and Pasi Nurmi, Antti Ahvensalmi and Pekka Heinämäki from Tuorla Observatory (Turku University, Finland) studied the structure of rich galaxy clusters, using the catalogue of groups and clusters compiled by E. Tempel, E. Tago and L.J. Liivamägi, based the SDSS galaxy data. They used data about 109 richest clusters in the distance interval 120 – 340 Mpc where the selection effects are the smallest; this is the largest sample of rich clusters studied for substructure so far. With a large number of 3D, 2D, and 1D methods they analysed the presence of substructure and multiple components in galaxy clusters, and compared the velocity distribution of galaxies in clusters with normal distribution. They also analysed the peculiar velocities of the main galaxies in clusters, and their location in components. The results of this study showed that at least 80% of rich clusters have substructure and they consists of several components. The main galaxies of clusters are typically located near the centre of one of the components but quite often this is not the central component. In about a half of clusters the peculiar velocities of the main galaxies are large. These results show that a large fraction of galaxy clusters are not in dynamical equilibrium yet, they are still forming. The sensitivity of different methods used in this study is different for various aspects of substructure, thus it is fruitful to apply a number of methods to study clusters. The probability to have substructure in richer clusters is higher than in poor clusters. The finding that a large fraction of galaxy clusters is still forming is in conflict with the results of cosmological simulations in which the fraction of clusters with substructure is relatively small, but this is in accordance with the largest presently available cosmological simulation, MXXL, in which all the richest clusters have substructure. Typically rich galaxy clusters are considered to be the largest virialised galaxy systems in the Universe; these results show that this is not so. M. Einasto and her collaborators studied also the connections between the structure of galaxy clusters and their environment. The environment in their study was defined with the luminosity density field calculated using SDSS galaxy data. In addition, they found that about 3/4 of clusters under study are located in superclusters, altogether in 50 host superclusters. They determined the morphological types of superclusters with Minkowski functionals, and searched for the possible connection between the properties of clusters and supercluster morphology. Such an analysis has been done for the first time. They showed that clusters in a higher global density environment have a larger number of components, a higher probability to have substructure, and larger peculiar velocities of their main galaxies than clusters in a lower local density environment. Clusters in superclusters of spider morphology have higher probabilities to have substructure and larger peculiar velocities of their main galaxies than clusters in superclusters of filament morphology. The most luminous clusters are located in the high-density cores of rich superclusters. Five of seven most luminous clusters, and five of seven most multimodal clusters reside in spider-type superclusters; four of seven most unimodal clusters reside in filament-type superclusters. This study shows the importance of the role of superclusters as a high density environment, which affects the properties of galaxy systems in them.

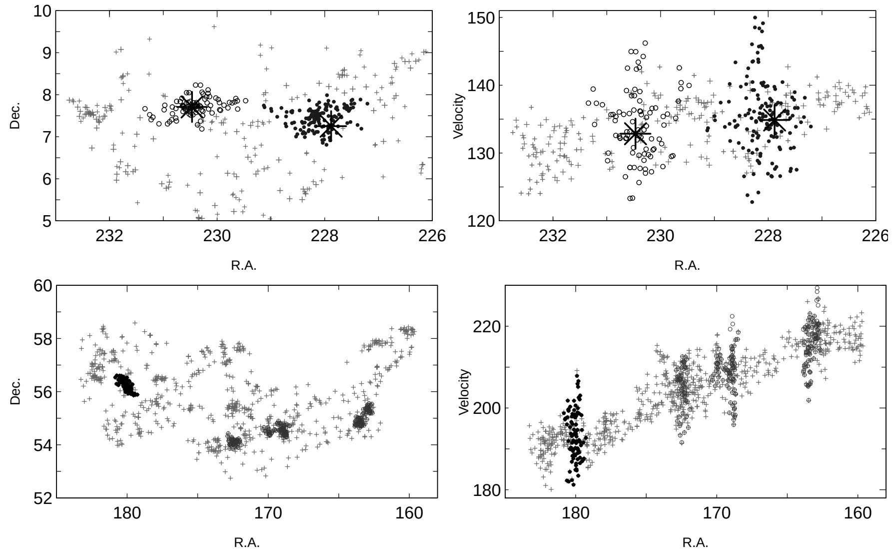


Figure 3.2: Distribution of galaxies in R.A. vs. Dec., and R.A. vs. velocity (in $10^2\ km\ s^{-1}$) plot (right panel) for the superclusters SCl 352 (upper row), and SCl 211 (Ursa Major supercluster). The filled and empty circles denote galaxies in rich clusters, grey crosses denote other galaxies in the supercluster. Black stars show the location of the main galaxies in both rich clusters. Galaktikate jaotus taevas (vasakul) ja kiiruste ($10^2\ km\ s^{-1}$ ühikutes) jaotus piki käändenurka (paremal), superparvede SCl 352 (ülal) ja SCl 211 (Ursa Major'i superparv, all) jaoks. Ringid tähistavad galaktikaid rikastes parvedes, hallid ristid aga ülejäänud galaktikaid. Mustad mitmikristid tähistavad parvede peagalaktikaid.

3.2.4 Groups of galaxies

E. Tempel, E. Tago and L.J. Liivamägi recompiled the galaxy group catalogue for the SDSS data using the new DR8 data release. The new catalogue includes 576 493 galaxies. The main differences between the previous DR7 release are:

- there are new additional galaxies observed in the SDSS programme,
- all the earlier data have been reprocessed with an improved software pipeline and as a result, all the data has changed (usually only slightly),
- we have improved the sample by removing erroneous data.

In order to compile groups, they used our improved friends-of-friends method. The group catalogue includes 77858 flux-limited groups up to the redshift 0.2, covering 25% of the sky. A supercluster catalogue was constructed on the basis of these groups, and many properties of superclusters were studied.

Using the same algorithm, a group catalogue for the 2MASS infrared galaxy data was compiled. This catalogue cover almost all the sky and is needed to study nearby superclusters. The first version of the catalogue had errors in it; the new one is in the works.

J. Vennik and T. Kuutma continued their photometric studies of galaxies in nearby groups of galaxies, to trace the influence of group environment on star-formation processes in satellite galaxies. They improved their interactive image processing procedure, based on the MIDAS software, and used it by processing the optical (SDSS) and near IR (UKIRT, 2MASS) frames of satellite galaxies in three nearby groups around UGC 2019, NGC 6962 and NGC 3665. Nearly a half of studied galaxies show statistically significant radial colour gradients, which can be interpreted using the evolutionary synthesis models (e.g. GALEV) in terms of age and metallicity gradients. Positive colour and age gradients are found to be more frequent in satellite galaxies residing in dense regions within the group virial radius. This is probably an effect of gas loss and star-formation quenching in outer regions of inner satellites. In the group infall region star formation in gas-rich disk galaxies continues in more common inside-out fashion and results in negative colour and age gradients. Metallicity gradients are generally negative in all satellites. These preliminary results need to be confirmed on a better statistical basis.

J. Vennik completed also the spectral and photometric analysis of a sample of about 50 galaxies, which were observed with the Hobby-Eberly telescope in collaboration with U. Hopp (Munich).

3.3 Galaxies

Galaxies are the main luminous constituents of the Universe. We are studying both nearby and far-away galaxies, in order to understand their properties and evolution.

3.3.1 Evolution of galaxies

Evolution of galaxies is one of the most actual topics in astrophysics. Among the most important factors determining the evolution are two galactic components which are difficult or even impossible to detect optically: the gaseous disks and the dark matter haloes. R. Kipper, E. Tempel and A. Tamm used deep Hubble Space Telescope images to construct a two-component (bulge + disk) model for stellar matter distribution of distant galaxies. Properties of the galactic components were derived using a three-dimensional galaxy modeling programme, which also estimates the disk thickness and inclination angle. They added a gas disk and a dark matter halo and used hydrodynamical equations to calculate gas rotation and dispersion profiles in the resultant gravitational potential. They compared the kinematic profiles with the Team Keck Redshift Survey observations. In this pilot study, two galaxies were analyzed deriving parameters for their stellar components; both galaxies were found to be disk-dominated. Using the kinematical model, the gas mass and stellar mass ratio in the disk were estimated.

Heidi Lietzen, Pekka Heinämäki and Pasi Nurmi from Tuorla Observatory together with E. Tempel, E. Saar and M. Einasto compared galaxy content of groups in different large scale environments and showed that groups of the same richness have different galaxy content in different large scale environments: in a high density environment (superclusters) groups are more luminous and they contain a larger fraction of passive, non-starforming galaxies than groups of the same richness in a low density environment outside superclusters. This result shows that the properties of galaxies are determined by processes, the effectiveness of which depends on their large scale environment.

Galaxies are arranged in filaments and sheets, where they have formed. Observationally, there is still no convincing evidence of a link between the properties of galaxies and their host structures. However, by the tidal torque theory (our understanding of the origin of galaxy angular momentum), such a link should exist. Using the presently largest spectroscopic galaxy redshift survey (Sloan Digital Sky Survey), E. Tempel and E. Saar together with Radu Stoica (University of Lille, France) studied the connection between the spin axes of galaxies and the orientation of their host filaments.

They used a 3D field of orientations to describe cosmic filaments. To re-

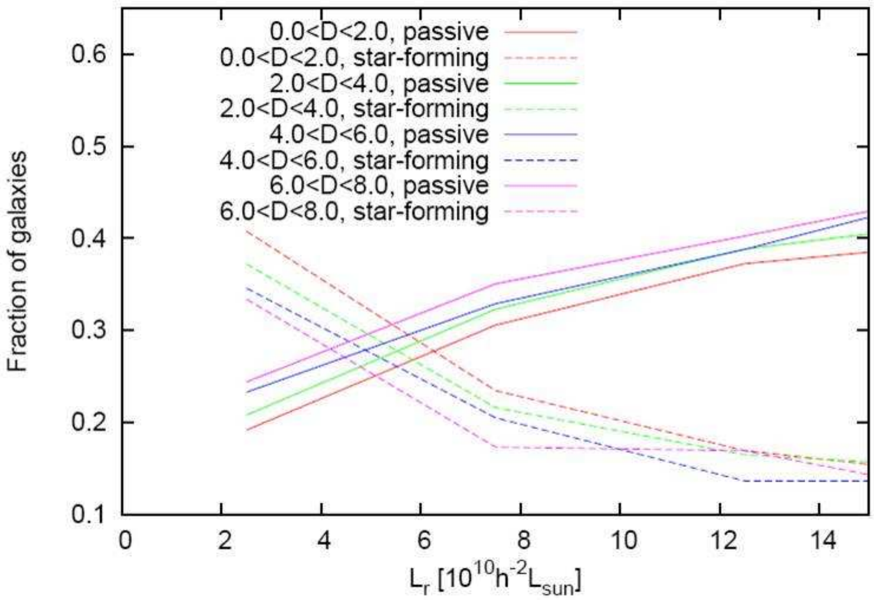


Figure 3.3: The fractions of passive and active galaxies as a function of group's richness in four global density intervals. Passiivsete ja aktiivsete galaktikate suhtarvude sõltuvus group rikkusest nelja globaalse tiheduse vahemiku jaoks.

store the inclination angles of galaxies, they used a 3D photometric model of galaxies that gives these angles more accurately than traditional 2D models. As a result, they found evidence that the spin axes of bright spiral galaxies have a weak tendency to be aligned parallel to filaments. For elliptical/S0 galaxies, there are a statistically significant result that their spin axes are aligned preferentially perpendicular to the host filaments; this signal practically does not depend on the accuracy of the estimated inclination angles for elliptical/S0 galaxies.

3.3.2 Stellar mass map and dark matter distribution in M31

Due to its proximity and size, our nearest large neighbour galaxy M31 offers a unique and attractive opportunity to study stellar populations and galactic structure in detail. Self-consistent multi-component models for M31 were built already decades ago. These days, new data from deep wide-field CCD allows to construct detailed stellar mass and dark matter maps. A. Tamm, E. Tempel, P. Tenjes, O. Tihhonova and T. Tuvikene did that.

In order to measure the mass of dark matter hidden in the galaxy, one has to know the properties of its visible components. To obtain these they used the SDSS and Spitzer 3.6-micron imaging data. The data was corrected for the Galactic extinction, and foreground and background objects were masked out. Using synthetic stellar population models they modeled the spectral energy distribution in each pixel of the galaxy image, getting a two dimensional stellar mass map of M31. The result for two random pixels is illustrated in a plot below. The fit of the 2D map to the model consisting of a nucleus, bulge, disk, young disk and stellar halo, yielded the three dimensional map of visible matter distribution in the galaxy.

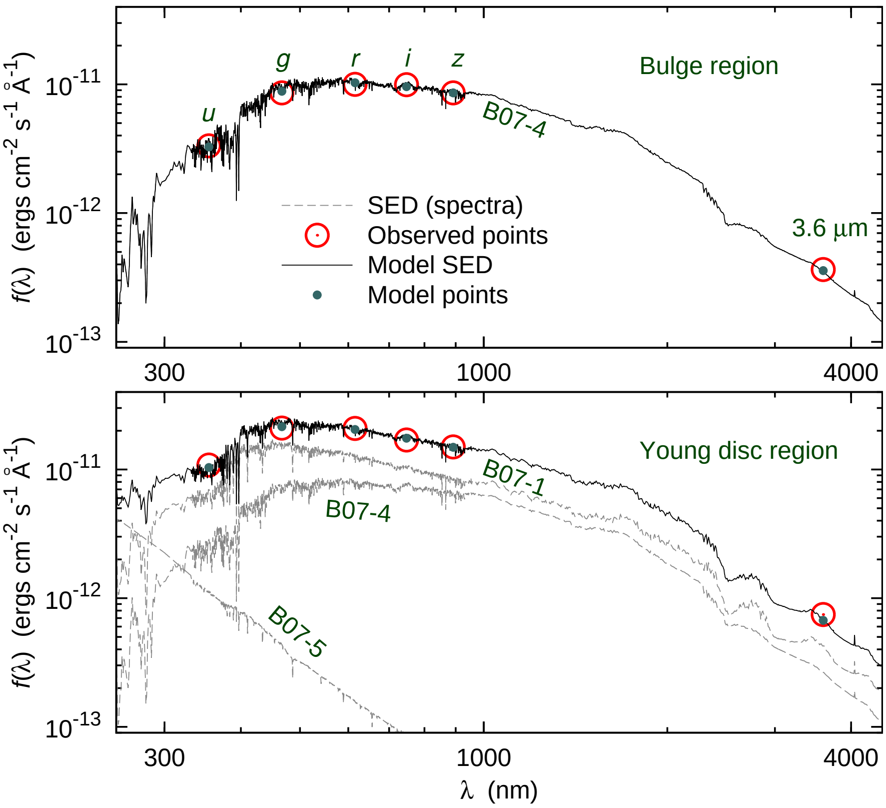


Figure 3.4: Examples of the observed (large circles) and modelled (lines) SED for a random pixel in the bulge region (upper panel) and in the young disk region (lower panel). Näited vaadeldud (suured ringid) ja modelleeritud (jooned) energiajaotustest juhuslike pikslite jaoks mõhnas (ülal) ja noores kettas (all).

The mass distribution yields the gravitational potential, which in turn enables to calculate the rotation curve of a galaxy. After adding gas and dark matter to the visible components, we can compare the model dynamics to the observations and constrain the properties of dark matter. In order to perform necessary calculations two neutral hydrogen datasets were used, and circular velocities were calculated from the measurements of the motions of globular clusters, satellite galaxies, and stellar streams. It was assumed that the distribution of the gas in the disk coincides with that of the young disk simply by raising the mass of latter. For the dark matter halo four most widely utilized model distributions were tested. The results for a simple two component (bulge and disk) model are presented in the plot.

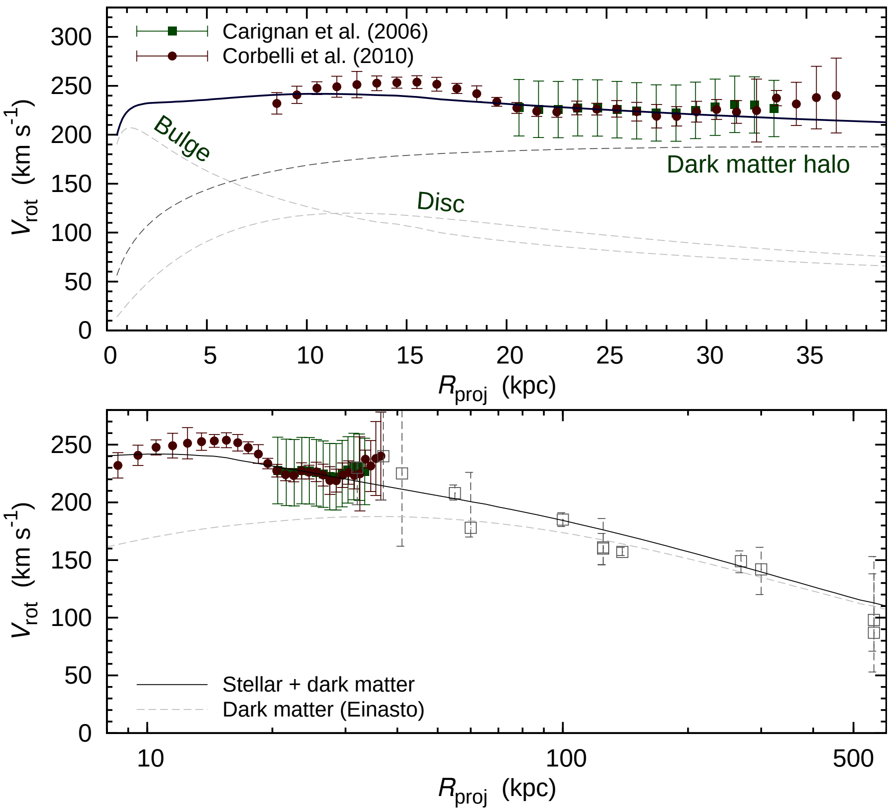


Figure 3.5: The observed inner (upper panel) and outer (lower panel) rotation curves compared to the model with two stellar components. Vaadeldud sisemised (ülal) ja välimised (all) pöörlemiskõverad võrrelduna kahekomponendilise täheaine mudeliga.

The conclusion is that unfortunately it is still not possible to prefer any of the given dark matter distribution models on the basis of the data on M31. The derived characteristic radii and densities of the dark matter haloes are very degenerate: a significant increase of the characteristic radius can easily be compensated by lowering the characteristic density and vice versa. Interestingly, the virial mass is well constrained, regardless of the chosen dark matter distribution model. It is quite firmly established by the outer ”test particles” of the dynamics and is almost independent of the stellar model of the galaxy. Despite its higher total mass, the central density of the dark matter halo of M31 cannot be distinguished from that of an average dwarf or low-surface-brightness galaxy. It suggests that the dark matter halo concentration process seems to be restricted rather uniformly over a very wide variety of halo masses, environments, and cosmological epochs.

Boris Deshev investigated the environmental dependence of the cold gas distribution in late type galaxies in the local universe, based on archival neutral hydrogen interferometric observations and optical data from the SDSS. This work is being done in collaboration with Paolo Serra (Netherlands Institute for Radio Astronomy (ASTRON)). Together with researchers from IAC (Spain) he is also working on a legacy survey of M33 based on archival observations with INT/WFC at La Palma. In addition he is working on a proposal for mapping the internal kinematics of galaxies in merging clusters together with Peter Kamphuis(CSIRO, Australia), who visited Tartu in August 2012.

3.4 Our Galaxy

U. Haud continued his work on narrow-line HI-emission clouds (NHIE). He also began the analysis of new HI-data form the Parkes Galactic all-sky survey (GASS). As the amount of the new data is much larger than that of the data from the older Argentina survey (IARS; 6655155 profiles against the earlier 50980 profiles) and the observation methods are also different, the new survey giving much more information per every profile, there was also a need for rewriting all the computer programs for the analysis of new data. This has largely been done by now. However, as the required amount of computations is very large, U. Haud had to rewrite his programs for parallel work on multiprocessor computers. The first decomposition of the GASS survey into the Gaussian components has been completed in the single processor regime. Based on the obtained results he has compiled lists of problematic profiles. These lists have been forwarded to the Argelander-Institut für Astronomie, Universität Bonn for correcting the profiles. V. Malyuto continued development of classification methods for deep surveys of stellar populations in the Galaxy. The aim was to create a representative set of templates (the stars with reliable parameters covering the whole HR diagram and metallicity range) which could serve as calibration stars in classification. One important range of metallicities (with $-1.6 < [Fe/H] < -0.4$) was considered containing thin and thick-disk stars as well as accreted and in-situ formed halo stars. For such stars some selected homogeneous subsamples from published stellar catalogues and libraries were analysed and their errors of effective temperatures were estimated from the data. Then the data were averaged with appropriate weights to produce two lists of about 130 stars with reliable temperatures.

4 Observational and theoretical investigation of stars and their envelopes during advanced evolutionary phases Evolutsiooni hilisfaasis tähtede ja nende ümbriste vaatluslik ja teoreetiline uurimine

Teema hõlmab mitmesuguseid evolutsiooni eri staadiumides olevaid tähti. Jahedatest tähtedest jätkati post-AGB, vesinikuvaeste ja punaste ülihiidtähtede uurimist (T. Kipper). Üksikasjalikuma vaatluse all oli υ Sgr, väikese grupi vesinikuvaeste kaksiktähtede heledaim esindaja. Õnnestus leida tähe atmosfääri parameetrid ja keemiline koostis. Identifitseeriti suur hulk nõrku emissioonijooni, mis pärinevad neutraalsete ja ioniseeritud metallide madala ergastusega tasemetelt. Nende profiilid näitavad, et süsteemis on nõrgalt paisuv akretsiooniketas.

T. Nugis koostöös H.J.G.L.M. Lamersiga (Utrechti Ülikool, Holland) jätkas väga suure massiga tähtede tuulte modelleerimist. Suure massiga tähtede väliskihtide aine läbipaistmatus kasvab järsult $T \approx 150\,000$ K juures ja ületab kriitilist läbipaistmatust piisavalt suure massi korral. Wolf-Rayet tähtede puhul on väliskihid ülekriitilise läbipaistmatusega juhul, kui $M > 20M_{\odot}$ ja O tüüpi tähtede korral on vastav piirmass umbes 3 korda suurem. Tavaliselt eeldatakse, et massiivsed tähed ei lagune kriitilise tsooni olemasolu tõttu ja et tähetuul formeerub pealpool kriitilist tsooni. Selliste mudelite korral välditakse kriitilise tsooni modelleerimist ja tähetuule tekke mehhanism jääb välja selgitamata. T. Nugise uute mudelite järgi formeerub tähetuul allpool kriitilist tsooni ja on oluliseks tähte stabiliseerivaks faktoriks.

A. Sapar, R. Poolamäe ja L. Sapar jätkasid täheatmosfääride ehituse ja tähespektrite mudelarvutusi ning täheatmosfäärides toimuvate füüsikaliste protsesside uurimist. Tuletati täpsem analüütiline vesiniku spektrijoone profiilifunktsioon, lähtudes kolmest ühekordse integraali avaldisest, mis oli varem leitud Holtsmarki, Lorentzi ja Doppleri profiilide sidumfunktsiooni kahekordse integreerimisega. Holtsmarki ja Lorentzi profiili kompleksset argumenti kasutades saab koostada hästi koonduva reaksarenduse spektrijoone tsentris ja tiibades. Spektrijoone vahetsoonis saab argumentide arvu vähendada ühe võrra, kasutades komplekseid paraboolseid silinderfunktsioone. Lisaks tavalisele täheatmosfäärimudelite iteratiivse parandamise meetodile (kiirgusvoo konstantsuse ja lokaalse kiirgusliku tasakaalu nõue) on välja töötatud tunduvalt täpsem arvutusmeetod, mis baseerub Levenberg-Marquardti vähimruudulisel variatsioonmeetodil, millele järgneb tulemuse parandamine Broydeni meetodil. Sel juhul arvutatakse jakobiaan lineariseerimismeetodil, kasutades väikesi sobivalt valitud argumentide lõplikke vahesid. Ühekordse jakobiaani parandustsükli rakendamisega saavutatakse kiirgusvoo väga hea konstantsus ja vastavus etteantud efektiivsele temperatuurile, samuti väga täpne lokaalne kiirguslik tasakaal.

Levenberg-Marquardti meetodi üks arvutustsükkel koos järgneva Broydeni parandusmeetodiga annab umbes 2 suurusjärku kõrgema lõpptulemuse täpsuse kui tavaline iteratiivne lahendusmeetod.

Järgnevaks oluliseks tähe mudelatmosfääride arvutuste täpsuse parandamise meetodiks on rakendamisel nilpotentsed duaalarvud. Neil arvudel on kasulik omadus, et nende infinitesimaalosa annab automaatselt kasutatud algoritmide täpsed tuletised. See meetod kõrvaldab vajaduse lõplike vahede meetodi rakendamiseks jakobiaani arvutamisel. Et tarkvaras SMART esinevad komplekssed funktsioonid, nõuab duaalarvude rakendamine nende üldistamist duaalseteks kompleksarvudeks, mida autorid nimetavad dupleksarvudeks. Taasalustati analüütiliste kvantmehhaaniliste avaldiste leidmist atomaarosakeste spektrijoonte arvutamiseks. Analüütilised üldistatud ortonormeeritud radiaalfunktsioonid leiti elektronide atomaarsetele allkihtidele ning töötati välja vastavate võrrandsüsteemide analüütilise lahendamise meetod. Leiti mõningad avaldised radiaalsete Slateri orbitaalide ja lubatud dipoolsiirete sageduste jaoks. Koostati uus alamprogramm kiirgusrõhu ja valgusindutseeritud triivi (LID) mõjul kujuneva keemiliste elementide ja nende isotoopide difusioonilise eraldumise arvutamiseks. Seda rakendati Ca isotoopide segregatsiooni uurimiseks, võttes ligikaudselt arvesse ka mikroturbulentsi. Varemkasutatud ajalise evolutsiooni stsenaariumi asemel on rakendatud iteratiivset isotoopide sisalduste arvutamismeetodit. Arvutustulemused näitavad, et CP atmosfäärides kujuneb oluline raskeima isotoobi ^{48}Ca liiasus.

A. Aret koostöös kolleegidega Tšehhi Vabariigist, Argentiinast ja Brasiiliast uuris massiivsete tähtede (eelkõige B[e] ülihiidude) ketaste struktuuri, kinemaatikat ja tekkemehhanisme, kasutades Euroopa Lõunaobservatooriumis spektrograafidega FEROS, CRIRES ja SINFONI saadud optilisi ja infrapunaspektreid. B[e] ülihiidude spektreid uurides avastati neis [Ca II] keelatud jooned, mis tekivad tihedamates ja kuumemates kettapiirkondades kui varem tuntud ja uuritud [O I] jooned ja CO molekulaarribad, võimaldades seetõttu saada täiendavat informatsiooni täheketaste struktuuri ja kinemaatika kohta. [Ca II] keelatud jooni otsiti ka teistsuguste tolmu- ja gaasiketastega ümbritsetud tähtede spektrites. Ondřejovi 2-meetrise teleskoobi abil on aastatel 2011–2012 saadud üle 80 tähe spektri, mille hulgas on B[e], Be, T Tauri ja FU Ori tüüpi tähed, Herbigi tähed ja kollased hüperhiiud.

Jätkus 2011. aastal alanud suure heledusega tähtede heledusmuutuste uurimise projekt (T. Tuvikene, J. Laur, T. Eenmäe, I. Kolka, L. Leedjärv, T. Liimets). USA-s New Mexico osariigis asuva robotteleskoobiga tehti vaatlusi 198 ööl ja koguti ulatuslik vaatlusmaterjal mitme OB assotsiatsiooni kohta. Põhjalikumalt analüüsiti kolme vaatlusala Luige tähtkujus. Eriti huvitav on täht Schulte 12 assotsiatsioonist Cygnus OB2. Tõraveres jätkati selle tähe spektraalvaatlusi, mis näivad kinnitavat spektri muutlikkuse seost tähe heleduse muutustega. T. Tuvikene koos TÜ üliõpilastega alustas assotsiatsiooni Perseus OB1 tähtede spektraalvaatlusi eesmärgiga teha kindlaks kaksiktähtede osakaal.

ESA kosmosemissiooni Gaia ettevalmistustööde kolmeaastase (2011–2013) projekti "Kiirgusjoontega tähtede klassifitseerimine Gaia kataloogis" (I. Kolka, L. Leedjärv, T. Eenmäe, T. Tuvikene) raames analüüsiti 2012. aastal missiooni eesmärkide saavutamiseks vajalikke maapealseid spektroskoopilisi tugivaatlusi. Samuti hinnati Gaia vaatluste testalas paiknevate objektide heledusmuutlikkust. Gaia põhiprogrammi käivitamisele eelneb testimise periood, mil vaadeldakse ekliptika poolusi ümbritsevaid alasid. Meie vaadeldud fotomeetrilise aegrea (ca 55 vaatlusööd märtsist 2011 kuni aprillini 2012 robotteleskoobiga New Mexicos) ca 700 tähte asuvad ekliptika põhjapooluse regioonis. Nende hulgas on muutlikkuse ilmingud 47 tähel, millest umbes poolte heleduse tegelik ebastabiilsus vajab kinnitamist lisauuringuga.

Iseäralike tähtedena olid uurimise all noovajäänuk GK Per ja (kaksik)täht V838 Mon (T. Liimets, I. Kolka, K. Verro, T. Kipper). Esimese objekti valguskaja uurimisest saadi noova ümbrise gaasipilvede paisumiskiiruseks ca 600–1000 km/s ja objekti kauguseks 400 ± 30 pc. Seejuures kasutati 2.56-meetrisel Põhjamaade teleskoobil NOT saadud uusi vaatlusandmeid. Teatud mõttes iseäralikud on ka sümbiootilised kaksiktähed, millest põhjalikuma käsitluse all oli taas AG Dra (L. Leedjärv, M. Burmeister). Selle tähe kuuma komponendi temperatuur vajab täiendavat uurimist, viimasel ajal on selle kohta saadud vastuolulisi tulemusi.

I. Vurm koos kolleegidega Iisraelist uuris footonite teket relativistlikes ainevooludes gammasähvatustes. Leiti, et tingimused, mis on vajalikud vaadeldava hulga footonite tekkeks, seavad ranged piirangud ainevoolu füüsikalistele omadustele nagu koostis ja Lorentzi faktor, samuti ainevoolu dünaamikale ning interaktsioonile plahvatava tähe väliskihtidega. I. Vurm ning A. Veledina ja J. Poutanen (Oulu) uurisid röntgenkaksiktähtede emissiooni optilises ja infrapunadiapasoonis. Vastupidiselt mudelitele, kus nimetatud kiirgus pärineb relativistlikust aine väljavoolust, esitati alternatiivne interpretatsioon, mille kohaselt on tegemist sünkrotronkiirgusega ulatuslikust kuumast akretsioonivoolust. See võimaldab anda loomuliku seletuse mitmele vaatluslikule efektile nagu kiire muutlikkus, optilise ja röntgenemissiooni ajaline korrelatsioon jne., mis on probleemiks väljavooludega seotud mudelitele.

J. Pelt tegi Päikese ja Maa kliima seoste uurimisel koostööd O. Kärneriga atmosfääri seire töörühmast. Uus statistiline lähenemine Päikese aktiivsuse pikaajalistele aegridadele annab lootust kasutada neid andmeid Maa solaarkonstandi tagasiulatuvaks hindamiseks.

4.1 Late-type stars

The studies of post-AGB, hydrogen-deficient and luminous red stars were continued by T. Kipper. This year the spectrum of υ Sgr, the brightest member of the small group of hydrogen deficient binaries (HdB stars) was analysed. Some years ago (2008), another star of this group KS Per was analysed.

The spectra were obtained with the Nasmyth Echelle Spectrograph of the 6 m telescope of Special Astrophysical Observatory (Russia). Some spectra from the NARVAL database (http://tblegacy.bagn.obs-mip.fr/narval.html) were also used.

The atmospheric parameters of υ Sgr are found to be $T_{\rm eff} = 12\,300 \pm 200$ K, $\log g = 2.5 \pm 0.5$ and $\xi_{\rm t} = 5 \div 15\,{\rm km\,s^{-1}}$ depending on element. For Fe II $\xi_{\rm t} = 9.3 \pm 0.3\,{\rm km\,s^{-1}}$. Iron is slightly (–0.2 dex) underabundant. Nitrogen is overabundant with [N/Fe]≈1.0, carbon and oxygen are underabundant with [C/Fe]≈–1.6 and [O/Fe]≈–1.1. S-process elements Y, Zr and Ba are overabundant about 0.5 dex. The very large overabundance of Ne found earlier by other observers was not confirmed.

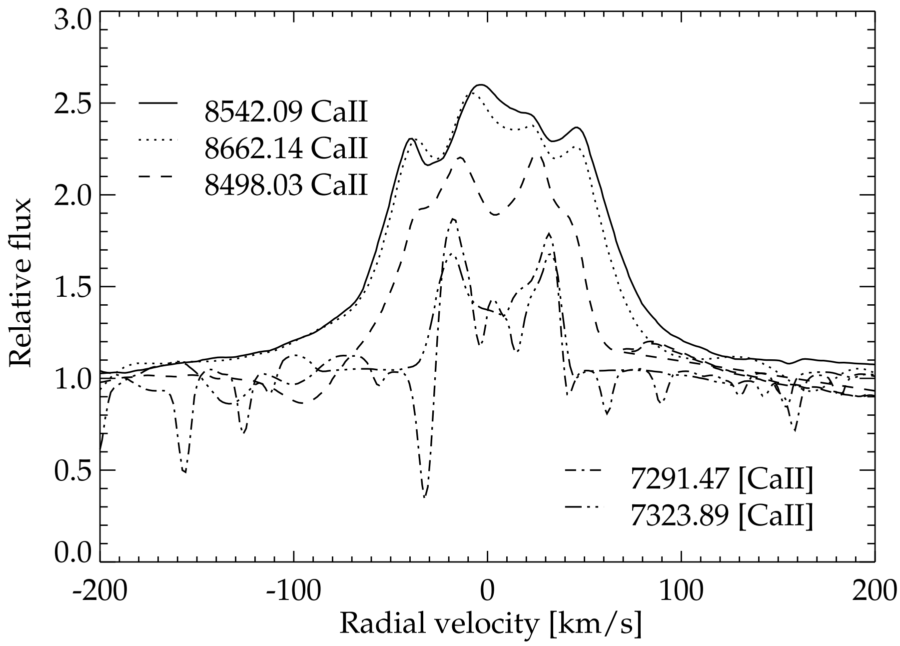


Figure 4.1: Some permitted and forbidden emission lines of Ca II in the spectrum of υ Sgr in the velocity scale. υ Sgr spektri mõned lubatud ja keelatud emissioonijooned kiiruste skaalas.

Quite a large number of emission lines, both permitted and forbidden, originating from the low excitation levels of neutral and ionized metals are identified. The radial velocities of these emission lines indicate that there is an accretion disc in the system of υ Sgr.

Gas-poor discs of circumstellar dust dubbed as "debris discs" have been found around many nearby young stars. One of such objects is a G2V field star HD 377, which according to its luminosity has already reached the main sequence. The high resolution spectrum of this young star was analysed. The atmospheric parameters were found to be: $T_{\rm eff} = 5875 \pm 40$ K, $\log g = 4.25^{+0.10}_{-0.05}$, and the microturbulent velocity $\xi_{\rm t} = 1.40 \pm 0.10\,{\rm km\,s^{-1}}$. The metallicity of HD 377 is slightly higher than that of the Sun, [Fe/H]=0.21. The lithium abundance is very high, $\log\varepsilon({\rm Li}) = 3.02$.

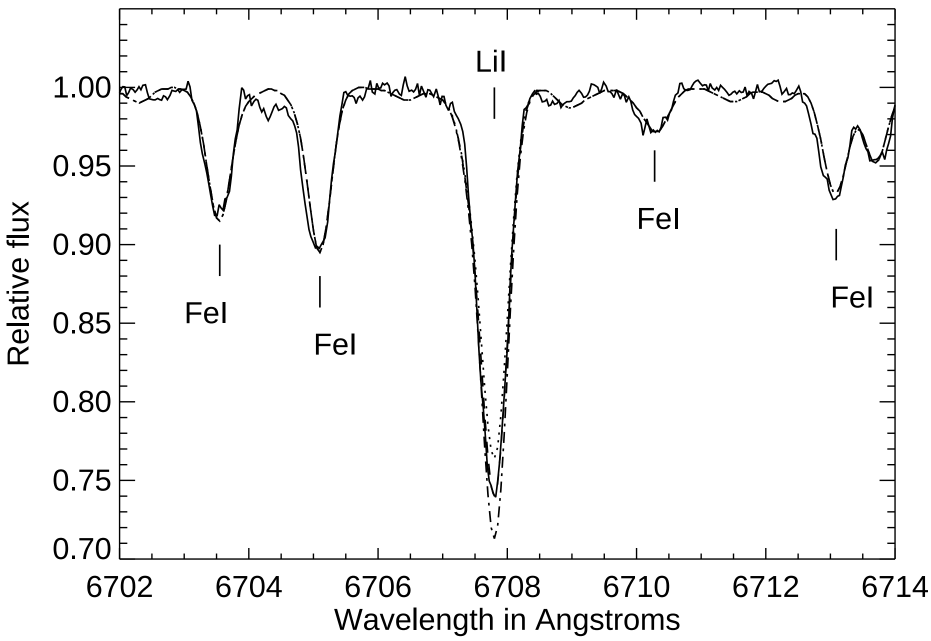


Figure 4.2: The observed and synthesized spectra of HD 377 with three different Li abundances: $\log\varepsilon({\rm Li}) = 2.95$ (dotted line), $\log\varepsilon({\rm Li}) = 3.02$ (dashed line), and $\log\varepsilon({\rm Li}) = 3.10$ (dash-dotted line). The abundance $\log\varepsilon({\rm Li}) = 3.02$ fits the observation (solid line) best.

Tähe HD 377 vaadeldud ja arvutatud spektrid kolme erineva Li sisalduse puhul: $\log\varepsilon({\rm Li}) = 2.95$ (punktiirjoon), $\log\varepsilon({\rm Li}) = 3.02$ (kriipsjoon), ja $\log\varepsilon({\rm Li}) = 3.10$ (punkt-kriipsjoon). Sisaldus $\log\varepsilon({\rm Li}) = 3.02$ sobib kõige paremini vaatlustega (pidev joon).

4.2 Hot luminous stars

T. Nugis in collaboration with H.J.G.L.M. Lamers (Utrecht University, the Netherlands) continued modelling of optically thick winds of the most massive stars.

The opacity in the outer regions of massive stars increases strongly at about 150 000 K and exceeds the critical opacity at some mass limit ($\chi_{\rm cr} \approx 4\pi c GM/L$, where L is the stellar luminosity). In the case of Wolf-Rayet stars this happens at masses exceeding about $20\,M_\odot$ and in the case of O type stars at about three times higher masses. The massive stars become convectively and pulsationally unstable in the critical zone ($100\,000 < T < 250\,000$ K). It is usually assumed that massive stars are not breaking up due to the presence of the critical zone and that the stellar wind is formed above that zone (such approach avoids the study of the critical zone structure and of the origin of mass outflow).

According to new models of T. Nugis, the stellar wind originates far below the critical zone and is the stabilizing factor for stellar structure (convection and stellar wind damp the pulsations and wind becomes turbulent). The results of this study are in preparation for publication.

4.3 Stellar spectra and physical processes in stellar atmospheres

In 2012, A. Sapar, R. Poolamäe and L. Sapar continued study and modelling of stellar atmospheres, stellar spectra and physical processes in stellar atmospheres.

A revised high-precision analytical line profile function has been derived for hydrogen, starting from three single integral expressions, obtained by integrating twice the convolution of the Holtsmark, Lorentz and Doppler spectral line profile functions as a triple integral. Introducing complex arguments instead of the Holtsmark and Lorentz profile arguments, the module of them gives well-converging series expansion for the spectral line wings and centres. Similarly, in the intermediate part the number of arguments has been reduced by one, using complex parabolic cylinder functions, expressed via the confluent hypergeometric series and Hermite polynomials.

There is an additional problem to be solved when modelling stellar spectra, connected with the circumstance that in the region of highly excited serial states complicated interplay of different quantum mechanical processes takes place, generating overlap of spectral lines and smooth dissolution of high quantum states. In the stellar spectra this appears as smooth transition from spectral series to the corresponding continua. A suitable approximate formula has been found to describe the dissolution rates, and it has been ap-

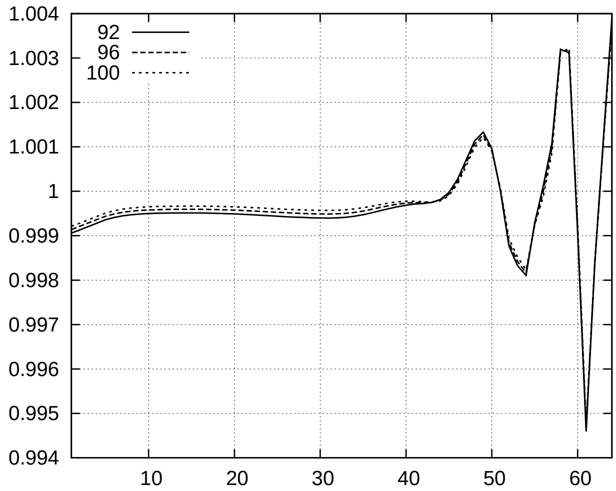


Figure 4.3: A typical picture of the final relative precision of the radiative flux obtained using the Unsöld-Lucy correction method. The model layer numbers are given as argument values. $T_{\rm eff}$ = 10 750 K, $\log g$ = 4. In legend – the iteration number. Tavameetodil arvutatud kiirgusvoo lõpptäpsus sõltuvalt mudeli kihi järjekorranumbrist.

plied to generate smooth transition from highly excited serial states to the corresponding continua of each element, thus avoiding cutoff type jumps in stellar spectra.

In addition to the usual stellar atmosphere iterative model correction codes, elaborated on the demands of the constancy of the radiative flux and local radiative equilibrium, an essentially better alternative using the Levenberg-Marquardt variational least-squares method and its subsequent improvement by the Broyden method has been applied. In this method the Jacobian has been computed by a linearization method using the suitably chosen small finite differences of the arguments (temperature values in model atmosphere layers, specified by standardized column densities of the atmospheric matter).

By single Jacobian correction cycle the high-precision constancy of the radiative flux corresponding to accepted effective temperature of the relative local radiative equilibrium (the ratio 'emitted flux versus the absorbed flux') has been obtained. The ratio of the obtained precision by these two methods for the radiative flux is illustrated in Figures 4.3 and 4.4. A single cycle of the Levenberg-Marquardt method with subsequent Broyden method has turned out to give the accuracy about two orders higher than the final result, obtained by the usual iterative model correction method, applied in the SMART code.

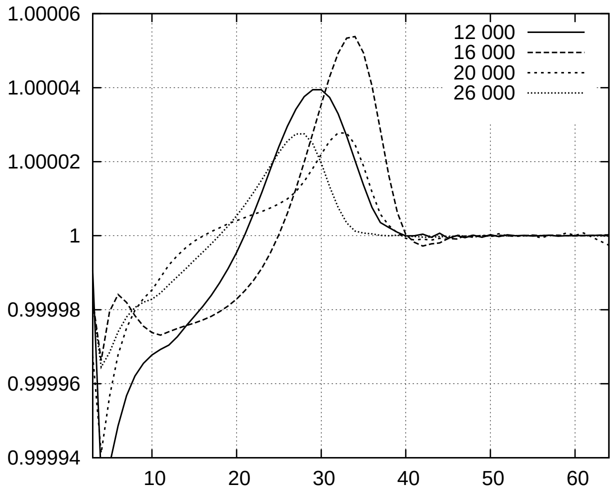


Figure 4.4: The final high-precision constancy of the model stellar atmosphere flux, obtained computing the Jacobian by Levenberg-Marquardt method and thereafter improving it by the iterations of Broyden loop. ($\log g = 4$, the effective temperatures are given in the legend). Jakobiaani abil arvutatud kiirgusvoo kõrgtäpsus.

For the next essential improvement the nilpotent dual numbers were taken into use. An attractive feature of the dual numbers is that in their second part, named the infinitesimal part, the values of exact derivatives are automatically generated. By this method the problem of finding suitable finite differences is also automatically removed in the Jacobian computations. However, presence of complex functions in the SMART code demands generalization of the dual numbers to the dual complex numbers, named by authors the duplex numbers. The Fortran module with corresponding data types, downloaded operators and functions has been composed, which also gives the Cauchy-Riemann equations for derivatives of the complex number formulae, needed for least-squares Jacobian computations.

The study, aimed to elaborate analytical quantum mechanical expressions for computation of spectral lines of atomic species, has been undertaken anew. It includes derivation of approximate, but high-precision analytical wave functions and transition probabilities instead of traditionally used complicated Hartree-Fock numerical methods. Such analytical expressions enable to unify and simplify the computations of spectral line formation in different physical processes, including the electron transition rates and line shifts in different spectral terms $(^{2S+1}L_J)$ according to the non-relativistic spin-orbital (LS) coupling scheme, well applied for lighter chemical elements, but useful also for approximate estimation of spectra of heavy elements, where JJ-coupling is dominating.

An analytical set of the generalized orthonormalized radial wave functions for atomic subshells of electrons has been derived and the algorithm for analytical solution of the system of equations has been found. Analytical expressions for corresponding Slater radial orbitals and radial parts of allowed dipole transitions have been derived. Some new analytical expressions for adding the angular momenta of electrons in the filled and partially filled optical subshells have been obtained.

This method is appropriate to specify the values of parameters if the number of parameters is large. This is the case if the least-square equations are accommodated for simultaneous determination of the values of free parameters for the ground state and for a number of excited atomic states.

In order to reduce the emergent spectra of the stellar model atmosphere computations to the form which enables them easily to compare with the observational data an additional software has been composed. This software enables to find the ratio of the computed line-rich stellar spectrum to the computed continuum spectrum from which the spectral lines are removed. Further, the line profile broadening due to stellar rotation and Gaussian instrumental broadening can be specified and applied to fit the computed spectrum with the observational data.

An additional routine has been composed to find non-solar element abundances, based on the computed pan-spectral equivalent widths for atoms and ions. The method enables also to apply it for finding the values of effective temperature and gravity.

Spectra of Ap and mercury-manganese stars show redshifts of near infrared triplet of Ca. Calcium has 6 stable isotopes, having mass numbers 40, 42, 43, 44, 46 and 48, of which ^{48}Ca has the largest shifted wavelengths. The observed anomalous isotopic composition in quiescent atmospheres of chemically peculiar (CP) stars can be explained by light-induced drift (LID). Line list of Ca I, Ca II and Ca III has been compiled, in which isotope splitting due to normal and specific mass shift of spectral lines and hyperfine splitting of odd isotope ^{43}Ca have been taken into account.

The special routine of SMART code for modelling diffusive separation of chemical elements and their isotopes in the quiescent atmospheres of stars has been applied for study of segregation of Ca isotopes due to LID, trying to take into account also presence of observed microturbulence. Hitherto, exact and physically uniquely determined expression for the microturbulence phenomenon in stellar atmospheres has not been found. Based on general conceptions, an approximate formula for the microturbulence velocity has been applied in computations of the LID of the Ca isotopes. Instead of formerly used temporal evolution scenario the software has been modified to compute iteratively the final isotope abundances of Ca. The results show formation of essential overabundance of the heaviest isotope, ^{48}Ca, in the atmospheres of CP stars. This result is similar to the former studied diffusive isotope separation of mercury. The study is aimed to explain the observed peculiar abundances of calcium isotopes in CP stellar atmospheres.

A. Aret in collaboration with colleagues from the Astronomical Institute of the Academy of Sciences of the Czech Republic, Instituto de Astrofísica de La Plata, Argentina and Observatório Nacional, Rio de Janeiro, Brazil carried out observational study of high-density discs around massive stars based on optical and infrared spectra obtained at the European Southern Observatory using FEROS, CRIRES and SINFONI spectrographs. The appearance of the B[e] phenomenon in evolved massive stars such as B[e] supergiants is still a mystery. While those stars are generally found to have discs that are cool and dense enough for efficient molecule and dust condensation, the origin of the disc material is still unclear. Information on the density, temperature, and kinematics within the disc can be obtained from different sources like optical emission lines and molecular bands that trace different regions within the circumstellar material. A set of forbidden emission lines, [Ca II] $\lambda\lambda$7291, 7324, as a new, valuable tracer of disc structure and kinematics has been discovered, supplementing well-known disc tracers like the [O I] emission lines or the CO band emission. This result inspired to carry out an observational survey of large sample of sources, surrounded by disc-like structures, consisting of Herbig Ae/Be stars, T Tauri stars, Be stars, B[e] stars, and yellow hypergiants. Observations have been carried out during 2011–2012 using the 2-m Luboš Perek Telescope (Ondřejov, Czech Republic). Spectra of more than 80 stars have been obtained and processed, first results of the survey are being prepared for publication.

4.4 Luminous stars in stellar associations

T. Tuvikene, J. Laur, I. Kolka, T. Eenmäe, and L. Leedjärv continued the time-resolved survey of the most luminous stars in OB associations. Remote photometric observations were carried out on 198 nights during 2012, using the 250-mm T4 telescope of the iTelescope.Net (formerly GRAS) network. The wide field of view (40×60 arcmin) and favourable weather at the location in New Mexico, USA, allowed us to collect data on many more targets than what is currently feasible with telescopes at Tõravere. Photometric variability of luminous stars in three fields in Cygnus was analysed, based on the 2011 season of observations. Also, several periodic variable stars, including suspected β Cephei and SPB stars, were discovered from the survey.

Spectra of OB stars in the Perseus OB1 association have been obtained with the 1.5-m telescope at Tõravere since 2012 October. These spectroscopic observations have been led by T. Tuvikene, with active support by the students from the University of Tartu (R. Matjus, R. Voog, E. Vaher, K. Verro)

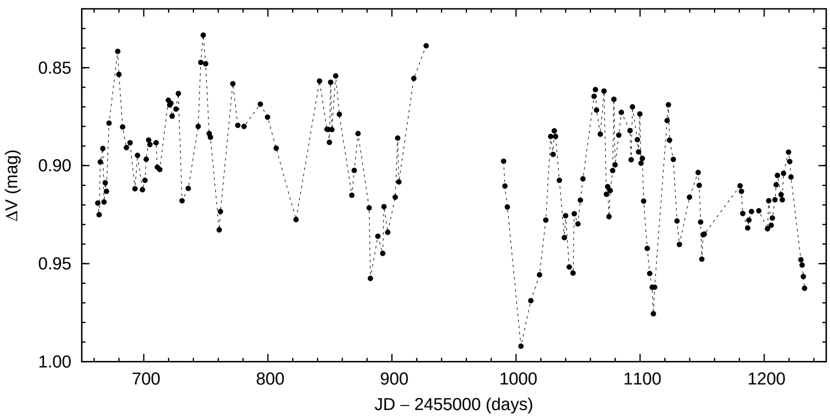


Figure 4.5: Differential V-band light curve of the blue supergiant Schulte 12 (2011 April – 2012 October). Sinise ülihiiu Schulte 12 heleduskõver V filtris.

and by colleagues from the cosmology group (E. Tempel, T. Kuutma). One of the aims of the spectroscopic survey is to determine the binary-star content in Perseus OB1, using radial-velocity measurements.

Special attention has been given to the heavily-reddened blue supergiant star Schulte 12 in the Cygnus OB2 association. From the photometric survey, we have found the star to be variable with no clear periodicity (see Figure 4.5). I. Kolka analysed spectra of Schulte 12, obtained with the 1.5-m telescope since 1999. In autumn 2012, T. Tuvikene obtained additional 8 spectra, which exhibit line-profile variations on time scales that are similar to the ones visible in the light curve.

4.5 Preparations for the ESA Gaia mission

In 2012 the preparations for the Gaia space mission at Tartu Observatory have been continued in the framework of the project ”Emission line star classification in the Gaia Catalogue” which is financed by the ESA PECS (Plan for European Cooperating State) programme. The present project contributes to the work of Coordination Unit 8 ”Astrophysical Parameters” at the Gaia Data Processing and Analysis Consortium, and concentrates mainly on ground-based support of the Gaia mission. The main cooperation partner of Tartu Observatory is the Royal Observatory of Belgium (ROB) in Brussels. Before the launch of the Gaia space observatory the task to prepare the catalogue of objects in the Gaia test-area around the North Ecliptic Pole (NEP) has turned to be highly actual. The variability monitoring of stars around NEP which was started in 2011 as a part of our project is the contribution of Tartu Observatory to this task. Our monitoring has been performed with a robotic telescope in New Mexico (USA) belonging to the iTelescope.Net. It concerns ca 700 stars down to the faintness limit $V \sim$15.6 mag. The brightness of targets has been measured during 55 nights in the period March 2011 – April 2012, and the variable star candidates have been selected using the criterion presented in Kjeldsen & Frandsen (PASP 104, 413, 1992).

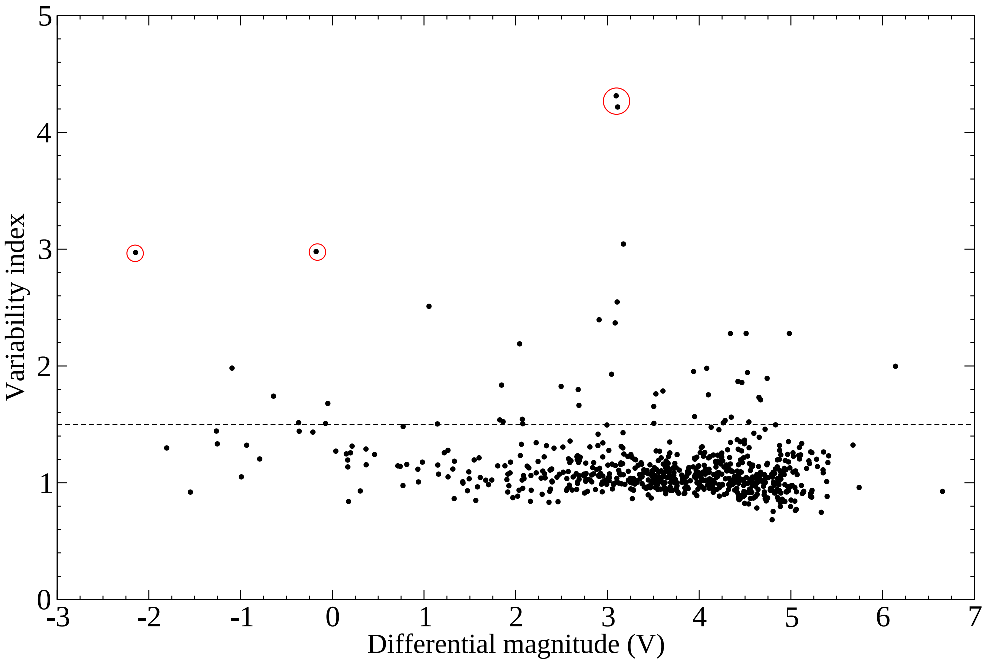


Figure 4.6: Variability index of the program stars around the North Ecliptic Pole. Stars marked with circles are large-amplitude variable stars. Programmi tähtede muutlikkuse indeks Ekliptika põhjapooluse ümbruses.

The results are demonstrated in the figure where we consider all the stars above the variability index value 1.5 as potentially variable. In this figure 47 objects out of 691 may be variable. However, nearly half of them need further analysis due to the suspicion of increased instrumental scatter caused by the too close proximity of neighbouring stars or errors of flat-fielding near the image borders. The list of confirmed variables can be used during the commissioning period of Gaia as test targets to estimate the photometric sensitivity of its instruments to discover the variability and to produce science alerts. The auxiliary database of spectra on emission line stars for Gaia will be prepared partially in the framework of our current project. One of the sources is observations in 2009 in ESO according to the programme 083.D-0472(A). In cooperation with Y. Fremat (ROB) the decision has been made to present the spectra in the flux scale relative to the continuum flux, and the subset of WR stars, Herbig AeBe stars, and peculiar B[e] stars spectra has been reduced to be ready for the inclusion in the database.

4.6 Symbiotic stars and related objects

L. Leedjärv and M. Burmeister continued analysis of the observations of the yellow symbiotic star AG Draconis. This star is considered to be a classical symbiotic star, undergoing 1–2 magnitude outbursts in about one year time intervals and higher amplitude major outbursts in about every 13–15 years. Hot component of AG Dra is a white dwarf undergoing thermonuclear burning on its surface. Our simplified estimates of the Zanstra temperature of the hot component indicate rather high temperatures, usually well above 100 000 K. The paper by Sion et al. published in late 2012, however, claims that effective temperature of the hot component in AG Dra should not exceed 80 000 K, Being aware that the simplified Iijima method used by us could not be quite appropriate, this discrepancy, however, deserves further investigation. Our long time-series of spectroscopic observations of AG Dra, starting in 1997, allow also to study possible variations of the parameters of its hot component. For example, it is well seen from our data that during the major outburst that started in 2006, temperature of the hot component dropped.

4.7 Peculiar stars

4.7.1 GK Persei

T. Liimets, I. Kolka and K. Verro together with R. Corradi and other researchers from Spain published the detailed dynamical and morphological study of the nova remnant GK Per (Nova Persei 1901).

The ejecta is a thick shell consisting of knots of different shape and sizes. Knots are expanding with a significant range of velocities, mostly between 600 and 1000 km/s. They have suffered only modest deceleration since their ejection more than a century ago. There is no clear evidence of the expansion rate to depend on the position angle. The latter is a surprising result of this study, as the previous interpretations of GK Per predict the southwest quadrant of the remnant to be slowed down by the interaction with the interstellar medium. The total Hα+[N II] flux of the whole nebula is linearly decreasing by 2.6% per year. However there are significant differences between the fluxes of various quadrants as well as when considering individual knots, which can show sudden changes in brightness, either fading or brightening on time-scales of months or few years. Improved kinematic distance of 400 $\pm$30 pc was found.

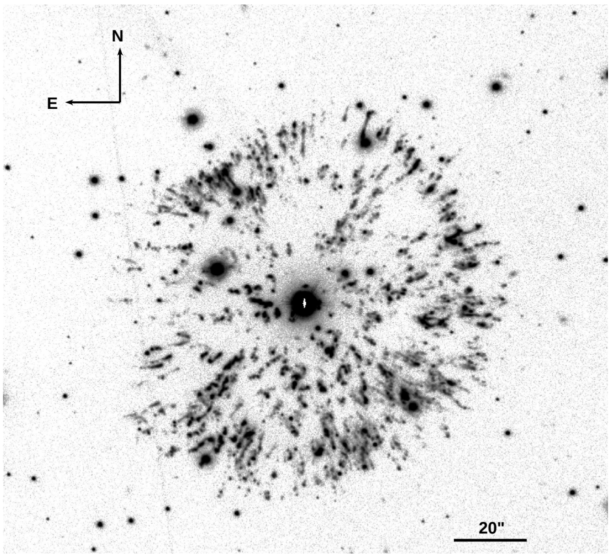


Figure 4.7: Nova remnant GK Per obtained with the Nordic Optical Telescope on September 5, 2007 using a narrowband Hα+[N II] filter. The field of view is 2.8x2.8 arcmin^2. Noovajäänuk GK Per vaadeldud Põhjamaade Optilise teleskoobiga 5. septembril 2007 läbi kitsasriba Hα+[N II] filtri. Vaatevälja suurus on 2.8x2.8 ruutkaareminutit.

4.7.2 V838 Monocerotis

I. Kolka, T. Liimets and T. Kipper together with T. Augusteijn from Nordic Optical Telescope (NOT) continued to monitor photometrically and spectroscopically the peculiar binary star V838 Mon with the NOT. From the latest spectra (November 2012) there are possible hints of the system starting to recover from the long-lasting eclipse-like event. However, photometric observations do not support this suggestion.

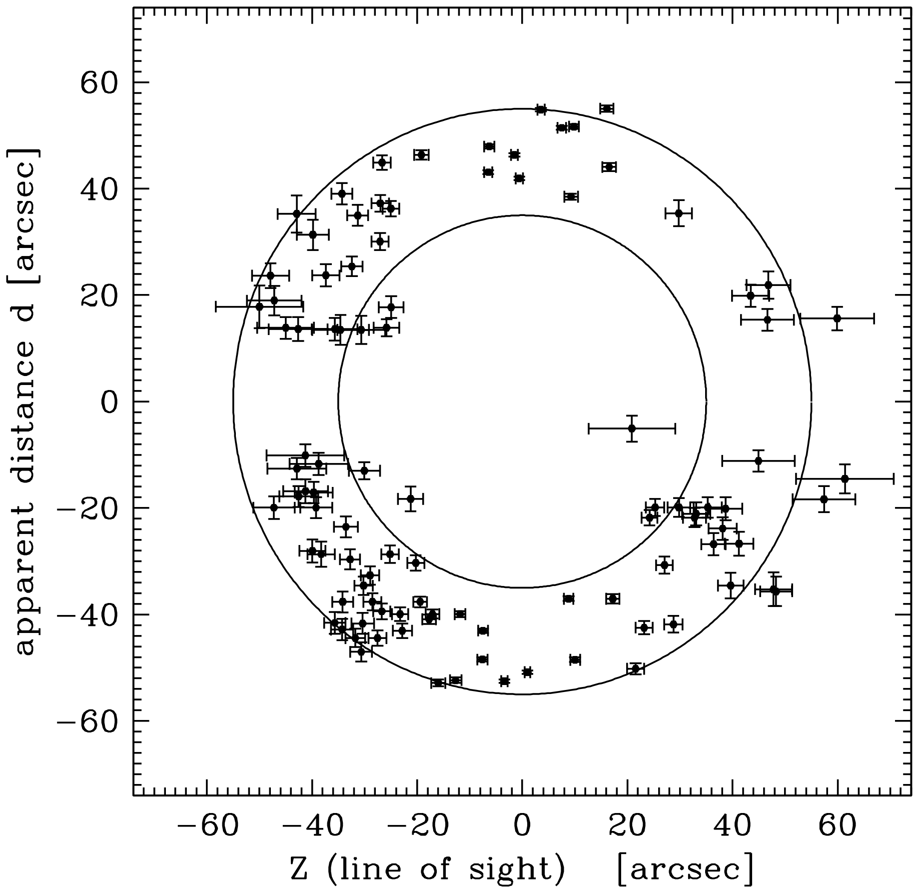


Figure 4.8: The geometry of the nova remnant GK Per along the line of sight, observer on the right side. In Y axis there is an apparent distance on the plane of the sky from the central star. The positions of 99 knots are presented. Circles indicate inner and outer radii: 35 and 55 arcseconds respectively. Noovajäänuki GK Per ruumiline jaotus. Z-telg on vaatekiiresuunaline, vaatleja paremal pool. Y-teljel on näiv kaugus tsentraalsest tähest mõõdetud taevasfääril. Graafikul on esitatud noovajäänuki 99 üksiku osakese asukoht. Ringid osutavad vastavalt 35 ja 55 kaaresekundit tsentrist.

4.8 Radiative transfer

I. Vurm together with Y. Lyubarsky and T. Piran (Israel) studied photon production in relativistic jets in gamma-ray burst sources, which is directly related to the average energies of the emerging soft gamma-ray photons. It was found that the requirement of sufficient photon generation to account for typical observed photon energies (i.e. spectral peak positions) places strong constraints on the jet properties, such as the Lorentz factor and outflow composition. It also has significant implications on the poorly understood dynamics of the outflow as well as its interaction with the progenitor star.

I. Vurm together with A. Veledina and J. Poutanen (University of Oulu, Finland) studied the optical and infrared (OIR) emission from the inner hot accretion flows in Galactic black hole sources. In several earlier works it was suggested that these energy bands are dominated by the jet emission, however, this scenario does not work in a number of cases. The present work proposes an alternative, namely that most of the OIR emission is produced by the extended hot accretion flow. It was shown that the hot flow scenario is consistent with many of the observed spectral data, at the same time naturally explaining the X-ray timing properties, fast OIR variability and its correlations with the X-rays, which were not possible to understand within the jet paradigm.

4.9 The Sun and Earth climate

To promote institutional synergy between various research branches J. Pelt and O. Kärner started a new line of investigations. It is well known that total solar irradiance is one of the main input variables for climatological models. Unfortunately the exact values for irradiance are known only for the latest thirty years. However, in order to understand past climatic events we need to have estimates for much earlier epochs. The new method to hindcast total irradiance values from historical records of solar activity was developed just to achieve this. The method itself is based on a novel method of statistical envelopes which was developed by J. Pelt earlier in the context of another research programme.

J. Pelt also took part in traditional collaboration projects with researchers from the University of Helsinki. They combine different methods of time series analysis, Doppler imaging and direct numerical simulation to obtain insights into kinematics and dynamics of the Sun and and sun-like stars. The results of this ongoing project are certainly useful in the climatological studies.

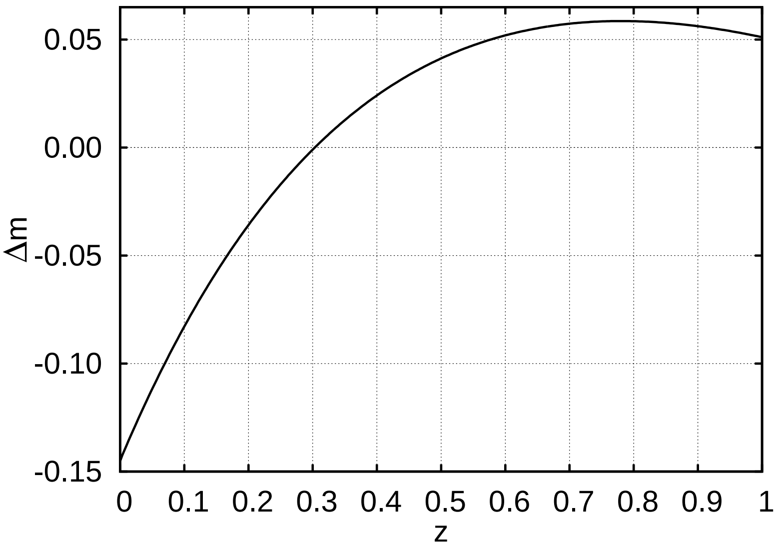


Figure 4.9: The ratio of the luminosity distances for the above-described flat and hyperbolic model Universes in stellar magnitudes. The difference is quite small and apparently not distinguishable from observations. Arvutatud tasaruumilise ja hüperboolse Universumi heleduskauguse suhe tähesuurustes on väike.

4.10 An alternative evolutionary scenario of the Universe

A. Sapar continued to elaborate an alternative evolutionary scenario of the Universe in more detail, using instead of the dominant dark energy paradigm an alternative version. He took into account the fact that the observations have not excluded the negative curvature of the Universe. Thus the dark energy corresponds to the usual energy integral, to which no localization can be ascribed as it has been made in the case of enigmatic dark energy. In this alternative scenario a classical conception is accepted that the kinetic energy of the expansion of the Universe has turned out to be somewhat larger than the potential one. In other words, the author holds the conservative point of view starting from the Occam's razor law of economy, stating that "among competing hypotheses, the one that makes the fewest assumptions should be selected".

Both in the paradigm of the flat space and of the hyperbolic space the paradox of the infinite space is present *ab initio* and its removal cannot be accomplished even by the inflationary expansion scenario of the Universe as it often has been stated.

A. Sapar has concluded that the subcritical density of all particles is about

20% of the critical value instead of usually adopted 30%. In these calculations the value of Hubble parameter has been taken to be H_0= 73 km/s Mpc^{-1} as it follows from observations. In this model of the Universe the characteristic expansion rate approaches the velocity of light in the future, instead of usually taken exponential expansion of the Universe. From these computations it follows that the hyperbolic Universe is presently in the starting evolutionary stage of its new, the kinetic energy dominated epoch with faster evolutionary expansion rate than usually accepted, but nevertheless slowly decelerating. This means that the first temporal derivative of the radial scale of Universe is positive, but the second derivative can be negative. This situation differs radically from the exponential expansion where all the temporal derivatives have positive values.

The nature of the preferred (non-rotating and thus the centrifugal and the Coriolis force free) coordinate frame in cosmology has always been a source of mutual misunderstanding. In the cosmology the finite value of the light velocity, coinciding with the velocity of the gravitational interaction, has not been explicitly taken into account. Taking into account that the preferred cosmological frame is connected with the extremely remote light sources, say, the quasars and supernovae, it has been proposed that the equations of general relativity may need modification. Instead of the local complicated non-linear second order differential equations the non-local integro-differential equations should be used, connecting the local space-time via the light cone to the remote regions of the Universe. A possibility to introduce the retarded gravitational potential of the Universe into the equations of cosmology, which modifies its local value, has been discussed.

5 Earth Observations and Space Technology
Kaugseire ja kosmosetehnoloogia

Tartu Observatooriumi kaugseire alased uuringud hõlmavad nii taimkatet, veekogusid kui atmosfääri.

Atmosfääriuuringuist oli kesksel kohal Eesti kiirguskliima. Uuringud selles vallas on tihedas koostöös Tartu Ülikooli ja Eesti Meteoroloogia ja Hüdroloogia Instituudiga. Tõraveres töötab juba rohkem kui 11 aastat AERONET võrgu päikesefotomeeter. Infot maapinnani jõudva päikesekiirguse muutlikkuse ja spektraalse koostise kohta kogutakse nii maapealsete kui satelliidimõõtmistega. Viimased on oluliselt mõjutatud vaatlustingimustest. Satelliidivaatlusteks sobivaid päevi Eestis on märtsis keskmiselt neli, novembris ainult üks.

Töötati välja meetod UV-dooside rekonstruktsiooniks meteoandmetest. Koostati veeauru ja aerosooli optiliste paksuste andmebaas aastate 1950–2011 kohta. Saabuva päikesekiirguse spektraalset koostist mõjutab kõige rohkem õhus olev suits.

Vee kaugseire alaste uuringute toeks tehti koostöös Eesti Mereinstituudi, Tartu Ülikooli Meresüsteemide instituudi ja Eesti Meteoroloogia ja Hüdroloogia Instituudiga rohkesti mõõtmisi Peipsil ja Võrtsjärvel. Projekti VeeOBS tulemusena valmis vee kaugseire andmete haldamise integreeritud süsteem, mis hõlmab nii satelliidi- *in situ* kui laboratoorseid mõõtmisi. Erilise tähelepanu all olid satelliidisensori MERIS andmestiku analüüsiks loodud vee kvaliteedi produktid ning nende rakendatavus Eesti rannikuvete ja siseveekogude jaoks. Satelliidiandmete võrdlusest *in situ* mõõtmistulemustega selgus, et MERIS-e produktid kirjeldavad hästi hägusate vete aktiivainete muutlikkust, aga kontsentratsioonid on süstemaatiliselt alla hinnatud.

Vee optiliste omaduste mõõtmiseks on koostöös optikafirmaga Interspectrum OÜ valmimas seade MVSM (Multi Volume Scattering Meter), mis on jõudnud metroloogiliste uuringute faasi.

Taimkatte kaugseire vallas on põhitähelepanu suunatud metsadele, kasutades nii satelliitide, lennukimõõtmiste kui maapealsete mõõtmiste andmestikku. Välja on selgitatud mitme metsatüübi klimatoloogilsed sesoonsed peegeldusomaduste muutused, mis on tingitud nii päikese kõrguse muutustest kui metsade eneste muutustest vegetatsiooniperioodi kestel. Välja töötati meetod metsade lehepindala hindamiseks homogeense taimkatte peegeldusmudeli pöördülesande lahendamisega, kasutades keskmise ruumilise lahutusega satelliidipilte. Satelliidiinfot kasutati nii metsade häirituste kui mahajäetud põllumaade metsastumise monitooringuks nii Eestis kui naaberpiirkondades. Selleks sobivad hästi keskmise ruumilise lahutusega (Landsat TM ja ASTER) talvised satelliidipildid. Metsade raided intensiivistusid hulga aastaid pärast poliitilisi muudatusi möödunud sajandi üheksakümnendate alguses.

Välja on töötatud meetod puistu kõrguse ja tüvemahu hindamiseks lennukilidari andmetest.

Maapealseid mõõtmisi kaugseiremõõtmiste toeks viidi läbi nii Järvseljal (lehtede kaldenurkade jaotus) kui koostöös Tartu Ülikooli ja Eesti Maaülikooli uurimisrühmadega arktilises Soomes ja Rootsis rahvusvahelise võrgustiku INTERACT testaladel.

Kosmosetehnoloogia arendamine Tartu Observatooriumis jätkus 2012. aastal arvukate projektidega. Uurimistöö põhisuunaks oli elektrilise päikesepurje tehnoloogia arendamine. Euroopa Liidu poolt finantseeritud ESAIL projektis töötati välja uudse kosmoselaeva mootori, elektrilise päikesepurje, komponente koostöös Uppsala Ülikooliga, Rootsi ettevõttega Nanospace ja Itaalia ettevõttega Alta Space. Samuti jätkus rahvusvaheline koostöö elektrilise päikesepurje komponentide esmakordseks katsetamiseks kosmoses satelliidi ESTCube-1 pardal. Selles projektis juhendavad Tartu Observatooriumi kosmosetehnoloogia töörühma teadlased üliõpilasi Tartu Ülikoolist, Eesti Lennuakadeemiast, Eesti Maaülikoolist ning Tallinna Tehnikaülikoolist.

5.1 Earth atmosphere and climate

Since the April 2012 the major task of the research group is to work on the environmental project ”Estonian radiation climate” coordinated by docent Hanno Ohvril from the University of Tartu. Beside the Institute of Physics of the University of Tartu as a coordinator, the participants are Tartu Observatory and Estonian Meteorological and Hydrological Institute. Close cooperation between the participating groups has been established. The aim of the project is 1) systematizing of collected solar radiation data and preparing the open access databases for potential users, 2) studying the variations and trends of broadband solar radiation and 3) studying the variations and trends in the spectral composition of incoming solar radiation. The variations in incoming radiation totals as well as its spectral composition, especially in its shortwave ultraviolet (UV) range depend strongly on the atmospheric factors, such as clouds, aerosols and precipitable water vapour. The availability of ground-level solar radiation is closely related to restrictions of the remote sensing activities. The variations and trends in the availability and spectral composition of UV radiation are related to the various effects on the atmospheric chemistry, health of plants, litter decomposition and carbon cycle.

A study of the remote sensing conditions in 1958–2011 using the broadband solar radiation and cloud visual inspection data collected in the Tartu-Tõravere meteorological station was performed and the results published (K. Eerme and M. Aun). The most stable conditions for optical remote sensing were in March with the largest average number of suitable days in month and the smallest per cent of years with no such days. The monthly average number of suitable days decreased from nearly four in March to one in November.

PhD student M. Aun developed a method for reconstruction of the UV doses using the neural network approach and model calculating clear-sky background. MSc student A. Vashtshenko from the Technical University of Tallinn under the supervision by K. Eerme classified the cloud situations using both ground-level and data collected from space and studied the dependence of UV cloud modification factor (CMF) on cloud type. In relatively thin stratiform clouds such as Sc and particularly St spectral CMF in the UVB spectral range did not decrease with the decreasing wavelength as is commonly declared for cloudiness and was confirmed in our work for clouds with significant vertical development.

Water vapour and aerosol play rather different roles in attenuation of direct solar radiation in the atmosphere. Using the routine solar radiation recordings at Tartu-Tõravere meteorological station, V. Russak has calculated the values of the optical depths for water vapour (WOD) and aerosol (AOD) during cloudless days, and created corresponding time series for the period

1950–2011.

Spectral composition of aerosol optical depth (AOD) influences the spectral composition of solar direct irradiance. The large AOD events in 2002–2012 and contributing about 7% to all recorded AOD data were in most cases related to the smoke aerosols. Quantifying of their effects on the incoming solar irradiance needs a more detailed specification of composition or type of smoke particles and determination the sources of smoke. A joint work on this was performed by the research groups of the University of Tartu (H. Ohvril with colleagues) and Tartu Observatory (K. Eerme, V. Russak, M. Aun).

E. Jakobson continued the study of water vapour and its variability. Major global atmospheric reanalyzes (of specific humidity, temperature and wind speed vertical profiles ERA-Interim, JCDAS JMA, NCEP-DOE, NCEP-CFSR, NASA-MERRA) were validated against independent dataset in the Arctic. NCEP-CFSR modeled precipitable water, specific humidity and temperature vertical profiles were validated against independent dataset in Tõravere. In NCEP-CFSR 32 years database systematic difference was presented in the diurnal cycle of precipitable water above land and above sea; also, atmosphere vertical layers responsible for these differences were identified.

Regular recording of UV spectra in the wavelength range 290–400 nm using Bentham double monochromator DMc150F-U based spectrometric system and collecting their database was continued (U. Veismann).

The collaboration with the AERONET network continues. A Sun photometer Cimel-318 has been measuring direct Sun radiation and sky radiance in several spectral bands for the estimation of atmosphere transparency and aerosol optical properties for more than 11 years. Data have been collected on more than 3500 days. Using the data of every-hour visual observations of clouds and radiation recordings at Tartu-Tõravere meteorological station, V. Russak has analyzed the collected Sun photometer data and created a new database for 2002–2011, where possible influence of clouds is eliminated.

5.2 Remote sensing of water bodies

Under the VeeOBS project, an integrated collaborative tool for water remote sensing data management and analysis has been developed (K. Uudeberg, R. Randoja, I. Ansko, S. Lätt and M. Ligi). The underlying database was created. It will store the data about the inherent optical properties measured in laboratory, concentration of optically active substances, composition of phytoplankton species, apparent optical properties measurement *in situ* (e.g. Ramses TRIOS, WISP), instrument calibrations, auxiliary data (e.g. GPS, photos, depth and inclination measurements, temperature, weather conditions, etc.), and user information data. The basic user interface elements were developed for web browsers using common web languages.

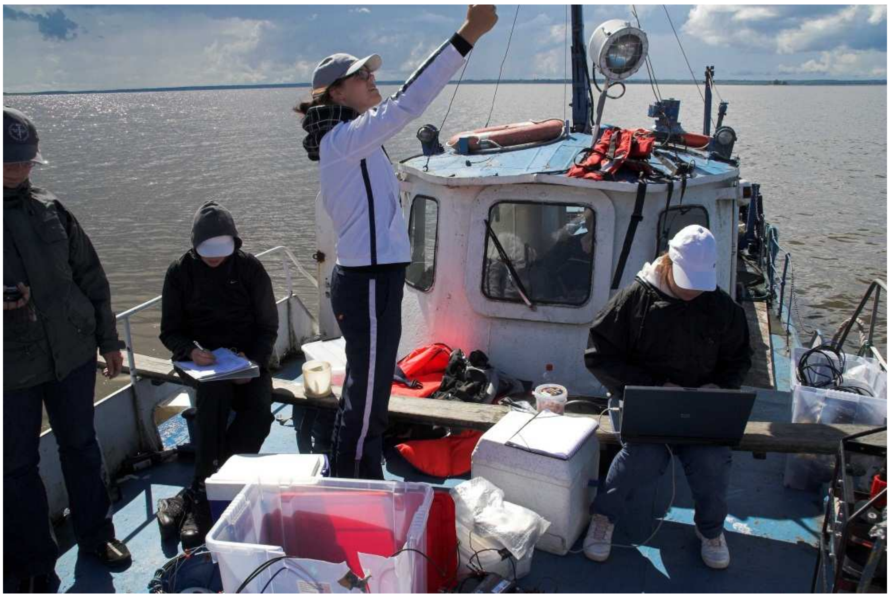


Figure 5.1: Fieldwork on Lake Võrtsjärv. In the centre is new master student Evelin Kangro. Välitööd Võrtsjärvel. Keskel seisab töörühma uus magistrant Evelin Kangro.

Three field work campaigns took place on Lake Peipsi and Lake Võrtsjärv together with Estonian Marine Institute, Marine Systems Institute and Estonian Meteorological and Hydrological Institute. The aim was to capture spatial variability of the bio-optical water properties. Two multiple day fieldwork trips were organized together with Estonian Marine Institute in the middle of June and August (Figure 5.1.). Additionally, M. Ligi participated in two cruises on the Baltic Sea in collaboration with Finnish Marine Institute and Finland's Environmental Administration.

MERIS water quality products on optically complex Estonian Lakes Peipsi and Võrtsjärv were examined (E. Kangro, A. Reinart, E. Asuküll and K. Uudeberg). In experimental part, various atmospheric correction and bio-optical models (Case 2 Regional, Boreal, FUB/WeW) were applied on MERIS images to retrieve optically active substances (chlorophyll-a, total suspended matter and coloured dissolved organic matter). In addition, to correct the images against the adjacency effect, the ICOL (Improve Contrast between Ocean & Land) processor was tested. The best assessment for chlorophyll-a and total suspended matter was retrieved by ICOL corrected images which were processed by the Case 2 Regional processor. For coloured dissolved organic matter, the Boreal processor gives the closest results to the *i*n situ measured values where the coefficient of determination R2 was 0.66 but the numerical

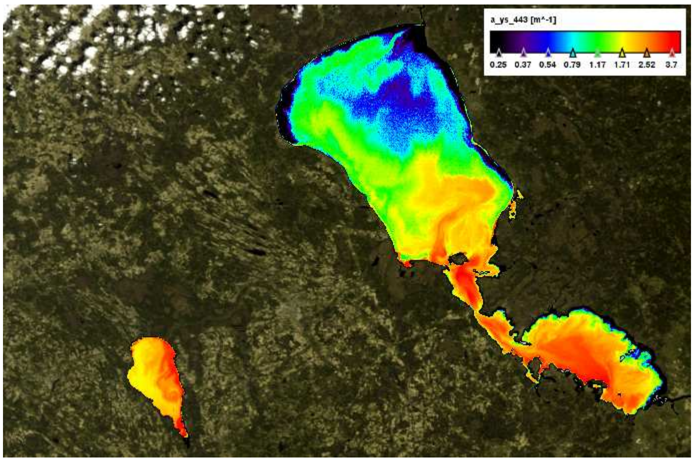


Figure 5.2: CDOM absorption by MERIS image May 28th, 2008. CDOM jaotus MERIS pildi alusel 28. mail 2008.

values were still underestimated by about 30% (Figure 5.2.). Although MERIS products allow successful monitoring of the temporal and spatial variability of optically active substances, the direct comparison of the values between satellite data and *in-situ* data yield high uncertainties and the underestimation of *in-situ* measured values due to high amounts of coloured dissolved organic matter in these waters.

In the frames of WaterS project exchange, K. Alikas in collaboration with P. Philipson (Brockman Geomatics Sweden AB) and K. Kangro started to work using remote sensing data to map water quality parameters that have been selected as important quality elements by the EU Water Framework Directive (2000/60/EC). From these parameters, chlorophyll-a and Secchi depth were chosen and various combinations of atmospheric correction modules and algorithms will be applied on ENVISAT/MERIS data in order to map them along the Swedish coastal areas.

The ESA PECS project ORAQUA continued (A. Reinart, H. Kuuste). The mechanics, optics, electronics and partially software drivers were developed for the Multi Volume Scattering Meter (MVSM) in cooperation with the company Interspectrum. First tests of the developed electronics and computer control were made. The preliminary results show that the technical solution of the instrument can be successfully used. For the MVSM a modern light source with the LEDs was developed. Optical characteristics and stability of the new light source are in testing phase.

In collaboration with SME Hohenheide a set of new improved reference standards for spectral radiance and spectral irradiance have been established and advanced methodology developed for the optical laboratory. Addition-

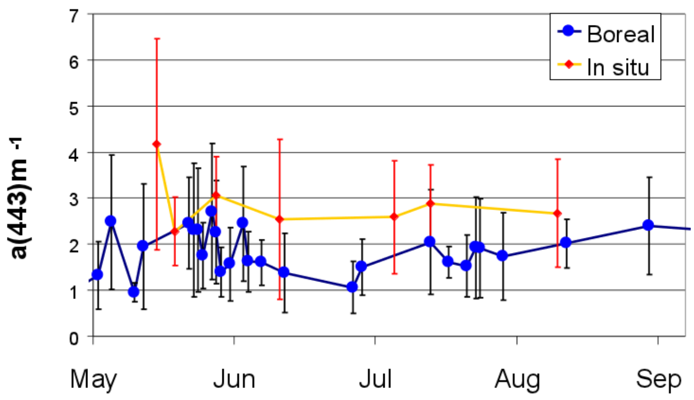


Figure 5.3: Time series of aCODM(443) by *in situ* measurements and the Boreal processor results in 2008. aCODM(443) varieeruvus 2008. aastal *in situ* mõõtmiste ja satelliidi andmete alusel.

ally, angular responsivities, temperature dependence coefficients and stray light properties can be estimated for spectroradiometers used for water remote sensing. This enables to analyze the metrological aspects and limitations related to the optical measurements (I. Ansko, R. Vendt, J. Kuusk).

5.3 Remote sensing of vegetation

T. Nilson, M. Lang, M. Rautiainen, J. Pisek, U. Peterson, A. Kuusk, J. Kuusk and A. Eenmäe studied the seasonal courses of reflectance for some forest types in Järvselja, Estonia using multi-source satellite images. "Climatological" seasonal courses as determined from 47 Landsat Thematic Mapper (TM) and SPOT images from an extended period of years were determined for six Landsat bands. Most pronounced seasonal changes were found for deciduous birch dominated forests in spectral bands corresponding to strong absorption by chlorophyll (red band, TM3) and water (middle infrared, TM7) and in the near infrared band (TM4) sensitive to the total amount of leaf tissue.

Considerable seasonal reflectance changes appeared to be in sparse pine bogs due to the dependence of reflectance on Sun elevation. Due to applied smoothing of the image calibration coefficients, climatological series can be applied even for individual stands or plots of size $\sim$ 1ha. Multiple sources of images were used to create seasonal reflectance series of three sample plots of 100x100m. The agreement between multiple image sources was satisfactory. A comparison with the helicopter-borne spectrometer measurements over the same targets showed that the atmospheric correction of the satellite images tends to somewhat overestimate surface (forest) reflectance. The climatological seasonal reflectance series can further be used to simulate climatological estimates of forest productivity and carbon balance.

J. Pisek examined if a spherical leaf angle distribution and the resulting isotropic G-function (G = 0.5) is indeed a valid assumption for temperate and boreal tree and shrub species. Leaf angle distributions were measured in cooperation with Xiaoven Zou of University of Helsinki for 62 deciduous broadleaf species in Kaisaniemi and Kumpula botanical gardens in Helsinki in August 2012. The studied species are commonly found in temperate and boreal ecoclimatic regions. The leaf inclination angles were obtained by sampling the complete vertical extent of trees and shrubs using a recently introduced technique based on digital photography. It was found a spherical leaf angle distribution is not a valid assumption for both tree and shrub species in temperate and boreal ecoclimatic regions. It was recommended to use planophile or plagiophile leaf angle distribution as more appropriate for modeling radiation transmission in temperate and boreal ecoclimatic region when no actual leaf inclination angle measurements are available.

M. Lang, T. Lükk and T. Arumäe from Estonian University of Life Sciences and J. Anniste from Metsabüroo OÜ studied options to use Leica airborne lidar ALS50-II data for estimation of main forest inventory variables in Aegviidu test site. The Leica ALS50-II is a discrete lidar working at wavelength 1064 nm and it records up to four returns per emitted pulse. The test set-up yielded in average 1.0–1.2 returns per square meter. Regression analysis on a data set of 452 sample plots was used to create models for average forest height and standing stem volume estimation. The results showed that average forest height can be estimated via linear relationship from upper percentiles of lidar return height distribution. Height models were not species specific in Aegviidu test site. Precision of stem volume estimates improved when canopy cover estimate was included into model and models were created according to main species. However, tree species discrimination solely from lidar data is not feasible for practical applications and additional spectral information from satellite or airborne cameras is needed.

J. Kuusk together with researchers from the Plant Physiology Workgroup of the Estonian University of Life Sciences and from the Institute of Ecology and Earth Sciences of the University of Tartu visited Abisko Scientific Research Station in Sweden and Kilpisjärvi Biological Station in Finland. The project "Diurnal changes in leaf physiological activity during polar day in natural environments (LEAF)" was funded by the transnational infrastructure access project "International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)". Long hours of sunlight are crucial for vegetation in high latitudes to compensate very short growing season. To estimate accurately biomass productivity in such environment it is neces-

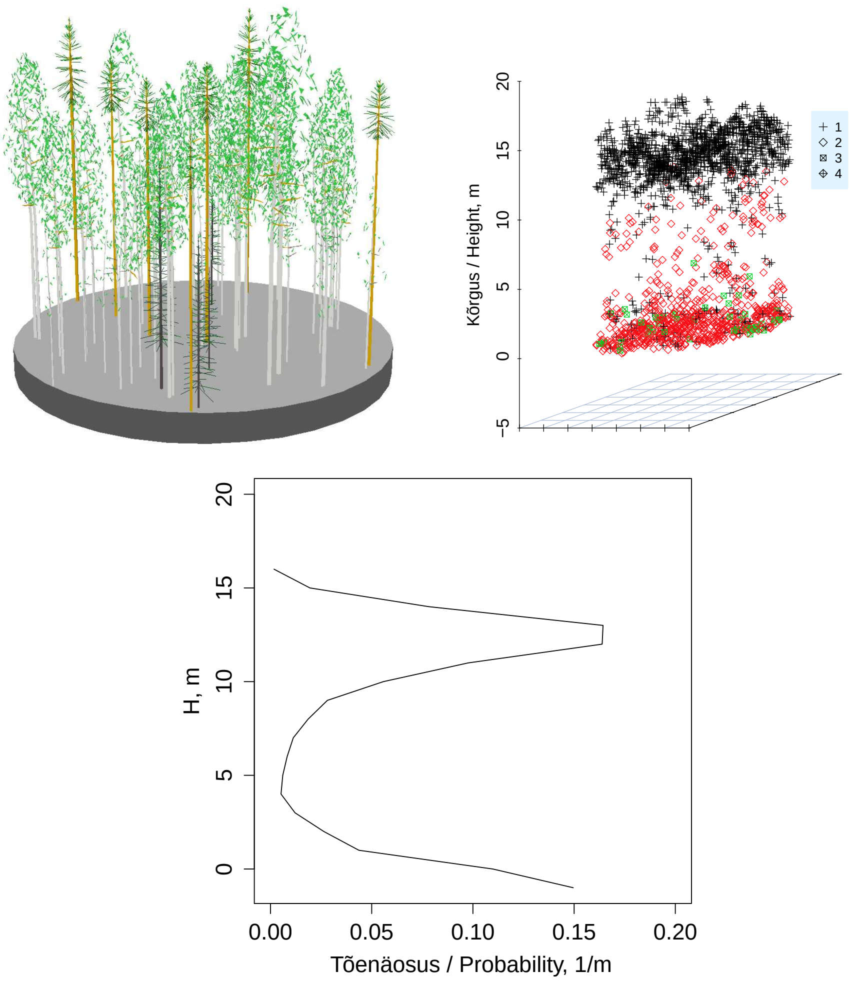


Figure 5.4: Visualization of sample plot KS-079 measurement data, extracted point cloud from lidar data and height distribution of pulse returns. Most of the returns are from canopy or from ground. Proovitüki KS-079 takseerandmete visualiseering, lidariandmetest välja lõigatud punktiparv ja punktide kõrgusjaotus. Enamik peegeldusi tekib võradelt või siis maapinnalt.

sary to consider the diurnal changes in leaf physiological activity. More detailed knowledge of diurnal changes in plant physiological activity in the conditions of extreme day length can be used to improve global productivity models and to estimate the possible effect of climate change on plant species in this environment more accurately. Canopy-level spectral reflectance was measured with the SVC HR-1024 and FieldSpec Pro VNIR handheld spectrometers to test the applicability of remote sensing methods to assess vegetation physiological state (e.g. photochemical reflectance index PRI) in high north vegetation. The diurnal course of Incident spectral flux was measured with the UAVSpec3 spectrometer system to couple the measurement results of physiological parameters (leaf chlorophyll fluorescence, leaf stomatal conductance, xylem sap flow) to light intensity and spectral composition.

A. Kuusk analyzed why homogeneous canopy reflectance (CR) models return systematically biased results over forests. The clustering of foliage into tree crowns is a kind of regularity of the forest canopy structure which dominates over clumping of foliage into shoots and branches in forming radiative transfer in a forest canopy. If this is accounted for by the clumping/regularity parameter in the homogeneous CR model then the model can be successfully applied for the estimation of leaf area index (LAI) of forest stands by the inversion of the CR model. In Fig. 5.5. the LAI histograms of the Järvselja test site estimated by the inversion of the homogeneous CR model ACRM developed at Tartu Observatory using CHRIS/Proba data of 05.07.2010 are compared to the LAI products of MODIS and MERIS satellites over the same area. The LAI histograms of MODIS and MERIS are narrower than the CHRIS/Proba one due to the differences in pixel size (1 km, 300 m, and 17 m, respectively). In the average the ACRM results using CHRIS/Proba data are between the MODIS and MERIS LAI products.

U. Peterson and J. Liira (University of Tartu) assessed forest disturbances and afforestation of abandoned agricultural land using medium resolution Landsat TM/ETM+ and ASTER images from 1985 to 2010. The mapping examples covered the areas in Estonia and the western regions of Pskov, Leningrad and Novgorod oblasts in Russia. The used satellite images were acquired in winter under the persistent snow cover conditions. Winter images are particularly suitable for change detection, when snow provides a uniformly bright background that accentuates tree crowns and their shadows and provides remarkable conditions for separating forested from non-forested areas. The medium resolution winter images were supported locally with medium resolution summer images, high resolution satellite images from both summer and winter seasons, orthophotos and database data if available.

Results show that a very simple approach using winter images is useful in mapping existing forest patches, canopy removal disturbances in forests and appearance of new forest patches within the context of agricultural lands in the situation of abandonment of agricultural land. Forest harvesting rates were found to be moderate in the early 1990-s, however the rates accelerated in the both countries several years after the change of political system in 1991 leading to higher levels of forest fragmentation. Forest disturbance rates differed markedly among the countries and also locally. Locally extensive afforestation of abandoned farmland was found in the studied region.

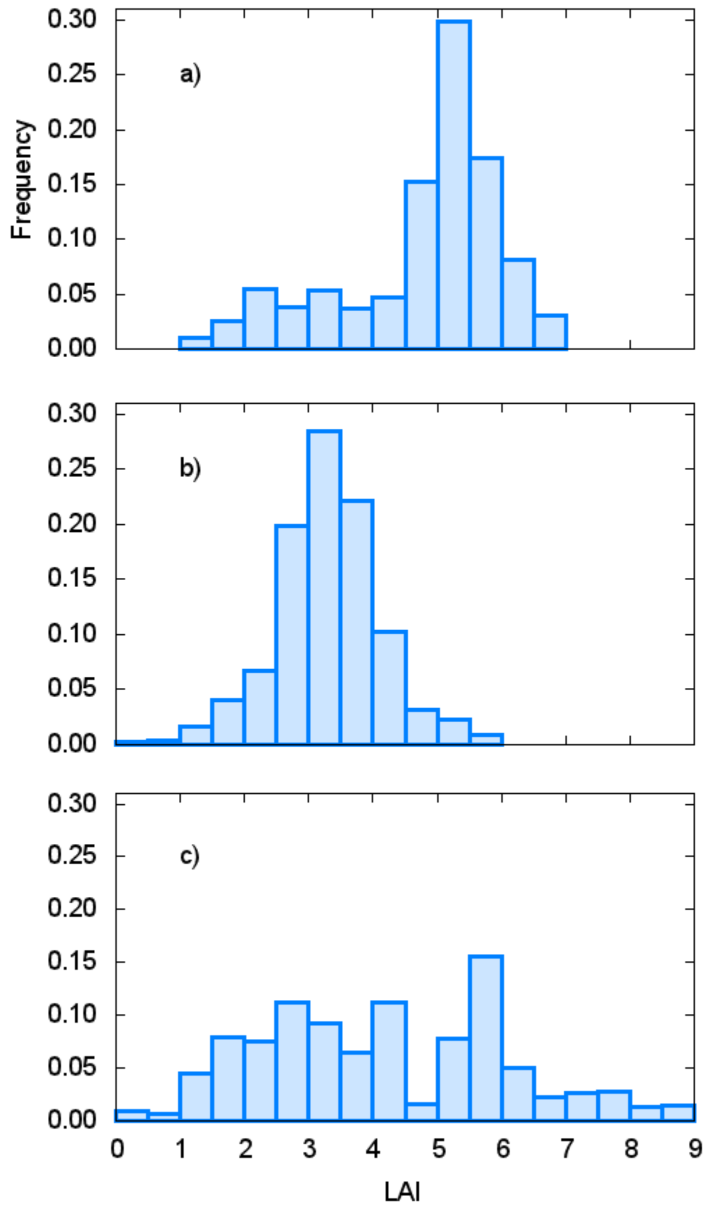


Figure 5.5: LAI histograms of the CHRIS scene; a) MODIS LAI product, LAI $_{mean}$ = 4.8; b) MERIS LAI product, LAI_{mean} = 3.3; c) ACRM inversion using CHRIS data, LAI_{mean} = 4.2. Lehepindala indeksi (LAI) histogramm CHRIS-i 5. juuli 2010 pildil oleval metsa-alal: a) MODIS-e andmetest, b) MERIS-e andmetest, c) CHRIS-i andmetest.

5.4 Space technology

In 2012 Space Technology development continued within numerous projects. The main research topics – electric solar wind sail technology development – continued with modeling exercises of sail behavior in Low Earth Orbit, possible application scenarios and experimental hardware development for in-orbit demonstration. In the frame of EU 7th framework project ESAIL the components of electric solar wind sail were developed in cooperation with the University of Uppsala, Swedish company Nanospace and Italian company Alta Space. The work to validate the electric solar wind sail in Earth's orbit using atmospheric plasma environment was continued in the frame of ESTCube-1 project which engaged many space technology department researchers as supervisors to students from University of Tartu, Estonian Aviation Academy, Estonian University of Life Sciences and Tallinn University of Technology. Teaching in Tartu University continued with several courses taught by space technology department researchers. An training event ”ESA radar remote sensing course” was organized in cooperation with ESA, University of Tartu and German Aerospace Center (DLR).

Figure 5.6: First Estonian satellite is ready! Last days and nights before delivering it to ESA, were really exhausting. On the picture: student from Tartu University, member of the team Erik Ilbis and EstCube 1. Eesti esimene satelliit on valmis! Viimased päevad ja ööd oli tõeliselt pingelised. Pildil Tartu Ülikooli üliõpilane, üks satelliidi loojatest, Erik Ilbis ja EstCube 1.

6 Publications Publikatsioonid

6.1 Papers in scientific journals and books Artiklid teadusajakirjades ja -kogumikes

6.1.1 Astronomy Astronoomia

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6.2 Conference papers Artiklid konverentsikogumikes

6.2.1 Astronomy Astronoomia

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6.2.2 Atmospheric physics Atmosfäärifüüsika

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Kuusk A.: Assessing Forest Parameters by Radiative Transfer Modelling. In: *Proceedings of the IEEE International Geoscience and Remote Sensing Sym-*

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Reinart A., Kübarsepp T., *Ansko I., Vendt R., Kuusk J.*: New Baseline Optical Laboratory for Calibration and Characterization of Remote Sensing Radiometers. In: *Ocean Optics XXI Conference, Glasgow, Scotland, 08.10.–12.10.2012. http://oceanopticsconference.org/extended-abstracts/extended-abstracts.zip.*

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6.3 Popular Articles Aimeartiklid

6.3.1 Astronomy Astronoomia

Einasto M.: Tähtis rahvusvaheline preemia Jaan Einastole. *Tähetorni Kalender 2013*, 81–86, 2012.

Leedjärv L.: Tähed, mis mahuksid Tallinna linna. *Horisont 2*, 10–15, 2012.

Leedjärv L.: Magnetarid ja teised kummalised taevakaunitarid. *Horisont 5*, 14–19, 2012.

Leedjärv L.: Osoon ja kiirgus: elu allikad ja hävitajad. Arvustus Uno Veismanni ja Kalju Eerme raamatule "Päikese ultraviolettkiirgus ja atmosfääriosoon". *Akadeemia 1*, 178–183, 2012.

Leedjärv L.: Kas Universum on sõbralik paik? *Katastroofid Maa ajaloos. Schola Geologica VIII*, Tartu, 65–66, 2012.

Leedjärv L., Vennik J.: Muljeid IAU XXVIII Peaassambleelt Pekingis. *Tähetorni Kalender 2013*, 121–129, 2012.

L. Leedjärv, T. Kipper, A. Tamm, P. Tenjes: TEA entsüklopeedia artiklid astronoomia valdkonnast.

Nugis T.: Suurima massiga tähed Universumis. *Tähetorni Kalender 2013*, 69–77, 2012.

Puss A.: Konservatiivne massiülekanne interakteeruvates kaksiktähtedes. *Tähetorni Kalender 2013*, 59–68, 2012.

Puss A.: Jõulukomeet ISON ja komeet Pan-STARRS. *Tähetorni Kalender 2013*, 78–80, 2012.

Puss A.: Nädal peale "maailmalõppu". *Meie Maa*, 29.12.2012.

Seil L., *Haud, U.*: Vaatemäng Veenuse ja Jupiteriga. *Sakala*, 29.03.2012.

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Tuvikene T.: Tagasivaade astronoomiahuviliste XVII kokkutulekule. *Tähetorni Kalender 2013*, 110–117, 2012.

Viik, T.: Schumacher et Clausen: Deux astronomes Danois aux relations tumulteuses. *L'Astronomie*, 54, 32–39, 2012 (inglise keelest prantsuse keelde tõlkinud S. Héral).

Viik T.: Liigirikkuse mõningaid aspekte astronoomias. *Lehed ja tähed*, nr 6, 8–13, 2012.

Viik T.: Anders Celsius – mees, kellelt saime temperatuuriskaala. *Geodeet 42*, 66–75, 2012.

Viik T.: Magnus Georg von Paucker – 225 aastat sünnist. *Tähetorni Kalender 2013*, 91–100, 2012.

6.3.2 Atmospheric physics Atmosfäärifüüsika

Eerme K.: Osooniaugust ja –kuplist Arktika kohal ehk Montreali protokolli kiituseks. *Horisont 3*, 50–55, 2012.

Eerme K.: Päike, osoonikiht ja inimene. *Kalender 2013* (koostaja G. Olevsoo), Tallinn, 122–126, 2012.
Noorma M.: Robotjuhitav maastikusõiduk Marsi eluvorme otsimas. *Horisont 5*, 6, 2012.
Reinart A.: Tartu Observatooriumi uuenenud peahoone – Eesti kosmoseteaduse keskus Tõraveres avab uksed moodsale tehnoloogiale. *Tähetorni Kalender 2013*, 101–104, 2012.
Veismann U.: Lugemisnoppeid: Teadusmõte Eestis VII. *Horisont 3*, 60–61, 2012.
Veismann U.: Saksa teadlased ja insenerid Nõukogude Liidus 1945-1955. *Akadeemia 6*, 988–1023, 2012.
TEA entsüklopeedia artiklid atmosfääriteaduste ja meteoroloogia alal – *K. Eerme, V. Russak* ning kosmose valdkonnas – *U. Veismann*.

6.4 Other papers Muud artiklid

Héral S.: Neli avaldamata Karl Knorre kirja Vladimir Dalile. *Akadeemia 4*, 708–732, 2012 (tõlkinud inglise ja saksa keelest *T. Viik*).
Viik T., Kana S.: The Activities of the Estonian Naturalists' Society in 2011. *Papers on Anthropology XXI*, 287–290, 2012.

6.5 Preprints Preprindid

Hackman T., *Pelt J.*, Mantere M.J., Jetsu L., Korhonen H., Granzer, T., Kajatkari, P., Lehtinen J., Strassmeier K.G.: Flip-Flops of FK Comae Berenices [arXiv:1211.0914].
Hektor A., Raidal M., *Tempel E.*: An Evidence for Indirect Detection of Dark Matter from Galaxy Clusters in Fermi-LAT Data. [arXiv:1207.4466].
Hektor A., Raidal M., *Tempel E.*: Double Gamma-Ray Lines from Unassociated Fermi-LAT Sources Revisited. [arXiv:1208.1996].
Hektor A., Raidal M., *Tempel E.*: Fermi-LAT Gamma-Ray Signal from Earth Limb, Systematic Detector Effects and Their Implications for the 130 GeV Gamma-ray Excess. [arXiv:1209.4548].
Kraus M., Oksala M.E., Nickeler D.H., Muratore M.F., Borges Fernandes M., *Aret A.*, Cidale L.S., de Wit W.J.: Molecular Emission from GG Car's Circumbinary Disk [arXiv:1211.5149].
Mantere M.J., Käpylä P.J., *Pelt J.*: Role of Longitudinal Activity Complexes for Solar and Stellar Dynamos [arXiv:1211.2990].
Tempel E., Tamm A., Kipper R., Tenjes P.: Uncertainties in SDSS Galaxy Parameter Determination: 3D Photometrical Modelling of Test Galaxies and Restoration of Their Structural Parameters [arXiv:1205.6319].
Tempel E., Stoica R.S., *Saar E.*: Evidence for Spin Alignment of Spiral and Elliptical/S0 Galaxies in Filaments. [arXiv:1207.0068].

7 Meetings Konverentsid ja seminarid

7.1 Astronomy Astronoomia

Seminar at Astrophysical Institute Potsdam (Potsdam, Germany, 15.04.2012) – E. Saar.
Saar E.: Shadows of Baryonic Oscillations (oral presentation).

ASTRONET Joint Call Workshop (Hamburg, Germany, 16.04.2012) – L. Leedjärv.

Gesellschaft für Kultur, Ingenieurwesen und Wissenschaft e.V., Wissenschaftliche Seminare (Dresden, Germany, 26.04.2012) – V. Malyuto.
Malyuto V.: Stellar Spectral Libraries (oral presentation).

Baltic Applied Astroinformatics and Space Data Processing (BAASP 2012) Conference (Ventspils, Latvia, 07.05.–08.05.2012) – J. Laur, R. Kipper, O. Kärner, J. Pelt.
Pelt J., Kärner O.: On the Variability of Total Solar Irradiance (oral presentation).

ASTRONET Board Meeting (Paris, France, 23.05.2012) – L. Leedjärv.

62nd Lindau Nobel Laureate Meeting (Lindau, Germany, 01.06.–06.06.2012) – T. Liimets.

Seminar at the University of Lille (Lille, France, 19.06.2012) – M. Einasto, E. Saar.
Saar E.: Estimating Cosmological Correlations (oral presentation).

TAM 2012 Meeting (Amsterdam, The Netherlands, 24.06.–30.06.2012) – T. Sepp.

European Week of Astronomy and Space Science 2012 (Rome, Italy, 01.07.–06.07.2012) – A. Tamm.
Tamm A.: Discs and Spheroids in the Universe (oral presentation).

The 13th Marcel Grossmann Meeting – MG13 (Stockholm, Sweden, 02.07.–06.07.2012) – J. Einasto, M. Einasto, E. Saar (session co-chair), E. Tempel, I. Vurm.
Vurm I.: Thermalization and Photon Sources in GRB Jets (invited talk).
Tempel E.: Correlation between Galaxies and Filaments in the Universe? (oral presentation).

Summer School on Cosmology (Trieste, Italy, 16.07.–27.07.2012) – R. Kipper, O. Tihhonova.

4th International Summer School on Astroparticle Physics (Nijmegen, The Netherlands / Kleve, Germany, 25.07.–03.08.2012) – E. Tempel, L.J. Liivamägi.

Nordic – Baltic Summer School (Moletai, Lithuania, 28.07.–11.08.2012) – J. Laur, T. Kuutma.

IAU XXVIII General Assembly (Beijing, China, 19.08.–31.08.2012) – L. Leedjärv, J. Vennik.

Vennik J., Kuutma T.: Colour and Stellar Population Gradients of Galaxies in Poor Groups of Galaxies (poster).

eROSITA Meeting (Kaasan, Russia, 27.08.–14.09.2012) – G. Hütsi.

Future Science with Metre-Class Telescopes. International BELISSIMA Conference (Belgrade, Serbia, 18.09.–22.09.2012) – L. Leedjärv.

Leedjärv L.: Small is Beautiful – Experience and Plans of the Tartu Observatory (oral presentation).

Seminar in the Center of Excellence "Dark Matter in (Astro)particle Physics and Cosmology" (KBFI, Tallinn, Estonia, 19.09.2012) – U. Haud.

Haud U.: Dark Matter from the Distribution of HI in the Milky Way (oral presentation).

Reception of the Viktor Ambartsumian International Prize (Armenian National Academy of Sciences, Yerevan, Armenia, 18.09.2012) – J. Einasto, M. Einasto.

Astrophysical Seminar (Byurakan Astrophysical Observatory, Armenia, 19.09.2012) – J. Einasto.

Einasto J.: Dark Matter Story (oral presentation).

Workshop "From School to Science: Meeting the Scientists" (Blankenberge, Belgium, 19.09.–20.09.2012) – T. Tuvikene, K. Verro.

Tuvikene T.: The Reduction of CCD Data (oral presentation).

Tuvikene T.: Live Remote Observation with iTelescope.net (oral presentation).

ICIC Meeting (Imperial College London, UK, 19.09.–22.09.2012) – E. Saar.

Tuorla – Tartu Annual Meeting 2012: Dark and Visible Universe (Tuorla, Finland, 20.09.–21.09.2012) – J. Einasto, M. Einasto, M. Gramann, E. Saar, T. Sepp, J. Laur, R. Kipper, T. Kuutma, E. Tago, E. Tempel, P. Tenjes, O. Tihhonova.

Kuutma T.: Colour and Stellar Population Gradients of Galaxies in Poor Groups of Galaxies (oral presentation).

Saar E.: Why (and How) to Calculate Supercluster Morphology (oral presentation).

Tihhonova O.: M31 Stellar Mass Map and Dark Matter Distribution (oral presentation).

Tempel E.: Are Galaxies and Filaments Correlated? (oral presentation).

Eesti Statistika Seltsi 20. konverents (Tartu, Estonia, 27.09.–28.09.2012) – E. Saar.

Saar E.: Statistics for Large Cosmological Surveys (oral presentation).

ASTRONET WG3 Meeting (Prague, Czech Republic, 01.10.–02.10.2012) – L. Leedjärv.

Leedjärv L.: Astronomy in Estonia: Current Status and Prospects (oral presentation).

5th KIAS Workshop on Cosmology and Structure Formation (Seoul, South-Korea, 15.10.–04.11.2012) – T. Sepp.

Astronomical Seminar (Astronomical Institute of Charles University, Prague, Czech Republic, 17.10.2012) – A. Aret.

Aret A.: Diffusive Separation of Chemical Elements and Their Isotopes in Stellar Atmospheres (oral presentation).

Inauguration Lecture (University of Tartu, 08.11.2012) – P. Tenjes.

Tenjes P.: Nähtava ja tumeda aine jaotus galaktikates (oral presentation).

Memorial Seminars (Academy of Sciences, Tallinn, 15.11.2012, Tartu Old Observatory, 16.11.2012) – A. Sapar.

Sapar A.: On the Creative Contribution of Academician Harald Keres as Scientist and Teacher (oral presentation).

Conference "225 Years of Magnus Georg Paucker" (Jelgava, Latvia, 23.11.2012) – T. Viik.

Viik T.: Magnus Georg Paucker and Tartu (oral presentation).

26th Texas Symposium on Relativistic Astrophysics (Sao Paulo, Brazil, 14.12.–21.12.2012) – J. Einasto.

Einasto J.: Dark Matter (invited talk).

7.2 Atmospheric physics Atmosfäärifüüsika

ESAIL Project Meeting (University of Uppsala, Sweden, 09.01.–11.01.2012) – V. Allik.

NordBaltRems (Nordic Network on Baltic Sea Remote Sensing) Network Kick-off Meeting (Helsinki, Finland, 11.01.–12.01.2012) – K. Alikas, A. Reinart, J. Pisek, K. Uudeberg, E. Kangro.

Alikas K.: A Robust Kd(490) Algorithm for Case-2 Waters (oral presentation).

Reinart A.: Water Remote Sensing Activities in Tartu Observatory (oral presentation).

European CubeSat Symposium (Brussels, Belgium, 29.01.–03.02.2012) – U. Kvell.

FP7 projects Meeting (Brussels, Belgium, 20.02.–22.02.2012) – A. Reinart.

Space EU Meeting (Brussels, Belgium, 28.02.–29.02.2012) – A. Reinart.

Final Conference of European Biodiversity Observation Network (EBONE) Project (Belgium, Brussels, 12.03.2012) – M. Lang.

Lang M., Vain A., Raet J., Sepp K., Bunce B.: Regional Classifications and Extrapolation of GHC Mapping Using Landsat-7 ETM+ and Airborne Lidar (poster).

FP7 Space Projects Committee Meeting (Brussels, Belgium, 12.03.–13.03.2012) – A. Reinart.

ESA Sentinel-3 Calibration and Validation Planning Meeting (Frascati, ESA–ESRIN, Italy, 18.03.–24.03.2012) – A. Reinart, M. Noorma.

PureBiomass Project Meeting (Ventspils, Latvia, 17.04.–18.04.2012) – M. Lang.
Lang M.: Recording Historical Change Järvselja Forest District – From Paper into Spatial Database (oral presentation).

UK-EE Space Technology Meeting (Warsaw, Poland, 18.04.–19.04.2012) – U. Kvell.

ESAIL Project Meeting (Uppsala, Sweden, 23.04.–25.04.2012) – V. Allik.

"Monitoring and Surveillance" Workshop (Tallinn, Estonia, 02.05.2012) – M. Lang.

The First International Scientific Conference "Baltic Applied Astroinformatics and Space Data Processing" (BAASP2012) (Ventspils University College, Latvia, 07.05.–08.05.2012) – U. Peterson.
Peterson U., Liira J., Lang M.: Cross-Border Comparison of Forest Cover Changes in Northeastern Europe Caused by Clear-Cutting and Afforestation of Abandoned Agricultural Land (oral presentation).

4th World Climate Research Programme International Conference on Reanalyses (Silver Spring, Maryland, USA, 07.05.–11.05.2012) – E. Jakobson.
Jakobson E.: Validation of Atmospheric Reanalyses Against Tethersonde Data from the Central Arctic Ocean in Spring and Summer 2007 (poster).

Finnish–Estonian Remote Sensing Seminar (Tartu, Estonia, 09.05.2012) – A. Kuusk, J. Kuusk, M. Lang, T. Lükk, T. Nilson, J. Pisek, M. Sulev.
Kuusk A.: Estimation of LAI of Hemiboreal Forests (oral presentation).
Lang M., Vain A., Raet J., Sepp K., Bunce B.: Mapping of General Habitat Categories from Satellite Images and Airborne Lidar Data in EBONE Project (oral presentation).
Pisek J.: Are Non-Varying Spherical Leaf Inclination Angle Distributions a Valid Assumption Across Temperate and Boreal Broad-Leaf Tree Species? (oral presentation).
Nilson T.: Time Course of Reflectance for Some Forest Types in Järvselja (oral presentation).
Lükk T.: Seasonal Imagery in kNN Estimation (oral presentation).

HISPARES (Spatial Planning in Archipelago Waters by High Spatial Resolution Remote Sensing) Information Days (Nelijärve, Estonia, 09.05.–10.05.2012) – U. Peterson, K. Uudeberg, A. Reinart.

32nd EARSEL Symposium: Advances in Geosciences (Mykonos, Greece, 21.05.–23.05.2012) – T. Nilson.

1st Workshop on Temporal Analysis of Satellite Images (Mykonos, Greece, 23.05.–25.05.2012) – T. Nilson.
Nilson T., Lang M., Rautiainen M., *Pisek J., Peterson U., Kuusk A., Kuusk J.,* Eenmäe A.: Time Course of Reflectance for Some Forest Types in Estonia (oral presentation).

Tackling Climate Change: the Contribution of Forest Scientific Knowledge. COST Action ECHOS Final Conference (Tours, France, 21.05.–24.05.2012) – M. Lang.

Interplanetary CubeSat Conference (Cambridge, USA, 29.05.–30.05.2012) – M. Noorma.

Aegviidu metsade kaugseireprojekt (Tallinn, Estonia, 31.05.2012) – M. Lang, T. Lükk.

Lang M., Arumäe T., Anniste J., *Lükk T.*: Takseertunnuste hindamine kaugseire abil Aegviidu katsealal (oral presentation).

WaterS Mid-Term Review Meeting (SYKE, Helsinki, 05.06.2012) – A. Reinart, K. Alikas, M. Ligi.

Reinart A.: WaterS Coordinator Report (oral presentation).

Alikas K.: WaterS Partner – Tartu Observatory (oral presentation).

Eesti-Vene piiriveekogude kaitse ja kasutamise ühiskomisjoni seire, hinnangu ja rakendusuuringute töörühma teadusseminar (Tartu, Estonia, 19.06.2012) – K. Alikas, A. Reinart, U. Peterson.

Alikas K.: Use of Satellite Information to Detect Water Quality Parameters in Lake Peipsi (oral presentation).

Reinart A.: Examples of Remote Sensing Applications for Lake Peipsi (oral presentation).

Peterson U., Liira J.: Valgala maakasutuse kaugseire võimalustest (oral presentation).

IOCCG Summer School "Frontiers in Ocean Optics and Ocean Colour Science" (Villefranche-sur-Mer, France, 02.07.–14.07.2012) – K. Alikas.

Field Work on the Baltic Sea (Helsinki, Finland, 10.07.–17.07.2012) – M. Ligi.

Remote Sensing for a Dynamic Earth, IGARSS'2012 (Munich, Germany, 22.07.–27.07.2012) – A. Kuusk.

Kuusk A.: Assessing Forest Parameters by Radiative Transfer Modelling (invited oral presentation).

Workshop of the Baseline Surface Radiation Network (BSRN) (Germany, Potsdam, 01.08.–03.08.2012) – A. Kallis.

Kallis A., *Russak V.*, Ohvril H., Jõeveer A., Nurmela K., Neiman L., Okulov O.: Solar Radiation Measurements in Estonia (poster).

European Meteorological Society's Annual Meeting (Łódź, Poland, 10.09.–14.09.2012) – O. Kärner.

Post P., *Kärner O.*: Mutual Analysis of Original and Reanalysed Temperature Series (oral presentation).

ForestSAT 2012 (Corvallis, Oregon, USA, 12.09.2012) – M. Lang, M. Ligi.

Lang M., Arumäe T., Anniste J., *Lükk T.*: Forestry Database Update in Aegviidu Test Site, Estonia, Using Multi Source kNN (oral presentation).

FP7 Project Meeting (DLR, Oberpfaffenhofen, Germany, 18.09.–21.09.2012) – J. Pisek.

Montreali protokolli 25. aastapäevale pühendatud seminar rahvusvahelise osoonipäeva tähistamiseks (Tallinn, Keskkonnaministeerium, 18.09.2012) – K. Eerme.

Eerme K.: Verstaposte osooni ja UV kiirguse uurimise teel maailmas ja Eestis (oral presentation).

ESAIL Project Meeting (Pisa, Italy, 26.09.–29.09.2012) – U. Kvell.

Mereuuringute konverents (Tallinn, 28.09.2012) – A. Reinart, U. Veismann.

Reinart A.: Satelliitkaugseire võimalused süsteemi maa-vesi-atmosfäär uurimiseks (oral presentation).

63th International Astronautical Conference (Napoli, Italy, 01.10.–05.10.2012) – A. Slavinskis, M. Pajusalu.

International Scientific Conference: Forests in the Future – Sustainable Use, Risks and Challenges (Belgrade, Serbia, 04.10.–05.10.2012) – U. Peterson.

Peterson U., Liira J.: Monitoring of Forest Area Changes Using Snow Covered Satellite Imagery in Northern Europe (oral presentation).

XXI Ocean Optics Conference (Glasgow, United Kingdom, 08.10.–12.10.2012) – K. Alikas, P. Grötsch, M. Ligi, A. Reinart, K. Uudeberg.

Alikas K., Kratzer S., *Reinart A.*: A Robust Kd(490) Algorithm for Optically Complex Waters (oral presentation and poster).

Uudeberg K., Ansko I., Lätt S., Randoja R.: An Integrated Collaborative Tool for Water Remote Sensing Data Management and Analysis at Tartu Observatory (poster).

Reinart A., Kübarsepp T., *Ansko I., Vendt R., Kuusk J.*: New Baseline Optical Laboratory for Calibration and Characterization of Remote Sensing Radiometers (poster).

Grötsch P.: Fractal Analysis of Patterns Along a Transect in the Baltic Sea (poster).

Ligi M., Peters S., Poser K., *Reinart A.*: Capabilities of New Algorithm for Use Satellite Based Spectral Measurements Over Nutrient Rich Lakes (poster).

3rd MERIS/(A)ATSR & OCLI–SLSTR Preparatory Workshop (ESRIN, Frascati, Italy, 15.10.–19.10.2012) – K. Alikas, E. Asuküll, E. Kangro, A. Reinart.

Alikas K., Kratzer S, *Ansko I., Reinart A.*: Evaluating the Effect of ICOL on MEGS 8 and Development of a New Robust Kd490 Algorithm for MERIS and OLCI (poster).

Asuküll E., Reinart A., Ligi M., Alikas K.: Measuring Dissolved Organic Matter from MERIS/Envisat Satellite (poster).

Kangro E., Reinart A., Uudeberg K.: Validation of MERIS/Envisat Water Quality Products on Estonian Lakes (poster).

Reinart A., Kübarsepp T., *Ansko I., Vendt R., Kuusk J.*: New Baseline Optical Laboratory for Calibration and Characterization of Remote Sensing Radiometers (poster).

Remote Sensing Seminar in VIRAC (Ventspils, Latvia, 22.10.2012) – M. Lang.
Lang M.: Remote Sensing of Forests in Estonia (oral presentation).

Finnish Remote Sensing Days 2012 (Helsinki, Finland, 25.10.–26.10.2012) – K. Alikas, I. Ansko, J. Kuusk, U. Peterson, J. Pisek.
Alikas K.: A Robust Kd(490) Algorithm for Remote Sensing of Optically Complex Waters (poster).
Ansko I.: A New Baseline Laboratory for Calibration and Characterization of Remote Sensing Radiometers (poster).
Kuusk J.: BRF of Forests (oral presentation).
Pisek J.: Estimating Leaf Inclination and G-function From Leveled Digital Camera Photography for Broadleaf Tree and Shrub Species in Kaisaniemi and Kumpula Botanical Gardens, Helsinki (oral presentation).
Peterson U., Lang M., Liira J., *Nilson T.*: Cross-Border Comparison of Forest Area Changes Caused by Clear-Cutting and Afforestation of Abandoned Agricultural Land Using Snow Covered Satellite Imagery in Northeastern Europe (oral presentation).
Kuusk J.: Reference Panel for Remote Sensing Studies at Järvselja, Estonia (poster).

NordForsk PhD Training Course "Remote Sensing of the Baltic Sea and Other Optically Complex Waters" (Lauenburg, Germany, 28.10.–01.11.2012) – K. Alikas, P. Grötsch, O. Krüger, M. Ligi, K. Uudeberg.
Alikas K.: Robust Kd(490) and Secchi Algorithms for Remote Sensing of Optically Complex Waters (oral presentation).
Grötsch P.: Spatial Patterns in Water Remote Sensing (oral presentation).
Ligi M.: Capabilities of New Algorithm for Use Satellite Based Spectral Measurements Over Nutrient Rich Lakes (oral presentation).
Uudeberg K.: An Integrated Collaborative Tool for Water Remote Sensing Data Management and Analysis Tartu Observatory (oral presentation).

Seminar "On the High North" (Norwegian Embassy, Tallinn, 30.10.2012) – A. Reinart.
Reinart A.: Arctic Related Research in Estonia (oral presentation).

IUFRO Landscape Ecology Conference "Sustaining Humans and Forest in Changing Landscape" (Concepcion, Chile, 05.11.–12.11.2012) – U. Peterson.
Peterson U., Liira J.: Impact of Forest Boundary Delineation on Change Detection in Highly Fragmented Landscapes (oral presentation).

Eesti Geoinformaatika Seltsi aastakonverents "ESTGIS 2012 – Traditsioonid vs innovatsioon GIS-is" (Pärnu, Estonia, 30.11.–01.12.2012) – A. Reinart.
Reinart A.: Euroopa Liidu programmi GMES arengutest Eestis (oral presention).

ESAIL Meeting (Helsinki, Finland, 02.12.–06.12.2012) – U. Kvell.

AGU Fall Meeting (San Francisco, USA, 03.12.–07.12.2012) – E. Jakobson, J. Pisek.

Pisek J.: Is the Spherical Leaf Inclination Angle Distribution a Valid Assumption for Temperate and Boreal Tree and Shrub Species? (poster).

Jakobson E., Keernik H.: A Case Study of Natural Variability of Water Vapor Content in the Baltic Sea Region (poster).

II eesti teaduskeele konverents (Tallinn, 07.12.2012) – U.Veismann.

2012 MISR Data Users Science Symposium (Pasadena, USA, 10.12.–11.12.2012) – J. Pisek.

Pisek J.: What Can Multi-Angle MISR Observations at 275m Resolution Tell us About Foliage Clumping? (oral presentation).

Laser Scanning Seminar (Mekrijärvi, Finland, 10.12.–11.12.2012) – M. Lang, T. Arumäe.

Arumäe T., Lang M.: Lidar Experiment in Aegviidu Test Site, Estonia (oral presentation).

7.3 Miscellaneous Muud koosolekud ja ettevõtmised

Broadening the Base of Europe's Space Community. NordicBaltSat Final Conference (Tallinn, Estonia, 02.02.–03.02.2012) – L. Leedjärv.

EU Space Policy Expert Group Meeting (Brussels, Belgium, 23.03.2012) – L. Leedjärv.

Tartu Kalevi Jahtklubi Väikelaevajuhtide koolitus (Estonia, 24.03.–30.04.2012) – K. Uudeberg, M. Ligi, E. Asuküll, I. Ansko.

ESA Radar Remote Sensing Course (Tartu, Estonia, 16.04.–20.04.2012) – K. Uudeberg, M. Ligi, E. Asuküll, E. Kangro, A. Reinart.

Eesti koolinoorte võistkonna juhid Rahvusvahelisel Astronoomiaolümpiaadil (Gwangju, South-Korea, 15.10.–24.10.2012) – T. Eenmäe, T. Sepp.

EUROMED Workshop on Space Applications (Brussels, Belgium, 28.11.2012) – L. Leedjärv.

7.4 Meetings at Tartu Observatory Tartu Observatooriumis korraldatud konverentsid

7.4.1 Strategy day of Tartu Observatory, Pühajärve, 15–16 February Tartu Observatooriumi strateegiapäev, 15.–16. veebruaril Pühajärvel

The strategy day 2012 of the Tartu Observatory was held at Pühajärve on February 15–16. The aim of this meeting was to discuss the status of the implementation of the development plan in Tartu Observatory together with the personnel, to target the goals for the end of 2012 and to set the strategic aims up to 2020. The topics considered were:

- research,
- teaching,
- popularization,
- management.

At that time there were 86 full or part-time persons working in the observatory, of whom 64 were research fellows. Those present were also four of the best bachelor students supervised by our researchers: two of space technology and two of remote sensing. In the first day of the meeting each working group had the possibility to carry out workshops, seminars of the doctoral students or strategic discussions. Only the groups of water monitoring and space technology made use of this possibility. In the evening the leaders of working groups specified the details of the forthcoming discussion. The meetings of the groups pointed out the most important problems and topics which were laid in the basis of the management decisions or the further discussions in the topics given above. The summary of the propositions made in the strategy days:

- Every fellow has to publish at least one paper per year, advisably 1.5–2.
- The number of co-authors should be as big as possible, the science policy favours the cooperation (the co-authors from abroad are preferable).
- Doctoral students and young fellows should attend at least two conferences a year and while attending speak about their work. The young fellows should look for the contacts for the further post-doc positions.
- The cooperation of the working groups should be intensified, e.g. in the field of the calibration of different instruments but also in other problems of mutual interest.
- Estonia must join the ESO.
- The data bases must be accessible to every fellow.
- For each scientific paper the author should write a short notice in Estonian.

- The Annual Review of the Tartu Observatory should be published annually.
- The Observatory Calendar should be published annually.
- The Calendar of the Starry Sky should be published annually.

Tartu Observatooriumi 2012. aasta strateegiaseminar toimus Pühajärvel 15.–16. veebruarini. Kokkusaamise eesmärgiks oli arutada kõigi töötajatega läbi Tartu Observatooriumi arengukava täitmise hetkeolukord, seada konkreetsed sihid 2012. aasta lõpuks ning püstitada strateegilised eesmärgid kuni aastani 2020. Teemad, mida käsitleti, olid järgmised:

- teadustöö,
- õppetöö,
- populariseerimine,
- administreerimine.

Sel ajal töötas Tartu Observatooriumis täis- või osakoormusega 86 inimest, kellest 64 on teadustöötajad. Kutsutud olid ka parimad observatooriumi teadlaste juhendatavad bakalaureuseõppe üliõpilased. Seminaril osales neist neli, kaks kosmosetehnoloogia ja kaks kaugseire valdkonnast. Strateegiaseminari esimesel päeval oli kõigil töörühmadel võimalus viia läbi töökoosolekuid, doktorantide seminare või strateegilisi arutelusid. Seda võimalust kasutasid vee kaugseire ja kosmosetehnoloogia töörühmad. Õhtul toimus valdkondade juhtide grupitöö detailide täpsustamiseks.

Strateegiaseminaril toimunud rühmatööde käigus tõid observatooriumi töötajad välja olulisemad küsimused ning teemad, mis said aluseks 2012. aasta jooksul tehtud juhtimisotsustele või edasistele aruteludele teadus- ja õppetöö, teaduse populariseerimise ning administreerimise valdkondades. Kokkuvõte strateegiaseminaril tehtud ettepanekutest:

- Teadlastelt peab ilmuma vähemalt 1 artikkel aastas inimese kohta, soovitavalt 1,5–2 artiklit.
- Kaasautoreid tuleb panna nii palju kui võimalik, teaduspoliitika soosib seda. Välismaised kaasautorid tulevad kasuks.
- Doktorandid ja noored teadlased peavad käima vähemalt kahel konverentsil aastas ning seal oma teadustööst rääkima. Samuti tuleb noortel otsida kontakte tulevase järeldoktori koha jaoks.
- Töörühmade koostööd tuleb tõhustada, näiteks mõõteseadmete kalibreerimise alal, samuti muudes ühist huvi pakkuvates.
- Eesti peab saama ESO liikmeks.
- Teadusandmebaasid peavad olema kättesaadavad kõigile observatooriumi teadustöötajatele.
- Iga avaldatud artikli kohta tuleb kirjutada eestikeelne teadusuudis.
- Traditsiooniliselt peab ilmuma ”Tartu Observatooriumi aastaraamat”.
- Traditsiooniliselt peab ilmuma ”Tähetorni kalender”.
- Traditsiooniliselt peab ilmuma ”Tähistaeva kalender”.

7.4.2 ESA Radar Remote Sensing Course ESA Radarkaugseire Kursus Eestis

To present and popularize the technology of remote sensing of the Earth both in research institutions and enterprises the European Space Agency (ESA) implements the series of scientific and technological courses. A part of this programme was carried out in 2012 in Estonia. Intensive course of the radar remote sensing was held on April 16–20 in Tartu, in the conference centre Dorpat and covered both lectures and practical sessions. In addition to ESA the organizers of the courses were from the German Space Agency (DLR) and from the Estonian side from the University of Tartu and the Tartu Observatory. The essential role in organizing the course was played by the University of Rennes (France) and the University of Jena (Germany) who sent lectors and the world-known researchers in the field of radar remote sensing: Dr F. De Zan, Dr L. Ferro-Famil and C. Thiel who were assisted by Dr F. Sarti and Dr A. Mouratidis from ESA. The interest of the sponsors from AS Regio and EAS was great and they assisted both in providing the software, in organizing the course and carrying it out in modern and comfortable environment. In addition to that AS Regio sent many participants (doctoral students) whose research in radar remote sensing is connected with its implementation in entrepreneurship and thus also with boosting the competence in space technology in Estonia and international markets in general. The participants from universities, institutions and organizations were mostly scientists, master and doctoral students and young specialists from Estonia, Latvia and Poland whose sphere of activities is connected with geoinfosystems and the remote sensing of the Earth. The course gave the participants the necessary preparation, practical base and knowledge to take into use the different applications of the radar remote sensing for more effective assessment of the environment through the monitored pictures. The assessment and study of the numerous applications gave many new ideas which could be applied for the conservation of the environment and for the assessment of the environmental impacts. Many important contacts were concluded between the participants and lectors and further plans for cooperation were made, especially with Polish and Latvian colleagues working in the same domain. The lectors and the organizers from ESA were very content with the research in the field of radar remote sensing in Estonia and offered some new courses. The good relationship between the lectors and students is a big step forward in globalizing the science in Estonia and helps to carry out the research together with international experts.

Maa seire tehnoloogia tutvustamiseks ja populariseerimiseks nii teadusasutustele kui ka ettevõtetele viib Euroopa Kosmoseagentuur (ESA) läbi tehniliste ja teaduslike kursuste seeriat, mille programmi üks osa käesoleval aastal ka Eestisse läbi viidi.

Intensiivne radarkaugseire kursus toimuski 16.–20. aprillini 2012 aastal Tartus, Dorpati konverentsikeskuses ja hõlmas endas loenguid ning praktilisi sessioone. Lisaks ESA-le olid kursuse korraldajateks ka Saksa kosmoseagentuur (DLR) ning Eesti poolt Tartu Ülikool ja Tartu Observatoorium. Oluline roll oli ka kursuse koostööpartneritel Rennes Ülikoolil (Prantsusmaa) ja Jena Ülikoolil (Saksamaa), kust saadeti Eestisse lektorid ja radarkaugseire alase uurimistöö ühed olulisemad tegijad maailmas: lektorid Dr. F. De Zan, Dr. L. Ferro-Famil ja C. Thiel, keda assisteerisid Dr. F. Sarti ja Dr. A. Mouratidis ESA-st. Ka sponsorite, AS Regio ja EAS-i huvi kursuse toetamise vastu oli suur ja oli abiks nii vajaliku tarkvara muretsemisega, kursuse korraldamisega ja selle läbi viimisega kaasaegses ja mugavas keskkonnas. Lisaks sellele saatis Regio intensiivkursusele ka mitu osavõtjat ehk teadusdoktoranti, kelle radarkaugseire alane teadustöö on seotud selle tulemuste ettevõtluses rakendamisega ja seeläbi kosmosetehnoloogia alase kompetentsi tõstmisega Eestis suunaga nii Eesti kui ka rahvusvahelistele turgudele.

Participants of the Meeting. Konverentsist osavõtjad.

Ülikoolidest, institutsioonidest ja organisatsioonidest saabunud osalejad olid peamiselt teadlased, üliõpilased, doktorandid ja noored spetsialistid Eestist, Lätist ja Poolast, kelle tegevusvaldkond on seotud geoinfosüsteemide ja Maa seirega. Kursuse andis kõigile vajaliku ettevalmistuse, praktilise baasi ja teadmised erinevate radarkaugseire rakenduste kasutusele võtmiseks, efektiivsemaks keskkonna hindamiseks radarkaugseire piltide abil ja Maa seire igapäevasesse töösse rakendamise võimalustest. Arvukate rakenduste uurimine ja hindamine andis palju uusi ideid, mida kohapeal rakendada võiks ning mis oleks abiks nii keskkonnakaitsel kui ka keskkonnamõjude hindamisel.

Tänu rahvusvahelistele õppejõududele ja osalejatele sõlmiti kursuse käigus palju olulisi kontakte ja tehti edasisi koostööplaane. Lisaks rajasid nii Eesti teadlased ja tudengid kui ka ettevõtjad kontakte samas valdkonnas tegutsevate Poola ja Läti kolleegidega, mis on heaks aluseks edasistele koostööprojektidele. Kursuse lõppedes olid lektorid ja ESA poolsed korraldajad väga rahul siinse teadustegevusega radarkaugseire vallas ning pakkusid omalt poolt välja juba uusi kursusi. Taolised head suhted nii õppejõudude kui tudengite ja spetsialistide vahel on väga suur samm edasi Eesti teaduse globaalsemaks muutmisel ja tutvustamisel ning aitab edaspidi siinsete teadlaste tööd läbi viia juba rahvusvaheliste ekspertide käe all.

7.4.3 Information Day on the European Southern Observatory, Enterprise Estonia, Tallinn, 21 June 2012 Teabepäev "Euroopa Lõunaobservatoorium", Ettevõtluse Arendamise Sihtasutus, Tallinn, 21. juuni 2012

From left ESO Director of Programmes Adrian Russel and Head of Administration Patrick Geeraert. Pildil vasakul on ESO programmide direktor Adrian Russell ja paremal administratsiooni ülem Patrick Geeraert.

On June 21, 2012 an information day on the European Southern Observatory (ESO) was organized by L. Leedjärv and A. Tamm, with technical help from T. Lillemaa and M. Ruusalepp. In order to facilitate participation of entrepreneurs as potential future procurement partners to ESO, the event took place in Tallinn, in the premises of Enterprise Estonia. About 25 participants included scientists from Tartu Observatory, University of Tartu and National Institute of Chemical and Biological Physics, as well as several entrepreneurs and officials of the Ministry of Education and Research. After opening words by Madis Võõras, head of the Estonian Space Office at Enterprise Estonia, the floor was given to the representatives of ESO. The head of administration Patrick Geeraert gave a general overview of ESO and its activities during 50 years, and in particular, introduced the process of joining ESO. The director of programmes Adrian Russell concentrated mostly on the 39.4-meter European Extremely Large Telescope (E-ELT) and opportunities for Estonian companies to participate in the procurements to build the telescope (planned to be operative by 2020). Laurits Leedjärv presented a brief overview of astronomy in Estonia and our expectations towards ESO. A general consensus was reached that joining ESO would be beneficial for developing astronomy in Estonia and for advancement of exact sciences and engineering. However, this brings along expenses which are not so easily affordable in the present economic situation. Our first application to the Ministry of Education and Research to finance joining ESO in the framework of the programme for internationalization of research was not satisfied, but the efforts towards ESO are continued.

21. juunil 2012 korraldasid L. Leedjärv ja A. Tamm (tehnilist abi pakkusid T. Lillemaa ja M. Ruusalepp) infopäeva Euroopa Lõunaobservatooriumi (ESO) teemal. Et lihtsustada Eesti ettevõtjate kui ESO potentsiaalsete hankepartnerite osavõttu, toimus üritus Tallinnas Ettevõtluse Arendamise Sihtasutuse (EAS) ruumides. Umbes 25 osaleja seas olid teadlased Tartu Observatooriumist, Tartu Ülikoolist ning Keemilise ja Bioloogilise Füüsika Instituudist, ettevõtjad ja Haridus- ja Teadusministeeriumi esindajad. Madis Võõras, EAS-i juures asuva Eesti kosmosebüroo juht, tegi lühikese sissejuhatuse, seejärel said sõna ESO esindajad. Administratsiooni ülem Patrick Geeraert andis põhjaliku ülevaate äsja 50-aastaseks saanud ESO tegevusest ja eriti temaga ühinemise protsessist. Programmidirektor Adrian Russell keskendus peamiselt 39.4-meetrise läbimõõduga E-ELT projektile ja Eesti ettevõtete võimalustele osaleda selle hiigelteleskoobi ehitamiseks korraldatavates hangetes (E-ELT peaks valmima 2020). Laurits Leedjärv andis lühiülevaate astronoomiast Eestist ja meie ootustest ESO suhtes. Eesti liitumine ESO-ga oleks kasulik nii astronoomiale kui täppisteaduste ja tehnoloogia arengule laiemalt, kuid praeguses majanduslikus olukorras on riigil raske võtta pikaajalisi rahalisi kohustusi. Meie esimest ametlikku avaldust rahastada ESO-ga liitumist teaduse rahvusvahelistumise programmist ei rahuldatud, kuid astronoomid tegutsevad edasi selles suunas, et Eesti saaks kord ESO liikmesriigiks.

7.4.4 Tuorla – Tartu Annual Meeting 2012: Dark and Visible Universe (20–21 September, Turku) Tuorla-Tartu ühisseminar "Tume ja nähtav Universum". 20.–21. september, Turu.

This meeting was already eighth. The programme lasted two full days, and we had the traditional Finnish-Estonian football match and deep scientific discussions in a smoke sauna. There were 38 registered participants, from Tuorla and Tartu observatories, from FINCA (Finnish Centre of Astronomy with ESO), CERN, AIP (Astrophysical Institute Potsdam), from Helsinki and St Petersburg. We will list the talks to give an idea of the topics discussed.

See oli juba kaheksas konverents. Programm täitis kaks päeva ja me pidasime maha traditsioonilise Soome-Eesti jalgpallilahingu ja arutasime keerulisi teadusprobleeme suitsusaunas. Kohal oli 38 osavõtjat, Tuorla ja Tartu observatooriumitest, FINCA-st (Soome keskus astronoomilisteks uuringuteks ESOs), CERN-ist, AIP-st (Potsdami Astrofüüsika Instituut), Helsingist ja Peterburist. Toome allpool ettekannete nimekirja, kust näha, millest juttu oli.

Thursday, 20 September

- Ricardo Salinas (FINCA): Heart of darkness: the massive cluster Abell 545 and its "star pile".
- *Antti Tamm* (Tartu): Discs and spheroids in the Universe.
- Kari Nilsson (FINCA): New BL Lacs from the SDSS.
- Seppo Katajainen (Tuorla): SN Ia progenitors: Where are they, and what they are.
- Andi Hektor (CERN): Gamma-ray excess at 130 GeV in the Fermi LAT data – the annihilation of Dark Matter.
- Orlov V.V., Kholshevnikov K.V (Russia): Multiple stars in our Galaxy.
- Adebusola Alabi (Tuorla): Bimodality in Globular Cluster Systems of Isolated ellipticals?
- Harry Lehto (Tuorla): ESA Rosetta mission?
- Elina Lindfors (FINCA): Magic and CTA.
- Riho Reinthal (Tuorla): Magic observations of BLLAC 0806+524?
- *Olga Tihhonova* (Tartu): Andromeda mass map.
- Pauli Pihajoki (Tuorla): Outbursts from the secondary component in OJ 287.
- Rami Rekola (Tuorla): NOT Science School – Recruiting Bright Young Minds to Science and Technology.

Friday, 21 September

- Francisco Kitaura (AIP): Unveiling the cosmic web.
- *Maret Einasto* (Tartu): Multimodality of galaxy clusters within the supercluster – void network.
- Heidi Lietzen (Tuorla): Galaxies in high and low-density environments.
- Jukka Nevalainen (Helsinki): Searching for Warm-Hot Intergalactic Medium WHIM using the Luminosity Density method.
- *Elmo Tempel* (Tartu): Are galaxies and filaments correlated??
- Pekka Heinämäki (Tuorla): Planck so far?
- *Tiit Sepp* (Tartu): Supercluster simulation on both sides of the gulf.
- Joonas Saarinen (Tuorla): Detecting Dark Energy near the Local Group.
- *Teet Kuutma* (Tartu): Colour and stellar population gradients of galaxies in poor groups of galaxies.
- Anup Poudel (Tuorla): Be wise to use WISE.
- Pasi Nurmi (Tuorla): Galaxy group or cluster.
- *Juhan Liivamägi* (Tartu): BAO and LSS.
- *Erik Tago* (Tartu): Compiling galaxy groups.

8 Visits and guests Visiidid ja külalised

8.1 Astronomy Astronoomia

I. Vurm – The Hebrew University of Jerusalem (Israel); 01.01.– 31.10.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 06.01.–22.02.2012.
I. Vurm – University of Oulu, Oulu (Finland); 07.02.–22.02.2012.
T. Tuvikene – Vrije Universiteit Brussel (Belgium); 11.03.–16.03.2012.
A. Aret – Ondřejov Observatory (Czech Republic); 11.03.–25.03.2012.
J. Einasto – ICRANet, Pescara (Italy); 12.03.–14.05.2012.
I. Kolka – ESO, Cerro Paranal (Chile); 22.03.–05.04.2012.
J. Pelt – University of Helsinki, Helsinki (Finland); 09.04.–14.04.2012.
E. Saar – Astrophysical Institute Potsdam (Germany); 10.04.–21.04.2012.
T. Sepp – Tuorla Observatory, (Turku, Finland); 15.04.–05.05.2012.
A. Tamm – Universiteit Gent, (Gent, Belgium); 18.04.–22.04.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 21.05.–22.06.2012.
E. Saar – University of Lille (France); 18.06.–23.06.2012.
T. Tuvikene – Vrije Universiteit Brussel (Belgium); 24.06.–26.06.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 26.06.–26.07.2012.
A. Aret – Ondřejov Observatory (Czech Republic); 30.07.–02.11.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 14.08.–24.08.2012.
T. Tuvikene – Vrije Universiteit Brussel (Belgium); 15.08.–18.08.2012.
B.Z. Deshev – Centro de Astrofísica en La Palma, La Palma (Spain); 03.09.–31.12.2012.
T. Liimets – Centro de Astrofísica en La Palma, La Palma (Spain); 03.09.2012–31.12.2012.
E. Saar – Observatori Astronómic, Universitat de Valéncia, Valéncia (Spain); 02.10.–01.12.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 09.09.–09.11.2012.
I. Vurm – University of Oulu, Oulu (Finland); 31.10.–09.11.2012.
L.J. Liivamägi – Observatori Astronómic, Universitat de Valéncia, Valéncia (Spain); 11.11.–01.12.2012.
I. Vurm – Columbia University, New York, (USA); 15.11.12 – 31.12.2012.
G. Hütsi – Max Planck Institute for Astrophysics (Garching, Germany); 19.11.–20.12.2012.
A. Tamm – Instituto de Astrofísica de Canarias, La Laguna (Spain); 13.12.–20.12.2012.

8.2 Atmospheric physics Atmosfäärifüüsika

M. Ligi – Helsinki (Finland); 10.04.–20.04.2012, 23.04.–27.04.2012.
J. Kuusk – Abisko Scientific Research Station (Sweden); 19.06.–01.07.2012.
J. Kuusk – Kilpisjärvi Biological Station (Finland); 01.07.–11.07.2012.
J. Pisek – Helsinki Botanical Garden (Helsinki, Finland); 22.09.–23.09.2012.
K. Alikas – Brockmann Geomatics (Sweden); 01.11.2011–28.02.2012; 27.10.2012–26.02.2013.

8.3 Guests of the observatory Observatooriumi külalised

Olaf Krüger – Brockmann Consult GmbH (Germany); 22.10.2011–21.01.2012.
Rien van de Weygaert – University of Groningen (The Netherlands); 07.03.–10.03.2012.
Pauline Stenberg, Miina Rautiainen, Matti Mõttus, Janne Heiskanen, Titta Majasalmi, Petr Lukes – University of Helsinki (Finland); 09.02.–10.02.2012.
Adrian Russell, Patrick Geeraert – ESO (Germany); 20.06.–22.06.2012.
Peter Kamphuis – Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Australia); 27.08.–30.08.2012.
Michael Lee – Sevastopol Marine Institute (Ukraine); 08.10.–12.10.2012.
Miguel A. Aragon-Calvo – Johns Hopkins University, Baltimore (USA); 30.10.–10.11.2012.
Mary Elizabeth Oksala – Astronomical Institute of the Academy of Sciences of the Czech Republic; 18.11.–28.11.2012.
Maarit Mantere – University of Helsinki (Finland) – 06.12.–07.12.2012.
Sergey Zubarev – Institute of Physics and Technology, Ural Federal University (Russia); 11.12.–18.12.2012.

9 Seminars at the Observatory Observatooriumis toimunud seminarid

9.1 Astronomy Astronoomia

18.01.2012 – Tõnu Kipper: Vesinikuvaesed kaksiktähed.
25.01.2012 – Uno Veismann: Terminoloogiaprobleeme kosmosetehnoloogia valdkonnas.
07.03.2012 – Rien van de Weijgaert (The Netherlands): The Alpha and Betti of the Universe.
14.03.2012 – Urmas Haud: Viis aastat möödas, viis aastat ees.
21.03.2012 – Antti Tamm: Tähed kosmoloogias.
11.04.2012 – Laurits Leedjärv: Rännakud sümbiootilisel maastikul koos kaksiktähega AG Draconis.
18.04.2012 – Tõnu Viik: Arthur Stanley Eddington – teoreetilise astrofüüsika rajaja.
25.04.2012 – Elmo Tempel: Andromeeda: 5+5 aastat.
02.05.2012 – Riho Reinthal: Highlights on AGN Studies with the MAGIC Telescope.
09.05.2012 – Maret Einasto: Rikkad galaktikaparved superparvede - tühikute võrgustikus.
16.05.2012 – Elmo Tempel: SDSS 500 000+: kas galaktikad ja filamendid on korrelleeritud?
30.05.2012 – Tiit Nugis: Suurima massiga tähed Universumis. Edetabel ja lahendamata probleemid.
13.06.2012 – Taavi Tuvikene: CCD Photometry of Variable Stellar Sources: Data Reduction Workflow, Assessment of Accuracy, Case Studies (ülevaade doktoritööst).
29.09.2012 – Peter Kamphuis (CSIRO, Austraalia): Gaseous Halos of Spiral Galaxies.
03.10.2012 – Manuel Hohmann: Multimetric Cosmology and Structure Formation.
12.10.2012 – Laurits Leedjärv, Jaan Vennik: IAU 28. Peaassambleest Pekingis.
07.11.2012 – Miguel Aragon Calvo (John Hopkins University): A Thousand Universes: Unveiling the Halo - Environment Relation with Constrained Ensembles.
21.11.2012 – Mary Elizabeth Oksala (Ondřejov Observatory): Centrifugally Supported Massive Star Magnetospheres.
28.11.2012 – Tiit Sepp: Astronoomiaolümpiaadist, kosmoloogiast ja Koreast.

06.12.2012 – Maarit Mantere (Helsinki University): Direct Numerical Simulations Can Reproduce Solar-Like Magnetic Cycle.

11.12.2012 – Jukka Nevalainen (University of Turku): Where Have Half the Baryons Gone?

19.12.2012 – Olavi Kärner: Kliima kulgeb nii nagu Päike juhatab.

9.2 Atmospheric physics Atmosfäärifüüsika

19.01.2012 – Elar Asuküll: Optiliselt aktiivse lahustunud orgaanilise aine varieeruvus Eesti suurtes järvedes.

26.01.2012 – Erko Jakobson: Peamiste globaalsete atmosfääri mudelite ja järelanalüüside vertikaalsete profiilide valideerimine Artikas.

01.03.2012 – Martin Ligi: Uus käsispektromeeter WISP-3 vee kvaliteedi uurimiseks.

15.03.2012 – Karlis Zalite: Introduction to SAR – Principles and Technology. Collaboration with ESA and DLR.

01.06.2012 – Maris Nikopensius: Järvselja metsade kiirgustemperatuuri olenevus puistu vanusest.

01. 06.2012 – Evelin Kangro: MERIS/Envisat vee kvaliteedi tulemite valideerimine järvede näitel.

01.06.2012 – Elar Asuküll: Lahustunud orgaanilise aine määramine satelliidipiltidelt.

04.10.2012 – Krista Alikas: Robust Kd(490) and Secchi Depth Algorithms for Remote Sensing of Optically Complex Waters.

15.11.2012 – Erko Jakobson: A Case Study of Natural Variability of Water Vapour Content in the Baltic Sea Region.

29.11.2012 – Olaf Krüger: Aerosols, Clouds and Radiation.

9.3 Joint Seminar of the Observatory Observatooriumi ühisseminarid

30.01.2012 – Arved Sapar: Rännak kuumade täheatmosfääride füüsikasse: atomaarprotsessidest tähespektriteni, valemeist tarkvaratulemusteni.

26.03.2012 – Jaan Pelt: Mineviku ennustamisest.

28.05.2012 – Anu Reinart: Tartu Observatooriumi kaugseire valdkonna uutest töösuundadest ja perspektiividest.

10.12.2012 – Andres Kuusk: Metsa peegeldumisindikatriss.

10 Membership in scientific organizations Teadusorganisatsioonide liikmed

Academia Europaea – J. Einasto
American Astronomical Society – J. Einasto
American Geophysical Union – K. Alikas (student member), E. Jakobson, J. Pisek, A. Reinart, S. Lätt (student member), K. Uudeberg (student member)
American Society of Photobiology – U. Veismann
ASTRONET Board – L. Leedjärv
Board of Directors "Astronomy and Astrophysics" – L. Leedjärv
Board of Member Countries Representatives of COST 726 Action – K. Eerme
Board of the Tartu Astronomy Club – E. Tago
British Interplanetary Society – U. Veismann
Editorial Board "Agricultural and Forest Meteorology" – A. Kuusk
Editorial Board "Baltic Astronomy" – T. Kipper
Editorial Board "Baltic Forestry" – M. Lang
Eesti Astronoomia Selts – K. Annuk, T. Eenmäe, J. Einasto, M. Gramann, A. Hirv, T. Liimets, T. Kipper, I. Kolka, L. Leedjärv, T. Nugis, J. Pelt, A. Puss, M. Ruusalepp, L. Sapar, E. Tago, E. Tempel, T. Tuvikene, U. Veismann, T. Viik
Eesti Füüsika Selts – A. Aret, K. Eerme, J. Einasto, T. Kipper, L. Leedjärv, S. Lätt (board member), A. Reinart, E. Saar, A. Sapar, P. Tenjes, T. Viik
Eesti Geofüüsika Komitee / Estonian Geophysical Committee – K. Eerme
Eesti Rahvuslik Astronoomia Komitee / Estonian National Committee on Astronomy – J. Einasto, L. Leedjärv (Chair), E. Saar, T. Viik
Eesti Kirjanduse Selts – U. Veismann
Eesti Kosmosepoliitika Töögrupp / Estonian Space Policy Working Group – L. Leedjärv (Vice-Chair), A. Reinart
Eesti Looduseuurijate Selts – K. Eerme, V. Russak, A. Sapar, U. Veismann, T. Viik (president)
Eesti Teaduste Akadeemia / Estonian Academy of Sciences – J. Einasto, E. Saar, A. Sapar
EUFAR (EUropean Fleet for Airborne Research): Education and Training – S. Lätt
European Association of Remote Sensing Laboratories (EARSeL) – department of atmospheric physics
European Astronomical Society – K. Annuk, J. Einasto, M. Gramann, G. Hütsi, T. Kipper, I. Kolka, L. Leedjärv, V. Malyuto, T. Nugis, E. Saar, A. Sapar, L. Sapar, I. Suhhonenko, E. Tago, P. Tenjes, U. Veismann, J. Vennik, T. Viik
European High Level Space Policy Group – L. Leedjärv
Euroscience – U. Veismann
Euro–Asian Astronomical Society – A. Aret, J. Einasto, V. Malyuto, A. Sapar

Field Editor "Agronomie. Agriculture and Environment" – A. Kuusk

The Gaia Data Processing and Analysis Consortium (DPAC), Coordination Unit CU8: Astrophysical Parameters – I. Kolka, V. Malyuto

German Astronomical Society – J. Einasto

Institute of Electrical and Electronical Engineers (IEEE) – S. Lätt (student member), J. Pisek (student member)

International Association for Great Lakes Research (IAGLR) – K. Alikas (student member)

International Astronomical Union – K. Annuk, J. Einasto, M. Einasto, M. Gramann, U. Haud, G. Hütsi, T. Kipper, I. Kolka, L. Leedjärv, V. Malyuto, T. Nugis, J. Pelt, E. Saar, A. Sapar, L. Sapar, I. Suhhonenko, E. Tago, A. Tamm, P. Tenjes, U. Veismann, J. Vennik, T. Viik

International Astrostatistics Association – E. Saar.

The International Society for Optical Engineering (SPIE) – U. Veismann, S. Lätt (student member)

Marie Curie Fellowship Association – A. Reinart

Nordic Network on Physically-based Remote Sensing of Forests – T. Nilson (director), M. Lang (member of steering committee)

Optical Society of America – S. Lätt (student member)

Royal Astronomical Society – J. Einasto (associated member)

Ultraviolettkiirguse, osooni ja aerosoolide uurimise koordineerimise Eesti Nõukogu – K. Eerme, U. Veismann

Õpetatud Eesti Selts – U. Peterson, T. Viik

Working Group 4 of COST 726 Action – S. Lätt

11 Teaching and Popularizing Õppetöö ja popularíseerimine

11.1 Lecture courses and seminars Loengukursused ja seminarid

11.1.1 Astronomy Astronoomia

The Equations of Mathematical Physics *Matemaatilise füüsika võrrandid* – T. Viik, University of Tartu.
The Physics of the Universe / *Universumi füüsika* – T. Viik, Tartu University.
Theoretical Astrophysics / *Teoreetiline astrofüüsika* – T. Viik, Tartu University.
Global Physics, *Globaalfüüsika* – M. Gramann together with H. Ohvril, K. Tarkpea and O. Tihhonova, University of Tartu.
Advanced Seminar of Theoretical Physics Teoreetilise füüsika eriseminar – P. Tenjes, University of Tartu.
Physics of Stellar Systems and Galaxies Tähesüsteemide ja galaktikate füüsika – P. Tenjes, University of Tartu.
Methods of Mathematical Physics Matemaatilise füüsika meetodid – P. Tenjes, University of Tartu.
Microworld Physics Mikromaailma füüsika – P. Tenjes, University of Tartu.
Seminar in Astrophysics Astrofüüsika seminar – J. Laur together with T. Liimets and P. Tenjes, University of Tartu.
Astronomy Course for the Nõo High School *Astronoomia kursus Nõo Reaalgümnaasiumi 12. klassidele* – K. Annuk, L. Leedjärv, E. Tempel, T. Viik.

11.1.2 Atmospheric physics Atmosfäärifüüsika

Introduction to Geophysics Sissejuhatus geofüüsikasse – K. Eerme, University of Tartu.
Environmental Science Keskkonnaõpetus – K. Eerme, University of Tartu.
Measurements and Measurement Uncertainty Mõõtmised ja mõõtemääramatused – E. Jakobson, University of Tartu (One general course and two separate courses for two different smaller groups of students).
Measurement Data Processing Mõõtmistulemuste töötlemine – E. Jakobson, University of Tartu.
Introduction to Probability and Statistics *Tõenäosusteooria* – E. Jakobson together with R. Rõõm, University of Tartu.
Graphical Programming Visuaalprogrammeerimine – Aivo Reinart, University of Tartu.
Embedded Systems Manussüsteemid – Aivo Reinart, University of Tartu.
Real-time Systems Reaalajasüsteemid – Aivo Reinart, University of Tartu.

Practical Course on Embedded Systems Manussüsteemide praktikum – Aivo Reinart , University of Tartu.

Environmental Remote Sensing Keskkonnakaugseire – K. Alikas, A. Kodar, T. Nilson, J. Pisek, University of Tartu.

Remote Sensing of Vegetation Taimkatte kaugseire – T. Nilson, University of Tartu.

Fundamentals of Remote Sensing Kaugseire alused – U. Peterson, University of Tartu.

Environmental Monitoring Keskkonnaseire – U. Peterson, Estonian University of Life Sciences.

Modelling of Environmental Processes and Spatial Analysis Looduslike protsesside modelleerimine ja ruumianalüüs – U. Peterson together with A. Kiviste, Estonian University of Life Sciences.

Remote Sensing in Nature Looduse kaugseire – M. Lang, Estonian University of Life Sciences.

Databases of Nature Resources Loodusressursside andmebaasid – M. Lang, Estonian University of Life Sciences.

Geographic Information Systems Geograafilised Informatsioonisüsteemid – U. Peterson and M. Lang, Estonian University of Life Sciences.

Quality Management I Kvaliteetjuhtimine I – M. Noorma, University of Tartu.

Quality Management II Kvaliteetjuhtimine II – M. Noorma, University of Tartu.

Space Technology Kosmosetehnoloogia alused – M. Noorma together with K. Voormansik and U. Kvell, University of Tartu.

*Project and Quality Management*Projekti- ja kvaliteedijuhtimine – Mart Noorma, University of Tartu.

Military Technologies Militaar- ja sisekaitsetehnoloogiad – Mart Noorma, University of Tartu.

Seminar on Space and Military Technologies Kosmose- ja militaartehnoloogia seminar – M. Noorma together with U. Kvell, University of Tartu.

Space Technology Project Kosmosetehnoloogia projekt – M. Noorma together with S. Lätt, University of Tartu.

11.2 Popular lectures Populaarteaduslikud loengud ja esinemised

11 intervjuud raadiole ja televisioonile – T. Viik.

152 planetaariumietendust Tartu Tähetornis – A. Puss.

Planetaariumietendused püsiplanetaariumis (Teaduskeskus AHHAA, 20.01.2012) – A. Puss.

Päikese aktiivsusest ja magnettormidest (otseintervjuu Raadio Kuku saatele "Saade", 24.01.2012) – L. Leedjärv.
Avalik vaatlusõhtu (Tartu Tähetorn, 26.01.2012) – A. Puss.
Päikese aktiivsusest ja magnettormidest (Labor, Vikerraadio, 29.01.2012) – L. Leedjärv.
Avalik vaatlusõhtu (Tartu Tähetorn, 01.02.2012) – A. Puss.
Kosmoselendude mõju inimesele (SA Tartu Ülikooli Kliinikum, 01.02.2012) – T. Viik.
Kosmoselendude mõju inimesele (Tallinna kopsuarstid, 02.02.2012) – T. Viik.
Inimkonda ähvardavad ohud kosmosest (Pärnu Rotary klubi koosolek, Pärnu, 06.02.2012) – A. Reinart, M. Noorma.
Kosmosevõidujooks XXI sajandil: nanosatelliitide ajastu (Tartu Tähetorni Astronoomiaring, 07.02.2012) – M. Noorma, U. Kvell.
Vesi väljaspool Maad (Eesti Veeühing, 28.02.2012) – T. Viik.
Üheksa aastat raha jagamas (Teaduskompetentsi Nõukogu ja Eesti Teadusfondi lõpukonverents, 29.02.2012) – T. Viik.
Kuidas ehitada Universumit? (Tartu Tähetorni Astronoomiaring, 06.03.2012) – T. Sepp.
Huviõhtute sari "Klassikalised planeedid": Merkuuri vaatlemine (Tartu Tähetorn, 07.03.2012) – A. Puss.
Päikese aktiivsusest ja magnettormidest (otseintervjuu Raadio Kuku saatele Ärataja, 09.03.2012) – L. Leedjärv.
Avalik vaatlusõhtu (Tartu Tähetorn, 13.,20.,21.03.2012) – A. Puss.
Huviõhtute sari "Klassikalised planeedid": Jupiteri vaatlemine (Teaduskeskuse AHHAA katusel, 14.03.2012) – A. Puss.
Imeline vesi (Tartu Tähetorni Astronoomiaring, 20.03.2012) – J. Pelt.
Teleskoobid (Teaduslaager "Astronoomiakool Tartu Tähetornis", Tartu Tähetorn, 21.03.2012) – A. Puss.
Kaugvaatluste läbiviimine (Teaduslaager "Astronoomiakool Tartu Tähetornis", Tartu Tähetorn, 22.03.2012) – J. Laur.
Pulsaritest ja neutrontähtedest (Loodusajakiri, Raadio Kuku, 22.03.2012) – L. Leedjärv.
Teleskoobid (Raadio 2 saade "Puust ja punaseks", 23.03.2012) – T. Liimets.
Uusi tulemusi ja ideid täheatmosfääride füüsikast ja modelleerimisest (Eesti Füüsika päevad, Tartu, 23.03.2012) – A. Sapar.
Alternatiiv tumekosmoloogia paradigmale (Eesti Füüsika päevad, Tartu, 23.03.2012) – A. Sapar.
Huviõhtute sari "Klassikalised planeedid": Marsi vaatlemine (Teaduskeskuse AHHAA katusel, 28.03.2012) – A. Puss.
Avalik vaatlusõhtu (Tartu Tähetorn, 10.,11., 27.04.2012) – A. Puss.
Huviõhtute sari "Klassikalised planeedid": Veenuse vaatlemine (Tartu Tähetorn, 11.04.2012) – A. Puss.

Kosmiliselt lahe tudengiteadus (Tallinna Reaalkooli teaduspäev, Tallinn, 12.04.2012) – M. Noorma.

Mis loom on astronoom? (Tallinna Reaalkooli teaduspäev, Tallinn, 12.04.2012) – T. Liimets.

Mis loom on astronoom? (Kohila Gümnaasium, Kohila, 12.04.2012) – T. Liimets.

Astrofotograafia (Tartu Tähetorni Astronoomiaring, 03.04.2012) – T. Eenmäe.

Päike ja teised tähed tumedas Universumis (Sänna Kultuurimõis, Sänna, 14.04.2012) – L. Leedjärv.

Arthur Stanley Eddington – teoreetilise astrofüüsika rajaja (Tartu Tähetorni Astronoomiaring, 17.04.2012) – T. Viik.

Huviõhtute sari "Klassikalised planeedid": Saturni vaatlemine (Teaduskeskuse AHHAA katusel, 02.05.2012) – A. Puss.

Eestlased ESA kosmoseprojektis Gaia (Püramiiidi tipus, ETV, 13.05.2012) – L. Leedjärv.

Avalik vaatlusõhtu (Muuseumiöö Tartu Tähetornis, 19.05.2012) – A. Puss.

Taevamehhaanika (Tartu Tähetorni Astronoomiaring, 22.05.2012) – A. Puss.

Mis on eksoplaneedid? (Tartu Lasteülikool, 01.06.2012) – T. Viik.

Avalik vaatlusõhtu, Veenuse üleminek Päikesest (Tartu Tähetorn, 06.06.2012) – A. Puss.

Intervjuu Vikerraadio saatele "Labor" (10.06.2012) – T. Liimets.

Tänapäevane teleskoobivaatlus (Projekt "Innovaatiline Ida-Virumaa", Teaduskooli suvelaager, Põlvamaa, 29.06.2012) – T. Liimets.

Kilde vanast Rohuneemest (Rohuneeme külapäev, 30.06.2012) – T. Viik.

Planetaariumietenduse planetaariumiga Starlab (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 10.08.2012) – A. Puss.

Universumi struktuur (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 10.08.2012) – J. Einasto.

Kauged galaktikad (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 11.08.2012) – R. Kipper.

Kosmoloogilised simulatsioonid (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 11.08.2012) – T. Sepp.

Galaktikate filamendid (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 11.08.2012) – E. Tempel.

Nobelleeritud supernoovad ja tumeenergia (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 12.08.2012) – E. Tempel.

Kõige viimased uudised (Astronoomiahuviliste XVII üle-Eestiline kokkutulek, Lüllemäe, 14.08.2012) – J. Pelt.

Avalik vaatlusõhtu (Tartu Tähetorn, 04.,05.,21., 28.09.2012) – A. Puss.

BBC filmi "Kõiksus" (Everything) kommenteerimine (ETV2, 18.09.2012) – L. Leedjärv.

Avalik vaatlusõhtu Teadlaste ööl (Tartu Observatoorium, 28.09.2012) – K. Annuk, I. Kolka, M. Ruusalepp, T. Tuvikene, E. Tempel, J. Vennik.

Reaalteadlaste põnev elu (Jaan Poska Gümnaasiumi teaduspäev, 02.10.2012) – M. Noorma.

Sputniku eelloost: Peenemündest Bajkongõrini (Tartu Tähetorni Astronoomiaring, 04.10.2012) – U. Veismann.

Virtuaalobservatooriumid (Tartu Tähetorni Astronoomiaring, 06.10.2012) – T. Sepp.

Katastroofid Päikesesüsteemis (VIII Geoloogia sügiskool, Nelijärve, 06.10.2012) – T. Viik.

Kas Universum on sõbralik paik? (VII Geoloogia sügiskool, Nelijärve, 06.10.2012) – L. Leedjärv.

Kohtumised Ernst Julius Öpikuga (Klaverifestival, Tartu, 09.10.2012) – J. Einasto.

Nobelleeritud supernoovad (Tartu Tähetorni Astronoomiaring, 16.10.2012) – E. Tempel.

Meie kosmiline kodu (Nõo Põhikool, 18.10.2012) – L. Leedjärv.

Elav raamat kosmoseteadlase/õppejõu/juhi elukutsest (Võru noorte karjääripäev Elläv Kiräkotus, Võru, 18.10.2012) – M. Noorma.

Uued eksoplaneedid mitmiktähtede juures (Labor, Vikerraadio, 21.10.2012) – L. Leedjärv.

Elu vanas peahoones (Renoveeritud Tartu Observatooriumi peahoone avamine, 22.10.2012) – T. Viik.

Avalik vaatlusõhtu (Tartu Tähetorn, 22.10.2012) – A. Puss.

Kuidas lennata kosmosesse (Narva Lasteülikool Tallinnas, Tallinn, 23.10.2012) – M. Noorma.

Galaktikate teke (Autumn School of Exact Sciences by EPS, Voore, Estonia, 26.10.2012) – P. Tenjes.

Elu võimalikkusest Päikesesüsteemis (Sänna Kultuurimõis, 16.11.2012) – T. Viik.

Avalik vaatlusõhtu (Tartu Tähetorn, 19.11.2012) – A. Puss.

Elu võimalikkusest Päikesesüsteemis (Nõmme Vanameeste Klubi, 11.12.2012) – T. Viik.

Viimased inimesed Kuul 40 aastat tagasi (intervjuu Vikerraadio saatele Stuudios on..., 11.12.2012) – L. Leedjärv.

Päikese aktiivsusest (Intervjuu saatele "Pealtnägija", 12.12.2012) – T. Viik.

KolmeDok: Kui reedel lõpeb maailm (Intervjuu TV3-le "maailmalõpu" teemal, 17.12.2012) – L. Leedjärv.

Avalik vaatlusõhtu (Tartu Tähetorn, 17.12.2012) – A. Puss.

Jõulutähest, päikesetormidest ja muudest taevastest asjadest (Jõulustuudio, Pereraadio, 20.12.2012) – L. Leedjärv.

Avalik vaatlusõhtu talve alguse puhul (Tõravere, 21.12.2012) – K. Annuk, T. Eenmäe, A. Puss, M. Ruusalepp, E. Tempel, T. Tuvikene, J. Vennik.

11.3 Theses defended, supervised and refereed by the staff of the Observatory Observatooriumi töötajate poolt kaitstud, juhendatud ja oponeeritud väitekirjad

11.3.1 Ph.D. theses Doktoritööd

T. Tuvikene: CCD Photometry of Variable Stellar Sources: Data Reduction Workflow, Assessment of Accuracy, Case Studies. Muutlike täheliste allikate CCD-fotomeetria: andmetöötluse töövoog, täpsuse hindamine, juhtumiuuringud. Ph.D. Thesis, Vrije Universiteit Brussel (Belgium).
Defence Kaitsmine: 17.08.2012.
Supervisor Juhendaja: Christiaan Sterken (Vrije Universiteit Brussel).
Jury members Komisjoni liikmed: Prof. Dr. Catherine De Clercq (Vrije Universiteit Brussel), Prof. Dr. Jean-Pierre De Greve (Vrije Universiteit Brussel), Prof. Em. Dr. Walter Van Rensbergen (Vrije Universiteit Brussel), Prof. Dr. Philippe Cara (Vrije Universiteit Brussel), Prof. Dr. László Szabados (Konkoly Observatory, Hungary), Dr. Herman Hensberge (Royal Observatory of Belgium), Dr. Christiaan Sterken (Vrije Universiteit Brussel).

11.3.2 M.Sc. theses Magistritööd

K. Eerme – *A. Vastsenko*: Influence of Cloudiness on the Spectral Composition of Ground-Level Ultraviolet Radiation. Pilvisuse mõju maapinnani jõudva ultraviolettkiirguse spektraalsele koostisele (M. Sc.), Tallinn University of Technology.

M. Lang – *O. Looga*: Accuracy Assessment of Digital Land Cover Maps. Digitaalsete maakattekaartide täpsuse hindamine (M. Sc), Estonian University of Life Sciences.

M. Noorma, V. Allik, R. Vendt – *M. Tverdokhlib*: Sun Sensors Angle Testing for ESTCube-1 Satellite. Päikese sensorite nurga testimine ESTCube-1 satelliidi jaoks (M.Sc.), University of Tartu.

E. Tempel – *R.Kipper*: Modelling Gas Kinematics of Distant Galaxies. Kaugete galaktikate gaasi kinemaatika modelleerimine (M. Sc.), University of Tartu.

J. Vennik – *T. Kuutma*: Study of Star Populations in the NGC 3665 Group Using Broadband Photometric Methods. Tähepopulatsioonide uurimine NGC 3665 galaktikagrupis lairiba fotomeetria meetodil (M.Sc.), University of Tartu.

U. Peterson – *K. Järve*: Assessment of Species Composition of Forest Stands with Passive Remote Sensing Methods in the Optical Spectral Region. Puistu koosseisu hinnang spektri optilises piirkonnas passiivse kaugseire vahenditega (M. Sc.) Estonian University of Life Sciences.

11.3.3 B.Sc. theses Bakalaureusetööd

K. Eerme, M. Noorma – *K. Prants*: Overview of Ionospheric Studies and Preparations for Joining the QB50 Network. Ülevaade senistest ionosfääri uuringutest ja ettevalmistused QB50 võrgustikuga liitumiseks (B.Sc.), University of Tartu.

T. Nilson – *M. Nikopensius*: The Dependence of Radiation Temperature on Stand Age in Järvselja Forests. Järvselja metsade kiirgustemperatuuri olenevus puistu vanusest (B. Sc.), University of Tartu.

A. Reinart, K. Uudeberg – *E. Kangro*: Validation of MERIS/Envisat Water Quality Products on Estonian Lakes. MERIS/Envisat vee kvaliteedi tulemite valideerimine järvede näitel. (B.Sc), University of Tartu.

U. Peterson, R. Aunap (TÜ) – *K. Narusk*: Mapping Coastline and Macrophytes of Lake Peipsi With Medium Spatial Resolution Satellite Images. Peipsi järve rannajoone ja suurtaimestiku kaardistamine keskmise ruumilise lahutusega satelliidipiltidelt (B.Sc.), University of Tartu.

U. Peterson, R. Aunap (TÜ) – *K. Raabe*: Mapping coastal reeds with medium resolution satellite imagery. Mereranna roostike kaardistamine keskmise ruumilise lahutusega satelliidipiltidelt (B.Sc.), University of Tartu.

E. Tempel – *O. Tihhonova*: Galaxy NGC 6384 Model. Galaktika NGC 6384 modelleerimine. (B. Sc.), University of Tartu.

T. Tuvikene – *T. Tuvi*: Analysis of Light Curves of Massive Binary Stars. Massiivsete kaksiktähtede heleduskõverate analüüs. (B.Sc.), University of Tartu.

U. Kvell, A. Slavinskis – *E. Kulu*: EstCube-1 Spin Control Using Electromagnetic Actuators. EstCube-1 pöörlemise juhtimise kontroll elektromagnetiliste aktuaatorite abil. (B.Sc.), University of Tartu.

V. Allik, T. Eenmäe, I. Ansko – *H. Kuuste*: ESTCube-1 Tether End Mass Imaging System Design and Assembly. ESTCube-1 satelliidi pardakaamera disain ja teostus. (B.Sc.), University of Tartu.

V. Allik, M. Noorma – *T. Uiboupin*: Design and development of automatic coil winding equipmen for ESTCube-1 electromagnetic actuators. ESTCube-1 elektromagnettõukurite automatiseeritud kerimisseadme arendus ja testimine. (B.Sc.), University of Tartu.

V. Allik, S. Lätt, T. Eenmäe – *I. Sünter*: Radiation Tolerant Hardware Design for EstCube-1 Command and Data Handling System. ESTCube-1 satelliidi radiatsioonikindla juhtimissüsteemi elektroonika disain. (B.Sc.), University of Tartu.

V. Allik, T. Eenmäe – *M. Neerot*; Demodulation of FSK radio signal using software-defined radio. Raadiosignaali demoduleerimine tarkvaralise raadio basil.(B.Sc.), University of Tartu.

11.3.4 Diplomitööd Diplomitööd

V. Allik – *K. Kivistik*: Ingliskeelnepealkiri. Tudengisatelliidi maajaama eelselektromoodul , Eesti Lennuakadeemia.

11.3.5 Refereeing of theses Oponeerimine

M. Lang – *A. Võsu*: Biomass Production in 20–45 Years Old Gray Alder Stands. Hall-lepikute bioproduktioon 20-45 aastastes puistutes (M.Sc.), Estonian University of Life Sciences.

M. Lang – *D. Kitsing*: Optimizing John Deere Forest Harvester Performance with TimberlinkTM Software. John Deere metsalangetusmasina jõudluse parandamise analüüs TimberlinkTM tarkvara abil (B.Sc.), Estonian University of Life Sciences.

M. Lang – *L. Punt*: Export and Import of Forest Products in Estonia 2006–2011. Metsa kõrvalsaaduste eksport ja import aastatel 2006–2011 (B.Sc.), Estonian University of Life Sciences.

J. Kuusk – *M. Tverdokhlib*: Sun Sensors Angle Testing for ESTCube-1 Satellite. ESTCube-1 satelliidi päikesesensori testimine (M.Sc.), University of Tartu.

U. Veismann – *A. Vastsenko*: Influence of Cloudiness on the Spectral Composition of Ground-Level Ultraviolet Radiation. Pilvisuse mõju maapinnani jõudva ultraviolettkiirguse spektraalsele koostisele (M.Sc.), Tallinn University of Technology.

U. Veismann – *K. Prants*: Overview of Ionospheric Studies and Preparation for Joining the QB50 Network. Ülevaade senistest ionosfääri uuringutest ja ettevalmistused QB50 võrgustikuga liitumiseks (B.Sc.), University of Tartu.

A. Kuusk (Pre-examiner) – *J. Suomalainen*: Empirical Studies on Multiangular, Hyperspectral and Polarimetric Reflectance of Natural Surfaces (Ph.D. in physics), University of Helsinki.

T. Viik – *M. Lust*: Assessment of Dose Components to Estonian Population. Eesti elanike doosikomponentide hindamine Ph.D.Thesis, University of Tartu.

T. Viik (Pre-examiner) – *A.K. Sarkar*: Polarized Radiative Transfer in Atmosphere Ocean Systems. Polariseeritud kiirguse levi süsteemis atmosfäär-ookean Ph.D.Thesis, University of North Bengal.

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