HARIDUS- JA TEADUSMINISTEERIUM
MINISTRY OF EDUCATION AND RESEARCH

TARTU OBSERVATOORIUMI AASTARAAMAT

2010

ANNUAL REPORT TARTU OBSERVATORY

TÕRAVERE 2011

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Eessõna

Tartu Observatooriumi aastaraamat ilmub oma senises ilus ja uhkuses, et kajastada siinsete inimeste töid ja tegemisi 2010. aastal. Kuigi pealtnäha on kõik endine – Tõraveres jätkatakse riiklikult finantseeritavaid uuringuid Universumi, tähtede ja maapealse keskkonna kohta, on muutused juba alanud. Üksteist aastat observatooriumit juhtinud Laurits Leedjärv otsustas pühenduda teadustööle ja uue direktorina püüan 200-aastase ajalooga Tartu Observatooriumi tegevust suunata. Tunnen suurt aukartust ja vastutust, kuid olen veendunud, et jätkame ühtse meeskonnana.

2010. a mais toimus Eesti teaduse rahvusvaheline evalveerimine. Vastvalitud teadusnõukogu eestvedamisel võtsime vastu loodusteaduste ja tehnoloogia ning bio- ja keskkonnateaduste komisjonid. Tulemus oli suurepärane – kõikide kriteeriumide alusel hinnati observatooriumi positiivselt. Euroopa Liidu struktuuritoetuste raames rahastatavates teadusaparatuuri kaasajastamise taotlusvoorudes saime toetust täielikult taotletud mahus kõigile oma projektidele! Kuigi üldisest majandusolukorrast tingituna olid riigieelarvest meile eraldatud summad natuke väiksemad kui eelneval aastal, hankisime lisa kahe uue Euroopa Liidu 7. raamprogrammi projekti käivitamisega: veekaugseire projekt "WaterS" ja tehnoloogia projekt "ESAIL".

Kogu observatooriumi pere on uhke, et meie kolleeg Enn Saar valiti akadeemikuks ja Mari Burmeister ning Indrek Vurm kaitsesid edukalt doktoriväitekirju. Tähtis hetk oli 22. septembril 2010. a, kui Pariisis kirjutati alla Euroopa Kosmoseagentuuri ja Eesti Vabariigi vaheline PECS leping. See tähendab uusi võimalusi koostööks meile kõigile. Kuidas me neid võimalusi ära kasutame, näitab aeg. Mis sellest, et meie rahastamine on projektipõhine, meie tegevused on eesmärgipärased ning põhinevad teadmistel ja uudsetel ideedel.

Anu Reinart
Direktor

Tõraveres
veebruar 2011

Foreword

The annual report about space research and development at Tartu Observatory is in your hands as usual. In general, these activities have been carried out according to plans on the basis of state financing for astronomy, cosmology and remote sensing. However, some big changes also took place – Laurits Leedjärv, who has led the observatory for 11 years, decided to concentrate on science, supervision of doctoral students and space policy. Now I will do my best as the next director of the 200 years old Tartu Observatory. This is a great honour and responsibility. However, I am confident that as a team we will continuously improve in solving challenging research tasks, inspiring students and creating awareness about space. How can I be so sure? The answer lays partly inside this report.

Also, in May 2010, Estonian research was internationally evaluated. Tartu Observatory's new Research Council prepared to introduce our activities for two commissions – Natural Science & Environment and Biological Science & Technology. The results were great – we earned only positive credits in all criteria. We also got funding for all our proposed ideas for the new research instruments and infrastructure under the national calls related to EU Structural Funds. Research funding from the government was slightly lower than the last year because of the general economical situation. Fortunately we were able to start new projects funded by EU Framework 7: WaterS for improving water remote sensing methods and ESAIL for developing innovative concept of electric solar sail.

We all are proud of Enn Saar, who became a new member of the Estonian Academy of Sciences. Mari Burmeister and Indrek Vurm defended their doctoral theses. For all space community in Estonia the great day was 22nd September 2010, when PECS Charter was signed between Estonia and European Space Agency. This offers new opportunities for enlarged international collaboration in the field of high technology and space for research institutes and especially enterprises. How we shall answer to this challenge will be clear only in future. I hope that even as the funding is project-based, our actions will be based on knowledge and great ideas.

Anu Reinart
Director

Tõravere
February 2011

1 Ülevaade

1.1 Uurimisteemad ja grandid

1.1.1 Sihtfinantseeritavad teadusteemad

2010. aastal jätkus Tartu Observatooriumis (TO) kolme sihtfinantseeritava teadusteema täitmine.

- Tumeenergia, tumeaine ja struktuuri teke Universumis (teema juht E. Saar) – 223 691 EUR.
- Evolutsiooni hilisfaasis tähtede ja nende ümbriste vaatluslik ja teoreetiline uurimine (teema juht T. Kipper) – 280 521 EUR.
- Optiliselt keerukate looduskeskkondade kaugseire (teema juht A. Kuusk) – 60 115 EUR.

1.1.2 Eesti Teadusfondi grandid

Sihtasutus Eesti Teadusfond rahastas 9 granti:

- Grant 7115: A. Tamm – Ketasgalaktikate evolutsioon kosmoloogilistel ajaskaaladel – 3207 EUR.
- Grant 7137: K. Eerme – Päikese ultraviolettkiirguse spektraalne koostis maapinnal – 6136 EUR.
- Grant 7146: M. Gramann – Galaktikate evolutsioon ja tume energia paisuvas Universumis – 5644 EUR.
- Grant 7691: V.-V. Pustynski – Füüsikalised protsessid, statistilised omadused ja evolutsiooniline areng kuumade allkääbustega kaksiksüsteemides – 4602 EUR Tartu Observatooriumile.
- Grant 7725: A. Kuusk – Metsa peegeldusindikatriss – 18 407 EUR.
- Grant 7765: U. Haud – Nähtav ja varjatud aine galaktikates – 9816 EUR.
- Grant 8005: E. Saar – Valguskoonused: kosmiliste struktuuride areng – 17 179 EUR.
- Grant 8290: M. Lang – Kaugseire, metsanduslike andmebaaside ning metsakasvu ja -heleduse mudeli lõimimine pideva metsakorralduse süsteemi poolboreaalsete metsade jaoks – 10 225 EUR.
- V. Russak oli üks põhitäitja TÜ dotsendi H. Ohvrili grandis nr. 7347 (3346 EUR Tartu Observatooriumile).

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

Alates 2008. aastast annab Eesti Teadusfond välja ka järeldoktorite grante ja nn mobiilsusgrante. Neli taotlejat töötasid 2010. aastal Tartu Observatooriumis:

- ETF järeldoktori grant JD 131: M. Saal – Üldistatud gravitatsiooniteooriate teoreetilised ja kosmoloogilised aspektid – 23 656 EUR.
- ETF järeldoktori grant JD 189: E. Jakobson – Atmosfääri optiliste omaduste muutlikkus Läänemere regioonis kaugseire rakenduste seisukohalt – 24 926 EUR.
- Mobiilsusgrant ERMOS-32 (alates 31.10.2010): J. Pisek – Taimkatte grupeerumisindeksi määramine satelliidisensori MISR mitme vaatesuuna mõõtmisandmetest – 3732 EUR.
- Mobiilsusgrant ERMOS-35 (alates 31.10.2010): G. Hütsi – Kosmiline suuremastaabiline struktuur: efektiivne vahend fundamentaalfüüsika kontrolliks – 3732 EUR.

1.1.3 FP7 projektid

- Jätkus EL 7. raamprogrammi projekt EstSpacE (Eesti kosmoseuuringute ja -tehnoloogia võimekuse avamine partnerluse kaudu tipptasemel Euroopa teadusasutustega). Projekti juht on A. Reinart, kestvus kolm aastat (01.03.2008–28.02.2011), Euroopa Komisjoni finantseering kokku *ca* 1.1 MEUR, millest 2010. aastal laekus 275 060 EUR. Projekti tegevustest 2010. aastal tuleb juttu Aastaraamatu vastavates osades.
- Algas EL 7. raamprogrammi projekt "Täiustatud vee kvaliteedi parameetrite määramine optilisest signatuurist strateegilise partnerluse abil" (01.06.2010–31.05.2014): Konsortsiumi koordinaator A. Reinart – 318 844 EUR TO-le.
- Algas EL 7. raamprogrammi projekt "Elektrilise päikesepurje tehnoloogia" (01.12.2010–30.11.2013): TO koordinaator M. Noorma – 141 926 EUR TO-le.

1.1.4 Muid projekte ja lepinguid

- Satelliitide tulemite parandamine kasutamiseks suurte järvede kaugseires. Finantsprogramm EMP-1: A. Reinart – 17 203 EUR.
- Vegetatsiooniperioodi ja sensori ruumilise lahutusvõime mõju k-lähima naabri meetodil lehepinnaindeksi kaardistamisele ja puuliikide eristamisele hemiboreaalsetes metsades. OASIS projekt nr 412: M. Lang.
- Ventspils and Tartu cooperation in Space Technologies related Research and Training. Norwegian grants No. 8-29/LV0017/09: A. Reinart – 24 344 EUR.
- Deklareeritud põllupindade kontroll kaugseirevahenditega. Teadus- ja arendusleping PRIA-ga: U. Peterson – 2556 EUR.
- Satelliidiandmete kasutamine vetikate massiõitsengute hindamiseks ja prognoosimiseks. Teadus-arendusleping Rootsi Meteoroloogia ja Hüdroloogia Instituudiga, Leping nr. 2007/2213/43, 2009–2010: TO koordinaator A. Reinart – 7167 EUR.

- Prognoositav kliimamuutus ja selle mõju Euroopa metsandusele, COST projekt FP0703 (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.
- Riikliku keskkonnaseire programmi allprogramm "Eesti maastike muutuste uuringud ja kaugseire": U. Peterson – 7558 EUR.
- Kosmoseterminoloogia arendamine. Eesti Terminoloogia Ühing: U. Veismann – 639 EUR.

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

1.2 Töötajad

1. veebruarist 2010 töötab EstSpacE projekti raames erakorralise teadurina Viljo Allik.

1. aprillil 2010 asus taimkatte seire töörühma vanemteadur Anu Reinart tööle Tartu Observatooriumi direktorina. Senine direktor Laurits Leedjärv jätkab tööd Tartu Observatooriumi astrofüüsika osakonna tähefüüsika töörühma vanemteadurina. Samast ajast on ta ka astrofüüsika osakonna juhataja.

31. märtsil 2010 toimus peahoone saalis pidulik koosolek, kus 11 aastat direktorina töötanud Laurits Leedjärv tänas kõiki kolleege, koostööpartnereid ja ülemusi. Meenutati möödunud aastaid ja sooviti jõudu uuele direktorile.

1. aprillist töötab vanemraamatupidajana Evelin Kelner.

13. maist lahkus töölt koristaja Mare Linnamägi. 30. juunil lõpetati tööleping insener Ingrid Enkvistiga. 1. juulist 2010 on taimkatte seire vanemteadur Matti Mõttus kolmeks aastaks Helsingi Ülikooli järeldoktor. 2. augustist asus tööle projektijuht Ain Jõesalu. 20 augustil lõpetati tööleping teadur Voldemar Harvigiga.

1. septembrist asus insenerina tööle Elar Asuküll. 1. oktoobrist liitus EstSpacE meeskonnaga Saksamaalt pärit noor atmosfäärifüüsik Sebastian Traud, kes õpib Tartu Ülikoolis doktorantuuris. Insenerina töötab alates 1. detsembrist Johan Kütt, kes tuli tagasi Eestisse pärast õpinguid Inglismaal, Suroey Kosmosetehnoloogia Ülikoolis.

Tähefüüsika osakonna teadur Mari Burmeister kaitses 1. oktoobril 2010 Tartu Ülikoolis edukalt oma doktoriväitekirja. Ka teoreetilise astrofüüsika osakonna erakorraline teadur Indrek Vurm kaitses 22. oktoobril 2010 Oulu Ülikoolis edukalt doktoriväitekirja.

Kõigi muutuste tulemusena oli 1. jaanuaril 2011 Tartu Observatooriumis tööl 79 inimest, neist 47 teadustöötajat ja 10 teadustööd tegevat inseneri.

Tartu Observatooriumi neli direktorit 27. mail 2010 peahoones, direktori kabinetis. Seisavad vasakult: Laurits Leedjärv (1999–2010), Väino Unt (1973–1985), Tõnu Viik (1985–1999), ees istub Anu Reinart (2010–). Four directors of Tartu Observatory on 27th of May 2010. From the left: Laurits Leedjärv (1999–2010), Väino Unt (1973–1985), Tõnu Viik (1985–1999), Anu Reinart (2010–) is sitting.

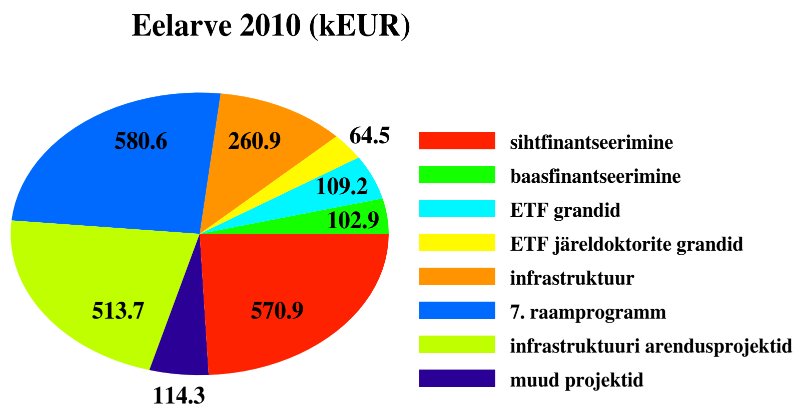
1.3 Tunnustused

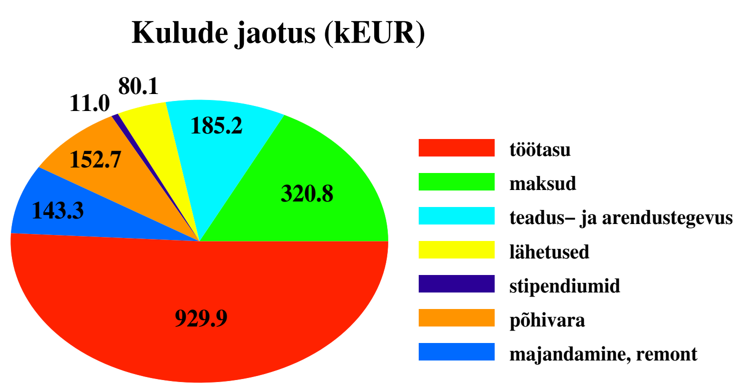
- Akadeemik Jaan Einasto valiti Tartu Ülikooli audoktoriks.
- Eesti Teaduste Akadeemia valis akadeemikuks astronoomia alal Tartu Observatooriumi kosmoloogia osakonna juhataja, vanemteadur Enn Saare.
- Eesti Teaduste Akadeemia autasustas Laurits Leedjärve oma medaliga.
- Eesti Meteoroloogia ja Hüdroloogia Instituut autasustas Viivi Russakut EMHI aumärgiga.
- Eesti Maaülikool autasustas Tiit Nilsonit teenete medaliga.
- Jaan-Mati Punningu sihtkapitali stipendiumi sai Krista Alikas.

1.4 Eelarve

Riigieelarvest eraldati Tartu Observatooriumile 2010. aastal 1110.95 kEUR (17.382 MEEK). Lisaks laekus *ca* 1208.61 kEUR (18.910 MEEK) mitmesugustest koostööprojektidest ja lepingutest, mida on nimetatud osades 1.1.3 ja 1.1.4, ning observatooriumi infrastruktuuri renoveerimise projekti arvelt. Osa projektide tulusid kanti üle 2011. aastasse.

Tulud ja kulud jagunesid järgnevalt:





Observatooriumi teadlaste (sh EstSpacE projekti teadlased) keskmine töötasu 2010. a lõpul oli 1178 EUR (18 434 EEK) kuus.

1.5 Aparatuur ja seadmed

- Euroopa Liidu struktuuritoetuste "Majanduskeskkonna arendamise rakenduskava" alameetmest "Teadus- ja arendusasutuste teadusaparatuuri ja seadmete kaasajastamine" rahastati Tartu Observatooriumi kahte projekti:
  1. TAP13-1 – 1,5-meetrise teleskoobi moderniseerimine maksumusega 184 029 EUR. Teleskoobi moderniseerimine toimub 2011. aastal.
  2. TAP13-2 – Kaugseire etalonide komplekslabor kogumaksumusega 183 987 EUR. Taimkatte seire töörühma eestvedamisel rajati Järvseljale lennuki- ja satelliidimõõtmiste peegeldusetalon. Osteti ka spektraalse kirkuse labori-peegeldusetalonid.

Peegeldusetalon Järvseljal. A reflection etalon at the Järvselja test site.

- Teaduse väikesemahulise infrastruktuuri kaasajastamiseks:
  1. osteti kaugseire sihtfinantseeritava teema raames ksenoonlambiga kiirgusallikas spektroradiomeetrite kalibreerimiseks, erinevate karakteristikute määramiseks ja mõõtemääramatuse hindamiseks UV, nähtavas ja lähisinfrapunases piirkonnas. Kogu komplekti maksumus oli 23 692 EUR.
  2. osteti tähefüüsika sihtfinantseeritava teema raames difraktsioonvõrede komplekt 1,5 m teleskoobi spektrograafi jaoks maksumusega 16 261 EUR. Uued võred vahetavad välja mitukümmend aastat kasutusel olnud võredekomplekti, mille efektiivsus on peegelkihi tuhmumise tõttu langenud. Uute võrede abil on võimalik tõsta spektraalvaatluste efektiivsust.

3. osteti kosmoloogia sihtfinantseeritava teema raames uus andmebaasiserver maksumusega 23 679 EUR.

Kõigi nimetatud projektide puhul on observatooriumi omaosalus 5%.

Ärimees Raivo Hein kinkis Tartu Observatooriumile teleskoobikomplekti, mis koosneb 12,5-tollisest teleskoobist PlaneWave ja monteeringust Paramount ME. Kingitud komplekt on võimalik käima panna täisautomaatse fotomeetrilise robotteleskoobina, komplekti töösse rakendamine jääb 2011. aastasse. Selline robotteleskoop võimaldab ära kasutada Eestis levinud osaliselt selgeid öid ning sellega tunduvalt tõsta fotomeetriliste aegridade ajalist tihedust.

1.6 Teadusnõukogu töö

Pärast uue direktori tööleasumist uuendati teadusnõukogu koosseisu. 26. aprillil 2010. aastal toimus teadustöötajate üldkoosolek, kus valiti teadusnõukogu 8 liiget. Koosolekust võttis osa 48 hääleõiguslikku töötajat. Uue teadusnõukogu koosseisus on 12 liiget ja selle kinnitas Haridus- ja Teadusminister oma käskkirjaga nr. 459 28. mail 2010.

Uue teadusnõukogu koosseis on järgmine:

Anu Reinart – Tartu Observatooriumi direktor, teadusnõukogu esimees,
Gert Hütsi – järeldoktor, teadustöötajate valitud liige,
Ene Kadastik – Haridus- ja Teadusministeeriumi teadusosakonna peaekspert,
Marco Kirm – Tartu Ülikooli Füüsika Instituudi direktor,
Andres Kuusk – vanemteadur, teadustöötajate valitud liige,
Laurits Leedjärv – vanemteadur, teadustöötajate valitud liige,
Mart Noorma – erakorraline vanemteadur, teadustöötajate valitud liige,
Martti Raidal – Keemilise ja Bioloogilise Füüsika Instituudi vanemteadur,
Enn Saar – vanemteadur, teadustöötajate valitud liige,
Antti Tamm – teadur, teadustöötajate valitud liige,
Elmo Tempel – teadur, teadustöötajate valitud liige,
Peeter Tenjes – vanemteadur, teadustöötajate valitud liige.

Teadusnõukogu pidas 10 koosolekut, kuulati järgmisi teaduslikke ettekandeid:

Jaanuar – *P. Tenjes*: Tolm galaktikates – ruumijaotus, temperatuur ja struktuur.
Veebruar – *A. Hirv*: Ajanihete mõõtmine kvasarite gravitatsioonilistest mitmikkujutistest.
Märts – *I. Ansko*: Kaugseire instrumentide parametriseerimine.
Aprill – *I. Vurm*: Kiirguslikest mehhanismidest gammasähvatustes.
Mai – *T. Eenmäe*: Kuumad B tähed – kiired pöörlejad?

September – *T. Sepp*: Galaktikate tekkimine ja arenemine paisuvas Universumis.

– *M. Aun*: Ultraviolettkiirguse spektraalsete dooside sõltuvus pilvisusest.

Muid teadusnõukogu tegemisi:

- 18. jaanuaril arutati "Tartu Observatooriumi astronoomia õpetamise ja populariseerimise tegevuskava aastateks 2010–2020". Eesmärk on suurendada Tartu Observatooriumi teaduspotentsiaali, parandada astronoomia õppimisvõimalusi ülikoolides, muuta astronoomia üliõpilaste jaoks atraktiivsemaks ja laiendada astronoomia ning sellega tihedalt seotud täppisteaduste populariseerimist Eestis. Kava edukust mõõdetakse astronoomias kaitstud teaduskraadide arvuga ja Tartu Observatooriumi külastatavuse suurenemisega ning observatooriumi tegevuse kajastatuse kasvuga meedias.
- 12. veebruaril toimus konkurss Tartu Observatooriumi direktori ametikohale. Ainuke kandidaat, vanemteadur Anu Reinart esitas oma tegevusprogrammi ja teadusliku nõukogu liikmed andsid sellele positiivse hinnangu. Nõutud dokumendid Anu Reinarti valimiseks direktori ametikohale esitati Haridus- ja Teadusministeeriumi juures töötavale teaduspoliitika komisjonile.
- 8. märtsil toimus konkurss teadurite ja vanemteadurite ametikohtadele. Vanemteaduriteks kosmoloogia erialal valiti Maret Einasto, Erik Tago ja Jaan Vennik. Teaduriteks kosmoloogia erialal valiti Elmo Tempel ja Lauri Juhan Liivamägi. Vanemteaduriteks astrofüüsika erialal valiti Tõnu Viik ja Indrek Kolka ning teaduriteks astrofüüsika erialal Mari Burmeister ja Anti Hirv.
- 26. märtsil kinnitati lõppenud ETF grantide lõpparuanded. Aruanded esitasid Indrek Kolka, Matti Mõttus, Jaan Pelt, Anu Reinart ja Tiit Nilson.
- 24. mail esitati kosmoloogia osakonna vanemteadur Enn Saare kandidatuur Eesti Teaduste Akadeemia akadeemikuks astronoomia erialal kandideerimiseks. Samal koosolekul arutati observatooriumi peahoone renoveerimise olukorda ja teadusnõukogu töökorda.
- 20. septembri koosolekul määrati kahele noorele inimesele stipendiumid. E.J. Öpiku nimelise stipendiumi sai TÜ doktorant Tiit Sepp ja J. Rossi nimelise stipendiumi TÜ doktorant Margit Aun. Toimus ka sihtfinantseeritavate teadusteemade jätkutaotluste arutelu ja kinnitamine. Kuna teemat "Optiliselt keerukate looduskeskkondade kaugseire" finantseeriti kolme aasta jooksul erandkorras ainult kolme põhitäitja mahus, siis otsustati teema peatada ja esitati uue teema "Taimkatte kvantitatiivne kaugseire" taotlus, mis on ühine koos Tartu Ülikooli Eesti Mereinstituudiga.

- 20. detsembril otsustati esitada Tiit Nilsoni kandidatuur riikliku teaduspreemia taotlemiseks elutöö valdkonnas ning Andres Kuuse, Mait Langi ja Joel Kuuse tööd teaduspreemia saamiseks täppisteaduste valdkonnas. Samuti kinnitati projektid teadusaparatuuri kaasajastamiseks 2011. aastaks. Võeti vastu otsus hakata järgmise aasta jaanuarist pidama ühiseid observatooriumi teadusseminare.

1.7 Suhted avalikkusega

Jätkuvalt külastas Tõraveret palju ekskursioone: 257 gruppi rohkem kui 6300 huvilisega. Ülevaate registreeritud ekskursioonidest saab observatooriumi koduleheküljelt.

Eriti suur oli külastatavus 24. septembri õhtul, kui oli rahvusvaheline Teadlaste Öö ja planeet Jupiteri ning teisi huvitavaid taevaseid objekte käis vaatamas umbes 500 inimest. Kasutuses oli neli teleskoopi: 1,5 m suur teleskoop, MEADE teleskoop ja kaks galileoskoopi. Traditsiooniliselt peeti astronoomia loenguid Nõo Reaalgümnaasiumi 12. klasside õpilastele.

Toimusid ka avalikud vaatlusõhtud ning väljasõit kaasaskantava teleskoobiga MEADE Tapa Gümnaasiumisse.

Eelmisel, Rahvusvahelisel Astronoomia Aastal, Kalju Annuki poolt komplekteeritud astronoomiaalaste piltide näitus oli populaarne ning seda eksponeeriti ka 2010. aastal:

- Puuetega Noorte Keskus Juks, Tallinn: 07.01.–28.02.2010.
- Nõo Raamatukogu, Tartumaa: 15.03.–30.04.2010.
- Türi Majandusgümnaasium, Türi: 02.11.–07.12.2010.

Kooliõpilaste poolt tehtud arvutijoonistuste pildid olid neljas kohas:

- Eesti Vabariigi Riigikogu, Tallinn: 11.01.–29.01.2010.
- Kännukuke Raamatukogu, Tallinn: 03.02.–10.03.2010.
- Dorpati Konverentsikeskus, Tartu: 12.04.–28.05.2010.
- Tartumaa Muuseum, Elva: 16.11.–31.12.2010.

Observatooriumi teadlaste arvukad populaarteaduslikud kirjutised on üksikasjaliselt ära toodud lk. 71, avalikud loengud ja intervjuud lk. 99.

Ilmus Tähetorni Kalender 2011 (87. aastakäik) ja juba traditsiooniline Tähistaeva Kalender 2011. 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 26.

2 Summary

2.1 Research projects and grants

2.1.1 Target financed projects

In 2010, 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) – 223 691 EUR,
- Observational and theoretical investigation of stars and their envelopes during advanced evolutionary phases (principal investigator T. Kipper) – 280 521 EUR,
- Remote sensing of optically complex natural environments (principal investigator A. Kuusk) – 60 115 EUR.

2.1.2 Estonian Science Foundation grants

The Estonian Science Foundation financed 9 grant projects from our Observatory:

- Grant 7115: A. Tamm – Evolution of disc galaxies on cosmological time scales – 3207 EUR.
- Grant 7137: K. Eerme – Spectral composition of the ground-level solar ultraviolet radiation – 6136 EUR.
- Grant 7146: M. Gramann – Evolution of galaxies and dark energy in the expanding Universe – 5644 EUR.
- Grant 7691: V.-V. Pustynski – Physical processes, statistical characteristics, and evolutionary changes in binary systems with hot subdwarfs – 4602 EUR to Tartu Observatory.
- Grant 7725: A. Kuusk – Angular distribution of forest reflectance – 18 407 EUR.
- Grant 7765: U. Haud – Visible and dark matter in galaxies – 9816 EUR.
- Grant 8005: E. Saar – Light cones: evolution of cosmic structures – 17 179 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 – 10 225 EUR.
- V. Russak participated in the grant 7347 led by H. Ohvril from University of Tartu (3346 EUR to Tartu Observatory).

Those amounts do not contain institutional overheads. The latter (20% of each grant) was transferred separately to the budget of the Observatory. The Estonian Science Foundation also financed two post-doc grants and two mobility grants:

- Post-doc grant JD 131: M. Saal – Theoretical and cosmological aspects of generalized gravitation theories – 23 656 EUR.
- 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-32: J. Pisek – Retrieving foliage clumping index from multi-angle MISR measurements – 3732 EUR.
- Mobility grant ERMOS-35: G. Hütsi – Large-scale structure of the Universe – a powerful probe of fundamental physics – 3732 EUR.

2.1.3 FP7 projects

- The European Commission 7th Framework Programme project EstSpacE (Expose the Capacity of Estonian Space Research and Technology through High Quality Partnership in Europe) was continued, with A. Reinart as the project leader (duration 01.03.2008–28.02.2011). Total financing by the EC is about 1.1 MEUR, of which 275 060 EUR was delivered in 2010. Main activities of the project in 2010 will be described in relevant chapters of the present Annual Report.
- A new FP7 project "Strategic partnership for improved basin-scale Water quality parameter retrieval from optical Signatures (WaterS)" (01.06.2010–31.05.2014) started: Consortium coordinator A. Reinart – 318 844 EUR to TO.
- A new FP7 project "Electric solar Sail Technology" (ESAIL) (01.12.2010–30.11.2013) started: coordinator from TO M. Noorma – 141 926 EUR to TO.

2.1.4 Some other projects and contracts

- Improving Satellite Remote Sensing Products for Large Lakes, EMP-1: A. Reinart – 17 203 EUR.
- Ventspils and Tartu cooperation in Space Technologies related Research and Training. Norwegian grants No. 8-29/LV0017/09: A. Reinart – 24 344 EUR.
- Review of declared agricultural parcels with remote sensing methods: U. Peterson – 2556 EUR.
- Using satellite data for assessment and prognosis of algae blooms. Swedish Meteorological and Hydrological Institute, contract No 2007/2213/43, 2009–2010: A. Reinart – 7167 EUR.
- Spectral sampling tools for vegetation biophysical parameters and flux measurements in Europe. COST Action ES0903, 2009–2013: TO coordinator M. Lang.

- Expected Climate Change and Options for European Silviculture (ECHOES). COST Action 2009–2012: TO coordinator M. Lang.
- Development of (Estonian) space terminology: U. Veismann – 639 EUR.
- National programme of environmental monitoring, subprogramme ”Studies on change of Estonian landscapes and remote sensing”: U. Peterson – 7558 EUR.

In addition, our researchers participated in several international projects which did not incur direct income to the Observatory.

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

2.2 Staff

Since February 1st Viljo Allik works as a research associate of the EstSpacE project.

On April 1st Dr. Anu Reinart, the senior research associate of the group of vegetation remote sensing, moved to the position of Director of Tartu Observatory. The former director Laurits Leedjärv continues to work at the Observatory as senior research associate in the group of stellar physics and head of the department of astrophysics. On March 31st, 2010 a ceremony was held where Laurits Leedjärv thanked all colleagues, partners, ministry officials etc. for eleven years of fruitful cooperation, and a new director Anu Reinart was inaugurated.

From April 1st, Evelin Kelner is working as a senior book-keeper. From August 2nd, Ain Jõesalu is working as a manager of the renovation project.

Some working contracts were terminated: Mare Linnamägi on May 13th, Ingrid Enkvist on June 30th, Voldemar Harvig on August 20th.

On July 1st the senior research associate of the group of vegetation remote sensing Dr. Matti Mõttus got the post-doc grant from the University of Helsinki. He will work in Helsinki for the next three years.

From September 1st, Elar Asuküll and Johan Kütt are working as engineers. From October 1st a young atmospheric physisist from Germany Sebastian Traud is working as engineer.

Research associate of the group of stellar physics Mari Burmeister successfully defended the Ph.D. thesis in the University of Tartu on October 1, 2010. Research associate of the group of theoretical astrophysics Indrek Vurm defended his Ph.D. thesis in the University of Oulu (Finland) on October 22, 2010.

As a result of all the changes, the number of people employed by the Tartu Observatory was 79 on January 1, 2011. Of them, 47 are on the position of researchers and 10 on that of research engineers.

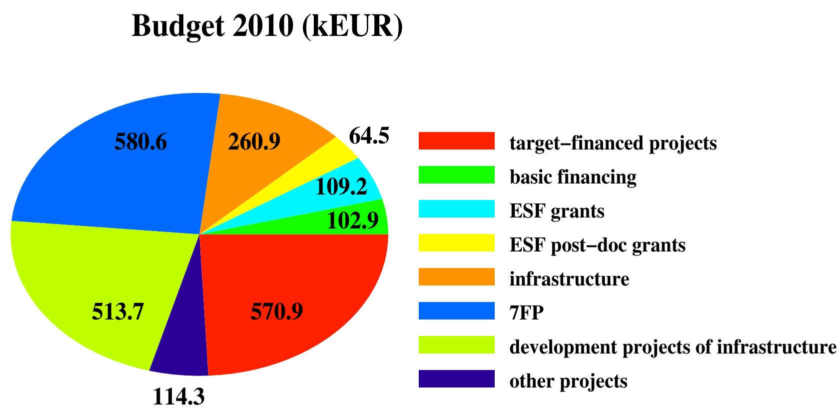
2.3 Awards

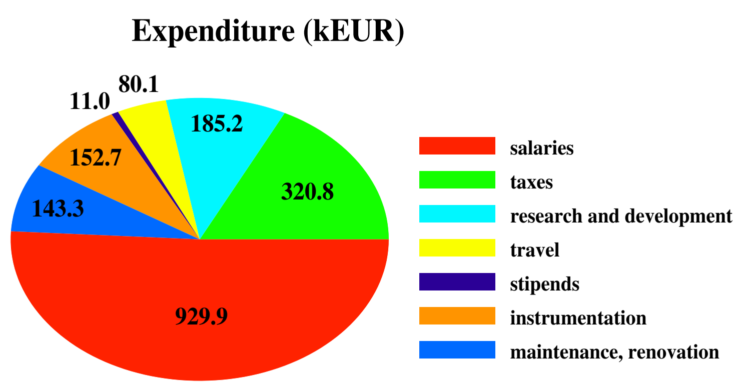
- Professor Jaan Einasto became a Honorary Doctor of the University of Tartu.
- Estonian Academy of Sciences elected head of the department of cosmology, senior research associate Enn Saar to a Member of the Academy.
- Medal of the Estonian Academy of Sciences was awarded to Laurits Leedjärv.
- Krista Alikas received a fellowship of the Jaan-Mati Punningu Foundation.
- Estonian Institute of Meteorology and Hydrology awarded a Medal of Merit to Viivi Russak.
- Estonian University of Life Sciences awarded a Medal of Merit to Tiit Nilson.

Laurits Leedjärv is receiving a Medal of the Estonian Academy of Sciences from the President of the Academy, Prof. Richard Villems. Eesti Teaduste Akadeemia President, Prof. Richard Villems annab Laurits Leedjärvele üle Teaduste Akadeemia medali.

2.4 Budget

The total amount allocated from the state budget directly to the Observatory was 1110.95 kEUR (17.382 MEEK). In addition, about 1208.61 kEUR (18.910 MEEK) from contracts with several organizations, for renovation of the infrastructure etc. were allocated to the Observatory. Some of the income was transferred to the year 2011.





The mean monthly salary of researchers (including those working in the EstSpacE project) was approximately 1178 EUR (18 436 EEK) by the end of 2010.

2.5 Instruments and facilities

Tartu Observatory was successful to obtain financing for its two 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”:

1. TAP13-1 – Modernization of the 1.5-m telescope, 184 029 EUR. Work will mostly take place in 2011.
2. TAP13-2 – Complex of the etalons for remote sensing, 183 987 EUR. In the framework of this project, a reflection etalon was built at the Järvselja test site, and some laboratory etalons were purchased.

In the framework of the subprogramme for modernization of small-scale research infrastructure three projects were supported:

1. Xenon lamp based radiation standard for spectroradiometric calibrations in ultraviolet, optical and near-infrared spectral region.
   Cost 23 667 EUR.
2. A set of diffraction gratings for the spectrograph of the 1.5-m telescope.
   Cost 16 261 EUR.
3. A database server for the group of cosmology. Cost 23 679 EUR.

Amateur astronomer and businessman Raivo Hein donated to Tartu Observatory the 12.5-inch telescope PlaneWave and the mounting Paramount ME. There is intention to put it into operation during 2011 as a fully automatic robotic telescope for photometric observations. Such a robotic telescope would allow to use more effectively our partly clear nights and thus to obtain timeseries with significally better time coverage.

2.6 Scientific Council

After taking a job by a new director, a new Scientific Council was formed. On April 26, 2010 at the meeting of the research personnel (with 48 researchers present), 8 new members were elected. Other members were appointed by the director and by the Ministry of Education and Research. On May 28, 2010 the Minister of Education and Research confirmed the new Council in his order No 459 as follows:

Anu Reinart – director, Chair of the Council,
Gert Hütsi – postdoc, elected by researchers,
Ene Kadastik – chief expert of the department of research policy, Ministry of Education and Research,
Marco Kirm – director of the Institute of Physics, 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,

Martti Raidal – senior research associate of the National Institute of Chemical Physics and Biophysics,

Enn Saar – senior 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.

Other activities of the Council:

The Scientific Council held 10 meetings in 2010. The following scientific reports were presented:

January – *P. Tenjes*: Dust in galaxies – spatial distribution, temperature and structure.

February – *A. Hirv*: Estimation of time delays from gravitationally resolved multiple images of quasars.

March – *I. Ansko*: Parametrization of remote sensing instruments.

April – *I. Vurm*: On the radiation mechanisms of gamma ray bursts.

May – *T. Eenmäe*: Hot B stars – fast rotators?

September – *T. Sepp*: Formation and evolution of galaxies in the expanding Universe.

– *M. Aun*: Dependence of ultraviolet spectral doses on the cloudiness.

Other activities of the Council:

- On January 18, a plan for teaching and popularizing astronomy at Tartu Observatory in 2010–2020 was discussed.
- On February 12, first step to fill the post of the director of Tartu Observatory took place. Senior research associate Anu Reinart presented her action plan, and the Council assessed it positively. Required documents were forwarded to the Research Policy Committee at the Ministry of Education and Research, which elected Anu Reinart to the post of director on March 1.
- On March 8, contest to the positions of researchers took place. In the department of cosmology, Maret Einasto, Erik Tago and Jaan Vennik were elected to the senior research associates and Elmo Tempel and Lauri Juhan Liivamägi to research associates. In the department of astrophysics, Tõnu Viik and Indrek Kolka were elected to senior research associates, and Mari Burmeister and Anti Hirv to research associates.
- On March 26, final reports of the Estonian Science Foundation grants were approved (grantholders Indrek Kolka, Matti Mõttus, Jaan Pelt, Anu Reinart and Tiit Nilson).
- On May 24, senior research associate Enn Saar was proposed as a candidate to the member of the Estonian Academy of Sciences in astronomy.

- On September 20, the Ernst Julius Öpik fellowship was awarded to Ph.D. student Tiit Sepp and Juhan Ross fellowship to Ph.D. student Margit Aun (both from the University of Tartu). Applications for continuation of two target financed projects were approved. The Council decided to terminate the third project "Remote sensing of optically complex natural environments", and to apply for a new project "Quantitative remote sensing of plant canopies" jointly with the Estonian Marine Institute, University of Tartu.
- On December 20, Tiit Nilson was proposed as a candidate to the National Science Prize for a lifelong work, and Andres Kuusk, Mait Lang and Joel Kuusk for a prize in exact sciences. Projects for modernization of research apparatus in 2011 were approved. The Council decided not to continue presenting scientific reports at Council meetings, but to start joint scientific seminars of the Observatory.

2.7 Public relations

A lot of excursions visited the site of Tartu Observatory at Tõravere: more than 6300 people in 257 groups.

The night of 24 September, the European Researcher's Night, was especially busy with about 500 people observing Jupiter and other celestial objects. Four telescopes were in use that night: the 1.5-m telescope, MEADE, and two galileoscopes. Several other public observing nights were arranged as well as field observations at Tapa High School using portative MEADE telescope. Traditionally, a course of astronomy for 12th grades of Nõo High School was held. On the occasion of the International Year of Astronomy 2009, an exhibition of large astronomical photos was compiled by Kalju Annuk. It continued to be popular in 2010 and was exposed as follows:

- Centre for Handicapped Young People Juks, Tallinn: 07.01.–28.02.2010.
- Nõo Library, Tartu County: 15.03.–30.04.2010.
- Türi Economic High School, Türi: 02.11.–07.12.2010.

The best pictures from the competition of computer drawings in 2009 were also exposed:

- The Parliament of Estonia, Tallinn: 11.01.–29.01.2010.
- The Kännukukk Library, Tallinn: 03.02.–10.03.2010.
- Dorpat Conference Centre, Tartu: 12.04.–28.05.2010.
- Museum of Tartu County, Elva: 16.11.–31.12.2010.

Numerous popular-scientific articles by our scientists are presented on the page 71, public lectures and interviews on the page 99.

The 87th issue of the Calendar of the Observatory was published as well as already 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 FP6 and FP7 project)
- Astrophysikalisches Institut Potsdam
- Estonian Academy of Sciences
- Estonian Ministry of Education and Research
- Estonian Science Foundation
- Enterprise Estonia
- Euro–Asian Astronomical Society
- European Astronomical Society
- European Commission
- European Space Agency
- Helsinki University
- International Astronomical Union
- Institute of Physics, University of Tartu
- Invent Baltics Ltd.
- Isaac Newton Group of Telescopes
- Nordic Forest Research Co-operation Committee (SNS)
- Nordic Optical Telescope
- Observatori Astronomic, Universitat de València
- Ondřejov Observatory
- Oulu University
- Pakker Avio
- Swedish National Space Board
- Tuorla Observatory, University of Turku
- University of Tartu
- World Radiation Center

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

Uurisime nii kosmoloogia põhiküsimusi (tumeaine ja tumeenergia omadusi, inflatsioonist tulenevaid järeldusi) kui ka suuremastaabilise struktuuri teket ja arengut Universumis. Struktuuri arenguga kaasneb galaktikate ja nende koosluste (galaktikagruppide, galaktikaparvede ja superparvede) teke ja areng – nende praeguste omaduste uurimine lubab meil teha järeldusi mineviku kohta. Kirjeldame tehtud töid ja saadud tulemusi teemade kaupa.

Inflatsioonilise paradigma (Universumi esialgse ülikiire laienemise) testimiseks jätkati inflatsiooniteooria poolt ennustatud barüonostsillatsioonide (BAO) jälgede otsimist.

E. Saar koos grupi Valéncia ja Pariisi kosmoloogidega otsis BAO jälgi galaktikate ruumjaotusest. Selleks töötasid nad välja spetsiaalsed lainikud ja avastasid, et galaktikad joonistavad hiiglasuuri kerakihte läbimõõduga umbes 280 Mpc. G. Hütsi leidis BAO jäljed galaktikaparvede võimsusspektris. Kuna galaktikaparvede ülevaated katavad palju suurema ruumiosa ja ulatuvad sügavamale kui galaktikakaardid, siis on galaktikaparvede evolutsioon paremini teada ja tema metoodika annab võimaluse BAO parameetrite oluliselt täpsemaks määramiseks.

G. Hütsi koos kolleegidega Hiroshima Ülikoolist uurisid, kuidas kontrollida erinevaid gravitatsiooniteooriaid, hinnates suuremastaabilise struktuuri kasvu kiirust sügavate galaktikavalimite põhjal. Nad leidsid nn Comptoni parameetri piirid praegustele teooriatele ja esitasid galaktikaülevaate plaani, mis lubaks teooriaid paremini eristada. Kuna tumeenergia mõju struktuurile avaldub kõige paremini superparvedes, jätkati nende omaduste uurimist. L.J. Liivamägi koostas SDSS andmebaasi alusel uue ja maailma suurima superparvede kataloogi. Artikkel on esitatud avaldamiseks ja kataloog avalikkusele kättesaadav. Ta identifitseeris koos P. Heinämäki (Tuorla) ja E. Saarega uutest satelliidi Planck SZ-andmetest avastatud superparve – sellest annab Planck'i töögrupp WG5 aru järgmisel aastal "Astronomy and Astrophysics" Plancki missiooni esimeste tulemuste erinumbris.

M. Einasto juhtimisel jätkati "Sloani Suure Seina" superparvede morfoloogia ja galaktikajaotuste uurimist. Leiti, et samas piirkonnas asuvad rikkad superparved on väga erinevad, olles erinevatel arenguastmetel. Uuriti rikkaid galaktikaparvi neis superparvedes ja leiti, et enamus neist areneb tormiliselt, koosnedes mitmest interakteeruvast komponendist. Alustati kogu SDSS superparvede valimi morfoloogilist analüüsi.

G. Hütsi koos A. Hektori ja M. Raidal'iga (KBFI) jätkas tumeaine annihilatsiooni jälgede otsimist gammakiirguse mõõtmistest, kasutades nii PAME-

LA ja Fermi kosmosemissioonide kui maapealse HESSI teleskoobi andmeid. Nad leidsid, et on võimalikud mudelid, mis sobivad kõigi nende tulemustega (siiani on leitud ainult vastuolud).

E. Tago lõpetas töö Sloani ülevaate galaktikagruppide ja -parvede kataloogi kallal. Artikkel on ilmunud ajakirjas "Astronomy and Astrophysics", kataloog publitseeritud Vizier'i andmebaasis. Uudsena on koostatud SDSS DR7 kauguspiiranguga gruppide kataloog, mille oluline eelis on selle homogeensus – seda saab otse rakendada gruppide arvutimudelite testimisel.

J. Einasto ja I. Suhhonenko koos kolleegidega Potsdamist avaldasid esimesed artiklid, mis summeerivad nende pikaaegse numbrilise struktuuri arengu tulemused. Nad käsitlesid eri skaaladega häirituste osa struktuuri arengus ja nende häirituste omavahelist mõju.

Galaktikate praeguseid omadusi ja nende evolutsiooni saab tervikuna kirjeldada nende heledusfunktsiooni (heleduste jaotuse) abil. E. Tempel uuris SDSS ülevaate galaktikate heledusfunktsiooni morfoloogiliste tüüpide ja ümbrustiheduse kaupa. Esmakordselt parandas ta spiraalgalaktikate tolmust tekkinud heledusmuutusi. Selle töö üllatav tulemus on see, et spiraalgalaktikate heledusjaotus ei näi ümbrusest sõltuvat; fakt, mida on praeguse galaktikatekketeooria raames raske seletada. T. Sepp koostas SDDS gruppide andmebaasi, mille sisu täieneb pidevalt. Samuti on ta võrrelnud neid gruppe Millenniumi simulatsiooni omadega, töö jätkub.

J. Vennik jätkas lähedaste gruppide koosseisu uurimist, kasutades kääbusgalaktikate spektraalvaatlusi Hobby-Eberly 11m teleskoobiga (Texas). Ta fotometreeris gruppide uusi kääbusliikmeid ja võrdles eri ümbruses asetsevate kääbusgalaktikate omadusi – need eriti ei erinenud, vaid parvedes on kääbused veidi punasemad (vanemad).

A. Tamm, P. Tenjes ja E. Tempel kaardistasid meie naabergalaktika (Andromeda, M31) tolmu jaotuse, kasutades Spitzeri kosmoseteleskoobiga kauges infrapunakiirguses saadud ülesvõtteid. See on teadaolevalt kõige suurema ruumlahutusega galaktika siseneeldumise analüüs (Linnutee välja arvatud). Töö M31-ga jätkub, valmimas on sarnane analüüs koostöös T. Tuvikesega, kus fotomeetria tugineb SDSS mitmevärvilistele vaatlustele. SDSS vaatlused on suurima ruumlahutusega M31 terviklik ülevaade, mis on saadud ühe teleskoobiga.

Peale tähtede on Galaktika oluliseks koostisosaks gaas, nii kuumades tähetekkepiirkondades kui külm vesinik neist eemal. Raadiovaatluste põhjal gaasijaotuse kaardistamine on aga keeruline probleem. U. Haud tegeles Leiden/Argentina/Bonni (LAB) vesinikuülevaate väga külmade pilvede otsimise ja uurimisega. V. Maljuto koostas tähtede automaatse klassifitseerimise tarbeks uudse, korraliku veaanalüüsiga standardtähtede kataloogi.

3.1 Testing the cosmological paradigm

The present cosmological paradigm includes the (already old and established) Big Bang scenario and three more recent components – dark matter, dark energy, and initial rapid expansion (inflation). We worked on exploring all three ideas.

3.1.1 Baryonic acoustic oscillations

Baryon acoustic oscillations (BAO) are present in the early Universe, before recombination, and are governed by the interplay between the gravitational pull of dark matter and the enormous pressure of the photon-electron plasma. After recombination, they leave traces both in the CMB background and in the large-scale distribution of galaxies. Studying these traces, we can determine physical conditions in the early Universe, and test theories of inflation – different inflation scenarios produce different baryonic oscillations. The basic strength of the BAO is its ability to provide us with a cosmological "standard ruler" that is physically well understood, and thus does not suffer from systematic errors inherent to most of the other probes.

E. Saar, together with colleagues from Valéncia and Paris, searched for traces of BAO in the present-day large scale distribution of galaxies. These have been found before, studying the fine structure of the second-order statistics of this distribution, the galaxy correlation function and in the power spectrum. They looked for BAO as physical structures in real space. They constructed special wavelets for that and found that galaxies delineate enormous spherical BAO shells with a diameter about 280 Mpc, the largest structures seen in the Universe. The paper has been submitted to "Science".

G. Hütsi, in the paper published in MNRAS, reported the first detection of BAO using a galaxy cluster sample (maxBCG); other studies have used large galaxy redshift samples. The ability to detect BAO with relatively small number of clusters ($\sim 10^4$) is encouraging in the light of several proposed large cluster surveys that can reach cluster counts beyond $\sim 10^5$. Although the number density of galaxy clusters detectable by those future surveys is relatively low, and thus we have a high level of discreteness noise, there is one quite important advantage for using galaxy clusters as tracers of the cosmic large-scale structure: compared to the galaxies we have significantly better understanding of biasing for the cluster-sized dark matter halos.

3.1.2 Dark energy

G. Hütsi, in collaboration with Kazuhiro Yamamoto and his students from Hiroshima University derived constraints on the $f(R)$ models of gravity using the luminous red galaxy sample from the Sloan Digital Sky Survey

(SDSS). In particular, they focused on the anisotropy of the redshift-space power spectrum, which is sensitive to the growth rate of density perturbations. As different models of gravity predict different growth rates for density fluctuations, the above measurements can potentially discriminate between them. The $f(R)$ model is specified by the Compton wavelength parameter, which effectively provides a scale below which standard theory of gravity gets modified. In the paper *"Constraint on the cosmological $f(R)$ model from the multipole power spectrum of the SDSS LRG sample and prospects for a future redshift survey"* they derived bounds on the Compton wavelength parameter and also made forecasts for the performance of a hypothetical future large-scale structure survey. This paper has been submitted to "Physical Review D" and is currently very close to being accepted. G. Hütsi is planning to continue this line of research. In addition to the Hiroshima University group there are good prospects of starting collaborations on similar topics with researchers from the Laboratory of Theoretical Physics of the University of Tartu.

3.1.3 Dark matter

G. Hütsi, together with M. Raidal and A. Hektor from NICPB (Tallinn) used space experiment data to determine the physics of dark matter. Recently, several experiments (e.g. PAMELA, Fermi, HESS) have shown an anomalous excess of energetic electrons/positrons towards the centre of our Galaxy. The most attractive possibility is that this might be due to annihilating or decaying dark matter. If true, this is very exciting, since it is the first time we might have relatively strong evidence, other than purely gravitational, for the existence of dark matter. They investigated the possibility that this excess signal is due to leptonically annihilating/decaying dark matter. Using this model they calculated the resulting diffuse (both Galactic and extragalactic) gamma-ray backgrounds, and compared those with the recent measurements by Fermi-LAT space telescope. By doing this they obtained strong constraints on the properties of annihilating (decaying) dark matter: mass and annihilation cross-section (mean lifetime). Also, it seems quite possible to have annihilating dark matter models, which simultaneously: (i) are compatible with the PAMELA-Fermi-HESS electron/positron data, and (ii) provide acceptable fits to the Fermi-LAT isotropic diffuse background, without being in clear conflict with the other Fermi-LAT gamma-ray measurements. Their latest results are presented in the paper *"Implications of the Fermi-LAT diffuse gamma-ray measurements on annihilating or decaying Dark Matter"* (arXiv:1004.2036), which is submitted to "Journal of Cosmology and Astroparticle Physics".

G. Hütsi is planning to continue this line of research. One of the obvious ways to extend this analysis is to calculate the resulting synchrotron emission from those excess relativistic electrons/positrons that are interacting with the

Galactic magnetic field, and compare these with the existing observational data in the radio frequency band. Also, of great interest would be to investigate possible bounds on dark matter properties using the measurements of energetic neutrinos by the Super-Kamiokande experiment. The other interesting issue is the potential contribution from the Galactic dark matter substructures. Since in currently well established cold dark matter dominated cosmological models the structure formation proceeds according to the hierarchical bottom-up scenario, one would expect significant amount of substructure inside our Galaxy's dark matter halo. This substructure would lead to a significant amplification, and also to the change of the spatial emission profile of the gamma-ray signal.

3.2 Superclusters

Superclusters are the largest elements of the cosmic web. As they are large, their evolution has not been completed yet, and they carry the memory of the initial conditions (the early universe) in their properties. We compiled supercluster catalogues for the SDSS DR7 data volume, and studied the properties of the best-observed superclusters in the Sloan Great Wall.

L.J. Liivamägi finished compilation of supercluster catalogues for the SDSS DR7 galaxy catalogue. He built the superclusters on the basis of the luminosity density field, cutting it at a selected global density level. As the proper level depends on the specific application (the problem to be solved using supercluster data), he created two series of catalogues with different density levels, both for the main and the LRG samples. He created also two catalogues (main and LRG) with adaptive density levels that were defined following the supercluster breakup from the percolation set.

He studied the statistical properties of these catalogues, demonstrated that the possible distance-dependent biases are small, and proposed quality parameters (mean signal/noise for the density field) for the superclusters. The catalogues are public.

The paper was submitted to "Astronomy and Astrophysics". Before that, one supercluster from the LRG catalogue was identified in the Planck mission data, and will be observed in a followup series of observations on Palomar telescopes. This is probably the first distant ($z = 0.45$) supercluster that will be observed in detail.

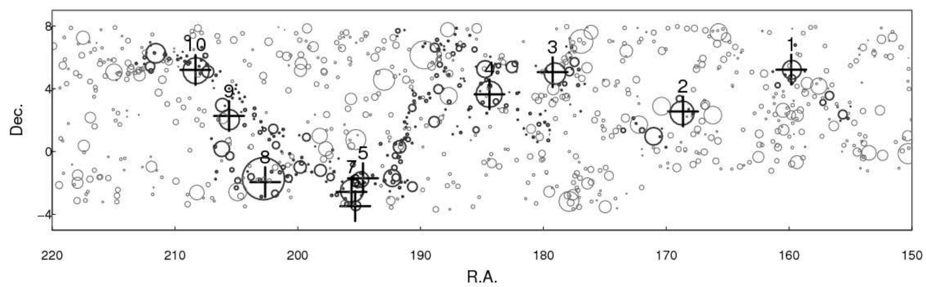


Figure 3.1: The groups and clusters of galaxies in the Sloan Great Wall (black circles) and its surroundings (grey circles). Black crosses denote the richest clusters in the Sloan Great Wall studied. Sloani Suure Seina galaktikagruppide ja -parvede jaotus taevas. Mustad ringid tähistavad Sloani Suure Seina kuuluvaid galaktikagruppe, hallid ringid vastavad galaktikagruppidele, mis asuvad Seina lähiümbruses. Ristid tähistavad meie uuritud rikkaid parvi.

3.2.1 The superclusters of the Sloan Great Wall

M. Einasto and her colleagues used the catalogue of superclusters compiled by L.J. Liivamägi and studied the morphology of the largest known galaxy system – the Sloan Great Wall (hereafter SGW) – and its member superclusters. They characterized the clumpiness and shape of the SGW using the fourth Minkowski functional and the morphological signature (the K1-K2 shapefinder plane).

The richest supercluster in the SGW, the supercluster SCl126, resembles a rich multibranching filament. Among other observed and simulated superclusters this is the only supercluster with such a morphology. Present-day numerical simulations have not been able to produce a supercluster like that. Another very rich supercluster in the SGW – the supercluster SCl111 (the Virgo-Coma supercluster) – resembles a multispider (a system where individual high density cores are connected by lower density filaments of galaxies). The morphology of this supercluster resembles that of several simulated superclusters we have studied before.

The differences between the morphology (and of individual galaxy populations) between the richest superclusters in the SGW suggest that these superclusters had different formation and evolution histories.

3.2.2 Morphology of superclusters in the SDSS

M. Einasto and her colleagues studied the morphology, as well as the cluster content and the large scale distribution of a large sample of superclusters in the Sloan Digital Sky Survey.

They used the fourth Minkowski functional V_3, the shapefinders K1 and K2, the morphological signature (in the K1-K2 shapefinder plane) and the shape parameter (the ratio of the shapefinders for the whole superclusters) to characterize the morphology of superclusters. The superclusters were chosen in the distance intervall 90–320 Mpc, where the luminosity-dependent selection effects are the smallest. They found the Abell clusters in the superclusters, about 1/3 of them are X-ray sources.

Figure 3.2: The central part of the Abell cluster A1516 (the richest galaxy cluster of the supercluster SCl 111 in the Sloan Geat Wall) from the SDSS Visual Database. Abelli parve A1516 (Sloani Suure Seina superparve SCl 111 kõige rikkam galaktikaparv) keskosa (SDSS Visuaalse andmebaasi põhjal).

The superclusters in our sample lie in three chains of superclusters, one of them is the Sloan Great Wall. Several very rich superclusters are located at the intersection of these chains, where they belong to the Dominant Supercluster plane, found earlier using the superclusters of Abell clusters. The calculations show that richer and more luminous superclusters are also more elongated and have more complicated inner morphology (larger values of the clumpiness as expressed by the fourth Minkowski functional V_3) than poor, less luminous superclusters. Morphologically, individual superclusters can be characterized as spiders, multispiders, filaments and multibranching filaments. Different morphologies of superclusters show that their evolution has been different.

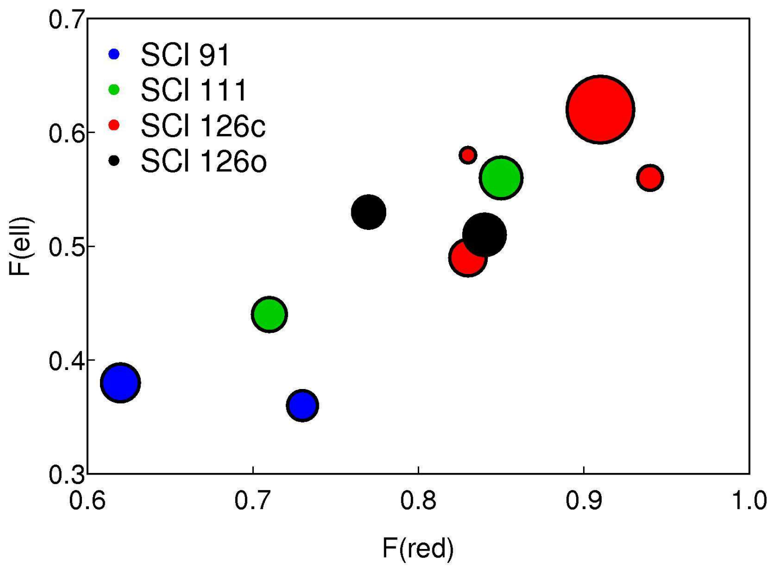


Figure 3.3: The fractions of red galaxies and elliptical galaxies in clusters from different superclusters of the Sloan Great Wall. The fraction of red (and elliptical) galaxies is the largest in the core region of the richest supercluster in the Sloan Great Wall, the supercluster SCl 126, and the smallest in the poorest supercluster in the Sloan Great Wall, the supercluster SCl 91. Punaste galaktikate ja elliptiliste galaktikate osakaal Sloani Suure Seina erinevatesse superparvedesse kuuluvates galaktikaparvedes. Punaste (ja elliptiliste) galaktikate osakaal on suurim Sloani Suure Seina kõige rikkama superparve, SCl 126, tuumapiirkonnas, ja väikseim Sloani Suure Seina kõige vaesemas superparves, SCl 91.

3.2.3 Simulation of the formation of the large scale structure

J. Einasto, I. Suhhonenko, G. Hütsi, in collaboration with Potsdam astronomers, calculated several series of numerical models of structure evolution in the universe. These simulations have several goals: to investigate the influence of density perturbations of different scale to structure formation and evolution, the role of phases in the formation of systems of galaxies of various scale, the absence of galaxies in voids etc. Simulations were made for several cube sizes: 64, 100, 256, 500, 768, 1000 Mpc/h. For most models, the simulations were performed using the full power spectrum, and, for comparison, using truncated power spectra, where long-wave perturbations were

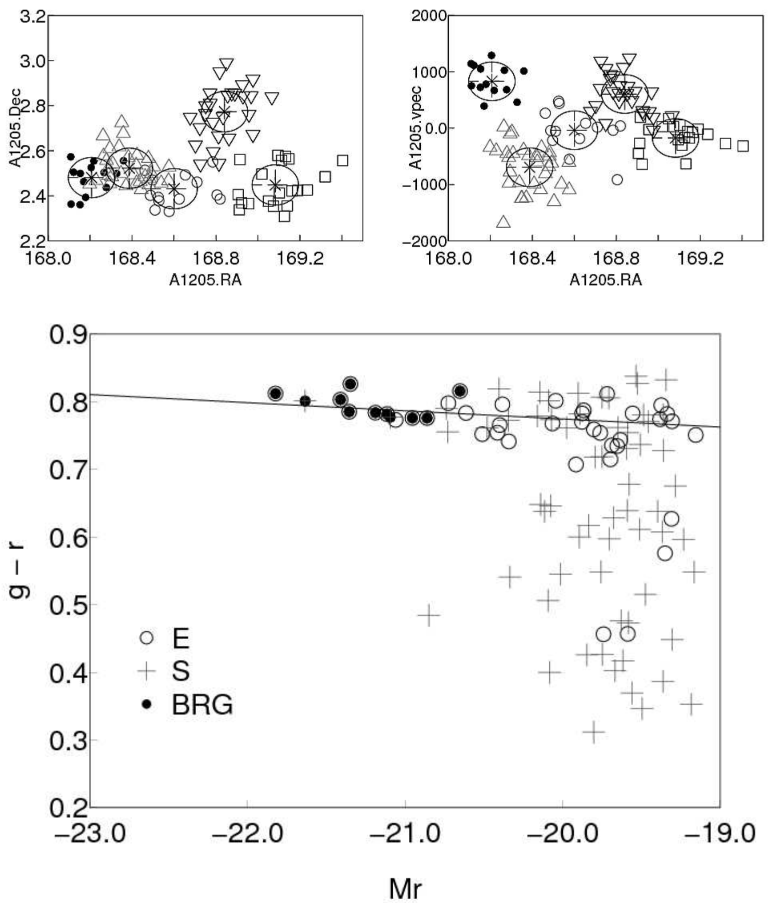


Figure 3.4: The cluster A1205 in the supercluster SCl 91 in the Sloan Great Wall; different components and the colour-magnitude diagram. Empty circles denote elliptical galaxies, crosses – spiral galaxies, filled circles – luminous red galaxies. Asteriks denote the first ranked galaxies. The colour-magnitude diagram shows that according to the colour index $g - r$, a large fraction of spiral galaxies are red ($g - r > 0.7$). The left-hand komponent of the cluster in the upper panel contains mostly red galaxies while other two components contain blue galaxies. Galaktikaparv A1205 superparves SCl 91 Sloani Suures Seinas (alamstruktuurid ja värvi-heleduse diagramm). Tühjad ringid tähistavad elliptilisi galaktikaid, ristid – spiraalseid galaktikaid, täidetud ringid – heledaid punaseid galaktikaid, tärnid näitavad peagalaktikaid. Värvi-heleduse diagrammil on näha, et suur osa spiraalseid galaktikaid on punased, nende värviindeks $g - r > 0.7$. Parve vasakpoolne komponent (ülemisel paneelil) koosneb enamasti punastest galaktikatest, teised komponendid aga spiraalgalaktikatest.

cut off. The initial conditions (the random amplitudes used to generate the initial positions and velocities of particles) were identical in models of different cuts. This allows to identify particles in systems (halos), and to compare the behaviour of halos in different models. Analysis of the models shows that voids appear in regions of space where large-scale density perturbations have similar phases in low-density regions, and superclusters form in regions where large-scale perturbations have similar phases in high-density regions.

3.3 Studying the formation and evolution of galaxies

We studied the observational differences in the properties of present-day galaxies, in order to discover the possible paths of their formation and evolution. For that, we compared the properties of galaxies in different local (groups, clusters) and global (voids, superclusters) environments. The present galaxy formation paradigm (merger-dominated formation and evolution) explains well most of the dependencies we found, but we discovered also interesting discrepancies.

3.3.1 Galaxy populations

E. Tempel and his colleagues carried out a careful determination of the luminosity functions of galaxy populations in the SDSS DR7 data, taking into account the dust attenuation. They found the luminosity functions for galaxies of different morphology in different global environments, using the smoothed bootstrap method to calculate pointwise confidence regions of the derived luminosity functions. They found a strong environmental dependency for the luminosity function of elliptical galaxies. In the contrary, the luminosity function of spiral galaxies is almost environment independent, suggesting that spiral galaxy formation mechanisms are similar in different environments. Absorption by the intrinsic dust influences the bright-end of the luminosity functions of spiral galaxies. After attenuation correction, the brightest spiral galaxies are still about 0.5 mag less luminous than the brightest elliptical galaxies.

While most the correlations found can be explained by the merger mechanisms of galaxy formation, the independence of the luminosity function of spiral galaxies on the global density environment is surprising. The authors saw the cause in the fragility of spiral galaxies, but it may have other reasons.

H. Lietzen with her colleagues from Tuorla Observatory and in collaboration with the members of our cosmology group studied the influence of the large-scale environment on the properties of the AGN. They compared the environments of quasars, BL Lac objects, Seyfert and radio galaxies in the SDSS DR7 volume. They found that while radio-quiet quasars are mostly located in low-density regions, radio galaxies have higher environmental densities. BL Lac objects usually have low-density environments, but some of them are also in very high density regions. This supports the theory of galaxy evolution where galaxies are affected by two modes of AGN feedback: the quasar mode that turns a blue star-forming galaxy into a red and dead one, and the radio mode that regulates the growth of massive elliptical galaxies. Quasars are in lower density environments than radio galaxies most likely because the galaxies in rich environments have evolved faster, and have therefore reached the radio mode by now, while the galaxies in poor environments have evolved slower, and are still going through the earlier quasar mode feedback in their evolution.

M. Einasto and her colleagues compared galaxy populations in the Sloan Great Wall superclusters. They found that the clumpiness of red galaxies in superclusters is larger than the clumpiness of blue galaxies. At intermediate density levels the systems of blue galaxies may have tunnels in them. The clumpiness of bright red galaxies is similar to that of all red galaxies in superclusters. The differences between the morphology and individual galaxy populations between the richest superclusters in the SGW suggest that these superclusters had different formation and evolution paths.

3.3.2 Galaxy groups and clusters

E.Tago compiled catalogues of groups of galaxies in the SDSS DR7 (the final release includes spectra of 929 555 galaxies). Applying a modified "friends-of-friends" group search method a flux-limited sample (altogether 78 800 groups with richness $N \geq 2$ up to the redshift z=0.2), and four volume-limited subsamples of groups were compiled and published. Using these catalogues, catalogues of superclusters and the large-scale luminosity density field in the SDSS volume were constructed, in collaboration with other members of the cosmology group.

We have described the supercluster catalogues above. The luminosity density field was used to define large-scale environments for galaxies in a luminosity function study by E. Tempel and colleagues, and in the study of the environments of active galaxies (AGN), led by H. Lietzen from Tuorla Observatory (Finland).

M. Gramann and T. Sepp in collaboration with P. Nurmi and P. Heinämäki (Tuorla Observatory) studied the properties of dark matter halos and galaxies, using semianalytic galaxy catalogues. They compared the luminosity functions of model and observed galaxies in the SDSS and found that simulations clearly overestimate the number of bright galaxies. In observations there are systematically more faint groups and less bright groups than in simulations. Differences may arise from many sources. All semianalytical methods populate halos with galaxies in different way and include different physical processes in their recipes.

The same group also started to examine the differences between the galaxy groups determined in real space and in redshift space. The hope is that such a comparison will lead to a physically better motivated recipes for extracting galaxy groups from observational catalogues.

3.3.3 Nearby groups of galaxies

J. Vennik continued his studies of dwarf galaxies in a sample of reasonably isolated local groups of galaxies. The area of the groups was searched for new dwarf galaxy candidates in the SDSS and DPOSS frames, using their surface brightness distribution, colours and morphological criteria. Follow-up spectroscopy of the highest rated dwarf galaxy candidates was carried out with the Hobby-Eberly telescope, in collaboration with U. Hopp (Munich). During several observing runs in 2007–2010, they have determined 41 redshifts and confirmed 19 new, mostly late-type, star-forming dwarf members in studied groups ($\sim$45 % success rate of morphological classification).

J. Vennik carried out detailed surface photometry of the secure dwarf members of groups using the SDSS frames, and compared the photometric scaling relations of late-type dwarf galaxies in the field, group and cluster environments. The new data do not provide any clear evidence for the structure-environment relations but give some hints for the colour-environment dependencies. He proposed that frequent tidal interactions (harassment) may exhaust the gas reserve of cluster dwarfs more rapidly, and result in on average redder colours, when compared to the colours of quiescently evolving field and group dwarfs.

J. Vennik continued also his studies of a sample of reasonably well isolated groups of galaxies, which are located in the outskirts of the Virgo supercluster.

3.4 Our Galaxy and Andromeda

As we live inside our Galaxy, and the Andromeda galaxy is located close-by, the amount of information about these two giant galaxies is superior to that we have and hope to get about other galaxies. This allows us to study in detail different aspects of their structure and to build and test models of their evolution.

3.4.1 Andromeda Galaxy

E. Tempel, T. Tuvikene, A. Tamm and P. Tenjes continued to study the structure of the nearby Andromeda galaxy (M 31). They had earlier developed a method to recover the intrinsic, absorption-corrected surface brightness distribution of a galaxy. Now they applied it to M 31 and found that in order to model the structure of different stellar populations in M 31, we should know the distribution on colours much better than we do. Small systematic deviations between different datasets lead to considerable uncertainties in colour indices, which are too big for building good chemical evolution models for the star formation history of stellar populations.

For this reason they decided to obtain an extinction-corrected optical surface brightness distribution of M 31, using the homogeneous observational data from the Sloan Digital Sky Survey (SDSS) images in five passbands. In total 12 scanlines with 56 frames each were used to construct mosaic images in the $ugriz$ colours. Special care was taken to subtract the varying sky background. In order to eliminate the contribution of foreground stars and the galaxies M 32 and NGC 205, circular masks were applied on top of these objects (see Fig. 3.5c). The final image of 2300×7400 pixels for the g filter is shown in panel (a) of Fig. 3.5.

Extinction corrections were applied using the model developed by E. Tempel, A. Tamm and P. Tenjes in 2009 and described in Annual Report 2009. To fit the model to the observations, they assumed the galaxy M 31 to consist of a bulge, an old and a young disc, an outer halo, and a central nucleus. The extinction map was applied to the full 2-dimensional optical imaging, yielding a dust-free image of the galaxy. As an additional constraint, it was demanded during the modelling process that the dust-free surface brightness profiles along the both sides of the minor axis should coincide as well as possible. The final dust free image of M 31 is shown in panel (b) of Fig. 3.5.

The derived luminosity profiles and the resulting distributions of colour indices have smaller systematic errors than those in the profiles derived by averaging data from different instruments. The improved spatial coverage and lower uncertainties provided by the SDSS data allowed to obtain tighter constraints for the star formation history and for the origin of M31. In addition, the model suggests that dust properties of M 31 may differ from those of the Milky Way. This remains to be confirmed or invalidated with future observations of M 31 with the Herschel Space Observatory, providing higher angular resolution in far-infrared than the Spitzer Space Telescope, and a coverage at longer wavelengths.

The results of this work have been accepted for publication in "Astronomy and Astrophysics" and have been presented at several international meetings.

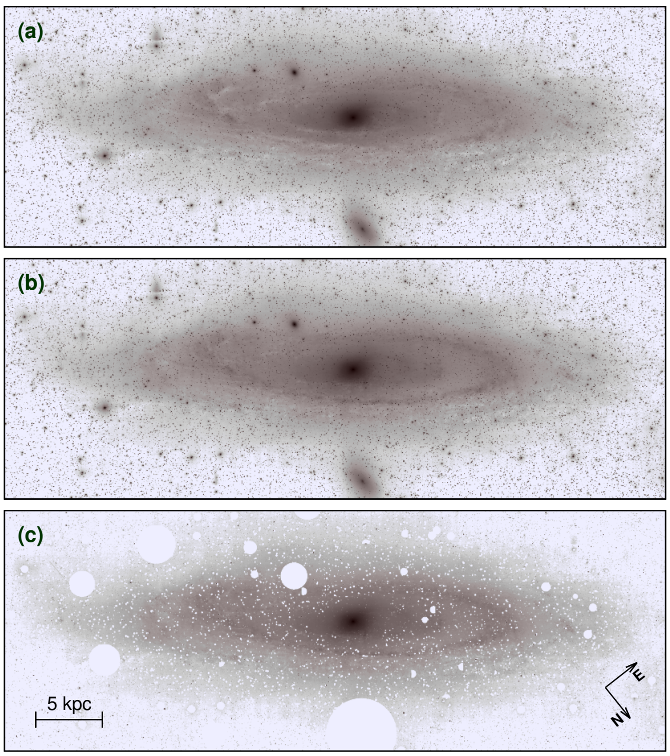


Figure 3.5: Upper panel (a): SDSS imaging of M 31 in the g filter, corrected for background variations. Middle panel (b): the same as the upper panel, with intrinsic extinction effects removed. Lower panel (c): the same as the middle panel, showing also the masked regions (white circles). Ülal (a): M 31 SDSS kujutis g-filtris, parandatuna foonimuutuste suhtes. Keskel (b): sama, mis ülal, kuid siseneeldumise arvel parandatud. All (c): sama, mis keskel, koos kasutatud maskidega (valged ringid).

3.4.2 Our Galaxy

For our Galaxy, we concentrated our attention to two topics: the physics and spatial distribution of cold hydrogen (HI) clouds, and stellar classification.

Continuing his studies of Galactic hydrogen, U. Haud worked on narrow line HI structures, found by him in 2009 in the LAB Survey. He compared the properties of the cold population clouds in the cold gas ring with those of the HI self-absorption (HISA) features.

For HISA clouds different authors have concluded that their temperature determinations are imprecise, but typically they must be cooler than 40 or 50 K, and sometimes as cold as 10–15 K. Due to the velocity resolution of the LAB data and optical depth effects of HI emission lines, it is impossible to obtain reliable temperature estimates for the clouds found in the LAB database. However, by using the temperature derived from better data for the largest cloud in the cold ring by Meyer et al. (2009) and assuming that the Gaussian widths of HI lines are at least roughly proportional to the actual cloud temperatures, U. Haud estimated that the clouds may have temperatures in the range of about 13–50 K, in good agreement with HISA clouds.

The similarity holds also for the line-of-sight velocity distributions of the two populations of clouds and for the dimensions of at least some clouds and complexes. Gibson et al. (2000) estimated the sizes for some HISA features in the range 0.029–3.6 pc. By accepting the distance estimate, obtained for the cold ring structure, the upper size limit of the largest ring cloud is 4.2 pc. Kavars et al. (2005) derived sizes for 70 HISA complexes. They found the sizes in the range from 3.4 pc up to about 400 pc. The total length of the visible part of the cold ring stream is about 60 pc. Therefore, as both the ring clouds and the HISA features have similar temperatures and are of a parsec scale, it seems plausible that they may be caused by the same physical phenomenon in different conditions (the contrast with the background). Unfortunately, these different conditions make the observations of the cold HI emission clouds and HISA features mutually exclusive. HISA is observable only near the galactic plane, where an intensive HI emission background exists, and the clouds, found in the LAB, are best observed at large angular distances from the Milky Way. As a result, it cannot yet conclusively stated that the HISA and LAB clouds belong to the same cloud population, but it seems highly probable.

V. Malyuto continued development of classification methods for deep surveys of stellar populations in the Galaxy. To estimate the external errors of effective temperatures of stellar catalogues, an improved technique was developed for the cases when the number of catalogues with the stars in common exceeds three: the least squares method was applied to derive the errors of catalogues. In other cases (when the number of catalogues with the stars is smaller) a previous technique developed by V. Malyuto and T. Shvelidze was applied.

After obtaining the external errors for the catalogues, the values of effective temperatures for every star included in two or more (up to five) catalogues were averaged with the weights inversely proportional to the variances and an average homogenized catalogue (803 stars) was produced, with effective temperatures accompanied by their errors.

Other popular catalogues do not include external errors and are heterogeneous. The new catalogue gives reliable homogeneous effective temperatures for stars, allowing to use them as calibration stars in stellar classification.

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

Tähtede füüsika alane uurimisteema hõlmas traditsiooniliselt väga erinevaid objekte. Jahedatest tähtedest oli peamise vaatluse all μ Cephei, mis kuulub punaste ülihiidtähtede hulka. Uuriti joonte laiusi tema spektris ja keemilist koostist (T. Kipper). Tähe jooned on väga laiad ja laienemine sõltub joonte tekke sügavusest atmosfääris. μ Cep osutus nõrgalt metallivaeseks täheks, [Fe/H]≈ -0.4.

T. Nugis ja K. Annuk koos partneritega Toruńist (Poola) määrasid kuumade Wolf-Rayet (WR) tähtede alamklassi WN objektide vesiniku ja heeliumi sisalduse suhteid. Jätkus WR tähtede optiliselt paksu tähetuule modelleerimine. K. Annuk alustas unikaalse muutliku tähe Pleione (BU Tau) spektrite töötlemist.

Kuumade tähtede atmosfääride modelleerimisel olid põhilised jõupingutused pööratud sellele, et leida analüütilised avaldised vesiniku aatomi ja vesinikusarnaste ioonide spektrijoonte profiilifunktsioonidele, kasutamaks neid täheatmosfääride ja tähespektrite mudelarvutustel (A. Sapar, A. Aret, R. Poolamäe ja L. Sapar). Vesiniku spektrijoonte profiilid moodustuvad kolme olulise füüsikalise protsessi tulemusena: 1) aatomseisundite statistilised spektraalnihked lineaarse Starki efekti tõttu ioonide elektrostaatilises väljas, mida kirjeldab Holtsmarki funktsioon; 2) aatomseisundite sumbumine elektronsiirete ja elektronpõrgete tulemusena, mida kirjeldab Lorentzi profiilifunktsioon; 3) aatomite soojusliikumine, mida kirjeldab Doppleri funktsioon. Nende kolme füüsikalise protsessi koosmõju tulemusena kujunevad spektrijoonte profiilid on kirjeldatavad kolmekordse integraaliga ehk nn sidumiga. Selles sidumivalemis õnnestus analüütiliselt läbi viia kahekordne integreerimine ja normeeritud profiilifunktsioon taandada kolme tavalise ühekordse integraali summaks. Õnnestus leida ka analüütiline lahend leitud profiilifunktsioonile. Saadud valemeid on plaanis kasutada kuumade kääbustähtede anomaalse vesiniku ja heeliumi suhtelise sisalduse seletamiseks valgusindutseeritud triivi nähtuse abil.

V.-V. Pustynski uuris ekstremaalse horisontaalharu (EHB) tähtede eeldatavate eellaste lähteparameetreid välja selgitamaks, missugustes parameetrite piirides on võimalik EHB objekti moodustumine lähiskaksiksüsteemis. Leiti, et vajalik on doonortähe mass $M_1 < 1.3\,M_\odot$, akretseeriva tähe mass on piiratud massiülekande stabiilsuse tingimustega ning on tarvis efektiivseid impulssmomendi kaomehhanisme (nt magnetiline interaktsioon).

V.-V. Pustynski uuris ka, kuidas prekataklüsmiliste süsteemide parameetrid mõjutavad nende heleduskõveraid, mille formeerumine on seotud peegeldusefektiga.

Sümbiootiliste kaksiktähtede puhul väärib märkimist, et prototüübi Z And spektris oli 2010. aastal taas märke kiirete bipolaarsete gaasijugade väljaheitmisest (M. Burmeister, L. Leedjärv). Eelmine selline nähtus toimus 2006. aastal, kui täht tegi läbi ühe oma heledaima purske.

Uurimise all on olnud kaks pekuliaarse käitumisega kaksiktähte – V838 Mon ja ϵ Aurigae (I. Kolka, T. Liimets). V838 Mon fotomeetriliste ja spektroskoopiliste aegridade analüüsi täiendavad vaatlused Põhjamaade Optilisel Teleskoobil ajavahemikus oktoober 2010 kuni aprill 2011. Kogunevate aegridade põhjal on kavas teha järeldusi kaksiksüsteemi käitumise kohta ajal, mil kuum komponent on varjutuses (alates 2008. a keskpaigast) ning on (prognoositavalt) varjutusest väljumas.

Unikaalse kaksiktähe ϵ Aurigae varjutus kestab augustist 2009 kuni maini 2011. Alates 2009. a algusest on registreeritud selle tähe keskmise lahutusega spektreid Tartu Observatooriumis ja umbes kord kuus ka kõrge lahutusega spektreid Põhjamaade Optilisel Teleskoobil La Palmal. Eesmärgiks on võrrelda varjutuse eri faasides tehtud spektreid valitud reeperspektriga varjutuse-eelsest ajast, et sel viisil rekonstrueerida näiteks aine- ja temperatuurijaotuse kuju varjutavas kettasarnases objektis. Esimeseks sammuks selles võrdlemises oli Liis Reisbergi bakalaureusetöö, mis käsitles Si II joonte tundlikkust varjutusefaasi eristamisel.

J. Pelt koos J. Lauriga (TÜ) uuris arvutimudelite abil fotomeetrilist mõõteskeemi nõrkade valguste kiireteks mõõtmisteks. Need ühe footoni detektoritel baseeruvad mõõteskeemid võivad osutuda kasulikuks mitte ainult perioodiliste kiirgusallikate otsimisel, vaid ka korrelatsioonide otsimisel kahe allika vahel – näiteks gravitatsiooniläätsedes. Ka töötati välja uus meetod moduleeritud vaatlusandmete töötlemiseks ja esitamiseks.

I. Vurm koos partneritega Oulust (Soome) tegeles akretseerivate kompaktsete objektide füüsikaga. Kasutades akretsiooniketta krooni lihtsat ühetsoonilist mudelit, töötas ta välja programmi kineetiliste võrrandite lahendamiseks, mis kirjeldavad laetud osakeste energiajaotust ja kiirgusvälja, kusjuures kõik olulised mikroprotsessid võetakse arvesse lihtsustusteta. I. Vurm uuris ka akretseerivate mustade aukude spektraalseisundeid (pehme ja kalk) iseloomustavaid parameetreid ning gammakiirguse sähvatuste kiirgusmehhanisme.

Tähtede kõrval olgu mainitud ka V.-V. Pustynski töö Apollo 11 kuumooduli maandumiskoha uue suure täpsusega kaardi koostamisel. Tulemused on avaldatud NASA saidil Apollo Lunar Surface Journal ning valmimas on publikatsioon ajakirjale Acta Astronautica.

4.1 Late-type stars

The studies of post-AGB, hydrogen-deficient and luminous red stars were continued by T. Kipper. In 2010 the spectrum of μ Cephei was investigated. μ Cep, Herscel's Garnet star, is one of the largest and most luminous stars in the Milky Way. It belongs to red supergiants (RSG) which are evolved massive ($M_{\rm init} = 10-25\,M_{\odot}$) stars burning He in their cores. The atmospheric dynamics of μ Cep was recently studied by Josselin & Plez (2007) using the tomography technique. We used the more traditional approach with concept of the line formation depth.

The studied spectra were taken from the ELODIE archive. The motions in the atmosphere of μ Cep are highly supersonic. The velocities derived from the line widths in the deepest layers are about 30 km s^{-1} but the lines forming in the surface layers are much wider (50 km s^{-1}). This indicates the presence of large granules in the atmosphere of μ Cep. At the same time the microturbulent velocity is rather low, about 4 km s^{-1}. Fe I lines stronger than $\log(EW/\lambda) \geq -1.2$, which form in the outer layers of the stellar atmosphere, show slightly larger microturbulent velocity $\xi_{\rm t} = 4.3\,{\rm km\,s^{-1}}$.

μ Cep turned out to be slightly metal deficient with [Fe/H]≈–0.4. This leads to somewhat lower (100 K) effective temperature than was assumed earlier. For elements other than those of the iron peak the results are very uncertain due to small number of measured lines.

4.2 Hot luminous stars

T. Nugis in collaboration with K. Annuk and A. Niedzielski and K. Czart from Toruń University (Poland) measured the line emission fluxes of the weak and blended He II, He I and HI lines of WN stars in the spectral range 8500–9000 Å and determined the hydrogen-to-helium ratios. The observational data used in this study are described in the paper of Nugis et al. (2008) (Baltic Astronomy, Vol. 17, 39–49). The results of this study are in preparation for publication.

T. Nugis continued the modelling of optically thick winds in collaboration with H.J.G.L.M. Lamers (Utrecht University, the Netherlands). The new aspect of the winds of WR stars found by them is that the winds near and above the sonic points become bi-stable and can switch from one regime to another (from high acceleration regime to low acceleration regime). The results of these studies are in preparation for publication.

T. Nugis also continued the investigation of the role of circumstellar (CS) extinction in the case of hot stars with strong winds.

K. Annuk continued spectroscopic observations of Wolf-Rayet stars and several OB-type stars using the 1.5 m telescope. He also started the reduction

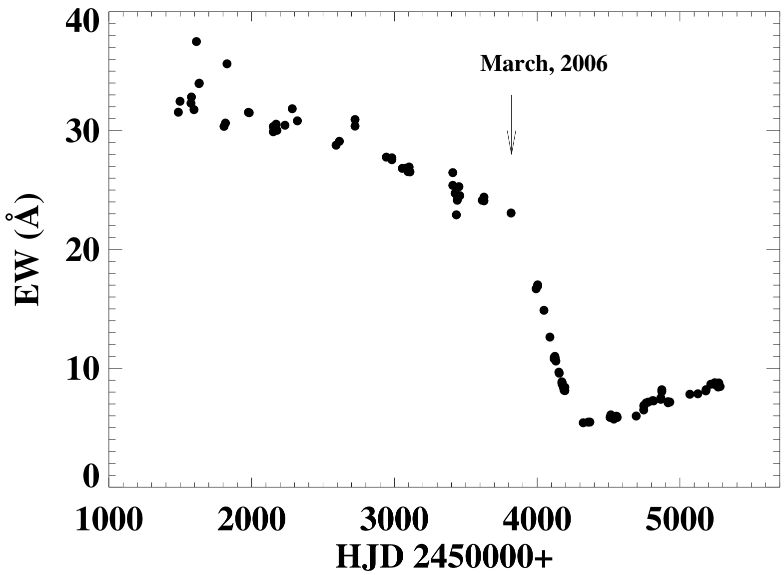


Figure 4.1: The equivalent width variation of the Hα line of Pleione.
Pleione Hα joone ekvivalentlaiuse ajaline muutus.

of spectra of the unique variable star Pleione (BU Tau). The observations were carried out at Tartu Observatory during the last ten years, from 1999 up to 2010. It is accepted that this star forms shells periodically ($P \sim 34$ years). The last shell phase started in 2005–2006. The preliminary results show that the equivalent widths of the Hα line has been continuously decreased from the value ∼35 Å (November 1999) down to ∼25 Å (March 2006). At that time the star was in the Be phase. During the next ∼450 days the EW very quickly decreased to its minimum value ∼5.5 Å. This period corresponded to the shell formation phase. Quite strong variations of the V/R ratios of the Hα and Hβ lines were found.

4.3 Physical processes in stellar atmospheres and formation of stellar spectra

Main efforts were directed to elucidate in more detail the formation of spectral lines of hydrogen and hydrogenic ions due to underlying physical processes by finding adequate analytical expressions for describing of them (A. Sapar, A. Aret, R. Poolamäe and L. Sapar).

The profiles of strong hydrogenic spectral lines, being dominating features in stellar spectra, can be described as triple integral incorporating three simultaneous physical processes, which act as independent statistical ingredients and the spectral line profiles can be consequently described as convolution of these contributing processes. Two of the processes, namely thermal motion of particles described by Doppler profile, and natural damping of atomic states described by Lorentz profile, act for each spectral line, and are described by their convolution, named the Voigt profile. For hydrogenic atoms in addition appears the third physical process, namely the linear Stark effect due to electrostatic field of slowly moving hydrogenic particles and additional contribution to the damping of quantum states due to rapidly moving electrons. Presence of linear Stark effect appears due to fact that the quantum states of hydrogenic particles are energetically degenerated, i.e. their energies coincide for different quantum number states. The corresponding spectral line is described by the Holtsmark function, expressed as Fourier type integral containing the detuning frequency as spectral line argument. Former we succeeded analytically to carry out double integration of the triple integral, reducing it to three single infinite integration formulae, containing Fourier type sine and cosine detuning arguments, but exponential integration term contains the damping as the sum of the three physical processes. During the current year as the main contribution the analytical solution for different Lorentz, Doppler and detuning parameter value domains have been found. Generally, the new function class is the complex parabolic cylinder functions, which in its turn consist of complex confluent hypergeometric series. The parabolic cylinder functions reduce the number of independent parameters and show how the total profiles depend on the values of these ratios. These formulae enable better to understand resulting coaction of physical processes and to formulate essentially more efficient software for trillions of subroutine calls in stellar atmosphere modelling. In addition these functions are useful as tools for laboratory plasma diagnostics.

Compact and effective software has been composed for application of the convolved line function in modelling of stellar atmospheres and spectra. The formulae are planned to use for explanation of observed anomalies in hydrogen-helium ratios of hot stars, especially white dwarfs, enabled due to small relative shifts of H and He^{+} spectral series, which can by LID generate underabundance of helium in hot B stars. An overview paper about SMART software, including recent improvements of formulae in the code, is in preparation for publication. A special improvement applied is a new iterative approximation method elaborated by the team for finding the final equilibrium isotope abundances. A new set of orthogonal radial wave functions has been proposed for multi-electronic atoms and ions. The free parameters in exponent terms are to be specified based on the variation method, say using the Levenberg-Marquardt method for finding the lowest energy states, which however is very time-consuming procedure. The modelling of diffusive separation of the chemical elements and their isotopes in the quiescent atmospheres of mercury-manganese (HgMn) CP stars has been continued. The time-consumption of the computation of evolutionary scenarios has been multiply reduced applying the method of parallelization based on the local network of the multi-core personal computers using the Python language software for link of master and slave computers with Fortran 90 software SMART.

Model-atmosphere computations have shown that the anomalous isotope ratios in stellar atmospheres can be explained only by the light-induced drift (LID), generated by asymmetric radiative flux forming systematically in the partly overlapping isotopically split spectral lines. In the result, levitation of the heavier isotopes to the upper layers of stellar atmospheres and sedimentation of the lighter isotopes is generated. As a new problem, study of the possible levitation of hydrogen and sedimentation of helium due to light-induced drift in hot white dwarfs was started in collaboration with colleagues from Ondřejov Observatory (Czech Republic). The C^{++} software Spectrum will also be applied in the studies.

Compilation of the atomic data for the study of anomalous calcium isotope abundances has been continued.

4.4 Eclipsing close binaries

V.-V. Pustynski continued research of Extreme Horizontal Branch (EHB) binary progenitors. Formation of close binary systems containing an EHB object was studied within the model assumptions proposed earlier by V.-V. Pustynski and I. Pustylnik. The model assumes Roche Lobe Overflow (steady RLOF) scenario, the EHB precursor fills in its Roche lobe and loses mass through the first Lagrangian point. It was found that formation of a close binary system containing EHB object is possible, although the range of initial parameters of the progenitor system is restricted. To produce a close binary, moderate masses of the donor are required. Systems with heavy donors ($M_1 > 1.3\,M_\odot$) seem not to produce close binaries. Larger masses of the accretor favour close binary formation, although accretor mass range is restricted by RLOF stability considerations. Effective mechanism of angular momentum loss is also required, its role may play magnetic interaction provoking corotation of matter. Range of the required initial separations is small and is mostly defined by the radius of the Roche lobe at the moment when the mass of the core of the donor core achieves 95 % of its final mass. The results were presented in poster at JENAM 2010, Lisbon, Portugal.

V.-V. Pustynski also continued research of Precataclysmic Binary systems

(PCB), he studied influence of PCB parameters on their light curves. The two-layer model of the irradiated atmosphere of the cold component (elaborated within the V.-V. Pustynski's Ph.D. thesis, supervisor I. Pustylnik) was applied, the reflection effect was considered as the major factor forming the light curve. It was found that influence of some parameters to the light curve is ambiguous. For instance, the amplitude of the reflection effect has its minimum at a certain value of the cool satellite radius, and grows when the radius becomes larger or smaller than this value. The reason is that the amplitude of the light curve depends not only on the absolute magnitude of the reflection effect, but also on the contrast between the brightness of the both components. The results were presented on the conference "New methods of investigation of space objects", Kazan University, Russia, and will be published in the proceedings of the conference.

For the detailed spectral limb-darkening data, obtained by Fortran 90 code SMART, an addendum to Fortran 90 code SMART has been elaborated for application to interpretation of spectra of rotating stars and light curves of close eclipsing binaries (A. Sapar).

4.5 Symbiotic stars and related objects

Spectroscopic observations of symbiotic stars and related objects (CH Cyg, AG Dra, EG And, Z And, AX Mon, VV Cep) were continued in 2010 mostly by K. Annuk and A. Puss. The number of collected spectra, however, was quite low due to bad weather conditions.

Main results of the long-term monitoring of some key symbiotic stars (AG Dra, Z And, CH Cyg, EG And) were summarized in the Ph.D. thesis by M. Burmeister, successfully defended in the University of Tartu. Besides the results published in the papers and in the previous annual reports, it is interesting to mention an episode in the behaviour of the prototypical symbiotic star Z And. It was in outburst in 2009–2010, and in at least one spectrum, obtained on February 6, 2010 there were again signs of bipolar collimated jets as those seen during the outburst in 2006 – high-velocity satellites of the Hα line. The strength and the shape of the additional emission components were similar to those seen in 2006, but the velocity was considerably higher. Assuming the orbital inclination of 47^0, the ejection velocity of about 2500 kms^{-1} was derived, opposed to about 1700 kms^{-1} in 2006. This episode shows that the phenomenon of jet ejection might be more widely spread among symbiotic stars, and that individual ejection events might look different even in the same star. On the other hand, one can also conclude that short-time ejection events could easily remain undetected by the observers.

4.6 Peculiar stars

4.6.1 V838 Mon

The investigation of photometric and spectroscopic time series on V838 Mon has been continued in 2010 (I. Kolka, T. Liimets). The additional observational data have been gathered thanks to the successful observing proposal (T. Liimets, I. Kolka) for the Nordic Optical Telescope on La Palma in the period October 2010 – April 2011. The new time series should fix the possible end of the still continuing eclipse of the hot component in this binary system. The pre-eclipse behaviour of the emission lines in V838 Mon has been investigated (T. Kipper, I. Kolka), and the results support the scenario that these lines had their origin in the outer layers of the cool component being excited by the hot component's radiation.

4.6.2 Epsilon Aurigae

The eclipse of the peculiar binary Epsilon Aurigae lasts from August 2009 until May 2011. Starting from the beginning of 2009 this star has been observed spectroscopically at Tartu Observatory with medium resolution (K. Annuk, A. Puss, T. Eenmäe), and once per month at the Nordic Optical Telescope on La Palma with high resolution. The comparison of spectra on different eclipse phases with the reference one obtained out of eclipse will give observational constraints on the physical structure of the eclipsing gaseous disk (I. Kolka). The first step of this comparison has been the B.Sc. thesis by Liis Reisberg (University of Tartu) on the sensitivity of Si II lines to the physical conditions during the eclipse.

4.7 Time and frequency analysis of astronomical phenomena

J. Pelt with J. Laur from the University of Tartu studied the shutter based high speed low light photometrical measurement schemes. They built computer models of such measurement schemes.

This kind of schemes are based on the use of single photon detectors and ultrafast optical switching. It occurred that schemes can be useful not only in the context of searching of periodic emitters but also in the context of correlating the two different sources. This opens new possibilities in the gravitational lensing research. The software package for analysis of classical photometric observations was also significantly extended and will be described in detail in soon to be ready doctoral dissertation by A. Hirv.

The kinematical properties of the spots and underlying activity zones on the Sun and on magnetically active stars was another subject of the investi-

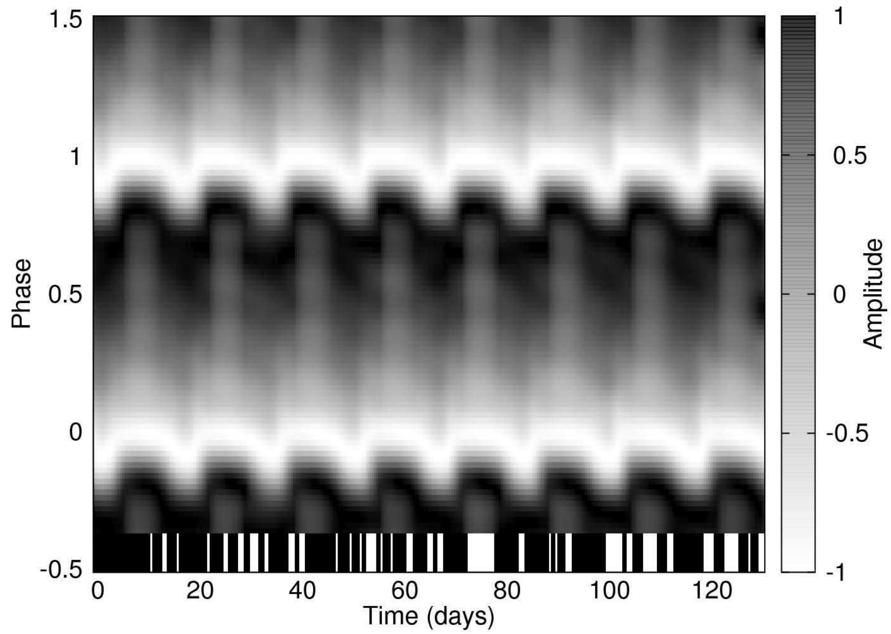


Figure 4.2: New method to present modulated data. The input data is interpolated using carrier fit method, normalized and displayed phase-wise. (Photometry of the RR Lyr star MW Lyr, main period is 0.397674 days, period for modulation is 16.5462 days.) Uus meetod moduleeritud andmete esitamiseks. Sisendandmed on interpoleeritud kasutades kandevsageduse sobitamise meetodit, siis normaliseeritud ja faaside kaupa esitatud. (RR Lyr tüüpi tähe MW Lyr fotomeetria põhiperiood on 0.397674 päeva ja modulatsiooniperiood 16.5462 päeva).

gations by J. Pelt. With colleagues from Finland (M. Korpi, I. Tuominen) and with N. Olspert (Playtech) they developed new methods to analyse statistical patterns and hidden correlations of the magnetic activity. They developed also a new and quite general method to study low frequency modulations in astronomical time series. The method is based on a idea that for many signals their frequency support is rather sparse and consists of low number of narrow bands. Every band can be modelled by using its central frequency as a carrier and slowly changing multiplicators as modulators. The first results of the method application are encouraging. It was used in traditional context of spotted magnetically active stars and also to present light curves of the RR Lyr stars with pronounced Blazhko effect.

Developed by N. Olspert program StarSpots was significantly improved and allows now to model rather complex an quite realistic spotted star light curves. The program was used to generate trial data sets for evaluating properties of the carrier fit method.

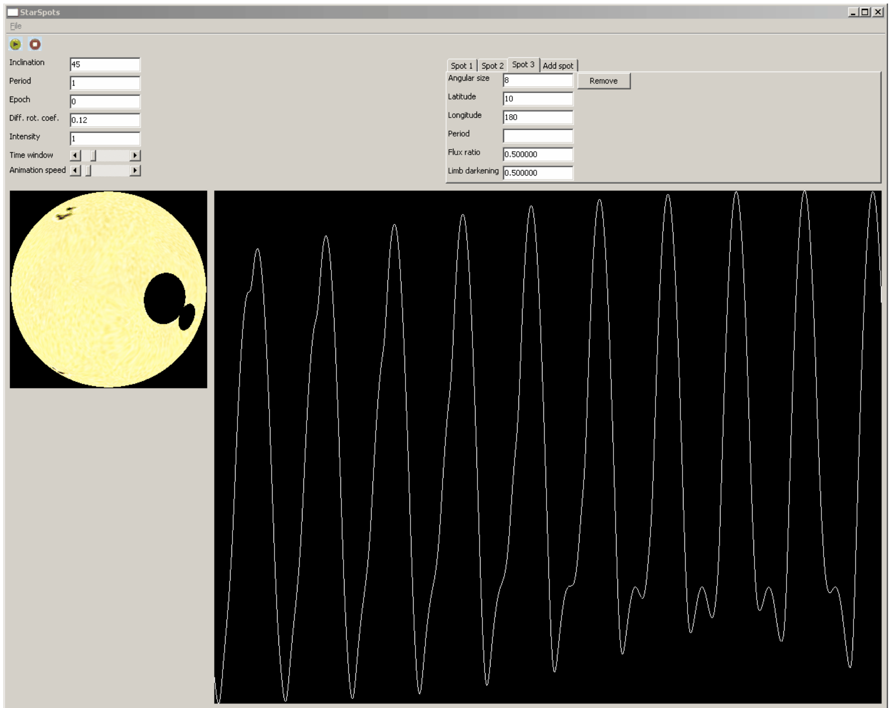


Figure 4.3: Program StarSpots allows to generate realistic light curves. Its output is used to test various time series analysis algorithms. Arvutiprogramm StarSpots võimaldab genereerida realistlikke heleduskõveraid. Tema väljundit kasutatakse erinevate aegridade analüüsi algoritmide testimiseks.

With colleagues from Finland (M. Korpi, I. Tuominen, L. Jetsu, T. Hackman) a new and extensive project was started to re-analyse extensive photometrical observations of the magnetically active stars FK Com, II Peg, LQ Hya and others.

4.8 Lunar mapping

V.-V. Pustynski performed a new photogrammetric analysis of the landing site of the Apollo 11 Lunar Module (LM). The analysis is based on the full set of photographs made by the crew during its only Extravehicular Activity (EVA). The aim of this analysis was to compile the most accurate map of the landing site, that would include camera stations, precise locations of the artifacts and prominent natural features. This work was done in collaboration with the editor of the Apollo Lunar Surface Journal (ALSJ, WWW project of NASA). The compiled map contains positions and azimuths of all camera stations, locations and orientations of the most important artifacts (the LM, the EASEP instruments etc.), as well as outlines of the rims of nearby craters and locations of boulders. The accuracy of the map is about 10 cm in the 30-m vicinity of the LM, that is about one order of magnitude better than the accuracy of the previous map (made in the year 1978) and 1.5 order of magnitude better than the accuracy of the map from the Preliminary Science report (1969). The camera stations map from the Preliminary Science report is significantly improved and amplified. The results were compared with Lunar Reconnaissance Orbiter Camera (LROC) high-resolution imagery and an excellent agreement was found. More than 50 boulders visible on LROC imagery were identified on EVA photographs. The results are published in the ALSJ and are prepared for publishing in Acta Astronautica.

4.9 Radiative transfer

The variation of the coefficient of polarization with the optical depth in a Rayleigh-scattering atmosphere was investigated by T. Viik.

I. Vurm with J. Poutanen (University of Oulu) studied radiative processes in the vicinity of accreting compact objects, using a numerical code developed to calculate synchrotron emission and absorption processes as well as Compton scattering over a wide energy spectrum. The observed X-ray and gamma radiation from such objects originates from the optically thick accretion disk and the hot rarefied corona above the disk, where magnetic reconnection processes can accelerate charged particles to relativistic energies. The observed spectrum is a combination of the disk blackbody radiation and a high energy component from the corona produced by inverse-Compton scattering. The latter generally follows a power-law dependence on the photon energy, depending among other things strongly on the energy distribution of charged particles in the corona, which in turn depends on the radiation field itself. Employing a simple one-zone model for radiative transfer in the corona, the developed code is able to self-consistently solve the coupled kinetic equations describing the energy distributions of the charged particles and the radiation field, taking the relevant microprocesses into account without any approximations.

I. Vurm and J. Poutanen studied the origin of spectral states in accreting black holes, which can be broadly divided into two classes: hard and soft. The hard state spectrum is dominated by the inverse-Compton component from the hot corona, following a power-law dependence on the photon energy and extending from soft X-rays to ~ 100 keV, with most of the energy emitted at the high energy end. In the soft state the spectrum is energetically dominated by the quasi-blackbody component from the optically thick accretion disk, having a power-law Comptonized tail which can extend to ~ 10 MeV. It was found that the transition from one spectral state to another can be caused by the changing inner radius of the accretion disk, which alters the amount of soft photons reaching the corona. This in turn leads to dramatic changes in the energy distribution of charged particles in the corona as well as the Comptonized high-energy spectral component produced by them.

I. Vurm and A. Beloborodov (University of Oulu) studied the radiative mechanisms responsible for prompt gamma-ray burst emission. The spectrum in these short-lived and extremely powerful objects is thought to be formed within a highly relativistic outflow associated with the birth of a compact object (i.e. black hole). To study the spectrum formation within the expanding outflow they have improved the kinetic code developed by I. Vurm and J. Poutanen for modelling radiative processes to account for adiabatic losses as well as relativistic aberration. They further developed the code to include electron-positron pair-production and annihilation processes, which become important at energies above mc^2. These processes are of crucial importance in the formation of the high-energy spectrum in the MeV – GeV range. The results of the simulations are in good agreement with the observed prompt gamma-ray burst spectra from X-ray to GeV energies.

They have also compared the results to those obtained by a Monte Carlo code developed by A. Beloborodov for the same problem, finding a good agreement.

They also studied the effect of magnetization and the resulting synchrotron emission on the formation of the observed spectrum. Magnetization was found to inhibit emission at the highest (GeV) energies, while adding an separate synchrotron component to the low-energy (keV) part of the spectrum. The latter component could provide an explanation for the X-ray excesses that have been observed in several bursts.

5 Remote sensing of optically complex natural environments Optiliselt keerukate looduskeskkondade kaugseire

Looduskeskkonna seire hõlmab nii atmosfääri, veekogude kui maismaa uuringuid.

Globaalse soojenemise üks võimalikke põhjusi on muutused atmosfääri infrapunases kiirguses. Viimast on mõõdetud vähestes kohtades, kusjuures andmete aegread on suhteliselt lühikesed. V. Russak uuris Tartu-Tõravere meteoroloogiajaamas alates 2003. aastast mõõdetud atmosfäärikiirguse olenevust veeauru rõhust ja madalast pilvisusest. Esialgse tulemusena (2006. aasta andmete analüüs) leiti, et osakorrelatsioon veeaururõhu ja atmosfäärikiirguse vahel (temperatuuri mõju elimineeritud) oli tugevam soojal aastaajal (aprillist septembrini vahemikus 0.72–0.93). Seevastu seos atmosfäärikiirguse ja madala pilvisuse vahel on tugevam talvekuudel (novembrist veebruarini oli osakorrelatsioon 0.88–0.93), mis on seletatav pilvisuse aastase käiguga Eestis.

Aivo Reinart jätkas aerosooli optiliste omaduste modelleerimist ja aerosooli toime uurimist atmosfääri kiirguslevile. Bentham Instruments'i spektroradiomeetrile loodi kasutajasõbralik pikaajaliste mõõtmiste jaoks sobiv tarkvara koos andmebaasi toega. Spektromeeter mõõdab 2008. aastast alates, kuid töökindel ja mugavalt kasutatav arhiveerimissüsteem siiani puudus. Samuti on käimas kergete aeroioonide spektromeetri KAIS moderniseerimine, kasutades kaasaegseid riistvara- ja tarkvaralahendusi. Välja on töötatud aerosooli mudel elektrilise aerosoolispektromeetri (EAS) mõõtmiste sisestamiseks riikidevahelise aerosooliuuringute projekti EUSAAR andmebaasidesse. Toimub mõõtmisandmete konverteerimine väljatöötatud formaati.

Kuue aasta kestel registreeritud UV kiirguse spektrite analüüsiga selgitati välja pilvisuse, aerosooli, veeauru, osooni ja päikese kõrguse roll maapinnale langeva UV-kiirguse spektraalse koostise kujundamisel (K. Eerme, M. Aun, U. Veismann, I. Ansko). Veeauru osa väljaselgitamiseks aerosooli kujunemisel mõõtis E. Jakobson augustis neljal päeval raadiosondidega atmosfääri temperatuuri, niiskuse ja tuule kiiruse profiile kolmetunniste intervallidega. See mõõtmisseeria toetab ka Tõraveres töötava AERONET-võrgu päikesefotomeetri andmetöötlust.

Nii Läänemeres kui ka Eesti suurtes järvedes toimuvad vetikate massiõitsengud, mille kestvus ja ulatus varieeruvad aastati vastavalt ilmastikutingimustele. Spetsiaalselt satelliidisensori MERIS jaoks loodud klorofülli maksimumi indeksit (MCI) kasutasid K. Alikas ja A. Reinart sinivetikate sesoonse dünaamika, ruumilise jaotuse ja katvuse uurimiseks

Peipsis ja Võrtsjärves. Selgus, et MCI tulemused on heas vastavuses eelnevate teadmistega fütoplanktoni jaotusest neis järvedes, mille optilised omadused on võrreldavad Läänemere rannikuvetega. MCI näitab heleduse suhtelist suurust 709 nm juures, mis viitab kõrgele klorofülli sisaldusele vees (>30 mg m^{-3}) ning omab kõrgeid väärtusi pinnakogumite puhul. Peipsis ja Võrtsjärves on saadud hea seos MCI ning nii fütoplanktoni (FBM) kui ka sinivetika biomassi (CY) vahel suvekuudel, mis võimaldab hinnata õitsengu ulatust, kestvust ja intensiivsust. Mõlemad parameetrid on tunnistatud olulisteks ökoloogilisteks parameetriteks Euroopa Veedirektiivi poolt.

1. juunist käivitus uus RP7 projekt WaterS "Täiustatud vee kvaliteedi parameetrite määramine optilisest signatuurist strateegilise partnerluse abil". Kuue partneriga konsortsiumi juhib Tartu Observatoorium (A. Reinart), lisaks kuulub sellesse veel kaks teaduspartnerit: Stockholmi Ülikool ja Soome Keskkonnauuringute Instituut, ning kolm ettevõtet: Water Insight Hollandist, Brockmann Consult Saksamaalt ja Vattenfall Power Consult Rootsist. Töö eesmärk on arendada nii satelliitkaugseire kui ka lähiseire meetodeid optiliselt keerukate veekogude jälgimiseks.

T. Nilson uuris koostöös Kalifornia Ülikooli (Berkeley) meeskonnaga taimkatte analüsaatorite abil metsade lehepinnaindeksi (LAI) määramise metoodikat. Leiti, et taimkatte analüsaatori LAI-2000 mõõtmistulemuste analüüsil on otstarbekas teha logaritmiline teisendus läbipaistvuse keskmistatud lugemitele, mitte leida LAI hinnangut eraldi iga mõõtepunkti jaoks ja siis leida keskmine LAI nii nagu seda näeb ette LAI-2000 originaalmetoodika. Tulemusena saadud nn efektiivne lehepinnaindeks erineb LAI-2000 originaalmetoodika abil saadavast efektiivse lehepinnaindeksi hinnangust. Toodi sisse nn näilise grupeerumisindeksi mõiste, mis sisuliselt kirjeldabki kahe metoodika erinevusi. T. Nilson koos A. Kuuse, M. Langi, J. Piseki ja A. Kodariga tuletasid teoreetilised valemid metsa läbipaistvuse teist järku statistikute arvutamiseks. Eriline tähelepanu oli pööratud taimkatte analüsaatori LAI-2000 mõõtmiste simulatsioonile. Tuletati teoreetilised hinnangud LAI-2000 mõõtmistulemuste dispersiooni, standardhälbe ja korrelatsioonimaatriksi jaoks ning tuletati teoreetiline hinnang saamaks teada vajalike LAI-2000 mõõtepunktide arvu uuritavas metsas, et saadav LAI väärtus oleks väiksema määramatusega kui etteantud suurus.

M. Lang uuris lennukilidari andmestikust taimkatte katvuse hinnangute saamise võimalusi kolme erineva keskealise puistu näitel. Selgus, et siirdesoomännikus oli maapealse katvuse hinnanguga lähedaseim esimestel peegeldustel põhinev hinnang. Mitmerindelistes naadikaasikus ja mustikakuusikus tuleks pigem eelistada jagunemata peegeldusi katvuse hindamisel. Kõikide peegelduste ja esimeste peegelduste suhe oli käsitletav liituse hinnanguna.

U. Peterson koos J. Liiraga Tartu Ülikoolist ning T. Feldmanni ja

H. Mäemetsaga Eesti Maaülikooli Limnoloogiakeskusest analüüsis tagasivaatavalt Võrtsjärve kaldavööndi taimkatte muutusi viimase kahekümne aasta jooksul. Keskmise ruumilise lahutusega satelliidipilte ning Tartus arendatud satelliidipiltide analüüsi metoodikat kasutades õnnestus näidata, kuidas Võrtsjärve kaldavöönd on alates 1980-ndate keskpaigast üha tihedamini pilliroostunud ning vöönd ise on üha enam järve avavee suunas laienenud. Eriti märkimisväärne on kinnikasvamise protsess olnud jõgede suudmealadel.

A. Kuusk, T. Nilson, J. Kuusk ja M. Lang kasutasid Tartu Observatooriumis loodud metsade struktuuri ja peegeldusomaduste andmebaasi metsa kiirguslevimudeli FRT igakülgseks uurimiseks. Leitud süstemaatilised erinevused simulatsioonide ja mõõtmisandmete vahel näitavad kätte mudeli edasiarendamise suunad. Kõige raskemaks probleemiks on mudelile adekvaatsete algandmete tagamine.

5. juulil 2010 mõõtis eksperimentaalsatelliit Proba kujutise spektromeetriga CHRIS Järvselja katseala. See oli mitme pilvede poolt nullitud üritamise järel teine edukas mõõtmine. A. Kuusk, J. Kuusk ja M. Lang toetasid satelliidimõõtmist samaaegsete spektraalse valgustatuse mõõtmistega ning metsade atmosfäärialuste heledusspektrite mõõtmisega helikopterilt, kasutades selleks Tartu Observatooriumis J. Kuuse poolt ehitatud spektromeetreid UAVSpec3 ja UAVSpec4SWIR.

J. Envall, V. Allik ja M. Noorma alustasid tegevust uues projektis, mis seisneb elektrilise päikesepurje testimiseks vajaliku kosmosemissiooni väljatöötamises. Projekt viiakse läbi Euroopa Liidu ülikoolide ja kosmosetehnoloogiaettevõtete konsortsiumi poolt Soome Meteoroloogiainstituudi juhtimisel. Elektrilise päikesepurje idee baseerub ühel hiljutisel leiutisel, mis seisneb üliefektiivses kosmoses liikumise tehnoloogias ilma keemilist kütust kasutamata. See kasutab päikesetuule poolt laetud ioonide tekitatud jõudu kosmoses liikumiseks. Elektriline päikesepuri kujutab endast pikkade ja peente positiivselt laetud juhtmete kogumit, mis suunatakse kosmoselaevast eemale tsentrifugaaljõu mõjul. Positiivne elektrilaeng antakse juhtmetele kosmoselaeval paikneva elektronkahuri abil, mida toidetakse päikesepaneelidest saadud energiaga. Kõige esimene elektrilise päikesepurje komponentide testimine kosmoses on planeeritud viia läbi Eesti esimese satelliidi EstCube-1 missiooni käigus.

5.1 Solar UV radiation and atmospheric ozone

Analysis of UV spectra recorded since 2004 has been the major research task in 2010 (K. Eerme, M. Aun, U. Veismann, I. Ansko). Spectral composition of the available solar ultraviolet (UV) radiation is related to different environmental, biospheric, and health effects (both harmful and beneficial) as well as to modification of atmospheric photochemistry. In quantifying the effects of UV radiation and possible responses, adequate estimation of doses weighted by action spectra is a necessary precondition. In the cloud-free conditions the amount and spectral composition of UV radiation reaching the ground-level depends mainly on solar zenith angle (SZA), column ozone and atmospheric aerosol burden. Both the variations of solar direct UV irradiance and the irradiance from sky background need quantitative characterization. The attenuation of solar direct irradiance by clouds is the most effective modulator of ground-level UV irradiance. When the Sun is cloud covered, the background irradiance from cloudy and cloudless skies is a major varying contributor to the spectral composition of recorded irradiance. Despite the fact that the most widely met low and medium level overcast cloudiness is seemingly the most stable attenuating medium for the UV radiation, its CMF for most frequently met cloud types was found to vary in wide range. In the most UV rich season May to August when local noon SZA remains between 35 and 45 degrees, the average cloud modification factor (CMF) for overcast days appeared to be around 0.35, manifesting a relatively large contribution of optically thick frontal clouds. The reduction of the daily dose with increasing noon SZA in the UVA spectral range is almost equal for clear and overcast days, while in the UVB range the attenuation increased strongly with SZA. In the UVB range the daily doses at similar SZA tend to be larger in fall than in spring in both clear and overcast days due to smaller column ozone. In the UVA range the daily doses at similar SZA tend to be larger in spring. Probably due to different aerosol situations, no clear difference in the influence of SZA on CMF between low level (St, Ns) and medium level (As, Ac) overcast cloudiness has been found. A case study on aerosol attenuation of UV radiation by large aerosol optical depth (AOD) met in April-May 2006 was performed. The aerosol attenuation during large AOD episodes can be comparable to that of medium level clouds. The major difference is that the aerosol attenuation decreases with wavelength in the whole UV range and has wavelength dependency opposite to that of attenuation by clouds in the UVA range.

Atmospheric humidity is closely related to aerosol formation and atmospheric chemistry. Diurnal cycle of humidity profile is unknown, as it needs radiosoundings with high temporal resolution, but regular radiosoundings are done usually 1–2 times per day. A first short-term campaign of atmospheric soundings from the Tartu-Tõravere Meteorological Station has been performed from 9 to 12 August 2010 within the framework of collaboration with the artillery battalion of the Estonian Northeastern defence district (E. Jakobson). Vertical profiles of atmospheric temperature, moisture and wind were recorded with 3 hour resolution using the sondes DFM-06 and GRAW sounding system. The largest variations of humidity were met in the lowest 200 m layer. One of the tasks related to soundings was validation of precipitable water measured by the sun-photometer Cimel-318 at different solar zenith angles with radiosonde values at Tõravere. There is hypothesis, that Aeronet system is calibrated primarily for 12 UTC, but at other hours and solar zenith angles the discrepancies from radiosounding data are larger.

About 10 000 UV spectra have been recorded by Bentham double monochromator DMc150F-U based spectrometric system. The testing and development of the system has been continued (U. Veismann, K. Eerme).

A manuscript of monograph "Solar ultraviolet radiation and atmospheric ozone" summarizing the outcomes of studies performed at Tõravere as well as the background has been compiled and prepared for publication (U. Veismann, K. Eerme).

5.2 Earth atmosphere and climate

A collaboration with the AERONET network continues. I. Ansko and M. Aun introduced the automatic transfer of sun-photometer data to the Goddard Space Flight Center, the coordinator of the AERONET.

Changes in downward atmospheric radiation should be considered as one of the possible factors causing the global climate warming. Downward atmospheric radiation has been measured in few regions, whereas its time series are relatively short. V. Russak studied the dependence of atmospheric infrared radiation on water vapour pressure and low cloudiness measured at Tartu-Tõravere meteorological station since 2003. The preliminary results (data from 2006) have shown a high partial correlation (influence of the temperature was excluded) between atmospheric radiation and water vapour pressure in warm season (from April to September 0.72–0.93). On the contrary, the link between atmospheric radiation and low cloudiness is closest in winter (from November to February the partial correlation is 0.88–0.93). This can be explained by the annual run of cloudiness in Estonia.

Aivo Reinart has continued research in radiation transfer and aerosol modelling. A database and user-friendly control software has been developed for the Bentham Instruments Solar spectroradiometric system. The spectrometer is in operation since 2008, but online data use and storing needed to be modernized. Also for small air ions spectrometer KAIS modern control hardware and respective software development is started. Aerosol

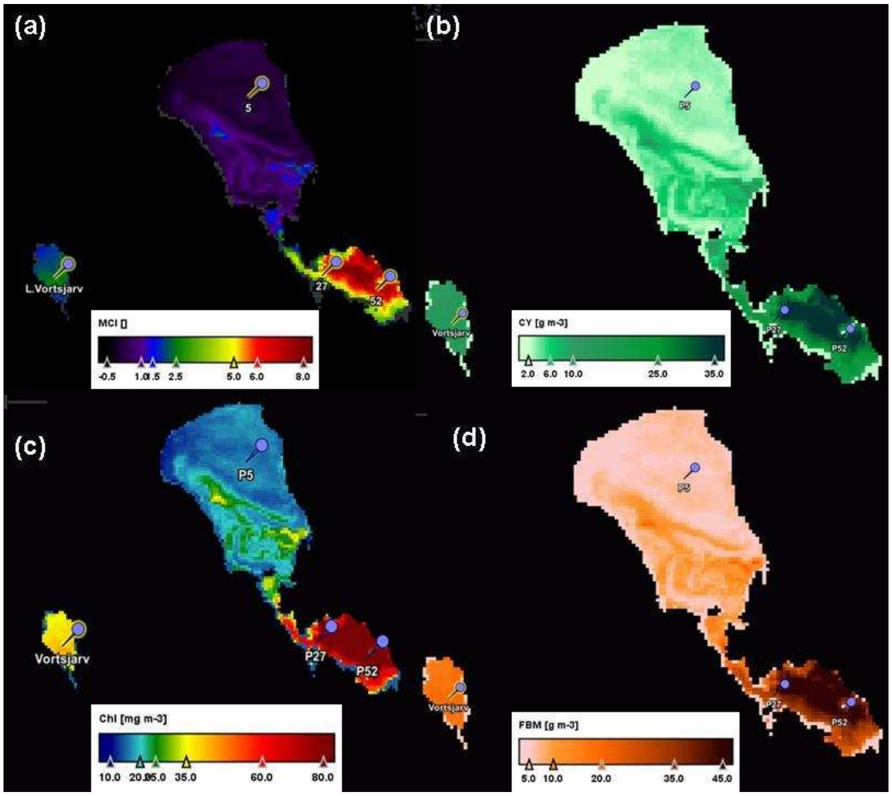


Figure 5.1: From MERIS L1 images (example 19 August 2005) various parameters for lake Peipsi are calculated using relationships between Maximum Chlorophyll Index, biomass and Chl a concentration: (a) MCI, (b) concentration of cyanobacteria, (c) Chl a concentration, (d) biomass. Kasutades MCI ning biomassi parameetrite ja Chl a vahelisi seoseid (näide 19. august 2005), arvutati kogu MERIS L1 andmetest Peipsi järve jaoks (a) MCI, (b) sinivetika kontsentratsioon (c) klorofülli kontsentratsioon, (d) kogu fütoplanktoni biomass.

database model of electrical aerosol spectrometer EAS for European Supersites for Atmospheric Aerosol Research (EUSAAR) project has been developed and data conversion to appropriate format is in progress.

5.3 Remote sensing of water bodies

Similarly to the Baltic Sea, also in large lakes cyanobacteria blooms occur regularly. According to the Water Framework Directive, estimation of water quality parameters is required. Phytoplankton biomass (FBM), cyanobacterial biomass (CY) and chlorophyll a concentration (Chl a) are considered as important ecological parameters.

We demonstrated that Maximum Chlorophyll Index (MCI) developed for optical satellite sensor MERIS processing scheme can be used to investigate seasonal dynamics, spatial distribution, and coverage of cyanobacterial blooms over Lake Peipsi (Estonia/Russia) and Lake Võrtsjärv (Estonia). It provides a new tool to detect and estimate water quality from MERIS data over optically complex waters, where amount of suspended matter and dissolved organic matter varies greatly and independently from phytoplankton variation. The MCI-derived results are consistent with known patterns of phytoplankton dynamics in these lakes (Fig. 5.1).

Figure 5.2: The measurement setup for radiance and irradiance spectroradiometers in AAOT tower. Spektroradiomeetrite paigaldus interkalibreerimise ajal mõõtetornis.

On June 1, FP7 project WaterS "Strategic partnership for improved basin-scale Water quality parameter retrieval from optical Signatures" (2010–2013) started. This consortium is leaded by Tartu Observatory (A. Reinart) and includes two more research partners Stockholm University (Sweden), Finnish Environment Institute (Finland), and three enterprises: Water Insight (The Netherlands), Brockmann Consult (Germany), Vattenfall Power Consult (Sweden). The goal is to advance both satellite and close range methods of monitoring optically complex waters in academy-industry partnership.

International activities started already in July, when we participated in intercalibration exercise in Aqua Alta Oceanographic Tower (AAOT, near Venice, Italy) and Joint Research Centre (JRC, Ispra, Italy) to evaluate the ability of different radiometric systems to reveal consistent results.

The radiometric sensitivity of the RAMSES spectroradiometers was measured before and after the field campaign in TO and JRC optical laboratory, respectively. For calibration, NIST traceable 1000 W FEL lamps were used.

5.4 Remote sensing of vegetation

Together with the team of University of California, Berkeley T. Nilson studied the methods of determination of forest leaf area index (LAI). It was found that

Figure 5.3: The measurement from the boat. Mõõtmised laevalt.

when using the plant canopy analyser LAI-2000, the logarithmic transformation of gap fraction data should be applied on the gap fractions averaged over all sample plots in the same forest stand. Thus, it is not reasonable to apply the transformation for the gap fractions in each measurement point and then find the average LAI, as it is recommended in the original method of the instrument. The values of the effective LAI estimated by the two methods are different. This difference can be described by a newly introduced index called the apparent clumping index. T. Nilson together with A. Kuusk, M. Lang, J. Pisek and A. Kodar derived the theoretical formulas to calculate the second-order statistics of random gap fraction for forest canopies. A special attention was paid to simulation of the measurements by the LAI-2000 plant canopy analyser. This analyser measures the gap fractions averaged over the view azimuth and within 15-degree view zenith angle zones. Theoretical formulas were derived for the gap fraction variance, standard deviation and correlation matrix as determined by a LAI-2000 instrument. Also an estimate for the required number of samples needed to ensure the LAI value of the stand with a given uncertainty.

Together with T. Nilson and J.M. Chen of University of Toronto, J. Pisek investigated whether it is feasible to derive the clumping index at 500 m resolution with the 16-day MODIS bidirectional reflectance distribution function model parameters product. The results were positive and they were compared with an assembled set of field measurements from 64 different sites, covering five continents and diverse biomes.

The effectiveness of using leveled digital camera for measuring leaf inclination angles was investigated by J. Pisek and Y. Ryu of Harvard University as an inexpensive and convenient alternative to existing approaches. The new method was validated with manual leaf angle measurements for various broadleaf tree species common to hemi-boreal region of Estonia and the tropical forests of Hawaii Islands. The acquired leaf angle distributions suggest that planophile case might be more appropriate than the commonly assumed spherical as the general approximation of leaf orientation while modelling the radiation transmission through the canopies of (hemi)-boreal broadleaf stands.

J. Pisek measured vertical profiles of foliage clumping in a mixed stand in Järvselja and in a native rain forest of Hawaii (together with J. M. Chen of University of Toronto and T. Giambelluca of University of Hawaii). In both stands, the increase of foliage clumping with the height from the forest floor was documented. This finding is important for validating the derived maps of foliage clumping from remote sensing data using field measurements, particularly in closed canopy forests.

M. Lang estimated canopy cover using airborne lidar data for three mature stands in Järvselja, Estonia. In the Scots pine stand growing on transitional bog, the first returns gave best estimate for ground measurements. In the Norway spruce stand and Silver birch stand growing on fertile site and having several tree layers the single and all returns gave slightly better estimate for ground measurements compared to the first returns.

U. Peterson together with J. Liira from University of Tartu and T. Feldmann and H. Mäemets from Centre for Limnology, Estonian University of Life Sciences made use of the more than 20-year archive of medium resolution Landsat TM and ETM+ satellite images to examine the change in coastal vegetation of a large shallow Lake Võrtsjärv, the second largest lake in the Baltic countries. Late summer satellite images were used for estimation of emergent macrophyte dynamics in a large lake in the shortage (absence) of ground data. The satellite images revealed the generally expanding changes in the coastal reed areas within the last 22 years, during the period of recession of agricultural activities in Estonia.

The shallow Lake Võrtsjärv showed a tendency to overgrow with reed and other helophytic macrophytes even in conditions, where eutrophication of inflows has reduced, which indicates a need for direct management activities along coast. Housing and other signs of anthropogenic interest along the coastline had a marginally negative impact on coastal reed. That was supported by presence of small inflows, which are frequently used as boat channels. However, the channels cut into reed are too narrow relative to the medium spatial resolution Landsat TM pixel size and the major effect of housings at the lakeshore is caused by seasonal holiday houses creating major openings in the encroaching reeds. The presence of major inlets and their estuaries in regions was the major factor of reed expansion. However, no clear eutrophication-related factor of the lake as a whole was found to explain the vegetation change over the study years while as the N and P contents in the lake were decreasing.

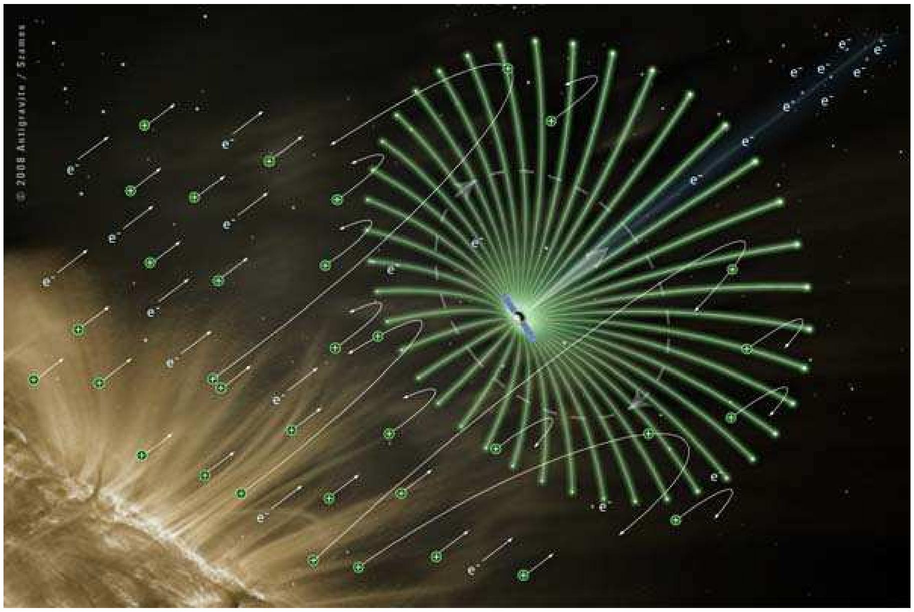
The database of forest structure and optical properties built at Tartu Observatory was used for the validation of the forest reflectance model FRT, developed at Tartu Observatory. Model simulations using all available data on stand structure and optical properties in the database were compared to the helicopter measurements of the top-of-canopy reflectance spectra of a birch, pine and spruce stands by A. Kuusk, T. Nilson, J. Kuusk and M. Lang. The comparison of measurements and simulated reflectance spectra revealed several problems of the model. As the FRT positions well in the comparison to other models in the third phase of radiative transfer model intercomparison RAMI, similar problems are expected in other canopy reflectance models as well. Anyway, the basic radiative transfer features are adequately described by the FRT model. In case of problems in fitting the measured reflectance spectra, the major problems are how adequately we are able to simulate the particular stand structure nad optical properties of the foliage elements in the canopy and understorey.

On July 5th the experimental satellite Proba measured the Järvselja test site with imaging spectrometer CHRIS at five view directions. This was the second successful attempt to measure the testsite. The previous successful acquisition was on July 10, 2005. Attempts to carry out a repeated measurements in 2007, 2008, and 2009 failed due to clouds. Satellite measurement was supported by A. Kuusk, M. Lang and J. Kuusk by simultaneous sunphotometer measurements and incident radiation spectra measurements at the test site, and by simultaneous helicopter measurements with spectrometers UAVSpec3 and UAVSpec4SWIR.

J. Kuusk studied the characteristics of the BRF (bidirectional reflectance factor) sensor incorporated in the UAVSpec3 instrument. It is a 256-pixel linear Si array detector with a bandpass filter and a wide angle lens. It has 140^0 along-track field-of-view and 10^0 cross-track field-of-view. The lens projects one transect along the flight path to the detector array and when the aircraft flies over a target, the reflectance from different view angles is recorded. Red (660 nm) and NIR (850 nm) filters with 10 nm bandwidth have been used for field measurements. The dark signal temperature dependence and the instrument function of the BRF sensor were measured. Data processing toolchain for the BRF sensor was developed by J. Kuusk and M. Lang.

5.5 Space technology

J. Envall, V. Allik and M. Noorma have started new project belonging to the consortium for developing the Electric Solar Wind Sail (FP7 ESAIL), leaded by Finnish Meteorological Institute. This idea bases on recent invention of



Artist view about Electric Solar Sail (Janhunen et al. 2010). Kunstniku nägemus elektrilisest päikesepurjest.

ultra-efficient propellantless in-space propulsion technology. It uses the solar wind charged ions as natural source for producing spacecraft thrust. The E-sail is composed of a set of long, thin, conducting and positively charged tethers which are centrifugally stretched from the main spacecraft and kept electrically charged by an onboard electron gun powered by solar panels. First space-test of the sail components is planned on the Estonian Student satellite EstCube1.

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6.3 Popular Articles Aimeartiklid

6.3.1 Astronomy Astronoomia

Annuk K.: Tagasivaade rahvusvahelisele astronoomia aastale. *Tähetorni Kalender 2011*, 77–84, 2010.

Einasto J.: In Memoriam. Geoffrey Burbidge. *Tähetorni Kalender 2011*, 125–127, 2010.

Einasto J.: In Memoriam. John Huchra. *Tähetorni Kalender 2011*, 128–130, 2010.

Einasto J.: In Memoriam. Allan Sandage. *Tähetorni Kalender 2011*, 131–134, 2010.

Haud U.: Dwingeloo Raadioobservatoorium. *TEA Entsüklopeedia, 5. köide*, Tallinn, TEA Kirjastus, 361–362, 2010.

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Kuutma T.: NASA Fermi teleskoop avastas uue struktuuri Linnutee galaktikas. *Vaatleja*, 29.11.2010.

Leedjärv L.: Kosmilistest gaasijugadest. Miks astronoomid neid uurivad? *Horisont 6*, 6, 2010.

Leedjärv L.: Tumeda energia abil naabritele külla. *Tarkade Klubi, Erinumber 2010*, 40–41, 2010.

Leedjärv L.: Teekaart näitab Eestile suunda kosmose poole. *Tähetorni Kalender 2011*, 87–107, 2010.

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Liimets T., Corradi R.: Observing Stellar Evolution in Real Time. *Nordic Optical Telescope Annual Report 2009*, 15–17, 2010.

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Pustynski V.-V.: Kuidas töötab tahkekütuse rakettmootor. *Tallinna Tähetorni Kalender,* 53–60, 2010.

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Tempel E.: ESO parimad pildid tähistaevast. *Vaatleja*, 11.10.2010.
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Tempel E.: Tähetekkepiirkond Väikeses Magalhãesi Pilves. *Vaatleja*, 19.10.2010.
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Tempel E.: Kust on pärit Universumi ehituskivid? *Vaatleja*, 17.12.2010.
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Tuvikene T.: Esimene spekter ümber kauge tähe tiirlevast planeedist. *Vaatleja*, 13.01.2010.
Tuvikene T.: Alanud aastakümne parim Marsi vastasseis. *Vaatleja*, 24.01.2010.
Tuvikene T.: Marsi vastasseis 2010: soovitusi vaatlemiseks. *Vaatleja*, 26.01.2010.
Tuvikene T.: Amatöörastronoomid avastasid korduvnoova plahvatuse. *Vaatleja*, 01.02.2010.
Tuvikene T.: Asteroidi ebatavaline saba viitab kokkupõrkele. *Vaatleja*, 05.02.2010.
Tuvikene T.: Mõõduka temperatuuriga eksoplaneet. *Vaatleja*, 23.03.2010.
Tuvikene T.: Maailma suurim teleskoop E-ELT ehitatakse Cerro Armazonese tippu. *Vaatleja*, 27.05.2010.
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Tuvikene T.: Tähistaeva retk nr. 2: Albireo ja Gamma Andromedae. *Vaatleja*, 28.11.2010.
Viik T.: Suhtlus maapealse tsivilisatsiooniga. *Tarkade Klubi 4*, 32–33, 2010.
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6.3.2 Atmospheric physics Atmosfäärifüüsika

Eerme K.: Miks Pluuto ei sobi planeetide hulka? *Kalender 2011*, Olion, Tallinn, 90–92, 2010.
Eerme K., Russak V., Kuusk A.: TEA entsüklopeedia artiklid atmosfääriteaduste ja meteoroloogia alal.
Veismann U.: TEA entsüklopeedia artiklid kosmose valdkonnas.

6.3.3 Other papers Muud artiklid

Leedjärv L.: Kuidas ma esimest korda Soomes käisin. *Nõo Valla Leht 7 (160); 9 (162)*, 2010.
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6.4 Preprints Preprindid

Cirelli M., Corcella G., Hektor A., *Hütsi G.*, Kadastik M., Panci P., Raidal M., Sala F., Strumia A.: PPPC 4 DM ID: A Poor Particle Physicist Cookbook for Dark Matter Indirect Detection. [arXiv:1012.4515].
Einasto J.: Two Hundred Years of Galactic Studies in Tartu Observatory. [arXiv: 1010.3977].
Einasto J., Hütsi G., Saar E., Suhhonenko I., Liivamägi L.J., Einasto M., Müller V., Starobinsky A.A., *Tago E., Tempel E.*: Wavelet Analysis of the Formation of the Cosmic Web. [arXiv: 1012.3550].
Haud U.: Gaussian Decomposition of HI Surveys. V. Search for Very Cold Clouds. [arXiv: 1001.4155].

Haud U.: Tähesüsteemide ja galaktikate füüsika. [http://www.aai.ee/∼ urmas/UT, 1–226].

Hütsi G., Hektor A., Raidal M: Implications of the Fermi-LAT Diffuse Gamma-ray Measurements on Annihilating or Decaying Dark Matter. [arXiv:1004.2036].

Liivamägi L.J., Tempel E., Saar E.: SDSS DR7 Superclusters. The Catalogues. [arXiv:1012.1989].

Sato T., *Hütsi G.,* Yamamoto K.: Deconvolution of Window Effect in Galaxy Power Spectrum Analysis. [arXiv:1010.0289].

Shore S.N., Wahlgren G.M., Augusteijn T., *Liimets T.,* Page K.L., Osborne J.P., Beardmore A.P., Koubsky P., Łlechta M., Votruba V.: The Spectroscopic Evolution of the Symbiotic-Like Recurrent Nova V407 Cygni During its 2010 Outburst. I. The Shock and its Evolution [arXiv: 1012.4847].

Suhhonenko I., Einasto J., Liivamägi L.J., Saar E., Einasto M., Hütsi G., Müller V., Starobinsky A.A., *Tago E., Tempel E.*: The Cosmic Web Density Perturbations of Various Scales. [arXiv:1101.0123].

Tempel E., Saar E., Liivamägi L.J., Tamm A., Einasto J., Einasto M., Müller V.: Galaxy Morphology, Luminosity and Environment in the SDSS DR7. [arXiv:1012.1470].

Tempel E., Tuvikene T., Tamm A., Tenjes P.: SDSS Surface Photometry of M31 with Absorption Corrections. [arXiv:1012.3591].

7 Meetings Konverentsid ja seminarid

7.1 Astronomy Astronoomia

Closing Ceremony of the International Year of Astronomy (Padova, Italy, 09.01.–10.01.2010) – K. Annuk.

ASTRONET Workshop on Joint Call (Hamburg, Germany, 08.02.–09.02.2010) – L. Leedjärv.

Astronomical Seminar (Baltimore University, USA, 19.04.2010) – J. Einasto.
Einasto J.: Large Scale Structure Studies in Tartu.

Board of Directors Meeting, "Astronomy and Astrophysics" (Budapest, Hungary, 08.05.2010) – L. Leedjärv.

Nordic Astrophysics 2010 (Visby, Gotland, Sweden, 25.05.–28.05.2010) – I. Vurm.
Vurm I.: Mechanisms of Gamma-Ray Burst Emission (invited report).

University of Tartu Seminar "Professor Taavet Rootsmäe 125" (Tartu, 25.05.2010) – J. Einasto, L. Leedjärv, A. Tamm, M. Ruusalepp, E. Tago, T. Viik.
Einasto J.: Professor Taavet Rootsmäe kui õpetaja (oral presentation).
Tamm A.: 50 aastat hiljem: Taavet Rootsmäe vaimne pärand (oral presentation).

Symposium "Gaia: at the Frontiers of Astrometry". ELSA Conference 2010 (Sèvres, France, 07.06.–11.06.2010) – L. Leedjärv.

CSC Summer School in Scientific and High-Performance Computing (Espoo, Finland, 12.06.–20.06.2010) – E. Tempel, L. J. Liivamägi.

A Universe of Dwarf Galaxies. CRAL-IPNL Conference (Lyon, France, 14.06.–18.06.2010) – J. Vennik.
Vennik J., Hopp U.: Dwarf Galaxies in Nearby Groups of Galaxies (poster).

Cosmic Horizons in Astronomy and Geodesy (Kazan, Russia, 07.07.–11.07.2010) – L. Sapar.

2nd Galileo – Xu Guangqi Meeting (Ventimiglia, Italy, 12.07.–18.07.2010) – J. Einasto, G. Hütsi.
Einasto J., Hütsi G.: Large Scale Structure of the Universe – a Powerful Probe for Fundamental Physics (invited talk).

Planck WG5 and SZ-Validation Team Meeting (Paris, France, 15.07.–16.07.2010) – E. Saar.

IAU Symposium 272 "Active OB Stars: Structure, Evolution, Mass Loss and Critical Limits" (Paris, France, 19.07.–23.07.2010) – K. Annuk.
Annuk K.: Spectral Variation of BU Tau (poster).

Galaxy Clusters: Observations, Physics and Cosmology (Garching bei München, Germany, 26.07.–30.07.2010) – G. Hütsi.
Hütsi G.: Power Spectrum of the maxBCG Sample: Detection of Acoustic Oscillations Using Galaxy Clusters (poster).

Simulation Methods in Astrophysics (Summer School of Finnish Graduate School in Astronomy and Space Physics) (Mariehamn, Finland, 16.08.–20.08.2010) – I. Vurm.

Vurm I.: Electron Thermalization and Emission from Magnetized Compact Sources (oral presentation).

Tuorla-Tartu Annual Meeting 2010: Observational Cosmology (Tuorla, Finland, 02.09.–03.09.2010) – M. Gramann, A. Tamm, E. Tempel, E. Saar, T. Sepp, T. Liimets, L.J. Liivamägi.

Tamm A.: Prospects of Galaxy Physics with ESO Facilities (oral presentation).

Saar E.: Traces of Baryon Oscillations (oral presentation).

Liivamägi L.J.: Superslusters in the SDSS DR7 (oral presentation).

IRAP PhD Erasmus Mundus School (Nice, France, 06.09.–10.09.2010) – J. Einasto, G. Hütsi.

Einasto J.: Large Scale Structure of the Universe I. Introduction (oral presentation),

Einasto J.: Large Scale Structure of the Universe II. Quantitative Analysis (oral presentation)

Einasto J.: Large Scale Structure of the Universe III. Dark Matter (oral presentation),

Einasto J.: Large Scale Structure of the Universe IV. Cosmological Parameters and Dark Energy (oral presentation),

Einasto J.: Large Scale Structure of the Universe V. Formation and Evolution (oral presentation).

JENAM 2010, The European Week of Astronomy and Space Science (Lisbon, Portugal, 06.09.–10.09.2010) – V.-V. Pustynski, J. Vennik.

Vennik J., Hopp U.: Dwarf Galaxies in Nearby Groups of Galaxies: Photometric Properties (poster and oral summary).

Pustynski V.-V., Pustylnik I.: On Formation of EHB Objects in Close Binary Systems (poster).

IAU Symposium 275 "Jets at All Scales" (Buenos Aires, Argentina, 13.09.–17.09.2010) – L. Leedjärv.

The 20th Workshop on General Relativity and Gravitation (Kyoto, Japan, 19.09.–05.10.2010) – M. Saal.

ASTRONET Board Meeting (Paris, France, 21.09.–22.09.2010) – L. Leedjärv.

Seminar at the University of Tartu (Tartu, 24.09.2010) – J. Einasto.

Einasto J.: The Structure and Evolution of the Universe (oral presentation).

Astronomical seminar (University of Helsinki, Finland, 01.10.2010) – J. Pelt.

Pelt J.: Analysis of Photometric Time Series with the Carrier Fit Method and Application to II Peg (oral presentation).

Novejshie metody issledovanija kosmicheskih objektov (Kazan, Russia, 07.10.–10.10.2010) – V.-V. Pustynski.
Pustynski V.-V.: Influence of Parameters of Precataclysmic Binary Systems on Their Light Curves (poster).
Virtual Institute of Astroparticle Physics (Paris via Internet, France, 29.10.2010) – J. Einasto.
Einasto J.: Large Scale Structure of the Universe – Current Problems (oral presentation).
Planck WG and Product Early Papers Meeting (Bologna, Italy, 08.11.–10.11.2010) – E. Saar.
IAU Symposium 277 "Tracing the Ancestry of Galaxies" (Ouagadougou, Burkina Faso, 13.12.–17.12.2010) – A. Tamm.
Tamm A.: Stellar Populations and dark matter in M31 (poster).

7.2 Atmospheric physics Atmosfäärifüüsika

Konverents "145 aastat Tartu Ülikooli Meteoroloogiaobservatooriumi avamisest ja 60 aastat Tartu - Tõravere meteoroloogiajaama asutamisest" (Tõravere, 01.02.2010) – V. Russak.
Russak V.: Kiirgustingimuste põhijooni Tõraveres (oral presentation).
Forest Ecosystems and Climate Change (Belgrade, Serbia, 09.03.–10.03.2010) – M. Lang.
Lang M.: Passive Terrestrial Optical Measurements for Assessing Climate Change Impacts on Forest Canopies (oral presentation).
GMES Seminar (Sofia, Bulgaria, 24.03.–26.03.2010) – A. Reinart.
MVT (MERIS Validation Team) Regular Meeting (Lauenburg, Germany, 28.03.–31.03.2010) – I. Ansko, K. Alikas.
Alikas K.: Validation of Chl a Product Over Large Lakes and Coastal Areas (oral presentation).
Eesti XI Ökoloogiakonverents (Tartu, Estonia, 08.04.–09.04.2010) – U. Peterson, T. Nilson, M. Lang, T. Lükk.
Nilson T., Lang M., Lükk T., Eenmäe A., *Pisek J.*: Eesti taimkatte süsinikubilansi kaugseirest (oral presentation).
Peterson U., Liira J., Feldmann T., Mäemets H.: Kaks aastakümmet kaldaveetaimestiku laienemist Eesti suurjärvede – Võrtsjärve ja Peipsi järve kaugseirepiltide retrospektiivses aegreas (oral presentation).
Eesti Statistikaseltsi 22. konverents "Statistika ja eluteadused" (Tartu, Estonia, 13.04.–14.04.2010) – U. Peterson, J. Pelt.
Peterson U., Liira J.: Kahe muutuja moodustatud bimodaalse ühisjaotuse klassifitseerimine (oral presentation).
BSRN Workshop (Queenstown, New Zealand, 13.04.–16.04.2010).
Russak V., Kallis A., Ohvril H., Jõeveer A., Tomson T., Neiman L., Okulov O.: Solar Radiation Measurements in Estonia (poster).

Space Donwstream Services Conference (Tallinn, Estonia, 05.05.–07.05.2010) – U. Peterson, A. Reinart.
Peterson U.: Remote Sensing in Terrestrial Environmental Monitoring Programme in Estonia (oral presentation).

Nordic Ozone Group (NOG) Meeting 2010 (Warsaw, Poland, 15.04.–16.04.2010) – K. Eerme.
Eerme K., Ansko I., Veismann U., Prüssel M.: UV Radiation and Related Atmospheric Research at the Tartu Observatory, Estonia (oral presentation).

PhD Training Course for Sea-Truthing (Askä island, Sweden,16.05.–23.05.2010) – I. Ansko, K. Alikas, M. Ligi.
Ansko I.: TriOS RAMSES Spectroradiometers for Water Remote Sensing (oral presentation).
Alikas K.: Remote Sensing and Optical Properties of Lakes (oral presentation).
Alikas K.: How to Check MERIS Overpass Times on EOLI-SA, MERCI Server and MIRAVI Database (oral presentation).

GMES Seminar (Brussels, Belgium, 02.06.–03.06.2010) – A. Reinart.

2nd Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing (WHISPERS 2010), (Reykjavik, Iceland, 14.06.–16.06.2010) – J. Kuusk, A. Kuusk.
Kuusk J., Kuusk A.: Autonomous Lightweight Airborne Spectrometers for Ground Reflectance Measurements (oral presentation, the best paper award).
Kuusk A., Kuusk J., Lang M., Nilson T.: Reflectance Spectra of RAMI Stands in Estonia (poster).

Conference ESA Living Planet Symposium and Joint Seminar in Norwegian Institute of Water Resesarch NIVA (Bergen, Norway, 28.06.–02.07.2010) – I. Ansko, A. Reinart, M. Noorma, K. Alikas, M. Ligi, K. Kangro.
Alikas K., Kangro K., Ansko I., Reinart A.: Detecting Cyanobacterial Blooms in Large Lakes and Baltic Sea using MERIS Images (oral presentation).

Eesti-Vene piiriveekogude kaitse ja kasutamise ühiskomisjoni seire, hinnangu ja rakendusuuringute töörühma teadusseminar (Haapsalu, Estonia, 29.06.2010) – U. Peterson.
Peterson U., Liira J.: Piiriveekogude kaldataimestiku ja valgala maakasutuse kaugseire võimalused ja kogemused (oral presentation).

Tartu Ülikooli atmosfäärifüüsika seminar (Tartu, Estonia, 30.06.2010) – V. Russak.
Russak V.: Atmosfääri kiirgusrežiimi seos õhutemperatuuriga (oral presentation).

Intercalibration Campaign of Measurement Instruments ARC-2000 (Venice and Ispra, Italy, 19.07.–06.08.2010) – I. Ansko, A. Reinart.

IEEE International Geoscience & Remote Sensing Symposium (Honolulu, Hawaii, USA, 25.07.–30.07.2010) – J. Pisek, K. Alikas.

Pisek J., Lang M., Nilson T.: Measurements of Canopy Nonrandomness at Järvselja RAMI (RAdiation transfer Model Intercomparison) Test Sites (poster).

Summer School (Ventspils, Latvia, 08.08.–14.08.2010) – S. Lätt.

Seminar with EstSpacE AS Group members (Hamburg, Germany, 17.08.–20.08.2010) – A. Reinart.

Summer School for Students of Remote Sensing (Valmiera, Latvia, 21.08.–24.08.2010) – K. Alikas.

Joint NASA-LCLUC Science Team Meeting and GOFC-GOLD/NERIN, NEESPI Workshop on Monitoring Land Cover and Land Use in Boreal and Temperate Eurasia (Tartu, Estonia, 25.08.–28.08.2010) – T. Nilson, A. Kuusk, J. Kuusk, U. Peterson, J. Pisek.

Nilson T.: Monitoring Vegetation: Theoretical Basis (oral presentation).

Peterson U.: Land Use and Land Cover in Environmental Monitoring Programme in Estonia (oral presentation).

Kuusk A., Kuusk J., Lang M.: Database for the Validation of Forest Reflectance Models (poster).

Nilson T., Lang M., Lükk T., Eenmäe A., *Pisek J.*: Remote Sensing of Estonian Vegetation-Related Carbon Budget Components (poster).

Pisek J., Chen J., *Nilson T.*: Estimation of Vegetation Clumping Index Using MODIS BRDF Data (poster).

ForestSat2010 (Lugo, Spain, 07.09.–10.09.2010) – M. Lang.

Lang M.: New Approach to Estimate Forest Canopy Indices from Digital Hemispherical Images (oral presentation).

Kodar A., *Lang M., Nilson T.*: Leaf Area Index Measurements and Mapping of Forest Canopies in VALERI Estonian Test Site in Järvselja (poster).

EPSC2010 Conference (Rome, Italy, 19.09.–25.09.2010) – M. Noorma.

IUFRO Landscape Ecology International Conference (Bragança, Portugal, 22.09.–27.09 2010) – U. Peterson.

XI International Comparisons of Pyrheliometers (Davos, Switzerland, 27.09.–15.10.2010) – V. Russak.

Kallis A., Ohvril H., *Russak V.*: Measurements of Solar Radiation in Estonia (oral presentation).

Kallis A., *Russak V.*, Ohvril H.: Changes in Solar Radiation Climate (oral presentation).

Noorgeograafide sügissümpoosion "Lendav maailm" (Tõstamaa, Estonia, 01.10.–03.10.2010) – K. Alikas.

Alikas K.: Sinivetikateõitsengu kaardistamisest satelliidiandmetega (oral presentation).

NanoSpace AB Seminar (Uppsala, Sweden, 12.10.–13.10.2010) – J. Envall.

Business Models in EO Domain Seminar (Hamburg, Germany, 24.10.–26.10.2010) – A. Reinart, S. Lätt.

Negotiations at SNSB (Stockholm, Sweden, 28.10.–29.10.2010) – A. Reinart.

Seirefoorum 2010 (Tallinn, Estonia, 04.11.2010) – K. Eerme, K. Alikas.

REGIOCLIMA "Open Days" Seminar (Tartu, Estonia, 15.11.2010) – K. Eerme, V. Russak.

WaterS PMB Meeting (Frascati, Italy, 16.11.–19.11.2010) – A. Reinart.

Russian Open Symposium "Current Problems of Earth Remote Sensing from Space" (Moscow, Russia, 15.11.–19.11.2010) – J. Pisek.
Pisek J., Nilson T., Kuusk A.: Physically Based Remote Sensing Methods and the Remaining Challenges of Monitoring Vegetation: New Angles on an Old Problem (invited oral presentation).

ESAIL Project Meeting (Finnish Meteorological Institute, Helsinki, Finland, 08.12.– 09.12.2010) – V. Allik, J. Envall, M. Noorma.

7.3 Miscellaneous Muud koosolekud ja ettevõtmised

Valgustehnika konverents (Tallinn, Estonia, TTÜ, 20.01.2010) – U. Veismann.

1st Baltic Space Roundtable (Tallinn, Estonia, 26.01.2010) – L. Leedjärv.
Leedjärv L.: Space Science in Estonia (oral presentation).

14th ISU Annual International Symposium "The Public Face of Space" (Strasbourg, France, 16.02.–18.02.2010) – L. Leedjärv, M. Noorma, A. Reinart.
Reinart Anu, Noorma M., Kolk A., Reinsalu K.: Estonian Activities Towards Sustainable Space Program via International Collaboration (poster).
Lätt S., Kvell U., Voormansik K., *Envall J., Noorma M.*: Social Impact of Estonian Student Satellite Program (oral presentation).

Meeting on the European Union Space Issues (Brussels, Belgium, 09.03.2010) – L. Leedjärv.

Conference on Space and Security (Madrid, Spain, 10.03.–11.03.2010)– L. Leedjärv.

Terminoloogia arendamise nõupidamine / ETER aastakoosolek (Tallinn, Estonia, 06.05.2010) – U. Veismann.

Meeting on the European Union Space Issues (Brussels, Belgium, 03.06.2010) – L. Leedjärv.

The 24th International Baltic Conference of History of Science (Tallinn, Estonia, 08.09.–09.09.2010) – T. Viik.
Viik T.: Heinrich Christian Schumacher – Geodesist and Astronomer (oral presentation).

Struve Arc Coordinating Committee Meeting (Vilnius, Lithuania, 15.09.–18.09.2010) – T. Viik.

Viik T: Heinrich Christian Schumacher – Geodesist and Astronomer (oral presentation).

Signing the ESA–Estonia PECS Agreement (Paris, France, 21.09.–22.09.2010) – A. Reinart, L. Leedjärv, S. Lätt.

European High-Level Space Policy Group Meeting (Brussels, Belgium, 13.10.2010) – L. Leedjärv.

Teadusmeedia konverents "Teadusrikkuse levialas" (Tallinn, Estonia, 28.10.–29.10.2010) – I. Kolka, T. Tuvikene, M. Ruusalepp, U. Veismann.

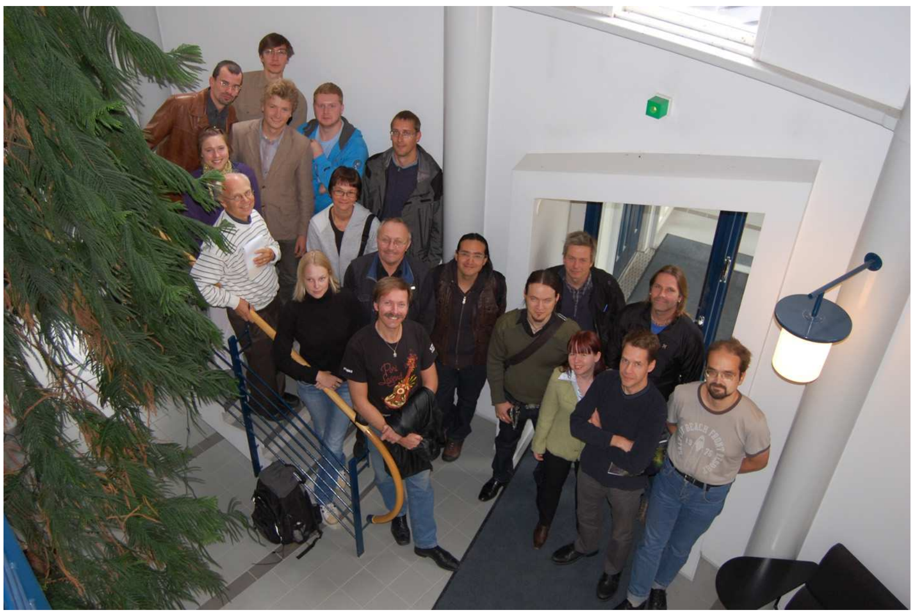
European High-Level Space Policy Group Meeting (Paris, France, 03.11.2010) – L. Leedjärv.

Workshop for FP7 Project Leaders (Brussels, Belgium, 28.11.–30.11.2010) – T. Lillemaa.

7.4 Meetings at Tartu Observatory Tartu Observatooriumis korraldatud konverentsid

7.4.1 Tuorla-Tartu Annual meeting 2010: Observational Cosmology

Tuorla-Tartu (Tartu-Tuorla) cosmology meetings have already a long tradition. These meetings are held annually, one year in Tartu, next in Tuorla. The topics cover all aspects of cosmology and astrophysics. The participants are mainly from the two observatories, but a substantial number of them come from all over Europe – from other institutes and observatories in Finland and Estonia, but also from Sweden, Great Britain, Spain, Germany, Italy. The number of registered participants this year was 31.



Participants of the Meeting. Konverentsist osavõtjad.

Every meeting has its main topics. This year the topics was observational cosmology. As a special unit, FINCA (Finnish Centre for Astronomy with ESO) was born at Tuorla Observatory this year, we used the expertise of the FINCA people to learn how to propose cosmological observing programs, and presented plans for the future.

As usual, the Tuorla-Tartu meetings are concluded with an international cosmological football match. This is always a lively occasion; this year the guests won by 7:6.

Football match. Jalgpallimäng.

Presentations from Tartu Observatory:

- *Antti Tamm*: Prospects of Galaxy Physics with ESO Facilities.
- *Enn Saar*: Traces of Baryon Oscillations.
- *Lauri Juhan Liivamägi*: Superclusters in the SDSS DR7 .

Tuorla–Tartu aastakonverents 2010: vaatluslik kosmoloogia

Tuorla-Tartu (Tartu-Tuorla) kosmoloogiakonverentsidel on juba pikk ajalugu. Need toimuvad igal aastal, kord Tartus, kord Tuorlas, teemad on nii kosmoloogiast kui kogu astrofüüsikast. Osalevad peamiselt mõlema observatooriumi töötajad, kuid osavõtjaid on ka mujalt Europast – teistest Soome ja Eesti instituutidest ja observatooriumidest kui ka Rootsist, Suurbritanniast, Hispaaniast, Saksamaalt, Itaaliast. Konverentsist osavõtjaid oli sel aastal 31. Igal konverentsil on oma peateema. Sellel aastal oli see vaatluslik kosmoloogia. Kuna sel aastal sündis Tuorla Obsevatooriumi juures eriline asutus, FINCA (Soome Astronoomiakeskus ESO'ga koostööks), kasutasime me FINCA rahva kogemusi, et õppida, kuidas esitada kosmoloogilisi vaatlusprogramme, ja esitasime oma tulevikuplaane.

Tuorla-Tartu konverentsid lõpevad alati rahvusvahelise kosmoloogilise jalgpallimänguga. See on lõbus ja dramaatiline sündmus; sel aastal võitsid külalised skooriga 7:6.

7.4.2 Monitoring Land Cover and Land Use in Boreal and Temperate Europe Joint NASA LCLUC Science Team Meeting and GOFC-GOLD/NERIN, NEESPI Workshop Maakatte ja -kasutuse muutuste jälgimine Euroopa subarktilises ja parasvöötmes

NASA Land-Cover/Land-Use Change (LCLUC) Science Team meeting was held jointly with the GOFC-GOLD Northern Eurasia Regional Information Network (NERIN) and the Northern Eurasia Earth Science Partnership Initiative (NEESPI) on August 25–28 in Tartu, Estonia. The focus of this meeting was on monitoring processes related to land-cover and land-use change in boreal and temperate regions of central, eastern and northern Europe. Forests and other biomes in boreal and temperate zones comprise about a half of the world vegetation cover. The workshop was organized to study the processes in the boreal and temperate ecosystems in the context of land-cover/land-use change – climate interactions. Four themes were at the focus of the workshop: (1) Changes in ecosystems, their composition and structure; (2) Carbon Cycle; (3) Water Cycle; and (4) Human dimensions of land-cover and land-use change. The overall goal of the meeting was to review the availability of satellite data, products, approaches and concepts for land monitoring in boreal and temperate ecosystems of Europe. Additionally, the meeting aimed to define the requirements for land-cover and land-use characterization that address the needs of all data users in these regions, including the community of scientists working on regional environmental issues. Presentations and discussions gave an overview of recent research accomplishments and the state of the art in this research area. Future research directions and applications development needs were formulated during the meeting. The scientists explored an opportunities for coordination and collaboration among research teams and ongoing projects aimed to advance our understanding of ecosystem processes in boreal and temperate zones and their socioeconomic effects. Tartu Observatory was the host of the meeting. Meeting details can be found on the LCLUC Website *http://lcluc.hq.nasa.gov*. Workshop Coordinators were Dr. Yuri Knyazikhin from Boston University, Boston, USA, Dr. Chris Justice from University of Maryland, USA, Dr. Olga N. Krankina from Oregon State University, Corvallis, USA and Dr. Matti Mõttus from Tartu Observatory, Tartu, Estonia.

Presentations from Tartu Observatory:

Mõttus M.: LCLUC Related Projects at Tartu Observatory, Tõravere (oral presentation).

Peterson U.: Land Use and Land Cover in Environmental Monitoring Programme in Estonia (oral presentation).

Nilson T.: Monitoring Vegetation: Theoretical Basis (oral presentation).

Reinart A.: Monitoring Water Quality in the Baltic region (oral presentation).

Participants of the Meeting. Konverentsist osavõtjad.

Noorma M.: Overview of University Programs on Land Remote Sensing in the Baltic States (oral presentation).

Knyazikhin Y., Schull M.A., Stenberg P., Rautiainen M., *Mõttus M.*: Monitoring Canopy Structure Across Multiple Scales from Leaves to Canopies and Stands (poster).

Stenberg P., Rautiainen M., *Mõttus M.*, Heiskanen J.: A New Method for Estimating Vegetation Cover Properties in Fennoscandia (poster).

Pisek J.: Comparison of Methods for Measuring Gap Size Distribution and Canopy Nonrandomness at Järvselja RAMI (RAdiation transfer Model Intercomparison) Test Sites (poster).

Pisek J.: Estimation of Vegetation Clumping Index Using MODIS BRDF/Albedo Product Data (poster).

Nilson T.: Remote Sensing of Vegetation-Related Carbon Budget Components in Estonia (poster).

Kuusk A.: A Database for the Validation of Forest Reflectance Models (poster).

25.–28. augustini 2010 toimus Tartus Atlantise konverentsikeskuses NASA maakattemuutuste programmis osalevate teadlaste ühiskonverents koos kolleegidega vastavatest Põhja-Euraasia koostööprogrammidest (GOFC-GOLD/NERIN ja NEESPI). Konverentsi ”Maakatte ja -kasutuse muutuste jälgimine Euroopa subarktilises ja parasvöötmes” keskmes oli maakatte ja maa kasutusotstarbe muutustega (näiteks metsast põlluks või vastupidi) seotud protsessid Kesk-, Ida- ja Põhja-Euroopas. Nelja päeva jooksul arutati juurdepääsu satelliitseire andmetele, nende kasutusvõimalusi ning satelliidipiltide töötlusmeetodite täiendamist. Tartusse kogunes 60 teadlast 11 eri riigist, lisaks Eestile ka Bulgaariast, Tšehhimaalt, Soomest, Saksamaalt, Ungarist, Itaaliast, Lätist, Venemaalt, Slovakkiast ja Ameerika Ühendriikidest. Konverentsi avas haridus- ja teadusminister Tõnis Lukas. Konverentsi Eesti-poolseks korraldajaks oli Tartu Observatoorium. Osalenud programmide kodulehed:

NASA LCLUC: Land Cover and Land Use Change Program, *http://lcluc.umd.edu/*,
GOFC-GOLD/NERIN: Global Observation of Forest and Land Cover Dynamics, Northern Eurasia Regional Information Network, *http://www.fao.org/gtos/gofc-gold/net-NERIN.html*,
NEESPI: Northern Eurasian Earth Science Partnership Initiative, *http://neespi.org/*

7.5 Meetings organized by EstSpacE team at Tartu Observatory. EstSpacE grupi poolt korraldatud üritused Tartu Observatooriumis

7.5.1 Space Downstream Services 2010 International Conference Boosting the Competitiveness of Business & Science: Satellite Services in Modern Society

Space Downstream Services 2010 International Conference was organized by EstSpacE team in cooperation with partners from May 5th to 7th 2010 in Swissôtel Conference Centre, Tallinn, Estonia. The event brought together about 300 specialists from Baltic and Nordic countries, whole Europe and world on common ground to exchange views, learn from each other, stimulate new partnerships and join forces in the satellite services sector. It connected together experience of researchers, market specialists, business executives, government representatives and leaders of regions. There were speakers from ESA, NASA, EADS Astrium, Infoterra, Thales, Nokia, Logica, Google, Microsoft, GMES Bureau, CNES, Italian Space Agency, British National Space Centre, German Aerospace Centre, etc.

The advanced space infrastructure has become available for complex applications in the modern society. The conference fuelled discussions about challenges delivering the services to users while developing innovative business models and demonstrating how satellite services contribute to sustainable economic development of the regions. The speakers presented possible solutions provided by existing and planned space applications in the areas of Earth observation, satellite positioning and navigation. The conference elaborated how to integrate regions into Global Monitoring for Environment and Security (GMES) Programme. The in-depth discussions dealt with Location-based services (LBS) business opportunities, understanding the needs of users and creating revenue.

During the conference exhibition aerospace, defence companies and R & D institutions, which are actively involved in the development of space technologies and applications, presented their achievements in this domain, giving the audience a unique opportunity to review currently operational products and services as well as future developments of space applications. The conference was successful and useful event for space scientists, officials, entrepreneurs and end-users.

Rahvusvaheline konverents Space Downstream Services 2010 Äri- ja teadustegevuse konkurentsivõime tugevdamine: satelliitteenused kaasaegses ühiskonnas

EstSpacE projekti raames korraldati Anu Reinarti juhtimisel 5.–7. maini 2010 Tallinnas Swissôteli konverentsikeskuses rahvusvaheline konverents Space Downstream Services 2010. Konverentsil osales ligi 300 teadlast, spetsialisti, ettevõtjat ja ametnikku Balti riikidest, Põhjamaadest, Venemaalt ja mujalt Euroopast, kes vahetasid kogemusi kosmose maapealsete teenuste valdkonnas, tutvusid uute ärivõimaluste ja teadusuuringute tulemustega, millest Eesti jaoks olid olulisemad satelliitkaugseire, -positsioneerimise ja navigatsiooni rakendused. Esinejateks olid ESA, NASA, EADS Astrium, Infoterra, Thales, Nokia, Logica, Google, Microsoft, GMES Bureau, CNES, Italian Space Agency, British National Space Centre, German Aerospace Centre jt organisatsioonide tippspetsialistid.

Kuna Euroopa Liidus on kosmosetehnoloogia maapealsed rakendused oluline allikas majanduskasvu tagamiseks ning siin arendatakse platvorme nagu GMES (Global Monitoring for Environment and Security) ja Galileo (navigatsioon, positsioneerimine), tutvustati konverentsi ettekannetes, kuidas satelliiditeenused võimaldavad arendada majandust ning edendada konkurentsivõimet telekommunikatsiooni, meedia, panganduse, ehituse, kinnisvara, turismi, jae- ja hulgikaubanduse, põllumajanduse, meditsiini, metsanduse, turvateenuste, transpordi ja logistika ettevõtetes ning avalikus sektoris. Samuti analüüsiti kasutajate vajadusi ning erinevatelt rakendustelt majandusliku tulu tootmise võimalusi.

Konverentsi raames toimus esinduslik näitus, mis tutvustas nii kosmosevaldkonna kui ka teenindussektori ühiseid huve, tooteid ning teadustegevuse tulemusi kosmose maapealsete teenuste valdkonnas. Konverents ja näitus tugevdasid koostööd erinevate osapoolte vahel, millega loodi soodne pinnas aruteludeks uute võimaluste üle eesmärgiga lõimida riiklikku teadustegevust ja tööstussektori tegevusi nii Euroopa kosmosekoostöö kui ka vastavate programmide raames (Euroopa Liidu 7. raamprogramm; koostöö Euroopa Kosmoseagentuuriga PECS programmi raames; ülemaailmse keskkonna- ja

Joint Panel Discussion *Space Services & Opportunities of the Future* (From left: Carsten Brockmann (Brockmann Consult, Germany), Anu Reinart (Tartu Observatory, Estonia), Mikko Strahlendorff (GMES Bureau, Belgium), Josef Aschbacher (ESA, Italy), Göran Boberg (SNSB, Sweden), Ene Ergma (President of the Riigikogu, Estonia), Alar Kolk (Ministry of Finance, Estonia). Konverentsi ühine paneeldiskussioon *"Kosmosepõhised teenused ja võimalused tulevikus".*

turvaseire süsteemi GMES kosmosekomponendi ja Galileo süsteemi arendamine).

7.5.2 EstSpacE Review Meeting

EstSpacE team gathered to the annual project review meeting from June 9th to 11th 2010 in Valkla, Harjumaa to evaluate the second project year activities and make a work plan for the last project year. There were 21 participants from Tartu Observatory and partner institutions. All work package leaders gave an overview of their achievements, collaboration activities and started or planned future projects. All 6 recruited researchers gave oral presentations about their work within EstSpacE project and discussed their working plans for the third year. The second project year was evaluated well by the work package leaders, recruited senior researchers and young researchers, who benefit from the transfer of knowledge.

EstSpacE projekti teise aasta ülevaateseminar toimus 9.–11. juunini 2010 Valklas. Seminaril osalesid 21 teadlast Tartu Observatooriumist ja partnerorganisatsioonidest. Seminari eesmärgiks oli teha kokkuvõte teise aasta tegevustest ning koostada kolmanda aasta tööplaan. Tööpakettide juhid andsid ülevaate oma tööpaketi tegevustest, koostöösuhetest ning projekti tegevustest välja kasvanud ideedest uute projektide käivitamiseks. Kõik 6 projekti raames Tartu Observatooriumisse tööle võetud teadlast tegid suulise ettekande oma teadustegevusest ja tutvustasid kolmanda aasta tegevuskava. Nii tööpakettide juhid kui sissetoodud teadlased hindasid EstSpacE projekti teise tegevusaasta väga edukaks.

7.5.3 Industry and Enterprise Targeted Workshop "How to do Business in the Space Sector" in Riga, Latvia

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EstSpacE team in cooperation with Latvian colleagues organized industry and enterprise targeted workshop "How to do business in the space sector" from October 11–12, 2010 in Riga, Latvia. There were about 30 participants. During the first day the Estonian and Latvian Space policy were introduced, overview of space business in Europe, project management in space sector, tendering process and preparation of technical documentation were given. During the second day the management of international projects, control mechanisms and intellectual property issues were focused on. The participants evaluated the event useful and proficient.

11.–12. oktoobril 2010 toimus EstSpacE projekti raames Silver Lätti eestvedamisel koostöös Läti kolleegidega Riias seminar "Kuidas teha äri kosmose valdkonnas", kus osales 30 Läti ettevõtjat. Seminari esimesel päeval tutvustati Eesti ja Läti kosmosepoliitikat, kosmose valdkonna ettevõtlust, projektijuhtimise ja hangete korda Euroopas, samuti nõudeid tehnilisele dokumentatsioonile. Teisel päeval keskenduti rahvusvaheliste projektide juhtimise, kontrolli ja intellektuaalse omandi küsimustele. Osalejad hindasid seminari tuleviku perspektiive silmas pidades asjatundlikuks ja vajalikuks.

8 Visits and guests Visiidid ja külalised

8.1 Astronomy Astronoomia

J. Einasto – ICRANet, Pescara (Italy); 17.01.–21.02.2010.

T. Liimets – Nordic Optical Telescope, La Palma (Spain); 01.01.–19.06.2010.

T. Tuvikene – Vrije Universiteit Brussel (Belgium); 16.02.–03.03.2010.

J. Einasto, P. Einasto – Baltimore, Astronomy Department of Johns Hopkins University (USA); 01.04.–01.05.2010.

T. Liimets – Kapteyn Astronomical Institute, Groningen (The Netherlands); 15.03.–27.03.2010.

T. Tuvikene – Vrije Universiteit Brussel (Belgium); 09.05.–14.05.2010.

A. Aret – Ondřejov Observatory (Czech Republic); 05.06.–20.06.2010.

T. Liimets – Kapteyn Astronomical Institute, Groningen (The Netherlands); 21.06.–02.07.2010.

J. Einasto – ICRANet, Pescara (Italy); 11.07.–12.09.2010.

V. Malyuto – Institute of Astronomy, Moscow (Russia); 25.09.–02.10.2010.

J. Pelt – University of Helsinki, Helsinki (Finland); 26.09.–02.10.2010.

J. Einasto – Astrophysical Institute Potsdam (Germany); 27.09.–27.10.2010.

A. Aret – Ondřejov Observatory (Czech Republic); 28.09.–20.12.2010.

T. Viik – University of Oulu (Oulu, Finland); 21.10.–23.10.2010.

E. Saar, L.J. Liivamägi – Observatori Astronómic, Universitat de València, València (Spain); 11.10.–10.12.2010.

8.2 Atmospheric physics Atmosfäärifüüsika

Anu Reinart, Aivo Reinart – University of Sevastopol (Ukraine); 17.01.–20.01.2010.

Anu Reinart, M. Noorma – National Centre for Scientific Research (CNRS) (Paris, France); 19.02.–21.02.2010.

Anu Reinart, M. Noorma – Surrey University and Estonian Embassy in UK (London, UK); 22.02.–23.02.2010.

M. Noorma – Helsinki University of Technology (Finland); 07.06.–11.06.2010.

S. Lätt – Ventspils University College and Ventspils International Radio Astronomy Centre (Latvia); 08.08.–14.08.2010.

J. Kuusk – INCREASE Climate Change Experiment Site at Mols Field Base (Denmark); 07.09.–11.09.2010.

K. Alikas – Stockholm University (Sweden); 09.10.–17.10.2010.

S. Lätt – Brockmann Consult (Germany); 10.10.–10.12.2010.

U. Veismann – Geophysical Center GFZ, Berlin-Potsdam (Germany); 11.10.–23.10.2010.

8.3 Guests of the observatory Observatooriumi külalised

Anatoly Malyarenko – Mälardan University (Sweden); 27.01.–28.01.2010.

Pekka Heinämäki – Tuorla Observatory, University of Turku (Finland); 07.03.–09.03; 13.04.–15.04; 02.05.–07.05; 25.05.–28.05.2010.

Luigi Fusco – European Space Agency (ESA); 05.05.–07.05.2010.

Goran Boberg – Swedish National Space Board (Sweden); 05.05.–7.05.2010.

Geir Hovmork – Norwegian Space Center (Norway); 05.05.–7.05.2010.

Robert Lawson – European Environment Agency (Belgium); 05.05.–07.05.2010.

Nuria Blanes Guardia – European Topic Center on Land Use and Spatial Information (ETC-LUSI) (Spain); 05.05.–07.05.2010.

Jean Jacques Favier – National Center for Space Studies (CNES) (France); 05.05.–07.05.2010.

Martin Sweeting Obe – Surrey Satellite Technology Ltd (SSTL) (France); 05.05–07.05.2010.

Prof Walter Peeters – International Space University (ISU) (Belgium); 05.05.–07.05.2010.

Jevgeni Ustinov – NASA (USA); 11.05.–15.05.2010.

Carsten Brockman – Brockman Consult (Germany); 10.06.–30.07.2010.

Danielle de Staerke – National Center for Space Studies (CNES) (France); 01.08.–06.08.2010.

Jaan Praks – University Of Aalto (Finland); 24.08.–24.10.2010.

Alexander Krusper – Vattenfall Power Consultant AB (Sweden); 19.09.–25.11.2010.

Nikolai A. Tomov – Institute of Astronomy and National Astronomical Observatory Rozhen (Bulgaria); 30.09.–03.10.2010.

Romano Corradi – Instituto de Astrofísica de Canarias (Spain); 30.09.–03.10.2011.

Katarina Eriksson – Vattenfall Power Consultant AB (Sweden); 07.11.–14.01.2011.

9 Seminars at the Observatory Observatooriumis toimunud seminarid

9.1 Astronomy Astronoomia

06.01.2010 – Arutelu "Astronoomia õpetamisest II".

13.01.2010 – Gert Hütsi, Elmo Tempel: EUCLID.

27.01.2010 – Anatoly Malyarenko (Mälardan University, Sweden): Invariant Random Fields in Vector Bundles and Application to Cosmology.

03.02.2010 – Enn Saar, Jaan Pelt: Kas kiire arvuti teeb vigade arvutamise lihtsamaks?

10.02.2010 – Heatahtlik arutelu teemal: mida ootavad noored ja vanad uuelt direktorilt?

03.03.2010 – Erik Tago: Galaktikagrupid Tartu moodi.

24.03.2010 – Valeri Maljuto: Determination of Precise Effective Temperatures from Stellar Catalogues.

07.04.2010 – Antti Tamm: Elliptilised üksiklased – kosmoloogiliste mudelite proovikivid.

14.04.2010 – Arutelu teemal: Observatooriumi arenguperspektiiv ja teadusnõukogu roll selles.

21.04.2010 – Jaan Kaplinski: Intelligentne loom ja Drake'i võrrand.

23.04.2010 – Olavi Kärner: Tartu õhutemperatuuri tolerants ja kliima muutlikkus.

05.05.2010 – Tõnu Viik: Heinrich Christian Schumacher – juristist astronoomiks.

12.05.2010 – Jevgeni Ustinov (NASA): Quo vadis NASA? An Insiders Attempt to Look From Outside.

14.05.2010 – Jevgeni Ustinov (NASA): Sensitivity Analysis of Quantitive Models of Physical Objects.

27.05.2010 – Tiit Sepp: Tõraveres koostatud galaktikagruppide kataloog ja sellega seonduv andmebaas.

27.05.2010 – Gert Hütsi: Barüonostsillatsioonide füüsika ja selle roll vaatluslikus kosmoloogias.

27.05.2010 – Siim Meerits (University of Tartu): Olekuleidja diagnostikud kosmoloogias.

27.05.2010 – Erik Randla (University of Tartu): Multiskalaar-tensor gravitatsiooniteooria.

16.06.2010 – Mari Burmeister: Sümbiootiliste tähtede kuumad komponendid (ülevaade valminud doktoritööst).

30.09.2010 – Nikolai A. Tomov (Institute of Astronomy and National Astronomical Observatory Rozhen, Bulgaria): Interpretation of the Line Spectrum of the Classical Symbiotic Stars in the Light of the Scenario for Their Prototype Z And.

30.09.2010 – Romano Corradi (Instituto de Astrofisica de Canarias): The Importance of Binary Evolution for the Formation of Planetary Nebulae.

06.10.2010 – Elmo Tempel: Galaktikate tekkimine: lahendamata probleemid.

20.10.2010 – Maret Einasto: Sloani Suure Seina rikkad galaktikaparved.

17.11.2010 – Laurits Leedjärv: Kosmilised gaasijoad IAU sümpoosionil 275.

24.11.2010 – Lilli Sapar: 200 aastat astronoomiat Kaasanis.

01.12.2010 – Tiit Nugis: Ekstinktsioon kiirgusallikate lähiümbruses.

08.12.2010 – Jaak Jaaniste (Eesti Maaülikool): Astrotaibud ja nende tulevik.

22.12.2010 – Arutelu teemal "Astronoomia 2010".

9.2 Atmospheric physics Atmosfäärifüüsika

19.03.2010 – Erko Jakobson: Atmosfääri optiliste omaduste muutlikkus – ülevaade järeldoktorantuuri tööplaanist.

14.04.2010 – Arutelu teemal: Observatooriumi arenguperspektiiv ja teadusnõukogu roll selles.

23.04.2010 – Olavi Kärner: Tartu õhutemperatuuri tolerants ja kliima muutlikkus.

10.09.2010 – Anu Reinart, Silver Lätt: Introduction about new FP 7 project WaterS.

17.09.2010 – Jaan Liira: Landsat-piltide kasutamise võimalustest taimkatte muutuste kirjeldamiseks Võrtsjärve kaldavööndi taimestiku näitel.

23.09.2010 – Alexander Krusper (Vattenfall Power Consultant AB): Research at Hydrology and GIS Group at Vattenfall Power Consultant AB, Stockholm.

05.11.2010 – Andres Kuusk: Päikesefotomeetri Cimel-318N-M9 kaliibrimine.

11.11.2010 – Katarina Eriksson (Vattenfall Power Consultant AB): Overview About Remote Sensing of Wetlands in Sweden.

02.12.2010 – Annika Ruusmann (Tartu Ülikool): Otsekiirguse aegridade filtreerimine.

10 Membership in scientific organizations
Teadusorganisatsioonide liikmed

Academia Europaea – J. Einasto
Akademische Gesellschaft für Deutschbaltische Kultur – T. Viik
American Astronomical Society – J. Einasto
American Geophysical Union – K. Alikas (student member), 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 "Journal of Quantitative Spectroscopy and Radiative Transfer" – T. Viik
Editorial Board "Silva Fennica" – T. Nilson
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, V.-V. Pustynski, 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, M. Sulev, 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 Kvaliteediühing – U. Veismann
Eesti Looduseuurijate Selts – K. Eerme, V. Russak, A. Sapar, M. Sulev, 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, V.-V. Pustynski, 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, V.-V. Pustynski, A. Sapar

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

Finnish Society of Forest Sciences – M. Mõttus

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)

The International Society for Optical Engineering (SPIE) – U. Veismann, S. Lätt (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, V.-V. Pustynski, E. Saar, A. Sapar, L. Sapar, I. Suhhonenko, E. Tago, A. Tamm, P. Tenjes, U. Veismann, J. Vennik, T. Viik

Marie Curie Fellowship Association – A. Reinart

MTÜ Euroscience Eesti – V.-V. Pustynski

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

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

Royal Astronomical Society – J. Einasto (associated member)

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

Õpetatud Eesti Selts – U. Peterson, T. Viik

Working Group 4 of COST 726 Action – S. Lätt

7. raamprogrammi keskkonna programmikomitee ekspert – A. Reinart

11 Teaching and Popularizing Õppetöö ja populariseerimine

11.1 Lecture courses and seminars Loengukursused ja seminarid

11.1.1 Astronomy Astronoomia

Physics of Stellar Systems and Galaxies *Tähesüsteemide ja galaktikate füüsika* – U. Haud, University of Tartu.

The Physics of the Universe *Universumi füüsika* – T. Viik, University of Tartu.

The Equations of Mathematical Physics *Matemaatilise füüsika võrrandid* – T. Viik, University of Tartu.

The Foundations of Theoretical Astrophysics *Teoreetilise astrofüüsika alused* – T. Viik, University of Tartu.

Physical Cosmology *Füüsikaline Kosmoloogia* – M. Gramann and E. Tago, University of Tartu.

Global Physics, *Globaalfüüsika* – K. Eerme and M. Gramann, University of Tartu.

General Astronomy: Observations *Praktiline astronoomia* – T. Liimets together with T. Eenmäe, University of Tartu.

Seminar in Astrophysics *Astrofüüsika seminar* – E. Tempel together with T. Tuvikene and P. Tenjes, University of Tartu.

Advanced Seminar of Theoretical Physics Teoreetilise füüsika eriseminar – P. Tenjes, University of Tartu.

Astronomy *Astronoomia* – P. Tenjes, University of Tartu.

Quantum Physics *Kvantfüüsika* – P. Tenjes, University of Tartu.

Atomic and Subatomic Physics I *Mikromaailma füüsika I* – P. Tenjes, University of Tartu.

Mathematical Physics I *Matemaatiline füüsika I* – P. Tenjes, University of Tartu.

Microworld Physics Mikromaailma füüsika – P. Tenjes, University of Tartu.

Introductory Fluid Mechanics Sissejuhatus hüdrodünaamikasse – P. Tenjes, University of Tartu.

Methods of Mathematical Physics Matemaatilise füüsika meetodid – P. Tenjes, University of Tartu.

Large-scale Structure of the Universe. 5 lectures Universumi suureskaalaline struktuur. 5 loengut – J. Einasto, Nice Observatory.

General Course of Physics Füüsika üldkursus – V.-V. Pustynski, Tallinn University of Technology.

Physics I, II *Füüsika I, II* – V.-V. Pustynski, Tallinn University of Technology.

Introduction to Space Flight *Sissejuhatus kosmonautikasse* – V.-V. Pustynski, Tallinn University of Technology.

Introduction to Astrophysics *Sissejuhatus astrofüüsikasse* – V.-V.Pustynski together with M.Mars, Tallinn University of Technology.

Introduction to Physics *Füüsika täiendõpe* – V.-V. Pustynski, Tallinn University of Technology.

*Amateur Radio*Amatöörraadioside – T. Eenmäe together with V. Allik, University of Tartu.

Space Technology Kosmosetehnoloogia alused – T. Eenmäe, University of Tartu.

Webcourse "Astronomy" in E-University Astronoomia veebikursus e-ülikoolis – T. Eenmäe, University of Tartu.

Building Tartu University satellite communication groundstation in the framework of Estcube student satellite project Tartu Ülikooli satelliitside tugijaama ehitamine Estcube tudengisatelliidi projekti raames – V. Allik, I. Ansko, T. Eenmäe, University of Tartu.

Building camera for Estcube student satellite project Satelliidi kaamera ehitamine Estcube tudengisatelliidi projekti raames – V. Allik, I. Ansko, T. Eenmäe, University of Tartu.

Open Contest in Astronomy at the Gifted and Talented Development Centre Astronoomia lahtine võistlus Teaduskoolis – T. Eenmäe, University of Tartu.

Astronomy Course for the Nõo High School, held at the Observatory *Astronoomia kursus Nõo Reaalgümnaasiumi 12. klassidele, läbi viidud observatooriumis* – K. Annuk, L. Leedjärv, M. Ruusalepp, E. Saar, 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.

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.

Data Acquisition and Analysis with LabVIEW Andmehõive ja analüüs LabVIEW keskkonnas – Aivo Reinart, University of Tartu.

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

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

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

Global Physics Globaalfüüsika – K. Eerme together with M. Gramann and K. Tarkpea, University of Tartu.

Measurements and Measurement Uncertainty Mõõtmised ja mõõtemääramatused – E. Jakobson, University of Tartu.

Processing of Measurement Data Mõõtmistulemuste töötlemine – E. Jakobson, University of Tartu.

Computer-aided Measurements Arvutijuhitavad mõõtmised – I. Ansko, University of Tartu.

Space Technology Kosmosetehnoloogia – U. Veismann, M. Noorma, A. Reinart, University of Tartu.

Image Processing in Remote Sensing Pilditöötlus kaugseires – U. Veismann together with A. Luts, University of Tartu.

Practical Astronomy Praktiline astronoomia – U. Veismann, T. Liimets and T. Eenmäe, University of Tartu.

Probability Theory and Statistics Tõenäosusteooria ja statistika – E. Jakobson, University of Tartu (Problem solving trainings, lectures by R. Rõõm).

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.

Programming in C# and Pascal Programmeerimine C# ja Pascal keeles – A. Sims and M. Lang, Estonian University of Life Sciences.

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

11.2 Popular lectures Populaarteaduslikud loengud ja esinemised

6 intervjuud, BNSile, ajalehtedele, raadiole ja televisioonile – T. Viik.

Eesti kosmosepoliitika töögrupist (intervjuu, ERR venekeelsed saated, 19.01.2010) – L. Leedjärv.

Sündmusi astronoomias aastal 2009 (Tartu Tähetorni Astronoomiaring, 19.01.2010) – E. Tago.

Päike ja tema aktiivsustsüklid (Eesti Raadioamatööride Ühingu talvepäev, Tallinn, 13.02.2010) – T. Eenmäe.

Päikese aktiivsusest (Tartu Tähetorni Astronoomiaring, 16.02.2010) – T. Eenmäe.

Avalik vaatlusõhtu (Tõravere, 27.02.2010) – K. Annuk, A. Puss, M. Ruusalepp.

Gravitatsioonilised lained - mida võime oodata? (Tartu Tähetorni Astronoomiaring, 02.03.2010) – J. Pelt.
Pierre Louis Moreau de Maupertuis ja Maa mõõtmine (Eesti Geodeetide Ühing, 05.03.2010) – T. Viik.
Infrapunaastronoomiast (Tartu Tähetorni Astronoomiaring, 16.03.2010) – A. Tamm.
Universumi struktuur (Paldiski Keskkool, 17.03.2010) – J. Einasto.
Universumi struktuur ja evolutsioon (Ala Põhikool, 19.03.2010) – J. Einasto.
Päikesekiirgus – atmosfääri liikumapanev jõud (Ilmapäev Rõuges, Viitina Loodushariduskeskus, 17.04.2010) – V. Russak.
Planetaariumiseansid "Ahhaa, omadega metsa!" (Ahhaa keskus, Tartu, 17.04.–18.04.2010) – A. Puss.
Heinrich Christian Schumacher – juristist astronoomiks (Akadeemiline Baltisaksa Kultuuri Selts, 20.04.2010) – T. Viik.
Kosmilised tuuled (Tartu Tähetorni Astronoomiaring, 04.05.2010) – T. Nugis.
Avalik vaatlusõhtu (Toomkiriku vaateplatvorm, Tartu, 12.05.2010) – A. Puss.
Mustadest aukudest (Huvitaja, Vikerraadio, 17.05.2010) – K. Annuk.
Planeetide liikumisest (36. teoreetilise bioloogia kevadkool, Kopra turismitalu Viljandimaal, 22.05.2010) – T. Viik.
Astronoomia: tähtedest ja Päikesesüsteemist (Miina Härma Gümnaasium, 20.05.2010) – E. Tempel.
Galaktikate ja nende gruppide tekkest ja arengust (LOTE doktorantide konverents, Tartu, 12.05.2010) – T. Sepp.
Vestlus kosmilistest asjadest (Hommikuprogramm, Raadio Ring FM, 18.06.2010) – L. Leedjärv.
Bernhard Voldemar Schmidt – kuulus naissaarlane (Eesti Looduskaitse Seltsi üleriigiline kokkutulek, Naissaar, 01.08.2010) – T. Viik.
Teleskoobivaatlus tänapäeval (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 12.08.2010) – T. Liimets.
Teoreetiline ja praktiline aja-arvutus (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 12.08.2010) – A. Puss.
Taevakoordinaatidest efemeriidideni (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 12.08.2010) – A. Puss.
Teleskoobi parameetrid (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 12.08.2010) – A. Puss.
Augustikuisest tähesajust (Looduskaitse ajaloo konverents, Kuressaare, 13.08.2010) – T. Viik.
Interferomeeter – eetri mõõtmistest kuni tumeda energia otsimiseni (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 15.08.2010) – J. Pelt.
Astronoomiauudised 2009/2010 (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 15.08.2010) – T. Tuvikene.
Avalikud vaatlusõhtud (Astronoomiahuviliste XV üle-Eestiline kokkutulek, Tihemetsa, 11.08.–15.08.2010) – T. Tuvikene, A. Puss, T. Eenmäe.

Tähed tumedas Universumis (VVV Sihtasutuse giidide koolitus, Tõravere, 21.08.2010) – L. Leedjärv.

SDSS DR7 Galaktikate kataloogid ja nendega seotud andmebaas (Fundamentalistide seminar, Tartu, 03.09.2010) – T. Sepp.

Teadlaste Öö vaatlusõhtu (Toomkiriku vaateplatvorm, Tartu, 24.09.2010) – A. Puss.

Teadlaste Öö vaatlusõhtu (Tõravere, 24.09.2010) – K. Annuk, M. Ruusalepp, T. Tuvikene, E. Tempel.

Kliima muutumine – mis toimub ja mida arvatakse toimuvat (TÜ Ajaloo Muuseumi populaarteaduslik teeõhtu "Huvitavat teadusest ja elust", Tartu, 30.09.2010) – K. Eerme.

Päikesesüsteemi astrobioloogia (Tartu Tähetorni Astronoomiaring, 05.10.2010) – T. Sepp.

Meie kosmiline kodu (Nõo Põhikool, 21.10.2010) – L. Leedjärv.

Kui läätsed ja peeglid enam ei aita: teleskoobid kalgi röntgenkiirguse ja gammasähvatuste vaatlemiseks (Tartu Tähetorni Astronoomiaring, 02.11.2010) – J. Pelt.

Origin of Galaxies: Different problems (Fundamentalistide seminar, Tartu, 12.11.2010) – E. Tempel.

Astronoomiast ja muust minu elus (2-tunnine otsesaade) (Kukul külas, Raadio Kuku, 14.11.2010) – L. Leedjärv.

Avalik vaatlusõhtu (Toomkiriku vaateplatvorm, Tartu, 16.11.2010) – A. Puss.

Päikesesüsteemi hämarates tagatubades (Otepää looduskeskus, 18.11.2010) – T. Viik.

Astronoomia: tähtedest ja Päikesesüsteemist (Türi Majandusgümnaasium, 19.11.2010) – E. Tempel.

Objektid tähistaevas (Tapa Kultuurikoda, 23.11.2010) – T. Tuvikene, E. Tempel.

Metsade kaugseire praktilised rakendused (Eesti metsateadus "Tänapäev ja tulevikuperspektiivid", EMÜ, Tartu, 26.11.2010) – M. Lang.

Heinrich Christian Schumacher – astronoom ja geodeet (Tartu Tähetorni Astronoomiaring, 30.11.2010) – T. Viik.

Kiirte optika ja optiline teleskoop (Tartu Tähetorni Astronoomiaring, 07.12.2010) – A. Puss.

Valgusreostus ja tähevaatlused (Loodusteaduste kool, Tõravere, 08.12.2010) – T. Eenmäe.

Avalik vaatlusõhtu (Toomkiriku vaateplatvorm, Tartu, 10.12.2010) – A. Puss.

Kaksiktähtedest (Huvitaja, Vikerraadio, 16.12.2010) – L. Leedjärv.

2 saadet "Astronoomiaminutid" (www.astronoomia.ee/minutid) – T. Tuvikene, T. Eenmäe.

Kvadrantiidide meteoorivoolust (Kuku Raadio, 31.12.2010) – K. Annuk.

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

M. Burmeister: *Characteristics of the Hot Components of Symbiotic Stars. Sümbiootiliste tähtede kuumade komponentide omadused,* Ph.D. Thesis, University of Tartu.
Defence Kaitsmine: 01.10.2010.
Supervisor Juhendaja: L. Leedjärv (Tartu Observatory).
Opponents Oponendid: Dr. Romano L.M. Corradi (Instituto de Astrofísica de Canarias, CALP, Breña Baja, La Palma, Spain), Dr. Nikolai A. Tomov (Institute of Astronomy, Bulgarian Academy of Sciences, National Astronomical Observatory Rozhen, Smolyan, Bulgaria).

I. Vurm: *Time-Dependent Modelling of Radiative Processes in Magnetized Astrophysical Plasmas*. Kiirgusprotsesside ajast sõltuv modelleerimine magnetilises astrofüüsikalises plasmas, Ph.D. Thesis, University of Oulu, Finland.
Defence Kaitsmine: 22.10.2010.
Supervisors Juhendajad: J. Poutanen (University of Oulu), T. Viik (Tartu Observatory).
Reviewers Esialgsed oponendid: G. Ghisellini (Brera Astronomical Observatory, Italy), A.A. Zdziarski (N. Copernicus Astronomical Centre, Warsaw, Poland).
Opponent Oponent: G. Ghisellini (Brera Astronomical Observatory, Italy).

11.3.2 M.Sc. theses Magistritööd

K. Eerme – *M. Prüssel*: Tõraveres mõõdetud ultraviolettkiirguse spektri sõltuvus pilvisusest Influence of Cloudiness on Ultraviolet Radiation Spectra Measured at Tõravere (M.Sc.), University of Tartu.
Opponent Oponent: U. Veismann.

11.3.3 B.Sc. theses Bakalaureusetööd

I.Kolka – *L. Reisberg*: Unikaalse kaksiktähe Epsilon Aurigae spekter varjutuse faasis ja varjutusevälisel ajal. The Spectrum of the Unique Binary Epsilon Aurigae During Eclipse and out of Eclipse (B.Sc.), University of Tartu.
Opponent Oponent: A. Puss.

E. Tempel – *R. Kipper*: Kaugete galaktikate kinemaatika modelleerimine. Kinematics Modellation of Distant Galaxies (B.Sc.), University of Tartu. Opponent Oponent: A. Tamm.

E. Tempel – *T. Kuutma*: Elliptiliste ja spiraalsete galaktikate heledusfunktsioonid erinevates keskkondades Sloani taevaülevaates. Luminosity Functions of Spiral and Elliptical Galaxies in Different Environments in the Sloan Digital Sky Survey (B.Sc.), University of Tartu.
Opponent Oponent: M. Gramann.

11.3.4 Refereeing of theses Oponeerimine

T. Viik – *K. Hillermaa*: Üldistatud Hénon-Heiles'i võrrandite liikumisintegraalid (M.Sc.), University of Tartu.

12 Staff Koosseis (01.01.2011)

Director / Direktor	Anu Reinart (Ph.D.)
Vice director (management) / Haldusdirektor	Enno Ruusalepp
Project manager / Projektijuht	Tiia Lillemaa
Project manager / Projektijuht (0.75)	Ain Jõesalu

Department of Astrophysics Astrofüüsika osakond

Group of stellar physics Tähefüüsika töörühm

Senior research associate / Vanemteadur	Laurits Leedjärv (Ph.D.) (Head of Department / Osakonna juhataja)
Senior research associate / Vanemteadur	Kalju Annuk (Ph.D.)
Senior research associate / Vanemteadur	Tõnu Kipper (D.Sc.)
Senior research associate / Vanemteadur	Indrek Kolka (Ph.D.)
Senior research associate / Vanemteadur	Tiit Nugis (Ph.D.)
Research associate / Teadur	Mari Burmeister (Ph.D.)
Research associate / Teadur	Anti Hirv (M.Sc.)
Research associate / Teadur	Alar Puss (M.Sc.)
Research associate / Erakorr. teadur (0.50)	Tõnis Eenmäe (M.Sc.)
Research associate / Erakorr. teadur (0.50)	Tiina Liimets (M.Sc.)
Research associate / Erakorr. teadur (0.25)	Taavi Tuvikene (M.Sc.)

Group of theoretical astrophysics Teoreetilise astrofüüsika töörühm

Senior research associate / Vanemteadur	Arved Sapar (D.Sc., Prof., EAS[1])
Senior research associate / Vanemteadur	Jaan Pelt (Ph.D.)
Senior research associate / Vanemteadur	Tõnu Viik (D.Sc.)
Research associate / Teadur	Anna Aret (Ph.D.)
Research associate / Teadur	Raivo Poolamäe (M.Sc.)
Research associate / Teadur	Lili Sapar (Ph.D.)
Research associate / Teadur (0.50)	Vladislav-Venjamin Pustynski (Ph.D.)
Research associate / Erakorr. teadur (0.25)	Indrek Vurm (Ph.D)

[1]Member of the Estonian Academy of Sciences Eesti Teaduste Akadeemia akadeemik

Group of telescopes Teleskoopide töörühm

Leading electronic engineer / Juhtinsener-elektroonik	Riho Koppel
Maintenance engineer / Hooldusinsener (0.50)	Toivo Kuusk

Department of Cosmology Kosmoloogia osakond

Group of cosmology Kosmoloogia töörühm

Senior research associate / Vanemteadur	Enn Saar (D.Sc., EAS[1]) (Head of Department / Osakonna juhataja)
Senior research associate / Vanemteadur	Jaan Einasto (D.Sc., Prof., EAS[1])
Senior research associate / Vanemteadur	Maret Einasto (D.Sc.)
Senior research associate / Vanemteadur	Mirt Gramann (Ph.D.)
Senior research associate / Vanemteadur	Erik Tago (Ph.D.)
Research associate / Teadur	Ivan Suhhonenko (Ph.D.)
Research associate / Teadur	Lauri J. Liivamägi (M.Sc.)
Post doctoral associate / Järeldoktor	Margus Saal (Ph.D.)
Post doctoral associate / Järeldoktor	Gert Hütsi (Ph.D.)
Technician / Tehnik (0.70)	Peeter Einasto
Technician / Tehnik (0.30)	Triin Einasto

Group of physics of galaxies Galaktikate füüsika töörühm

Senior research associate / Vanemteadur	Urmas Haud (D.Sc.)
Senior research associate / Vanemteadur	Jaan Vennik (Ph.D.)
Senior research associate / Vanemteadur (0.25)	Peeter Tenjes (D.Sc.)
Research associate / Teadur	Antti Tamm (Ph.D.)
Research associate / Teadur	Elmo Tempel (M.Sc.)
Research associate / Erakorr. teadur (0.25)	Valeri Malyuto (Ph.D.)

Group of data communication Andmeside töörühm

Leading engineer / Andmeside juhtinsener	Margus Sisask

Department of Atmospheric Physics Atmosfäärifüüsika osakond

Group of remote sensing of vegetation Taimkatte seire töörühm

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