Contents Sisukord

Eessõna

2008. aasta algas lootusrikkalt. Eelarve suurenemine ja sellega seotud palgatõus on ju ikka meeldiv. 1. märtsil läks käima EL 7. raamprogrammi projekt EstSpacE. Meie taotlus peahoone renoveerimiseks ja juurdeehituse rajamiseks võeti valitsuse poolt kinnitatud investeeringute kavasse. Kui kõik läheb kavakohaselt, tegeleme 2009. aastal projekteerimise ja muude ettevalmistustöödega ning 2010. aastal läheb ehitus lahti. Euroopa Kosmoseagentuuri eksperdid tunnistasid Tartu Observatooriumi üheks oluliseks koostööpartneriks tulevases koopereerunud riigi lepingus, mille Eesti võiks sõlmida juba lähemas tulevikus. Olime edukad mitmetel grandikonkurssidel, saime oma perre juurde kaks järeldoktorit jne.

Kuid igal asjal on kaks külge. 2008. aastast võib meenutada ka seda, et üks meie uute teadusteemade taotlustest sai kehva hinnangu ja taotletust oluliselt vähem raha. Jäime ukse taha teaduse tippkeskuste konkursil, kus kummalisel kombel ei osutunud edukaks ükski täppisteadustega tegelev asutus. Kuigi meie majas liigub noori inimesi ja teadlaste keskmine vanus tasapisi väheneb, ei saa juurdekasvuga siiski päris rahul olla jne.

Tegelik elu kulgeb sageli parima ja halvima stsenaariumi vahel. 2009. aasta on alanud üsna hirmuäratavate prognoosidega Eesti ja kogu maailma majanduse olukorrast, mis ei jäta puutumata ka teadusasutusi. Ilmselt on aeg harjuda mõttega, et kõik ei pea alati kasvama. Tuleb ette aastaid, mil peab läbi ajama väiksemate võimalustega kui eelmisel. Muidugi tuleb otsida ka uusi võimalusi arenguks, tänavu võib-olla isegi äraelamiseks. Tartu Observatoorium on üks teaduspartner 2009. aasta algul esitatud kosmosetehnoloogia arenduskeskuse taotluses, samuti mitmetes muudes granditaotlustes. Loodame, et mõni neist annab lisatulu ja muidugi ka lisatööd juba alanud aastal.

Aasta 2009 on ju Rahvusvaheline Astronoomia Aasta! Mitmed ettevõtmised sel puhul on juba alanud ja palju tööd on veel ees. Aga eks see olegi hea võimalus näidata astronoomia rolli ühiskonnas ja kultuuris ning selle kaudu anda oma panus Tartu Observatooriumi tuleviku kindlustamisse Eesti ühiskonnas.

Laurits Leedjärv
Direktor

Tõraveres
veebruar 2009

Foreword

Beginning of the year 2008 was full of optimism. It is always pleasant to have significant increase of the budget and higher salaries. On March 1, the FP7 project EstSpacE started. Our application for renovating the main building and erecting an extension to it was preliminarily approved. If everything goes according to the plans, designing and other preparations will be finished in 2009, and real building works will start in 2010. Experts from the European Space Agency recognized Tartu Observatory as an essential partner in the future European cooperating state agreement which Estonia and ESA could conclude in a near future. We were successful in several grant competitions, we could employ two new post-docs etc.

However, every affair has two sides. We can also remember from 2008 that one of our applications for new target financed projects earned low grade and was insufficiently financed. We were not successful in the competition for Centres of Excellence in research. Although we have more and more young people in our house, and mean age of the researchers is slowly decreasing, there should be much more active young people etc.

Real life mostly goes between the best and the worse scenario. Beginning of the year 2009 has revealed threatening prognoses for the economy of Estonia and of the whole world. Research institutions cannot remain untouched of those. Obviously, it is time to understand that nothing is growing forever. There could be years having lesser (financial) possibilities than previous ones. Of course, one should look for new opportunities for development and may-be even for survival. Tartu Observatory is one of science partners in the application for a new space technology development centre, as well as in several other grant applications. We hope that at least some of them would be successful, providing additional income (and additional workload as well) in 2009.

2009 is an International Year of Astronomy. Several of its activities have already started, and we have a lot of work ahead. It is just a good opportunity to demonstrate the role of astronomy in society and culture, and therefore to contribute into consolidation of the future of Tartu Observatory in the society of Estonia.

Laurits Leedjärv
Director

Tõravere
February 2009

1 Ülevaade

1.1 Uurimisteemad ja grandid

1.1.1 Sihtfinantseeritavad teadusteemad

2008. aastal algas Tartu Observatooriumis uute sihtfinantseeritavate teadusteemade täitmine. Kõik meie kolm taotlust rahuldati, kuid kaugseire teema puhul kahjuks taotletust oluliselt väiksemas mahus:

- Tumeenergia, tumeaine ja struktuuri teke Universumis (teema juht E. Saar) – 3870 kEEK,
- Evolutsiooni hilisfaasis tähtede ja nende ümbriste vaatluslik ja teoreetiline uurimine (teema juht T. Kipper) – 5040 kEEK,
- Optiliselt keerukate looduskeskkondade kaugseire (teema juht A. Kuusk) – 1080 kEEK.

(1 kEEK = 1000 EEK = 63.9 EUR)

1.1.2 Eesti Teadusfondi grandid

Sihtasutus Eesti Teadusfond rahastas 14 granti:

1. Grant 6100: A. Kuusk – Kiirgusenergia hajumine ja neeldumine looduslikes ja kultiveeritud taimkatetes – 127.1 kEEK.
2. Grant 6104: E. Saar – Suuremastaabilise struktuuri täppiskosmoloogia – 220 kEEK.
3. Grant 6105: A.-E. Sapar – Täheatmosfääride ja tähetuule ehitus ja spektrid; füüsikalised protsessid neis – 140 kEEK.
4. Grant 6106: J. Vennik – Galaktikate evolutsioon gruppides – 137 kEEK.
5. Grant 6810: I. Kolka – Suure kiirgusvõimsusega kaugelearenenud tähed kosmoseteleskoobi Gaia objektidena – 141 kEEK.
6. Grant 6812: M. Mõttus – Hüperspektraalsete ja mitme vaatenurga alt mõõdetud kaugseireandmete kasutamisvõimalused metsa struktuuri hindamiseks – 174.9 kEEK.
7. Grant 6813: J. Pelt – Dispersioonispektrite teooria ja rakendused – 80 kEEK.
8. Grant 6814: A. Reinart – Satelliitkaugseire meetodite arendamine Eesti optiliselt mitmekomponendiliste veekogude uurimiseks – 249 kEEK.
9. Grant 6815: T. Nilson – Eesti metsade produktiivsuse monitooring satelliitkaugseire abil – 205 kEEK.
10. Grant 7115: A. Tamm – Ketasgalaktikate evolutsioon kosmoloogilistel ajaskaaladel – 57.5 kEEK.
11. Grant 7137: K. Eerme – Päikese ultraviolettkiirguse spektraalne koostis maapinnal – 100 kEEK.

12. Grant 7146: M. Gramann – Galaktikate evolutsioon ja tume energia paisuvas Universumis – 92 kEEK.
13. Grant 7691: I. Pustylnik, V.-V. Pustynski – Füüsikalised protsessid, statistilised omadused ja evolutsiooniline areng kuumade allkääbustega kaksiksüsteemides – 73 kEEK Tartu Observatooriumile.
14. V. Russak oli üks põhitäitja TÜ dotsendi H. Ohvrili grandis nr. 7347 (60 kEEK 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. Kaks taotlejat asus tööle Tartu Observatooriumisse:

1. ETF järeldoktori grant JD 107: A. Kallel – Taimkatte kiirguslevi modelleerimine: liitmismeetodi täiendamine ja kontroll – 212.5 kEEK 2008. aastal + ümberasumistoetus 400 kEEK.
2. ETF järeldoktori grant JD 131: M. Saal – Üldistatud gravitatsiooniteooriate teoreetilised ja kosmoloogilised aspektid – 204.5 kEEK 2008. aastal.

1.1.3 FP7 projekt EstSpacE

1. märtsil 2008 algas Tartu Observatooriumis EL 7. raamlepingu REGPOT projekt EstSpacE: Eesti kosmoseuuringute ja -tehnoloogia võimekuse avamine partnerluse kaudu tipptasemel Euroopa teadusasutustega. Projekti juht on A. Reinart, kestvus kolm aastat, Euroopa Komisjoni finantseering kokku *ca* 1.1 MEUR (17.206 MEEK). Projektis osalevad ka mõned Tartu Ülikooli Füüsika Instituudi ja Tehnoloogiainstituudi teadlased. Projekti tegevustest 2008. aastal (teadusaparatuuri hankimine, uute inimeste töölevõtmine, nõupidamiste ja suvekoolide korraldamine) tuleb juttu Aastaraamatu vastavates osades.

1.1.4 Muud projektid ja lepingud

1. EL 6. raamlepingu projekt "Hüperspektraalne kaugseire Euroopas – spetsiaalsed toetusmeetmed (HYRESSA)": M. Mõttus (TO esindaja) – TO osa 2008. aastal 25.76 kEEK.
2. Metsade kaugseire füüsikalised alused (PHYSENSE), SamNordisk Skogsforskning: T. Nilson – 93.9 kEEK 2008. aastal.
3. Deklareeritud põllupindade kontroll kaugseirevahenditega, teadus- ja arendusleping PRIA-ga: U. Peterson – 80 kEEK.
4. Riikliku keskkonnaseire programmi allprogramm "Eesti maastike muutuste uuringud ja kaugseire": U. Peterson – 300 kEEK + 40 kEEK infomaterjalide koostamiseks.
5. Satelliitide tulemite parandamine kasutamiseks suurte järvede kaugseires, EMP1 2008: A. Reinart – 215 kEEK.

6. MERIS-e produktide Vänerni järvel ja Balti mere loodeosa rannikuvetel testimise tehniline tugi, ESA/ESRIN projekti alamprojekt, leping Stockholmi Ülikooliga, nr. 21524: A. Reinart – 125 kEEK.
7. Rannikumere muutuste uuring ja kaugseire, allhanke töövõtuleping: TO koordinaator A. Reinart – 70 kEEK.
8. Kosmoseterminoloogia arendamine, Eesti Terminoloogia Ühing, koostööleping 02-14/2008: U. Veismann – 20 kEEK.

Lisaks osalesid mitmed teadlased rahvusvahelistes projektides ilma otsese tuluta Observatooriumile. SA Archimedes eraldas EstSpacE projekti raames ostetud teadusaparatuuri käibemaksu tasumiseks 835.8 kEEK.
Nende teemade ja projektide raames tehtust leidub põhjalikum ülevaade peatükkides 3–5.

1.2 Töötajad

2. mail 2008 lahkus raske haiguse tagajärjel igaveseks meie kauaaegne hea kolleeg vanemteadur Izold Pustõlnik. Ta jääb töökaaslaste mälestustesse kui hea spetsialist lähiskaksiktähtede ehituse ja evolutsiooni alal, innukas astronoomia ajaloo ja arheoastronoomia uurija, aga ka kui lihtsalt andekas inimene – tulnud 1962. aastal Odessast Tartusse aspirantuuri, pidas ta juba paari kuu pärast seminaris ettekande eesti keeles.

5. juunil lõppes insener Matti Pehki tööleping. 30. aprillil lõpetas Observatooriumiga töösuhte ka staažikas teadur Ain Kallis, kuid ta jätkab meiega koostööd. Sama toimus ka Valeri Maljutoga. Järeldoktor Jevgeni Vasiliev lahkus meilt juunis 2008.

Tänu uutele rahastamisvõimalustele lisandus ka uusi – ja mis eriti rõõmustav – noori teadustöötajaid. ETF järeldoktori grandi toel töötab 1. maist kosmoloogia osakonnas Margus Saal ja 1. juunist atmosfäärifüüsika osakonnas Abdelaziz Kallel, kes kaitses doktorikraadi Pariisis. FP7 projekti EstSpacE üheks tegevuseks on välisteadlaste sissetoomine ja välismaale läinud eesti noorte tagasitoomine. Selle projekti raames töötab alates 1. septembrist atmosfäärifüüsika osakonnas Jouni Envall, kes tuli Helsingi Tehnikaülikoolist. Astrofüüsika osakonnas töötab 1. novembrist Taavi Tuvikene, kes naases doktoriõpingutelt Brüsselis.

Suurte projektide haldamine nõuab tõsist tööd ja nii töötabki alates 1. maist direktsiooni koosseisus projektijuhina Tiia Lillemaa, kelle hallata on nii EstSpacE kui ka peahoone renoveerimise ja juurdeehituse projekt. 1. septembrist töötavad osalise koormusega tehnikutena teadusarhiivide korrastamisel Peeter Einasto ja Triin Einasto.

Kõigi muutuste tulemusena oli 1. jaanuaril 2009 Tartu Observatooriumis tööl 75 inimest, neist 44 teadustöötajat ja 9 teadustööd tegevat inseneri.

1.3 Tunnustused

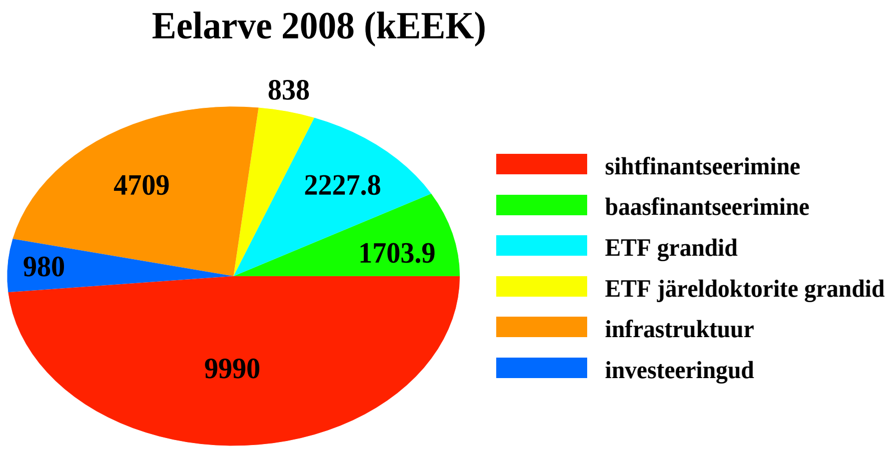
Eesti Teaduste Akadeemia, Haridus- ja Teadusministeerium ja Sihtasutus Archimedes korraldasid järjekordse teaduse populariseerimise konkursi. 2008. aastal pälvisid I auhinna ilmateadlane Ain Kallis, kes on aastate jooksul tutvustanud nii ilmateadust, geograafiat, astronoomiat kui ka teisi valdkondi paljudes ajakirjandusväljaannetes ja loengutel, ning astronoomide MTÜ Stellaarium ja selle juht Mare Ruusalepp, kes korraldavad huvilistele ekskursioone Tõraveres.

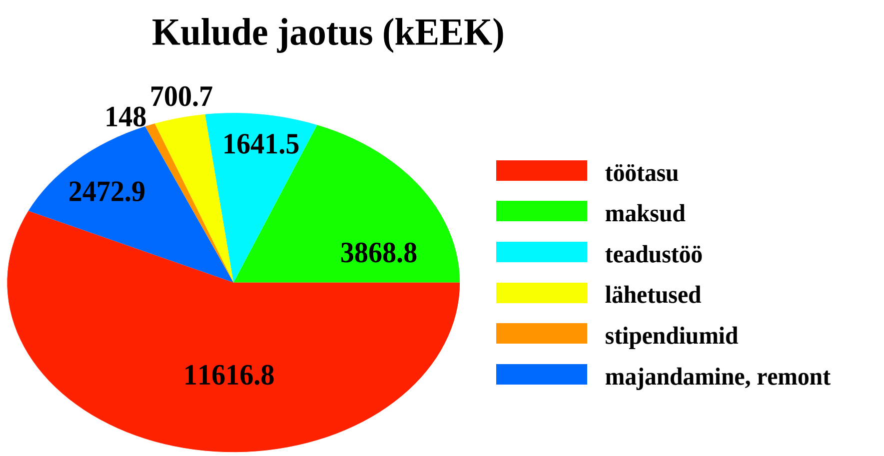
Vanemteadur Tiit Nilson inaugureeriti 6. juunil 2008 Helsingi Ülikooli audoktoriks.

Vasakult: Teaduse populariseerimise konkursi tööde hindamiskomisjoni liige, akadeemik Georg Liidja, I auhinna saanud Ain Kallis (ülemisel fotol) ja Mare Ruusalepp (alumisel fotol), Euroopa Liidu teaduse peadirektoraadi peadirektor José Manuel Silva Rodriguez ning Haridus- ja Teadusministeeriumi teaduse asekantsler Andres Koppel auhindade kätteandmisel 29. aprillil 2008.

1.4 Eelarve

Riigieelarvest eraldati Tartu Observatooriumile 2008. aastal 20.4487 miljonit krooni (20448.7 kEEK). Tulud ja kulud jagunesid järgnevalt:





Lisaks laekus *ca* 11039.8 kEEK mitmesugustest koostööprojektidest ja lepingutest, mida on nimetatud osades 1.1.3 ja 1.1.4.

Observatooriumi teadlaste keskmine töötasu 2008. a lõpul oli 17 819 EEK (*ca* 1139 EUR) kuus.

1.5 Aparatuur ja seadmed

2008. aastal hangiti uut teadusaparatuuri peamiselt FP7 projekti EstSpacE raames.

Olulisemad uued instrumendid:

1. Taimkatte kaugseire töörühm hankis välispektromeetri SVC HR-1024 (Spectra Vista Corporation):
   - 350–2500 nm,
   - 1024 spektraalset kanalit.
2. Üheksa spektraalkanaliga päikesefotomeetri, CE-318N-EBM9 (CIMEL Electronique),
3. Raadio teel juhitava väikekopteri JR Voyager 260 GSR.
4. Atmosfääri seire töörühm hankis päikese ultraviolettkiirguse spektromeetria süsteemi, mis baseerub topeltmonokromaatoril DMc150 (Bentham Instruments Ltd). Instrument seati üles EMHI Tartu-Tõravere meteoroloogiajaamas.
5. 0.6 m teleskoobiga tehtavateks heledusmõõtmisteks muretseti uus tundlikum, stabiilsem ja tühise omamüraga CCD kaamera Andor iKon-L.
6. 1.5 m teleskoobiga toimuvate spektraalvaatluste piirküündivus spektraalse lahutusvõime 0.3–0.4 nm korral ulatub nüüd umbes 16. tähesuuruseni, kuna 2008. a. sügisest alates võimaldab nõrku tähti spektrograafi pilul gideerida ülitundlik CCD kaamera Andor Luca, mis muretseti ETF grandi eest.

1.5 m teleskoobiga tehti spektraalvaatlusi 50 ööl ning 0.6 m teleskoobiga fotomeetrilisi vaatlusi 24 ööl.

1.6 Teadusnõukogu töö

Tartu Observatooriumi teadusnõukogu on 13-liikmeline. 2008. a selle koosseis ei muutunud. Nõukogu esimees on direktor Laurits Leedjärv ja aseesimees vanemteadur Tõnu Viik. Väljastpoolt Observatooriumi kuuluvad nõukogusse Riigikogu esimees akadeemik Ene Ergma ja Tartu Ülikooli professor Rein Rõõm. Haridus- ja Teadusministeeriumi poolt määratud liige on Tartu Ülikooli dotsent Peeter Tenjes.

Teadusnõukogu pidas 12 koosolekut, kuulati järgmisi teaduslikke ettekandeid:

Jaanuar – *E. Saar*: Kosmoloogiliste väljade morfoloogia.
Veebruar – *V. Russak*: Tegurid, mis mõjutavad õhutemperatuuri Eestis.
Märts – *A. Puss*: VV Cephei tüüpi kaksiktähed ja nende prototüüp.
Aprill – *J. Vennik*: Väikeste galaktikasüsteemide ehitus.
Juuni – *T. Nilson*: Kuhu lähed, taimkatte kaugseire?

September – *E. Tempel*: Galaktikate heledusfunktsioon: 2dFGRS.
– *K. Kiis*: Keskmise ruumilise lahutusega satelliidipiltidelt tehtavate lageraiealade pindalahinnangute täpsust mõjutavad tegurid.
Oktoober – *K. Eerme*: Milleks uurida UV kiirgust?
November – *R. Poolamäe*: Täheatmosfäärides toimuvate protsesside modelleerimisest.
Detsember – *I. Suhhonenko*: Sammudest tühikutest arusaamiseks.

Muid teadusnõukogu tegemisi:

- 18. veebruari koosolekul arutati ning 3. märtsi koosolekul arutati veelkord ja kinnitati Tartu Observatooriumi arengukava aastateks 2008–2013.
- 24. märtsil kinnitati sihtfinantseeritavate teemade lõpparuanded.
- 31. märtsil toimus konkurss teadurite ja vanemteadurite ametikohtadele. Vanemteaduriteks atmosfäärifüüsika erialal valiti Andres Kuusk, Tiit Nilson ja Kalju Eerme. Vanemteaduriks astrofüüsika erialal valiti Kalju Annuk. Lili Sapar ja Alar Puss valiti teaduriteks astrofüüsika erialal ning Peeter Tenjes valiti 0.25 koormusega vanemteaduriks kosmoloogia erialal.
- 22. septembril määrati Ernst Julius Öpiku nimeline stipendium Tartu Ülikooli doktorant Elmo Tempelile ja Juhan Rossi nimeline stipendium Tartu Ülikooli doktorant Kadri Kiisile. Mõlema stipendiumi suurus oli 12 000 EEK.
- 13. oktoobri koosolekul kinnitati sihtfinantseeritavate teadusteemade jätkutaotlused.
- 2. detsembri koosolekul toimus konkurss vanemteadurite ja teadurite ametikohtadele. Vanemteaduriks 0.5 koormusega kaugseire erialal valiti Mait Lang. Teadurina kaugseire erialal 0.75 koormusega jätkab Urmas Peterson, samuti jätkavad teaduritena astrofüüsika erialal Anna Aret ja Raivo Poolamäe ning teadurina kosmoloogia erialal Ivan Suhhonenko.

1.7 Suhted avalikkusega

26. mail toimus koostöös Tartu Ülikooli Ajaloo Muuseumi ja AHHAA keskusega suur "Tartu astronoomilise nurgakivi päev". Sellel päeval möödus 200 aastat nurgakivi panemisest Tartu Tähetornile (1808) ja 50 aastat Tartu observatooriumi peahoone mahamärkimisest maastikule (1958). Tõraveres, peahoone ees avati uus päikesekell, mille valmistasid Tartu Kõrgema Kunstikooli skulptorid Bruno Kadak ja Rein Maantoa. Tartu Tähetornis toimus lühikonverents, kus Juhan Maiste rääkis teemal ”Ahhaa piir Euroopa ja Liivimaa vahel. Uuest kosmosest Tartus 19. sajandi algul”. Tõnu Viik esines teemal ”Teadus Tartu Tähetornis 1810–1939” ning Jaan Einasto tegi lühikokkuvõtte ”Tartu Observatoorium – 200 aastat”.

Päikesekell peahoone ees.

Jätkuvalt külastas Tõraveret palju huvilisi. Käis 242 gruppi 5300 huvilisega. Nüüdsest saab ülevaate registreeritud ekskursioonidest observatooriumi koduleheküljelt. Traditsiooniliselt peeti astronoomia loenguid Nõo Reaalgümnaasiumi 12. klasside õpilastele. Observatooriumi teadlaste arvukad populaarteaduslikud kirjutised on üksikasjaliselt ära toodud lk. 76, avalikud loengud ja intervjuud lk. 102.

Ilmus Tähetorni Kalender 2009 (85. aastakäik) ja juba traditsiooniline Tähistaeva Kalender 2009.

Trükist ilmusid K. Annuki koostatud Rahvusvahelise Astronoomia Aasta poster ja A. Tamme koostatud voldik *Universumi areng Suurest Paugust tänapäevani*. Materjalid on mõeldud eelkõige koolidele.

1.8 Tänuavaldused

Meie teadlased on saanud rahalist või muud toetust paljudelt asutustelt üle maailma. Oleme tänulikud kõigile toetajatele, nende nimed leiate inglisekeelsest osast leheküljel 26.

2 Summary

2.1 Research projects and grants

2.1.1 Target financed projects

In 2008, research in the framework of three new target financed projects was started:

- Dark Energy, Dark Matter, and the formation of structure in the Universe (principal investigator E. Saar) – 3870 kEEK,
- Observational and theoretical investigation of stars and their envelopes during advanced evolutionary phases (principal investigator T. Kipper) – 5040 kEEK,
- Remote sensing of optically complex natural environments (principal investigator A. Kuusk) – 1080 kEEK.

(1 kEEK = 1000 EEK = 63.9 EUR)

2.1.2 Estonian Science Foundation grants

The Estonian Science Foundation financed 14 grant projects from our Observatory:

1. Grant 6100: A. Kuusk – Scattering and absorption of radiation energy in natural and cultivated vegetation canopies – 127.1 kEEK.
2. Grant 6104: E. Saar – Precision cosmology of the large scale structure – 220 kEEK.
3. Grant 6105: A.-E. Sapar – Structure and spectra of stellar atmospheres and stellar winds; physical processes in them – 140 kEEK.
4. Grant 6106: J. Vennik – Evolution of galaxies in groups – 137 kEEK.
5. Grant 6810: I. Kolka – Luminous highly evolved stars in the framework of Gaia – 141 kEEK.
6. Grant 6812: M. Mõttus – Applicability of hyperspectral and multiangular remotely sensed data for estimating forest structure – 174.9 kEEK.
7. Grant 6813: J. Pelt – Theory and applications of dispersion spectra – 80 kEEK.
8. Grant 6814: A. Reinart – Development of the remote sensing methods according to the specific conditions of Estonian optically multicomponental waters – 249 kEEK.
9. Grant 6815: T. Nilson – Monitoring the productivity of Estonian forests by satellite remote sensing – 205 kEEK.
10. Grant 7115: A. Tamm – Evolution of disc galaxies on cosmological time scales – 57.5 kEEK.
11. Grant 7137: K. Eerme – Spectral composition of the ground-level solar ultraviolet radiation – 100 kEEK.

12. Grant 7146: M. Gramann – Evolution of galaxies and dark energy in the expanding Universe – 92 kEEK.
13. Grant 7691: I. Pustylnik, V.-V. Pustynski – Physical processes, statistical characteristics, and evolutionary changes in binary systems with hot subdwarfs – 73 kEEK to Tartu Observatory.
14. V. Russak participated in the grant 7347 led by H. Ohvril from Tartu University (60 kEEK 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.

In 2008, The Estonian Science Foundation started to award post-doc grants. Two applications for the positions in our Observatory were successful.

1. Post-doc grant JD 107: A. Kallel – Modelling radiative transfer in vegetation: Enhancement and validation of the adding method – 212.5 kEEK in 2008 + 400 kEEK relocation expenses.
2. Post-doc grant JD 131: M. Saal – Theoretical and cosmological aspects of generalized gravitation theories – 204.5 kEEK in 2008.

2.1.3 The FP7 project EstSpacE

On March 1, 2008 the European Commission 7th Framework Programme REGPOT project EstSpacE (Expose the Capacity of Estonian Space Research and Technology through High Quality Partnership in Europe) started. A. Reinart is a leader of this three-years-long project with a total financing about 1.1 MEUR (17.206 MEEK) from EC. Some researchers from the Institute of Physics and Institute of Technology of Tartu University also participate in this project. Main activities of the project in 2008 (purchase of scientific equipment, employing new people, organizing workshops and summer schools) will be described in relevant chapters of the present Annual Report.

2.1.4 Other projects and contracts

- EC FP6 project Hyperspectral remote sensing in Europe – specific support actions: TO coordinator M. Mõttus – TO share 25.76 kEEK in 2008.
- Nordic Forest Research Co-operation Committee (SNS) grant "Physically-based remote sensing of forests (PHYSENSE) network": T. Nilson – 93.9 kEEK.
- Review of declared agricultural parcels with remote sensing methods: U. Peterson – 80.0 kEEK.
- National programme of environmental monitoring, subprogramme "Studies on change of Estonian landscapes and remote sensing": U. Peterson – 300.0 kEEK + 40 kEEK for publishing information materials.

- Subcontract for ESA/ESRIN contract ”Technical Assistance for the validation of MERIS products in lake Vänern and coastal waters of the north-western Baltic Sea (Sweden)”, contract number 21524: A. Reinart – 125 kEEK.
- Improving Satellite Remote Sensing Products for Large Lakes, EMP1 2008: A. Reinart – 215 kEEK.
- Remote sensing and study of trends of coastal waters: TO coordinator A. Reinart – 70 kEEK.
- Development of (Estonian) space terminology, contract number 02-14/2008: U. Veismann – 20 kEEK.

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

The Archimedes Foundation supported paying value added tax for the equipment purchased in the framework of the EstSpacE project in the amount of 835.8 kEEK.

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

Radio-controlled miniature helicopter JR Voyager 260 GSR.

2.2 Staff

On May 2, 2008 our long-time good colleague Izold Pustylnik passed away, after a short fatal disease. Colleagues will remember him as a specialist in structure and evolution of close binary stars, as a dedicated researcher in history of astronomy and archaeoastronomy, and a multiply talented person – having come to Tartu in 1962 from Odessa, he was after a couple of month only able to give a seminar talk in Estonian.

On June 5, the contract with engineer Matti Pehk was ended. On April 30, research associate Ain Kallis formally left the Observatory, but he will continue collaboration with us. The same happened to Valery Malyuto. The post-doc term of Evgeni Vasiliev ended in June 2008.

On the other hand, we are happy that new financing opportunities allowed to employ new young researchers. Thanks to the post-doc grants from the Estonian Science Foundation, we have Margus Saal working in the department of cosmology from May 1, and Abdelaziz Kallel (who came from Paris) in the department of atmospheric physics from June 1. One of the activities of the FP7 project EstSpacE is to recruit outstanding foreign scientists and to repatriate young Estonian scientists. Jouni Envall from Helsinki University of Technology is working in the department of atmospheric physics from September 1, and Taavi Tuvikene returned to the department of astrophysics from Ph.D. studies in Brussels since November 1 under this scheme.

Management of big projects requires big effort, and so we have Tiia Lillemaa working as a project manager from May 1. She takes care of both the EstSpacE project and the renovation project of the main building. Starting from September 1, Peeter Einasto and Triin Einasto are working as part-time technicians on systematization of scientific archives.

As a result of all the changes, the number of people employed by the Tartu Observatory was 75 on January 1, 2009. Of them, 44 are on the position of researchers and 9 on that of research engineers.

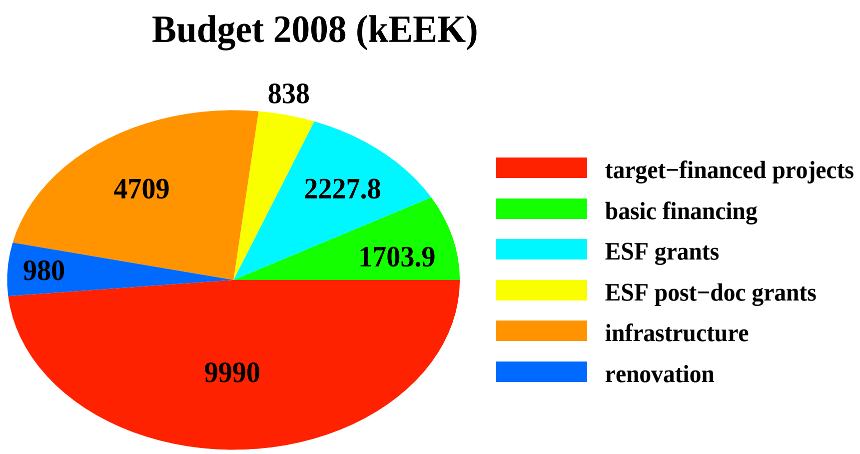
2.3 Rewards

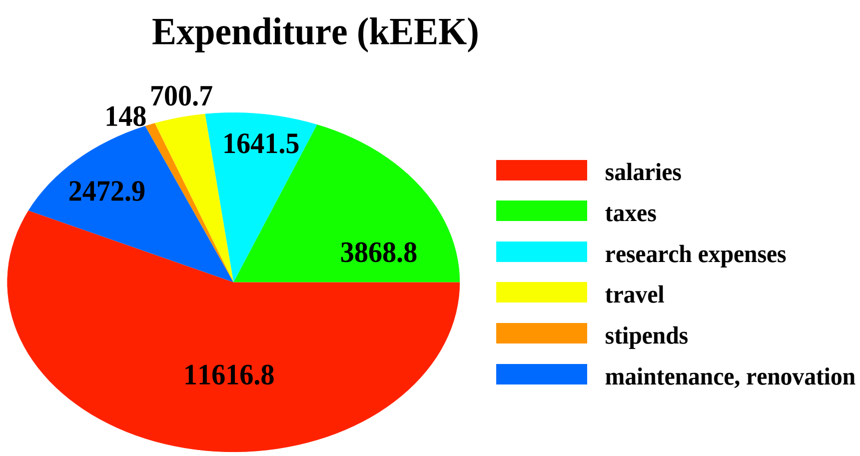
Estonian Academy of Sciences, Ministry of Education and Research and the Archimedes Foundation organize a yearly competition on popularization of science. In 2008, two first prizes were awarded to our Observatory: to the climatologist Ain Kallis for long-time popularization of climatology, geography and astronomy, and to the non-profit organization Stellaarium and its leader Mare Ruusalepp for arranging excursions in the Observatory.

On June 6, 2008 the senior research associate Tiit Nilson was confered an honorary doctor of the University of Helsinki, Faculty of Agriculture and Forestry.

2.4 Budget

The total amount allocated from the state budget directly to the Observatory was 20448.7 kEEK and it was divided as follows:





In addition, about 11039.8 kEEK from contracts with several organizations were allocated to the Observatory.

The mean monthly salary of researchers was approximately 17 819 EEK (1139 EUR) by the end of 2008.

2.5 Instruments and facilities

Thanks to the EstSpacE project, it was possible to obtain several new scientific instruments of which our researchers had dreamed for a long time. Those include:

1. Field portable spectroradiometer system SVC HR-1024 (Spectra Vista Corporation), 350–2500 nm, 1024 spectral bands.
2. Automatic Sun tracking photometer CE-318N-EBM9 (CIMEL Electronique), nine spectral bands.
3. Radio-controlled miniature helicopter JR Voyager 260 GSR.
4. Spectrometric system for measurements of solar ultraviolet radiation, based on the Bentham DMc150F-U double monochromator. The monochromator is installed in a thermostated Envirobox chamber at the Tartu-Tõravere Meteorological Station of EMHI.
   Optical interface:
   - Diameter of diffuser 10 mm,
   - Length of optical fibre 6 m,
   - Rotating shadow band.

   Spectrometer:
   - Diffraction grating 2400 lines/mm,
   - Spectral range 200–600 nm,
   - Energy maximum 250 nm,
   - Spectral resolution at the slit width 0,1 mm 0,14 nm,
   - Spectral resolution at the slit width 1 mm 1,35 nm,
   - Spectral resolution at the slit width 3,7 mm 5 nm.

   Recording:
   - Amplifier of photocurrent,
   - Resolution of A/D-converter 20000,
   - USB-output,
   - Software Benwin.
5. A CCD camera Andor iKon-L, with high sensitivity and low dark noise, for photometric observations on the 0.6 m telescope Zeiss-600.
6. In addition, the group of stellar physics obtained a new highly sensitive guiding CCD camera Andor Luca which was attached to the spectrograph slit at the 1.5 m telescope. It allows the faint limit of spectroscopic observations $\sim 16^m$ at the spectral resolution 0.3–0.4 nm.

Astronomical observations were continued as usually. The 1.5 m telescope was used for spectroscopic observations during 50 nights, and the 0.6 m telescope for photometric observations during 24 nights.

2.6 Scientific Council

Tartu Observatory has a Scientific Council consisting of 13 members. There were no changes in the content of the Council during 2008. Director Laurits Leedjärv acts as a chairman of the Council, and senior research associate Tõnu Viik as a vice-chairman. There are two members from outside the Observatory, appointed by the director: Academician Ene Ergma, speaker of the Parliament of Estonia, and Prof. Rein Rõõm from Tartu University. Associate professor Peeter Tenjes has been appointed by the Ministry of Education and Research.

The Scientific Council held 12 meetings in 2008. The following scientific reports were presented:

January – *E. Saar*: Morphology of cosmological fields.
February – *V. Russak*: Factors influencing air temperature in Estonia.
March – *A. Puss*: VV Cephei type binary stars and their prototype.
April – *J. Vennik*: Structure of small galaxy systems.
June – *T. Nilson*: *Quo vadis*, remote sensing of vegetation?
September – *E. Tempel*: Luminosity function of galaxies from 2dFGRS.
– *K. Kiis*: Factors influencing accuracy of area estimates of forest clear-cut areas from medium resolution satellite images.
October – *K. Eerme*: Why to study UV radiation?
November – *R. Poolamäe*: On modelling of processes in stellar atmospheres.
December – *Ivan Suhhonenko*: Steps to understand the voids.

Other activities of the Council:

- A new development plan of Tartu Observatory for 2008–2013 was discussed on February 18. The plan was further discussed and accepted on March 3.
- On March 24, final reports of target financed projects were approved.
- On March 31, the contest to the positions of research associates and senior research associates took place. Andres Kuusk, Tiit Nilson and Kalju Eerme were elected to senior research associates in the department of atmospheric physics, Kalju Annuk in the department of astrophysics, and Peeter Tenjes (with 0.25 workload) in the department of cosmology. Lili Sapar and Alar Puss were elected to the position of research associate in the department of astrophysics.
- On September 22, the Ernst Julius Öpik fellowship (12 000 EEK) was awarded to the Ph.D. student of Tartu University Elmo Tempel, and Juhan Ross fellowship (12 000 EEK) to the Ph.D. student of Tartu University Kadri Kiis.
- On October 13, applications for continuation of the target financed projects were approved.

- On December 2, another content to the positions was carried out. Mait Lang was elected to the post of senior research associate (0.5 workload) and Urmas Peterson to that of research associate (0.75 workload) in the department of atmospheric physics. Anna Aret and Raivo Poolamäe were elected to the positions of research associates in the department of astrophysics, and Ivan Suhhonenko in the department of cosmology.

2.7 Public relations

On May 26, "The Astronomical Corner-stone Day" was organized jointly by the Museum of History of the University of Tartu, Tartu Observatory and the Science Centre AHHAA. It was ment to celebrate the 200th anniversary of laying corner-stone to the Old Tartu Observatory (1808) and 50th anniversary of the beginning of building works at the site of the new observatory at Tõravere (1958). On this occasion, a sundial modelled by the sculptors Bruno Kadak and Rein Maantoa from Tartu Art College, was opened at Tõravere. A mini-conference took place in the Old Tartu Observatory, with Jaan Einasto, Tõnu Viik and art historian Juhan Maiste as speakers.

Academicians J. Einasto and A. Sapar at the opening of the sundial.

The site of the observatory at Tõravere continued to be a popular destination of excursions. We received 242 groups with about 5300 visitors. One can now see the registered excursions groups in the Internet. Traditionally, a course of astronomy to 12th grades of Nõo High School was held. Numerous popular-scientific articles of our scientists are given on page 76, public lectures and interviews on the page 102.

The 85th issue of the Calendar of the Observatory was published as well as already becoming traditional Calendar of the Starry Sky.

As preparations to the International Year of Astronomy 2009, K. Annuk compiled a poster and A. Tamm compiled a little booklet "Evolution of the Universe from Big Bang to nowadays". Both these materials were printed, and were sent to the schools in Estonia in early 2009.

2.8 Acknowledgements

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

- ASTRONET (EC FP6 project)
- Astrophysikalisches Institut Potsdam
- CNES (Centre National d'Études Spatiales, France)
- Estonian Academy of Sciences
- Estonian Meteorological and Hydrological Institute
- Estonian Ministry of Education and Research
- Estonian Ministry of Environment
- Estonian Science Foundation
- Eurisy
- Euro–Asian Astronomical Society
- European Astronomical Society
- European Commission
- European Southern Observatory
- European Space Agency
- Helsinki University
- International Astronomical Union
- Institute for Astronomy, University of Vienna
- Institute of Astronomy of Russian Academy of Sciences
- Institute of Physics, Tartu University
- Isaac Newton Group of Telescopes
- Ministére de l'Enseignement Supérieur et de la Recherche, France
- Nordic Forest Research Co-operation Committee (SNS)
- Novespace
- Observatori Astronomic, Universitat de València
- Oulu University
- Pakker Avio
- Sternberg Astronomical Institute, Moscow
- Swedish National Space Board
- Tartu University
- Tuorla Observatory, Turku
- World Radiation Center

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

Kosmoloogia osakonna põhiteemaks oli jätkuvalt Universumi suuremastaabilise struktuuri mõistmine ja järelduste tegemine Universumi omaduste ja arengu kohta. Suur osa töid põhines viimase aja suurimal galaktikate ja nende punanihete (kauguste) andmebaasil, Sloani Numbrilisel Taevaülevaatel (SDSS). Esimese etapina leidsime galaktikate grupid ja galaktikaparved (kuna valimi omadused muutuvad sügavusega, on see üpris keeruline operatsioon). Saadud gruppide põhjal leidsime galaktikate superparved, seni teada kõige suuremad struktuurielemendid Universumis.

Superparvi on palju, aga kõige huvitavamad on rikkad superparved, mida saab detailselt uurida, millel on pikk ajalugu, ja mida on siiani olnud millegipärast pea võimatu numbriliselt modelleerida. Me uurisime täpsemalt kaht rikast superparve 2dFGRS valimist ja kirjeldasime selle siseehitust nn "morfoloogilise jälje" abil. SDSS valimist valisime uurimiseks ühe suhteliselt lähedase, aga väga ulatusliku superparve, "Sloani Suure Seina". Siin pöörasime erilist tähelepanu punastele heledatele galaktikatele (LRG), mille seos harilike galaktikatega on Sloani Seinas veel näha, kaugemal on aga need galaktikad ainsad, mis meile superparvi näitavad.

Sloani ülevaate lähedasemas osas saab ka võrrelda galaktikate ja lähedaste kvasarite paiknemist ja seoseid. Kuna arvatakse, et igas galaktikas on kunagi olnud või kunagi süttib kvasar, annab nende võrdlemine infot kvasarite evolutsiooni kohta. Praegu igatahes näivad kvasarid hoiduvat kohtadesse, kus galaktikaid vähem.

Galaktikate praeguseid omadusi ja nende evolutsiooni on juba ammu uuritud, kasutades galaktikate heledusfunktsiooni. Uute andmebaaside põhjal saab seda teha palju täpsemini ja detailsemalt. Me uurisime 2dFGRS ülevaate galaktikate ja gruppide heledusfunktsioone, võrreldes eri populatsioone, ja leidsime mitmeid piiranguid, mida galaktikasüsteemide tekke teooria arvestama peab.

Detailsemalt uurisime mitut lähedast galaktikagruppi – kuigi suurtes ülevaadetes on neid gruppe tuhandeid, näeme seal ainult heledaid hiidgalaktikaid ja nõrgematest kaaslastest ei tea me midagi. Need kaaslased kannavad aga väärtuslikku infot nii grupi tekke kui selle praeguse füüsika kohta.

Tulles veelgi lähemale, kontrollisime valguse siseneeldumist meie naabergalaktika (M 31) tolmus ja leidsime, et see võib olla väga suur, pea pool tähesuurust. Kui sama juhtub ka teistes galaktikates, oleme nende masse tihti oluliselt alla hinnanud.

Meie Galaktikas kaardistasime eriti külmade vesinikupilvede jaotuse. Ka pakkusime välja uued meetodid tähtede automaatseks klassifitseerimiseks; need on eriti olulised uute suuremahuliste täheülevaadete töötlemiseks.

Teoreetilise kosmoloogia osas kontrollisime, kuidas kirjeldab vaadeldavat Universumit gravitatsiooni skaalar-tensor-teooria; leidsime tingimused, mille puhul selle teooria piirjuhuks on tuntud üldrelatiivsusteooria, ja kirjeldasime kosmoloogilise mudeli evolutsiooni faasiruumis. Jälgisime numbriliselt struktuuri arengut Universumis, püüdes mõista, mis määrab struktuuri arengu erinevates keskkondades (tühjades piirkondades, filamentides, superparvedes).

Kosmoloogias mängib suurt osa statistika, eriti praegu, kus andmebaasid on väga mahukad; need võimaldavad otsida väga peeni efekte. Me näitasime, et galaktikaparvede ja galaktikate omavahelise korrelatsiooni uurimine lubab oluliselt täpsustada meie galaktikajaotuse mudeleid. Hindasime galaktikate paariskorrelatsiooni suurtel vahekaugustel, kus peaksid ilmnema varaste barüonvõnkumiste jäljed, ja näitasime, et need jäljed on kindlalt olemas, kuigi mitte päris sellised kui ennustab teooria. Tulemuste usaldusväärsuse hindamiseks pakkusime uue kordusvaliku meetodi ja näitasime, et see hea on. Gravitatsiooniteooriate kontrolliks hindasime ka struktuuri arengukiirust eri punanihetel.

3.1 Observed large-scale structure

3.1.1 Groups, clusters and superclusters of galaxies

The main data used for studying galaxy aggregates was the Sloan Digital Sky Survey and its several data releases (DR). E. Tago compiled an extensive catalogue of groups using the SDSS DR5 (more than 675 000 galaxies with observed redshifts). He used the Friends-of-Friends (FoF) group finder, modified by E. Saar, who proposed to calibrate the change of the linking length in depth by artificially shifting nearby observed groups. Such a scaling of the linking length reduces selection effects in a flux limited sample.

The obtained catalogue was used to study the group luminosity function, the luminosity density field, group properties in various large scale environments and to compile a supercluster catalogue.

A more extensive study of the SDSS DR6 (790 860 galaxy redshifts) was carried out and a volume-limited group sample was created. Such a homogeneous sample is required by many large-scale structure studies, and for comparison with numerical simulations. The properties of the observed groups were compared with subhalo simulations in collaboration with colleagues from Tuorla (P. Heinämäki, P. Nurmi).

E. Tago started also the FoF analysis of the SDSS DR7 – the final release of the SDSS. A flux-limited sample of galaxies and of groups of galaxies was created. The group catalogues will be completed and analysed in detail next year.

E. Tago also continued upgrading the database of rich galaxy clusters in collaboration with H. Andernach (Guanajuato, Mexico; Bonn University, Germany). The catalogue contains redshifts for 5625 clusters and velocity dispersions are known for 3405 clusters. Their analysis of a subsample of about 1400 rich clusters shows that the peculiar velocities of the brightest cluster galaxies are too high to be explained in the cold dark matter halo (CDMH) models. These might be in agreement with the scenario of merging groups.

3.1.2 Superclusters from the Sloan Digital Sky Survey

The cosmology group started a preliminary study for compiling a supercluster catalogue from the final SDSS data similar to the 2dF Galaxy Redshift Survey (2dFGRS) supercluster catalogue compiled by us earlier. Eventually we hope to obtain superclusters for both the SDSS main and LRG samples.

We used the SDSS DR6 as a proving ground for testing several methods. L.J. Liivamägi used the galaxy and group catalogue by E. Tago as a starting point and created its luminosity density field using the $B3$ spline smoothing kernel with an effective radius of $8\,\mathrm{Mpc\,h^{-1}}$. The finger-of-God redshift distortions were reduced by using the ratio between the rms velocity σ_v and the rms spread in the sky σ_r for the groups. E. Tempel calculated the k-correction, evolutionarily corrected luminosities and also the weights to correct for the missing galaxies that lie outside the observational window.

Superclusters were defined as regions where the density is above a chosen threshold. In order to find a suitable threshold density value, multiple sets of superclusters were created and the analysis is still in progress. As a final step, galaxies are attributed to the superclusters.

A number of supercluster properties are available for study; from the density field: their location, volume, total luminosity, the number and heights of peaks; from galaxies: the number of galaxies and groups, supercluster diameter, its location data and the total luminosity.

In the future we plan to find the Minkowski functionals for each supercluster (as done by M. Einasto for the 2dFGRS) or for the whole density field.

3.1.3 Morphology of the richest superclusters

M. Einasto and E. Saar (together with V. Martínez (Valencia), and J.-L. Starck (Paris)) continued the study of the morphology of the two richest superclusters from the 2dFGRS, the superclusters SCL126 and SCL9 (the Sculptor supercluster). They used Minkowski functionals and shapefinders to describe the detailed substructure of these superclusters and the clumpiness of individual galaxy populations in superclusters. L. J. Liivamägi, J. Einasto and V. Müller (Potsdam) have joined this study. In contrast to most earlier studies we calculate the Minkowski functionals for the whole range of threshold densities, starting with the lowest density used in the supercluster search, up to the peak density in the supercluster core. At low densities, Minkowski functionals and shapefinders characterize the whole superclusters, at high densities – their high density core regions.

In this study, the fourth Minkowski functional (Euler characteristic) that gives us a number of isolated clumps (or holes) in the sample was used to characterize the clumpiness both of the full supercluster, and of individual galaxy populations. The shapefinders $K1$ and $K2$, defined on the basis of Minkowski functionals, give us information about the shapes of superclusters. In the shapefinder's plane rich superclusters have a characteristic signature that can be modelled by a simple multibranched filamentary structure. Interestingly, our calculations show that at the density level at which about 2/3 of galaxies in superclusters belong to lower density regions (outskirts) and about 1/3 of galaxies belong to high density cores, the characteristic morphology of superclusters changes. At the same density level the galaxy content and clumpiness of individual galaxy populations also changes. In the core regions of superclusters, there are relatively more red, passive, non-star forming galaxies than in the outskirts of superclusters. Thus this density level can be used to define cores and outskirts of superclusters.

In addition, our study reveals interesting differences between the clumpiness of galaxy populations defined by their colour and by spectral information. These differences can be explained introducing a population of galaxies with red colours and high star formation activity (or with blue colours without star formation). In superclusters, these galaxies are located at intermediate density regions in poor groups (or they do not belong to any group).

We found several differences between superclusters under study. For example, in the supercluster SCL126 galaxies of different colour are segregated – red galaxies are located in richer groups, and blue galaxies in poor groups, or they do not belong to any group. In the supercluster SCL9 red and blue galaxies reside together in groups of any richness. In addition, the overall morphology of these superclusters is different, the supercluster SCL126 is a very rich filament with a high density core, and the supercluster SCL9 looks like a spider. These differences indicate different formation and evolution paths of these very rich galaxy systems.

M. Einasto applied Minkowski functionals also to subhalo simulations to study the substructure of filaments in these numerical models as traced by different types of haloes.

3.1.4 The Sloan Great Wall and Luminous Red Galaxies

M. Einasto, E. Saar, L.J. Liivamägi, E. Tempel, J. Einasto and E. Tago together with V. Martínez (Valencia) started a detailed study of the Sloan Great Wall region. The Sloan Great Wall is one of the richest system of galaxies known; the very rich supercluster SCL126 forms the most dense part of this wall. One particular aspect of this study is the detailed analysis of the spatial distribution and morphology of the Luminous Red Galaxies (LRGs). These galaxies are thought to be early type galaxies which mostly reside in central parts of rich groups and clusters of galaxies, being the first-ranked galaxies in these systems. Thus they can be used as tracers of the galaxy distribution up to very large distances.

We decided to check whether these galaxies really are of early type and main galaxies of the groups. This can be done at redshifts where there are also the data about other galaxies; the Sloan Digital Sky Survey is well suited for such a task. Our preliminary results are somewhat surprising – we found that there are almost as many isolated galaxies among the LRGs as there are main galaxies among them. Many groups contain more than one LRG. For example, the very rich group Gr49134 contains 17 LRGs. Moreover, the study of the morphology of LRGs (with the help of the Visual Tools of the SDSS) shows that many LRGs can be classified as spirals. We plan to continue this study next year.

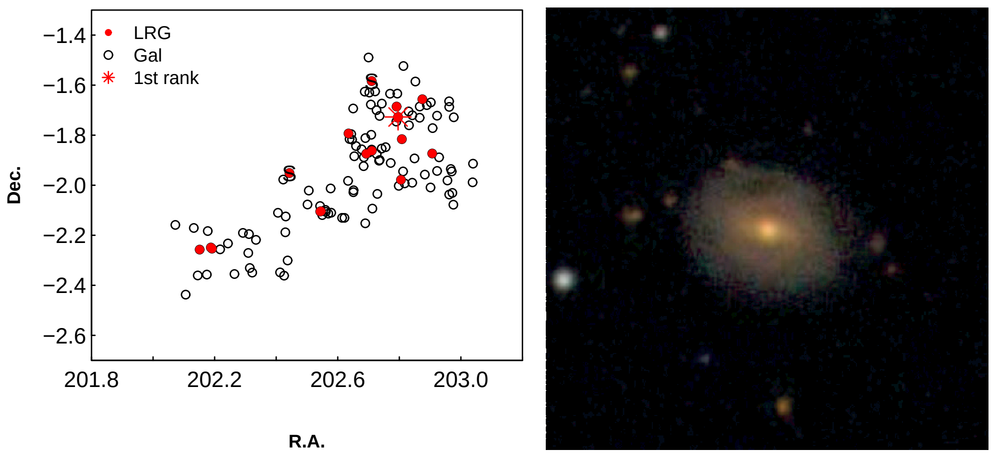


Figure 3.1: Left panel: The sky distribution of galaxies in a very rich group of galaxies, Gr49134, the richest group in the supercluster SCL126. The red cross shows the location of the main galaxy in the group, filled circles represent LRGs and empty circles – other galaxies in group. Right panel: an image of one spiral LRG in this group, taken from the Sloan Digital Sky Survey image database. Vasak paneel: Rikkasse galaktikagruppi Gr49134 kuuluvate galaktikate jaotus taevas. See grupp on superparve SCL126 kõige rikkam grupp. Punane rist tähistab grupi peagalaktikat, täidetud ringid vastavad heledatele punastele galaktikatele (LRG), rõngad teistele galaktikatele. Parempoolsel joonisel on ühe sellesse gruppi kuuluva heleda punase spiraalse galaktika kujutis Sloani andmebaasist.

3.1.5 Environments of nearby quasars

E. Tago, E. Saar, L.J. Liivamägi, E. Tempel, M. Einasto, J. Einasto and M. Gramann in collaboration with H. Lietzen, P. Heinämäki and P. Nurmi from Tuorla Observatory (Finland) examined the properties of galaxies and galaxy groups in the vicinity of nearby quasars. For the first time, spectroscopic galaxy redshift surveys are reaching the scales where galaxies can be studied together with the nearest quasars. This gives and opportunity to study the relation between the activity of a quasar and its environment in much more detail than before, and to check different theories of evolution of galaxies and quasars.

We analysed the environments of nearby quasars using number counts of galaxies and groups of galaxies. We also studied the dependence of group properties on their distances to the nearest quasar. The large-scale environment was studied by analysing the locations of quasars in the luminosity density field.

We found that there are relatively few bright galaxies around quasars. Also, the groups of galaxies that have a quasar closer than 2 Mpc are poorer and less luminous than average groups. Quasars clearly avoid the cores of rich superclusters and are located in the outskirts of superclusters or in filaments connecting them. Therefore, quasar evolution is affected by density variations on supercluster scales.

We plan to continue this study and to investigate in more detail the origin and evolution of quasars in different environments, using cosmological simulations.

3.2 Galaxies and groups

3.2.1 Luminosity functions of galaxies and their systems

Luminosity functions (probability distributions of absolute luminosities of objects) are an important tool for describing populations of galaxies and galaxy groups. Our cosmology group has studied these for a long period. Several years ago G. Hütsi found the galaxy luminosity function for the early SDSS data. A couple of years ago, J. Einasto and E. Saar derived the luminosity function for the 4th data release of the SDSS, using a non-parametric approach and describing the final result in terms of a double-power-law function. In 2007 and 2008, E. Tempel determined the luminosity function of the latest SDSS (DR6 and DR7) and 2dFGRS data and the corresponding group catalogues.

The first paper published on this work is dedicated to the analysis of the 2dFGRS data. We preferred the 2dF data to the SDSS, because the former has

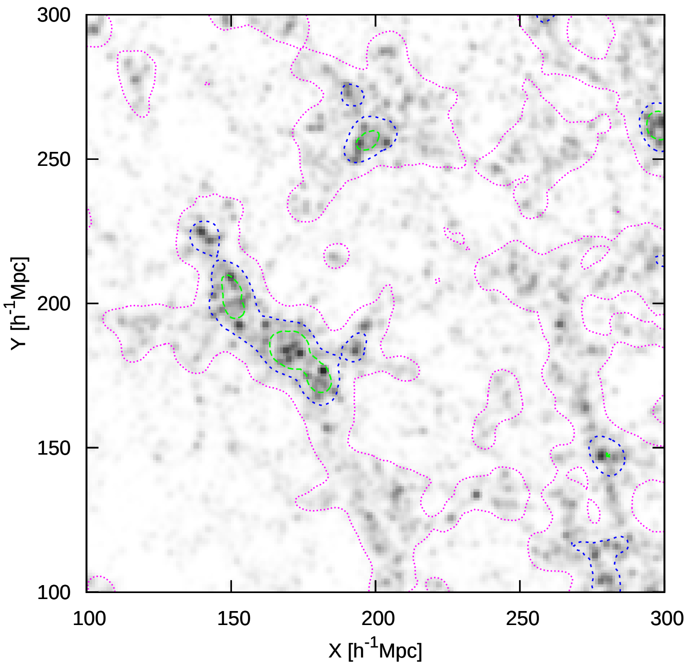


Figure 3.2: The projected luminosity density distribution of the central area of the 2dFGRS Northern sample. The green long-dashed line surrounds the supercluster core region, the blue dashed line – the supercluster region, and the dotted violet line – the filament region, the rest is the void region. The luminous supercluster near the centre of the Figure is SCL126, according to the catalogue by Einasto et al. (1997). Projekteeritud heledustiheduse jaotus 2dFGRS põhjapoolse valimi keskosas. Joonisel on selgelt eristatavad neli tiheduspiirkonda: rikaste superparvede tuumad, superparved, filamendid ning tühjad piirkonnad.

a much wider luminosity window. E. Tempel derived the luminosity function for different types of galaxies and for various density environments. Galaxy types were chosen, using the group catalogue by E. Tago. Based on this catalogue, we discriminated between first-ranked galaxies (the most luminous galaxies in groups), second-ranked galaxies (the second luminous galaxies in groups), satellite galaxies (all group galaxies, except the first-ranked) and isolated galaxies (i.e. galaxies that do not belong to any group in our catalogue). Describing the density environment, we used a smoothed density distribution with a kernel width $8\,\mathrm{Mpc}\,\mathrm{h}^{-1}$. With these environmental densities, we divided our galaxies into four density classes: void, filament, supercluster and supercluster core galaxies. An example of the distribution of the environmental densities is shown in Fig. 3.2.

The principal result of our study is that the luminosity functions of galaxies depend strongly on the environment and on the galaxy types. In the

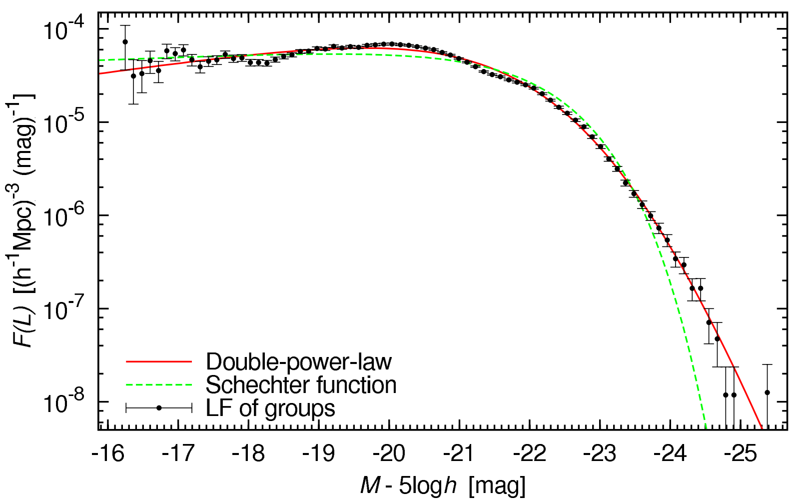


Figure 3.3: The differential luminosity function of groups (shown by points). The red solid line is the double-power-law fit and the green dashed line is the Schechter function. Galaktikagruppide diferentsiaalne heledusfunktsioon. Punase joonega on toodud kahe-astme seaduse lähend ning rohelise joonega Schechteri lähendus.

highest density regions (supercluster cores) the luminosity function for all galaxy populations have a well-defined lower luminosity limit, about $10^9 L_\odot$; in the lowest density regions (voids) the luminosity functions are shifted in respect to the luminosity functions of all other regions, toward lower luminosities. The luminosity function of second-ranked galaxies in high-density regions is similar to the luminosity function of first-ranked galaxies in lower-density regions. This result can be explained, using the hierarchical galaxy formation scenario: second-ranked galaxies in high-density regions have been first-ranked galaxies in the past, before they were accreted into larger systems. Almost all bright isolated galaxies can be identified with first-ranked galaxies of groups where the remaining galaxies lie outside the survey magnitude window.

The luminosity function of galaxies and groups can be expressed by a double-power-law more accurately than by the usual Schechter function. Fig. 3.3 shows the luminosity function of groups and the fitted Schechter and double-power-law functions: it is clear that the double-power-law gives a much better fit than the Schecter function.

3.2.2 Nearby groups of galaxies

J. Vennik continued his studies of about ten relatively rich ($n > 10$) and reasonably well isolated groups of galaxies, which are located in and around the Local Supercluster. New possible dwarf group members were selected basing on quantitative (photometric) and qualitative (morphological) criteria, and their membership probabilities were evaluated. The highest rated dwarf member candidates were observed spectroscopically with the Hobby Eberly Telescope (HET). Presently, long-slit spectra (Fig 3.4) of 20 galaxies have been registered for seven groups. For 13 objects the new radial velocities confirm their preliminary classification (either a group member or a field galaxy), and 10 galaxies could have been classified as secure new dwarf members of the corresponding groups.

The structure and kinematics of an isolated rich group of galaxies WLB 666 (centered on NGC 6962/64) was studied in more detail, basing on the imaging and spectral data of the SDSS and on our own spectroscopy obtained with the HET. The bi-modal velocity distribution may indicate the existence of two subgroups, which are projected to each other along the line-of-sight. The photometric structure of the E pec and S0 galaxies, which are populating the dense group core, does not reveal clear signs of mutual interactions. The sparse group halo that extends out to about 3 Mpc, is populated by actively star-forming emission-line galaxies (ELGs).

3.2.3 Dust-corrected surface brightness distribution of M 31

A. Tamm, E. Tempel and P. Tenjes started to study the distribution of intrinsic absorption of light in nearby galaxies. Such an absorption reduces the observed luminosity of a galaxy and can seriously influence the study of its dynamics. As the first step, the nearby Andromeda galaxy (M 31) was selected for modelling.

The dust content and its distribution inside M 31 was estimated using its 180 μm far-infrared emission. The observational data were obtained from the Spitzer Space Telescope archives. These data were processed in a standard way; the most crucial stage was the determination of the background. Far-infrared fluxes were averaged within concentric ellipses with a fixed eccentricity and position angle.

The actual absorption along each line-of-sight depends strongly on the geometry of the stellar populations and of the dust layer. Using a preliminary stellar population model and assuming that the optical depth (τ) of the dust disc is proportional to the infrared flux, dust absorption along each line-of-sight was found. The calculations were done in the thin disc approximation (for the disc region) and in the general case (for the bulge region).

Interestingly, the result found in the thin disc approximation is rather insensitive to the assumptions about the thickness of the dust disc and on the face-on optical depth for nearly edge-on galaxies. The high inclination angle of a galaxy increases the effective optical depth of the dust disc so much

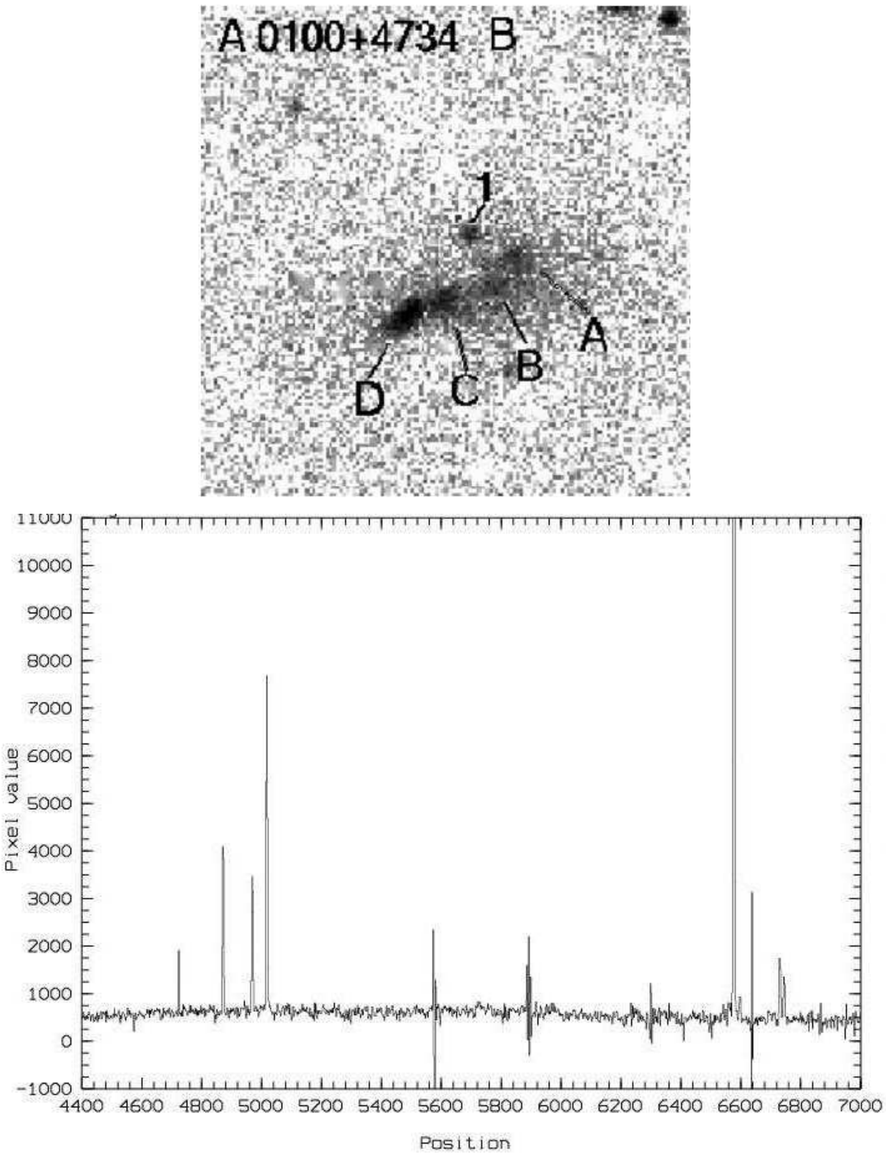


Figure 3.4: Bottom: HET LRS long slit spectrum ($\exp = 2 \times 1500$ sec) of a newly found dwarf galaxy ($v = 568 \pm 11$ km/s, $M_{\rm B} = -14.0$) in a nearby group of galaxies, showing typical emission lines (Hβ, O III, Hα, N II, S II) of H II galaxies and night sky residuals. Top: the B image ($1.2' \times 1.2'$) of the galaxy, obtained with the 1.23 m telescope at Calar Alto, prominent star-formation knots are labelled A through D. All: Hobby Eberly teleskoobiga (HET+LRS) saadud lähedases grupis paikneva kääbusgalaktika ($v = 568 \pm 11$ km/s, $M_{\rm B} = -14.0$) spekter, milles domineerivad HII galaktikale omased emissioonijooned (Hβ, O III, Hα, N II, S II) ning näha on ka öötaeva joonte jäägid. Ülal: galaktika foto ($1.2' \times 1.2'$) on saadud Calar Alto observatooriumi 1.23 m teleskoobiga ja sellel on osundatud aktiivse tähetekkega piirkonnad.

that nearly all the radiation from the other side of the dust layer becomes absorbed; naturally, all the light from the stars between us and the dust layer reaches us unaffected. Thus in the case of a dust layer that is much thinner than the stellar disc, dust absorption is effectively grey, being about 0.75 mag (nearly half of the light is absorbed) in all optical filters and for any optical depth within the range $\tau_V = 0.5 - \infty$. For face-on galaxies the dust absorption is more sensitive to the optical depth value. The original and restored luminosity profiles of M 31 are shown in Fig. 3.5.

We found that the dust disc absorbs as much as 41 % (or 0.57 mag) of the total *B*-flux in M 31. Such a high intrinsic absorption, even for a well-studied nearby galaxy, suggests that total luminosities of galaxies may be significantly underestimated and need to be corrected for the dust absorption.

3.3 Our Galaxy

3.3.1 Cold H I in the Galaxy

U. Haud continued the analysis of the results of the Gaussian decomposition of the Leiden/Argentine/Bonn (LAB) Survey of Galactic H I. This year the main attention was focussed on identification of the "clouds" of similar Gaussians in the 5-dimensional parameter space (two sky coordinates, the velocity, the width and height of the Gaussians). A computer program was written for such cluster analysis, but so far the results are not yet fully satisfactory. As the problems with the analysis seem to be greatest for the coldest structures (very narrow Gaussians), special attention was paid to studying these features and an all-sky map of the coldest neutral hydrogen gas was prepared.

3.3.2 Stellar classification

V. Malyuto continued development of classification methods for deep surveys of stellar populations in the Galaxy. He proposed a method of determining the unreddened colour indices from homogeneous atmospheric parameters for supergiants that allows to carry out large-scale extinction mapping of the Galaxy with a sensitivity about 0.1–0.2 mag. He also estimated the accuracy of a set of selected stellar catalogues of effective temperatures by data intercomparison. This allows to produce a homogenized catalogue of merged data.

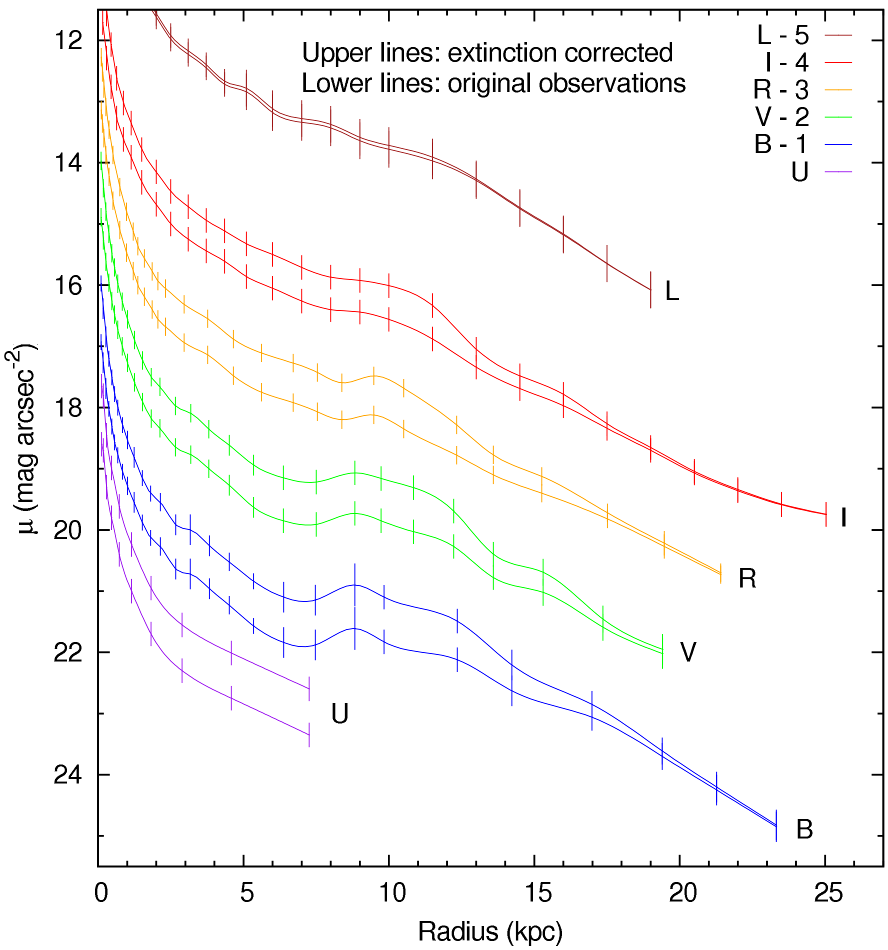


Figure 3.5: The M 31 surface brightness distribution along the major semiaxis in *U*, *B*, *V*, *R*, *I*, and *L* colours. For each colour, the lower line corresponds to the measured data points, and the upper line shows our surface brightness distribution corrected by the intrinsic absorption. Note that except for *U*, all other distributions have been shifted along the *y*-axis as indicated in the legend. Galaktika M 31 pindheleduse sõltuvus kaugusest piki peatelge filtrites *U*, *B*, *V*, *R*, *I* ja *L*. Iga värvi puhul näitab alumine joon mõõtmistulemusi ja ülemine joon siseneeldumise arvel korrigeeritud tulemusi. Graafikud on nihutatud piki *y*-telge, nagu joonisel märgitud (välja arvatud *U*).

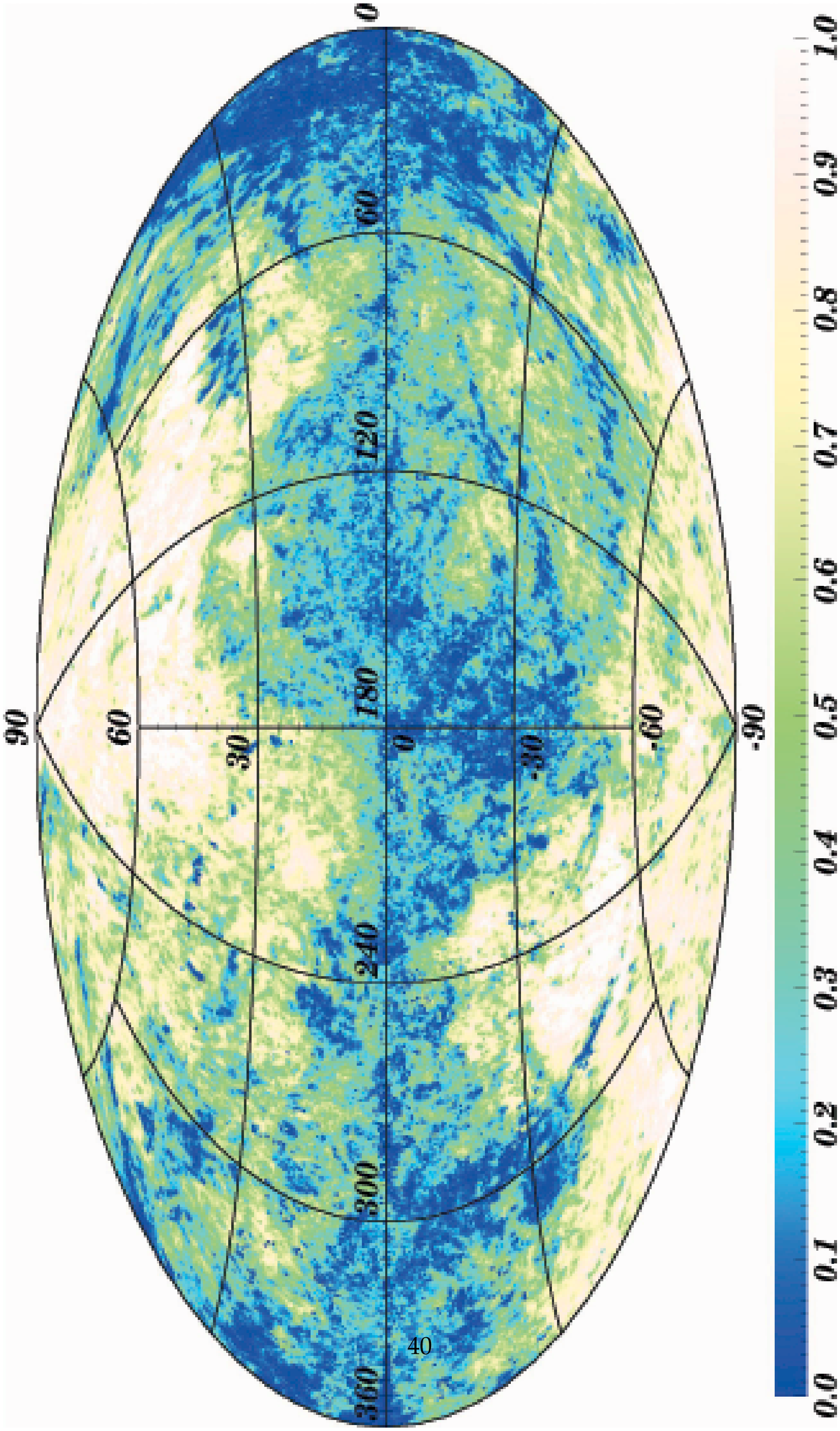


Figure 3.6: The distribution of the cold H I in the sky. The bluer the colour, the narrower and stronger the H I 21 cm lines in the corresponding region. Külma H I jaotus taevasfääril. Mida sinisem on värvus, seda kitsamaid ja tugevamaid H I 21 cm jooni antud piirkonnas leidub.

3.4 Cosmological statistics

3.4.1 Cluster-galaxy cross-correlations

There are several wide field galaxy and cluster surveys planned for the nearest future, e.g. BOSS, WFMOS, ADEPT, Hetdex, SPT, eROSITA. In the simplest approach one would analyse these independently, thus neglecting the extra information provided by the cluster-galaxy cross-pairs.

G. Hütsi, together with O. Lahav (University College London) focused on the possible synergy between these surveys by investigating the amount of information encoded in the cross-pairs. They presented a model for the cluster-galaxy cross-spectrum within the Halo Model framework. To assess the gain in performance due to inclusion of the cluster-galaxy cross-pairs they carried out a Fisher matrix analysis for a BOSS-like galaxy redshift survey targeting luminous red galaxies and a hypothetical mass-limited cluster redshift survey with a lower mass threshold of $1.7 \times 10^{14} M_{\odot}/h$ over the same volume.

On small scales cluster-galaxy cross-spectrum probes directly the density profile of the halos, instead of the density profile convolved with itself, as is the case for the galaxy power spectrum. Due to this different behaviour, adding information from the cross-pairs helps to tighten constraints on the halo occupation distribution. By inclusion of the cross-pairs a factor of about two stronger constraints are obtained for σ_8, while the improvement for the dark energy figure-of-merit is somewhat weaker: an increase by a factor of 1.4.

3.4.2 Searching for baryonic oscillations

E. Saar (together with V.J. Martínez and a Ph.D. student P.A. Mur, University of Valencia) worked on the search for traces of baryonic oscillations in the Sloan Digital Sky Survey (SDSS) data. Such a search is one of the most actual topics in cosmology these days, and the SDSS is the best galaxy database (3-D map) at the moment. They chose to work on the galaxy two-point correlation function, where those traces should be seen best.

This work included careful analysis of the data; they started with the SDSS DR6 and continued work on DR7 when this was made available. They determined the selection functions, both in depth and in the sky, with different methods, and selected a large number of subsamples, in order to see how stable are the results.

They devised also a new approach to estimating the sampling errors of the correlation function, applying bootstrap methods in a rigorous manner. They tested the prescriptions on two test problems – the Bessel universes, realizations of Cox processes in spherical samples, and on the process of the Poisson-Voronoi vertices, in samples of the SDSS geometry.

They found the correlation functions at large pair distances for a large number of the SDSS subsamples, and also for the 2dFGRS database, the previous largest galaxy map.

After extensive work, they found that the baryonic peak in the correlation function is a stable feature, but it is much more distorted than the present theory predicts. They also found that there might exist extra peaks in the correlation function that cannot be explained by the accepted simple theory of inflation (the extremely rapid expansion of the Universe at very early epochs).

3.4.3 Testing theories of gravitation

G. Hütsi, together with K. Yamamoto (Hiroshima University), and T. Sato (University College London) measured the γ parameter for the growth rate of density perturbations using the redshift-space distortion of the luminous red galaxies in the Sloan Digital Sky Survey.

Assuming the cosmological constant model that matches the results of the WMAP experiment, they found $\gamma = 0.62 + 1.8(\sigma_8 - 0.8) \pm 0.11$ at 1-sigma confidence level, which is consistent with the prediction of general relativity, $\gamma \simeq 0.55$. A rather high value of $\sigma_8 (\geq 0.87)$ is required to be consistent with the prediction of the cosmological DGP brane model, $\gamma \simeq 0.68$.

3.5 Theory and simulations

3.5.1 Scalar-tensor gravity and cosmology

The concordance model based on the Einstein equations of general relativity with phenomenological cosmological constant Λ is in agreement with observation. However, the well known problem of interpreting the cosmological constant as vacuum energy encourages to look for alternative theories of gravitation and for corresponding cosmological models.

In general, the modifications of Einstein's general relativity may be divided into two alternative approaches. The first, and more common approach, is to modify the matter side of the Einstein's equations by postulating unknown types of matter with suitable properties for dark matter and dark energy. In the simplest models the unknown energy density is taken to be a scalar field which is characterized by its kinetic and potential term. In this case the cosmological constant is replaced by a field dependent potential (quintessence, phantom field, radion etc.). The second approach, however, is to modify the gravitational/geometrical side of the Einstein's equations by generalizing the Einstein-Hilbert term of the action. In order to hold agreement with observations, these modifications should become important only at very large scales.

The simplest generalized theory of gravity is the scalar-tensor theory which employs a scalar field besides the usual metric tensor to describe the gravitational interaction. In the scalar-tensor theory the scalar field is in the role of a variable Newtonian gravitational "constant". Theories of scalar-tensor type arise naturally as effective (low dimensional) limits of higher dimensional theories via the Kaluza-Klein reduction mechanism, where the scalar field (moduli field) characterizes the internal manifold. This is also true for the braneworld models, for example in the Randall-Sundrum two-brane scenario the low energy theory on the brane (our visible Universe) is given by a specific scalar-tensor theory where the scalar field is interpreted as a radion which measures the distance between the branes.

An important issue in the context of scalar-tensor theory is the list of conditions under which the theory relaxes to general relativity. An attractor mechanism that drives the scalar-tensor theory towards the general relativity was proposed by M. Saal, together with L. Järv and P. Kuusk (Tartu University). They used the dynamical system approach for that.

Another important aspect in the context of the scalar-tensor theory, as well as in the case of any generalized theories of gravity, is the question about the physical frame. The same group found that the scalar field transformation is singular at the limit of general relativity and therefore the correspondence between the frames is lost.

M. Saal, L. Järv, and P. Kuusk (Tartu University) also studied the evolution of cosmological models within the general scalar-tensor theory of gravity with arbitrary coupling function and potential. After introducing the limit of general relativity, a detailed analysis of the phase space geometry was done. Using the methods of dynamical systems for the decoupled equation of the Jordan frame scalar field, they found the fixed points of flows in two cases: potential domination and matter domination. The conditions on the mathematical form of the coupling function and potential, which determine the nature of the fixed points (attractor or other) were presented. There are two types of fixed points, both are characterized by cosmological evolution mimicking general relativity, but only one of the types is compatible with the Solar System constraints. The phase space structure should also carry over to the Einstein frame as long as the transformation between the frames is regular. This, however, is not the case for the latter fixed point.

3.5.2 Evolution of the structure of the Universe

J. Einasto, in collaboration with I. Suhhonenko, E. Tempel, E. Saar, M. Einasto, and with Volker Müller from Potsdam started a study of the evolution of large-scale structure using numerical simulations of LambdaCDM models with truncated power spectra. So far three series of models have been calculated, for the cube sizes of 256 Mpc/h, 64 Mpc/h, and 100 Mpc/h; the number of particles in all three models was $N = 256^3$. In all series one model has the full LambdaCDM power spectrum, and other models have truncated spectra with large-scale fluctuations taken to zero from the wavelengths of 8, 16, 32 and 64 Mpc/h. For all models the particle files for early epochs have been stored, for the redshifts $z = 30,\ 20,\ 10,\ 5,\ 2,\ 1,\ 0.5,\ 0.2,\ 0.1,\ 0$.

The first series of models has been analysed for the deep void and supercluster core regions. The results show that halos (primordial galaxies or groups) form everywhere in voids if medium-scale waves are cut out. Thus the observbed absence of halos in voids can be explained by the combined action of waves of medium scales.

This work will continue: other models need to be analysed to clarify the effect of the numerical resolution, and medium-sized galaxy systems (filaments) need to be studied.

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 evolutsioon kujundab olulisel määral kogu Universumi olekut. Kosmoloogiliste uuringute kõrval jätkus meil uue teadusteema raames ka tähefüüsika.

Evolutsiooni keerdkäigud võivad viia mitmesuguste huvitavate, lühikest aega eksisteerivate objektideni. Nn vesinikuvaeseid lähiskaksiktähti on teada ainult neli. Neist ühe, KS Per, keemiline koostis näitab, et selles tähes ei ole heeliumi põlemine nn kolmik-alfa tuumareaktsioonides veel alanud. Teist tüüpi tähe, tolmümbrisega G-ülihiiu V1427 Aql keemiline analüüs aga näitas hilisemat evolutsioonilist faasi, kus täheaine kolmas segunemine on juba toimunud.

Kuumade Wolf-Rayet tähtede WN alamtüübi 21 tähe vesiniku ja heeliumi sisalduse suhe määrati uudse meetodiga, mis arvestab tähetuule klombilist struktuuri. Leidsime ka, et kuumade tähtede optiliselt paksu tähetuule välised osad võivad sama massi ja massikao kiirusega tähtede puhul olla väga erineva struktuuriga. Hilise B-ülihiiu HD 199478 kiirgusjoonte muutlikkus näib olevat põhjustatud tähe ekvaatori kohal "hõljuvast" gaasipilvest, mis on jällegi klombilise struktuuriga.

Jätkus täheatmosfääride mudeleid ja neist väljuvat kiirgust arvutava programmipaketi SMART täiustamine. Püüti leida täpsemaid lähendvalemeid olulisemate füüsikaliste protsesside jaoks. See toob olekuvõrranditesse sisse nn vastasmõju-liikmed, mis võtavad arvesse, et täheatmosfäärides ei ole ideaalne gaas, vaid reaalne hõrendatud kõrge temeperatuuriga plasma. Saadi ka uued üldistatud valemid Gaunti faktorite arvutamiseks seotud-seotud ja seotud-vaba üleminekute puhul.

Nn horisontaalharu ehk EHB objektid kuuluvad enamasti kaksiktähtede koosseisu, orbitaalsete perioodidega vahemikus 0.1–30 päeva. Varem leitud analüütilist seost aine väljavoolu kiiruse ning süsteemi kogumassi, heleduse ja doonortähe raadiuse vahel õnnestus veelgi lihtsustada: laias kaksiksüsteemi parameetrite vahemikus on aine väljavoolu kiirus doonortähest lihtsalt võrdeline kaksiksüsteemi Roche'i piiri raadiusega teatud astmes.

Jätkuvalt uuriti nii vaatluslikult kui teoreetiliselt mitmeid suhteliselt unikaalseid objekte. Näiteks iseäraliku sümbiootilise tähe CH Cyg puhul saadi uusi kinnitusi, et tegemist on tõepoolest erakorraliselt pika orbitaalse perioodiga (5689 päeva ehk 15.6 aastat) kaksiktähega. Ühe meie "tunnustähe" V838 Mon vaatlusi raskendasid mitmed järsud heleduse langused

2008. aasta jooksul. Noova V458 Vul spekter ennustas peatset nebulaarstaadiumi lähenemist. Mõningase vaheaja järel võtsime uuesti luubi alla kaksiktähe RX Cas, mille massiivset komponenti varjab ulatuslik akretsiooniketas.

Ettevalmistustes ESA satelliidi Gaia andmetöötluseks oli peatähelepanu all kunstlike närvivõrkude teooria rakendamise võimalus iseäralike objektide äratundmiseks. Konkreetse matemaatilise mudeli väljavalimiseks on vaja veel täiendavaid uuringuid. Algas tugevate kiirgusjoontega S-tüüpi sümbiootiliste tähtede spektrite kui standardite kataloogi koostamine.

Töötati välja uus statistiline meetod Päikese aktiivsuskomplekside eluea hindamiseks – tänu nn mitteparameetrilisele olemusele on see meetod üsna automaatne ega nõua mingeid etteantud kitsendusi. Uudseid meetodeid rakendati ka gravitatsiooniläätse efektist tingitud ajanihete hindamisel.

Neeldumise mõju uurimine kiirguse polarisatsioonile täheatmosfääris näitas, et üldjuhul neeldumine nõrgendab ülespoole liikuva kiirguse polarisatsiooni ja suurendab allapoole liikuva oma.

Mustade aukude ümber tiirlevate akretsiooniketaste röntgenkiirguse spektris on teada kaks olekut: kalk ja pehme. Meie arvutuste toel sai selgemaks, et üleminekuid nende olekute vahel põhjustab eelkõige akretsiooniketta sisemise raadiuse muutus – sellest sõltub, kui palju pehme röntgenkiirguse footoneid jõuab akretsiooniketta krooni.

Alljärgnev inglisekeelne osa kirjeldab kõiki neid ja teisigi tähefüüsikute uuringuid põhjalikumalt.

4.1 Late-type stars

The studies of post-AGB and hydrogen-deficient stars were continued by T. Kipper in collaboration with V.G. Klochkova (Special Astrophysical Observatory, Russia).

The single-line binary system KS Per was analysed. Studies of such hydrogen-deficient binaries are important for stellar evolution theory as these objects could be the progenitors of type Ia or Ib supernovae. Only four hydrogen-poor close binaries (HdBs) are currently known. We have found that the chemical composition of the metal- and hydrogen-deficient pulsating star KS Per corresponds to the material which is primarily CNO processed without indications of triple α processing. During CNO processing nitrogen is enhanced at the expense of carbon and oxygen. This happens during the first and second dredge-up and one could not decide whether the star has passed the second dredge-up. Soon after that the star will burn He sporadically via the triple α process. The low carbon abundance shows that the donor star had not yet experienced the third dredge-up. In this sense it differs from the other group of hydrogen-poor stars – extreme helium stars (EHs) in which the carbon abundance is considerably enhanced.

The second star analysed, HD 179821 (V1427 Aql), is a G-type supergiant with a detached dust shell which double-peaked energy distribution is similar to that observed in planetary nebulae. The main question was whether the star is a post-AGB object or a post-red-supergiant. The distinction between these is a difficult task. The derived CNO abundances show that HD 179821 has experienced the third dredge-up on the AGB, contrary to yellow post-red-supergiants, which have gone through the first and second dredge-ups after which their C and probably O abundances are reduced and N abundance is enhanced. In HD 179821 abundances of all these elements are increased. The s-process elements are, however, only slightly overabundant.

Apart of chemical composition there are several indicators of very high luminosity of HD 179821. We found objections to most of the arguments favouring post-red-supergiant nature of HD 179821. The remaining evidences, such as the high spatial velocity, high sodium abundance and very high macroturbulent velocity need to be further studied.

4.2 Hot luminous stars

T. Nugis in collaboration with K. Annuk, A. Hirv and with A. Niedzielski and K. Czart from Toruń University (Poland) measured the equivalent widths of the helium and hydrogen emission lines of the WN stars in the near IR spectral range (8500–8950 Å) and determined the hydrogen-to-helium ratios for them by using the new method which accounts for the clumped structure of the winds. The observations of the near IR spectra of 21 WN stars which have been used in this study are described in the paper of Nugis et al. (2008). The results of the hydrogen-to-helium ratio determinations are in preparation for publication.

T. Nugis continued the study of optically thick winds of hot stars. He found that optically thick winds of the hot stars having equal masses and mass-loss rates can have totally different structures of the outer parts of the wind. One solution corresponds to the small velocity gradient around the sonic (critical) point and above. This model has quite extended quasiadiabatic convective zone above the sonic point. The second solution corresponds to the large velocity gradient around the sonic point and this solution has no outer convection zone. From the mathematical point of view these solutions correspond to two different solutions of the quadratic equation for the velocity gradient at the critical point. This equation is derived from the momentum equation by using l'Hopital rule. The results of this study are in preparation for publication.

The spectroscopic time series on the late-B type supergiant HD 199478 obtained at Tartu Observatory were reduced by I. Kolka and included in the collaborative database at the Bulgarian NAO to investigate this strongly variable star. In a paper published in 2008 on the basis of these collected spectra the conclusion has been drawn that the line emission originating in the gas which rotates above the stellar equator in the form of individual clouds or disc is responsible for the spectral variability on different time-scales (~ 20 days and over 60 days).

K. Annuk continued spectroscopic observations of Wolf-Rayet and O-type stars using the 1.5 m telescope.

4.3 Modelling of stellar atmospheres and formation of spectra in them

A. Sapar, A. Aret, R. Poolamäe and L. Sapar worked on the modelling of stellar atmospheres and spectra. In 2008 the efforts were directed to refinement of formulae for algorithms of the Fortran 90 code SMART composed for computation of stellar spectra, modelling of stellar atmospheres and physical processes in them. Attention was focused on finding higher precision approximation formulae for main physical processes, which dominate in the equation of state in stellar atmospheres. Thereby it was assured that the main thermodynamical concepts following from the Helmholtz free energy concept as well as its derivatives must hold.

Such a formulation of the problem demands to include interaction terms, which take into account circumstance that the matter of stellar atmospheres is not ideal gas, but rarefied real high-temperature plasma. Such an approach helps to specify self-consistently the truncation fractions incorporated in the partition functions and contributing to the absorption coefficients of the transition regions from high excitation (Strömgren) states to the corresponding continua, thus avoiding the abrupt cutoff features in the computed stellar spectra.

The Gaunt factors describe deviations of more exact computed electron transition rates from approximate Kramers formula for the hydrogenic absorption coefficients. A new generalized expression of those factors for bound-bound and bound-free transitions has been found.

Analytical series expansion formulae, integrated over azimuthal angles, have been derived to treat adequately the multiple scattering of radiation on free electrons (Thomson scattering). These formulae take into account frequency redistribution, which is important in the frequencies of spectral lines, giving drastically different dispersions in different directions, starting from the monochromatic scattering in the forward direction to the very wide Doppler profile in the backward direction.

R. Poolamäe continued to refactor and improve the C++ code for computing stellar spectra for wider range of spectral classes than SMART. More complicated algorithms and more exact approximations for computing H and He line profiles broadened by the linear Stark effect are used in the code.

4.4 Diffusion of chemical elements and their isotopes in the chemically peculiar (CP) stellar atmospheres

A. Sapar, A. Aret, R. Poolamäe and L. Sapar continued to study diffusion of chemical elements and their isotopes in the quiescent atmospheres of chemically peculiar (CP) mercury-manganese (HgMn) stars. The process of long time consuming computations of evolutionary segregation of chemical elements and their isotopes was essentially shortened by applying the method of parallelization on local multi-core personal computers joined into a cluster. Higher accuracy of the theory of light-induced drift (LID) was obtained, elaborating and applying a new algorithm for the computation of diffusive separation of mercury isotopes. The algorithm provides high-precision mass conservation of segregating species during evolutionary process.

Computations of the evolutionary sequences for changing abundances of mercury and its isotopes in several quiescent model atmospheres have been made using the Fortran 90 program SMART. It has been argued (G. Michaud et al.) that the observed high abundances of heavy chemical elements in the stellar atmospheres are formed by the lifting radiative-driven diffusion from the voluminous envelope, where it generates depletion of heavy chemical ele-

Figure 4.1: Evolutionary variation of concentrations of mercury isotopes relative to initial ones in a model atmosphere with $T_{\rm eff} = 10\ 750$ K, $\log g = 4$. Initial Hg abundance: solar+5 dex with solar system isotope ratios. Rotation and turbulence are ignored. Elavhõbeda isotoopide kontsentratsioonide evolutsiooniline muutumine esialgsete suhtes täheatmosfääri mudelis põhiparameetritega $T_{\rm eff} = 10\ 750$ K, $\log g = 4$ ja Hg sisaldusega solar+5 dex ning Päikesesüsteemile vastava isotoopide suhtelise sisaldusega. Tähe pöörlemist ega turbulentsi atmosfääris pole arvestatud.

ments. The mass of this envelope exceeds by several decimal orders the mass of the high-abundance clouds in the atmospheric layers. Clouds of Hg form because its radiative absorption coefficient is large due to large number of strong and moderate spectral lines in the spectrum of Hg II. The overabundance of Hg can reach to about six orders of magnitude while the general isotope abundance remains normal. The observed anomalous isotope ratios are generated in the quiescent stellar atmospheres, where the radiation field is different from the black-body one and the radiative flux is asymmetrical in overlapping spectral lines of isotopes. This asymmetry generates the light-induced drift which for heavy metals generally results in subsequent diffusive settlement of the lighter isotopes and rising of the heavier ones, leaving finally only the heaviest isotope in the atmosphere (Figure 4.1). Its equilibrium abundance is then determined predominantly by the usual radiative acceleration.

Recently isotopic anomaly of calcium has been reported based on high-resolution observations of several HgMn and Ap stars. Infrared Ca II triplet lines have been observed to be redshifted by about 0.2 Å, which corresponds to the wavelength of the most heavy stable isotope ^{48}Ca. Results obtained from computations of LID for mercury encouraged to start similar studies also for calcium. A list of calcium lines, where the hyperfine and isotopic splitting are taken into account is in a stage of compilation.

Important factors for the process of segregation of chemical elements and their isotopes are also the presence of weak stellar wind and microturbulence, both reducing or even cancelling the diffusion process. The studies of the influence of these phenomena on the diffusive segregation have been initiated in order to elaborate adequate method for including microturbulence and stellar wind into evolutionary computations. It turned out from observations that the hyperfine and isotopic shifts of spectral lines for some ions are in contradiction with present theoretical concepts, based on application of lower order Feynman diagrams for description of elementary atomic processes. Preliminary estimates have shown that computations including also higher order Feynman diagrams can remove these enigmas. Thus, the preparations for such study have been undertaken.

4.5 Eclipsing close binaries

V.-V. Pustynski and I. Pustylnik continued studies of assumed Extreme Horizontal Branch (EHB) binary progenitors. EHB objects are helium burning stars with very thin hydrogen envelopes, with high effective temperatures and surface gravity values, their core masses are estimated as $0.5 M_\odot$. UV excess in spectra of halos of elliptical galaxies and globular clusters is attributed to them. The origin of these objects is still unclear, however, it was found recently that most of EHB stars are probably companions in binaries with periods of $\sim 0.1^{\rm d} - 30^{\rm d}$. So it is important to clarify the role of binarity in formation of EHB objects.

Earlier V.-V. Pustynski and I. Pustylnik elaborated a model of EHB precursor as a binary where the donor fills its Roche lobe on a certain stage of its nuclear evolution and loses mass through the 1st Lagrangian point. The system additionally loses angular momentum due to corotation at the Alfvén radii. Previously an analytical relation was discovered between the mass loss rate, mass, radius and luminosity of the red giant donor when the orbital evolution of the system is set by the mass loss. Following analysis enabled to simplify this relation. It was demonstrated that the mass loss rate may be presented as a power law function only of the critical Roche lobe radius R_L, namely $\dot{M} = C \cdot R_L^{2.8}$, where $\dot{M}$ is the mass loss rate by the donor and C is a numerical constant depending on the system's parameters.

Under certain conditions this power law may hold twice during the orbital evolution of the system, with different values of the factors C at each stage. The law seems to be valid for a wide range of initial parameters of the system, donor's masses laying in the range of $\sim 1 - 20\ M_\odot$, accretor masses laying in the range of $\sim 0.2 - 1.5\ M_\odot$ and initial separations being $\sim 50 - 250\ R_\odot$. However, masses of the components set certain limits on effectiveness of the mass transfer and Alfvén corotation radius. Smaller masses of the donor, as well as smaller corotation radii, imply more effective mass transfer rates needed for effective shrinkage of the orbit. Small initial separations favour smooth and lengthy orbital shrinkage process as well, providing fulfillment of the power law until a close binary is formed. In favourable conditions, the empirical law may hold for mass loss rates in the range $10^{-6} - 10^{-2}\ M_\odot/\mathrm{yr}$, i.e. it is fulfilled on the scale of 4 orders of magnitude.

V. Harvig together with T. Aas and M. Mars from Tallinn University of Technology continued to observe and study variable objects in the open cluster NGC 7160, V497 Cep and EM Cep. V497 Cep is an ellipsoidal or eclipsing variable with the period of 1.2^{d} and the amplitude $< 0.2^{\mathrm{m}}$. EM Cep is an ellipsoidal or eclipsing variable with the period of 0.8^{d} and the amplitude $< 0.2^{\mathrm{m}}$. Their interesting peculiarity is high dispersion of the observational points. The observations, made for years in Tallinn Observatory and Maidanak Observatory, were continued by Ph.D. student M. Mars during his visit to Hlohovec Observatory, Slovak Republic.

Long-term photometric observations of the bright Be star V2148 Cyg in Tallinn Observatory were analysed, including data from international databases. The analysis did not prove the presence of periods proposed by other authors. K. Annuk started spectroscopic observations of the peculiar Be star V2148 Cyg.

4.6 Symbiotic stars and related objects

Detailed analysis of the results of the extensive spectroscopic monitoring of the peculiar symbiotic star CH Cyg was performed by M. Burmeister and L. Leedjärv. There was our paper almost ready for submission when a preprint by Hinkle et al. (astro-ph/0811.0631) became available. In this paper, the authors decline from their triple star model, and show convincingly that CH Cyg is a binary star with an exceptionally long (5689 days or 15.6 yr) orbital period. This is in good agreement with the conclusions of our paper. Thanks to the orbital elements given by Hinkle et al., we could improve our paper, confirming that period of increased symbiotic activity in CH Cyg in 1998–1999 was related to the periastron passage in an elliptic binary orbit.

A. Puss investigated the long-period binary star VV Cep. The comparison of the theoretical models and observations based on the Hα line give a circumspect reference that parameters of the VV Cep system may not need revision as referred meantime. On the other hand, this result is still not very conclusive.

Spectroscopic monitoring of CH Cyg and other symbiotic stars and related objects (AG Dra, EG And, Z And, AX Mon, VV Cep) was also continued in 2008 (K. Annuk, A. Puss, L. Leedjärv).

4.7 Peculiar stars

In 2008, I. Kolka, A. Puss, T. Liimets and T. Eenmäe continued the spectroscopic and photometric investigations of three stars with peculiar behaviour – V838 Mon, V458 Vul and GK Per. The brightness of V838 Mon dropped suddenly in 2008 in few occasions and the formerly observed emission in Hα line disappeared. The spectrum of the nova V458 Vul predicts its approaching nebular stage evidenced by the slow rise of the excitation level in the matter outflow. The old nova GK Per demonstrated a sudden small ($\sim 1^m$) outburst in September 2008. Our spectroscopic and photometric observations of this event offer the possibility to compare the parameters of GK Per in this period with its characteristics during more common 3^m dwarf nova outbursts.

T. Liimets, I. Kolka and T. Tuvikene together with R. Corradi (Isaac Newton Group, La Palma) continued preparations for the investigation to establish the structure and kinematics of circumstellar matter around typical representatives of outbursting stellar objects. For that reason we analysed the light-echo images of V838 Mon, and long time-series of direct images and spectra on Nova Per 1901 and R Aqr observed by many ground-based telescopes: South African Astronomical Observatory (1.0 m telescope), Roque de los Muchachos Observatory, Spain (Isaac Newton Telescope 2.5 m, William

Herschel Telescope 4.2 m, Jacobus Kapteyn Telescope 1.0 m, Nordic Optical Telescope 2.5 m), United States Naval Observatory Flagstaff Station (1.0 m and 1.55 m telescopes).

During the year 2008, both spectroscopic and photometric observations of an eclipsing star HD 292574 continued.

T. Eenmäe continued the analysis of B spectral class stars which appear to rotate very slowly. In the second half of the year, extensive databases of observational spectra were obtained, allowing to study the effects of rapid rotation on the observed spectra. In longer perspective those additional spectra may allow to create a method to measure actual rotating speed of hot stars.

Spectroscopic and photometric observations of the Be star X Per continued, the star is in interesting phase – circumstellar decretion disc is very extensive and dense.

In 2008, spectroscopic observations of the binary star RX Cas were reestablished at Tartu Observatory, using best possible spectral resolution. The purpose is to solve mystery of massive component of binary system which is largely obscured by accretion disc.

4.8 Gaia mission

The Gaia mission will use low resolution slitless spectroscopy for the classification of observed objects. The subsample of emission line stars (ELS) requires specific treatment to be separated from ordinary objects. Different methods have been tested in Tartu Observatory for that task in 2008. Preliminary analysis of the artificial neural network (ANN) approach and of the support vector machine (SVM) algorithm has shown the better classification performance of SVM in the case of Be stars against normal B stars (J. Jänes, I. Kolka). The classification sensitivity of a numerical Hα-index designed on the basis of simulated Gaia spectra was also checked, and its dependence on the level of random noise in the spectra was estimated (I. Kolka). The selection of the optimal ELS detection algorithm needs further investigations.

The calibration of the wavelength scale in the Gaia low resolution spectra depends on the observations of standard stars. S-type symbiotic stars are good candidates for the standards thanks to their point-like angular nature and narrow emission lines with strong contrast over the continuum. We have started to compile the catalogue of spectra of such potential standards in the northern sky including local spectral observations with $\sim$ 0.3 nm resolution (I. Kolka, A. Puss, T. Eenmäe).

4.9 Time and frequency analysis of astronomical phenomena

J. Pelt with colleagues from Finland proceeded with investigations of historical records of sunspots. He developed a new statistical method to estimate lifetimes of activity complexes on the Sun. The new method belongs to the class of nonparametric estimates and its application is absolutely automatic – it does not need any pregiven constants or bin sizes. The algorithm allows to get answers to some important questions about historical behaviour of sunspot groups: how large are statistical differences between two hemispheres, how characteristic statistics depend on differential rotation and how persistent along longitudes is sunspot generating mechanism.

With N. Olspert (Playtech) J. Pelt proceeded with investigations of magnetically active stars. For that purpose the software was written to model spotted stars with arbitrary parametrization of the rotating spots. Computed models will be used as input data to the algorithms which solve the inverse problem: recovery of the spot's properties from observed time series.

J. Pelt (with A. Hirv) proceeded with computer analysis of different time-delay estimation schemes in the context of gravitational lens investigations. This year the main topic was to work on the cases where different previous actual data analyses gave different time delays as results. As they are working on fully automatic time delay estimation software, such analysis of historical incompatibilities is very important.

There is a well known Nyquist limit for sensible frequency analysis range of regularly measured time series. J. Pelt analysed its applicability to the case of irregular time sampling. He found that sometimes various generalizations of the limit tend to overestimate achievable frequencies and sometimes they very strongly underestimate highest frequency which can be looked for. This work allows better planning for future photometric experiments and makes possible some new and unexpected schemes in the context of ultra-precise time series measurement.

4.10 Radiative transfer

T. Viik studied the impact of absorption on the polarization in homogeneous Rayleigh-scattering atmospheres. Generally speaking the absorption reduces the degree of polarization of the upward radiation and enhances it for the downward radiation for the most of the azimuth angles. At the same time, the impact of the absorption on the degree of polarization is not monotonous.

I. Vurm together with J. Poutanen (University of Oulu) 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.

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

Looduskeskkondade keerukusest on tingitud ka uurimismeetodite mitmekesisus. Kaugseire meetodite edasiarendamine hõlmab nii uute teoreetiliste mudelite loomist, satelliidimõõtmisi kui ka atmosfääri omaduste ja käitumise uurimist ja atmosfäärialuseid uuringuid õhusõidukeil ning maapealseid väli- ja laborimõõtmisi.

Jätkus aktiivne koostöö Euroopa riikidega kaugseire ning Päikese UV kiirguse mõõtmiste ja analüüsi vallas. Troposfääri ülaosa ja stratosfääri alumiste kihtide olekut mõjutavad oluliselt lennukimootorite poolt atmosfääri paisatavad heitgaasid ja kondensatsioonituumad. Eesti õhuruumi läbib aastas üle 100 000 lennuki. Lennukite keskkonnamõju on otseses seoses nende kulutatud kütuse kogusega. Keskkonnaseisundit kirjeldavatest meteoandmetest on kõige kauem registreeritud õhutemperatuuri ja sademeid, päikesekiirguse aegread Eestis on juba pikemad kui 50 aastat. Kiirgusvoogude, sademete ja temperatuuri pikaajalist muutlikkust kirjeldab sama tüüpi autoregressiooni ja liikuva keskmistamise (ARIMA) mudel, mis annab tunnistust, et Maa kliimasüsteemis domineerib päikesekiirguse aastase ja Päikese aktiivsuse tsükliga peale surutud rütm.

Põhjamaade veekaugseire võrgustik NordAquaRemS seob Tartu Observatooriumi ja Eesti Mereinstituudi kaugseirajaid Balti merd ümbritsevate riikide sama eriala teadlastega. Ühiselt kasutatakse kallist aparatuuri ning koolitatakse noori teadlasi. Ühisuuringuid viidi läbi Peipsil, Võrtsjärvel ja Askö Merejaamas Rootsis. Koguti suur andmebaas Euroopa Kosmoseagentuuri (ESA) seiresatelliidil Envisat töötava spektromeetri MERIS andmete interpreteerimiseks. MERISe valmisproduktid hindavad Eesti järvedele ja rannikuvetele rakendatuna mitmekordselt üle vee klorofülli sisaldust. Põhjuseks on suur lahustunud aine ja hõljumi hulk vees.

Suvel tehti ulatuslikke mõõtmisi satelliidimõõtmiste tugialal Järvseljal. On ette valmistatud andmebaas kolme Järvselja 100x100 m puistu kasutamiseks testobjektina rahvusvahelise taimkatte peegeldusmudelite võrdluse RAMI järgmisel etapil. Maapealseid optilisi ja struktuurimõõtmisi toetavad ESA eksperimentaalsatelliidi PROBA hüperspektraalsed andmed, millele on tehtud atmosfääri- ja radiomeetriline korrektsioon, ning Tartu Observatooriumis (TO) valminud lennukispektromeetriga mõõdetud metsa atmosfäärialused peegeldumisspektrid. Tehti proovimõõtmisi TO-s väljatöötamisel oleva indikatrissimõõtjaga, mis on kavandatud mitmes vaatesuunas mõõtvate satelliidisensorite (CHRIS/PROBA, Rapid-eye jt.) atmosfäärialuseks toeks. Analüüsiti metsa peegeldusmudeli suutlikkust kirjeldada metsade peegeldusomaduste sesoonseid käike ning uuriti ilmatingimuste muutlikkusest tingitud puistute peegeldusomaduste muutusi aastast aastasse. Metsa spektraalne heleduskoefitsient võib mõnes spektripiirkonnas muutuda kuni 10%. Loodi SQL päringuid võimaldav 2007. a suvel Järvseljal Hispaania Aerokosmilise Tehnika Instituudi lennukilt mõõdetud hüperspektraalsete indikatrisside andmebaas. Kogutud satelliidimõõtmiste andmestik lubab jälgida nii metsade pikaajalisi kui sesoonseid muutusi, mis on põhjustatud nii kliima muutustest kui inimtegevusest. Seiresatelliidid on tublisti abiks metsade majandamise ning maakasutuste muutuste jälgimisel. Niisugune teave on vajalik riiklike majandusotsuste tegemisel.

EL 7. raamprogrammi projekti EstSpacE toel paranes tublisti riistapark. Hankisime päikesefotomeetri atmosfääri läbipaistvuse mõõtmiseks, spektromeetrid UV kiirguse ja taimkatte kaugseire alasteks mõõtmisteks ning raadio teel juhitava väikekopteri metsade peegeldusomaduste mõõtmiseks.

5.1 Solar UV radiation and atmospheric ozone

The importance of recording ground-level solar UV radiation spectra in addition to the broadband and narrowband filter instrument measurements has increased in recent decade. It is related to the deepened research of the health effects of UV radiation as well as of its environmental effects in the atmosphere, in plants and microorganisms. The group of solar UV radiation research (K. Eerme, U. Veismann, Ph.D. students I. Ansko, S. Lätt and M.Sc. students M. Prüssel and I. Krivonožko) had stated the development of UV spectrometry and its applications as a major task. The collaboration with colleagues from European countries has continued within the COST 726 action ending in 2009. The group has also participated in preparation of a new proposal. Further tasks are to extend the current collaboration on the UV measurements in Europe and to develop applied studies on the UV effects in Estonia.

Figure 5.1: The solar UV spectrometer AvaSpec-256. Päikese UV-spektromeeter AvaSpec-256 igapäevases töös.

The work in 2008 included: 1) assessment of the quality of the UV spectra recorded using the minispectrometer AvaSpec-256, 2) purchasing and preparing the installation of the UV spectrometer Bentham-150 using funding from the FP7 REGPOT project EstSpacE, 3) developing the ability of collaboration with other Estonian researchers in natural and technical domains on the destructive as well as beneficial effects of UV radiation. The effects depend much on the ratio of $UV\text{-}B/UV\text{-}A$ irradiances. The Bentham-150 spectrometer offers instrumental facilities for UV measurements comparable with those in other European countries.

The new spectrometric measurement system is installed at the Tartu-Tõravere Meteorological Station of the EMHI, the diffuser interface on the roof and spectrometer with the auxiliary equipment inside. The control and data recording are performed through the local computer network.

There is a wider interest currently to the applications of low cost array spectrometers like AvaSpec-256 in field measurements related to health and environmental effects and to their quality assurance. The values of spectral irradiance at 306 nm retrieved from the spectra agreed with the CUVB1 data within $\sim$10% at solar zenith angle values below $70°$. The linear correlation between the daily doses of irradiance in the full $UV\text{-}B$ range and the daily doses of spectral irradiance at 306 nm were as high as 0.98–0.99. The narrowband spectral irradiance at 306 nm could be considered as a good proxy for the whole $UV\text{-}B$ irradiance. The agreement between the daily UV doses integrated from the spectra, recorded by the filter instruments, and by the LibRadtran codes at the study site (latitude 58.3 degrees) in the summer half-year period is satisfactory. In the summer half-year period the integrated from the recorded spectra daily UV doses at the study site weighted by different response functions are in satisfactory agreement with the calculated values and those recorded by filter instruments. Comparison with the Bentham spectrometer allows more well-founded quality assessment.

The commercial air transport is one of the important factors influencing the ozone chemistry and cirrus cloud condensation. A quantitative estimation of the influence on atmosphere by civil aircrafts flying over Estonia has been performed (K. Eerme and M.Sc. student I. Krivonožko). The emissions depend on the amount of fuel consumed. The main aircrafts emissions are carbon dioxide and water vapour. Nitrogen oxides, sulfur dioxide and aerosols are emitted to lesser extent. The emissions over Estonia are close to the global average.

5.2 Earth atmosphere and climate

Air temperature and precipitation are the two best measured variables to describe state of the environment. Time series analysis of these variables enables us to monitor possible changes in the environment. During 2008, O. Kärner worked on two topics in this field.

Mean precipitation amount in Estonia (in mm) is estimated on the basis of daily measurements in 40 stations over Estonia during 45 years (1961–2005). Temporal variability for the obtained daily time series is examined by means of an autoregressive and integrated moving average (ARIMA) family model of the type (0,1,1). The fitted model appears to be non-stationary showing that the mean precipitation amount during the last 45 years has been more variable than possible to describe by means of a stationary model. The model can be interpreted to be consisting of random walk in a noisy environment. Such an interpretation emphasizes dominating role of a random component in the precipitation series. The result is understandable due to the small territory of Estonia that is situated in the mid latitude cyclone track.

ARIMA models are used to compare long-range temporal variability of the total solar irradiance (TSI) at the top of the atmosphere (TOA) and surface air temperature series. The comparison shows that one and the same type of the model is applicable to represent the TSI and air temperature series. In terms of the model type surface air temperature imitates closely that for the TSI. This may mean that currently no other forcing to the climate system is capable to change the random walk type variability established by the varying activity of the rotating sun. The result should inspire more detailed examination of the dependence of various climate series on short-range fluctuations of TSI.

Based on the data from Tartu-Tõravere Meteorological Station, changes in solar radiation and temperature in Estonia have been studied for the period 1955–2007 (V. Russak). Two different parts have become evident in the time series of solar radiation: a statistically significant decrease in the annual totals of solar radiation has been detected up to the beginning of the 1990s, while opposite trend has become evident during more recent years. These changes are in correlation with the changes in the amount of low clouds and in the transparency of cloudless atmosphere (atmospheric aerosol loading). Unlike solar radiation, annual mean temperature has continuously and relatively uniformly increased during 1955–2007. The atmospheric aerosol content as a factor masking the influence of greenhouse effect enhancement on the warming has turned out to be negligible in Estonia.

5.3 Remote sensing of water bodies

Year 2008 was especially fruitful in sense of international collaboration. Several international projects on remote sensing of water started in Tartu Observatory during this year. Estonian Science Foundation funded cooperation projects with Norwegian Water Research Institute and Oslo University for harmonisation of optical measurements over large lakes. Researchers from Vrije Universiteit Amsterdam and related spin-off company Water Insight participated in our field campaigns on lakes Peipsi and Võrtsjärv in order to improve monitoring methods for inland waters. Finally, after two years attempts, NORDic network for AQUAtic REMote Sensing (NordAquaRemS) was funded by NordForsk. This project connects research groups from all Nordic countries – Sweden, Finland, Norway, Denmark, but also Estonia, Iceland, Germany and Poland. From this network both Ph.D. students and researchers will benefit by shared experience and expensive instrumentation, but also coordinated efforts to attract new grants.

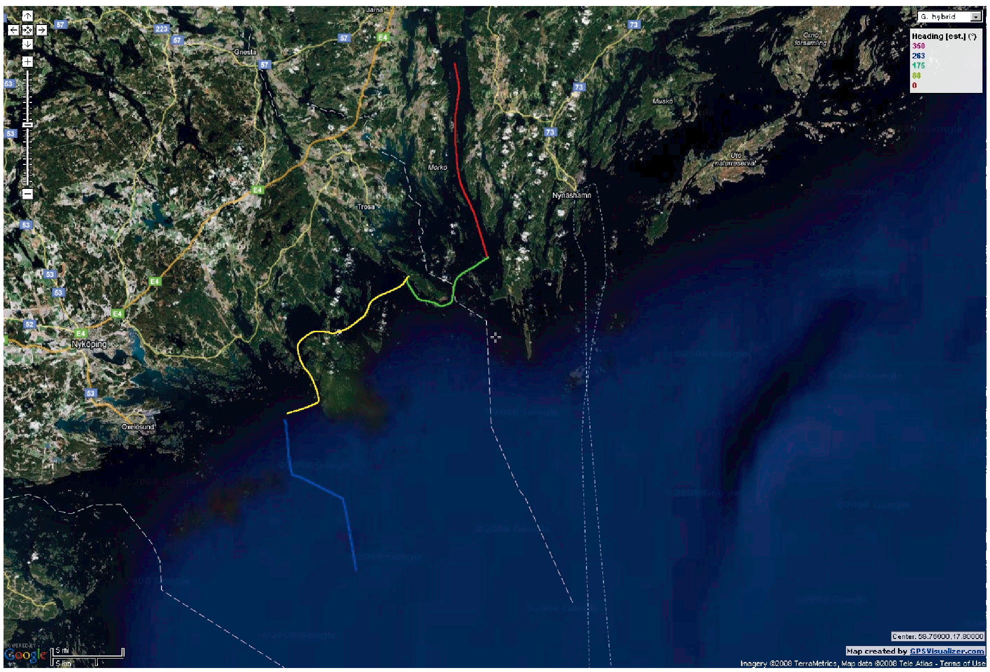


Figure 5.2: Transects during ESA/ESRIN MERIS validation campaign: 28 July (red), 30 July (green), 31 July (blue), 31 July (yellow). MERIS tulemite valideerimise mõõteliinid: 28. juuli (punane), 30. juuli (roheline), 31. juuli (sinine) ja 31. juuli (kollane).

As subcontractors for Stockholm University ESA/ESRIN grant to provide technical assistance for the validation of MERIS products in lakes and coastal waters, A. Reinart, I. Ansko, K. Alikas and K. Valdmets participated in ESA intercalibration workshop held at Askö Laboratory, Sweden, during the last week of July 2008. At the same time, we carried out extensive field measurements of remote sensing reflectance using our TriOS Ramses set. Four different transects (Figure 5.2) were measured including open Baltic water around Gustaf Dahlén lighthouse – one of seven AERONET-Ocean Color sites in the world, and narrow straight in Swedish coast, Himmerfjärden, where water properties vary greatly. These data will be analysed together with other participating institutes from Sweden, UK and Portugal.

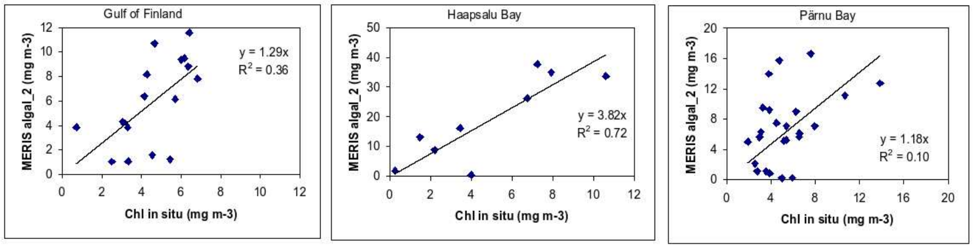


Figure 5.3: Comparison of MERIS standards Chlorophyll product (algal-2) with *in situ* measured values in three different locations in Estonia. MERIS standardse Chl tulemi (algal-2) võrdlus *in situ* andmetega kolmes erinevas kohas Eestis (Soome laht, Haapsalu laht, Pärnu laht).

We continued MERIS validations also for use in Estonian monitoring system. Different spatial patterns can be observed (Figure 5.3): the highest differences between *in situ* measured and satellite estimated values are in the Pärnu bay. There is a very strong effect by the incoming river (the largest one in Estonia, with very high turbidity and rather brownish incoming water). The sampling points located between mainland and Hiiumaa (Sea of Straits) results in difference up to 3 times, as water is very shallow and it might be that satellite sees bottom there. In the Gulf of Finland coincidence may be very good at some images, however during summer month cyanobacterial bloom is typical, and then mixed water samples (over 10 m layer) can not adequately represent surface water properties, which is detected by satellites.

5.4 Remote sensing of coastal vegetation in great shallow lakes: Lake Võrtsjärv and Lake Peipsi

Common reed *Phragmites australis* is a well adapted species for growth in lake littoral conditions and is a strong competitor dominating in coastal areas. In Europe the reduction of areas covered by coastal reed is noted since 1950s. This tendency is different from that found in America and in Australia where the expansion of coastal reed areas is described. The reduction trend of coastal reed areas in Estonia is not supported by available data. Just the contrary is currently prevailing – reed patches have populated the coastal zones of many inland lakes and western seashore bays both on mainland and on the islands.

Data about the macrophyte vegetation of the two great Estonian lakes – Lake Peipsi and Lake Võrtsjärv have been collected for the whole lake areas

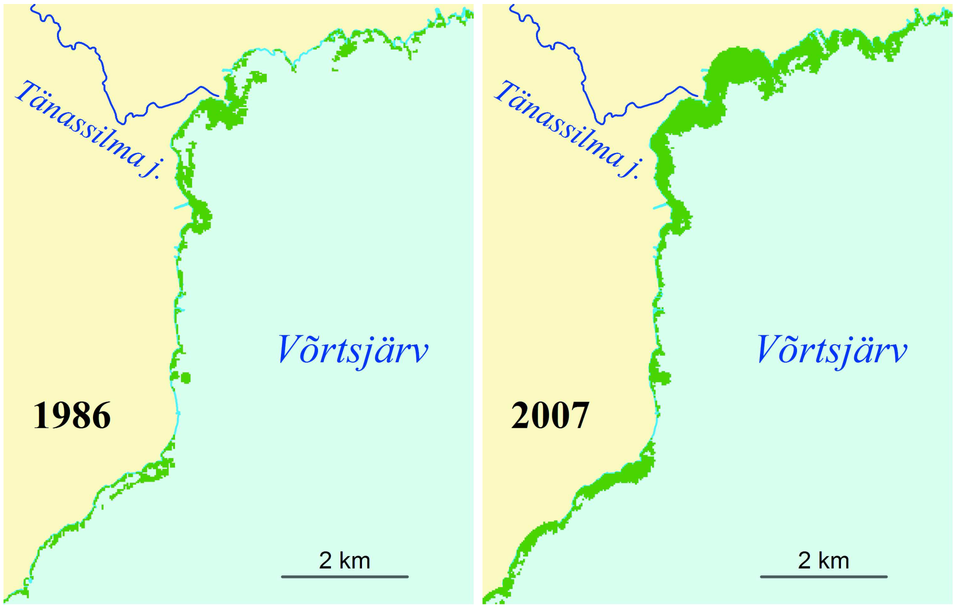


Figure 5.4: A subset of the Lake Võrtsjärv macrophyte vegetation map, close to the inflow of the River Tänassilma. This is the littoral region where the expansion of coastal reed patches has been most intense. Fragmendid satelliidipiltidest koostatud Võrtsjärve rannaroostike kaardist aastaist 1986 ja 2007 järve loodeosast rannalõigul Tänassilma jõe suudmelahe ümbruses. See on Võrtsjärve rannalõike, kus roostike ala laienemine viimase kahekümne aasta kestel on olnud kõige ulatuslikum.

since 1960s for Lake Peipsi and since 1930s for Lake Võrtsjärv. Numerical estimates supporting assessments of long-time tendencies in coastal vegetation that rely on descriptions of macroflora could be given cautiously since the available data are either too scarce or were collected with different sampling methods.

U. Peterson has studied the time series of medium spatial resolution satellite images dating back to mid-1980s permitting the estimates of lake macrophyte cover within the last twenty years. Unfortunately the images do not extend to 1970s, to the period of strong human influence for our lakes since when according to the notes by local people the expansion of reed patches at Lake Peipsi started.

Radiance differences of open water and patches of coastal reed vegetation are generally sufficient for these two classes to be separable on Landsat Thematic Mapper (TM) satellite images. Landsat TM images though were originally designed to be applicable primarily in terrestrial remote sensing. The satellite images taken in late summer, in July or in August, close to the time when the common reed is at its seasonal vegetation maximum were used for

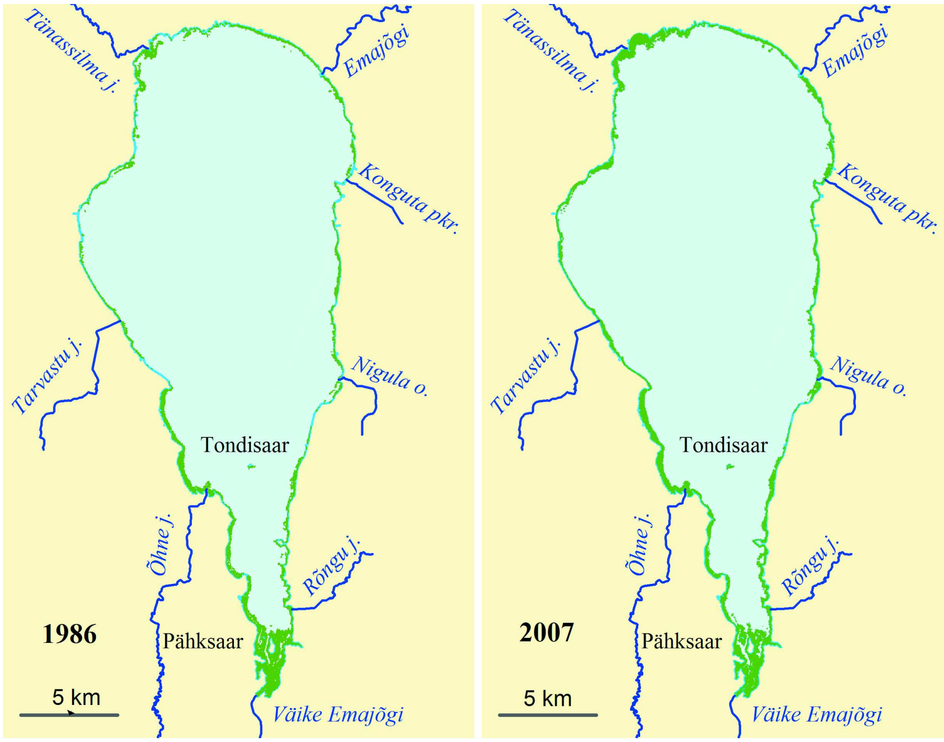


Figure 5.5: The area of Lake Võrtsjärv, covered by macrophytes has increased from 1000 hectares in 1986 to 1400 hectares in 2007. In the southern part of the lake close to the inflow of the river Väike Emajõgi the lake macrophyte cover is mostly comprised of plants with floating leaves. Aastate 1986 kuni 2007 vahemikus on kaldaveetaimestiku pindala mõlemas Eesti suurjärves eelkõige hariliku pilliroo levikupindala laienemise tõttu suurenenud. Võrtsjärves on suurtaimedega kaetud ala pindala suurenenud tuhandelt hektarilt 1986. aastal tuhande neljasajale hektarile aastal 2007 Võrtsjärve lõunaosas, Väike-Emajõe suudmeala ümbruses on tegemist vähem roostikega, peamiselt aga ujulehtedega taimestikuga.

mapping. The boundaries of coastal macrophyte patches, comprised mostly of common reed were derived from Normalized Difference Vegetation Index (NDVI) images. This NDVI index has approved itself in terrestrial remote sensing but is also applicable in separating open water or lake bottom from vegetated areas. Macrophyte patches have been mapped from satellite images from the coastline of the lakes defined on National Basic Map towards open water area.

At Lake Võrtsjärv coastal vegetation forms a continuous belt for the present that is several tens to two hundred meters wide. At small bays the extent of the coastal vegetation belt is even more extensive. Several gaps in the generally continuous coastal vegetation belt are mostly at the eastern shoreline. In the narrow southern part of the lake towards south of the inlet of the River Rõngu where the wind and wave influence is weaker, the coastal vegetation is joined by a continuous belt of plants with floating leaves. Within the time interval covered by the satellite images from 1986 till 2007 the area of coastal vegetation at Lake Võrtsjärv as well as at the Estonian reach of the Lake Peipsi has expanded. This expansion is attributed to the eutrophication of the lake waters.

5.5 Remote sensing of vegetation

M. Mõttus and M. Rautiainen continued the investigation of the applicability of the spectral invariants (or photon recollision probability) theory to forest reflectance modelling by using the CHRIS/PROBA image of Järvselja test site. The multiangular properties of the remote sensing system were utilized to separate first- and higher-order scattering inside the vegetation canopy. First-order scattering (i.e., the fraction of scattered radiation that has only once reflected from canopy elements before being registered by the sensor) is linearly related to leaf albedo and is expected to be highly anisotropic. Higher-order scattering, on the other hand, is contributed by photons that have interacted with the canopy at least twice and is much less dependent on the phase angle, the angle between the solar and view directions. The separation thus allows to retrieve the spectral shape of the single scattering albedo of sunlit and visible canopy elements from the first-order component. In case of closed leaf canopies, these canopy elements are dominantly green leaves. Higher scattering orders depend on the diffuse radiation regime inside the vegetation, closely related to photon recollision probability and better described by the spectral invariants theory. However, the work is still in its early stages and no conclusive results have been obtained.

The problem of energy conservation in canopy reflectance models was studied (A. Kallel, A. Kuusk). Considering the hot-spot effect only in the single scattering of radiation brings along violation of energy conservation, the magnitude of which depends on the share of single and multiple scattering of radiation in vegetation canopy.

Extensive field studies at the satellite test site at Järvselja were carried out. The database describing three mature forest stands of 100x100 m is prepared for the use as the test data in the next phase of the RAdiation transfer Model Intercomparison (RAMI). Ground-based spectral and structure measurements are supported by atmospherically and radiometrically corrected hyperspectral CHRIS data of ESA experimental satellite PROBA, and top-of-canopy reflectance measurements with the airborne spectrometer UAVSpec developed in our research group. Test measurements with the indicatormeter for the support of multiangular satellite measurements were carried out

Figure 5.6: Measurements of reflectance spectra of ground vegetation in a spruce stand. Kuusiku alusmetsa peegeldusspektrite mõõtmine.

(A. Kuusk, J. Kuusk, M. Lang). The flight test of the radio controlled helicopter JR Voyager GSR260 for the spectroscopic measurements of forests were carried out.

Spectral properties of alder and birch leaves were measured throughout the vegetation period in order to create the database of leaf spectra for common Estonian trees (M. Sulev).

M. Mõttus has been working on retrieving basic forest canopy properties (shape of leaf reflectance spectrum and directional gap probabilities) from multiangular and hyperspectral remote sensing data. Preliminary results from CHRIS/PROBA image acquired over Järvselja testsite indicated that novel physically-based methods may be used to retrieve additional forest variables.

The performance of the forest reflectance model FRT in describing seasonal trends of forest reflectance was analysed (M. Rautiainen, T. Nilson, T. Lükk). The change of forest spectral reflectance from year to year depending on the weather conditions may reach 10% in some spectral regions, most stable is the forest reflectance in the chlorophyll absorption bands (A. Kuusk,

J. Kuusk, M. Lang). Methods of estimating forest leaf area index (LAI) with optical methods were analysed (A. Kodar, R. Kutsar, M. Lang, T. Lükk, T. Nilson).

A SQL compatible database of hyperspectral angular distributions of forest reflectance measured onboard the EUFAR airplane of the Instituto Nacional de Técnica Aeroespacial (INTA), Spain in summer 2007 at Järvselja test site was created (M. Lang, J. Kuusk, M. Mõttus).

Based on the smoothed reflectance time series of the Landsat and SPOT images over Järvselja, seasonal courses of reflectance in the Landsat spectral bands were derived for forest stands of different dominating species and site quality (T. Nilson, M. Lang, T. Lükk). For the same forest types seasonal courses of the NDVI index and seasonal sums of NDVI weighted by the incoming photosynthetically active radiation were derived. The latter correlated well with the yearly increment of volume, as estimated by the data from the forestry database of Järvselja and with the yearly sum of accumulated carbon. However, the correlation was poor among the forests of highest site index. The results confirm the applicability of the Monteith relation for Estonian forests (at least for poor and medium site quality) and encourage us to use satellite remote sensing to describe the carbon balance of Estonian forests.

The Ph.D. student A. Eenmäe collected the yearly net primary production (NPP, Collection 5) estimates over Estonia on the 1 km grid as produced by the MODIS team. A. Eenmäe and T. Nilson carried out a preliminary analysis of the NPP of different landcover classes from years 2000 to 2007 and found that the MODIS algorithm tends to overestimate the NPP on the Estonian islands if compared with the inland areas.

The influence of attributes, describing forest clear-cut patch size, age, shape, nearest neighbours and habitat conditions on classification results of medium spatial resolution satellite images was investigated (U. Peterson, J. Budenkova, K. Kiis (UT), A. Kiviste (EULS)). The set of attributes causing area differences of regenerating cleancuts classified from satellite images to that represented in forestry database was investigated (U. Peterson, A. Kardakov, A. Kiviste (EULS)). The dependence of the width of the coastal reed belt on a number of abiotic factors in a large, shallow and eutrophic Lake Võrtsjärv was investigated. A time series of coastal reed dynamics was built for the lake for a period of the last 20 years (U. Peterson, J. Liira (UT)). Studies on the magnitude and distance of the forest edge effect were continued on very high resolution IKONOS and Quickbird images (U. Peterson, J. Liira (UT)).

During northern hemisphere autumn, M. Rautiainen and M. Mõttus visited the Spatial Information Group of the University of Adelaide, Australia (led by assoc. prof. Megan Lewis) for four months. The aim of the visit

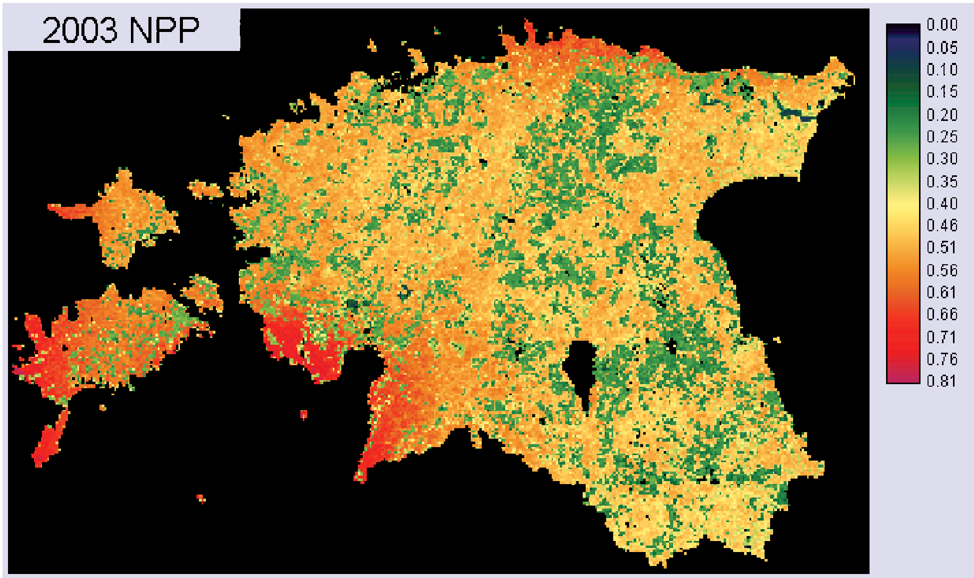


Figure 5.7: The yearly net primary production (NPP) estimates over Estonia on the 1 km grid as produced by the MODIS team. MODISe andmetest koostatud Eesti taimkatte aastase produktsiooni kaart.

was to establish contacts, exchange experience in using hyperspectral remote sensing data, and apply physically-based vegetation canopy reflectance models to Australian vegetation. In collaboration with prof. Lewis and her co-workers, they established a dry open Eucalyptus woodland test site in Monarto, 60 km east of Adelaide. The area was covered by an aerial hyperspectral measurement in the previous summer. In addition to existing leaf and soil reflectance spectra, cover photography was used to estimate leaf area index and canopy cover of a 1.5 ha test area. The images were analysed by dr. Sigfredo Fuentes from the School of Agriculture, Food and Wine of the University of Adelaide.

6 Publications Publikatsioonid

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

6.1.1 Astronomy Astronoomia

Aas T., Kestlane Ü., *Harvig V.,* Rästas M.: RU Cam Revised. *Tallinna Tähetorn = Tallinn Observatory 5,* No. 3, 7–26, Tallinn University of Technology, 2008.

Einasto M., Saar E., Martínez V.J., *Einasto J., Liivamägi L.J., Tago E.,* Starck J.-L., Müller V., Heinämäki P., Nurmi P., Paredes S., *Gramann M., Hütsi G.*: Toward Understanding Rich Superclusters. *The Astrophysical Journal 685*, 83–104, 2008.

Haud U.: Gaussian Decomposition of HI Surveys. IV. Galactic Intermediate and High Velocity Clouds. *Astron. Astrophys. 483*, 461–469, 2008.

Kalv P., Aas T., *Harvig V.*: Observations of RX Cassiopeiae. *Tallinna Tähetorn = Tallinn Observatory 5,* No. 5, 7–41. Tallinn University of Technology, 2008.

Kalv P., Aas T., *Harvig V.*: The Mystery of V2148 Cygni. *Tallinna Tähetorn = Tallinn Observatory 5,* No. 1, 7–15. Tallinn University of Technology, 2008.

Karitskaya E.A., Bochkarev N.G., Bondar A.V., Galazutdinov G.A., Lee B.-C., Musaev F.A., *Sapar A.A.*, Shimansky V.V.: Spectroscopic Monitoring of V1357 Cyg = Cyg X-1 in 2002–2004. *Astronomicheskij Zhurnal 85,* 409–426, 2008 (in Russian); *Astronomy Reports 52*, 362–378, 2008.

Kipper T., Klochkova V.G.: Improved Parameters of the Hydrogen-Deficient Binary Star KS Per. *Baltic Astronomy 17*, 195–207, 2008.

Kipper T.: Optical Spectrometry of a Post-AGB Star HD 179821 (V1427 Aql). *Baltic Astronomy 17*, 87–102, 2008.

Kovtyukh V.V., Soubiran C., Belik S.I., Yasinskaya M.P., Chehomadskih F.A., *Malyuto V.*: Fundamental Parameters and Intrinsic Colours of FGK Supergiants and Classical Cepheids. *Kinematika i Fizika Nebesnykh Tel 24*, 231–237, 2008 (in Russian).

Markova N., Prinja R.K., Markov H., *Kolka I.*, Morrison N., Percy J., Adelman S.: Wind Structure of Late B Supergiants. I. Multi-line Analyses of Near-surface and Wind Structure in HD 199478 (B8 Iae). *Astron. Astrophys.* 487, 211–223, 2008.

Mars M., Aas T., *Harvig V.*: The Tallinn Public Observatory in Changing Conditions. *Odessa Astronomical Publications 20,* 126–127, 2007.

Nugis T., Annuk K., Hirv A., Niedzielski A., Czart K.: Near Infrared Spectra of Galactic Wolf-Rayet Stars. *Baltic Astronomy 17*, 39–49, 2008.

Pustylnik I., *Kalv P.*, *Harvig V.*, Aas T.: On Quasi-Periodic Intrinsic Light Variability in a Close Spectroscopic Binary CX Dra. *Odessa Astronomical Publications 20*, 186–188, 2007.

Pustynski V.-V., *Pustylnik I.*: On the Evolutionary History of Progenitors of EHBs and Related Binary Systems Based on Analysis of their Observed Properties. *Odessa Astronomical Publications 20*, 189–192, 2007.

Sapar A., Aret A., Poolamäe R., Sapar L.: Segregation of Isotopes of Heavy Metals Due to Light-induced Drift: Results and Problems. *Contrib. Astron. Obs. Skalnaté Pleso 38*, 273–278, 2008.

Sapar A., Aret A., Sapar L., Poolamäe R.: Formulae for Study of Light-induced Drift Diffusion in CP Star Atmospheres. *Contrib. Astron. Obs. Skalnaté Pleso 38*, 445–446, 2008.

Tago E., Einasto J., Saar E., Tempel E., Einasto M., Vennik J., Müller V.: Groups of Galaxies in the SDSS Data Release 5. A Group-Finder and a Catalogue. *Astron. Astrophys. 479*, 927–937, 2008.

Tago E., Einasto J., Saar E., Tempel E., Einasto M., Vennik J., Müller V.: Groups of Galaxies in the SDSS Data Release 5. A group-finder and a catalogue (online catalog). *Vizier Online Data Catalog*, 479, 2008.

Tuvikene T., Eenmäe T., Sterken C., Brogt E.: The Contact Binary GSC 04778-00152 with a Visual Companion. *Baltic Astronomy 17*, 79–86, 2008.

Tuvikene T., Sterken C., *Eenmäe T.*, Hinojosa-Goni R., Brogt E., Longa Pena P., *Liimets T.*, Ahumada M., Troncoso P., Vogt N.: Photometry and Spectroscopy of the Contact Binary GSC04778-00152. *Journal of Astronomical Data 14*, 1T, 2008.

Vennik J., Hopp U.: Photometric Study of the IC 65 group of Galaxies. *Astron. Astrophys. 481*, 79–92, 2008.

Vurm I., Poutanen J.: Electron Thermalization and Photon Emission from Magnetized Compact Sources. *Int. J. Mod. Phys. D. 17*, 1629–1634, 2008.

6.1.2 Atmospheric physics Atmosfäärifüüsika

Alikas K., Reinart A.: Validation of the MERIS Products on Large European Lakes – Peipsi, Vänern and Vättern. *Hydrobiologia 599*, 161–168, 2008.

Ansko I., Eerme K., Lätt S., Noorma M., Veismann U.: Study of Suitability of Cheap AvaSpec Array Spectrometer for Solar UV Field Measurements. *Atmospheric Chemistry and Physics 8(12)*, 3247–3253, 2008.

Arst H., Erm A., Herlevi A., Kutser T., Leppäranta M., *Reinart A.*, Virta J.: Optical Properties of Boreal Lake Waters in Finland and Estonia. *Boreal Environment Research 13*, 133–158, 2008.

Kaasik M., Ploompuu T., Ots R., Meier E., Ohvril H., Okulov O., Teral H., Neiman L., *Russak V., Kallis A.*, Post P.: Growth Acceleration of *Pinus sylvestris* in Bog Stands due to Intensified Nutrient Influx from the Atmosphere. *Oil Shale 25*, 75–93, 2008.

Kodar A., Kutsar R., *Lang M., Lükk T. Nilson T.*: Leaf Area Indices of Forest Canopies from Optical Measurements. *Baltic Forestry 14*, 185–194, 2008.

Kuusk A., Nilson T., Paas M., *Lang M., Kuusk J.*: Validation of the Forest Radiative Transfer Model FRT. *Remote Sensing of Environment 112*, 51–58, 2008.

Mõttus M., Stenberg P.: A Simple Parameterization of Canopy Reflectance Using Photon Recollision Probability. *Remote Sensing of Environment 112*, 1545–1551, 2008.

Nilson T., Suviste S., Lükk T., Eenmäe A.: Seasonal Reflectance Course of Some Forest Types in Estonia from a Series of Landsat TM and SPOT Images and via Simulation. *International Journal of Remote Sensing 29*, 5073–5091, 2008.

Nilson T., Lang M.: Kvantitatiivne kaugseire pakub tulevikuvõimalusi. *Eesti Mets 4*, 22–24,2007.

Nõges P., Kangur K., Nõges T., Simola H., *Reinart A.*, Viljanen M.: Highlights of Large Lake Research and Management in Europe. *Hydrobiologia 599*, 259–276, 2008.

Paavel B., Arst H., *Reinart A.*: Variability of Bio-Optical Parameters in two North-European Large Lakes. *Hydrobiologia 599*, 201–211, 2008.

Peltoniemi J., Suomalainen, J., Puttonen E., Näränen J., *Rautiainen M.*: Reflectance Properties of Selected Arctic-Boreal Land Cover Types: Field Measurements and Their Application in Remote Sensing. *COSIS Biogeosciences Discussions 5*, 1069–1095, 2008 (available online http://www.biogeosciences-discuss.net/5/issue2.html).

Post P., *Kärner O.*: Simple Statistical Structure in Time Series for Daily Air Flow Characteristics. *Environmetrics 19*, 49–59, 2008.

Rautiainen M., Lang M., Mõttus M., Kuusk A., Nilson T., Kuusk J., Lükk T.: Multi-Angular Reflectance Properties of a Hemiboreal Forest: an Analysis Using CHRIS PROBA Data. *Remote Sensing of Environment 112*, 2627–2642, 2008.

Rautiainen M., Mõttus M., Stenberg P., Ervasti S.: Crown Envelope Shape Measurements and Models. *Silva Fennica 42*, 19–33, 2008.

Rautiainen M., Stenberg P., Heiskanen J., *Mõttus M.*, Korhonen L., Peltoniemi J., Suomalainen J., Kaasalainen S., Manninen T.: Metsän kaukokartoituksen perustutkimuus? *Metsätieteen aikakauskirja – Folia Forestalia 2*, 117–126, 2008.

Rautiainen M., Mõttus M., Stenberg P., Ervasti S.: Latvusmuodon mittaus ja mallitus metsän fysikaalisia heijastusmalleja varten. *Metsätieteen aikakauskirja – Folia Forestalia 1*, 63–65, 2008.

Rautiainen M., Mõttus M., Stenberg P.: On the Relationship of Canopy LAI and Photon Recollision Probability in Boreal Forests. *Remote Sensing of Environment*, DOI:10.1016/j.rse.2008.10.014, 2008.

Reinart A., Reinhold M.: Mapping Surface Temperature in Large Lakes with MODIS data. *Remote Sensing of Environment 112*, 603–611, 2008.

Reinart A., Pedusaar T.: Reconstruction of the Time Series of the Underwater Light Climate in a Shallow Turbid Lake. *Aquatic Ecology 42*, 5–15, 2008.

Roots O., Holoubek I., Cupr P., Klanova J., *Kallis A.*, Kuningas K.: Air and Soil Pollution. Part 1: Organochlorine Pesticides in the North- and North-Eastern Part of the Estonia. *Ecological Chemistry 17*, 88–93, 2008.

Stenberg P., *Rautiainen M.*, Manninen T., Voipio P., *Mõttus M.*: Boreal Forest Leaf Area Index from Optical Satellite Images: Model Simulations and Empirical Analyses Using Data from Central Finland. *Boreal Environment Research 13*, 433–443, 2008.

Stenberg P., Korhonen L., *Rautiainen M.*: A Relascope for Measuring Canopy Cover. *Canadian Journal of Forest Research 38*, 2545–2550, 2008.

6.2 Conference papers Artiklid konverentsikogumikes

6.2.1 Astronomy Astronoomia

Alamo-Martínez K.A., Andernach H., Coziol R., *Tago E.*, Caretta C.A.: Dynamics of Brightest Cluster Galaxies in Rich Clusters. In: *Galactic Structure and the Structure of Galaxies, Ensenada, Mexico, March 17–21, 2008*, 20, 2008.

Annuk K., Ruusalepp M.: Popularisation of Astronomy in Estonia. In: *Communicating Astronomy with the Public 2007: Proceedings From the IAU/National Observatory of Athens/ESA/ESO Conference 8-11 October 2007*, eds. L.L. Christensen, M. Zoulias and I. Robson, *ESA/Hubble*, 370–372, 2008.

Aret A., Sapar A., Poolamäe R., Sapar L.: SMART – a Computer Program for Modelling Stellar Atmospheres. In: *The Art of Modeling Stars in the 21st Century. Proceedings of the IAU Symposium 252. Sanya, Hainan Island, China, April 6–11, 2008,* eds. L. Deng and K.L. Chan, Cambridge University Press, 41–42, 2008.

Burmeister M., Leedjärv L.: Discovery of Jets from the Spectra of Z Andromedae. In: *RS Ophiuchi (2006) and the Reccurent Nova Phenomenon. Keele, United Kingdom, June 12–14, 2007*, eds. A. Evans, M.F. Bode, T.J. O'Brien and M.J. Darnley, *ASP Conf. Series 401*, 347–350, 2008.

Heinämäki P., Nurmi P., *Tago E., Saar E., Liivamägi J.L., Einasto M., Einasto J.*: Nearby Quasars in SDSS. In: *Problems of Practical Cosmology. Russian Geographical Society, 23-27 June 2008, Saint Petersburg, Russia*, eds: Y.V. Baryshev, I.N. Taganov and P. Teerikorpi, 123–128, 2008.

Jänes J., Laur S., *Kolka I.*: Detection and Characterisation of Hα Emission Lines from Gaia BP/RP Spectra. In: *Classification and Discovery in Large Astronomical Surveys*, ed. C.A.L. Bailer-Jones, *AIP Conf. Proc. 1082, AIP (Melville, New York)*, 71–75, 2008.

Kipper T., Klochkova V.G.: Optical Spectrum of Z UMi during its Maximum Light. In: *Hydrogen-Deficient Stars. Tübingen, Germany, September 17-21, 2007*, eds. K. Werner and T. Rauch, *ASP Conf. Series 391*, 43–44, 2008.

Kuusk P., Järv L., *Saal M.*: The Dynamics of Scalar-Tensor Cosmology from RS Two-Brane Model. In: *Proceedings of the Eleventh Marcel Grossmann Meeting on General Relativity: 11th Marcel Grossmann Meeting on General Relativity, Berlin, July 23–29, 2006*, eds. H. Kleinert, R. Jantzen and R. Ruffini, Singapore: World Scientific Publ Co Pte Ltd, 2842–2844, 2008.

Martayan C., Fremat Y., Blomme R., Jonckheere A., Borges M., de Batz B., Leroy B., Sordo R., Bouret J.-C., Martins F., Zorec J., Neiner C., Naze Y., Alecian E., Floquet M., Hubert A.-M., Briot D., Miroshnichenko A., *Kolka I.*, Stee P., Lanz T., Meynet G.: The Gaia Satellite: a Tool for Emission Line Stars and Hot Stars. In: *SF2A-2008: Proceedings of the Annual Meeting of the French Society of Astronomy and Astrophysics*, eds. C. Charbonnel, F. Combes and R. Samadi, *SF2A*, 499–502, 2008.

Nugis T.: Optically Thick Winds of Hot Stars: What Determines the Mass Flux? In: *Mass Loss from Stars and the Evolution of Stellar Clusters. Lunteren, The Netherlands, May 29–June 1, 2006*, eds. A. de Koter, L.J. Smith and L.B.F.M. Waters, *ASP Conf. Series 388*, 207–208, 2008.

Nurmi P., Heinämäki P., Biemi S., *Saar E., Tago E., Einasto M., Tempel E., Einasto J.*, Martínez V.J.: Galaxy Groups in LCDM Simulations and SDSS DR6. In: *Problems of Practical Cosmology. Russian Geographical Society, 23-27 June 2008, Saint Petersburg, Russia*, eds: Y. V. Baryshev, I.N. Taganov, and P. Teerikorpi, 78–85, 2008.

Sapar A., Aret A., Sapar L., Poolamäe R.: A Pan-spectral Method of Abundance Determination. In: *Precision Spectroscopy in Astrophysics. Proceedings of ESO/Lisbon/Aveiro Conference, Aveiro, Portugal, September 11–15, 2006*, eds. N.C. Santos, L. Pasquini, A.C.M. Correia and M. Romaniello, *ESO Astrophysics Symposia 22*, 145–148, 2008.

Vennik J., Hopp U.: Photometric Study of the Disk Galaxies in a Poor Group of Galaxies LGG 16. In: *Formation and Evolution of Galaxy Disks, Rome, October 1–5, 2007*, eds. J.G. Funes, S.J., and E.M. Corsini, *ASP Conf. Series 396*, 293–294, 2008.

Viik T.: F.W. Bessel and Geodesy. In: *The Struve Arc and Extensions in Space and Time. Haparanda and Pajala, Sweden, August 13–15, 2006*, ed. H.-F. Wennström, *LMV-Rapport 2006:8*, 53–63, 2008.

6.2.2 Atmospheric physics Atmosfäärifüüsika

Alikas K., Reinart A.: Kaugseire kasutamise võimalused siseveekogude seireks. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 174–186, 2008.

Eerme K., Veismann U., Ansko I.: Päikese ultraviolettkiirgus ja loodus. In: *31. Estonian Naturalists Congress. Planet Earth: Global and Local Problems*. Eesti Loodusuurijate Selts, 24–41, Tartu, 2008.

Heino R., Tuomenvirta H., Vuglinsky V.S., Gustafsson B.G., Alexandersson H., Bärring L., Briede A., Cappelen J., Chen D., Falarz M., Førland E.J., Haapala J., Jaagus J., Kitaev L., Kont A., Kuusisto E., Lindström G., Meier H.E.M., Mietus M., Moberg A., Myrberg K., Niedzwiedz T., Nordli Ø., Omstedt A., Orviku K., Pruszak Z., Rimkus E., *Russak V.*, Schrum C., Suursaar Ü., Vihma T., Weisse R., Wibig J.: Past and Current Climate Change. In: *Assessment of Climate Change for the Baltic Sea Basin*, eds. H.-J. Bolle, M. Menentind and I. Rasool, Springer-Verlag, Heidelberg, 35–131, 2008.

Isemer H.-J., *Russak V.*, Tuomenvirta H.: Atmosphere. In: *Assessment of Climate Change for the Baltic Sea Basin*, eds. H.-J. Bolle, M. Menentind and I. Rasool, Springer-Verlag, Heidelberg, 386–392, 2008.

Kutser T., Metsamaa L., Vahtmäe E., *Reinart A.*: Rannikumere kaugseire. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 80–84, 2008.

Kuusk A., Kuusk J., Lang M.: A Dataset for the Validation of Reflectance Models. In: *Proceedings of "The 4S Symposium – Small Satellites Systems and Services", Rhodes, Greece, May 26–30, 2008, ESA SP-660*, 10 pp., 2008.

Kuusk J., Kuusk A.: Mehitamata õhusõidukid kaugseires In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 41–47, 2008.

Kärdi T.: Vettpidava pinna suhtelise paiknemise kaardistamine spektrisegu lineaarse lahutamise meetodiga Tartu linna näitel. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 17–33, 2008.

Mõttus M., Stenberg P., *Rautiainen M.*: Vegetation Reflectance Modeling: Connecting Canopy Structure, Angular Effects and Photon Recollision Probability. In: *Proceedings of the 14th Australasian Remote Sensing and Photogrammetry Conference, Darwin, Australia (September 29 – October 03, 2008)*, 8 pp., 2008.

Nilson T., Lang M., Lükk T., Eenmäe A.: Metsade produktiivsuse kaugseire. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 78–90, 2008.

Peterson U., Liira J., Püssa K.: Metsaga alade ning lageraiete ja nendega sarnaste häiringute kaugseire. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 48–68, 2008.

Peterson U.: Maastike kaugseire. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 85–88, 2008.

Peterson U., Eerme K., Lang M., Nilson T., Kuusk A., Väljataga K.: Kaugseire koht ja tähendus loodusandmete kogumises ning andmetöötluses. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 8–16, 2008.

Rautiainen M., Mõttus M., Stenberg P.: Photon Recollision Probability in Forest Reflectance Modelling. In: *Proceedings of the 14th Australasian Remote Sensing and Photogrammetry Conference, Darwin, Australia (September 29 – October 03, 2008)*, 7 pp., 2008.

Reinart A., Kärbla V., Okulov O.: Peipsi järve veepinna temperatuuri määramine MODIS sensori abil. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 187–194, 2008.

Reinart A., Kutser T., Dišlis T.: Keskkonna ja turvalisuse globaalse seire (GMES) teenused. In: *Kaugseire Eestis*, eds. K. Väljataga and K. Kaukver, Tartu Observatoorium, Keskkonnaministeeriumi Info- ja Tehnokeskus, Tallinn, 17–33, 2008.

Stenberg P., *Mõttus M., Rautiainen M.*: Modeling the Spectral Signature of Forests: Application of Remote Sensing Models to Coniferous Canopies. In: *Advances in Land Remote Sensing: System, Modeling, Inversion and Application*, ed. S. Liang, Springer-Verlag, 147–171, 2008.

Tomson T., *Russak V., Kallis A.*: Dynamic Behavior of Solar Radiation. In: *Modeling Solar Radiation at the Earth's Surface*, ed. V. Badescu, Springer-Verlag, 257–281, 2008.

6.3 Popular Articles Aimeartiklid

6.3.1 Astronomy Astronoomia

Aas T., *Harvig V.*, Johani T.: Kuukalender 2008 Lunar Calendar. Tallinna Tehnikaülikooli Kirjastus. Tallinn, 28 lk., 2008.

Aas T., *Harvig V.*, Johani T.: Tallinna Tähetorni kalender 2008. Tallinna Tehnikaülikooli Kirjastus. Tallinn, 72 lk., 2008.

Aas T., *Harvig V.,* Johani T.: Kuukalender 2009 Lunar Calendar. Tallinna Tehnikaülikooli Kirjastus. Tallinn, 26 lk., 2008.

Aas T., *Harvig V.,* Sinivee V.: Educational Space Physics and Astronomical Experiments at Tallinn Observatory. *Tallinna Tähetorn = Tallinn Observatory 5,* No. 6, 7–30, Tallinn University of Technology 2008.

Aas T., *Harvig V.*: Dr. Wernher von Braun'i mälestuseks. *Tallinna Tähetorni Kalender,* 65–72, 2008.

Annuk K.: Rahvusvaheline astronoomia aasta 2009. *Tähetorni Kalender 2009*, 47–48, 2008.

Eenmäe T.: Amatöörastronoomi teleskoop. *Tehnikamaailm 6*, 80–85, 2008.

Eenmäe T.: Augustitaevas. *Roheline Värav*, 07.08.2008.

Eenmäe T.: Septembritaevas. *Roheline Värav*, 04.09.2008.

Eenmäe T.: Oktoobritaevas. *Roheline Värav*, 03.10.2008.

Eenmäe T.: Novembritaevas. *Roheline Värav*, 11.11.2008.

Eenmäe T.: Detsembritaevas. *Roheline Värav*, 11.12.2008.

Eenmäe T.: Asteroid 2007 TU24. *Vaatleja 1*, 2008.

Eenmäe T.: Rahvusvaheline kosmosejaam 2008. a. suvel. *Vaatleja 4*, 2008.

Einasto M.: William Herschel – vaatlusliku kosmoloogia rajaja. *Tähetorni Kalender 2009*, 58–71,2008.

Harvig V.: Florida 1999. *Tallinna Tähetorni Kalender,* 23–36, 2008.

Harvig V.: Kalifornia 2007. *Tallinna Tähetorni Kalender,* 39–46, 2008.

Jaaniste J., *Eenmäe T.*: Astronoomiaolümpiaadil Itaalias. *Tähetorni Kalender 2009*, 85–93, 2008.

Liimets T.: Tudengina Poiste-Kivi Observatooriumis La Palmal. *Tähetorni Kalender 2009*, 80–84, 2008.

Lõhmus L., *Harvig V.,* Aas T.: A Proposal from Dr. E. Schoenberg and H. Mäe to Establish an Observatory to the Glehn's Park. *Tallinna Tähetorn = Tallinn Observatory 5,* No. 2, 7–22, Tallinn University of Technology, 2008.

Pelt J.: Gravitatsioonilääts teeb nähtamatu nähtavaks. *Horisont 1*, 10–17, 2008.

Puss A.: Meteoorivooludest ja ursiidide meteoorivoolust. *Tähetorni Kalender 2009*, 49–53, 2008.

Pustynski V.-V.: Programm "Constellation". *Tallinna Tähetorni Kalender,* 55–64, 2008.

Ruusalepp M.: Tartu Observatoorium. *Eesti keele õpik 3 klassile, II osa*, 34, 2008.

Sapar A.: Poliitmaastik värvuskolmnurgal. *Horisont 2,* 10–15, 2008.

Sapar A.: Intervjuu R. Veskimäele: Ühe vägeva dinosauruse tööst ja arusaamadest. *Horisont 4,* 19–24, 2008.

Sapar A.: In Memoriam. Izold Pustylnik. *Tähetorni Kalender 2009*, 99–100, 2008.

Tago E.: Päike on taltunud, aga kahevahel. *Vaatleja 2*, 2008.

Tago E.: 100 aastat Tunguusi plahvatusest. *Vaatleja 4*, 2008.

Tago E.: Fermi gammateleskoop avastas uut tüüpi pulsari. *Vaatleja 5*, 2008.
Tago E.: NASA: Päike ilmutab elumärke. *Vaatleja 6*, 2008.
Tago E.: Maad tabavad suure energiaga elektronid kosmosest. *Vaatleja 6*, 2008.
Tago E.: "Hubble" näeb tähe Fomalhaut planeeti. *Vaatleja 6*, 2008.
Tago E.: Sündmusi astronoomias 2008. *Tähetorni Kalender 2009*, 54–57, 2008.
Viik T.: Carl Friedrich Tenner – vene geodeesia rajaja. *Geodeet 36*, 50–59, 2008.
Viik T.: Emakeel minu elus. *Keelekaitsja nr 8*, 81–87, 2008.
Viik T.: In Memoriam. Izold Pustylnik. *www.folklore.ee/folklore*, 147–148, 2008.

6.3.2 Atmospheric physics Atmosfäärifüüsika

Eerme K.: Päike kütab kliimakatelt. *Horisont 5*, 28–33, 2008.
Eerme K.: Kas tulevik toob uputuse või jääväljad? *Akadeemia 9*, 1928–1957, 2008.
Eerme K.: Tõraverelaste tegemised kosmoseriigis. *Tarkade klubi 10*, 32–33, 2008.
Kallis A.: Veel üks soe ja vesine jõulukuu. *Maaleht*, 10.01.2008.
Kallis A.: Detsember pani punkti soojale aastale. *Postimees*, 26.01.2008.
Kallis A.: Sea-aasta lõppes ilmataadi tembutustega. *Postimees*, 09.02.2008.
Kallis A.: Püha Anna kiusab inglite linna. *Maaleht*, 24.01.2008.
Kallis A.: Ilmataat aprillitas juba näärikuus. *Maaleht*, 14.02.2008.
Kallis A.: Kliima soojenemisega ei maksa hirmutada. *Eesti Päevaleht Online*, 08.02.2008.
Kallis A.: Kuulus asteroidikütt külastas Tõraveret. *Postimees*, 16.02.2008.
Kallis A.: Läänerannikule sattus haruldane äike. *Postimees*, 16.02.2008.
Kallis A.: Pagi käis maruhoona üle Tõravere. *Postimees*, 16.02.2008.
Kallis A.: Naabrivalve – üleaedsete ilmarekordid. *Maaleht*, 21.02.2008.
Kallis A.: President austas tormide maaletoojat. *Postimees*, 23.02.2008.
Kallis A.: Ameerikal on uus presidendikandidaat! *Postimees*, 01.03.2008.
Kallis A.: Tänavune talv oli rekordsoe. *Postimees*, 03.03.2008.
Kallis A.: Emma tappis inimesi Lääne-Euroopas, Friedrich kaitses Eestit. *Postimees*, 15.03.2008.
Kallis A.: Lumesõjast verepulma. *Postimees*, 15.03.2008.
Kallis A.: Alatine unistus valgetest pühadest. *Postimees*, 29.03.2008.
Kallis A.: Nabad – kas ainult imetlemiseks? *Maaleht*, 13.03.2008.
Kallis A.: Teine ja parem ilmaradar. *Postimees*, 29.03.2008.
Kallis A.: Talv tegi lõpuponnistuse märtsis. *Postimees*, 05.04.2008
Kallis A.: Koerad tegid kassidele ära. *Postimees*, 12.04.2008.
Kallis A.: Linnud-ämmaemandad. *Postimees*, 12.04.2008.
Kallis A.: Õige talv tuli märtsis. *Maaleht*, 03.04.2008.
Kallis A.: Suri kaoseteooria looja. *Postimees*, 19.04.2008.
Kallis A.: Kuidas meid petetakse. *Postimees*, 19.04.2008.

Kallis A.: Miks me mõõdame päikesekiirgust? *Horisont 3*, 10–11, 2008.
Kallis A.: Üks liblika tiivalöök Brasiilias võib tekitada Texases tornaado. *Maaleht*, 24.04.2008.
Kallis A.: Paides nähti äsjasel jüripäeval kuradit! *Postimees*, 26.04.2008.
Kallis A.: Inimesed, olge valvsad – kevad saabus! *Postimees*, 26.04.2008.
Kallis A.: Aprill polnudki kuigi tujukas. *Postimees*, 03.05.2008.
Kallis A.: Tsüklon Nartsiss tõi Birmale hukatust. *Postimees*, 10.05.2008.
Kallis A.: Kartkem punast kukke! *Postimees*, 17.05.2008.
Kallis A.: Orkaanid Dean, Felix ja Noel saadeti erru. *Postimees*, 17.05.2008.
Kallis A.: Mesilased ja veesooned aitavad ilma prognoosida. *Postimees*, 24.05.2008
Kallis A.: Pilved ennustasid maavärinat. *Postimees*, 24.05.2008.
Kallis A.: Suvi tuleb külm ja vihmane! Vähemalt Šveitsis. *Maaleht*, 29.05.2008.
Kallis A.: Ära kutsu kukke! *Postimees*, 31.05.2008.
Kallis A.: Keeris keeras plekki kokku. *Postimees*, 31.05.2008.
Kallis A.: Lehekuu kiusas jälle põuaga. *Maaleht*, 05.06.2008.
Kallis A.: Maikuus oli palju päikest ja äikest. *Postimees*, 07.06.2008.
Kallis A.: Juuni oli kui kehv saun. *Maaleht*, 03.07.2008.
Kallis A.: Lennukid teevad ilma. *Postimees*, 14.06.2008.
Kallis A.: Tornaado lükkas rongi ümber. *Postimees*, 14.06.2008.
Kallis A.: Ja maa kadus jalge alt. *Maaleht*, 19.06.2008.
Kallis A.: Ilmataadi meel muutub pööripäevadel heitlikuks. *Postimees*, 21.06.2008.
Kallis A.: Ilmataat ei armasta paraade. *Postimees*, 28.06.2008.
Kallis A.: Kliima võib minna külmemaks, järgmise jääaja poole. *SL Õhtuleht*, 05.07.2008.
Kallis A.: Jaan tõi vihma ja äikest. *Postimees*, 05.07.2008.
Kallis A.: Ilmalugude ähvardavad pealkirjad. *Postimees*, 12.07.2008.
Kallis A.: Loomad ja linnud veavad ennustajaid alt. *Postimees*, 19.07.2008.
Kallis A.: Kus on ilm kõige koledam? *Maaleht*, 17.07.2008.
Kallis A.: Heinakuul oli raske heina teha. *Maaleht*, 07.08.2008.
Kallis A.: Ilmad korraldavad atentaate. *Postimees*, 26.07.2008.
Kallis A.: Kiiremini, kõrgemale, kuumemini. *Postimees*, 09.08.2008.
Kallis A.: Park pärapõrgus. *Postimees*, 16.08.2008.
Kallis A.: Prognooside tõlgendamise keerulisest kunstist. *Postimees*, 23.08.2008
Kallis A.: Lõikuskuu, mil ei saanud lõigata. *Maaleht*, 04.09.2008.
Kallis A.: Vilust vihmast villand! *Postimees*, 30.08.2008.
Kallis A.: Kas saab veel hullemat augustit tulla? *Postimees*, 06.09.2008.
Kallis A.: Maa ilmarekordid aina muutuvad. *Postimees*, 13.09.2008.
Kallis A.: Miks on meie suvi ja sügis olnud nii vihmased? *Eesti Loodus 9*, 15, 2008.

Kallis A.: Mürk tudengite mälus. *Maaleht*, 18.09.2008.
Kallis A.: Ike Ameerika rahva turjal. *Postimees*, 13.09.2008.
Kallis A.: Kas osooni on vähe või palju? *Postimees*, 27.09.2008.
Kallis A.: Sügiskuu ilmade üle ei saanud nuriseda. *Postimees*, 04.10.2008.
Kallis A.: Sügiskuul polnud viga. *Maaleht*, 02.10.2008.
Kallis A.: Pilved on vahel taevalikud. *Postimees*, 18.10.2008.
Kallis A.: Vananaiste- või leskedesuvi? *Maaleht*, 09.10.2008.
Kallis A.: Nobeli preemiast ja kanakitkumisest. *Postimees*, 11.10.2008.
Kallis A.: Üleilmse soojenemise põhjus leitud? *Postimees*, 25.10.2008.
Kallis A.: Üleilmse soojenemise põhjus leidmata! *Postimees*, 01.11.2008.
Kallis A.: Oktoober oli soe, märg ja pime. *Maaleht*, 06.11.2008.
Kallis A.: Viinakuu oli viinatagi soe. *Postimees*, 08.11.2008.
Kallis A.: Kundas kadusid katused. *Postimees*, 15.11.2008.
Kallis A.: Taevased jõud soosisid muudatusi. *Postimees*, 22.11.2008.
Kallis A.: Ilm ei kata kõigile lauda, öeldi Rõuges. *Maaleht*, 20.11.2008.
Kallis A.: Mardikuus oli kolm aastaaega. *Maaleht*, 04.12.2008.
Kallis A.: Ilm on kõige suurem kool. *Postimees*, 29.11.2008.
Kallis A.: Talvekuul saabus talv, korraks. *Postimees*, 06.12.2008.
Kallis A.: Mis on elu ilma riskita? *Postimees*, 13.12.2008.
Kallis A.: Eestimaa ilm on kuri ja kaval. *Maaleht*, 18.12.2008.
Kallis A.: Kliima on seaduslikult tuksi keeratud! *Postimees*, 20.12.2008.
Kallis A.: Kas ilmataat on kristlane? *Postimees*, 27.12.2008.
Kallis A.: Ilm. Ülevaade ilmaoludest september 2007 – september 2008. *Aastaraamat Kes?Mis?Kus? 2009*. Tänapäev, 429–442, 2008.
Kallis A.: Kas me ilm on ikka hukas? *Energia. Kliima. Jäätmed. Taskutark*. Tallinna Ülikool, 29–44, 2008.
Peterson U.: Eesti loodus 100 aasta pärast. *Tark mees taskus 1*, 24–32, 2008.
Veismann U.: ET – uued panused otsimisse. *Horisont 3*, 26–27, 2008.
Veismann U.: Kuidas turistina kosmoses ära käia. *Horisont 4*, 50–51, 2008.
Tammets T. (koostaja), *Kallis A.* (tead. toimetaja). *Eesti kliima riskid*. Tallinn. Eesti Entsüklopeediakirjastus, 1–152, 2008.

K. Eerme, U. Haud, L. Leedjärv, P. Tenjes, V. Russak and U. Veismann together with H. Jaaniste and J. Jaaniste from Old Tartu Observatory wrote entries on astronomy, geophysics and space research for the new universal encyclopedia published by the TEA Publishers. The first volume of this 22-volume set was published in September 2008.

Under the contract with the Koolibri Publishers, *P. Einasto, I. Kolka, L. Leedjärv and A. Tamm* translated from English into Estonian a comprehensive popular-scientific book "Astronomica". The book is scheduled to be available in April 2009.

6.4 Grant Reports Grandiaruanded

Koepke P., De Backer H., Bais A., Curylo A., *Eerme K.*, Feister U., Johnsen B., Junk J., Kazantzidis A., Krzyscin J., Lindfors A., Olseth J. A., den Outer P., Pribullova A., Schmalwieser A., Slaper H., Staiger H., Verdebout J., Vuilleumier L., Weihs P.: Modelling Solar UV radiation in the Past: Comparison of the Algorithms and Input Data. Cost Action 726. *Earth System Science and Environmental Management. Final Report. COST Office, Luxembourg*, 94 pp., ISBN 978-92-898-0043-3, 2008.

6.5 Preprints Preprindid

Arnalte-Mur P., Fernández-Soto A., Martínez V.J., *Saar E.*, Heinämäki P., *Suhhonenko I.*: Recovering the Real-Space Correlation Function from Photometric Redshift Surveys [astro-ph/0812.4226].

Gutierrez L., *Tamm A.*, Beckman J., Abramson L., Erwin P., Guittet M.: Where Have all the Bulges Gone? [astro-ph/0810.2609].

Järv L., Kuusk P., *Saal M.*: Scalar-Tensor Cosmologies: Fixed Points of the Jordan Frame Scalar Field [astro-ph/0807.2159 [gr-qc]].

Kuusk P., Järv L., *Saal M.*: Scalar-Tensor Cosmologies: General Relativity as a Fixed Point of the Jordan frame Scalar Field [astro-ph/0810.5038 [gr-qc]].

Martínez V.J., Arnalte-Mur P., *Saar E.*, de la Cruz P., Pons-Borderia M.J., Paredes S., Fernández-Soto A., *Tempel E.*: Reliability of the Detection of the Baryon Acoustic Peak [astro-ph/0812.2154].

Tempel E., Einasto J., Einasto M., Saar E., Tago E.: Anatomy of Luminosity Functions: the 2dFGRS Example [astro-ph/0805.4264].

7 Meetings Konverentsid ja seminarid

7.1 Astronomy Astronoomia

European Astronomical Society Meeting "Astronomy in Europe: An Evolving Collaboration" (Leiden, The Netherlands, 21.01.–23.01.2008) – L. Leedjärv.
Leedjärv L.: Estonian Astronomical Society and Astronomy in Estonia (oral presentation).

ASTRONET Funding Agencies Meeting (London, United Kingdom, 11.02.–12.02.2008) – L. Leedjärv.

ASTRONET Board Meeting (Paris, France, 26.02.–27.02.2008) – L. Leedjärv.

Cool Disks, Hot Flows (Funäsdalen, Sweden, 06.04.–10.04.2008) – I. Vurm.
Vurm I.: Electron Thermalization and Emission from Compact Magnetized Sources (oral presentation).

IAU Symposium 252 "The Art of Modelling Stars in the 21st Century" (Sanya, Hainan Island, China, 06.04.–11.04.2008) – A. Aret.
Aret A., Sapar A., Poolamäe R., Sapar L.: SMART – a Computer Program for Modelling Stellar Atmospheres (poster).

Board of Directors Meeting, "Astronomy and Astrophysics" (Bonn, Germany, 03.05.2008) – L. Leedjärv.

Astronomical seminar (Main Astronomical Observatory of the National Academy of Sciences of Ukraine, Kiev, Ukraine, 14.05.2008) – T. Viik.
Viik T.: The Impact of Absorption on the Radiation Field in a Rayleigh-Scattering Atmosphere (oral presentation).

Astronomy and Astrophysics School: "Scientific Writing for Young Astronomers" (Blankenberge, Belgium, 19.05.–21.05.2008) – T. Eenmäe, A. Hirv, T. Tuvikene.

Astronomical Seminar (Kapteyn Astronomical Institute, Groningen, The Netherlands, 09.06.2008) – T. Liimets.
Liimets T.: Astronomy in Real Time (oral presentation).

IAU Symposium 254 "The Galaxy Disk in Cosmological Context" (Copenhagen, Denmark, 09.06.–13.06.2008) – A. Tamm.
Gutierrez L., *Tamm A.*, Beckman J., Abramson L., Erwin P., Guittet M.: Where have all the Bulges Gone? Less than 1/4 of Early Type Disc Galaxies Show Bulges with Classical Morphology (poster).
Tamm A., Tempel E, Tenjes P.: Luminous and Dark Matter in the Andromeda Galaxy (poster).

ASTRONET Infrastructure Roadmap Symposium (Liverpool, United Kingdom, 16.06.–19.06.2008) – L. Leedjärv.

Summer School "Cosmology: an Astrophysical Perspective" (Heraklion, Crete, Greece, 30.06.–04.07.2008) – E. Tempel.

The 9th General Meeting of the Euro-Asian Astronomical Society and The International Conference "Astronomy and Astrophysics of the Beginning of the XXI Century" (Moscow, Russia, 01.07.–05.07.2008) – V.-V. Pustynski.
Pustynski V.-V., *Pustylnik I.*: Mass-loss Rate in EHB Binary Progenitors (poster).

Astronomical Students Seminar (Isaac Newton Group of Telescopes, La Palma, Spain, 08.07.2008) – T. Liimets.
Liimets T.: Astronomy in Real Time (oral presentation).

Nordic-Baltic Research Course 2008 "Observational Stellar Astrophysics" (Moletai AO, Lithuania, 10.08.–24.08.2008) – A. Aret, T. Liimets.
Aret A.: Chemical Diffusion of Elements (lecture).

Workshop "Stellar Atmospheres. The Chemical and Dynamical Evolution of Stars and Galaxies" (Odessa, Ukraine, 25.08.–29.08.2008) – V. Malyuto.
Malyuto V., Shvelidze T.: Accuracy of Effective Temperatures through Intercomparison of Stellar Catalogues (poster).

JENAM 2008 "New Challenges to European Astronomy" (Vienna, Austria, 08.09.–12.09.2008) – K. Annuk, L. Leedjärv, J. Vennik, T. Viik.
Vennik J., Hopp U.: Testing the Dwarf Galaxy Content and Evolutionary Status of Nearby Groups of Galaxies (poster + oral summary).

400 Years of Astronomical Telescopes (ESTEC, Noordwijk, The Netherlands, 28.09.–03.10.2008) – K. Annuk.
Annuk K.: Fraunhofer Refractor at Tartu Observatory (poster).

Kinetic Modeling of Astrophysical Plasmas (Cracow, Poland, 05.10.–08.10.2008) – I. Vurm.

Algebra, Geometry and Mathematical Physics: 4th Baltic-Nordic Workshop (Tartu, Estonia, 09.10.2008) – M. Saal.
Saal M.: Modified Theories of Gravity (oral presentation).

XIII International Astronomy Olympiad (Trieste, Italy, 13.10.–21.10.2008) – T. Eenmäe.

Workshop "Classification and Discovery in Large Astronomical Surveys 2008" (Ringberg, Germany, 13.10.–17.10.2008) – J. Jänes.

Astronomical Seminar (Astrophysical Institute Potsdam, Germany, 17.10.2008) – E. Tempel.
Tempel E.: Anatomy of Galaxy Luminosity Functions (oral presentation).

Workshop "NOVICOSMO 2008" (Trieste, Italy, 18.10.–22.10.2008) – I. Suhhonenko.

Workshop "Emission Line Stars in the Area/Era of Gaia" (Paris-Meudon, France, 28.10.–29.10.2008) – I. Kolka.
Kolka I.: Emission Line Stars with Gaia BP/RP Spectrophotometry (oral presentation).

XX Canary Islands Winter School of Astrophysics: "Local Group Cosmology" (Tenerife, Spain, 17.11.–28.11.2008) – E. Tempel.

7.2 Atmospheric physics Atmosfäärifüüsika

GSE Project MARCOAST User Meeting (Rome, Italy, 06.02.–08.02.2008) – A. Reinart.

Ocean Sciences Meeting (Orlando, Florida, USA, 02.03.–07.03.2008) – A. Reinart.

Reinart A., Valdmets K., Arst H., *Alikas K., Ansko I.*: Optical Classifications of Lakes (oral presentation).

Valdmets K., Ansko I., Reinart A.: Effect of Calibration Uncertainty and Spectral Band Location to Modelled Remote Sensing Reflectance (poster).

XXXVIII Eesti Füüsikapäevad (Tartu, Estonia, 18.03.–19.03.2008) – about 10 researchers.

Valdmets K., Ansko I., Reinart A.: Effect of Calibration Uncertainty and Spectral Band Location to Modelled Remote Sensing Reflectance (poster).

Meteoroloogiapäeva konverents (Tallinn, Estonia, 25.03.2008) – A. Kallis.

Kallis A.: Miks me mõõdame päikesekiirgust (oral presentation).

Nordic Ozone Group (NOG) Meeting 2008 (Abisko, Sweden, 31.03.–01.04.2008) – K. Eerme.

Eerme K., Veismann U., Ansko I., Lätt S., Prüssel M.: Preliminary Analysis of UV Spectra Recorded by AvaSpec Array Spectrometer (oral presentation).

The Tenth COST 726 Member Countries Meeting (El Arensillo, Spain, 10.04.–11.04.2008) – K. Eerme.

Small Satellites Systems and Services – The 4S Symposium (Rhodes, Greece, 26.05.–30.05.2008) – A. Kuusk.

Kuusk A., Kuusk J., Lang M.: A Dataset for the Validation of Reflectance Models (oral presentation).

AGU (American Geophysical Union) Joint Assembly (Fort Lauderdale, Florida, USA, 27.05.–30.05.2008) – K. Alikas.

Metsamaa L., Kutser T., *Reinart A., Alikas K.,* Jaanus A.: Chlorophyll Retrieval from Ocean Color Satellites in Optically Complex Waters (oral presentation).

PHYSENSE (Physically-based Remote Sensing of Forests) Workshop (Helsinki, Finland, 03.06.–04.06.2008) – A. Kuusk, J. Kuusk, T. Kärdi, M. Lang, T. Lükk, M. Mõttus, T. Nilson, M. Rautiainen.

Nilson T., Lang M., Lükk T., Eenmäe A.: On Remote Sensing of Forest Productivity in Järvselja, Estonia (oral presentation).

Mõttus M.: Contribution of Multiply-Scattered Radiation to Multi-Angular Forest Reflectance (oral presentation).

Kuusk J.: Hyperspectral Reflectance of Boreonemoral Forests in a Dry and Normal Summer (oral presentation).

Lang M.: Combining LAI-2000 PCA and Digital Camera for Gap Fraction Measurements (oral presentation).

MERIS Validation Planning Meeting (Wimereux, France, 07.07.–10.07.2008) – A. Reinart.

Workshop "BSRN-2008" (De Bilt, The Netherlands, 07.07.–11.07.2008) – A. Kallis.

Kallis A.: Solar Radiation Measurements in Estonia (poster).

Western Pacific American Geophysical Union, Western Pacific Conference (Cairns, Australia, 29.07.–01.08.2008) – M. Rautiainen, M. Mõttus.

Rautiainen M.: Seasonal Reflectance Variation of Birch Stands (oral presentation).

Mõttus M.: Contribution of Multiply-Scattered Radiation to Multiangular Forest Reflectance (oral presentation).

School of Earth and Environmental Sciences; Spatial Information Group (The University of Adelaide, Australia, 29.08.2008) – M. Mõttus.

Mõttus M.: Physically Based Models and Measurements in Remote Sensing of Vegetation (invited seminar presentation).

School of Earth and Environmental Sciences; Discipline of Soil and Land Systems (The University of Adelaide, Australia, 03.09.2008) – M. Mõttus.

Mõttus M.: Reflectance, Radiation Models and Remote Sensing of Vegetation (invited seminar presentation).

SNSB Cyanobacterial Project Meeting (SMHI, Göteborg, Sweden, 03.09.–04.09.2008) – A. Reinart.

School of Earth and Environmental Sciences; Spatial Information Group (The University of Adelaide, Australia, 11.09.2008) – M. Rautiainen.

Rautiainen M.: A Short Overview of the Spectral Signature of European boreal forests (invited seminar presentation).

International Conference of the Landscape Ecology Working Group (IUFRO.8.01.02) (Chengdu, China, 16.09.–22.09.2008) – T. Kärdi, U. Peterson.

Liira J., Mander Ü., *Peterson U.*: Magnitude and Distance of Edge Influence at Anthropogenically Created Forest Edges, Analysis of Very High Resolution IKONOS Satellite Images (oral presentation).

Kärdi T.: Quantification of the Changes in Urban Forests and in Urban Greenery in the Baltic Sea Region During the Last Twenty Years (oral presentation).

Peterson U., Liira J.: Robustness of Forest Boundary Change Detection in the Conditions of Afforestation of Abandoned Agricultural Lands in Eastern Europe Using Medium Resolution Imagery (oral presentation).

The Eleventh COST 726 Member Countries Meeting (Rome, Italy, 18.09.–19.09.2008) – K. Eerme.

2nd MERIS/(A)ATSR User Workshop (ESA/ESRIN, Frascati, Italy, 22.09.–27.09.2008) – A. Reinart, K. Alikas.

Reinart A., Ansko I., Jänes J., Alikas K., Valdmets K.: Optical Classification of Lakes for Remote Sensing Applications (oral presentation).
Alikas K., Ansko I., Reinart A., Lill E., *Valdmets K.*: Testing Available MERIS Image Processors for Lakes (poster).

14th Australasian Remote Sensing and Photogrammetry Conference (Darwin, Australia, 29.09.–03.10.2008) – M. Rautiainen, M. Mõttus.
Rautiainen M.: Photon Recollision Probability in Forest Reflectance Modelling (oral presentation).
Mõttus M.: Vegetation Reflectance Modelling: Connecting Canopy Structure, Angular Effects and Photon Recollision Probability (oral presentation).

Seirefoorum (Tallinn, Estonia, 07.11.2008) – K. Eerme, A. Kuusk, T. Kärdi, M. Lang, T. Nilson, U. Peterson, A. Reinart, V. Russak.
Peterson U., Budenkova J., Kiviste A., Liira J.: Kaugseire vahendid, võimalused ja piirangud, Eesti maismaa-alade satelliitkaugseire pikk aegrida (oral presentation).
Nilson T., Lang M., Lükk T., Eenmäe A.: Metsade produktiivsuse kaugseire (oral presentation).
Kärdi T.: Vettpidava pinna suhtelise paiknemise kaardistamine spektrisegu lineaarse lahutamise meetodiga Tartu linna näitel (oral presentation).
Reinart A.: Keskkonna ja turvalisuse globaalse seire (GMES) teenused (oral presentation).

Eesti Innovatsiooni Aastakonverents (Tallinn, Estonia, 13.11.–14.11.2008) – A. Reinart.
Reinart A.: GMES – platvorm uuteks rakendusteks ja teenusteks (oral presentation).

Structure and Function of World Shallow Lakes (Montevideo, Uruguay, 22.11.–29.11.2008) – U. Peterson, A. Reinart.
Reinart A., Ansko I., Valdmets K, Alikas K., Arst H., *Jänes J.*: Comparison of Lake Water Typology and Optical Classification of Lakes Used in Remote Sensing Applications (oral presentation).
Peterson U., Liira J., Feldmann T., Freiberg L., Mäemets H.: Changes in Shoreline Vegetation of Two European Great Shallow Lakes over a 20-year Period Using Medium Resolution Satellite Imagery (oral presentation).

Seminar on Theoretical Background and Current Issues in Optical Remote Sensing of Forests (Helsinki, Finland, 09.12.2008) – T. Nilson, M. Mõttus, M. Rautiainen.
Nilson T.: Radiative Transfer in Vegetation and Application of the Theory in Remote Sensing of Forests (invited keynote presentation).
Mõttus M.: Theoretical Studies on the Validity and Utility of the Spectral Invariants (oral presentation).

Rautiainen M.: Current Applications and Future Prospects of the 'p-theory' in Remote Sensing of Forests (oral presentation).

7.3 Miscellaneous Muud koosolekud ja ettevõtmised

Short Course on Remote Sensing with Special Emphasis on Digital Image Processing (Dehradun, India, 08.01.–02.03.2008) – K. Alikas.

Teadusmeedia konverents "Teadus – tumm või tummine?" (Tallinn, Estonia, 29.04.2008) – K. Annuk, A. Kallis, I. Kolka, L. Leedjärv, M. Ruusalepp, U. Veismann.

SWECO kliendipäev (Tallinn, Estonia, 15.05.2008) – A. Kallis.
Kallis A.: Kuidas ilm meid mõjutab? (oral presentation).

EURISY Workshop "Innovation at the Service of Regional Growth: The Competitive Advantages of Satellite Information and Services" (Dublin, Ireland, 20.05.–21.05.2008) – L. Leedjärv.

Teoreetilise bioloogia kevadkool (Vaskna, Estonia, 24.05.–25.05.2008) – T. Viik.

Eesti Terminoloogiaühingu seminar-aastakoosolek (Tallinn, Estonia, 28.05.2008) – U. Veismann.

Kõrgemad keskkonnakursused (Sagadi, Estonia, 30.05.2008) – A. Kallis.
Kallis A.: Kliima. Mis toimub? (oral presentation).

European High-Level Space Policy Group Meeting (Paris, France, 06.06.2008) – L. Leedjärv.

Eesti Füüsika Seltsi Täppisteaduste Suvekool (Nelijärve, Estonia, 21.06.2008) – K. Alikas, K. Valdmets.
Valdmets K., Alikas K.: Kosmosetehnoloogia rakendused 71% Maa pinna seireks (oral presentation).

XXXI Eesti Loodusuurijate Päev. Planeet Maa globaalsed ja lokaalsed probleemid (Lüllemäe – Ähijärve, Estonia, 28.06.–29.06.2008) – K. Eerme, U. Veismann, T. Viik.
Eerme K., Veismann U., Ansko I.: Päikese ultraviolettkiirgus ja loodus (poster).

European High-Level Space Policy Group Meeting (Brussels, Belgium, 03.07.2008) – L. Leedjärv.

Informal Meeting of the European Space Ministers (Centre Spatial Guyanais, Kourou, French Guiana, 20.07.–22.07.2008) – L. Leedjärv.

Struve International conference "Geodetic Arc and its Extension in Time and Space" (Jekabpils, Latvia, 22.08.– 23.08.2008) – T. Viik.
Viik T.: Carl Friedrich Tenner – the Founder of Russian Geodesy (oral presentation).

Eesti Akrediteerimiskeskuse seminar–õppepäev (Tallinn, Estonia, 28.08.2008) – U. Veismann.

European High-Level Space Policy Group Meeting (Paris, France, 04.09.2008) – L. Leedjärv.

H. Mürgi 100. sünniaastapäeva konverents (Tartu, Estonia, 12.09.2008) – A. Kallis.

Kallis A.: Mürk kui värvikas isiksus (oral presentation).

AHHAA üritus "Teadlaste öö" (Tartu, 26.09.2008) – A. Kallis.

Kallis A.: Pilvedest ja pilvede pildistamise võistlusest (oral presentation).

Schola Geologica (Mäetaguse, Estonia, 10.10.–12.10.2008) – M. Gramann, T. Viik.

Gramann M.: Universum ja selle areng (oral presentation).

Valgustustehnika seminar (TTÜ, Tallinn, Estonia, 16.10.2008) – U. Veismann.

Visit to Novespace and Institut de Maintenance Aéronautique Including Parabolic Flight on Airbus A300 ZERO-G (Bordeaux, France, 06.11.–07.11.2008) – L. Leedjärv.

Tallinna VI Visioonikonverents: Tallinna energiaportfell (Tallinn, Estonia, 10.11.2008) – U. Veismann.

Konverents "Taastuvate energiaallikate uurimine" (Tartu, 13.11.2008) – A. Kallis.

Konverents "Agronoomia-2008" (Tartu, Estonia, 20.11.2008) – A. Kallis.

Kallis A.: Põllumees ja ilm (oral presentation).

Keskkonnaministeeriumi lahtiste uste päev (Tallinn, Estonia, 26.11.2008) – A. Kallis.

Kallis A.: Kas ilm on hukas? (oral presentation).

European Science Foundation – Conference on Science Policy and Assembly (Stockholm, Sweden, 26.11.–28.11.2008) – T. Viik.

Negotiations at the European Space Agency (ESA-ESTEC, Noordwijk, The Netherlands, 11.12.2008) – L. Leedjärv, M. Noorma.

Konverents "Kolmteist aastat Kiirguskeskust" (Tallinn, 22.12.2008) – T. Viik.

7.4 Meetings at Tartu Observatory Tartu Observatooriumis korraldatud konverentsid

7.4.1 Tartu - Tuorla Annual Meeting 2008. Cosmology: from Observations to Simulations and Beyond

From October 1 to 4, 2008 the department of cosmology arranged a joint seminar, with A. Tamm leading the organization team. About 40 participants from Tuorla Observatory of the University of Turku, the University of Oulu, the Astrophysical Institute Potsdam, the University of Valencia, National Institute of Chemical and Biological Physics (Tallinn), the University of Tartu and Tartu Observatory listened to and discussed 25 reports. The following reports were presented by the researchers from Tartu Observatory:

Pelt J.: To the Left and to the Right of the Nyquist Limit.

Hütsi G.: The Cluster-Galaxy Cross-Spectrum: an Additional Probe of Cosmological and Halo Parameters.

Saar E.: Bootstrapping Correlations.

Liivamägi L.J.: Density Fields and Superclusters.

Saal M.: Scalar-Tensor Theory of Gravity.

Tamm A.: Galaxy Structure and its Connection with Nuclear Activity.

Tempel E.: Anatomy of Luminosity Functions.

Tago E.: A Volume-Limited Sample of Groups of Galaxies in the SDSS DR6: *pro et contra*.

Vennik J.: Testing of the Dwarf Galaxy Content and the Evolutionary Status of Nearby Groups of Galaxies.

1.–4. oktoobrini 2008 korraldas kosmoloogia osakond Waide motellis ühisseminari. Korraldustoimkonda juhtis A. Tamm. Umbes 40 osalejat Turu Ülikooli Tuorla Observatooriumist, Oulu Ülikoolist, Potsdami Astrofüüsika Instituudist, Valencia Ülikoolist, Keemilise ja Bioloogilise Füüsika Instituudist (Tallinn), Tartu Ülikoolist ja Tartu Observatooriumist kuulasid 25 ettekannet.

7.4.2 2nd PHYSENSE workshop

T. Nilson, M. Rautiainen, M. Lang and M. Mõttus organized the "2nd PHYSENSE workshop" for students and young researchers from Nordic and Baltic countries in Helsinki, Finland, June 3–4, 2008. The workshop was founded by SNS (Nordic Forest Research Co-operation Committee).

T. Nilson, M. Rautiainen, M. Lang ja M. Mõttus korraldasid PHYSENSE (Põhjamaade koostöövõrgustik metsade füüsikaliseks kaugseireks) 2. tööseminari 3.–4. juunini 2008 Helsingis (Soome).

7.5 Meetings organized by EstSpacE team at Tartu Observatory. EstSpacE grupi poolt korraldatud konverentsid ja seminarid Tartu Observatooriumis

7.5.1 Estonian Space Research and Technology Network Workshop

A. Reinart organized the opening meeting of the EstSpacE project in Pühajärve, Estonia from April 17 to 18, 2008. 27 participants from Tartu Observatory, University of Tartu, Enterprise Estonia and Invent Baltics Ltd. listened to 6 presentations and participated in 2 workshops: ambitions and expectations of young researchers and EstSpacE activities. The reports were on following subjects:

Noorma M.: Patterns in Space Field.

Leedjärv L.: European Space Policy.

Leedjärv L.: Development Plan of Tartu Observatory.

Reinart A.: EstSpacE Action Plan.

Võõras M.: Funding Possibilities For Research Institutions to Participate in the Development of Entrepreneurship in the Space Field.

Toomla S.: Requirements and Recommendations for the Project Activities and Reporting.

17.–18. aprillil 2008 korraldas A. Reinart Pühajärvel projekti EstSpacE avaürituse – Eesti kosmoseuuringute ja -tehnoloogiavõrgustiku seminari. Seminaril osales 27 teadlast ja spetsialisti Tartu Observatooriumist, Tartu Ülikooli Tehnoloogiainstituudist, Tartu Ülikooli Füüsika Instituudist, Ettevõtluse Arendamise Sihtasutusest ja Invent Baltics OÜ-st. Osavõtjad kuulasid 6 ettekannet ning võtsid osa kahest töötoast – noorteadlaste ambitsioonid ja ootused ning projekti EstSpacE tegevuste arutelu.

7.5.2 Space Technology, Including Satellite Remote Sensing: Prospective and Horizons

EstSpacE project team, leaded by A. Reinart organized an international scientific workshop in Tartu, Estonia on August 26, 2008. 29 participants from 6 countries listened to 7 presentations and visited Tartu Observatory in Tõravere as well as Institute of Physics and Institute of Technology of Tartu University in Tartu. Estonian participants introduced EstSpacE, Estonian Space Strategy and national possibilities for research and industry collaborations. Four members of the EstSpacE Advisory Council introduced their topic of science, as all of them are working in very different fields: astronomy, water remote sensing, land remote sensing and atmospheric research. There was also time for special discussions on strategic partnerships and further collaboration activities during the workshop. The following reports were presented by the EstSpacE project team members from Tartu Observatory:

Reinart A.: EstSpacE – FP7 Capacity Project in Tartu Observatory.

Noorma M.: Principles of Estonian Space Strategy.

Leedjärv L.: Research and Development Programme of Tartu Observatory.

26. augustil 2008 korraldas EstSpacE projekti meeskond A. Reinarti juhtimisel Tartus rahvusvahelise seminari. 29 osavõtjat 6 riigist kuulasid 7 ettekannet, külastasid Tartu Observatooriumi Tõraveres ning Tartu Ülikooli Füüsika Instituuti ja Tehnoloogiainstituuti Tartus. Projektimeeskonna liikmed tutvustasid EstSpacE projekti, Eesti kosmosepoliitika põhimõtteid, Tartu Observatooriumi arengukava ja võimalusi teadusasutuste ja ettevõtete koostööks Eestis. Neli EstSpacE projekti nõuandva kogu liiget tutvustasid oma uurimisteemasid astronoomia, vee kaugseire, maa kaugseire ja atmosfääri uuringute valdkonnas. Lisaks ettekannetele toimus arutelu vastastikku huvipakkuvate koostöövõimaluste üle.

7.5.3 EstSpacE Project Advisory Council Meeting

Project team leaded by A. Reinart and M. Noorma organized the EstSpacE project Advisory Council Meeting in Tõravere, Estonia on August 26, 2008. 26 researchers from 6 countries took part of the extended AC meeting. Discussions were held on the strategic plan of the EstSpacE project and development plan of Tartu Observatory. Clear suggestion from Advisory Council members was to promote space science to public and especially among youngsters, as this will give a good motivation for continuity in natural sciences. Second suggestion was directed to the EstSpacE team – to find out and concentrate on specific topics which correspond to the needs of Estonia but also make Tartu Observatory an attractive partner in Europe.

26. augustil 2008 toimus Tõraveres EstSpacE projekti Nõuandva Kogu laiendatud koosolek, millest võttis osa 26 teadlast 6 riigist, sh 4 Nõuandva Kogu liiget. Korraldustoimkonda juhtisid A. Reinart ja M. Noorma. Koosolekul arutati EstSpacE projekti tegevuskava ning Tartu Observatooriumi arengukava. Välisekspertide selge soovitus oli jätkata kosmoseteaduse tutvustamist avalikkusele, eriti noortele, mis tagab loodusteaduste arengu järjepidevuse ja teadlaskonna järelkasvu. Projekti meeskonnale soovitati leida üles ja keskenduda konkreetsetele teemadele, mis vastavad Eesti vajadustele ja suudavad samas muuta Tartu Observatooriumi atraktiivseks partneriks Euroopas.

The participants of EstSpacE Advisory Council meeting at Tõravere.
EstSpacE Nõuandva Kogu laiendatud koosolekust osavõtjad Tõraveres.

7.5.4 International summer school "Applications and Operational Use of Remote Sensing for Monitoring Environment and Security"

EstSpacE project team leaded by A. Reinart organized the international summer school from August 27 to 29, 2008 in Tartu, Estonia. 59 participants from 10 countries listened to the lectures, participated in practical training in the computer lab and attended a field trip to remote sensing test sites in Estonia, Järvselja and Lake Peipsi, including demonstration of instruments. There were altogether 10 lessons covering whole range of remote sensing topic including land, water and atmosphere held by A. Reinart and T. Nilson (Tartu Observatory), T. Pyhälahti (Finnish Environmental Institute), H. Tork (Modesat Communications, Estonia), A. Rohrbach (Leica Geosystems, Switzerland), P. Krusberg (Estonian Land Board), S. Kratzer (Stockholm University, Sweden), J. Praks (Helsinki Technical University, Finland), C. Brockmann and K. Stelzer (Brockmann Consult, Germany), H. van der Woerd (Vrije Universiteit Amsterdam, The Netherlands) and M. Laanen (Water Insight, The Netherlands). Practical applications for monitoring water using satellite images in conjunction with *in situ* data were demonstrated. In addition to passive remote sensing, active methods using radar or lidar systems were also introduced. Two presentations introduced new developments in airborne instruments for environmental monitoring and their applications in Estonia.

Students teams from Finland, Latvia and Estonia presented their work. In practical session training for BEAM software was provided by Brockmann Consult. Students were encouraged to use their own data for tests. The following lectures were given by researchers of Tartu Observatory:

Reinart A.: Environmental Aspects in EU/ESA Programme GMES.

Nilson T.: Land Cover Remote Sensing Applications.

27.–29. augustini 2008 toimus Tartus rahvusvaheline suvekool, mille korraldas EstSpacE meeskond eesotsas A. Reinartiga. Suvekoolis osales 59 noort 10 riigist. Osavõtjad kuulasid loenguid, said arvutiklassis praktilise väljaõppe kaugseire tarkvara BEAM kasutamiseks ning käisid tutvumas Eesti kaugseire katsealadega Järvseljal ja Peipsi järvel, kus neile tutvustati ka vastavaid mõõteriistu. Loengutes käsitleti nii maa, vee kui atmosfääri kaugseire teemasid. Suvekoolis osalejatele esinesid A. Reinart ja T. Nilson (Tartu Observatoorium), T. Pyhälahti (Soome Keskkonna Instituut), H. Tork (Modesat Communications, Eesti), A. Rohrbach (Leica Geosystems, Šveits), P. Krusberg (Eesti Maa-amet), S. Kratzer (Stockholmi Ülikool, Rootsi), J. Praks (Helsingi Tehnikaülikool, Soome), C. Brockmann ja K. Stelzer (Brockmann Consult, Saksamaa), H. van der Woerd (Amsterdami Vaba Ülikool, Holland) ja M. Laanen (Water Insight, Holland). Eesti, Läti ja Soome tudengid tutvustasid oma töid.

7.5.5 New particle generation in atmosphere

The 11th Finnish-Estonian Air-ion and Aerosol workshop was organized by EstSpacE project team member U. Hõrrak (Institute of Physics, Tartu University) from September 8 to 10, 2008 in Pühajärve, Estonia. These workshops are held on a regular basis and discuss the latest results in atmospheric nucleation, air ions, clusters and ultrafine aerosols measurements, instrumentation development, modelling and climate impacts of ultrafine aerosol particles. 44 scientists and Ph.D. students from Finland, Sweden, Germany, Poland and Estonia took part of the event. There were participants from University of Helsinki, Finnish Meteorological Institute, Lund University, Institute of Geophysics of the Polish Academy of Sciences, Leibniz Institute for Tropospheric Research in Leipzig, Estonian University of Life Sciences, Tartu Observatory, Institute of Physics of the University of Tartu, Estonian Ministry of Education and Research.

24 scientific presentations were given and discussed, and three special meetings and tour to aerosol laboratory in the Institute of Physics, the University of Tartu were organized during the workshop. Participants got new information about the recent results of the investigations in the field of aerosol research and new practical skills to operate and service air ion spectrometers. Joint research activities within the EU FP6 projet EUCAARI were discussed and planned, as well as publication of joint papers in

international journals. The co-operation preagreement between aerosol research groups of the University of Helsinki and University of Tartu was agreed. During the SMEAR meeting, the establishment of the SMEAR like station (Station for Measuring Forest Ecosystem - Atmosphere Relation; http://www.atm.helsinki.fi/SMEAR/index.php) in Estonia in co-operation with different Estonian and Finnish research institutions was discussed. Such station would help to integrate various research groups, their interests, objectives and results of scientific research, and would open new perspectives for international collaboration. Current situation with the SMEAR Estonia project implementation was analysed and tactics for the next steps was proposed.

The development of strategic partnership with the European aerosol network EUSAAR and planning of joint activities in aerosol research with the University of Helsinki was a topic of the EstSpacE meeting. During the EstSpacE meeting, A. Reinart and WP leaders met with member of the Advisory Council Prof. Markku Kulmala from the University of Helsinki and discussed joining EUSAAR and necessary procedures to become an associated member of the network.

Prof. Markku Kulmala explained the status of associates, contribution to and benefits from the EUSAAR activities. He recommended applying for the association with the EUSAAR network during the implementation of EstSpacE project.

8.–10. septembrini 2008 toimus Pühajärvel XI Soome-Eesti aeroioonide ja atmosfääriaerosooli ühisseminar. Korraldustoimkonda juhtis EstSpacE meeskonna liige U. Hõrrak, Tartu Ülikooli Füüsika Instituut. Osavõtjaid oli Soomest, Saksamaalt, Poolast, Rootsist ja Eestist, kokku 44 teadlast ja kraadiõppurit, kes kahe päeva jooksul esitasid 24 ettekannet. Esindatud olid Helsingi Ülikool, Soome Meteoroloogiainstituut, Lundi Ülikool, Poola Teaduste Akadeemia Geofüüsika Instituut, Leibnizi Troposfääriuurimise Instituut Saksamaalt, Eesti Maaülikool, Tartu Observatoorium ja Tartu Ülikooli Füüsika Instituut. Seminariettekannete temaatika oli seotud atmosfääriaerosooli tekke ja dünaamika, aerosoolis toimuvate füüsikaliste protsesside teoreetilise ja eksperimentaalse uurimisega, nanomeeterosakeste ja aeroioonide uute spektromeetrite kalibratsiooniga ja lennukilt tehtud mõõtmistega. Lisaks traditsioonilistele ettekannetele toimus seminari käigus ka arutelu Soome SMEAR jaamadega analoogilise uurimisjaama rajamise vajalikkusest Eestis, mis aitaks integreerida erinevate valdkondade teadusgruppide uurimistöö eesmärgid ja tulemused ning avaks uued perspektiivid rahvusvaheliseks koostööks.

8 Visits and guests Visiidid ja külalised

8.1 Astronomy Astronoomia

T. Liimets – Isaac Newton Group of Telescopes, La Palma (Spain); 01.01.–04.08.2008.
I. Vurm – University of Oulu, Oulu (Finland); 01.01.–23.12.2008.
A. Tamm – Instituto de Astrofisica de Canarias, La Laguna (Spain); 01.04.–29.04.2008.
J. Pelt – University of Helsinki (Finland); 02.03.–06.03.2008, 06.04.–10.04.2008, 04.05.–08.05.2008.
J. Einasto – Astrophysical Institute Potsdam (Germany); 07.05.–26.06.2008.
T. Liimets – Kapteyn Astronomical Institute, Groningen (The Netherlands); 02.06.–13.06.2008,
M. Mars – Hlohovec Observatory (Slovak Republic); 08.09.–31.10.2008.
E. Tempel – Astrophysical Institute Potsdam (Germany); 13.10.–26.10.2008.
M. Gramann – Tuorla Observatory, Turku (Finland); 13.10.–29.10.2008.
E. Saar – Observatori Astronòmic, Universitat de València, València (Spain); 13.10.–12.12.2008.
L.J. Liivamägi – Observatori Astronòmic, Universitat de València, València (Spain); 13.10.–14.11.2008.
J. Einasto – Astrophysical Institute Potsdam (Germany); 13.10.–13.12.2008.
T. Liimets – Kapteyn Astronomical Institute, Groningen (The Netherlands); 03.11.–25.11.2008.
J. Vennik – Munich University Observatory (Germany); 15.11.–22.11.2008.

8.2 Atmospheric physics Atmosfäärifüüsika

M. Mõttus– Department of Forest Resource Management, University of Helsinki (Finland); 10.03.–04.04.2008, 12.05.–13.06.2008, 01.12.–11.12.2008.
K. Alikas – Department of Geography and Program in Planning, University of Toronto (Canada); 07.04.–23.05.2008, 21.10.–17.12.2008.
M. Rautiainen, M. Mõttus – School of Earth and Environmental Sciences, The University of Adelaide (Australia); 25.07.–29.11.2008.
K. Valdmets – Oslo University and Norwegian Water Research Institute (Norway); 13.10.–19.10.2008.

8.3 Guests of the observatory Observatooriumi külalised

Eric W. Elst – Royal Observatory Belgium, Uccle (Belgium); 08.02.2008.
Pekka Heinämäki – Tuorla Observatory, University of Turku (Finland); 18.02.–20.02.2008; 17.04.–18.04.2008; 12.06.–13.06.2008.

Dana Reizniece – Ventspils Technology Park, Ventspils (Latvia); 27.03.–28.03.2008.

Juris Žagars – Ventspils International Radio Astronomy Centre, Ventspils (Latvia); 27.03.–28.03.2008.

Melanie Guittet – Paris Observatory (France); 27.04.–20.06.2008.

Suzanne Héral, Albert Desprez, Serge Prat – Descendants of the first astronomer-observer in Tartu Ernst Ch. Knorre (1759–1810), Paris, (France); 05.05.–07.05.2008.

Gennadi Pinigin – Nikolaev Astronomical Observatory, Nikolaev (Ukraine); 05.05.–07.05.2008.

Radu Stoica – Université Lille (France); 09.06.–19.06.2008.

Jan Pisek – Department of Geography and Program in Planning, University of Toronto (Canada); 05.07.–23.07.2008.

Jaan Praks – Helsinki Technical University (Finland); 27.08.–29.08.2008.

Arthur Rohrbach – Leica Geosystems (Switzerland); 27.08.–29.08.2008.

Marnix Laanen – Water Insight (The Netherlands); 14.07.–18.07.2008; 27.08.–29.08.2008.

Bernard Pinty – EC Joint Research Centre, Ispra (Italy); 25.08.–27.08.2008.

Gunther Seckmeyer – Institute for Meteorology and Climatology, University of Hannover (Germany); 25.08.–27.08.2008.

Roland Doerffer – GKSS (Germany); 25.08.–27.08.2008.

Esko Valtaoja – University of Turku, Tuorla Observatory (Finland); 25.08.–27.08.2008.

Susanne Kratzer – Stockholm University (Sweden); 25.08.–29.08.2008.

Timo Pyhälahti – Finnish Environmental Institute (Finland); 25.08.–29.08.2008.

Are Folkestad – Norwegian Water Research Institute (Norway); 25.08.–27.08.2008.

Carsten Brockmann – Brockmann Consult (Germany); 25.08.–29.08.2008.

Kerstin Stelzer, Hans van der Woerd – Vrije Universiteit Amsterdam (The Netherlands); 27.08.–29.08.2008.

Markku Kulmala – University of Helsinki (Finland); 08.09.–11.09.2008.

Janusz Krzyscin – Institute of Geophysics, Polish Academy of Sciences (Poland); 08.09.–13.09.2008.

Anabelle Fonseca-Colomb, Pedro Poiares Baptista, Bernard Zufferey – European Space Agency, Paris (France) and Noordwijk (The Netherlands); 17.09.2008.

Participants of the Tartu-Tuorla Annual Meeting 2008, 01.10.–04.10.2008:

Sarah Bird, Chris Flynn, Esko Gardner, Pekka Heinämäki, Heidi Lietzen, Samuli Kotiranta, Pasi Nurmi, Sami Niemi, Rami Rekola and Mauri Valtonen – Tuorla Observatory, University of Turku (Finland);

Vicent Martínez – University of Valencia (Spain);

Petri Mutka – University of Oulu (Finland);

Volker Müller – Astrophysical Institute Potsdam (Germany).

9 Seminars at the Observatory Observatooriumis toimunud seminarid

9.1 Astronomy Astronoomia

09.01.2008 – Liia Hänni: Kosovo, nii nagu Liia teda nägi.
16.01.2008 – Jaan Kaplinski: Mikrokosmoloogia.
23.01.2008 – Jaan Vennik: Ketasgalaktikate-alasest konverentsist Roomas ja Vatikani observatooriumist.
30.01.2008 – Tõnu Viik: Tagasi Jeans'i juurde.
08.02.2008 – Eric W. Elst (Royal Observatory Belgium, Uccle): Hazardous Asteroids.
13.02.2008 – Maret Einasto: William Herschel – vaatlusliku kosmoloogia rajaja.
20.02.2008 – Üldine arutelu "Kas tulevik on tume?"
27.02.2008 – Tiit Nugis: Varjatud kiirgus Universumis.
05.03.2008 – Tõnu Viik: Carl Friedrich Tenner – vene geodeesia rajaja.
12.03.2008 – Enn Saar: Tõenäosusjaotused antiikajast tänapäevani.
19.03.2008 – Uno Veismann: Nelisada aastat teleskoope.
26.03.2008 – Jaan Pelt: Kuidas kellad käivad?
02.04.2008 – Urmas Haud: Kui kellad on kaua käinud.
16.04.2008 – Elmo Tempel: Galaktikate tekke modelleerimine.
06.05.2008 – Suzanne Héral (France): Astronomers and Other Professions in the Knorre Family.
– Gennadi Pinigin (Nikolaev Astronomical Observatory, Ukraine): Karl Knorre and Nikolaev Observatory.
14.05.2008 – Anna Aret: Tähtede modelleerimise kunst 21. sajandil. IAU Sümpoosion 252, Sanya, Hiina.
21.05.2008 – Margus Saal: Teoreetiliste kosmoloogide standardmudel. I.
28.05.2008 – Maret Einasto: Superparvede morfoloogiast.
04.06.2008 – Melanie Guittet (Pariisi Observatoorium): Mõhnad ja Pariisi Observatoorium.
11.06.2008 – Margus Saal: Teoreetiliste kosmoloogide standardmudel. II.
18.06.2008 – Radu Stoica (Université Lille): A Three-Dimensional Object Point Process for Detection of Cosmic Filaments.
03.09.2008 – Tõnu Kipper: Supernoovadest.
24.09.2008 – Laurits Leedjärv: Reis Euroopa kosmoseväravasse Lõuna-Ameerikas.
01.10.2008 – Tõnu Viik: Struve kaare konverents Jekabpilsis.
08.10.2008 – Kalju Annuk: 400 aastat teleskoope. Konverents ESTECis.
15.10.2008 – Arutelu teemal: Kuhu kõik esinejad jäid ......

29.10.2008 – Anna Aret: Keemiliste elementide ja nende isotoopide difusioon CP tähtede atmosfäärides.
05.11.2008 – Mihkel Kama: Protoplanetaarsete ketaste siseosa ehitus.
12.11.2008 – Indrek Kolka: Emissioonijoontega tähed kosmoseteleskoobi Gaia objektidena.
19.11.2008 – Tõnis Eenmäe: Vaatlusvõimalused Tõravere teleskoopidel.
26.11.2008 – Taavi Tuvikene: Ühe lähiskaksiktähe avastamise lugu.
03.12.2008 – Jaan Vennik, Kalju Annuk: Meenutame JENAM2008-t sõnas ja pildis.
10.12.2008 – Kalju Eerme: Looduslik ja inimeste maailm kui iseorganiseeruvad komplekssüsteemid (ühisseminar koos atmosfäärifüüsikutega).
17.12.2008 – Taavi Tuvikene: Eise Eisinga, Franekeri fenomen. Film maailma vanimast töötavast planetaariumist.

9.2 Atmospheric physics Atmosfäärifüüsika

15.02.2008 – Joel Kuusk, Silver Lätt: Grupitöö tarkavarade tutvustav võrdlemine.
28.03.2008 – Krista Alikas: Koolituskursus India Kaugseire Instituudis: pildid ja tõlgendused.
04.04.2008 – Kristi Valdmets: Kuidas Kristi ja Ilmari poster Ameerikat avastas.
25.04.2008 – Mait Lang: Ülevaade Tartu Observatooriumi olemasolevatest kaugseireandmebaasidest (”bib", ”pildid” ja ”jarvselja”).
16.05.2008 – Kaugseire tudengite ja magistrantide seminar.
Kadri Kiis – Keskmise ruumilise lahutusega satelliidipiltidelt tehtavate lageraidealade pindalahinnangute täpsust mõjutavad faktorid.
Ave Kodar – Metsade lehepinnaindeksi hindamine optiliste meetoditega.
Jürgen Jänes – Analysing lake spectra using machine learning methods.
Irina Krivonožko: Reisilennukite mõju atmosfäärile Eesti kohal.
30.05.2008 – Jaan Pelt: Päike – Maa suhted ja aegread.
27.06.2008 – Garik Gutman: The NASA Land-Cover/Land-Use Change Program and its Contribution to the International Northern Eurasia Earth Science Partnership Initiative.
12.09.2008 – Prof. Janusz Krzyscin (Poola TA Geofüüsika Instituut): Comparison Between Model and Observation – Taylor Diagram Tool.
03.10.2008 – Anu Reinart: MERIS produktide kasutamine suurte järvede kaugseires – uued töötlused ja rakendused.
09.10.2008 – Jouni Envall: Calibration of Broadband UV Detectors at TKK: Methodology, Equipment and Special Considerations.
21.11.2008 – Abdelaziz Kallel: Modelling Radiative Transfer within Vegetation Based on Flux Decomposition.

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 – M. Mõttus, M. Rautiainen, A. Reinart, S. Lätt (student member), K. Valdmets (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
Eco-Ethics International Union – A. Kallis
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, V. Harvig, T. Kipper, I. Kolka, L. Leedjärv, T. Nugis, J. Pelt, A. Puss, V.-V. Pustynski, M. Ruusalepp, L. Sapar, E. Tago, U. Veismann, T. Viik
Eesti Füüsika Selts – A. Aret, K. Eerme, J. Einasto, T. Kipper, L. Leedjärv, S. Lätt (juhatuse liige), A. Reinart, E. Saar, A. Sapar, M. Sulev, P. Tenjes, T. Viik
Eesti Geograafia Selts – A. Kallis
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, A. Kallis, V. Russak, A. Sapar, M. Sulev, U. Veismann, T. Viik (president)
Eesti Teadlaste Liit – J. Einasto, T. Viik
Eesti Teaduste Akadeemia / Estonian Academy of Sciences – J. Einasto, A. Sapar
Eesti Teadusfondi Nõukogu – T. Viik
EUFAR (EUropean Fleet for Airborne Research): Expert in the Imaging Remote Sensing Workgroup – M. Mõttus
EUFAR (EUropean Fleet for Airborne Research): Education and Training – S. Lätt

EURISY Programmatic Steering Committee – L. Leedjärv

European Association of Remote Sensing Laboratories (EARSeL) – department of atmospheric physics

European Astronomical Society – K. Annuk, J. Einasto, M. Gramann, V. Harvig, T. Kipper, I. Kolka, L. Leedjärv, T. Nugis, V.-V. Pustynski, E. Saar, A. Sapar, L. Sapar, 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

Finnish Society of Forest Sciences – M. Mõttus, M. Rautiainen

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

German Astronomical Society – J. Einasto

GMES (Global Monitoring for Environment and Security) Advisory Council – A. Reinart

Institute of Electrical and Electronical Engineers (IEEE) – S. Lätt (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, T. Kipper, I. Kolka, L. Leedjärv, V. Malyuto, T. Nugis, J. Pelt, E. Saar, A. Sapar, L. Sapar, I. Suhhonenko, E. Tago, 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. Rautiainen (secretary), M. Lang (member of steering committee), M. Mõttus (member of steering committee)

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

Royal Astronomical Society – J. Einasto (associated member)

Societas Biologica Fennica Vanamo – M. Rautiainen

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

Õpetatud Eesti Selts – U. Peterson

Working Group 4 of COST 726 Action – S. Lätt

WMO World Climate Research Programme, Baseline Surface Radiation Network (BSRN), PAR (Photosynthetically Active Radiation) Working Group – A. Kallis

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

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. Tago, T. Viik.

Astronomy Astronoomia – P. Tenjes, Tartu University.

Quantum Physics Kvantfüüsika – P. Tenjes, Tartu University.

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

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

Physical Cosmology Füüsikaline kosmoloogia – M. Gramann, E. Tago, Tartu University.

General Astronomy Üldine astronoomia – E. Tempel, Tartu University.

Selected Topics in the Theories of Gravity Valitud peatükke gravitatsiooniteooriast – M. Saal (together with L. Järv and P. Kuusk), Tartu University.

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 Physics Sissejuhatus füüsikasse – V.-V. Pustynski, Tallinn University of Technology.

Introduction to Astrophysics Sissejuhatus astrofüüsikasse – V. Harvig, Tallinn University of Technology.

Radiative Processes in Astrophysics Kiirguslikud protsessid astrofüüsikas – I. Vurm (teaching assistant), University of Oulu.

Time Series Analysis in Astronomy Aegridade analüüs astronoomias – J. Pelt, University of Helsinki.

11.1.2 Atmospheric physics Atmosfäärifüüsika

Environmental Science Keskkonnaõpetus – K. Eerme, Tartu University.
Introduction to Geophysics Sissejuhatus geofüüsikasse – K. Eerme, Tartu University.
Environmental Remote Sensing Keskkonna kaugseire – T. Nilson, Tartu University.
Remote Sensing of Vegetation Taimkatte kaugseire – T. Nilson, Tartu University.
Fundamentals of Remote Sensing Kaugseire alused – U. Peterson, Tartu University.
Meteorological Technology and Observational Networks Meteotehnoloogia ja vaatlusvõrgud – A. Kallis, Tartu University.
Space Technology Kosmosetehnoloogia – M. Noorma (coordinator), U. Veismann, A. Reinart, T. Eenmäe, P. Tenjes, Tartu University.
Image Processing in Remote Sensing Pilditöötlus kaugseires – U. Veismann (together with A. Luts), Tartu University.
Meteorological Technology and Observational Networks Meteotehnoloogia ja vaatlusvõrgud – A. Kallis, Tallinn University of Technology.
General Meteorology and Climatology Üldine meteoroloogia ja klimatoloogia – A. Kallis, Tallinn University of Technology.
Problems in Climatology Kliima probleemidest – A. Kallis, Eurouniversity.
Remote Sensing of Nature Looduse kaugseire – M. Lang, Estonian University of Life Sciences.
Geographic Information Systems Geograafilised Informatsioonisüsteemid – U. Peterson, Estonian University of Life Sciences.
Environmental Monitoring Keskkonnaseire – U. Peterson, Estonian University of Life Sciences.
Advanced Studies of Remote Sensing Kaugseire edasijõudnutele – M. Mõttus, visiting lecturer, University of Helsinki.
Remote Sensing I Kaugseire I – M. Rautiainen, visiting lecturer, University of Helsinki.

11.2 Popular lectures Populaarteaduslikud loengud ja esinemised

43 intervjuud BNS-ile, raadiole ja televisioonile – A. Kallis.
7 intervjuud BNS-ile, raadiole ja televisioonile – T. Viik.
Surmatants tähtedega 2007 (Tartu Tähetorni Astronoomiaring, 15.01.2008) – E. Tago.
Kosmoloogia ja stringiteooria (Tallinna Tehnikaülikool, 21.02.2008) – M. Saal.

Eesti teaduse, hariduse ja tehnoloogia arendamisest ehk kuidas saada suureks vaimult (Eesti Vabariigi Presidendi Akadeemiline Nõukoda, 27.02.2008) – J. Einasto koos akadeemik Mart Saarmaga.

Tumeaine galaktikates (Tartu Tähetorni Astronoomiaring, 04.03.2008) – P. Tenjes.

Carl Friedrich Tenner – vene geodeesia rajaja (Eesti Geodeetide Ühingu kevadkonverents, Tartu, 07.03.–08.03.2008) – T. Viik.

Õppetund teemal "Kaugseire" (Eesti Maaülikooli Loodusteaduste Kool, Tartu, 12.03.2008) – U. Peterson.

Mõnda uut Päikesesüsteemis (Mahtra Rahvakool, Mahtra, 15.03.2008) – T. Viik.

Carl Friedrich Tenner – vene geodeesia rajaja (Akadeemiline Baltisaksa Kultuuri Selts, Tartu, 18.03.2008) – T. Viik.

Radioaktiivne kiirgus meie ümber (Eesti Looduseuurijate Selts, Tartu, 27.03.2008) – T. Viik.

Maailmapildi muutlikkusest ehk Kuumehe taevastest seiklustest (Tartu Tähetorni Astronoomiaring, 01.04.2008) – A. Puss.

Amatöörteleskoobid (Eesti Astronoomia Seltsi aastakoosolek, Tallinn, 19.04.2008) – T. Eenmäe.

Ernst Öpik (Eesti Teaduste Akadeemia 70. aastapäeva seminar, Tartu, 28.04.2008) – J. Einasto.

Amatöörteleskoobid (Tartu Tähetorni Astronoomiaring, 29.04.2008) – T. Eenmäe.

Astronoomia: tähtedest galaktikateni (Miina Härma Gümnaasium, Tartu, 06.05.2008) – E. Tempel.

Stellaarium – koht, kus tutvustada astronoomiat (Konverents "Eesti taevas II. Aeg ja Ruum", Tartu Tähetorn, 22.05.2008) – M. Ruusalepp.

Maailmapildi ennatlikust konstrueerimisest Kuu nähtavuse näitel (Konverents "Eesti taevas II. Aeg ja Ruum", Tartu Tähetorn, 22.05.2008) – A. Puss.

Tartu Observatoorium – 200 aastat (Tartu Astronoomilise Nurgakivi Päev) (Tartu, Estonia, 26.05.2008) – J. Einasto.

Teadus Tartu Tähetornis: 1810–1939 (Tartu Astronoomilise Nurgakivi Päev) (Tartu, Estonia, 26.05.2008) – T. Viik.

Naabreid otsimas (XXXI Eesti Looduseuurijate päev, Lüllemäe, 28.06.2008) – T. Viik.

Maailma sünd ja areng (Eesti patendivolinike ühingu suvekool, Rapla, Estonia, 26.06.2008) – J. Einasto.

Struve-Tenneri meridiaanikaar või hoopis Tenner-Struve meridiaanikaar (Astronoomiahuviliste XIII üle-Eestiline kokkutulek, Väike-Maarja, 10.08.2008) – T. Viik.

Astrofotograafia (Astronoomiahuviliste XIII üle-Eestiline kokkutulek, Väike-Maarja, 11.08.2008) – T. Eenmäe.

Tunguusi katastroof 100 (Astronoomiahuviliste XIII üle-Eestiline kokkutulek, Väike-Maarja, 09.08.–13.08.2008) – E.Tago.

Maailm ja mis selles leida: Päikesesüsteem (Tallinna Ülikooli Suveakadeemia, Luua, 14.08.–15.08.2008) – T. Viik.

Maailm ja mis selles leida: Tähed, galaktikad ja kosmoloogia (Tallinna Ülikooli Suveakadeemia, Luua, 14.08.–15.08.2008) – T. Viik.

Maailm ja mis selles leida: Päikesesüsteem (Sagadi Looduskool, Sagadi, 29.08.2008) – T. Viik.

Koostöövõimalusi (Eesti Teaduste Akadeemia seminar "Kus on sünergia", Tallinn, 17.09.2008) – T. Viik.

Tumeda aine probleem ja inimkonna sünergia (Tartu Tähetorni Astronoomiaring, 30.09.2008) – E.Tago.

Tähtede ja planeetide tekkest (Tartu Ülikooli usuteaduskond, loengusari "Algused ja lõpud", 01.10.2008) – L. Leedjärv.

Uudiseid Hiina kosmoseprogrammist ja muust (Ärataja, Raadio Kuku, 03.10.2008) – L. Leedjärv.

Galaktikate ja galaktikaparvede teke ja areng (Loengutsükkel "Algused ja lõpud", 08.10.2008) – P. Tenjes.

Eesti kosmosepoliitikast ja Tartu Observatooriumi tegemistest (Huvitaja, Vikerraadio, 16.10.2008) – L. Leedjärv.

Aktiivsed galaktikad (Tartu Tähetorni Astronoomiaring, 21.10.2008) – A. Tamm.

Kosmoloogia ja selle viimased arengud (Eesti Füüsika Seltsi Sügiskool, Kääriku, 30.10.–02.11.2008) – M. Gramann.

Struve kaar – vast siiski Struve-Tenneri kaar (Tartu Tähetorni Astronoomiaring, 04.11.2008) – T. Viik.

Koduõuest Universumi avarustesse (Loengusari Haapsalu Kutsehariduskeskuses, 14.11.–15.11.2008) – L. Leedjärv.

Tumedast energiast Planckini (Tartu Ülikooli teoreetilise füüsika seminar, 18.11.2008) – M. Gramann.

Eestlaste tähistaevast ja vaatlustest (Meie Annid, TV3, 20.11.2008) – K. Annuk.

Valgusreostus ja tähevaatlused (Eesti Maaülikooli Loodusteaduste Kool, loeng Tõraveres, 19.11.2008) – T. Eenmäe.

Kosmoloogia ja selle arengud (Tallinna Ülikooli füüsika seminar, 25.11.2008) – M. Gramann.

Ülevaade talvekoolist "Local Group Cosmology" (Tartu ülikooli teoreetilise füüsika seminar, 09.12.2008) – E. Tempel.

Tume aine ja tume energia astronoomias (Miina Härma Gümnaasium, Tartu, 12.12.2008) – E. Tempel.

Supernoovadest üldse ja Tycho omast eriti (Nõo Kooli õpetajate täienduskoolitus, Tartu, 29.12.2008) – T. Viik.

Intervjuu ajakirjale "Tark mees taskus" – U. Peterson.

Rubriik "Ain Kallis ilmast" – veebisaidis *www.ilm.ee*.

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

11.3.1 M.Sc. theses Magistritööd

T. Nilson – *A. Kodar*: Metsade lehepinnaindeksi hindamine optiliste meetoditega Assessing Leaf Area Index of Forests by Means of Optically-Based Methods (M.Sc.), Tartu University.
Opponent Oponent: U. Peterson.

U. Peterson – *A. Kardakov*: Puistute vanuse hindamine keskmise ruumilise lahutusega satelliidipiltidelt Forest Stand Age Estimation with Medium Resolution Satellite Images (M.Sc.), Estonian University of Life Sciences.
Kaasjuhendaja Co-supervisor: A. Kiviste.

U. Peterson – *K. Kiis*: Keskmise ruumilise lahutusega satelliidipiltidelt tehtavate lageraiealade pindalahinnangute täpsust mõjutavad tegurid Factors that Influence the Clear-Cut Area-Estimation Accuracy on Medium Resolution Satellite Images (M.Sc.), Tartu University.
Kaasjuhendaja Co-supervisor: T. Oja.

11.3.2 B.Sc. theses Bakalaureusetööd

I. Ansko, T. Eenmäe – *T. Ginter*: Automaatfokuseerija Tartu Observatooriumi teleskoobile Zeiss-600 Automated Focuser for Telescope Zeiss-600 of Tartu Observatory (B.Sc.), Tartu University.

K. Eerme – *I. Krivonožko*: Üle Eesti lendavate reisilennukite mõju atmosfäärile The Influence on the Atmosphere by Civil Aircrafts Flying through Estonia (B.Sc.), Tartu University.

M. Lang – *A. Vassar*: Lineaarse spektraalse segu rakendatavusest segapuistutele puistu koosseisu valemi alusel Linear Unmixing of Spectral Signatures of Mixed Forest Stands (B.Sc.), Estonian University of Life Sciences.

M. Lang – *M. Vipp*: Metsanduslike püsikatsealade andmete täiendamine aerofotode abil GIS-keskkonnas Using Historical Aerial Photos to Update Forest Data in GIS of Long-Term Forest Test Sites (B.Sc.), Estonian University of Life Sciences.

M. Lang – *K. Kuusk*: Järvselja metsade andmete digitaliseerimine Digitization of Järvselja Forest Data (B.Sc.), Estonian University of Life Sciences.

P. Tenjes – *R. Pala*: Galaktikate masside määramise meetodid Galactic Mass Determination Methods (B.Sc.) Tartu University.

U. Veismann, I. Ansko – *K. Nurmela*: Optilise kiiritustiheduse etalonlambi stabiilsuse uurimine Stability of Irradiance Standard Lamp (B.Sc.), University of Tartu.

11.3.3 Refereeing of theses Oponeerimine

M. Saal – *M. Kadastik*: Kahekordse laenguga Higgsi bosoni lagunemiste analüüs ja selle mõju neutriinofüüsikale Doubly Charged Higgs Boson Decays and Implications on Neutrino Physics (Ph.D.), Tallinn University of Technology.

M. Saal – *M. Müntel*: Topeltlaetud Higgsi bosoni detekteerimine CMS'i detektoril Detection of Doubly Charged Higgs Boson in the CMS Detector (Ph.D.), Tartu University.

I. Ansko – *I. Krivonožko*: Üle Eesti lendavate reisilennukite mõju atmosfäärile The Influence on the Atmosphere by Civil Aircrafts Flying Through Estonia (B. Sc.), Tartu University.

E. Tago – *R. Reinthal*: SDSS kauguspiiranguga alamvalimite korrelatsioonifunktsioon Correlation Functions of SDSS LRG Volume-Limited Samples (B.Sc.), Tartu University.

12 Staff Koosseis (01.01.2009)

Director / Direktor	Laurits Leedjärv (Ph.D.)
Vice director (management) / Haldusdirektor	Enno Ruusalepp
Project manager / Projektijuht	Tiia Lillemaa

Department of Astrophysics Astrofüüsika osakond

Group of stellar physics Tähefüüsika töörühm

Senior research associate / Vanemteadur	Tõnu Kipper (D.Sc.) (Head of Department / Osakonna juhataja)
Senior research associate / Vanemteadur	Kalju Annuk (Ph.D.)
Senior research associate / Vanemteadur	Tiit Nugis (Ph.D.)
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