Report of the activity of the Tartu Observatory cosmology group in 2011

Tartu Observatory cosmology group has 14 members: Jaan Einasto, Maret Einasto, Mirt Gramann, Urmas Haud, Gert Hütsi, Juhan Lauri Liivamägi, Valery Malyuto; Enn Saar, Ivan Suhhonenko, Erik Tago, Antti Tamm, Elmo Tempel, Peeter Tenjes, Jaan Vennik; and graduate and postgraduate students Tiit Sepp and Anti Hirv.

1 Scientific studies

1.1 Testing the cosmological paradigm

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

1.1.1 Baryonic acoustic oscillations

Baryon acoustic oscillations (BAO) are present in the early Universe, before recombination, and are governed by the interplay between the gravitational pull of dark matter and the enormous pressure of the photon-electron plasma.

1.1.2 Dark energy and dark matter

G. Hütsi together with J. Chluba (CITA, Toronto), A. Hektor and M. Raidal (KBFI, Tallinn) (Hütsi et al., 2011) calculated constraints on weakly interacting massive particle (WIMP) annihilation cross sections using the Cosmic Microwave Background (CMB) temperature and polarization measurements from the WMAP space mission (Hütsi et al., 2011). The predictions for the Planck and ideal (cosmic variance limited) CMB experiments were also made. Particular attention was given to the WIMPs with masses \( \sim 10 \text{ GeV} \), which have recently been claimed to be consistent with the CoGeNT and DAMA/LIBRA direct detection experiment results, while also providing viable dark matter (DM) candidates to explain the measurements of Fermi and WMAP haze. It was shown that the CMB signal of DM annihilations is independent of the details of large-scale structure formation, distribution, and profile of DM halos and other cosmological uncertainties. The bounds on all particle physics models of DM annihilation can be effectively described with only one parameter, the fraction of energy carried away by neutrinos in DM annihilation. It was demonstrated that thermal relic DM in the CoGeNT, DAMA/LIBRA favored mass range is in a serious conflict with present CMB data for the annihilation channels with few neutrinos, and will definitely be tested by the Planck mission for all possible DM annihilation channels.

G. Hütsi participated in a project of KBFI scientists which investigated in detail the consequences of the model by Isidori and Kamenik that is claimed to explain the top quark forward-backward asymmetry at Tevatron, provide GeV-scale DM, and possibly improve the agreement between data and theory in Tevatron \( W+jj \) events (Hektor et al., 2011). By computing the DM thermal relic density, the spin-independent DM-nucleon scattering cross section, and the CMB constraints on both Dirac and Majorana neutralino DM in the parameter space that explains the top asymmetry it was demonstrated that a stable light neutralino is not allowed unless the local DM density is 3-4 times smaller than expected. In that case Dirac DM with mass around 3 GeV may be possible, which will be tested by the Planck CMB mission.

G. Hütsi was participant in a collaborative project (M. Cirelli, G. Corcella, A. Hektor, M. Kadastik, P. Panci, M. Raidal, F. Sala, A. Strumia) aimed to provide ingredients and recipes for computing signals of TeV-scale Dark Matter annihilations and decays in the Galaxy and beyond (Cirelli et al., 2011). For each DM channel, the energy spectra of particles at production, computed by high-statistics simulations, were presented. The Monte Carlo uncertainty of those input spectra were estimated by comparing the equivalent results from the Pythia and Herwig event generators. The propagation functions for charged particles in the Galaxy, for several DM distribution profiles and sets of propagation parameters were calculated. The energy spectra of \( e^\pm \), \( \bar{p} \) and \( \bar{d} \), gamma ray fluxes (both from prompt emission and from Inverse Compton scattering in the Galactic halo) at the location of the Earth along with extragalactic gamma ray spectra were all provided in easily usable numerical form.

G. Hütsi in collaboration with T. Sato and K. Yamamoto (Hiroshima University) developed a fast Fourier transform based method for deconvolving the smearing effect of the survey window in the
analysis of the galaxy clustering multipole power spectra (Sato et al., 2011). After testing the validity of the method with Monte Carlo mock catalogs it was applied to the luminous red galaxy sample from the Sloan Digital Sky Survey data release 7.

G. Hütä in collaboration with A.J. Hawken, F.B. Abdalla and O. Lahav (UCL, London) investigated the prospects of using the Baryon Acoustic Oscillation (BAO) scale as a feature of known physical size in the pattern of the galaxy distribution for braking the degeneracy between geometric (Alcock-Paczynski) and dynamic (redshift space) distortions (Hawken et al., 2011). Assuming that the BAO scale can be calibrated with an accuracy of \(\sim 1\%\), using the precise measurement of the equivalent feature in the CMB, it was shown, using a Fisher matrix analysis, that error ellipses for line of sight and tangential distortion parameters shrink by a factor of two for a \(20\,\text{(Gpc}/\text{h})^3\) ‘DESpec/BigBOSS’-like galaxy survey. The improvement turned out to be even more marked in smaller surveys.

G. Hütä participated in TO projects led by J. Einasto devoted to deepen our understanding of the formation of the cosmic web (Einasto et al., 2011a,b; Suhhonenko et al., 2011).

### 1.2 Planck early results

E. Saar participated in the analyse of Planck CMB satellite data. An all-sky sample of Sunyaev-Zeldovich clusters was compiled (Planck Collaboration et al., 2011a), a very X-ray luminous and massive cluster at redshift \(z \approx 1\) was discovered (Planck Collaboration et al., 2011b), the XMM-Newton follow-up of Planck cluster candidates was described (Planck Collaboration et al., 2011c).

Together with collaborators from Spain and France E. Saar studied the wavelet detection of baryon acoustic structure in the galaxy distribution (Arnalte-Mur et al., 2011).

### 1.3 Superclusters

Superclusters are the largest elements of the cosmic web. As they are large, their evolution has not been completed yet, and they carry the memory of the initial conditions (the early universe) in their properties. We compiled supercluster catalogues for the SDSS DR7 data volume (Liivamägi et al., 2010), and studied the properties of the best-observed superclusters in the Sloan Great Wall. Sepp et al. (2011) studied the patterns of the Universe.

#### 1.3.1 The morphology and galaxy populations of the Sloan Great Wall

We used the data from the Sloan Digital Sky Survey to continue the study of the morphology of superclusters. We used the catalogue of superclusters compiled by L.J. Liivamägi and studied the morphology of the largest known galaxy system – the Sloan Great Wall (hereafter SGW) and it’s member superclusters. We characterized the clumpiness and shape of the SGW using the fourth Minkowski functional and the morphological signature (shapefinder’s \(K_1 - K_2\) plane).

To calculate Minkowski functionals we at first reconstruct the density field of galaxies. There are two main effects that affect the reconstructed density field and its Minkowski functionals. The first is due to the fact that about 6-7% of galaxy redshifts are missing, because of fiber collisions. About 60% of these galaxies are probably located approximately at the same distance as their close neighbours. We found the collision groups in the SDSS, determined the galaxies that do not have redshifts because of fiber collisions, and ran Monte-Carlo simulations, assigning to 60% of randomly selected non-redshift galaxies the redshift of their neighbours. Other 40% of non-redshift galaxies were omitted, assuming that their true redshift will take them out of the supercluster. This procedure should give upper limits for errors. We ran 1000 simulations and found that both the morphological signatures and \(V_3\) did not change (at the 95% confidence level) – fiber collisions are too scarce to affect the estimates of the morphological characteristics. Another effect is the discreteness of galaxy catalogues (shot noise) that induces errors in the density estimates. To take this into account we have to define first the statistical model for the spatial distribution of galaxies within a supercluster. One possibility is to use the Cox model, where we have a realization of a random field and a Poisson point process populates the supercluster by dropping galaxies there with the intensity proportional to the value of the realization in the neighbourhood of a possible galaxy. We tested that model and found that it is not able to describe the structure of superclusters. Then we used the popular halo model ideology to define a statistical model for superclusters. We assume that supercluster structure is defined by its dark matter haloes, and discreteness errors are caused by the random positions of galaxies within these haloes. As the halo model assumes that the main galaxy of a halo lies at its centre, the main galaxies of our groups and the isolated galaxies (the main galaxies of haloes where other galaxies are too faint to see) remain fixed. For satellite galaxies, we use smoothed bootstrap to simulate the distribution
of satellites inside our haloes – we select satellite galaxies by replacement, and add to their spatial positions. We generated mock superclusters with new galaxy distributions by smoothed bootstrap and calculated again the density field and Minkowski functionals, repeating this procedure 1000 times, and obtained confidence intervals for Minkowski functionals and shapefinders.

1.3.2 The morphology of a large sample of superclusters from the SDSS

The study of the morphology of superclusters gives us information about the properties of superclusters and the cosmic web. Morphology is one aspect of the environment for galaxies and galaxy systems in them. The comparison of the morphology of observed and simulated superclusters is a test for cosmological models (Einasto et al., 2011d). Maret Einasto, Enn Saar, Juhan Liivamgi together with Erik Tago, Elmo Tempel, Vicent Martinez from Valencia University, Pekka Heinmki from Tuorla Observatory and Jaan Einasto studied the morphology, as well as the cluster content and the large scale distribution of a large sample of superclusters from the Sloan Digital Sky survey.

Superclusters in our sample formed three chains of superclusters, the richest of them was the Sloan Great Wall. At the connection of these chains several rich superclusters, the well-known Corona Borealis supercluster among them, form the Dominant supercluster plane, described earlier by us using data about superclusters of Abell clusters.

We used the fourth Minkowski functional V3, the shapefinders K1 and K2, the morphological signature (shapefinder’s K1 - K2 plane) and the shape parameter (the ratio of the shapefinders for the whole superclusters) to characterise the morphology of superclusters. With multidimensional normal mixture modelling we showed that superclusters can be divided into two sets according to their shape parameter. The richer and more luminous superclusters are also more elongated and have more complicated inner morphology than poor, less luminous superclusters. The morphology of individual superclusters can be characterized as spiders, multispiders, filaments and multibranching filaments. Different morphologies of superclusters suggest that their evolution have been different. At present simulations do not explain well the morphological variety of observed superclusters.

M. Einasto, J.L. Liivamgi, E. Saar, E. Tempel, J. Einasto, E. Tago ja Vicent Martinez from University of Valencia used principal component analysis to study relations between the physical and morphological properties of superclusters from the Sloan Digital Sky Survey (Einasto et al., 2011c,f). We found that the properties of superclusters are strongly correlated. We showed already in our earlier study that richer superclusters are more elongated and have more complicated inner structure than poor superclusters, but so strong correlations as we found now was unexpected. Two first principal components take into account more than 90% of variance in superclusters data and define the fundamental plane of superclusters – superclusters are simple objects which can be described with a small number of parameters. We used principal component analysis to derive scaling relations between the luminosities, sizes, and shapes of superclusters on the fundamental plane. We found that superclusters can be divided according to their shapes into two populations on the fundamental plane, these populations have different scaling relations. The presence of different populations of superclusters shows that their evolution have been different. At present it is not clear which cosmological model describes the properties of observed superclusters best.

1.3.3 Multimodality of rich clusters of galaxies in the Sloan Digital Sky Survey

Most galaxies in the Universe reside in groups and clusters of galaxies, which by themselves form larger systems – superclusters of galaxies, and filaments which connect superclusters over huge voids to form a supercluster-void network. According to the current theories of the structure formation and evolution in the Universe systems of galaxies grow by hierarchical clustering driven by gravity. Signatures of multimodality (the presence of substructures, non-Gaussian velocity distributions and large peculiar velocities of the brightest galaxies) in galaxy clusters give us information about the dynamical state of these systems, and about the processes which shape clusters, galaxies in them and also about larger systems where clusters reside. Maret Einasto, Jaan Vennik, Elmo Tempel, Erik Tago, Enn Saar, Juhan Liivamgi and Jaan Einasto together with Pasi Nurmi, Anti Ahvensalmi and Pekka Heinmki from Tuorla Observatory and Vicent Martinez from Valencia University started the study of multimodality in the richest galaxy clusters from the Sloan Digital Sky Survey. They used data about the richest systems from the group catalogue based on SDSS Data Release 8, compiled by Erik Tago and Elmo Tempel together with their colleagues from cosmology group. They employed a number of 3D, 2D, and 1D tests to search for substructures and non-Gaussian velocity distributions in galaxy clusters, and analysed peculiar velocities and locations in clusters of cluster brightest galaxies. Their preliminary results show that more than 80 % of clusters have substructures. Main galaxies
Simulations were made for several cube sizes: 64, 100, 256, 500, 768 Mpc/h, and resolutions of phases to the formation of systems of galaxies of various scale, the absence of galaxies in voids etc. The influence of density perturbations of different scale to structure formation and evolution, the role of density field of MAIN and LRG (Luminous Red Galaxy) samples to determine the environment of active galaxies. They showed that Seyferti galaxies, radio-quiet QSOs, and BL Lac objects reside mostly in low density environments while radio galaxies can be found in high density environments. This result suggests that several processes are responsible for galaxy activity, and their effectiveness depends on the large scale environment of objects.

The group of cosmologists from Tuorla Observatory and Tartu Observatory leaded by Pasi Nurmi from Tuorla analysed the properties of galaxy groups in the Millennium simulation and SDSS. The aim of this study is to test the hypothesis that real galaxy groups are galaxy systems hosted by shared dark matter halo. For that they analyse in detail the statistical properties of galaxy groups in the SDSS galaxy group catalogue and mock catalogues. The comparison between simulations and observations reveal differences between groups, based on the semi-analytical galaxy models, and the real galaxy group properties. They construct three different mock galaxy group catalogues from the Millennium semi-analytical galaxy catalogue and study how well these represent the real Universe based on the SDSS galaxy group catalogue by Erik Tago and his colleagues, and compare the group luminosities, group richness, virial radius, maximum separation and velocity dispersion distributions. They found that the spatial densities of groups agree within one order of magnitude in all samples. There is a rather good agreement between the mock catalogue and observations for groups constructed in the same way in the simulations and in the observations. The distributions have similar shapes and amplitudes. However, the semi-analytical methods create too many too bright galaxies. The comparison between the observed groups and groups with a common dark matter halo in simulations shows that only a small fraction of groups in the SDSS catalogue indicates the existence of a common halo. The spatial distribution of galaxies in groups is different between simulations and observations. Beyond the virial radius of the group there are systematically more galaxies in the simulations than in the observations although the agreement is good inside the virial radius.

1.4 The formation of the large scale structure

In collaboration with Tartu and Potsdam astronomers J. Einasto made several series of numerical simulations of structure evolution of the Universe. These simulations have several goals: to investigate the influence of density perturbations of different scale to structure formation and evolution, the role of phases to the formation of systems of galaxies of various scale, the absence of galaxies in voids etc. Simulations were made for several cube sizes: 64, 100, 256, 500, 768 Mpc/h, and resolutions 256$^3$ and 512$^3$ particles and cells. For all models simulations were performed with the full power spectrum, and with truncated spectra, where long-wave perturbations were cut at wavelengths 8, 16, 32, 64, and 128 $h^{-1}$ Mpc. Initial conditions (random numbers used to generate initial positions and velocities of particles) were identical in models of various cuts, this allows to identify particles in systems (halos), and to follow the behavior of halos in varying conditions.

The wavelet analysis of models leads us to the conclusion that the properties of the large-scale cosmic web with filaments and voids depend on two connected properties of the evolution of density perturbations. The first property is the synchronisation of density waves of medium and large scales. Due to the synchronisation of density waves of different scales, positive amplitude regions of density waves add together to form rich systems of galaxies, and negative amplitude regions of density waves add together to decrease the mean overall density in voids. The amplification of density perturbations is another property of density evolution. Due to the addition of negative amplitudes of medium and large scale perturbations, there is no possibility for the growth of the initial small-scale positive density peaks in void regions. For this reason, small-scale protohaloes dissolve there. In the absence of medium and large-scale density perturbations, these peaks would contract to form haloes, which would also fill the void regions, i.e. there would be no void phenomenon as observed. The analyz is published by Einasto...
et al. (2011a,b) and Suhhonenko et al. (2011). Results of this study have been discussed on the Warsaw workshop “Cosmic Web Morphology and Topology”, and on the IRAP PhD Erasmus Mundus School, Nice. Our study of the evolution of density perturbations of various scales has led to the following conclusions:

- The formation of the cosmic web with filaments and voids is due to the synchronisation of density waves of medium and large scales, and the amplification of both over- and under-dense regions.
- Voids are regions in space where medium- and large-scale density waves combine in similar under-density phases.
- Owing to phase synchronisation, the mean density of matter in void regions is below the mean density, thus initial small-scale perturbations cannot grow.

J. Einasto participated in the analyse of the morphology of superclusters of galaxies in the Sloan Great Wall by Einasto et al. (2011c,e,d). Together with E. Tempel, E. Tago, E. Saar and other members of the Tartu Observatory cosmology group J. Einasto participated in the study of the luminosity function of galaxies of the SDSS by Tempel et al. (2011a).

J. Einasto started work on book “Dark Matter and Large Scale Structure Story”, a personal recollection of the story of the discovery of dark matter and the large scale structure of the Universe, as seen from our viewpoint. An agreement with World Scientific Publishing Co. on the publication of this book is signed, the deadline to present the manuscript is end of 2012.

1.4.1 Gravitational lensing

Hirv (2011); Hirv et al. (2011a,b) studied the gravitational lensing effect. Estimation of time delays from a noisy and gapped data is one of the simplest data analysis problems in astronomy by its formulation. But as history of real experiments shows, the work with observed data sets can be quite complex and evolved. By analysing in detail previous attempts to build delay estimation algorithms we try to develop an automatic and robust procedure to perform the task. To evaluate and compare different variants of the algorithms we use real observed data sets which have been objects of past controversies. In this way we hope to select the methods and procedures which have highest probability to succeed in complex situations. As a result of our investigations we propose an estimation procedure which can be used as a method of choice in large photometric experiments. We can not claim that proposed methodology works with any reasonably well sampled input data set. But we hope that the steps taken are in correct direction and developed software is truly useful for practising astronomers.

1.5 The formation and evolution of galaxies

We studied the observational differences in the properties of present-day galaxies, in order to discover the possible paths of their formation and evolution. For that, we compared the properties of galaxies in different local (groups, clusters) and global (voids, superclusters) environments. The present galaxy formation paradigm (merger-dominated formation and evolution) explains well most of the dependencies we found, but we discovered also interesting discrepancies (Tempel, 2011a; Tempel et al., 2011b).

1.5.1 Galaxy populations

The differences between the morphology and individual galaxy populations between the richest superclusters in the SGW suggest that these superclusters had different formation and evolution paths (Einasto et al., 2011e).

1.5.2 Andromeda Galaxy

1.5.3 Galaxy groups and clusters

Tago et al. (2010) compiled catalogues of groups of galaxies in the SDSS DR7 (the final release includes spectra of 929 555 galaxies). Applying better selection criteria Tempel et al. (2011a) and E. Tempel, E. Tago, L. J. Liivamaigi 2011 (in preparation) compiled catalogues of groups of galaxies in the SDSS DR8. Both of group catalogues were used for construction of luminosity density field and for study of superclusters.

Using the same group finding algorithm (modified FoF method) E. Tago has also compiled a catalogue of groups of galaxies using the 2MASS galaxy sample.

1.5.4 Nearby groups of galaxies

J. Vennik continued his studies of dwarf galaxies in a sample of local poor groups of galaxies (Vennik & Hopp, 2011). He searched the area of groups for new dwarf galaxy candidates and carried out follow-up spectroscopy of the highest rated dwarf galaxy candidates with the Hobby-Eberly telescope in collaboration with U. Hopp (Munich). They confirmed the group membership of about 20 newly detected dwarf satellites. According to their emission-line diagnostics, these are almost all actively star-forming dwarf irregulars. The surface photometry on the SDSS frames has shown zero or positive radial colour gradients, which could be interpreted as age gradients, indicating continuing star-formation preferentially near center of (gas-rich) dIrr’s. J. Vennik and T. Kuutma (TU) studied the light and colour distribution of galaxies in nearby groups, with ultimate aim of determining the radial changes of stellar populations and tracing the star-formation history of galaxies in group environment. They have compiled an interactive image processing script, based on the MIDAS software, with interactive sky-background subtraction and image cleaning options. The members of two nearby groups around the NGC 3655 and NGC 6962 have been studied on optical (SDSS) and near-IR (2MASS) frames. Derived colours and colour gradients are to be interpreted using stellar population models.

1.6 Our Galaxy

U. Haud continued the work with HI radio data. This year the studies were carried out in three main directions. He continued the cluster analysis of the Gaussian decomposition of the Leiden-Argentina-Bonn (LAB) Survey. The main interest was related to the separation of the high- and intermediate velocity clouds (HVCs and IVCs) from the general database of the Gaussians. This yielded the first catalogs of HVCs and IVCs, compiled by the same method and based on statistically more precisely specified definition of these objects (Haud, 2008). After obtaining the catalogs, a trial was made to estimate the distances of these clouds, using the method proposed by Haud (1990). Unfortunately the obtained results were very noisy and not of great value.

In parallel with the continuing work with the LAB data, U. Haud started the preparations for the usage of the new Effelsberg-Bonn HI Survey (EBHIS). As the methods of observations of LAB and EBHIS differ considerably, the new survey requires also substantial revisions in the Gaussian decomposition algorithm. This year U. Haud got acquainted with the main properties of the EBHIS, developed the basic ideas for changing the decomposition algorithm and visited the Argelander-Institute Astronomie of Bonn University to discuss these topics with the authors of the EBHIS.

In September the Tartu-Tuorla joint meeting “Remote sensing of the Universe” was held in Tartu. One topic of this meeting was the discussion of recent results from the Planck mission. In this context a question arouse about the relation between the narrow-lined HI emission (NHIE) features, studied by U. Haud in recent years, and the Planck cold clumps (CC), reported by Planck Collaboration at the beginning of 2011. This was now specially studied by U. Haud and the results were reported at the meeting. Afterwards U. Haud has continued this research to demonstrate that NHIE (which may be physically identical structures with HI self-absorption (HISA) clouds in different observing conditions), Planck CC and Bok globules may be successive stages in conversion of the diffuse HI gas into the stars.

V. Malyuto continued development of classification methods for deep surveys of stellar populations in the Galaxy (Malyuto & Shvelidze, 2011b,a). Such methods are capable of extracting the main atmospheric parameters (effective temperatures, gravity, metallicity) for large stellar samples from available spectral and photometric data, the obtained parameters are used to investigate the structure and evolution of the Galaxy. A representative set of templates (the stars with reliable parameters covering the whole HR diagram and metallicity range) is necessary to serve as calibration stars in classification. To increase the number of templates and to improve the data, V. Malyuto analysed some selected independent catalogues of effective temperatures for F-G-K stars of normal metallicity, determined the
external errors of data for homogeneous subsamples through data intercomparisons and produced a preliminary mean homogenized catalogue of 800 stars with reliable effective temperatures (Malyuto & Shvelidze, 2011a). Some recent published catalogues and new spectral libraries were added and treated with the same approach, their external errors of effective temperatures for some new subsamples were estimated. To apply the used approach to the stars of low metallicity, V. Maljuto analysed selected catalogues containing metal-deficient stars, too. Producing an extended homogenized catalogue of stars with reliable atmospheric parameters for using them as templates in classification, is planned.

2 Lectures, conferences

2.1 Conference: “Expanding the Universe”, dedicated to the 200 anniversary of Tartu University Observatory, Tartu, April 27 - 29

Tim de Zeeuw (ESO): “Grigori Kusmin and stellar dynamics”;
Jaan Einasto: “Dark Matter” (Einasto, 2011);
Elmo Tempel: “Tracing galaxy evolution by their present-day luminosity function” (Tempel, 2011a);
Volker Müller (Potsdam): “Studies of the cosmic web”.

2.2 Cosmology Workshop “Cosmic Web Morphology and Topology”, Warsaw, July 12 - 17

Jaan Einasto: “Formation of the Cosmic Web”;
Maret Einasto: “Morphology of superclusters from the SDSS DR7”;
Lauri Juhan Liivamägi: “Superclusters their properties of the SDSS main and LRG galaxy samples”;
Enn Saar: “Large-scale density maps by kernel methods”.

2.3 IRAP PhD Erasmus Mundus School, Nice, September 8 - 16

Jaan Einasto: “Galactic models”;
Jaan Einasto: “Formation of the cosmic web”;
Jaan Einasto: “Evolution of the cosmic web”.

2.4 Tartu-Tuorla Cosmology Meeting “Remote sensing of the Universe”, Tartu, September 21 - 22

Enn Saar: “Mapping the large-scale dark-matter distribution”;
Maret Einasto: “Tracing luminous and dark matter in the Sloan Great Wall”;
Laur Järvä (University of Tartu): “Scalar-tensor cosmology in the general relativity limit”;
Juhan Liivamägi: “Superclusters in Planck mission observations”;
Tiit Sepp (University of Tartu): “The new Tartu galaxy cluster catalog”;
Rain Kipper (University of Tartu): “Kinematics of distant galaxies”;
Elmo Tempel: “Modelling galaxies”;
Urmas Haud: “NHIE, HISA, and Planck CC”;
Jaan Laur (University of Tartu): “Remote observing of luminous stars in OB associations”;
Teet Kuutma (University of Tartu): “Analysis of galaxy group members colour index profiles”.

2.5 Tartu Observatory seminars

March 9: Elmo Tempel: “Tracing galaxy evolution by their present-day luminosity function (summary of the PhD thesis)” (Tempel, 2011b);
April 6: Maria Haupt (Potsdam University): “Catalogue of galaxy clusters of SDSS-DR8”;
June 8: Anti Hirv: “Estimation of time delays from light curves of gravitationally lensed quasars (summary of PhD thesis)” (Hirv, 2011);
September 14: Maret Einasto: “On the morphology of superclusters”;
September 28: Maret Einasto “The study of superclusters using the Principal Component Analysis”;
October 12: Urmas Haud: “Narrow-line clouds of neutral hydrogen, regions of self-absorption, and Planck cold clumps”;
October 17: Enn Saar: “On the center of excellence on Dark Matter and Cosmology”.
2.6 Other lectures

February 09: J. Einasto: talk on a conference dedicated to the opening of the AHHAA science education center “200 years of Tartu Observatory”;
August 08: J. Einasto: talk on summer school “Structure of the Universe”;
November 14: J. Einasto: discussion in Tartu University Museum “Meeting with scientists”.

Table 1: Publications and citations

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The columns are as follows:
column 1: Total number of papers, \(N_{pap}\);
column 2: Total number of citations, \(N_{cit}\);
column 3: Total \(h\) index;
column 4: Maximal number of citations to a paper, \(N_{max}\);
column 5: Number of papers, \(N_{pap}\), in 2001 - 2011;
column 6: Number of citations, \(N_{cit}\), in 2001 - 2011;
column 7: \(h\) index, in 2001 - 2011;
column 8: Maximal number of citations to a paper, \(N_{max}\), in 2001 - 2011.

3 Visits

- September 04 – November 07: J. Einasto: Nice, Pescara ICRANet;
- October 24 – November 25: E. Tempel: Valencia, University of Valencia;

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This document describes estimates of the prevalence of anaemia for the year 2011 in preschool-age children (6–59 months) and women of reproductive age (15–49 years), by pregnancy status, and by regions of the United Nations and World Health Organization (WHO), as well as by country. This report is based on analyses previously published (1) to estimate trends (from 1995 to 2011) in the distribution of blood haemoglobin concentrations and the prevalence of anaemia in these same population groups. Environments of galaxies in groups within the supercluster-void network. Save to Library. Download. We find the peculiar velocities of the main galaxies, and use principal component analysis to characterise our results. As one of the most luminous types of active galaxies, quasars can be used for studying the growth of supermassive black holes in galaxies. The location of quasars in the large-scale structure of the universe can give us valuable information on the co-evolution of galaxies and the supermassive black holes. Our latest results on the environments of quasars suggest that both the local and large scale environments affect the evolution of activity in galaxies. Save to Library. by Pasi Nurmi. This article focuses on the dynamics of the memory work of journalism in covering historical anniversaries in the calendar. The object of the commemorative activity under analysis is the Molotov-Ribbentrop Pact (MRP) i.e. the Non-Aggression Pact that was signed between Germany and the USSR on 23 August 1939 in Moscow. This study focuses on questions of the role of Estonian journalism in [Show full abstract] commemoration of the MRP during the period from 1989 to 2009.