Reaalteaduste doktorantide konverents
Workshop-seminar for PhD students
Abstracts

May 9, 2019

Contents

0.1 Maria Neem: Polarized W boson in Weak decays.

Tartu Ülikool, Füüsika instituut; Tartu University, Institute of physics

Starting from the periodic system of elements and radioactive decays in this presentation i will deal with the theoretical description of weak decays

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0.2 Katri Pärna : Could we predict your risk for the "sugar" disease?

Tartu Ülikool, Genoomika instituut; Tartu University, Institute of genomics

Long title: Improving personalized prediction of polygenic risk scores for type 2 diabetes by combining population genetics, epigenetics and new disease classification

Diabetes is a disease characterized by high sugar levels in blood. Latin term used for diabetes "*Diabetes mellitus*" translates as "*frequent urination*" and "*sweet*" referring to the nature of this disease. What results the rise in sugar levels and to pee often? Two main risk factors are known (1) diet: high consumption of carbohydrates like eating pasta, sweets, bread, lemonade and; (2) lifestyle: low physical activity resulting the weight gain, which is like the best friend of diabetes. Sometimes people follow similar diets and like to binge-watch series lying on the sofa. Though this does not mean that they all get sick. How can it be? Genetics! Let me introduce you Tõnu and Jüri! Jüri has diabetes and Tõnu does not, although they are the same height, weight, body built and with similar lifestyle and diet. Accumulation of disease associated mutations, which are passed on from parents to children, makes Jüri more vulnerable to diabetes than Tõnu. In other words, Jüri has a high genetic risk, which makes him less talented in handling sugar levels than Tõnu. Though talent isn't all, and you could perhaps 'train' to handle. Discovering the disease-associated mutations or even knowing all of them before the diabetes develops would perhaps make Jüri to 'train' his lifestyle? That's also *the goal* of my PhD project, to improve the methods to detect the genetic risk of diabetes better.

How am I planning to do that? By combining knowledge from different fields:

1. **population genetics** is a sub-field of genetics dealing with detecting genetic differences on a wider scale- within and between populations. It means that if Jüri, the one with diabetes, remember, has one parent from Asia and one from Europe, it could result different genetic risk compared to Tõnu, who has both parents from Europe, and it would be great if we would know exactly which population (multiply the number of Tõnus and Jüris with million) has which kind of genetic risk, so we would not put them all in the same level of risk "pot".

2. **epigenetics** translates as "*on top of*" referring to lifestyle and environmental changes, which make your genes to be switched "on" or "off". For example, it's like your boss, who will say these and these tasks should be completed during the next week. Same is with reading your genes, some harmful environmental changes might associate with which genes are "on" and which "off". I bet Jüri would have liked to know which of his

epigenetic patterns are associated with diabetes, so based on it we could have detected his high diabetes-risk before the disease onset.

3. **new disease classification**: diabetes is not simple disease. Instead based on the severity and/or occurrence of different disease symptoms, it could perhaps be divided into more groups allowing tailor- made treatment for Jüri, so he would have this "*diaBEAST*" under better control.

   All in all, discovering the individual (genetic) differences for diabetes risk resulted by population genetics, epigenetics and by more specific disease classification would improve the current risk prediction of diabetes, Jüri could enjoy his life better and the treatment costs would be lower.

   All in all, discovering the individual (genetic) differences for diabetes risk resulted by population genetics, epigenetics and by more specific disease classification would improve the current risk prediction of diabetes, Jüri could enjoy his life better and the treatment costs would be lower.

Take home message: Everyone's genetics is fixed for life, but if you know you could measure your genetic risk as accurate as possible, and that before the other already known disease-related risk factors occur, diabetes could become preventable or it would be possible to postpone it, and perhaps the similar methods would be even applicable for other burdensome diseases.

0.3 Iuliia Burdun: Climate, Wetlands & Satellites

Tartu Ülikool, Ökoloogia ja maateaduste instituut; Tartu University, Institute ecology and earth sciences

In recent decades, carbon cycle has increasingly become a focus of studies investigating the climate system. Methane plays a vital role in the feedback mechanism of climate change and leads to climate warming. The main global interannual variability of methane emissions is caused by natural wetlands fluctuations of CH_4 emissions. Of particular concern are emissions from northern peatlands, particularly from peat bogs, which possess a peat soil. Northern peatlands contain one-third of global.

Simulations of future climate scenarios suggest an increasing tendency in warming and wetness for the northern ecosystems. What is not yet clear is the impact of these tendencies on CH_4 emission from the boreal peat bogs. Nowadays, with the aim to decrease uncertainty in this area, field measurements of greenhouse gases (GHGs) with chamber methods and eddy covariance towers are used in the wetland studies.

Recently published climate change assessment for Estonia for periods 2041–2070 and 2071–2100 used in this study suggests that during summer, dominance of anticyclones in the weather conditions will result in long heat waves and increase in precipitations. These facts suggest that additional shifts in the GHG emission from Estonian wetlands already in the next 40 years.

Wetlands are the largest terrestrial deposits of organic carbon but also the largest natural source of methane (CH_4) emission. However, estimations of CH_4 emissions are still very much uncertain.

My work

I am collecting GHG, soil temperature and water table measurements using the manual chamber technique in field experiments. In addition, I am working with remote sensing data and doing modelling of field-measured data.

0.4 Janika Raun: How to measure tourism flows?

Tartu Ülikool, Ökoloogia ja maateaduste instituut; Tartu University, Institute ecology and earth sciences

Understanding the essence of tourism flows is one of the fundamental undertakings of tourism geography research and a key issue behind effective destination management and development. However, thus far few studies have analysed tourist movement on a national scale. This is due to the deficiency of spatially accurate data that can be used for recording tourists' intra-national movements. In this presentation, I fill the lacuna by illustrating foreign tourists' movements using two spatially and temporally precise tracking datasets — call detail records from passive mobile positioning data and GPS data from smartphones — in two countries, Estonia and Israel. The results demonstrate the applicability of using tracking data to analyse tourism flows on national scale. It enables to measure spatial, temporal, and compositional dimensions of tourism flows empirically based on a quantitative dataset that is important above all for solving management, marketing and planning-related issues.

0.5 Jaanus Liigand: Let's quant'em like they do on the Discovery Channel

Tartu Ülikool, Keemia instituut; Tartu University, Institute of chemistry

Liquid chromatography-high-resolution mass spectrometry (LC/HRMS) is the golden standard for the analysis of pollutants in environmental samples. As LC/HRMS can detect thousands of molecular features in a single run and the recent rapid developments in the identification of these molecular features scientists have a good overview of what can be detected in the environment. Up to now for the quantitative information standard substances are needed. For all of the detected molecular features, unfortunately, standard substances are not available or affordable, especially, if we consider hundreds or even thousands of different molecular features in one sample. To overcome this issue, we propose a quantification approach based on machine learning.

0.6 Raul Sampaio de Lima: Watching the world burn: developing new methods to monitor landscape fires

Eesti Maaülikool, Põllumajandus- ja keskkonnainstituut; Estonian University of Life Sciences, Institute agriculture and environmental sciences

Recently, it has been observed the intensification of weather extreme events, resulted from changes in mean annual temperature and in seasonal rainfall patterns, which is expected to cause alterations on wildfire regimes. Wildfires are important phenomena to the maintenance and functioning of natural ecosystems but can lead to several negative impacts on humans, including losses of life and infrastructures. Monitoring of wildfires involves activities for providing information for identification, measurement, mapping, and analysis of its possible occurrence on the landscape. Remote sensing enabled the estimation of fire risk metrics for larger spatial extents, and not only for singles points, as provided by previous frameworks. The rise of new technologies allowed a wide range of applications for fire hazard and risk mapping, offering an interesting possibility to integrate data with both high spectral and spatial resolutions. In this context, the aim of the project is to develop a framework to integrate different sensors and equipment for mapping the risk of wildfires in semi-natural and forested landscapes

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0.7 Moorits Mihkel Muru: Looking for the cosmological highways

Tartu Ülikool, Tartu observatiorium; Tartu University, Tartu observatory

We understand that sooner or later we have to leave Earth. When we are looking for our new home, it is quite useful to have a map. Luckily, it appears that the vastness of the Universe is entangled in an intricate network of currents. As our observational capabilities improve, we understand it more thoroughly and map it ever more precisely. I will introduce what we already know about these cosmological highways and how we are looking for the network of currents.

0.8 Rafieh Mosaheb: Quantum Computing-Catching up 5000 years of algorithm research in a few decades

Tartu Ülikool, Arvutiteaduse instituut; Tartu University, Institute of computer science

In this talk, I am going to tell the story of computation from 3000 BC to 2019 AD, which is approximately 5000 years. Then, I will explain how fast we are in comparison to the past and what is the roll of quantum computing in this timeline.

0.9 Ove Korjus: Study of solid oxide fuel cell ceramic anode stability using operando high temperature X-ray diffraction simultaneously with electrochemical impedance analysis

Tartu Ülikool, Keemia instituut; Tartu University, Institute of chemistry

Sate of art anode materials for solid oxide fuel cells (SOFC) are Ni-cermets, either Ni/yttria stabilized zirconia (Ni-YSZ) or Ni/gadolinia doped ceria (Ni-GDC). In the case of Ni-cermet materials before the anode is ready for work NiO is reduced to Ni. During reduction process solid phase volume of anode decreases approximately 40%. Due to either system malfunction or contamination, air (oxygen) might diffuse into anode compartment, which causes Ni reoxidation to NiO. During this process anodes solid phase volume increases 66%. Ni reoxidation might take place when after cells operation fuel gas flow is stopped in order to decrease fuel cell upkeep costs. This causes reoxidation cycles during fuel cell's lifetime. These cycles decrease the lifetime of SOFC.

In my PhD work i study full ceramic anodes, so that they can one day replace Ni-cermets and increase the SOFC life time. I use *operando* high temperature X-ray diffraction simultaneously with electrochemical impedance analysis to understand to relationship between electrochemical degradation and changes in anode materials crystal structure, so i could design better SOFC anodes.

0.10 Laurits Puust: Development of light converters for solar panels and LEDs

Tartu Ülikool, Füüsika instituut; Tartu University, Institute of physics

During day and night different light sources are all around us giving us energy (sun to solar panels) or just illuminating our everyday doings. Insatiable beings as we are we always need to make things better, but there are many limitations inhibiting us doing so. As we can't alter some light sources (like the sun for example) we have to find other ways to get the specific light that we want-this is where light converters come into play, these are materials that absorb the light that we do not care for and transform it into desired emission.

0.11 Oleksandr Karasov: What We Do in the Landscapes

Eesti Maaülikool, Põllumajandus- ja keskkonnainstituut; Estonian University of Life Sciences, Institute agriculture and environmental sciences

According to the World Travel & Tourism Council, travel and tourism are "world's largest economic sectors, supporting one in 10 jobs (319 million) worldwide and generating 10.4% of world GDP" (WTTC, 2019). To a significant extent, this socio-economic influence of travelling and tourism activities is enhanced by landscape multifunctionality, meaning environmental ability to support, among others, various human activities such as walking, jogging, swimming, sports, barbecuing, picnicking, spending time with children or pets, wildlife

watching, educational, scientific and spiritual activities etc, attracting people to particular places. Knowledge of such activities informs spatial planning and contributes to the preservation of valuable landscapes while it is still a challenging task due to the intangible character: they remain to be hardly measurable. To measure the volume and variety of landscape functions, supporting outdoor recreation and tourism activities, we used public geotagged photographs, uploaded to social media such as Flickr and VK.com. We applied automated tagging of the photographs according to their content and further topic modelling to classify the photographs, corresponding to the mentioned activities. As a result, we suggested crowdsourcing-based indicators of the landscape multifunctionality, informing decision-makers on the landscape values within the country. Since VK.com is primarily a social media, used by Russian-speaking minority in Estonia, there would be possible to examine the differences in outdoor activities performed by the Russian-speaking community and other recreants within Estonia.

0.12 Joonas Kollo : Annual and inter-annual dynamics of Atmosphere — Forest Ecosystem exchange processes

Eesti Maaülikool, Metsandus- ja maaehitusinstituut; Estonian University of Life Sciences, Institute of Forestry and Rural Engineering

Forest ecosystems and the atmosphere exchange energy and matter in multiple ways. This exchange is to a large portion determined by the fluxes of different gases (carbon dioxide, methane, water vapour, ozone, nitrogen oxides, and sulphur dioxide), energy (light, temperature) and momentum (wind, turbulence) between the forest ecosystem and the atmosphere (Noe et al. 2015). Earths rotation around the sun leads to regularities in the dynamics of these exchange processes, the diurnal and annual cycles. These regularities are modulated by different natural and man-made events. Especially, so-called, short-lived climate forcers (SLCF) like ozone (O_3) in the interplay with regional and long range transported pollutants (Noe et al. 2016) like nitrogen oxides (NO_x) and sulphur dioxide (SO_2) have been found to impact negatively on tree growth (Morgan et al. 2003; Simpson et al. 2014). Typical effects of SLCF and pollutant exposure on trees are lowered photosynthesis, lowered biomass production, increased oxidative damage of foliar tissues (Mills et al. 2016; Nunn et al. 2005).

0.13 Giovanni Marcone: Sheep welfare and behaviour

Eesti Maaülikool, Veterinaarmeditsiini ja loomakasvatuse instituut; Estonian University of Life Sciences, Institute of Veterinary Medicine and Animal Sciences

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0.14 Mohammad Jamsher Ali: Ruin Probability for merged risk processes with correlated arrivals

Tartu Ülikool, Matemaatika ja statistika instituut; Tartu University, Institute mathematics and statistics

We extend the concept of classical risk process, $W_t(u) = u + pt - \sum_{i=1}^{N_t} Z_i$ and obtain the exact formula of ruin probability for the risk process $W_t(u) = u + pt - \sum_{i=1}^{N_t^{(1)}} Z_{1i} - \sum_{i=1}^{N_t^{(2)}} Z_{2i}$, where $N_t^{(1)}$ and $N_t^{(2)}$ are correlated Poisson processes; Z_{1i} and Z_{2i} are independent having exponential distributions. Two dependence structures of $N_t^{(1)}$ and$N_t^{(2)}$ are studied: Common Shock Model (CSM) and random intensities.

0.15 Tapashi Binte Mahmud Chowdhury: Science

0.16 Mariliis Hinnu: Bacterial reporter system for studying mistranslation during antibiotic treatment

Tartu Ülikool, Tehnoloogiainstituut; Tartu University, Institute of technology

Background: Aminoglycosides are antibiotics that bind specifically to ribosomes causing mistranslation and cell death through accumulation of aberrant proteins. While mistranslation can be in general considered as an unwanted process there is growing evidence that increase in translation errors can promote bacterial cell population survival under certain stress conditions. We hypothesize that during chemotherapy intracellular bacteria face slowly increasing aminoglycoside concentrations that can induce mistranslation and subsequent stress response makes bacteria more tolerant to antibiotics. The aim of our study was to develop a fluorescence-based mistranslation reporter system for *Escherichia coli*, which can be used during infection and/or antibiotic treatment at a single-cell level.

Materials/methods: We developed a set of reporter plasmids for *E. coli* with two fluorescent genes — green fluorescent protein (GFP) as a control for expression, and red fluorescent protein mScarlet-I as the reporter gene (Figure A). Stop-codon and frameshift mutations were introduced into the reporter gene. Ratio of red and green fluorescent signals was used to estimate the level of mistranslation. Fluorescence microscopy and flow cytometry were used for analyses. Effects of different antibiotics and growth conditions were studied.

Results: We are able to detect stop-codon readthrough and translational frameshifting caused by aminoglycosides. Spontaneous mistranslation levels vary depending on the specific genetic context and are typically in the range of 0.2% to 6%. Mistranslation increase by aminoglycosides is most prevalent during exponential growth phase and in case of reporters with low basal mistranslation levels. There is a correlation between mistranslation and aminoglycoside concentration (Figure B).

Conclusions: E. coli is considered to be the most prevalent cause of urinary tract infections and intracellular localization can be the cause of treatment failure and reinfection.

Our developed reporter system allows detecting spontaneous and aminoglycoside-induced mistranslation to elucidate its role in *E. coli* virulence and drug tolerance.

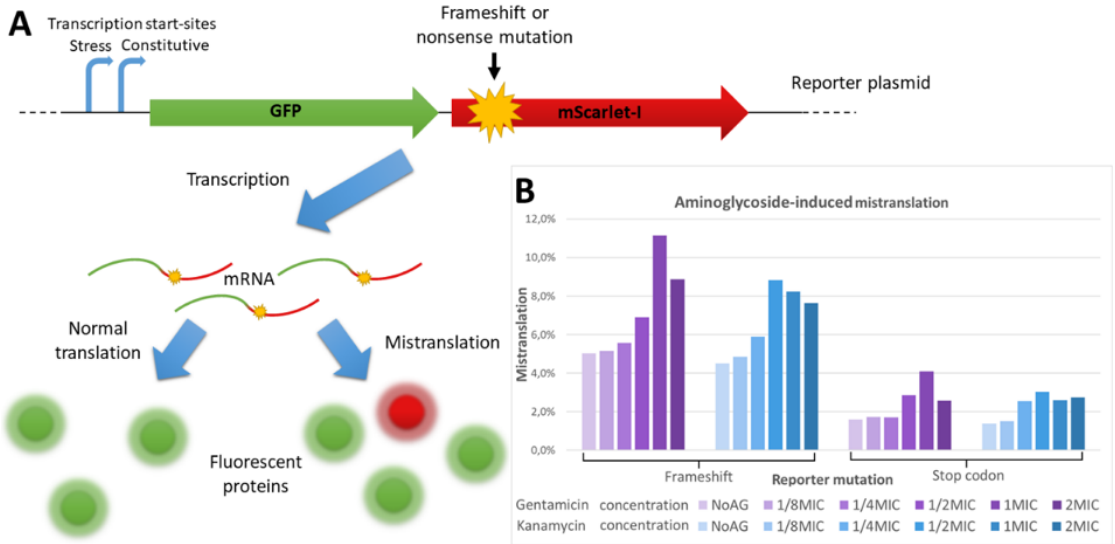

Figure A depicts the scheme of the plasmid-based reporter system, where GFP is the control protein for expression and mScarlet-I is the reporter gene. Mature form of red fluorescent mScarlet-I is only produced in case of mistranslation. **Figure B** shows the mistranslation values of a frameshift and a stop codon mutant with two aminoglycosides (AG), gentamicin and kanamycin. Mistranslation is most prevalent near the MIC value, noAG shows spontaneous mistranslation values. Flow cytometry analysis of single cells.

0.17 Liisi Talas : Past biodiversity of lakes

Tartu Ülikool, Tehnoloogiainstituut; Tartu University, Institute of technology

Lake ecosystems are constantly affected by surrounding stressors like climate change, human impact, pollution, forest fires and pathogen outbreaks. Long-term records (deposited plant, animal and fungal material in sediments) are useful to compose ecosystem "reference conditions" to see the natural range of variability in microbial communities. These "reference" conditions enables to make comparisons with more current environments (with human impact). This info would be crucial for modelling future scenarios relating water quality and availability. It is also proposed that fungal species observed in ancient DNA associated with host allow us to reconstruct biodiversity of paleoenvironment. We tested fungi as additional bio-indicators of other organisms to reconstruct whole past biodiversity by using fungal specific ITS2 region primers. We detected high richness in all major fungal phyla groups (*Ascomycota, Basidiomycota* and *Chytridiomycota*). We also observed increased richness of several groups of pathogenic fungi (especially in plankton parasites group) in the last 2000 years that can be related to moderate human impact. The results indicate that some freshwater communities are sensitive to anthropogenic stressors.

0.18 Sylvester Ikenna Ofili: Environmental conditions and metal geochemistry of the Fennoscandian Cambro-Ordovician black shale formation

Tartu Ülikool, Ökoloogia ja maateaduste instituut; Tartu University, Institute ecology and earth sciences

Black shales, especially those that contain appreciable quantities of organic carbon, have long been known to be enriched with a variety of transition metals, especially Mo, Zn, Ni, Cu, Cr, V, Co, Pb, U, and Ag, and are, thus, a major reserve for metals worldwide. In Fennoscandian-Baltoscandian region, unmetamorphosed to low grade metamorphosed Middle Cambrian to Late Ordovician organic-rich black shale deposits cover an extensive area of Sweden (alum shale), Norway, Northern Estonia (graptolite argillite; GA), Poland and North-West Russia. Alum shale, as well as graptolite argillite, contains remarkably high concentrations of trace metals such as U (up to 1200 ppm in Estonia), Mo (1000 ppm), V (1600 ppm) and Ni, but may also be locally enriched with rare earth elements, Cd, Au, Sb, As. These beds have historically been exploited for uranium production in Sweden and Estonia. The total weight of Estonian GA is about 67 billion tonnes (@ density of 2,100 kg/m^3). For example, the calculated resource of Estonian GA is about 6.7 million tonnes for U_3O_8, 20.6 million tonnes for ZnO and 19.1 million tonnes for MoO_3. Considering these metal concentrations, the Estonian GA may be a considerable transitional and other metal resource for Estonia and Europe. However, little is known about the environmental conditions of Estonian and Swedish black shale formation and origin of the metals within the shale units.

0.19 Martin Kala: The Virus-Host Interactions of Papillomaviruses Science Education

Tartu Ülikool, Tehnoloogiainstituut; Tartu University, Institute of technology

Human papillomaviruses (HPVs) are considered to be the most widely spread sexually transmitted infectious agents known. They are also responsible for approximately 5% of all human cancers. HPVs infect keratinocytes in basal layer of the epidermis and their life-cycle is strictly regulated by the various differentiation states of the cells in different layers of the epidermis. Therefore, studying the various gene expression modulators that could affect the life-cycle of HPV might lead us to new potential drug targets and possibly antiviral compounds to tackle the ongoing infection. POU homeodomain transcription factors have been in the focus of such studies for several decades now, but due to the methodological difficulties their impact on the HPVs replication has remained inconclusive. Our group has developed a robust and effective method to study the replication of the entire genomes of HPVs in U2OS cells that allows us to easily manipulate the replication efficiency by overexpressing genes of interest. We have shown that multiple POU homeodomain transcription factors possess the ability to inhibit HPV replication in our system to a great extent. Targeting the expression levels of those transcription factors could one day hold the key to being able to control the life-cycle of HPVs in already infected epidermis.

0.20 Zahra Alijani : Fuzzy Logic: History, Methodology and Applications to Real World

Tartu Ülikool, Matemaatika ja statistika instituut; Tartu University, Institute mathematics and statistics

Fuzzy Logic has been evolved today to a valuable extension and necessary supplement of the traditional bi-valued Logic, with applications covering almost all the vision of human activities. This new logic of infinite values, developed rapidly during the last 50 years, is based on the notion of fuzzy set introduced by Zadeh in 1965. The target of the present review article is two aspect: First to give to the non expert a general idea about the content and the perspectives of Fuzzy Logic. Second to present applications of it to Real World (student assessment), which constitute part of the author's research work during the recent years on building fuzzy models representing several real life situations.

0.21 Jaana Lilloja: Developing carbon-based catalysts for electroreduction of oxygen

Tartu Ülikool, Keemia instituut; Tartu University, Institute of chemistry

With the increasing energy consumption, there is an urgent need for clean, renewable and sustainable energy technologies. One option is to use different chemical energy conversion devices, like low temperature fuel cells. The performance of a fuel cell is limited by the sluggish kinetics of electrochemical oxygen reduction reaction (ORR) at the cathode. Noble metals (especially platinum) are commonly used as catalysts to improve the kinetics of the ORR. The large-scale production of these catalysts is limited by the large cost and scarcity of the precious metals in the world. For that reason, non-noble metal or even metal-free catalysts are investigated, namely different carbon-based materials due to their low cost, wide availability and structural diversity.

Herein, a simple synthesis route is used to prepare carbon-based catalysts for the ORR. A brief overview of the progress done so far and perspective of the future work will be given.