Astronomer's Days 2022
Abstract Book

23-25.5.2022

Jyväskylä, Finland

SUOMEN TÄHTITIETEILIJÄSEURA RY
THE FINNISH ASTRONOMICAL SOCIETY

Magnus Ehrnrooth Foundation

VAISALA

Tieteellisten seurain valtuuskunta

FINCA
Finnish Centre for Astronomy with ESO

Session: Milky Way

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Prusti	**Timo**	**ESA**	*INVITED TALK Gaia mission and science*	I will give an outline of the ESA cornerstone mission Gaia. A selection of the science results will also be presented. A brief preview to the third data release (Gaia DFR3) in June will be provided.
Juvela	**Mika**	**University of Helsinki**	*Star-formation studies with the Next Generation VLA interferometer*	To probe the evolution of molecular clouds down to the birth of protostars, we need radio-wavelength spectral-line observations with very high sensitivity and resolution. In the ngVLA community study "Ultra-high-resolution studies of pre-stellar evolution with ngVLA", we are studying the possibilities that the Next Generation Very Large Array (ngVLA) offers to map structures from cloud filaments (~0.1 pc) down to the scale of the smallest pre-stellar core fragments (below 1000 au) so far detected with the ALMA interferometer. We use data from large-scale magneto-hydrodynamic simulations to examine a model cloud that has properties similar to infrared dark clouds (IRDCs), known sites of high-mass star formation. With the help of radiative-transfer modelling, we have produced synthetic observations of some key molecular species (e.g. NH3, N2H+, HCO+, and CO isotopomers) observable with the ngVLA. The results show that the ngVLA is able to accurately trace the density, temperature, and kinematics across many size scales. In SF studies, the formation of binary and multiple stellar systems is one of the key questions. The multiplicity is assumed to be caused in part by turbulent fragmentation. However, few pre-stellar cores show any signs of sub-structure, in spite of intensive searches with the ALMA and other radio interferometers. Using synthetic observations of fragmenting cores, we are quantifying, what new light the sensitivity and resolution of the ngVLA could shed on this problem. Our results show the great promise of the ngVLA in tracing all stages of the SF process. However, they also highlight some limitations in the observations ever providing a fully unbiased picture of a star-forming cloud.
Mannfors	**Emma**	**University of Helsinki**	*Analyzing massive star-forming filaments using Herschel and ArTeMiS*	Cloud filaments have a central role in star formation, but there are still open questions about the differences between low-mass and high-mass star-forming regions regarding the structure, growth, and fragmentation of the filaments. Many of these characteristics are well known in nearby, lower-mass regions due to Herschel surveys. In spite of many interferometric studies, the picture is less clear for more distant and massive regions. We have studied massive filaments using continuum observations and the analysis of synthetic observations. Four massive filaments (distances 0.5-2 kpc, line masses 260-1000 MSun/pc), part of the SCOPE survey and previously observed with Herschel, were mapped with the ArTeMiS instrument on the APEX telescope. Only one of these, OMC-3 in Orion, had sufficiently good S/N to enable detailed comparison between the results obtained at the Herschel resolution. We have analyzed dust properties, filamentary profiles, and fragmentation of the filament. The sources show high column densities up to 10^23 cm^-2, and dust opacity spectral index from 1.5-2.0. While Herschel observations show characteristic 0.1 pc width, the combination with ArTeMiS results in narrower and steeper profiles. We also detect strong correlation between derived column densities and filament widths. Fragmentation on multiple scales is more visible with the addition of ArTeMiS data, allowing for a more thorough analysis of massive filament collapse.
Väisälä	**Miikka**	**Academia Sinica Institute of Astronomy and Astrophysics**	*GPU simulations of pseudodisk formation*	The process of star formation is connected to its cold core envelope. In the process of core collapse, magnetic forces of the prestellar cores lead into phenomena where the shape of this matter infall is strongly affected by magnetic field. This can lead into disk-like structures, named “pseudodisks”, which however are created by magnetic effects and are not rotationally supported. Instead they are under supersonic motions. We have modeled the pseudodisk formation with the novel GPU code Astaroth, highlighting the strong dependence of magnetic fields to the system development. In my talk I will introduce the pseudodisk concept to the audience demonstrated by our recent numerical results.

Session: Galaxies

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Heinämäki	**Pekka**	**Tuorla observatory, UTU**	*The largest gravitationally bound systems in the Universe ?*	We use the flux-limited supercluster sample drawn from the SDSS DR7 main survey. Using topological arguments, we found that pancake type superclusters form low-luminosity, small, poor and low mass end of superclusters. We found four superclusters of unusual types, exhibiting exceptionally spherical shapes. These systems contain a high-density core surrounded by a relatively spherical density/galaxy distribution. The mass-to-light ratio of these superclusters is higher than the the rest of the superclusters, suggesting a relatively high dark matter content. We also show how to apply and use the Λ significance diagram also to oblate and prolate spheroids. This approach suggests that three quasi-spherical superclusters are gravitationally bound at the present epoch. If so, then these objects are the largest gravitationally bound systems found to date.
Oksanen	**Arto**	**Jyväskylän Sirius ry**	*Making scientific observations at Hankasalmi observatory*	
Rautio	**Riku-Petteri**	**University of Oulu**	*The varied ionization sources of extraplanar gas in eight low-mass galaxies galaxies*	Extraplanar diffuse ionized gas (eDIG) is an important component of the interstellar medium that connects the disk and halo components of galaxies. We use MUSE integral field specroscopy and Cloudy photoinization modeling code to investigate the ionization mechanisms of eDIG in eight nearby low-mass edge-on disk galaxies: ESO 157-49, ESO 443-21, ESO 469-15, ESO 544-27, IC 217, IC 1553, PGC 28308, and PGC 30591. From emission-line maps, we show that leaky HII regions are the primary source of eDIG ionization for our sample, while hot low-mass evolved stars (HOLMES) and shocks may also contribute to the ionization to a significant degree. We construct a Cloudy model to quantify the contributions of leaky HII regions and HOLMES to the ionziation budget. Despite our galaxies' similar structures and masses, our results support a surprisingly composite image of ionization mechanisms for the eDIG.
Sawala	**Till**	**University of Helsinki**	*The Plane of Milky Way satellites: the end of ΛCDM?*	The Milky Way is surrounded by 11 “classical” satellite galaxies arranged in a remarkable configuration: an unusually thin plane which is possibly rotationally supported. Such a configuration is thought to be highly unlikely to arise in the standard (ΛCDM) cosmological model. There is no known mechanism for making long-lived satellite planes within the dispersion-supported dark matter haloes predicted to surround galaxies like the Milky Way. Using a new set of constraint simulations of Local Group analogues in ΛCDM, I examine the origin of the observed anisotropy and investigate to which extent planes or rotationally supported disks of satellites are (in)compatible with the ΛCDM framework of structure formation.

Session: Väisälä Prize

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Lahén	**Natalia**	**Max Planck Institute for Astrophysics, Garching, Germany**	*Towards resolved formation of globular clusters in galactic-scale hydrodynamical simulations*	The old ages and relatively uniform chemical contents of globular clusters (GCs) make them essential both for tracing the galactic mass assembly but also for probing the star formation process during the first few Gyrs. Our understanding of the formation of GCs is however restricted by the limitations of observations where the parsec-scale star formation environment can only be resolved in rare lensed systems with e.g. HST and VLT/MUSE and soon with JWST. On the other hand, in the local Universe, young massive star clusters are seen to form only in extreme star formation environments such as starbursts. It is currently unclear whether the formation process of such local massive clusters can be studied as analogous to the formation of GCs. Hydrodynamical simulations of low-metallicity environments supplement the spatial and temporal scales relevant to GC formation that are inaccessible to observations. Our GRIFFIN hydrodynamical simulation project presents a setting where the formation of star clusters in low-metallicity, gas-rich dwarf galaxies can be studied together with detailed stellar enrichment models. The simulations resolve the multi-phase ISM across multiple orders of magnitude in SFR, ISM density and pressure. We employ a chemical network and metal-line cooling coupled with stellar feedback, accounting for dust and line-of-sight attenuation of the evolving interstellar radiation field. The formation of stars and star clusters is resolved down to a few solar masses and sub-parsec spatial scales. We discuss the formation process of the star cluster population with masses up to a million solar masses, derived both from direct simulation output and through radiative transfer post-processing. The most massive star clusters that form in the simulation evolve as expected for GCs. Our future efforts include resolving the detailed chemical composition of the simulated star clusters and testing of stellar evolutionary processes possibly responsible for the so-called multiple populations of stars observed in GCs.

Session: NOT

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Mattila	**Seppo**	**University of Turku**	*NOT discussion session on Monday*	This will consist of two presentations followed by discussion and possibility to ask questions. One presentation will be by myself and another one by Karri Muinonen. One hour in total should be sufficient for the whole session.

Session: Education, IAU

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Lehto	**Kirsi**	**Turun yliopisto**	*Astrobiologia tarjoaa vahvan kokonaiskuva-perustan eri tieteenalojen opetukselle*	Koulujen tiedeopetusta tarjoillaan monien eri nimisten aiheiden ja kurssinimikkeiden alla: koululaiset opiskelevat fysiikkaa, kemiaa, biomeiaa, geologiaa ja maaperätiedettä, biologiaa. Kaikki nämä oppiaineet kuvaavat maailman tilaa ja kehittymistä kukin omalta sektorilataan, ne kaikki kertovat oman näkemyksensä maailma olemassaolon suuresta tarinasta. Tämä erillisiin tarinoihin perehtyminen syvenee yliopistossa: yliopisto-opintojen aikana opiskelijat miettivät lähinna oman pääaineensa tai oman tutkimusaiheensa kysymyksiä. Tämän erillisiin aiheisiin ja lokeroihin jakaantuneen opetuksen piirissä opiskelijoilta helposti katoaa kokonaiskuva maailmasta, ja kunkin erillisen ilmiön yhteyksistä ympäröivään todellisuuteen. Astrobiologia tarjoaa kouluopetukseen työkalua, jonka avulla eri luonnontieteiden näkökulmat yhdistyvät yhtenäisemmäksi maailmankuvaksi. Astrobiologia pyrkii selvittämään eri ilmiöiden keskinäisiä vuorovaikutiksia. Erityisesti se selvittää sitä miten elämän olemassaolo tällä planeetalla – ja kenties myös muilla taivaankappaleilla – riippuu kosmisesta historiasta ja paikallisista (aurinkokunnan ja planeetan) olosuhteista, ja miten elämän olemassaolo myös vaikuttaa oman planeettansa elinympäristöön. Astrobiologia selvittää siis kaiken yhteistä historiaa ja elämän olemassaolon edellytyksiä. Se esittelee myös maailman dynaamisia ilmiöitä ja tapahtumia, sitä miten maailma kehittyy jatkuvasti eteenpäin erilaisten, sekä elottomien että eloperäisten vuorovaikutusten ajamana.
Mäntylä	**Terhi**	**Jyväskylän Yliopisto**	*Astronomy in Teacher Education*	The possibilities and challenges of astronomy education in teacher education
Nurmi	**Pasi**	**University of Turku**	*ESON and IAU OAO activities in Finland*	I'll present the Finnish participation to ESO and IAU public outreach activities and the need to activate more general audience and researchers to participate to different actions. This year is also the 60th birthday for ESO and every member country should organize related science activities to the public. I'll also review the outcome of the national NOT-school for the upper secondary school students.

Session: Black Holes

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Jormanainen	**Jenni**	**FINCA**	*Confronting observations of VHE gamma-ray blazar flares with reconnection models*	Several models have been suggested to explain the fast gamma-ray variability observed in blazars, but its origin is still debated. One scenario is magnetic reconnection, a process that can efficiently convert magnetic energy to energy of relativistic particles accelerated in the reconnection layer. In our study, we compare results from state-of-the-art particle-in-cell simulations with observations of blazars at Very High Energy (VHE, E > 100 GeV). Our goal is to test our model predictions on fast gamma-ray variability with data and to constrain the parameter space of the model, such as the magnetic field strength of the unreconnected plasma and the reconnection layer orientation in the blazar jet. For this first comparison, we used the remarkably well-sampled VHE gamma-ray light curve of Mrk 421 observed with the MAGIC and VERITAS telescopes in 2013. The simulated VHE light curves were generated using the observable parameters of Mrk 421, such as the jet power, bulk Lorentz factor, and the jet viewing angle, and sampled as real data. Our results pave the way for future model-to-data comparison with next-generation Cherenkov telescopes, which will help further constrain the different variability models.
Koljonen	**Karri**	**Norwegian University of Science and Technology**	*Shocking news - a polarizing study of a tidal disruption event*	Supermassive black holes have been known to disrupt passing stars producing outbursts called tidal disruption events (TDEs) offering a unique view on the early stages of the accretion disk and jet formation. The advent of large-scale optical time-domain surveys has significantly increased the number of known events and challenged our understanding of their dynamics and emission processes. Especially, the so-called optical TDEs have shown late-time X-ray and radio emission years after the optical peak emission indicating delayed accretion disk formation and long timescales for the circularization process. In this seminar, I will present our study on the most polarized TDE up-to-date without any indication of contribution from a jet to the emission. Our observations demonstrate that optical TDE emission can be powered by tidal stream shocks.
Lindfors	**Elina**	**FINCA**	*Multi-messenger emission of relativistic jets*	Active galactic nuclei are the most numerous sources of the extragalactic gamma-ray sky. They are also in the spotlight of the multi-messenger astronomy as they are candidate sources to emit high-energy astrophysical neutrinos and ultra-high-energy gamma-rays. The observed variability from radio to VHE gamma-rays can be used to constrain the particle acceleration and emission mechanisms, but this requires extensive multiwavelength observations of a large sample of sources. In this talk, I will present our recent study on the connection between radio flares from blazars and astrophysical neutrinos. I will also highlight the major leap forward that the Cherenkov Telescope Array very high-energy gamma-ray observations of AGN will bring us.
Nilsson	**Kari**	**FINCA**	*Time series analysis of Blazars*	
Poutanen	**Juri**	**University of Turku**	*Black hole spin–orbit misalignment in the X-ray binary MAXI J1820+070*	The observational signatures of black holes in X-ray binary systems depend on their masses, spins, accretion rate, and the misalignment angle between the black hole spin and the orbital angular momentum. We present optical polarimetric observations of the black hole X-ray binary MAXI J1820+070, from which we constrain the position angle of the binary orbital axis. Combining this with previous determinations of the relativistic jet orientation, which traces the black hole spin, and the inclination of the orbit, we determine a lower limit of 40 deg on the black hole spin-orbital angular momentum misalignment angle. The misalignment must originate from either the binary evolution or black hole formation stages. If other X-ray binaries have similarly large misalignments, these would bias measurements of black hole masses and spins from X-ray observations. A high misalignment adds complexity to the models of the X-ray and optical quasi-periodic oscillations observed from black hole X-ray binaries in their hard state. We will also discuss the prospect of measuring misalignment using the polarimetric data from the Imaging X-ray Polarimetry Explorer. Reference: Poutanen et al., 2022, Science, 375, 874-876
Stone	**Maria Babakh**	**University of Turku, FINCA**	*Comparing neighborhoods of quasars and inactive galaxies with the Galaxy and Mass Assembly (GAMA) survey through Monte Carlo simulation*	Active galactic nuclei (AGN) are galaxies which host active supermassive black holes (SMBHs) and present a crucial element in the evolution of galaxies. In this paper, we aim to contribute to the understanding of how the nuclear activity is related to its surrounding environment. We present results of an archival project, where we use the GAMA survey to compare the neighborhoods of quasars and inactive galaxies via Monte Carlo simulation. The GAMA survey project collected observations using the latest facilities for about 300,000 galaxies and provides a multi-wavelength photometric and spectroscopic data. For each seed-quasar or a comparison seed-galaxy, we select neighboring galaxies within a set volume. Our preliminary results show that there is no significant difference in any of the morphological or star formation properties between the neighbors of quasars and neighbors of inactive galaxies. This finding suggests that quasar activity is a phase in the life of a galaxy and is not dependent on its environment.
Mahmoudi K	**Pouya**	**FINCA**	*Blazar Optical Variability and Their Relation to High-Energy Neutrino Events*	Blazars are Active Galactic Nuclei (AGN) with their relativistic jets pointed at us. They are among the most extreme particle accelerators of the Universe and therefore also good candidates to be sources of astrophysical neutrinos discovered by IceCube Observatory. The optical light-curve of 3000+ blazars is used to study their variability over a time period of 10-15 years. The optical variability is quantified via the intrinsic modulation index and we are developing methods to robustly identify optical flares from the large sample of light-curves. A novel statistical analysis is to be devised to see if the optical flaring events in the variable blazars correlate with high-energy neutrino events. In this talk, we will show first results from our study.

Session: Galaxy evolution

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Irodotou	**Dimitrios**	**University of Helsinki**	*The effects of AGN feedback on the bars and bulges of Milky Way-mass galaxies in cosmological simulations*	Feedback from active galactic nuclei has become established as a fundamental process in the evolution of the most massive galaxies. However, its impact on Milky Way-mass systems remains comparatively unexplored. In this talk, I use the Auriga simulations to probe the impact different modes (i.e. radio vs quasar) of AGN feedback have on the dynamical and structural properties of galaxies, focussing on the bar, bulge, and disc. I will show that when removing the radio mode, gas in the circumgalactic medium is allowed to cool more efficiently and subsequently settles in an extended star-forming disc, with little effect on the inner regions. On the contrary, the removal of the quasar mode results in more massive central components, which are in the form of compact discs, rather than spheroidal bulges. Therefore, galaxies without quasar mode feedback are more baryon-dominated and thus prone to forming stronger and shorter bars, which is in tension with past theoretical work. These results are particularly important for large scale simulations, since their implementation of the different AGN feedback modes (i.e. radio and quasar) can change the morphology and dynamics of galaxies and consequently their predictions of the fraction of barred galaxies in a particular simulated volume.
Johansson	**Peter**	**University of Helsinki**	*Simulating black hole dynamics and gravitational wave emission in galaxy formation simulations*	Recently, large-scale cosmological simulations have been used to predict the gravitational wave background. These simulations typically rely on semi-analytic models to describe the small-scale black hole binary dynamics and gravitational wave emission, as these processes cannot be directly resolved in simulations employing gravitational softening. An alternative is to use a hybrid approach, such as the KETJU code, recently developed in our group. The KETJU code includes algorithmically regularised regions around every SMBH. This allows for simultaneously following global galactic-scale dynamical and astrophysical processes, while solving accurately the dynamics of SMBHs at sub-parsec scales. We show how the KETJU code can be used to study the formation of diffuse cores in very massive galaxies through the scouring by inspiraling supermassive black hole binaries. The KETJU code also includes post-Newtonian terms in the equations of motions of the SMBHs, which allows us to directly calculate the expected gravitational wave signal from the motion of the resolved SMBH binary in mergers of massive galaxies. Finally, we will present new cosmological zoom-in simulations, which include gas cooling, star formation and both stellar and AGN feedback together with KETJU accurate BH dynamics and discuss how these type of simulations could be used to make predictions for the upcoming space-based LISA gravitational wave observatory.
Liao	**Shihong**	**University of Helsinki**	*Modelling accretion and feedback for supermassive black hole binaries in galaxy merger simulations*	Gravitational waves (GW) from supermassive black hole (SMBH) binaries formed during galaxy mergers are the primary targets for low-frequency GW detectors such as LISA and Pulsar Timing Array. Improving the models of gas accretion and feedback for SMBH binaries in cosmological galaxy formation simulations is particularly important for making GW predictions. In this talk, I will introduce an improved and more physically motivated SMBH feedback model for the KETJU project, which allows us to simulate more accurately the evolution of SMBH binaries in gas-rich late-type galaxy mergers.
Martikainen	**Elvira**	**Aalto University**	*TIME DEPENDENT MODELLING OF RELATIVISTIC JETS*	Astrophysical jets are collimated outflows of relativistic plasma and are known to produce broadband spectra of non-thermal origin. Such jets can be found in AGNs and microquasars, and some display substantial variability in their emission. In this work, time dependent variability of broadband emission from astrophysical jets is reproduced by means of self-consistent time-dependent numerical modelling. In the adopted model, the emission is assumed to be produced by radiating region in jet that undergoes various cooling processes. The model is applied to several test cases, with the range of physical parameters. In particular, we test the model by simulating observed light curves using radio light curves from the Metsähovi Radio Observatory, and spectral evolution from flaring events using data from archival multifrequency data. (Author(s): Elvira Martikainen, Joni Tammi)
Rantala	**Antti**	**Max Planck Institute for Astrophysics, Garching, Germany**	*Studying the dynamics of galactic nuclei and massive star clusters using the novel BIFROST code*	I present the novel fourth-order forward symplectic N-body integrator code BIFROST. The code can simulate dynamical systems with arbitrary binary fractions up to a few million stars using both MPI parallelization and GPU acceleration. In addition to the description of the simulation code I present simulation results of the formation of the Milky Way center S-star cluster and the coalescence of a star cluster formation region including intermediate-mass black holes.
Salomé	**Quentin**	**FINCA - Metsähovi**	*Molecular outflow and AGN feedback in the Narrow-Line Seyfert 1 galaxy IRAS17020+4544*	AGN-driven outflows are often invoked as a key mechanism in galaxy evolution and the regulation of star formation. While accreting matter, the central supermassive black hole may produce winds of highly ionised gas seen in X-ray and moving at relativistic velocities. With the development of mm interferometry, an increasing number of the molecular counterpart of these ultra-fast outflows are observed. IRAS17020+4544 is one of the few examples where the X-ray and molecular outflows follow the prediction of energy conservation. However, contrary to the other examples, IRAS17020+4544 is associated with a smaller black hole mass, accreting near to the Eddington limit. I will present the results of our recent analysis of NOEMA observations. NOEMA enabled the molecular outflowing gas previously detected as a broad wing in CO with the LMT to be resolved. We detected three outflowing components, one following the energy-conserving predictions while the other two are consistent with momentum conservation. NOEMA also allowed us to study for the first the molecular gas within the host galaxy, which revealed the presence of a galaxy interaction with a small companion. This analysis brings a new light on the understanding of AGN-driven outflows and opens the way to the study of outflows and AGN feedback in low-mass, highly accreting AGN.

Session: Stars

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Knigge	**Christian**	**University of Southampton**	*INVITED TALK*	
Hackman	**Thomas**	**Department of Physics, University of Helsinki**	*Lessons from historical solar eruptions*	J. Uusitalo, T. Hackman & M. Oinonen In order to estimate how strong solar storms can be, it is important to study solar particle events from history. A strong particle event can produce radiocarbon (14C) in the atmosphere and this can be stored within plants through photosynthesis. Therefore, such an event can be seen as a peak in radiocarbon (14C) concentration in tree rings, annually dated by dendrochronology (Miyake et al. 2012). Using methods developed at the University of Helsinki (Uusitalo et al. 2022) we have analysed data from the years of two historical solar eruptions: the solar superstorm of AD 774 (Uusitalo et al. 2018) and the Carrington event of AD 1859. A comparison of these events is important, because the Carrington event is frequently used as a model for worst-case scenarios. References F. Miyake, K. Nagaya, K. Masuda, T. Nakamura, A signature of cosmic-ray increase in AD 774–775 from tree rings in Japan, Nature. 486 (2012) 240–242. https://doi.org/10.1038/nature11123. J. Uusitalo, L. Arppe, T. Hackman, S. Helama, G. Kovaltsov, K. Mielikäinen, H. Mäkinen, P. Nöjd, V. Palonen, I. Usoskin, M. Oinonen, Solar superstorm of AD 774 recorded subannually by Arctic tree rings, Nat. Commun. 9 (2018) 3495. https://doi.org/10.1038/s41467-018-05883-1 J. Uusitalo, L. Arppe, S. Helama, K. Mizohata, K. Mielikäinen, H. Mäkinen, P. Nöjd, M. Timonen & M. Oinonen, From lakes to ratios: 14C measurement process of the Finnish tree-ring research consortium, Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater., in press (2022).
Koivisto	**Niilo**	**University of Turku**	*Long-term follow up on two type IIb supernovae*	In my master's thesis I performed photometric and spectroscopic analysis on two type IIb supernovae, 2017gkk and 2019gaf. The observations were obtained using the Nordic Optical Telescope (NOT) on La Palma and they cover epochs from early days to about a year after the explosion. The motivation for this long time series of spectra and light curves was to better understand the physics of core-collapse supernovae and especially transitional type IIb SNe. I will also briefly present programs, which I used in my master's thesis work. For spectroscopy I used the ALFOSCGUI (E. Cappellaro 2020, https://sngroup.oapd.inaf.it/foscgui.html) and for photometry AutoPhot (Brennan & Fraser 2022), which are also useful for other observational astronomy applications.
Willamo	**Teemu**	**University of Helsinki**	*Stellar magnetic activity cycles*	The solar cycle is the best known example of stellar magnetic activity cycles. The amount of sunspots has been recorded since the early 17th century, shortly after when Galileo and other early scientists pointed their newly invented telescopes to the sky. Similar activity cycles have been found in other stars as well. They are studied through long-term photometry and narrow band chromospheric emission data. An important tool is also Zeeman-Doppler imaging; this method is used to construct surface maps of stellar magnetic fields. We know that the polarity of the solar magnetic field is reversed between each solar cycle, and these polarity reversals can be identified in other stars as well, when comparing Zeeman-Doppler maps from different observing epochs. Here I will present recent results, where new polarity reversals have been identified. I will also present some results of an analysis regarding the shapes of stellar activity cycles; the solar cycle is known to have a more rapid rising phase and a slower decline, which is shown in our study to be true for other stars as well.

Session: Solar System

Last name	First name	Affiliation	Title of the presentation	Abstract of the presentation
Granvik	**Mikael**	**U Helsinki / Luleå U of Tech**	*Solving the mystery of disappearing asteroids with telescopic observations, numerical modeling, space missions, and lab experiments*	A couple of asteroids with perihelion distances of less than 0.2 au have been observed to show unexplained, short-lived activity during their perihelion passages. The activity is significant enough that it will destroy these asteroids over time, and in the process it contributes to the meteoroid population in the inner Solar System. Although we only have direct evidence for activity from this very limited sample, we know from evolutionary modeling of the population of near-Earth asteroids (NEAs) that all asteroids, that eventually reach similar perihelion distances during their dynamical evolution, are affected. This corresponds to about 70% of all near-Earth asteroids, and the disruptions offer us an independent avenue for constraining the bulk compositions of asteroids. We don't currently understand the mechanism(s) responsible for the activity, although a number of explanations have been proposed. I will describe our current efforts to understand the mechanism(s) driving the activity and ultimately destroying entire asteroids. These efforts range from observations and numerical modeling to space missions and lab experiments.
Muinonen	**Karri**	**University of Helsinki, Department of Physics**	*Asteroid physical properties from Gaia photometry*	Photometry is a key tool for characterizing the physical properties of asteroids. An asteroid's photometric lightcurve and phase curve refer, respectively, to the variation of the asteroid's disk-integrated brightness in time and in phase angle (the Sun-asteroid-observer angle). They depend on the asteroid's shape, rotation, and surface light-scattering properties, and the geometry of illumination and observation. We present Bayesian lightcurve inversion methods for the retrieval of the asteroid's phase function, the unambiguous phase curve of a fictitious spherical asteroid with surface scattering properties equal to those of the original asteroid. A collection of such phase functions can give rise to a photometric taxonomy for asteroids. In the inverse problem, on one hand, there are four classes of lightcurves that require individual error models. The photometric observations can be absolute or relative and they can be dense or sparse in comparison to the rotation period of the asteroid. On the other hand, the observations extend over varying phase angle ranges, requiring different phase function models. The photometry of the ESA Gaia space mission extends, typically, over a range of phase angles, where the photometric phase curve tends to be linear on the magnitude scale. The ground-based photometry can reach small phase angles, where the asteroids show an opposition effect, a nonlinear increase of brightness on the magnitude scale towards zero phase angle. We provide error models for all four classes of lightcurves and make use of linear or linear-exponential phase functions for phase angles below 50 degrees. We validate the modeling with the help of a numerical forward simulation followed by the application of the inverse methods and we apply the inverse methods to sparse absolute Gaia (from Data Release 2) and dense relative ground-based lightcurves and obtain absolute magnitudes and phase functions, with uncertainties, for hundreds of asteroids. Finally, Gaia Data Release 3 is due in June 13, 2022, allowing us to apply the methods to some 150,000 asteroids with high-precision photometry. The authors of the present study are: Karri Muinonen (University of Helsinki, Finland & National Land Survey of Finland), Elizaveta Uvarova (University of Helsinki, Finland), Julia Martikainen (Instituto de Astrofisica de Andalucia, CSIC, Granada, Spain), Antti Penttilä (University of Helsinki, Finland), Alberto Cellino (INAF, Osservatorio Astrofisico di Torino, Pino Torinese, Italy), and Xiaobin Wang (Yunnan Observatories, CAS, Kunming, PR China & University of Chinese Academy of Sciences, Beijing, PR China).
Pöntinen	**Mikko**	**University of Helsinki**	*Identification of asteroid streaks in simulated ESA Euclid images*	The ESA Euclid space telescope observes up to 150 000 asteroids as a sideproduct of its primary cosmological mission. Asteroids appear as streaks in the images. Due to the survey area of 15 000 square degrees and the number of sources, automated methods are required to find them. Euclid carries a visible camera VIS and a near-infrared camera NISP with three filters. The Euclid mission substantially increases the number of asteroids with multi-band photometry that extends to near-infrared. We tested two methods for finding the asteroid streaks in simulated Euclid images. The first method is StreakDet; a software developed to detect space debris. We optimized the parameters of StreakDet to maximize completeness and developed a post-processing algorithm to improve the purity of the sample of detected sources by removing false-positive detections. The second method is deep learning, i.e., deep artificial neural networks. We developed a custom-built object detection pipeline based on convolutional and recurrent neural networks. StreakDet detects almost all bright and long streaks in Euclid images, but there is room for improvement for finding short (less than 13 pixels, corresponding to 8 arcsec/h) and/or faint streaks (fainter than apparent magnitude 23). The deep learning pipeline can detect streaks up to a magnitude fainter than StreakDet, and it also works for short streaks. However, a deep learning model trained only with simulated data probably does not work optimally out of the box for the real images. Therefore, StreakDet and deep learning are complementary. After Euclid is launched and real data becomes available, StreakDet can gather non-synthetic training examples for the neural network, which can then be trained to detect fainter and shorter streaks than StreakDet can.
Virkki	**Anne**	**University of Helsinki**	*Characterising near-Earth asteroids using radar observations*	Radar delay-Doppler observations provide images of near-Earth asteroids with a resolution as fine as 7.5 meters per pixel. I characterised the near-surface physical properties of 20 near-Earth asteroids (NEAs) using the disk-function analysis. I modelled the observed radar reflectivity as a function of the incidence angle, theta_i, by a scattering law of the form sigma_0 = R(C+1) cos(theta_i)^(2C), where R defines the reflectivity, which is proportional to the permittivity, and C is a roughness parameter. The permittivity was then used for estimating the regolith mass density near the asteroid surfaces. Only NEAs that were observed using the Arecibo S-band (2380 MHz, 12.6 cm) radar, appear spheroidal in the delay-Doppler images, and are greater than 100 meters were included in this pilot study. The goal is to expand the number of NEAs to understand the connection of radar polarimetry and electric properties as well as to find clues of the densities and surface-roughness characteristics that are typical for different types of asteroids.