Finnish Centre for Astronomy with ESO

Annual Report

2024

CONTACT INFORMATION
Finnish Centre for Astronomy with ESO
Vesilinnantie 5
University of Turku, 20014
Finland
Email (general): finca@utu.fi
Website: http://www.utu.fi/en/units/finca

DIRECTOR
Petri Väisänen
petri.vaisanen@utu.fi

FINNISH CENTRE FOR ASTRONOMY WITH ESO, ANNUAL REPORT 2024

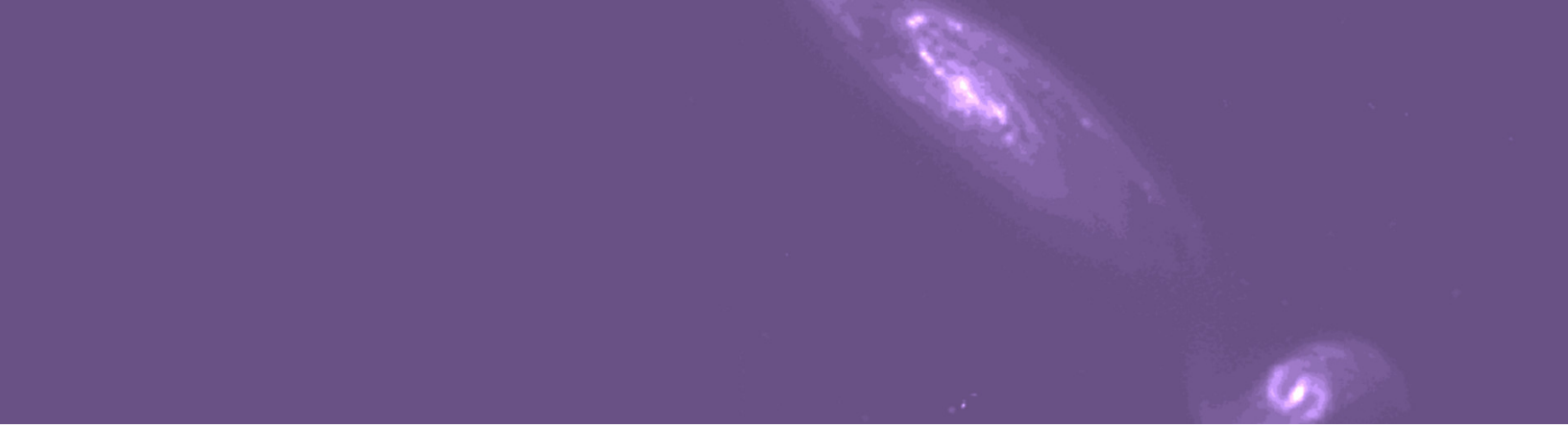
EDITOR: KARI NILSSON (KANI@UTU.FI)

Based on a template by Andrea Hidalgo.

September 2025

Cover: VLT auxiliary telescopes after sunset in Paranal. (Picture: Johanna Hartke)

Contents



1. Foreword

The European Southern Observatory (ESO) is a government-level treaty organisation, with 16 member states currently, including Finland, which joined in 2004. It is the world's leading science and technology organisation in ground-based astronomy, and the most productive astronomical observatory in the world. Its headquarters are in Garching, Germany, and it operates state-of-the-art observatories in Chile, where it is also building the revolutionary €1.5 billion Extremely Large Telescope (ELT). Being an integral part of ESO is essential for the Finnish astronomical community to remain at the forefront of high-quality research in the field. To ensure this, a national astronomy research institute, the Finnish Centre for Astronomy with ESO **(FINCA)** was founded in 2010 to promote high-quality national research in the field by utilising ESO infrastructure and technological projects, and to lead co-operation between all the Finnish universities, Aalto (AU), Helsinki (UH), Oulu (UO), Turku (UT), that are engaged in astronomical research.

The year being reported on here, 2024, marked the 15^{th} year of operation for FINCA, administratively a Special Unit of the University of Turku, and funded by the Ministry of Education and Culture, and by the participating universities. The highest decision-making body is the Board, which comprises of two members from each participating university, and one member from FINCA staff. The Board is chaired by UT's Vice-Rector of research; Kalle-Antti Suominen had served in this role for many years, also through 2024, and was replaced at the end of the year by the new in-coming Vice-Rector, Piia Seppänen.

In addition to ESO-based and driven science, FINCA promotes and coordinates Finnish participation in ESO-related infrastructure and technological development projects. Furthermore, as best science is usually done collaboratively and across multiple wavelengths, FINCA supports observational astronomy more broadly as well by, e.g., participating in researcher training in observational astronomy at the universities. It also holds a coordination role in Finland, with UT, regarding activities and training related to the Nordic Optical Telescope (NOT) on La Palma. In fact, since 2024, after an agreement between the NOT, the Aarhus University, and the FINCA Board, the FINCA Director also serves (on a part-time basis) as the director of the NOT.

As can be seen from the research reports in this Annual Review, research at FINCA covers a wide range in contemporary astronomy, from cosmology, active galaxies, and galaxy formation and evolution, through properties of nearby galaxies, to supernovae and their progenitor stars, stellar activity and star formation in our own Galaxy. We use multi-wavelength observational data from radio to gamma-rays, from both ground-based and space telescopes. Of special focus are the four 8m ESO Very Large Telescopes (VLT) and the Atacama Large (Sub)Millimetre Array (ALMA) in the optical, near-infrared and (sub)millimetre wavelengths. In this spirit, FINCA awards incentive grants to any Finland-based astronomer who is successful in winning very competitive observing time from ESO facilities. Observational research is supplemented by modeling, simulations and theoretical work, that are essential in understanding the physics behind the observations.

Our research is characterized by strong collaboration both nationally and internationally. To foster this at a national level, we fund, through a competitive application-based *FINCA Visitor and Mobility program*, both visits of international research collaborators coming to Finland, as well as research visits outward to top-level international research centres. This scheme is well-used, many visits both ways were realised in 2024 as well. Results-wise, FINCA scientists published **115** officially recognized refereed journal papers during the course of 2024, which is an excellent number considering the size of our unit. Most of these are listed at the end of this Report.

Researcher training activities in 2024 focused on supervision (including graduations in 2024) of PhD and MSc students in the participating universities. Furthermore, as before, FINCA funded the annual national course on remote optical/infrared observing with the NOT for MSc and PhD students organized by the UT Department of Physics and Astronomy, participated in another UT-run national school, a practical ESO-school, and also participated in the extremely popular hands-on course for Finnish high school students utilizing remote observations with the NOT that is run by the LUMA Centre South West.

Regarding ESO-developments, the construction of the ESO's ELT, the 39m diameter giant for infrared and optical astronomy, is well underway, with Phase 1 instruments being constructed. In 2024, in particular, the telescope/dome structure on the top of Cerro Armazones "started looking like a telescope", and the first mirror segments of the eventual 798 arrived in Chile. ESO thus remains in a world-leading position in constructing a facility of this size, with the ELT expected to start operations in 2029/2030 revolutionising our perception of the Universe. The ELT instrumentation brings an enormous leap forward in sensitivity and resolution for the global astronomy community, and, FINCA is proud to be involved in some of these instrumentation projects (see below).

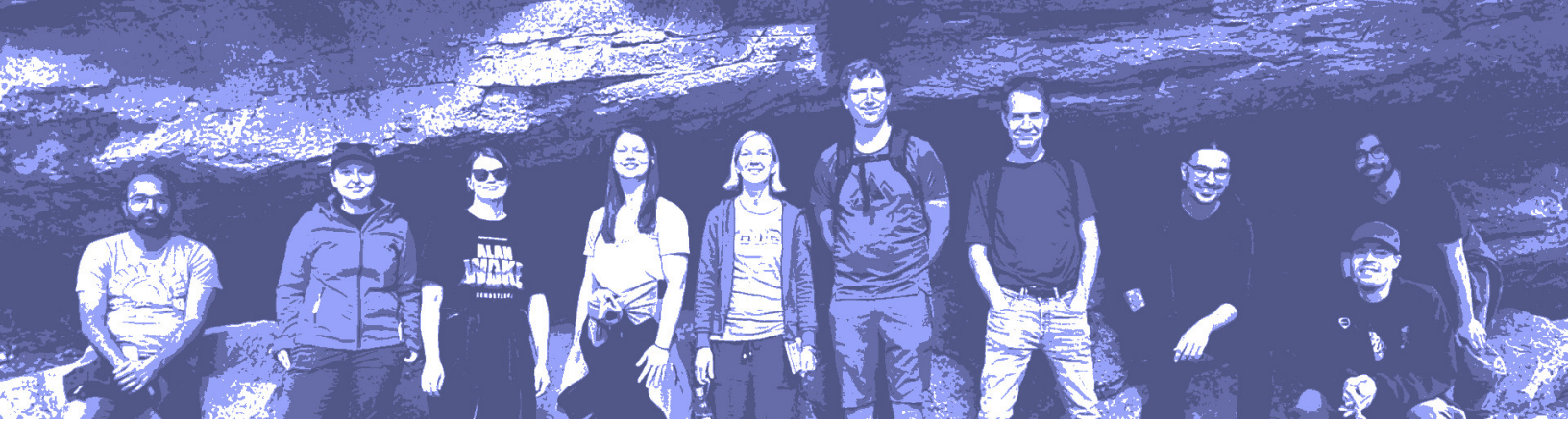
In addition to individual FINCA researchers having been awarded competitive external grants, a research infrastructure (FIRI) grant in 2017 and 2024 from the Research Council of Finland has enabled our participation in ESO instrument projects. FINCA is participating, on behalf of the Finnish community, in the ELT first-light instrument consortium MICADO (near-infrared adaptive optics imager) in the form of both direct funding, and by participating in the PSF reconstruction work package. The latter is led by UT in collaboration also with the Lappeenranta University of Technology. MICADO is expected to be the first-light instrument at ELT giving Finnish astronomers an unprecedented front-row seat when this new window into the universe opens. FINCA is also participating in another ELT instrument, MOSAIC (optical and near-infrared multi-object spectrograph), a 2nd phase instrument projected to see light in the 2030's, though the exact details of our contributions are still being investigated. Furthermore, we have been involved in a new instrument being built for the ESO 3.5-m New Technology Telescope (NTT), the Son Of X-Shooter (SOXS) – this completed instrument was shipped to Chile right at the turn of the year 2024/25. Finally, FINCA, together with UT and UH, is participating in an imaging spectrograph being built at the Niels Bohr

Institute in Copenhagen, the NOT Transient Explorer (NTE).

The year 2024, since March, was my first year in Finland for decades, and first full year as director of FINCA. It has been an absolute pleasure to work in Turku and get to visit the other places in the country where astrophysics research happens. We have also managed to do several fun things together with the FINCA staff, as some of the pictures in the Annual Review show. A very special memory, that combined past and present, was participating with several FINCAns, past and current, and other Finns, in the 2024 IAU General Assembly in Cape Town, where I had spent my previous 20 years.

I look forward to continuing work together with FINCAns, and the whole Finnish astronomical community, to continue developing and strengthening the field amidst the exciting developments happening at ESO, and elsewhere.

Petri Väisänen,
FINCA Director



2. Staff and Organization

FINCA staff 2024

Director :	Petri Väisänen	Turku
Professor Emeritus :	Mauri Valtonen	Turku
University Researchers :	Roberto De Propris (on leave)	Turku
	Pasi Hakala	Turku
	Kari Nilsson	Turku
Academy Research Fellows	Talvikki Hovatta	Aalto/Turku
Postdoctoral Researchers	Vandad Fallah Ramazani	Aalto
	Grigori Fedorets	Helsinki
	Johanna Hartke	Turku
	Tuomas Kangas	Turku
	Erik Kool	Turku
	Jyri Lehtinen (until 31.8.2024)	Helsinki
	Venkatessh Ramakrishnan	Aalto
	Quentin Salomé	Aalto
PhD Students	Jenni Jormanainen	Aalto/Turku
	Timo Kravtsov (from 1.10.2024)	Turku
	Pouya Mahmoudi Kouch	Aalto/Turku
	Maria Stone (Graduated June 2024)	Turku
Visiting researcher	Bela Dixit	Aalto
Other	Kelly Kelder (Summer intern)	Turku

FINCA board

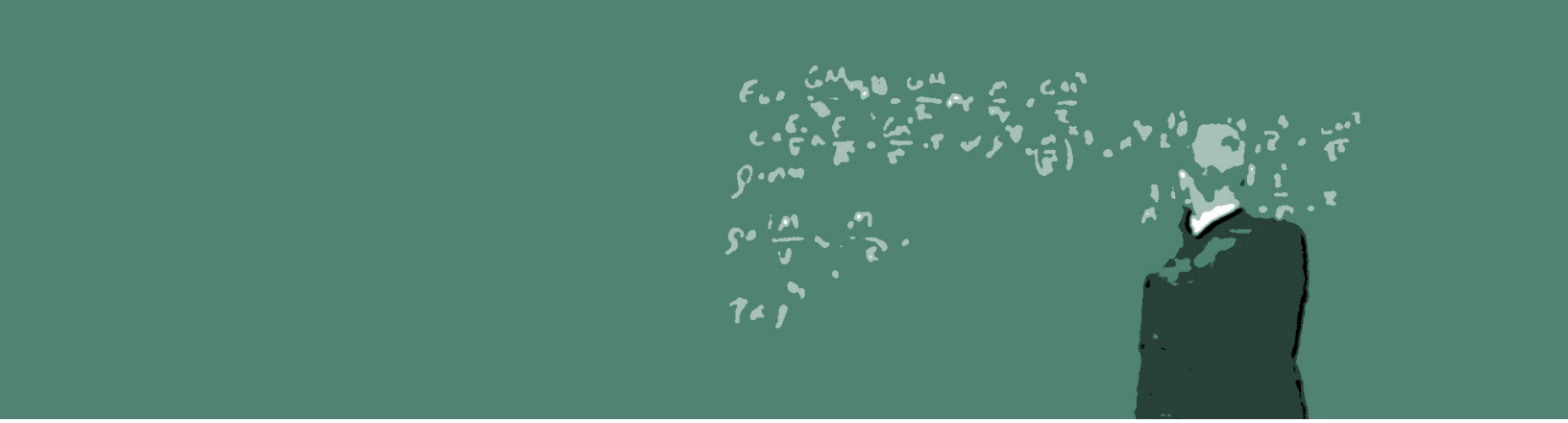
Members

Anne Lähteenmäki	Aalto
Merja Tornikoski	Aalto
Simo Huotari	Helsinki
Alexis Finoguenov	Helsinki
Heikki Salo	Oulu
Vitaly Neustroev	Oulu
Kalle-Antti Suominen (Chair)	Turku
Seppo Mattila	Turku
Talvikki Hovatta (staff representative)	Turku

Deputy members

Joni Tammi	Aalto
Tuomas Savolainen	Aalto
Karri Muinonen	Helsinki
Mika Juvela	Helsinki
Jurgen Schmidt	Oulu
Aku Venhola	Oulu
Mikael Granvik	Helsinki
Juri Poutanen	Turku
Kari Nilsson (staff representative)	Turku

Indoor and outdoor activities during the August 2024 retreat in Nuuksio, Espoo (Pictures: Petri Väisänen).



3. Research

3.1 Research Highlights

3.1.1 Solar system objects

Very small asteroids

Grigori Fedorets has continued his research under the auspices of the Planetary System research group at the University of Helsinki, with the main focus in the physical characterisation of very small asteroids with optical telescopes. G. Fedorets has carried out visiting observations at the Nordic Optical Telescope and the Metsähovi Optical Telescope, and is continuing to gather physical characterisation data of very small asteroids through his target-of-opportunity programme at the Nordic Optical Telescope. In terms of software development, he has carried out a major overhaul of the moving object observing tool used at the Nordic Optical Telescope. He has also continued his duties as the maintainer of the software for orbit determination of the short-term processing (i.e. new discoveries) of ESAs Gaia mission.

Fedorets has also continued his participation in the Solar System Science Collaboration for the Legacy Survey of Space and Time (LSST), particularly in the development of a synoptic small Solar System body survey simulator. Within the University of Helsinki, the primary interest of modeling with this simulator lies with the discoverability of the peculiar population of Earth's temporary moons. In new openings, G. Fedorets has taken an active role in a new collaboration for follow-up of new high-profile LSST solar system discoveries with ESO telescopes. He has also participated in a study assessing the feasibility of a cubesat swarm space mission concept to Earth's temporary moons.

3.1.2 Stellar and Galactic Astrophysics

Superluminous supernova SN 2023gpw

Tuomas Kangas led the follow-up of the superluminous supernova (SLSN) explosion SN 2023gpw. This object was a member of the rare class of hydrogen-rich SLSNe, whose progenitor stars and power sources are still a mystery as the power sources active in ordinary supernovae cannot produce the required luminosity. SN 2023gpw highlights the diversity within its class, as it exhibits a steep

cutoff in its light curve, so far unprecedented among SLSNe, and its other observational properties also show peculiarities. While most hydrogen-rich SLSNe can be explained by a typical supernova mechanism combined with an unusual amount of circumstellar matter around the progenitor star converting most of the supernova's kinetic energy into emission, this scenario does not apply to all of them. The kinetic energy required by SN 2023gpw seems to be so high that it requires a more powerful explosion mechanism, while the cutoff in its brightness is a serious constraint for such mechanisms. It is possible that a mechanism typically invoked to explain such high kinetic energies, the spin-down of a highly magnetic neutron star born in the supernova, cannot reproduce it, and other options – such as accretion onto a nascent black hole – must be considered. In any case, the progenitor star must have been very massive compared to most stars exploding as supernovae. A paper on this object will be submitted soon.

Interacting binaries

The FINCA research in the field of interacting binaries has been continued by **Pasi Hakala** very actively during 2024. Dr Hakala has exploited the resources provided by both ESO (VLT+NTT) and the NOT in his research to study cataclysmic variables of various kind. In particular Hakala, together with an international team of scientists (from Universities of Warwick(UK), Cambridge(UK) and Dartmouth (USA) as well as IAC(Spain) and ESO), discovered that the source ASASSN-14dx, a cataclysmic variable consisting of a white dwarf and a "normal" donor star, contains a massive white dwarf, that shows various pulsations modes (Hakala et al. 2025, submitted to MNRAS). The white dwarf is amongst the most massive detected in cataclysmic variables. This, together with the presence of non-radial white dwarf pulsations, makes the source very valuable for studies of accreting white dwarfs and white dwarfs in general. These results are based on a large observing campaign involving data from VLT/XSHOOTER, NTT/ULTRACAM, SAAO 1.9m, Kitt Peak 1.3m, as well as NOT photometry + polarimetry. We show a NOT and VLT spectra of the source in Fig 3.1

In addition, Hakala worked more on a large VLT/XSHOOTER P.I. data set of a supersoft source V Sge. The work was completed during early 2015 and has been submitted for publication in MNRAS. The team, that also included researchers from Oxford/Southampton Universities (UK) and IAC (Spain) discovered that this extraordinary and extremely rare system contains a circumbinary disc/ring of matter and that the accretion disc in the system exhibits chaotic behavior due to Eddington limited very high accretion rate, which leads to rapid changes in the structure/geometry of the inner accretion disc.

Hakala also opened new international collaborations, by joining in the very large effort to survey all the cataclysmic variables within 300pc spectroscopically. He used NOT to obtain spectra of a subset of 60-70 CVs. These will be combined with spectra from VLT, GTC and various smaller telescopes. The project is lead by Dr Anna Pala (ESO). Other two new collaborations involves researchers from Harvard/CFA and Caltech. Hakala, together with people from Caltech and Warwick, obtained linear polarimetry from NOT to set stringent limits on the nature of a newly found peculiar cataclysmic variable Gaia22ayj, which appears to be a sought after missing link in between different types of magnetic cataclysmic variables. More detailed polarimetric modeling is underway. Hakala was also contacted by the researchers at Harvard/CFA to carry out inversion modeling of cyclotron emission from two new magnetic cataclysmic variables, that appear to be particularly old, and thus rare. The first paper regarding these is already in press, but detailed cyclotron emission modeling is only starting.

Finally, Hakala has also continued his research on stellar magnetic cycles with the Armagh (N.I./UK) research group. They surveyed a sample of 1960 M dwarfs observed by NASA's TESS

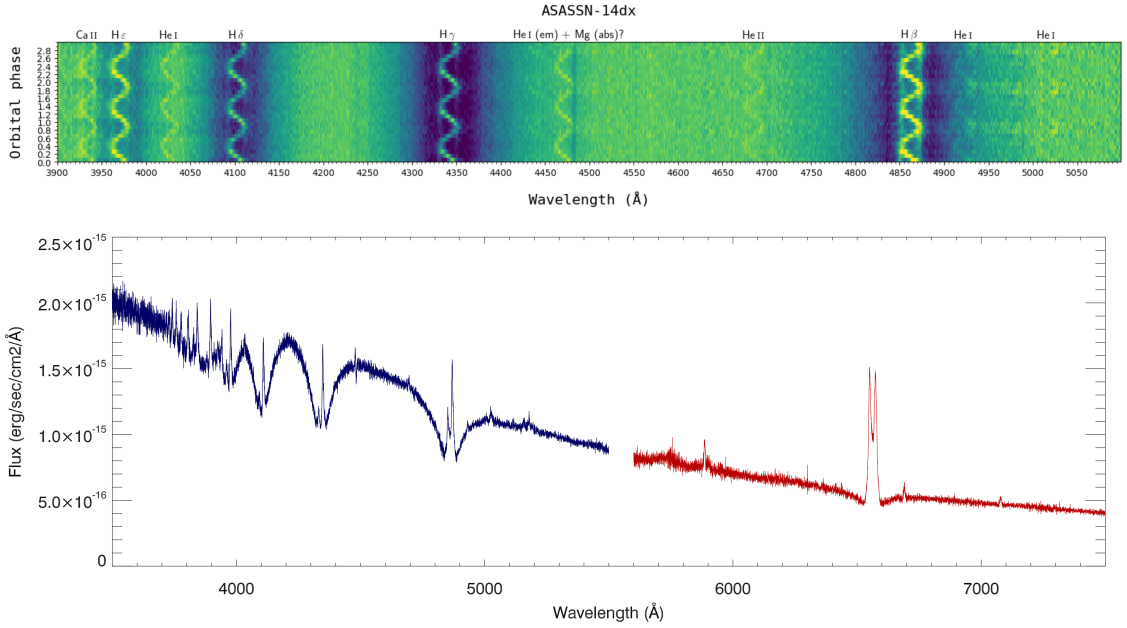


Figure 3.1: The NOT trailed spectra binned into 10 phase bins and plotted over three orbital periods for clarity (top). The single epoch X-Shooter UVB+VIS band spectrum (bottom)

satellite over several years in search of long term periods, reminiscent of solar cycles. They found 26 low-mass stars that showed evidence of variability in their photometric amplitude. Based on these they found a marginally statistically significant correlation between the range in the rotational amplitude modulation and the rotation period.

Oxygen rich supernova remnants

Timo Kravtsov completed his first lead author paper in which and his collaborators presented a new method of finding extragalactic supernova remnants. They also reported the discovery of extremely rare oxygen-rich supernova remnants in nearby galaxies, effectively doubling the number of known O-rich SNRs (Fig. 3.2).

3.1.3 Cosmology and Extragalactic Astrophysics

The UV upturn evolution to $z = 1$ and beyond

Ali et al. (including **Roberto De Propris**) have used data from the CLAUDS and HSC surveys to measure the rest-frame $NUV - V$ colors for several tens of galaxies in hundreds of clusters at $0.4 < z < 1.1$, using the local sample of clusters at $z < 0.15$ from De Propris et al. (2021 and in preparation) to cover the whole redshift range of interest. The evolution is compared with a series of models with varying helium abundance.

Figure 3.3 shows that the observed $NUV - V$ color is nearly constant at $z < 0.6$ but then becomes quickly redder beyond this redshift. At $z = 1$ the $NUV - r$ color is consistent with standard predictions for old early type galaxies formed at high redshift over short timescales with solar or higher metallicity. The rapid blueing at lower redshift can only be explained if these galaxies also contain a stellar population enriched in helium to nearly 45%, double the cosmological value, evolving to the blue horizontal branch after core hydrogen exhaustion. This is the same mechanism

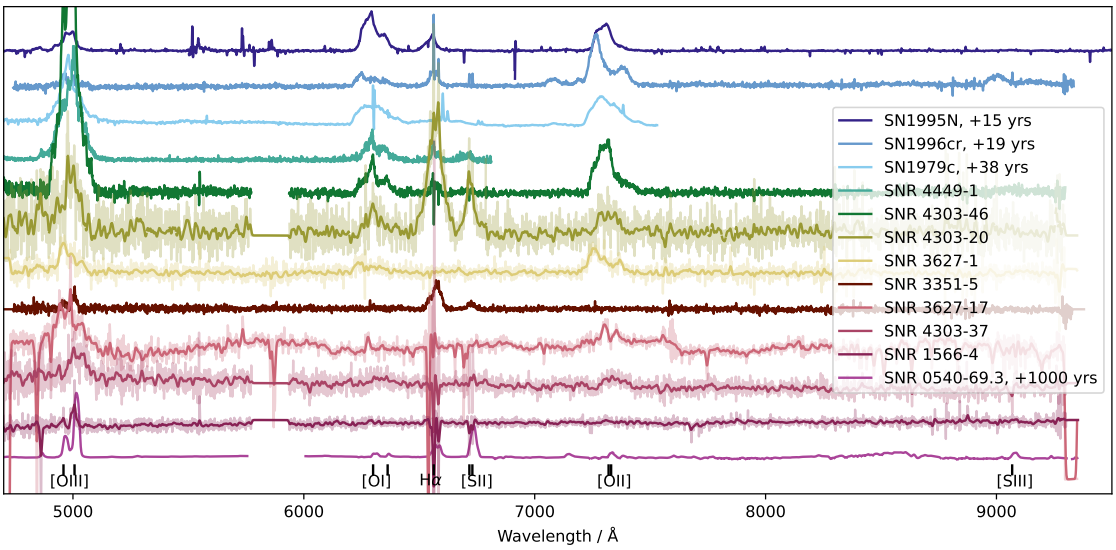


Figure 3.2: Examples of oxygen-rich supernova spectra.

responsible for the multiple populations in Galactic globular clusters, albeit at much higher metallicity. It implies that most of the stellar mass of early-type galaxies must have formed in situ at least by $z = 4$.

At higher redshifts the $NUV - V$ color is very sensitive to the age and star formation history of stellar populations and we have used this to estimate the epoch of star formation and its e-folding time for a simple exponential star formation history. We find that $3 < z_{form} < 10$ with $0.3 < \tau < 0.7$ Gyr, confirming that early type cluster galaxies form rapidly at early times (Figure 3.4).

Massive nearby compact galaxies by INSPIRE

2024 was an important year for the INSPIRE collaboration (PI Spiniello), where FINCA postdoctoral fellow **Johanna Hartke** is a member. The INSPIRE collaboration investigates relic galaxies, nearby massive compact galaxies that formed very early in the universe and have since not interacted with any other galaxies. They are made of only "in situ" stars since they missed the accretion phase of galaxy growth. They thus provide a unique opportunity to track the formation of this stellar component that formed in the very early Universe. In 2024, the third and final data release of the INSPIRE ESO large programme with the X-Shooter spectrograph and accompanying paper were published (Spiniello et al., including JH, 2024, MNRAS, 534, 1597). With this data release, the number of known relics has been increased tenfold. During a FINCA mobility visit to the University of Oxford, JH closely collaborated with INSPIRE collaboration members on the definition of a degree of relicness for this intriguing class of galaxies and the visualization of the final data products for the ESO data release. The collaboration furthermore published papers on the low-mass end slope of the stellar initial mass function (Maksymowicz-Maciata et al., including JH, 2024, MNRAS, 531, 2864) and the local environment of relic galaxies (Scognamiglio et al., including JH, 2024, MRNAS, 534, 1597). The most interesting targets from the INSPIRE sample are scheduled to be observed with the ESO MUSE integral-field spectrograph in 2025 (PI Hartke).

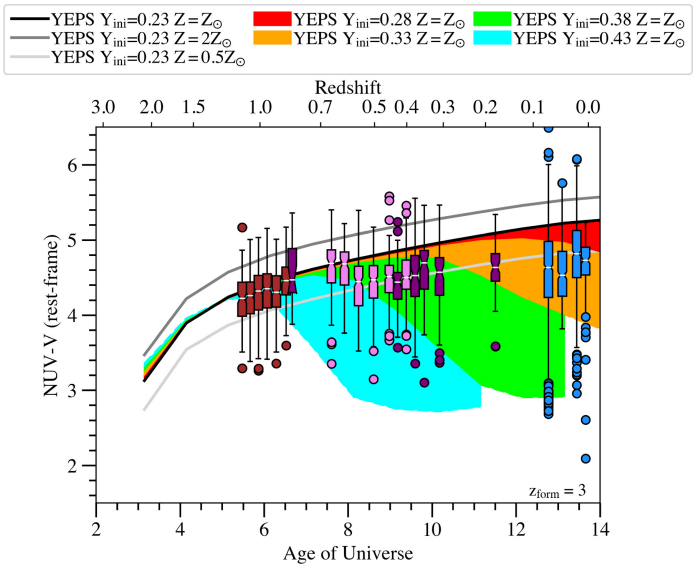


Figure 3.3: Evolution of the rest-frame $NUV - V$ (observed $g - y$ at z = 1) color over redshift/lookback time as given by the YEPS spectrophotometric (infall) models for a range of initial helium abundances Yini = 0.28, 0.33, 0.38, 0.43 (shaded areas), with zform = 3 and metallicities as detailed in the figure legends. Also included is the evolution of the same color for infall models with Yini = 0.23 (i.e., standard cosmological He abundance with no upturn) for Z = $Z_\odot$, 0.5 $Z_\odot$, and 2 $Z_\odot$ (solid lines). Plotted on top are box plots that show the rest-frame NUV – V colors of cluster galaxies in bins between z = 0 and 1.1, with different colors indicating the data sets from which the galaxies are derived, as labeled in the figure. Photometric uncertainties in color are <0.2 mag.

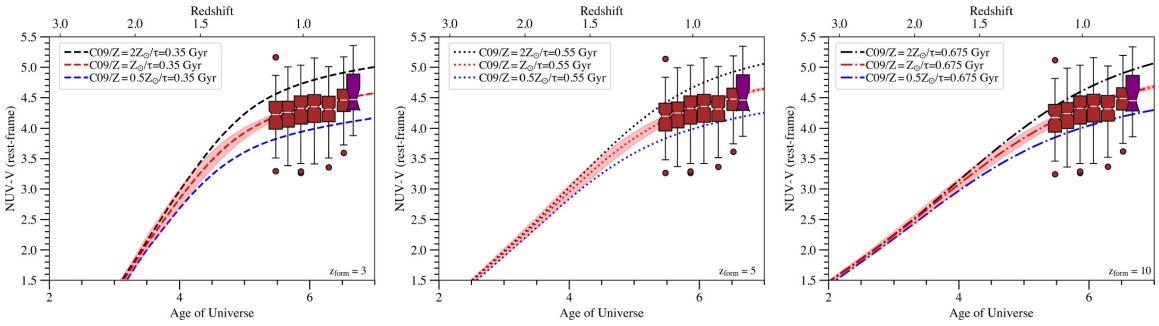


Figure 3.4: Evolution of the rest-frame $NUV - V$ (observed $g - y$ at z = 1) color of cluster ETGs over redshift/lookback time, but only for $z > 0.8$ where the upturn is expected to no longer be present. Also plotted for comparison are C09 CSP models for zform = 3, 5, and 10 (covering roughly 1.5 Gyr in range) and varying e-folding timescales (τ) that best fit the data for each formation redshift. The red dashed lines show the closest fit to the median for all redshift bins in each case (the red envelope indicates the uncertainty due to photometric error), with the black and blue lines showing the Z = $2Z_\odot$, and Z = $0.5Z_\odot$, models respectively. The results suggest that ETGs have zform = 3–10 and τ = 0.35–0.7 Gyr.

The extreme coronal line emitter AT 2022fpx

Supermassive black holes are known to disrupt passing stars, triggering tidal disruption events (TDEs). TDEs have recently attracted significant attention due to their unique dynamics and emission processes, which remain not fully understood. Optical TDEs, in particular, are intriguing because they often exhibit delayed or obscured X-ray emission from the accretion disk, leaving the origin of the prompt emission unclear. Our team, including **Elina Lindfors** and **Kari Nilsson** from FINCA, studied a peculiar optical TDE candidate, AT 2022fpx (Koljonen et al. 2024MNRAS.532..112K). We presented optical spectra obtained with the Nordic Optical Telescope (NOT), revealing highly ionized iron emission lines characteristic of extreme coronal line emitters. Additionally, we observed variable, low-polarization optical photometry, suggesting changes in the geometry of the emitting region. The overall outburst decay of AT 2022fpx deviates from that of typical TDEs, more closely resembling Bowen fluorescence flares. These observations suggest that AT 2022fpx may represent a transitional case, potentially linking various long-lived TDE scenarios (Fig 3.5) .

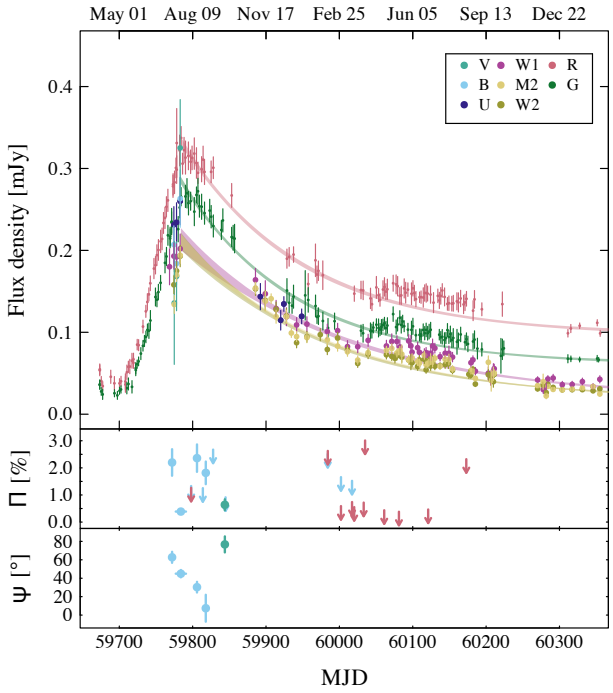


Figure 3.5: Follow-up optical polarization observations of AT2022fpx obtained using polarimeters on the NOT and Liverpool Telescope. The top panel show the optical/UV light curves from the Zwicky Transient Facility, NOT, and Swift/UVOT. The middle panel display the multiband, host-galaxy-corrected polarization degrees. The bottom panel show the polarization position angles.

MAGIC blazars

he international MAGIC Collaboration operates two Imaging Air Cherenkov Telescopes' at La Palma, Canary Islands, Spain. During 2024, FINCAns **Pouya M. Kouch**, **Jenni Jormanainen**, **Vandad Fallah Ramazani**, **Elina Lindfors**, **Kari Nilsson**, and **Talvikki Hovatta** were involved in many blazar studies in utilising the very high-energy (VHE, E > 100 GeV) gamma-ray data of MAGIC. To maximize the science output, the FINCA team also continues to perform quasi-simultaneous optical

observations of the sources observed by MAGIC using the Nordic Optical Telescope and Joan Oró Telescope.

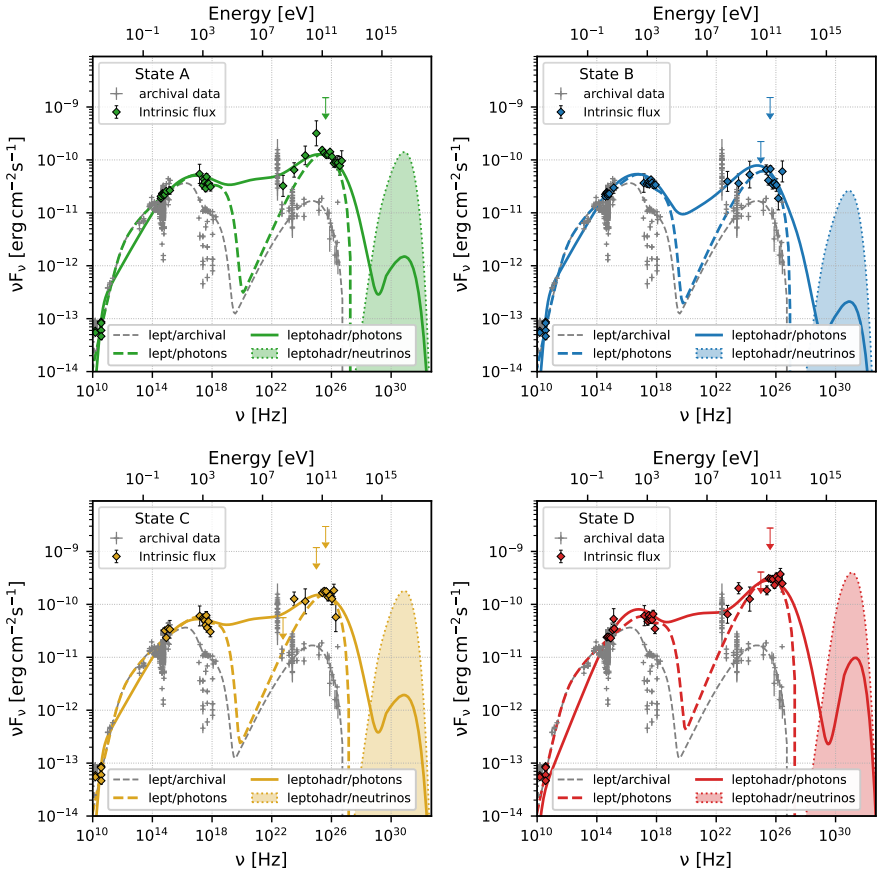


Figure 3.6: Four modelled SEDs of VER J0521+211 during four different states of the 2020 VHE gamma-ray flare. Archival data are shown in grey while the data of each epoch are shown in their respective colours. The two-zone leptonic model fluxes are shown in dashed lines and those of the one-zone lepto-hadronic model are shown as solid lines. The predicted neutrino spectra from the lepto-hadronic model are shown as dash-dotted lines with filled areas.

The BL Lacertae object VER J0521+211 underwent a flaring episode in February 2020. As part of the MAGIC collaboration we submitted a study (MAGIC Collaboration et al. 2025, corresponding authors: Jenni Jormanainen, Vandad Fallah Ramazani, Mireia Nievas-Rosillo, and Manuel Artero) focussing on the short-term modelling of the spectral energy distribution (SED) of this source (Fig. 3.6). Two plausible emission mechanisms were tested: a leptonic two-zone synchrotron-self-Compton scenario, and a lepto-hadronic one-zone scenario, and both models reproduced the observed SED from radio to the VHE gamma-ray band during four states of the flare. In addition, we modelled the long-term optical polarisation data using parameters derived from the leptonic SED modelling. This modelling was an important step forward in the modelling of the long-term polarisation features with a physical jet model, and it was found to partially replicate the observed data. At an earlier epoch, the polarisation degree and polarisation angle were not reproduced, and this was taken as evidence of changed jet conditions.

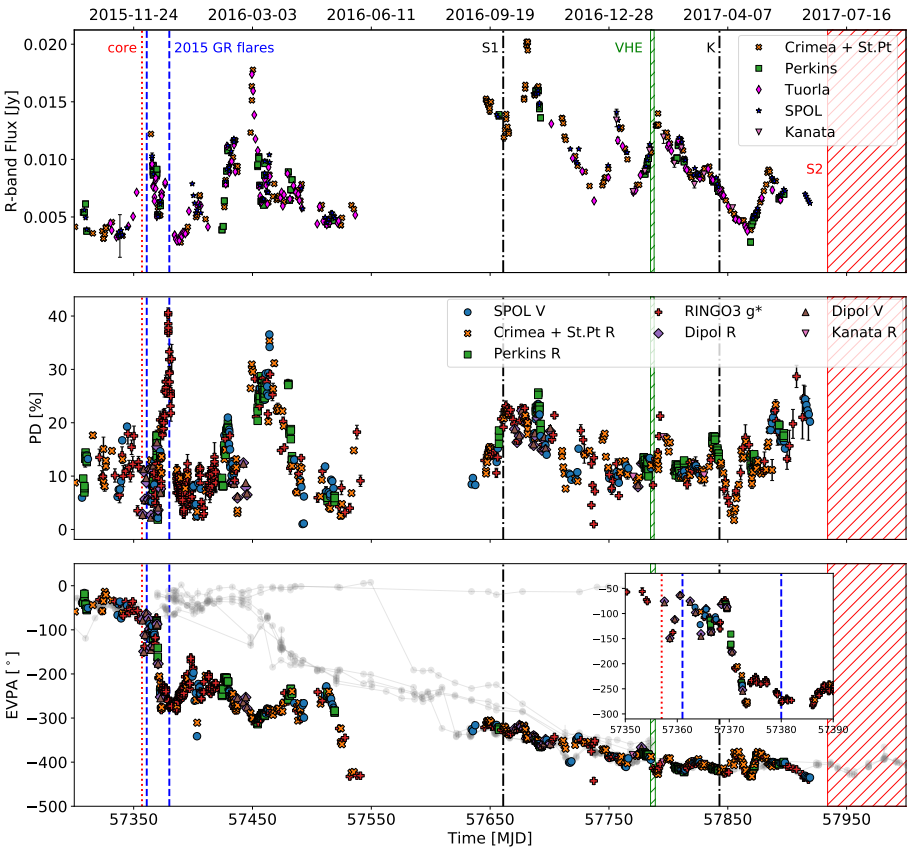


Figure 3.7: Light curves displaying the R-band flux and combined R-, V- and g*-band polarisation degree and electric vector polarisation angle curves. The inset panel shows a zoomed-in view of the long rotation seen in the optical data. The grey data points in the bottom panel show the evolution of the radio band. The vertical lines mark the times of various events observed during this epoch such as the moving component traversing down the jet and the VHE gamma-ray flare.

Polarisation observations were also analysed in the study (Jormanainen et al. 2025) submitted in 2024. OJ 287 is a bright blazar and one of the strongest candidates to host a supermassive black hole binary. We studied its polarisation behaviour between 2015 and 2017 by collecting optical photometric and polarimetric data from several telescopes (Fig. 3.7) and millimetre-wavelength polarisation data from the AMAPOLA programme. We combined these data with earlier multi-frequency polarimetric radio results and the results of very long-baseline interferometry imaging with the Global mm-VLBI Array at 86 GHz. In this study, we suggested that the multiwavelength polarisation signatures such as a fast optical 210-degree rotation and a gradual 360-degree trend seen in optical and radio bands could be explained with a moving component traversing down the bent jet. Additionally, the moving component passed through a stationary shocked region that we suggested to be the cause of a VHE gamma-ray flare seen from OJ 287.

Multiwavelength polarization of blazars with the IXPE satellite

FINCAns **P. Kouch**, **J. Jormanainen**, **V. Fallah Ramazani**, **E. Lindfors**, **K. Nilsson**, and **T. Hovatta** participated in several photo-polarimetric campaigns of blazars across the electromagnetic spectrum, from the radio band all the way to X-rays. Polarimetry in such high energy bands as X-rays is made possible by the Imaging X-ray Polarimetry Explorer (IXPE) satellite. They directly contributed to the studies by performing photo-polarimetric observations using the Nordic Optical Telescope (NOT)(Fig 3.8). While the group members were co-authors on tens of IXPE papers, they led two IXPE multiwavelength papers: (1) on the high-synchrotron peaked blazar PKS 2155304 in Kouch et al. (2024; A&A, 689, A119); and (2) on the low-synchrotron peaked blazar S4 0954+65 in Kouch et al. (2025; A&A, 695, A99).

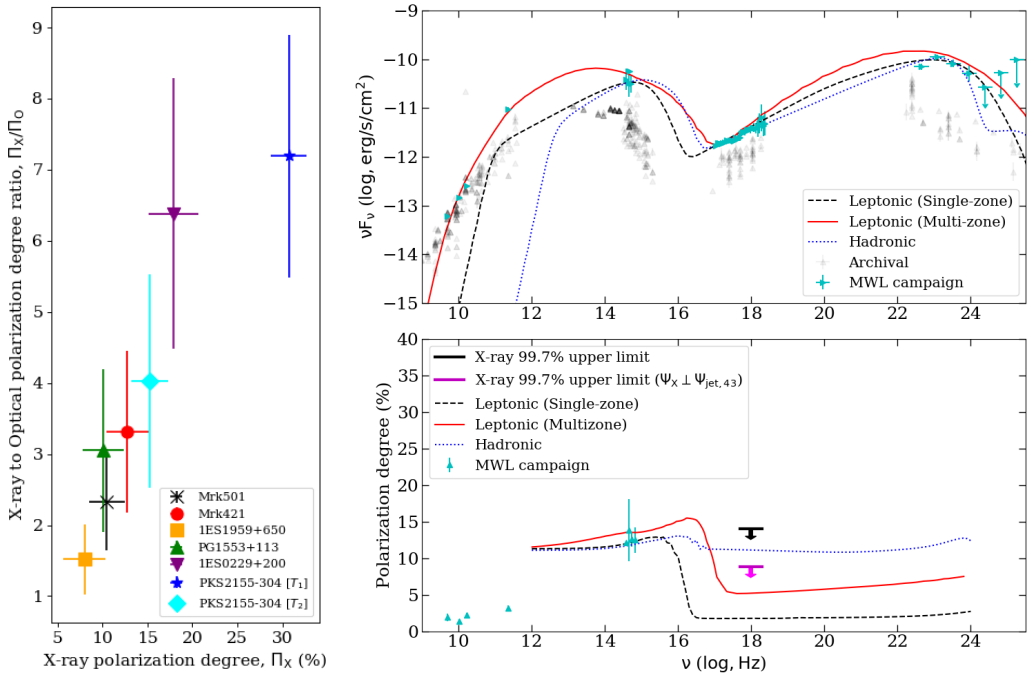


Figure 3.8: *Left*: X-ray-to-optical polarization degree against X-ray polarization degree in high-synchrotron peaked blazars observed by IXPE. This trend hints toward the energy-stratification of plasma in the acceleration zones of blazars. *Right*:Spectral energy distribution (top) and spectral polarization distribution (bottom) of S4 0954+65 during the IXPE campaign. The bottom panel shows how the upper limit of <9% on the X-ray polarization degree disfavors the prediction of the hadronic scenario (blue dotted line).

In the PKS 2155304 paper we detected the highest polarization degree from a blazar in the X-ray band to date (31%), which was several times greater than that in the optical band, reaffirming the energy-stratified picture in the acceleration zones of blazar jets. Our results pointed toward shocks as the likely acceleration mechanism in blazar jets.

Multimessenger emission of blazars

The FINCA blazar group also continued their research on the mystery of the blazar-neutrino connection. Ever since the high significance spatio-temporal correlation of a high-energy (HE;

>100 TeV) neutrino event with the flaring blazar TXS 0506+056, researchers have been trying to establish a systematic correlation between blazars and HE neutrinos. The results have so far remained inconclusive, albeit suggestive, which motivates further population-based studies.

P. Kouch, **J. Jormanainen**, **V. Fallah Ramazani**, **E. Lindfors**, **K. Nilsson**, and **T. Hovatta** simulated >4000 blazars with varying degrees of correlation to neutrinos. The aim was to establish the most optimal test-statistic construction for our spatio-temporal correlation test, which was used in previous papers Kouch et al. (2024; A&A, 690, A111), Liodakis et al. (2022; A&A 666, A36), and Hovatta et al. (2021; A&A 650, A83). It was found that a counting-based test-statistic parameter, weighted using our novel scheme from Kouch et al. (2024), offers the greatest detection power and should robustly detect a potential blazar-neutrino correlation at least at the 4 level.

Blazar host galaxy studies

Blazars constitute the most numerous source class in the known extragalactic population of very high energy (VHE) gamma-ray sources. However, determining their redshifts is often challenging due to weak or non-existent emission lines in their spectra. Therefore, we have organized within CTAO consortium a task force to perform large redshift surveys of blazars, using also ESO telescopes. Within the task force, already three papers using direct spectroscopy with high S/N to determine the distance has been published with FINCA co-authors (Goldoni et al. 2021, Kasai et al. 2022, D'Ammando et al. 2024). In 2024, we also published two FINCA led papers on indirect constraints to distance to blazars for which the direct spectroscopy had yielded only in lower limits.

K. Koljonen, **E. Lindfors** and **K. Nilsson** analyzed multiobject spectroscopy obtained with ESO/FORS2 on galaxies around two blazars, where previous attempts at redshift determination had faced difficulties (Fig, 3.9). By combining spectroscopic observations with photometric redshift estimates, a redshift of z = 0.634 to KUV 00311-1938 and a likely redshift of z = 0.49 to S2 0109+22 were tentatively assigned.

In another study, **K. Nilsson**, **V. Fallah Ramazani** and **P. Kouch** obtained deep I-band images of 17 Fermi-LAT detected BL Lacertae objects with the Nordic Optical Telecope (NOT) with the aim of deriving photometric redshifts for these targets. These observations were part of a larger campaign to pick up suitable targets for the upcoming Cherenkob Telescope Array Observatory (CTAO). BL Lacertae objects have been found to be hosted by luminous elliptical galaxies with a relatively narrow luminosity range ($\pm$0.5 mag), which enables determining their redshift to an accuracy of 0.05-0.07 up to z$\sim$0.7, if the host galaxy can be detected with sufficient signal to noise. A second method using the Kormendy relation of elliptial galaxies was also employed.

Using a 2-dimensional image decomposition (Fig. 3.10), the group was able to derive redshift estimates for 9 out of 17 targets. The two methods we found to yield identical results. They also compared their estimates made during the past 20 years to spectroscopic redshifts measured later showing a good correlation between the two thus validating the method.

Blazar variability timescales

In collaboration with the Aalto University Metsähovi Radio Observatory, **Sofia Kankkunen** used up to 42 years of monitoring data to analyze the long-term radio variability of blazars and to understand the potential pitfalls in the typical methodologies used (Kankkunen et al. 2025a and Kankkunen et al. 2025b, see Fig 3.11 for an example). The work was continuation to Hovatta et al. (2007) and confirmed the difficulty in constraining radio variability timescales even with such long monitoring periods. Nevertheless, there appears to be a connection between the time how long the jet knots are visible in very long baseline interferometry (VLBI) images and the obtained characteristic timescales,

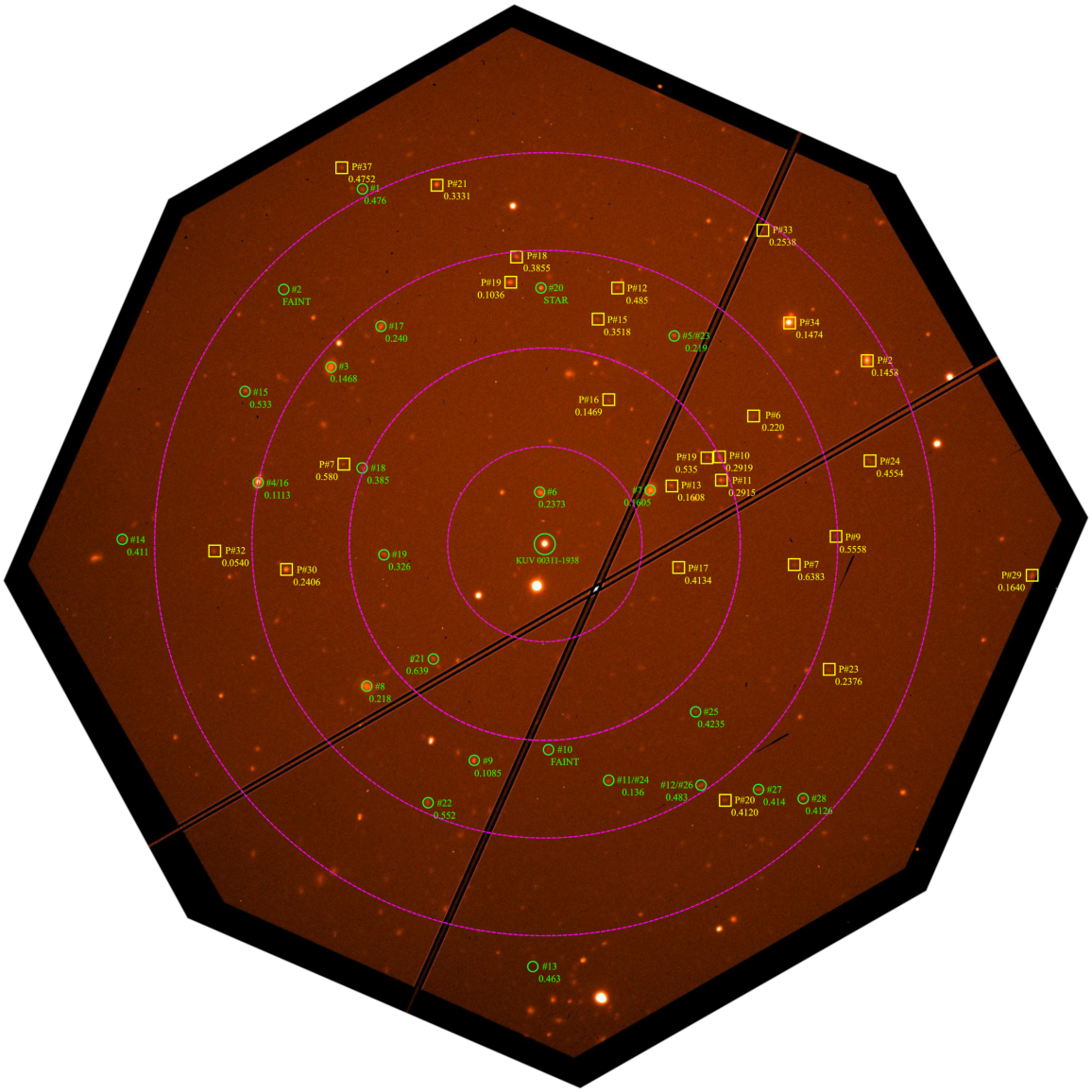


Figure 3.9: Mosaic R-band image of the field of KUV 00311-1938 taken with FORS2 from our observations. The green circles indicate the sources observed with FORS2 MOS, the yellow squares indicate the sources observed with Gemini, and the blue diamonds mark the GTC sources from Pichel et al. (2021). Corresponding source redshifts are shown along with the source numbering. Sources with a stellar spectrum are marked as 'STAR'. Magenta dashed lines show angular radii of 0.5, 1.0, 1.5, and 2.0 Mpc at a redshift of z = 0.64 (the most likely distance of the blazar based on our analysis). The yellow and green stars show the centre locations of the spectroscopic and photometric groups at z = 0.64 and z = 0.7, respectively, derived from our analysis. The black lines crossing the image come from chip gaps and the image is cropped to show only the area covered by the two exposures.

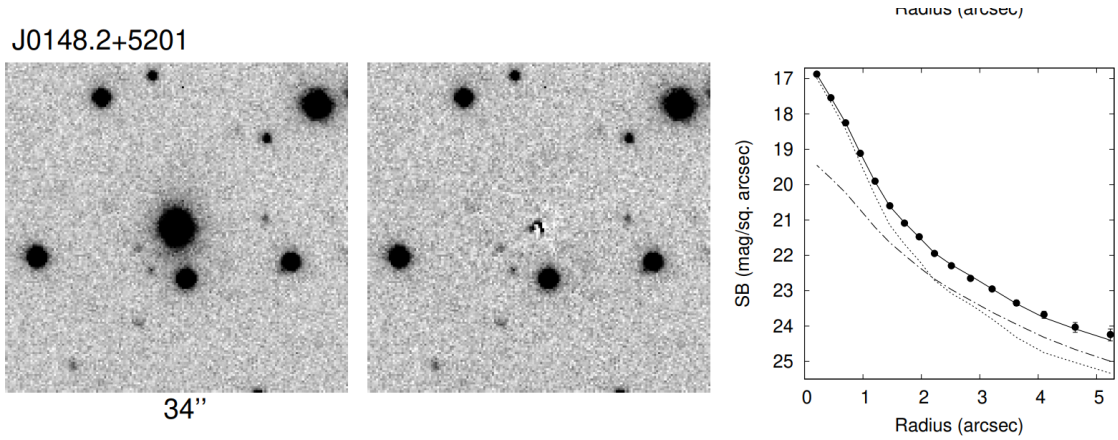


Figure 3.10: Two-dimensional image decomposition: *left*: observed image, *center*: residuals after model subtraction, *right*: radial surface brightness profiles of the AGN nucleus, host galaxy and their sum.

and the work continues to confirm the physical link (Kankkunen et al. in preparation).

Physical conditions of the gas in Centaurus A's northern filaments

Evidence of recent star formation is observed in the halo of few radio galaxies, where the radio jet encounters a gas reservoir. This suggests that star formation is triggered by the interaction (jet-induced star formation). The northern filaments of Centaurus A are a testbed to study the influence of the radio jet on gas in the halo. Located at about 15 kpc from the galaxy, where the jet encounters a large HI shell, the filaments host a large reservoir of molecular gas associated with very inefficient star formation.

Quentin Salomé is leading a multi-wavelength spectroscopic campaign to study the physical conditions of the gas in the filaments and the energetic budget (heating vs cooling). ALMA observations were conducted to look for dense gas, as traced by the HCN and HCO^+ emission, at the scale of giant molecular clouds. The detection of HCO^+ and the non-detection of HCN suggest that the molecular clouds are likely dominated by diffuse molecular gas, which could explain the low star formation efficiency in the filaments. A complementary analysis based on VLT/KMOS observations now aims at identifying the mechanism that dominates the excitation of HCO^+.

Black holes with the Event Horizon telescope

The Event Horizon Telescope (EHT) results on M87* and Sgr A* now directly, and almost unequivocally, provide evidence for the existence of two Supermassive black holes (SMBH). This significant breakthrough forms the foundation for my attempt to directly image and measure the properties of nearby SMBHs and to study their interaction with their environment. As per the no- hair theorem, SMBHs are best described by the Kerr metric, which characterises the black holes by their mass and angular momentum or spin. The mass can be estimated by the diameter of a black hole's shadow, while the spin, despite being insensitive to the size of the shadow and its shape, can be constrained with a combination of sensitive EHT observations and high-precision general relativistic ray tracing (GRRT) algorithms. Crucially, for the classes of SMBH systems of interest for EHT observations, the near-event horizon regions that lead to these spectacular sub-mm images are also responsible for producing the X-rays.

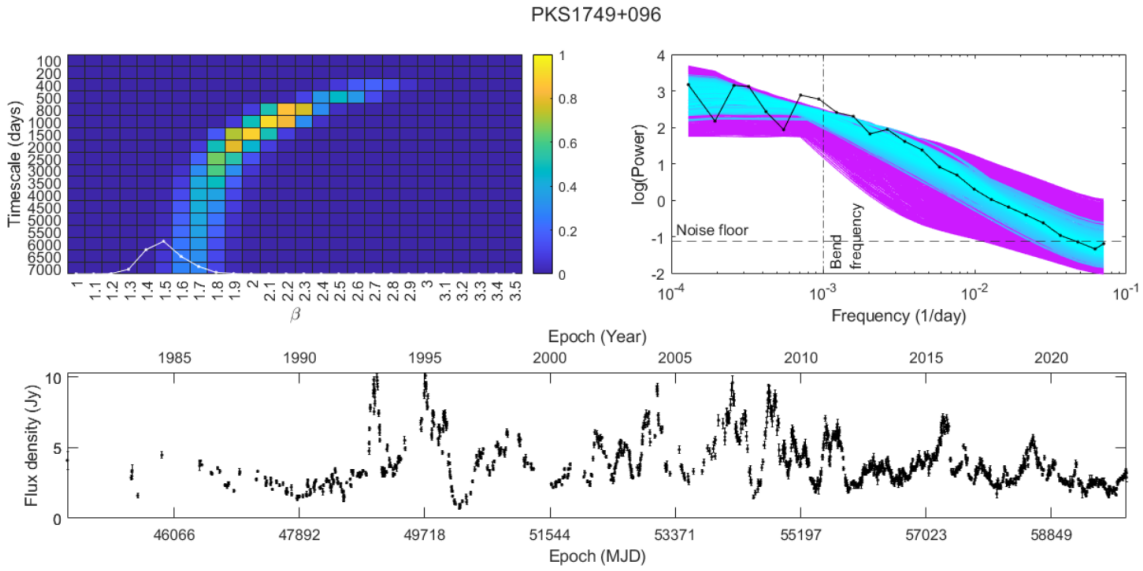


Figure 3.11: Results from the periodogram analysis of source PKS1749+096. The upper left- side plot shows the heat map overlaid with the simple power-law fit in white. The plot on its right is the periodogram of the source including all of the mean periodograms of the simulated bending power laws with cyan indicating the best fit and magenta the worst. The bottom row shows the source light curve.

Venkatessh Ramakrishnan started a project to exploit the scale-invariance property (black hole mass and accretion rate) of the GRMHD simulations to modelling the spectral energy distribution (SED) from radio to gamma rays. They can constrain the electron distribution function that determines the nature of accretion in respective targets

In support of this study, Ramakrishnan got some multi-frequency observations through an ALMA proposal and a soft and hard X-ray proposal submitted to NICER and NuSTAR space telescopes. Thus far only a single class of accretion models in which the magnetic field was added in an ad hoc manner are considered. Similarly, only simple, qualitatively jet model are used for AGN studies. While this has a variety of advantages, a more detailed study of existing accretion/jet simulations is warranted. Hence, Ramakrishnan began to incorporate the improvements based on both analytical one-zone model and GRMHD simulations to the observations. There is great scientific return from this broad spectral coverage which will be addressed with the relevant emission-related processes at radio through sub- millimetre wavelengths and at X-ray energies.

The multi-frequency observations of AGNs provide a powerful method to constrain many physical parameters, including the opacities of accretion flows and hence providing independent estimates of black hole masses. Using a one-zone model, the synchrotron spectra for Sgr A*, M87*, and three AGNs were solved as shown in Figure 3.12. The filled circles, plug-sign, and open circles in the plot indicate optically thick, opacity $\sim$1, and optically thin accretion flows. It is remarkable that for both Sgr A* and M87*, the proposed observation frequencies probe all three regimes. The three AGN cases have the same flux (0.1 Jy) and distance (10 Mpc), but different masses (10^8, 10^9, 10^{10} times the mass of the sun). Their opacities vary from [thick, thick, thick] to [thick, $\sim$1, thin] to [$\sim$1, $\sim$1, thin] as marked by the different symbols (Fig 3.13). Conversely, it is possible to use

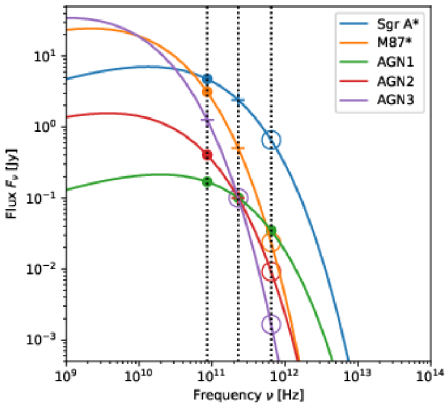


Figure 3.12: One-zone modelling of AGNs.

the multi-frequency observations from the three bands to independently estimate the distances and masses, and other physical properties, of the sources.

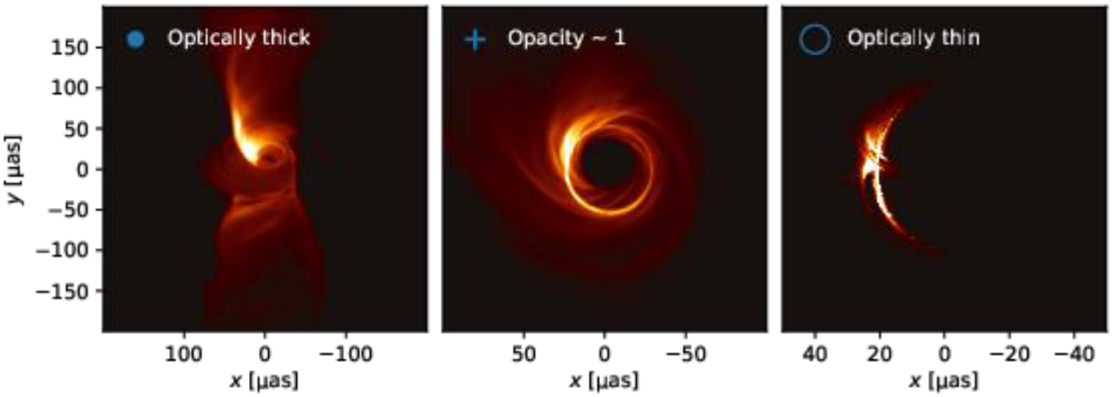


Figure 3.13: Possible models of Sgr A* at the three opacity regimes. (Left) An optically thick accretion flow, where the accretion disk blocks the black hole shadow. (Middle) the situation with opacity $\sim$1, where both the black hole shadow and accretion flow visible. (Right) an optically thin regime, where only the photon ring is visible.

4. Instrument Development

Son of X-Shooter (SOXS): In commissioning

The SOXS instrument was completed in INAF Padova, Italy (Fig. 4.1). Following verification tests and a review late in 2024, ESO awarded preliminary acceptance in Europe (PAE), signifying the readiness of the instrument to be shipped to Chile for installation at the NTT telescope in ESO La Silla Observatory. It was packed and shipped to Chile after the New Year. The SOXS consortium is now preparing for the scientific use of the instrument, set to start in autumn 2025.

The calibration unit (CU) of SOXS was constructed at the University of Turku as Finland's contribution funded through a FINCA FIRI grant. The work was led by Academy Researcher Hanindyo Kuncarayakti, in collaboration with University of Turku's Protopaja workshop and optical design company IncidentAngle Oy.

Hardware at Metsähovi Radio Telescope

Backend development for the new ultra-wideband triple-band receiver for Metsähovi Radio Observatory continued as part of the Research Council of Finland early career research project led by Academy Research Fellow Talvikki Hovatta. In 2024, the polarimeter design was successfully compiled for the desired RFSoC (Radio Frequency System on Chip) board, ensuring it operates without timing errors. Various options for a fast data acquisition system were explored to enhance performance. Additionally, the implementation of an interleaved ADC algorithm on a Generation 1 RFSoC board was demonstrated, and the results were presented by **Bela Dixit** at the 4th URSI Atlantic Radio Science Meeting – 2024. **Kaj Wiik** started to design the backend carrier board with design of a digital subsystem including e.g. 128 Gbit/s ethernet connection which is now completed. Block-level design of the microwave part containing the synthesizers and baseband I/Q downconverters is also complete and electromagnetic FDTD (finite-difference time-domain) simulation of printed circuit board is ongoing. **Talvikki Hovatta** was also granted a prestigious European Research Council Consolidator grant, including funds for building the backend based on the design completed during the Resarch Council of Finland project that ended in August 2024.

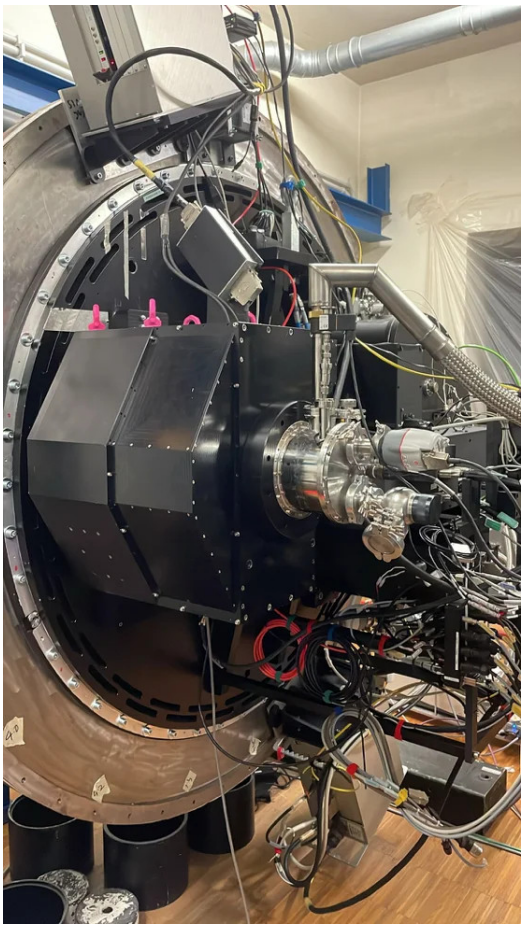


Figure 4.1: Fully integrated SOXS instrument in Padova. Picture: INAF.

Africa Millimeter Telescope (AMT)

FINCAns **Talvikki Hovatta** and **Elina Lindfors** continued their active participation in the Africa Millimeter Telescope (AMT) project where a new radio telescope will be built in Namibia. The telescope will participate in Event Horizon Telescope observations and also perform single-dish monitoring, which will have important synergies with the CTAO. In 2024, the preliminary design review of the telescope was completed and plans for the telescope site were made.

The CTA array at ESO

CTAO, the first VHE gamma-ray observatory, will consist of two telescope arrays: the CTAO Northern array, on Instituto de Astrofísica de Canarias' (IAC) Roque de los Muchachos Observatory on the Canary island of La Palma (Spain), and the CTAO Southern array, at the European Southern Observatory's (ESO) Paranal Observatory in the Atacama Desert. In 2024, the construction of the three more LST telescopes of the Northern array continued. Also the preparation of the Active Galactic Nuclei Key Science Program continued with active participation from FINCAns **Kari Nilsson** and **Talvikki Hovatta** and former FINCAn **Elina Lindfors**.

5. Teaching

5.1 Lectured courses

Basic level - in Finnish

Teacher	Course	Credits	Location
K. Nilsson (co-lecturer)	Johdatus Maailmankaikkeuteen	5	Turku
P. Väisänen (lecturer)	Johdatus Maailmankaikkeuteen	5	Turku

Advanced level - in English

Teacher	Course	Credits	Location
G. Fedorets (co-lecturer)	Observational Techniques Using the Nordic Optical Telescope	7	Turku
T. Hovatta (co-lecturer)	Space Instrumentation	5	Aalto
J. Hartke (co-lecturer)	Optical Systems Applications	5	Turku
	Data Processing Techniques for Astronomy with ESO	5	Turku
T. Kangas (co-lecturer)	Observational Techniques Using the Nordic Optical Telescope	7	Turku
Q. Salomé (lecturer)	Radio Astronomy I	5	Aalto
P. Väisänen (co-lecturer)	Data Processing Techniques for Astronomy with ESO	5	Turku

5.2 Completed theses

MSc theses

Milla Välitalo, University of Turku, *Progenitor stars of Type IIn supernovae using the NCR method*, supervisor: Tuomas Kangas.

PhD theses

Maria Stone, University of Turku, *"Galaxy Evolution through the Lens of Active Galactic Nuclei, Their Host Galaxies and Environments"*, supervisors Kari Nilsson and Roberto de Propris.

6. Other research activities

FINCA Visitor and Mobility Program

Twice a year, FINCA publishes a Call for Applications for its "Visitor and Mobility Program" to promote the scientific interaction of FINCA, and Finnish astronomers, with research institutions worldwide.

During 2024, the following trips were approved to be funded, in full, in part, or in some cases conditionally. Some of the actual trips approved in the second call in the latter part of 2024 would have happened in 2025.

Mobility grants – the awardee, their institute, and the research visit destination, are indicated

Panagiotis Charalampopoulos	Turku	Warwick University, UK
Ghassem Gozaliasl	Helsinki	University of Heidelberg, Germany, or Caltech, USA
Vadim Kraustou	Turku	INAF Brera, Italy
Paula Kvist	Oulu	ESO, Chile
Takashi Nagao	Turku	Kyoto University, Japan
Venkatessh Ramakrishnan	FINCA/Aalto	University of British Columbia, Canada

Visitor grants – the visitor with their home institute, and their Finnish destination and host, are indicated

Enrico Congiou	ESO, Chile	FINCA/Turku	Johanna Hartke
Luc Dessard	IAP, Paris, France	Turku	Rubina Kotak
Anna Ferré-Mateu	IAC, Tenerife	Turku	Johanna Hartke
Anna Ferré-Mateu		Oulu	Aku Venola, Melina Poulain
Jonah Gannon	Swinburne University, Australia	Turku	Johanna Hartke
Jonah Gannon		Oulu	Aku Venola, Melina Poulain
Arka Sarangi	NBI, Denmark	Turku	Rubina Kotak
Danny Steeghs	Warwick, UK	Turku	Tom Killestein
Federico Vincentelli	Southampton, UK	Turku	Alexandra Veledina

ESO Incentive program

To support new ESO-related research, and the timely analysis and publication of such results, FINCA awards grants to all Finland-based PIs, who have been successful in their ESO or ALMA observing proposals. In 2024, the following grants were awarded:

ESO period 113

P. Charalampopoulos	Turku	Two separate VLT/FORS2 programs studying Tidal Disruption Events.
P. Hakala	FINCA/Turku	VLT/XShooter studies of a black hole in a low-mass X-ray binary.
T. Hovatta	FINCA/Aalto	VLTI/GRAVITY studies in high-resolution of jets in blazars.
R. Kotak	Turku	VLT/UVES studies of young Supernovae.

ESO period 114

T. Kangas	FINCA/Turku)	VLT/XShooter studies of hydrogen-rich supernovae.
T. Killestein	Turku	VLT/FORS2 studies of circumstellar matter and progenitor of a supernova.
V. Neustroev	Oulu	VLT/XShooter studies of dwarf nova cataclysmic variables.

ALMA Cycle 11

T. Hovatta	FINCA/Aalto	ALMA studies of dust in blazars.
M. Juvela	Helsinki	ALMA studies of fragmenting prestellar cores.
V. Ramakrishnan	FINCA/Aalto	ALMA studies of accretion and jets in low-luminosity AGN.

NOT observations support program

FINCA also supports PIs, based in FINCA-affiliated universities, who are successful in obtaining observing time from the NOT. This support comes in the form of reimbursing travel costs to La Palma, Canary Islands, in case of Visitor mode observations, or the payment of Service Observing fees.

During 2024, three trips to La Palma were supported from FINCA funds, and there were 26 payments made for Service Observing fees for 15 different programs. These programs included also remote observing nights for the national NOT School run by UT and FINCA, and the hands-on NOT school for Finnish high school students run by the Turku-based LUMA Centre.

Memberships in conference SOC/LOC and other committees

J. Hartke	Panel member, ESO Observing Programmes Committee
T. Hovatta	Finnish representative in the ESO Scientific Technical Committee Chair of the European Science Advisory Committee for ALMA SOC member of the 16th European VLBI Network symposium, Sep 2-6, 2024, Bonn, Germany SOC memeber of the1st Nordic Meeting on Neutrino and Radio Astronomy, May 27-30, 2024, Gothenburg, Sweden
T. Kangas	ESO Observing Proposal Committee participation for Period 114 SOC co-chairship in, and preparing a proposal for, an IAU-sanctioned conference "Future landscape of astrophysical transients: novel approaches in theory and observations"
P. Kouch	LOC member for the Astronomers' Days 2024 (May 2024) Chair of the Scientific Organizing Committee of the Nordic-Baltic Astronomy Days 2026 (Turku) Chair of the Local Organizing Committee of the Nordic-Baltic Astronomy Days 2026 (Turku)
Q. Salomé	LOC member for the Astronomers' Days 2024 (May 2024)
P. Väisänen	Member of the Finnish ESO National Committee Member of the Finnish National Committee for Astronomy Finnish Representative at the XXXII IAU General Assembly Business Meetings Member of the ELT/MICADO Consortium Board Member of the ELT/MOSAIC Consortium Board Member of the UTU EXACTUS Steering Committee / Board NOT representative in the International Scientific Committee of the Canary Islands (CCI) *ex-officio* Member of the NOT Council *ex-officio* Member of the FINCA Board

Conference presentations

R. De Propris	AGN across continents, Durham, UK, 8-12 July 2024, "The Social Network of Quasars" (poster) IAU General Assembly, Cape Town, South Africa, 11-15 August 2024 "The Social Network of Quasars" (poster) IAU General Assembly, Cape Town, South Africa, 11-15 August 2024 "The Merger-AGN-SFR connection or not ?" (poster) IAU General Assembly, Cape Town, South Africa, 11-15 August 2024 "Helium rich stars produce the UV upturn" (poster) Lurking Lions, workshop on galaxy formation, Kruger Park, South Africa, 17-21 August 2024,"The UV upturn in early type galaxies" (talk)
G. Fedorets	What was that? – an ESO workshop on planning follow up for transients, variables, and solar system objects in the era of LSST, Garching, Germany, 22.-26.1.2024 (poster) Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "Characterising very small asteroids as building blocks of the Solar System" (talk) Workshop "Microsatellites and their use in planetary and astrobiology research", Tartu Observatory, Tartu, Estonia, "Earth's temporary moons as potential targets for space missions" (poster)
J. Hartke	Tuorla-Tartu meeting 2024: Borderless Universe, May 6-8, 2024, Turku: Unveiling the dynamical status of galaxies and intra-group light in nearby groups and clusters with discrete tracers (talk) Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "Catching the formation of the ultra- diffuse galaxy Hydra-UDG 32 in the act" (talk) EAS 2024, SS7: Unlocking the Secrets of Ultra Diffuse Galaxies, Padova, Italy, July 2024: "UDG32: an ultra-diffuse galaxy formed from ram-pressure strippped gas in the Hydra cluster?" (talk) Vienna ELT Science + Simulations Workshop #1 "First Light", Vienna, Austria, November 2024: "Supernovae and UCMGs at high-redshift with MICADO" (talk)
T. Hovatta	The promises and challenges of the ALMA Wideband Sensitivity Upgrade, June 24-28, 2024, Garching, Germany: "Polarization over wide bandwidths - impact of ALMA WSU on studies of extreme Faraday rotation" (invited talk) Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "Resolving supermassive black hole jets in near-infrared wavelengths" (talk) Tuorla-Tartu meeting 2024: Borderless Universe, May 6-8, 2024, Turku: "Resolving near-infrared emission of blazars with VLTI-GRAVITY" (talk)

J. Jormanainen	BlackHolistic Meeting December 16–18 2024, Oxford, United Kingdom "The polarisation behaviour of OJ 287 viewed through radio, millimetre and optical observations between 2015 and 2017"(talk) 8th Heidelberg International Symposium on High-Energy Gamma-Ray Astronomy September 2–6 2024, Milan, Italy "Describing the ultra fast very-high-energy gamma-ray flare of IC 310 with relativistic reconnection models"(talk) Finnish Astronomers' Days 2024 May 20–22 2024, Vaasa, Finland "The long 2016 polarisation angle rotation of OJ 287"(talk) Tuorla-Tartu meeting 2024 May 6–8 2024, Turku, Finland "The long 2016 polarisation angle rotation of OJ 287" (talk) FinCOSPAR Convention 2024 January 17–19 2024, Espoo, Finland "Statistical comparisons of VHE gamma-ray blazar flares with reconnection models" (talk)
T. Kangas	IAU General Assembly, Cape Town, South Africa, August 202, "The enigmatic double-peaked stripped-envelope SN 2023aew" (poster) European Astronomical Society Annual Meeting, Padua, Italy, July 2024. "The enigmatic double-peaked stripped-envelope SN 2023aew" (poster) Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "Resolving supermassive black hole jets in near-infrared wavelengths" (talk)
P. Kouch	in COSPAR 2024 (Espoo, Finland): "Are blazars emitting high energy neutrinos?"(talk) Tuorla-Tartu 2024: Borderless Universe (Turku, Finland): "Are blazars emitting high-energy neutrinos?" (talk) Astronomers' Days 2024 (Vaasa, Finland): "Are blazars high-energy neutrino factories?" (talk) Neutrino-Radio Astronomy: 1NM (Gothenburg, Sweden): "Association of IceCube neutrinos with major blazar flares?" (talk)
K. Nilsson	Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "Precession of the jet of PG 1553+113?" (talk)
V. Ramakrishnan	IAU General Assembly 2024, South Africa, "Accretion flows and photon rings in nearby Universe", (talk) EAS 2024, Italy, "Probing the structure and physics of accretion flows in nearby low-luminosity AGNs", (invited talk)
Q. Salomé	Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: Inefficient jet-induced star formation in Centaurus A: Are shocks regulating star formation in the northern filaments? (talk)
M. Stone	Finnish Astronomers' Days 2024, May 20-22, Vaasa, Finland: "GAMA low-redshift ($0.1 < z < 0.35$) quasars: environments, star formation history and morphology" (talk) Tuorla-Tartu meeting 2024: Borderless Universe, May 6-8, 2024, Turku "Low-redshift quasar environments" (talk).

FINCA staff at the Astronomers' days in Vaasa, May 2025. From left to right: Vandad Fallah Ramazani, Kari Nilsson, Petri Väisänen, Grigori Fedorets, Pouya Kouch, Maria Stone, Jenni Jormanainen, Talvikki Hovatta, Johanna Hartke and Quentin Salomé.

P. Väisänen

Tuorla-Tartu meeting 2024: "Borderless Universe", 6-8 May, 2024, Turku: "ESO/FINCA & South African facilities: studying interacting galaxies" (talk)
Finnish Astronomers' Days 2024, May 20-22, Vaasa: "FINCA special session" (talk & moderation)
IAU General Assembly, 6-15 August, 2024, Cape Town, South Africa: "Connection of AGN and starbursts in a sample of LIRGs" (talk and poster)
IAU General Assembly, 6-15 August, 2024, Cape Town, South Africa: "Kinematics of multi-phase gas in interacting galaxies" (poster)

Other talks

J. Hartke	ESO Wine and Cheese seminar, Garching, Germany, June 2024: "Mapping the low-surface brightness outskirts of galaxies with planetary nebulae as discrete tracers" ESO Lunch Talk, Garching, Germany, June 2024: "Catching the formation of the ultra-diffuse galaxy Hydra-UDG 32 in the act" FINCA seminar, online, April 2024: "The structure of the ultra-diffuse galaxy UDG 32" Astronomy and Space Science Seminar, University of Oulu, Finland, January 2024: "Galaxy evolution in nearby clusters and groups: hints from discrete tracers and ultra-diffuse galaxies" "Ring-a-scientist" talk to students at Rudolf-Hildebrand-Schule, Markkleeberg, Germany, June 2024
K. Nilsson	"100 vuotta Tähtitedettä Turun Yliopistossa", Tuorlan avoimet ovet, 18.10.2024 "100 vuotta Tähtitedettä Turun Yliopistossa", Kaarinan Kansalaisopisto, 10.12.2024
P. Väisänen	Helsinki Physics Colloquim, 18 October, 2024, Helsinki: "Giant telescopes and new possibilities: Finnish astronomy using ESO" IntegraatioFest, 25 October, 2024, Turku, "Uusia ikkunoita maailmankaikkeuteen" Oulu Physics-Astronomy Seminar, 11 December, 2024, Oulu: "Finnish astronomy using ESO, and its Extremely Large Telescope"

Research Visits

P. Hakala	Oxford,V Sge VLT-project meeting, Apr 2024 Celebrating 21 years of Astronomy at Warwick, Sep 2024
J. Hartke	Invited seminar, University of Oulu, Oulu, Finland, 18 – 20 January 2024 NEON observing school, Asiago Observatory, Italy, February 3 – 17 2024 FINCA mobility visit, University of Oxford, UK, March 13 – March 23 2024 (co-funded by Prof. Dr. Martin Bureau, Wadham College) EAS 2024, Padua, Italy, July 1 – 5 2024 MICADO Consortium meeting #20, Max-Planck Institute for Extraterrestrial Physics and ESO HQ, Garching, Germany, October 8 – 11 2024
V. Ramakrishnan	University of British Columbia, Canada, Sep 2024. Worked with Prof Allison Man on Black hole mass determination of LLAGNs using IFU observations National Observatory of Athens, Greece, June 2024. Worked with Thanassis Akylas on XMM- Newton data reduction of LLAGNs ALMA Allegro, Leiden University, Netherlands, April 2024. Worked with Dr Violette Impellizzeri on ALMA processing of EHT targets Harvard & Smithsonian Centre for Astrophysics, Cambridge, USA, Feb 2025. Worked with Dr Garrett Keating on SMA observations of supermassive black holes in low-luminosity AGNs Boston University, USA, Feb 2024. Worked with Prof Alan Marscher on Imaging relativistic jets in blazars University of Arizona, USA, Jan 2024. Worked with Dr Chi-Kwan Chan on Accretion properties of low-luminosity AGNs
Q. Salomé	LERMA - Observatoire de Paris, 26 March-05 April, Collaborators: Philippe Salomé, Pierre Guillard, Benjamin Godard, Antoine Gusdorf LERMA - Observatoire de Paris, 03-09 November, Collaborators: Philippe Salomé, Pierre Guillard

Other Activities

G. Fedorets	Planetary Science Journal Club (organiser), Helsinki
J. Hartke	Tutor in Neon observing school 2024, February 2024
R. De Propris	M.Sc., Lister Kgwatalala (BIUST), reviewer Member of the ESO ELT PSF-R working group Member of the MICADO PSF-R working group
T. Hovatta	PhD thesis committee member: Deepika Venkattu "Supernovae with LOFAR: Exploring the transient radio Universe at low frequencies", Stockholm University, Sweden
T. Kangas	SOXS Consortium Meeting, Naples, Italy, June 2024
Q. Salomé	Board member of the Finnish Astronomical Society

Hosted visitors

Dr. Enrica Iodice (INAF Capodimonte)	May 11–14, 2024	J. Hartke
Dr. Enrico Congiu (ESO Chile)	November 11–15, 2024	J. Hartke

7. Publications

FINCA Refereed publications 2024:

1. Abe, H. et al. (including **T. Hovatta**), 2024, Prospects for a survey of the galactic plane with the Cherenkov Telescope Array, JCAP, 10, 81
2. Abe, H. et al. (including **T. Hovatta** and **V. Fallah Ramazani**), 2024, Dark matter line searches with the Cherenkov Telescope Array, JCAP, 7,47
3. Abe, H. et al. (including **V. Fallah Ramazani**, **P. Hakala**, **T. Hovatta**, **K. Nilsson** and **Q. Salomé**), 2024, Insights into the broadband emission of the TeV blazar Mrk 501 during the first X-ray polarization measurements, A&A, 685, 117
4. Abe, H. et al. (including **T. Hovatta** and **K. Nilsson**), 2024, The variability patterns of the TeV blazar PG 1553 + 113 from a decade of MAGIC and multiband observations, MNRAS, 529, 3894
5. Abe, H. et al. (including **T. Hovatta** and **J. Jormanainen**), 2024, Multi-year characterisation of the broad-band emission from the intermittent extreme BL Lac 1ES 2344+514, A&A, 682, 114
6. Abe, H. et al. (including **P. Kouch**, **J. Jormanainen** and **K. Nilsson**), 2024, Constraints on VHE gamma-ray emission of flat spectrum radio quasars with the MAGIC telescopes, MNRAS, 535, 1484
7. Abe, H. et al. (including **P. Kouch**, **J. Jormanainen** and **K. Nilsson**), 2024, Constraints on Lorentz invariance violation from the extraordinary Mrk 421 flare of 2014 using a novel analysis method, JCAP, 7, 44
8. Abe, H. et al. (including **P. Kouch**, **J. Jormanainen** and **K. Nilsson**), 2024, MAGIC detection of GRB 201216C at z = 1.1, MNRAS, 527, 5856
9. Abe, H. et al. (including **J. Jormanainen**, **P. Kouch**, **K. Nilsson** and **Q. Salomé**), 2024, First characterization of the emission behavior of Mrk 421 from radio to VHE gamma rays with simultaneous X-ray polarization measurements, A&A, 684, 127
10. Abe, H. et al. (including **J. Jormanainen**, **P. Kouch**, **K. Nilsson**), 2024, Constraints on axion-like particles with the Perseus Galaxy Cluster with MAGIC, Physics of the Dark Universe, 44, 101425
11. Abe, K. et al. (including **V. Fallah Ramazani**), 2024, A detailed study of the very high-energy Crab pulsar emission with the LST-1, A&A, 690, 167

12. Abe, S. et al. (including **J. Jormanainen** and **P. Kouch**) 2024, Standardised formats and open-source analysis tools for the MAGIC telescopes data, Journal of High Energy Astrophysics, 44, 266
13. Abe, S. et al. (including **J. Jormanainen**, **P. Kouch**, **K. Nilsson**), 2024, Performance and first measurements of the MAGIC stellar intensity interferometer, MNRAS, 529, 4387
14. EHT Collaboration, Akiyama, K. et al. (including**V. Ramakrishnan**), 2024, First Sagittarius A* Event Horizon Telescope Results. VII. Polarization of the Ring, ApJ, 964, L25
15. EHT Collaboration, Akiyama, K. et al. (including**V. Ramakrishnan**), 2024, First Sagittarius A* Event Horizon Telescope Results. VIII. Physical Interpretation of the Polarized Ring, ApJ, 964, L26
16. EHT Collaboration, Akiyama, K. et al. (including**V. Ramakrishnan**), 2024, The persistent shadow of the supermassive black hole of M 87. I. Observations, calibration, imaging, and analysis ApJ, 964, L26
17. Albert, A. et al. (including **T. Hovatta** and **K. Nilsson**), 2024, Searches for Neutrinos in the Direction of Radio-bright Blazars with the ANTARES Telescope, ApJ, 964, 3
18. Algaba, J. C. et al. (including **J. Jormanainen**, **P. Kouch**, **K. Nilsson** and **V. Ramakrishnan**), 2024, Broadband multi-wavelength properties of M87 during the 2018 EHT campaign including a very high energy flaring episode, A&A, 692, 140
19. Ali, S. et al. (including **R. De Propris**), 2024, Probing the Stellar Populations and Star Formation History of Early-type Galaxies at $0 < z < 1.1$ in the Rest-frame Ultraviolet, ApJ, 966, 50
20. Álvarez-Hernández, A, et al. (including **P. Hakala**), 2024, The mass of the white dwarf in YY Dra (=DO Dra): Dynamical measurement and comparative study with X-ray estimates, A&A, 690, 218
21. Baczko, A.-K. et al. (including **V. Ramakrishnan**), 2024, The putative center in NGC 1052, A&A, 692, 205
22. Baghel, J. et al. (including **T. Hovatta**), 2024, Investigating Differences in the Palomar-Green Blazar Population Using Polarization, ApJ, 977, 192
23. Baghel, J. et al. (including **T. Hovatta**), 2024, A Kpc-scale radio polarization study of PG BL Lacs with the uGMRT, MNRAS, 527, 672
24. Bevacqua, D. et al. (including **R. De Propris**), 2024, A new perspective on the stellar mass-metallicity relation of quiescent galaxies from the LEGA-C survey, A&A, 690, 150
25. Bhirombhakdi, K. el al. (including **T. Kangas**), 2024, The Redshift of GRB 190829A/SN 2019oyw: A Case Study of GRB-SN Evolution, ApJ, 977, 256
26. Chen, C.-T. J. et al. (including **P. Kouch**), 2024, X-Ray and Multiwavelength Polarization of Mrk 501 from 2022 to 2023, ApJ, 974,50
27. Cheong, W. Y. et al. (including **V. Ramakrishnan**), 2024, A near magnetic-to-kinetic energy equipartition flare from the relativistic jet in AO 0235 + 164 during 2013-2019, MNRAS, 527, 882.
28. Charalampopoulos, P., et al. (including **T. Kangas** and **T. Kravtsov**), 2024, The fast transient AT 2023clx in the nearby LINER galaxy NGC 3799, as a tidal disruption event of a very low-mass star", A&A, 689, 350
29. D'Ammando, F. et al (including **V. Fallah Ramazani**), 2024, Optical spectroscopy of blazars for the Cherenkov Telescope Array - III, A&A, 683, 222
30. Damsted, S. et al, 2024, AXES-SDSS: Comparison of SDSS galaxy groups with all-sky X-ray extended sources, A&A, 690, 52
31. Dobson, M. M. et al. (including **G. Fedorets**), 2024, The Discovery and Evolution of a Possible New Epoch of Cometary Activity by the Centaur (2060) Chiron, Planetary Science Journal, 5, 165
32. Duffy, C. et al. (including **P. Hakala**), 2024, Characterizing high and low accretion states in VY Scl CVs using ZTF and TESS data, MNRAS, 535, 3035

33. Echiburú-Trujillo, C. et al., 2024, Chasing the Break: Tracing the Full Evolution of a Black Hole X-Ray Binary Jet with Multiwavelength Spectral Modeling, ApJ, 962, 116
34. Ergon, M. et al., 2024, Light curve and spectral modelling of the type IIb SN 2020acat. Evidence for a strong Ni bubble effect on the diffusion time, A&A, 683, 241
35. Errando, M. et al. (including **P. Kouch**), 2024, Detection of X-Ray Polarization from the Blazar 1ES 1959+650 with the Imaging X-Ray Polarimetry Explorer, ApJ, 963, 5
36. Fabiani, S. et al., 2024, Discovery of a variable energy-dependent X-ray polarization in the accreting neutron star GX 5-1, A&A, 684, 137
37. Ferrari, L. et al., 2024, The metamorphosis of the Type Ib SN 2019yvr: late-time interaction, MNRAS, 529, 33
38. Ferrari, L. et al., 2024, Progenitor mass and ejecta asymmetry of supernova 2023ixf from nebular spectroscopy, A&A, 687, 20
39. Fiore, A. et al., 2024, Detailed spectrophotometric analysis of the superluminous and fast evolving SN 2019neq, MNRAS, 527, 6473
40. Garrappa, S. et al., 2024, Fermi-LAT follow-up observations in seven years of real-time high-energy neutrino alerts, A&A, 687
41. Gkini, A. et al. (including **T. Kangas**), 2024, SN 2020zbf: A fast-rising hydrogen-poor superluminous supernova with strong carbon lines, A&A, 685, 20
42. González-Díaz, R. et al. (including **T. Kangas**), 2024, Supernova environments in J-PLUS. Normalized cumulative-rank distributions and stellar-population synthesis combining narrow- and broad-band filters, A&A, 684, 104
43. González-Díaz, R. et al., 2024, Bidimensional Exploration of the warm-Temperature Ionised gaS (BETIS). I. Showcase sample and first results, A&A, 687,20
44. Gran, F., et al. (including **J. Hartke**), 2024, The treasure behind the haystack: MUSE analysis of five recently discovered globular clusters, A&A, 683, 167
45. Greenwell, C. L.et al. (including **P. Väisänen**), 2024, The NuSTAR Serendipitous Survey: The 80 Month Catalog and Source Properties of the High-energy Emitting Active Galactic Nucleus and Quasar Population, ApJS, 273, 20
46. Gutiérrez, C. P. et al. (including **T. Kangas**), 2024 SS161010: a luminous, fast blue optical transient with broad blueshifted hydrogen lines, ApJ, 977, 162
47. Hackman, T. et al. (including **J. Lehtinen**), 2024, From convective stellar dynamo simulations to Zeeman-Doppler images, A&A, 682, 156
48. Heyl, J. et al., 2024, Complex rotational dynamics of the neutron star in Hercules X-1 revealed by X-ray polarization, Nature Astronomy, 8, 1047
49. Holwerda, B. W. et al.(including **R. De Propris** and **M. Stone**) ,2024, The Galaxy Zoo catalogues for Galaxy And Mass Assembly (GAMA) survey, PASA, 41, 115
50. Järvelä, E. et al. (including **T. Hovatta**), 2024, Unprecedented extreme high-frequency radio variability in early-stage active galactic nuclei, MNRAS, 532, 3069
51. **T. Kangas** et al. (including**T. Kravtsov**), 2024, The enigmatic double-peaked stripped-envelope SN 2023aew, A&A, 689, 182
52. Kennedy, M. R. et al. (including **P. Hakala**), 2024, Analysis of optical spectroscopy and photometry of the type I X-ray bursting system UW CrB, arXiv:2408.06404
53. Kiehlmann, S. et al., 2024, Compact Symmetric Objects. II. Confirmation of a Distinct Population of High-luminosity Jetted Active Galaxies, ApJ, 961, 241
54. Kim, D. E. et al. (including **P. Kouch**), 2024, Magnetic field properties inside the jet of Mrk 421. Multiwavelength polarimetry, including the Imaging X-ray Polarimetry Explorer, A&A, 681, 12

55. Koljonen, K. et al. (including **K. Nilsson**), 2024, The extreme coronal line emitter AT 2022fpx: varying optical polarization properties and late-time X-ray flare, MNRAS, 532, 112
56. Koljonen, K. et al. (including **K. Nilsson**), 2024, Galaxy group-associated distances to very high energy gamma-ray emitting BL Lacs KUV 00311-1938 and S2 0109+22, 2024, MNRAS, 531 5084
57. **Kouch, P. M.** et al. (including **V. Fallah Ramazani**, **J. Jormanainen**, **T. Hovatta** and **K. Nilsson**), 2024, Association of the IceCube neutrinos with blazars in the CGRaBS sample, A&A, 619, 111
58. **Kouch, P. M.** et al. (including **K. Nilsson**), 2024 IXPE observation of PKS 2155–304 reveals the most highly polarized blazar, A&A, 689, 119
59. GAIA Collaboration, Krone-Martins, A. et al. (including **G. Fedorets**), 2024, Gaia Focused Product Release: A catalogue of sources around quasars to search for strongly lensed quasars, A&A, 685, 130
60. Liodakis, I. et al., 2024, Testing particle acceleration in blazar jets with continuous high-cadence optical polarization observations, A&A, 689, 200
61. Marcotulli, L. et al., 2024, The high energy X-ray probe (HEX-P): the most powerful jets through the lens of a superb X-ray eye, FrASS, 11, id 1290057
62. Marshall, H. L. et al. (including **J. Jormanainen** and **Kouch, P. M.**), 2024, Observations of Low and Intermediate Spectral Peak Blazars with the Imaging X-Ray Polarimetry Explorer, ApJ, 972, 74
63. Martinez-Rodriquez, H. et al, 2024, Recovering Lost Light: Discovery of Supernova Remnants with Integral Field Spectroscopy, ApJ, 963, 125
64. McCall, C. et al. (including **T. Hovatta**), 2024, Distinguishing radiation mechanisms and particle populations in blazar jets through long-term multiband monitoring with RINGO3 and Fermi, MNRAS, 532, 2788
65. Maksymowicz-Maciata, M. et el, (including **J. Hartke**), 2024, INSPIRE: INvestigating Stellar Population In RElics - VI. The low-mass end slope of the stellar initial mass function and chemical composition, MNRAS, 531, 2864
66. **Mason, A. B.** at al, 2024, 4XMM J182531.5-144036: A new persistent Be/X-ray binary found within the XMM-Newton serendipitous survey, PASA,41, 8
67. Mason, P. A. et al. (including **P. Hakala**), 2024, TESS Photometry of AM Her and AR UMa: Binary Parameters, Cyclotron Emission Modeling, and Mass Transfer Duty Cycles, ApJ, 965, 96
68. Matsuura, M. et al. (including **T. Kangas**), 2024, Deep JWST/NIRCam imaging of SN 1987A, MNRAS, 532, 3625
69. Moran, S. et al. (including **T. Kravtsov**), 2024, Red eminence: The intermediate-luminosity red transient AT 2022fnm, A&A, 688, 161
70. Nagao, T. et al., 2024, Spectropolarimetry of Type II supernovae. II. Intrinsic supernova polarization and its relation to photometric and spectroscopic properties, A&A, 681, 11
71. Nagao, T. et al., 2024, The aspherical explosions of the 03fg-like Type Ia supernovae 2021zny and 2022ilv revealed by polarimetry, A&A, 687, L19
72. **Nilsson, K.** et al. (including **V. Fallah Ramazani** and **Kouch, P. M.**), Distance estimation of gamma-ray-emitting BL Lac objects from imaging observations, A&A, 691, 154
73. Gaia Collaboration, Panuzzo, P. et al. (including **G. Fedorets**), 2024, Discovery of a dormant 33 solar-mass black hole in pre-release Gaia astrometry, A&A, 686, L2
74. Paraschos, G. F. et al. (including **V. Ramakrishnan**), 2024, Ordered magnetic fields around the 3C 84 central black hole, A&A, 682, L3
75. G. Ramsay, **P. Hakala**, J. Gerry Doyle, 2024, Searching for the stellar cycles of low-mass stars using TESS data, A&A, 689, 288

76. Rastinejad, J. C. (including **T. Kangas**), 2024, A Hubble Space Telescope Search for r-Process Nucleosynthesis in Gamma-Ray Burst Supernovae, ApJ, 968, 14
77. Ratheesh, A. et al., 2024, X-Ray Polarization of the Black Hole X-Ray Binary 4U 1630–47 Challenges the Standard Thin Accretion Disk Scenario, ApJ, 964, 77
78. Raymond, A. W. et al. (including **V. Ramakrishnan**), 2024, First Very Long Baseline Interferometry Detections at 870 μm, AJ, 168, 130
79. Readhead, A. et al., 2024, Compact Symmetric Objects. III. Evolution of the High-luminosity Branch and a Possible Connection with Tidal Disruption Events, ApJ, 961, 242
80. Reguitti, A. et al., 2024, The fast rise of the unusual type IIL/IIb SN 2018ivc, A&A, 692, 26
81. Ridley, E. J. et al. (including **T. Kangas**), 2024, Time-varying double-peaked emission lines following the sudden ignition of the dormant galactic nucleus AT2017bcc, MNRAS, 531, 1905
82. Rosu, S. et al. (including **T. Kangas**), 2024, Hubble Space Telescope Images of SN 1987A: Evolution of the Ejecta and the Equatorial Ring from 2009 to 2022, Apj, 966, 238
83. **Salomé, Q.** et al. 2024, Physical conditions in Centaurus A's northern filaments II: Does the HCO+ emission highlight the presence of shocks?, A&A, 690, L18
84. Schulze, S. et al. (including **T. Kangas**), 2024, 1100 days in the life of the supernova 2018ibb. The best pair-instability supernova candidate, to date, A&A, Volume 683, 223
85. Scognamiglio, D., et al. (including **J. Hartke**), 2024, INSPIRE: INvestigating Stellar Population In RElics - VII. The local environment of ultra-compact massive galaxies, MNRAS, 534, 1597
86. Simon, D. A. et al. (including **J. Hartke**), 2024, Supermassive black hole mass in the massive elliptical galaxy M87 from integral-field stellar dynamics using OASIS and MUSE with adaptive optics: assessing systematic uncertainties MNRAS, 527, 2341
87. Sneppen, A. et al (including **P. Väisänen**), 2024, Emergence hour-by-hour of r-process features in the kilonova AT2017gfo, A&A, 690, 398
88. Spiniello, C. et al. (including **J. Hartke**), 2024, INSPIRE: INvestigating Stellar Population In RElics - V. A catalogue of ultra-compact massive galaxies outside the local Universe and their degree of relicness, MNRAS, 527, 8793
89. Svoboda, J. et al., 2024, First X-Ray Polarization Measurement Confirms the Low Black Hole Spin in LMC X-3, ApJ, 960, 3
90. **M. B. Stone,** et al., 2024, Galaxy and Mass Assembly (GAMA): Low-redshift Quasars and Inactive Galaxies Have Similar Neighbors, ApJ, 946, 2
91. Traianou, E. et al, 2024, Lost in the curve: Investigating the disappearing knots in blazar 3C 454.3, A&A, 682, 154
92. Tuomi, M. et al. (including **J. Lehtinen**), 2024, Characterising the stellar differential rotation based on largest-spot statistics from ground-based photometry, A&A, 689, 262
93. Valtonen, M. et al. (including **K. Nilsson**), 2024, Evidence of Jet Activity from the Secondary Black Hole in the OJ 287 Binary System, ApJ, 968, 17
94. Vercellone, S. et al. (including **T. Hovatta**), 2024, Multiwavelength observations of the lensed quasar PKS 1830-211 during the 2019 gamma-ray flare, MNRAS, 527, 5717
95. Veršič, T., et al. (including **J. Hartke**), 2024, Shapes of dark matter haloes with discrete globular cluster dynamics: The example of NGC 5128 (Centaurus A), A&A, 687, 80