Turun yliopisto
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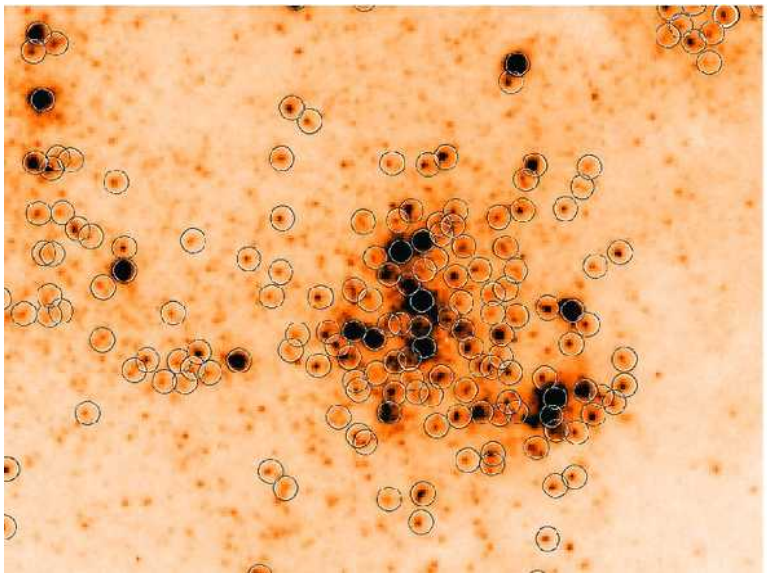
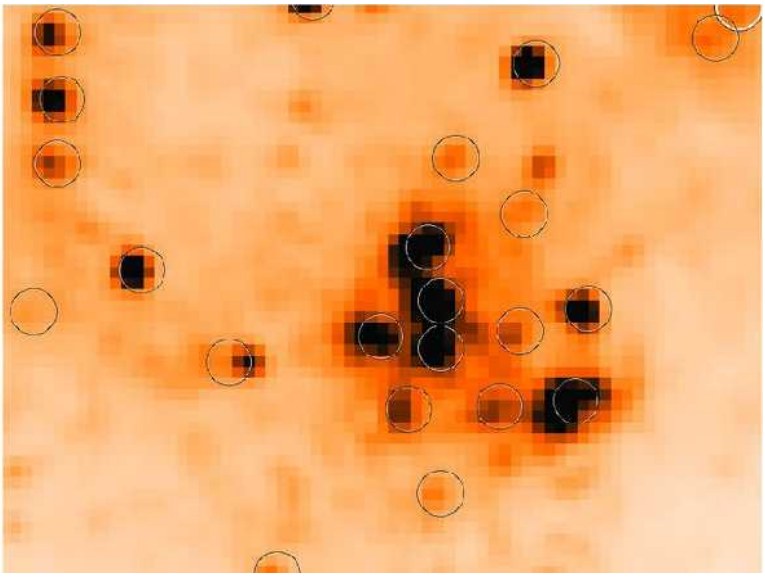
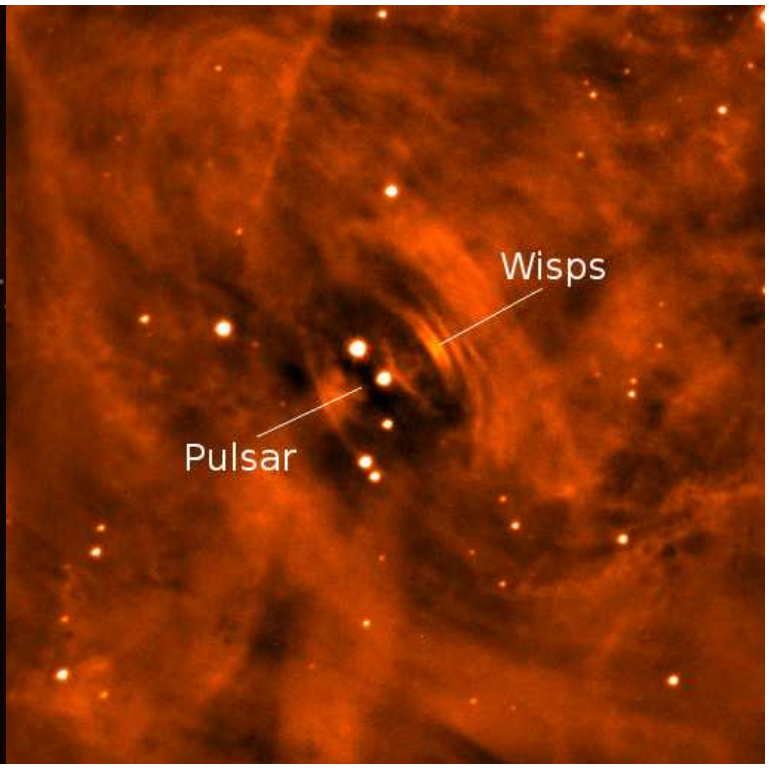
FINCA
Finnish Centre for Astronomy with ESO

ANNUAL REPORT 2013
FINNISH CENTRE FOR ASTRONOMY WITH ESO (FINCA)







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Cover illustration:

Top left: I-band image of the central regions of the Antenna interacting galaxies, with ∼160 super star cluster (SSC) detected. **Top right:** the image after moving the galaxy four times further away. Only ∼20 SSCs are detected due to blending, though the brighter population remains unchanged.
Bottom left: A multi-color image of the Crab Nebula. **Bottom right**: I-band image of the central Crab Nebula with main components indicated.

FOREWORD

Finland became a member of the European Southern Observatory (ESO) in 2004. ESO is a world leading international astronomical research and technology organization, with headquarters in Garching, Germany. ESO operates three world-class observatories in Chile, and it has currently 15 member states.

Efficient and comprehensive utilization of Finland's ESO membership requires coordinated co-operation between all the Finnish universities engaged in astronomical research. The Finnish Centre for Astronomy with ESO (FINCA) is a national research institute for astronomical and astrophysical research in Finland. FINCA coordinates Finnish co-operation with ESO by networking into the ESO infrastructure and projects; practices and promotes high quality research in all fields of astronomy, and ESO-related technological development work; participates in researcher training in astronomy; and fosters and implements ESO-related co-operation of Finnish universities in astronomy. The ultimate goal of FINCA is to improve the scientific and industrial benefit of Finland's membership in ESO, and Finland's international competitiveness in astronomical research.

FINCA started operations 1.1.2010 as a Special Unit of the University of Turku and it is funded by the Ministry of Education and Culture, and by the participating universities (Aalto, Helsinki, Oulu and Turku). The current staff consists of 17 PhD scientists, majority of them based in the University of Turku. The highest decision-making body is the Board, comprising of two members from each participating university and one member from the FINCA staff. A Scientific Advisory Board (SAB) consisting of seven foreign members, oversees the functioning of FINCA.

The research at FINCA covers a large range in contemporary astronomy, from cosmology, distant active galaxies, and galaxy formation and evolution, through studies of the structure of nearby galaxies, to binary stars, stellar magnetic activity, interstellar medium, star formation and exoplanets in our own Galaxy. In our research, we use multi-wavelength observational data from large ground-based and space telescopes, especially from the four 8m class Very Large Telescopes (VLT) and the three 2-4m class telescopes of ESO in Chile, and the Nordic Optical Telescope (NOT) on La Palma, Spain, in the optical, near-infrared and mid-infrared, but also at radio and millimeter wavelengths and at X-ray and gamma-rays. Observational research is supplemented by modelling, simulations and theoretical work, that are essential in the understanding of the physics behind the observational results.

In 2014, the major step forward at ESO, with implications for research at FINCA, will be the start of construction of the European Extremely Large Telescope (E-ELT), a 39 m diameter giant for infrared and optical astronomy, to start operations in less than 10 years time. It will never be too early to start adjusting one's research goals for the enormous leap forward in sensitivity and resolution! Meanwhile, FINCA is continuing in an active role to facilitate Finnish industry to participate as sub-contractors in building the E-ELT and its instrumentation (for example, there was a very fruitful meeting between the Astrium EADS company, a main competitor to construct the Dome and Main Structure of the E-ELT, and 27 Finnish companies and organizations – including FINCA – at Tekes, in October 2013). Discussion are also underway for the participation of the Finnish community in one of the E-ELT instrument consortia that will start operations towards the end of 2014.

Jari Kotilainen
Director of FINCA

FINCA ORGANISES NEW PRACTICAL ASTRONOMY TEACHING

A new observational astronomy course making use of the Nordic Optical Telescope (NOT) was organized as a national collaboration by FINCA with **Seppo Mattila** as the person in charge. The course took place at Tuorla Observatory in University of Turku on 14.-19.10.2013 and was attended by a total of 19 students, 10 from Helsinki and 9 from Turku. The course is already integrated as a part of the M.Sc. degree programs of University of Turku and University of Helsinki, hence providing a working example on how national collaboration can be used in the teaching of astronomy in Finland. The course has also important value in educating a competitive future user community in Finland to make use of the observing facilities of the ESO.

The course was organized as a one week intensive course at Tuorla Observatory followed by independent work on the obtained data. The program included afternoon lectures given by researchers from FINCA that covered optical and infrared observations, principles of data reduction and high resolution echelle spectroscopy (Fig. 1). The lectures were followed by sessions dedicated to preparation of observations and project work. The students were divided into five groups with different science project to be carried-out using observations with the NOT. The topics of the projects covered a wide range of science: distant galaxy clusters, flares in A-type stars, high mass X-ray binaries, supernovae and the Crab Nebula. The projects were supervised by **Heidi Korhonen, Andrew Mason, Seppo Mattila** and **Kari Nilsson** from FINCA and Alexis Finoguenov from University of Helsinki.

Fig. 1 The NOT observational astronomy course in full swing.

Each night a person with an extensive experience from observations with the NOT (typically a previous NOT student support astronomer) was in charge of supervising the observations. Each project had two half-nights to use with two different instruments, adding to the wide experience the students received from this course. Only about 15% of the time was lost due to weather, technical problems or target of opportunity triggers. The students were highly motivated by the opportunity to use a professional telescope and excellent data sets were obtained for every project. The data obtained during the course were reduced and analyzed by the students under the guidance of the project supervisors. One month after the observations each group gave a presentation on their project, including an introduction to their science question, describing the observations and data reductions and presenting the results obtained.

Part of the data obtained will also be useful for M.Sc. theses work and one of the science projects was already followed by a successful NOT proposal with the participating students as co-investigators. Two astronomical telegrams with the students as coauthors were also published as a result of the observations. The course is planned to be organized again in the autumn of 2014.

FINCA RESEARCH HIGHLIGHTS 2013

GALAXIES AND COSMOLOGY

VERY HIGH ENERGY GAMMA-RAYS FROM ACTIVE GALACTIC NUCLEI

Radio-loud Active Galactic Nuclei (AGN) hosting a relativistic jet are the most numerous sources of extragalactic gamma-ray sky. MAGIC collaboration, operating two 17 meter IACTs located at La Palma, has observed several gamma-ray emitting AGN since 2004.

When MAGIC started the operations, less than 10 VHE gamma-ray AGN were known, while the current number is already ~60. Many of the new discoveries have been made using optical triggers from Tuorla Blazar Monitoring Program (http://users.utu.fi/kani/1m). In 2013 yet another BL Lac H1722+119 was discovered (Cortina on behalf of the MAGIC Collaboration, ATel #5080). This BL Lac object is particularly interesting, because it has redshift of >0.4, as measured from NOT data by E. Farina, who was visiting FINCA in summer 2013. In 2013 also a detailed multi-wavelength study of PKS1424+240, which is the most distant known VHE source, was finalized (Aleksic et al. (the MAGIC Collaboration), 2014, A&A submitted, **Elina Lindfors** is one of the corresponding authors). These distant VHE gamma-ray emitters are particularly interesting, because they can be used to study the star forming history of the universe. This is possible, because on their way from the blazar to us, the gamma-ray photons interact with the extragalactic background photon field. The star forming history of the universe is imprinted into this background photon field and by studying its interaction with blazar gamma-rays, information on star forming history of the universe can be obtained. However, in order to extract such information the AGN intrinsic gamma-ray spectrum has to be known and it can only be assessed by modeling the spectral energy distribution using quasi-simultaneous multi-wavelength data, which was collected in collaboration with many observatories including also NOT data by FINCAns Jari Kotilainen and Erkki Kankare. In the case of PKS1424+240 we showed that simple one-zone synchrotron self Compton model is not sufficient and two zone model is needed to reproduce the observed spectral energy distribution.

Most of the gamma-ray emitting AGN are of blazar type, where the relativistic jet is viewed with very small angle to our line of sight. However, also few radio galaxies are known, one of them being NGC1275, the central galaxy of the Perseus Cluster of galaxies (Fig. 2). MAGIC discovered VHE gamma-ray emission from this galaxy in 2011 and now a detailed multi-wavelength study has been performed (Aleksic et al. 2014, A&A, in press, Elina Lindfors is one of the corresponding authors). This multi-wavelength study revealed a correlation between optical and gamma-rays, which suggests common origin of the emission in these energies. Also in the case of NGC1275 the modeling of the quasi-simultaneous spectral energy distribution revealed that single-zone model is not sufficient to reproduce all the observed multi-wavelength characteristics.

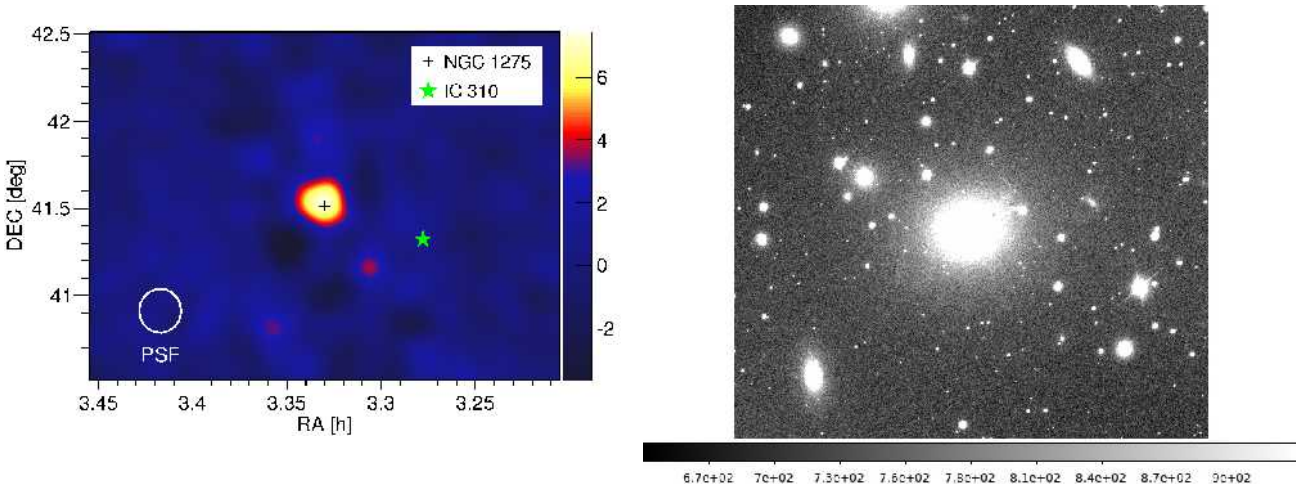

Fig. 2: The central galaxy of Perseus Cluster NGC 1275 in Very High Energy Gamma-rays as seen by MAGIC (left) and in optical as seen by NOT (right). The NOT image was taken by the high school students participating in NOT school organized by Rami Rekola.

RADIO STUDIES OF BL LACERTAE OBJECTS

BL Lacertae objects are a subclass of active galactic nuclei typically characterized by variable emission across the electromagnetic spectrum, high polarization rate and a featureless optical spectrum. However, this ever-growing class encompasses a vast range of objects and not all of them meet every criterion used to define the early, radio-selected BL Lac samples. BL Lac behaviour in radio frequencies is diverse: it varies from strong, flaring flux emission to very faint, at times even undetected sources for which we have little information of their variability behaviour. The standard BL Lac radio spectrum is flat. The flatness results from the superimposition of several individual components emitting synchrotron radiation and travelling in the BL Lac jet. **Elina Nieppola** and collaborators have used the RATAN-600 radio telescope of the Special Astrophysical Observatory (SAO) of the Russian Academy of Sciences in the North-Caucasus to observe the instantaneous radio spectra on six frequencies from 1.1 to 21.7 GHz of 108 BL Lac objects (Fig. 3). The spectra have been measured on several epochs from 2006 to 2011. The sample includes many faint sources that have little archival radio data, which makes this data set unique. Snapshot multi-epoch radio spectra are an ideal tool to investigate these sources. The shape of the radio spectrum tells about the emission mechanisms governing the wavelength domain in question, and reveals the circumstances in which the radiation was produced. The sizable sample also allows them to investigate the differences between the subclasses of low synchrotron-peaked (LBL) and high synchrotron-peaked (HBL) BL Lacs.

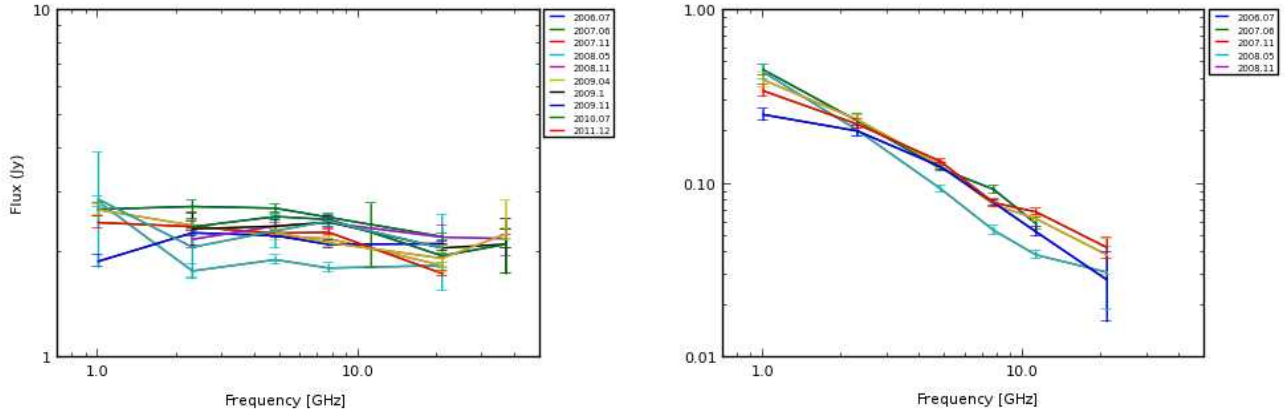

Fig. 3: An example of the different types of radio spectra of BL Lacs from the RATAN-600 data set: a flat spectrum (left) and a steep spectrum (right).

Preliminary results show that there are fundamental differences between the subgroups, HBLs having preferentially a steep low frequency radio spectrum. Only LBLs seem to adhere to the flat radio spectrum requirement for BL Lacs.

Elina Nieppola and colleagues also launched a new observing campaign using the RATAN-600 telescope. The new campaign targets the Narrow Line Seyfert 1 galaxies, which are active galaxies with a lower mass black hole than BL Lacertae objects. They also have exceptionally small widths of hydrogen Balmer lines. NLS1 galaxies have recently received a lot of attention in the community due to the discovery of gamma-ray emission originating in NLS1 jets. They are quite weak in radio frequencies, and their simultaneous radio spectra have not been studied before in this extent. The NLS1 sample comprises 45 sources at the moment, and it is likely to be increased.

THE COOL GASEOUS HALOES OF QUASARS

Jari Kotilainen and collaborators presented optical spectroscopy of projected quasar (QSO) pairs in order to investigate the Mg II and C IV absorption features imprinted on the spectrum of the background object by the gaseous halo surrounding the foreground QSO. They observed 13 projected pairs in the redshift range $0.7 \lesssim zF \lesssim 2.2$, spanning projected separations between 60 and 120 kpc. In the spectra of the background QSOs, they identified Mg II intervening absorption systems associated with the foreground QSOs in seven out of 10 pairs, and one absorption system out of three is found for C IV (Fig. 4). The distribution of the equivalent width (EW) as a function of the impact parameter shows that, unlike the case of normal galaxies, some strong absorption systems (EWr > 1 Å) are also present beyond a projected radius of ~70 kpc. Taking into account the mass of the galaxies as an additional parameter that influences the extent of the gaseous halos, the distribution of the absorptions connected to the QSOs is consistent with that of galaxies. In the spectra of the foreground QSOs, they do not detect any Mg II absorption lines originated by the gas surrounding the QSO itself, in two cases, these features are present for C IV. A comparison between the absorption features observed in the transverse direction and those along the line of sight allows them to comment on the distribution of the absorbing gas and on the emission properties of the QSOs.

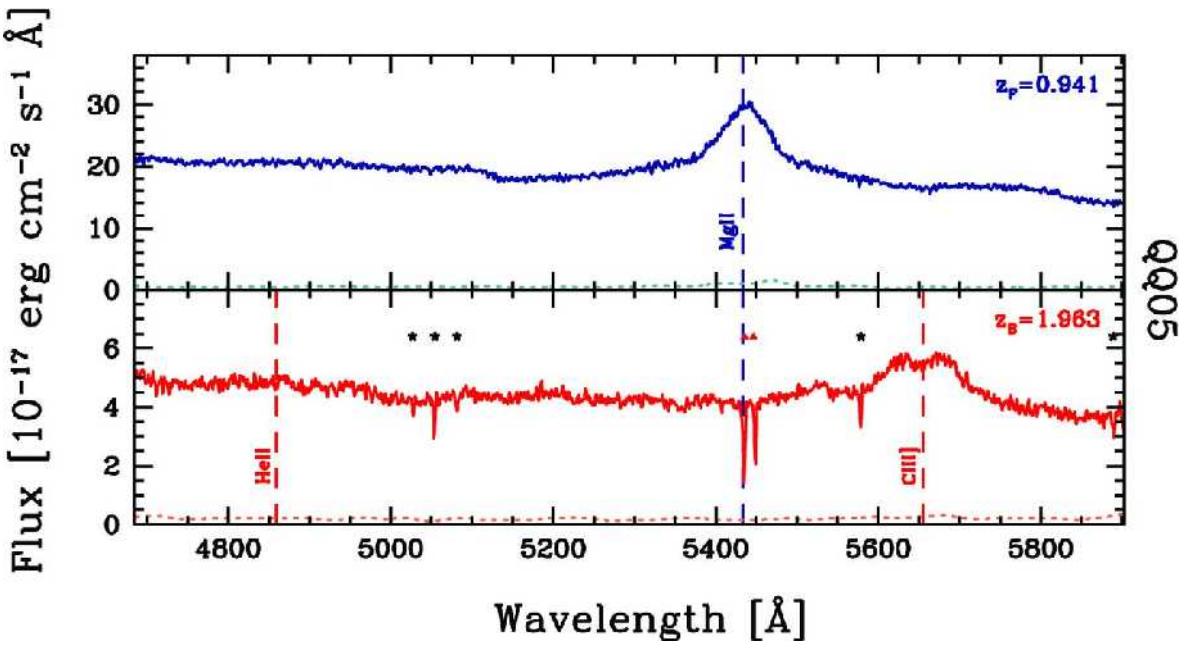

Fig. 4: Example spectra of a projected QSO pair. The blue and red lines refer to the foreground and background QSO, respectively. There is a clear detection of the MgII absorption from the foreground QSO imprinted on the spectrum of the background QSO. From Farina et al., 2013, MNRAS, 429, 1267.

OJ287, GALACTIC DYNAMICS AND DARK ENERGY

Mauri Valtonen continued the analysis of the OJ287 data from the 2004-2010 observing campaign with Pauli Pihajoki (Tuorla Observatory) and others. The radio jet data shows interesting wiggles in jet orientation, up to 90 degrees in angle. The optical polarization shows similar long term trends, but out of phase with radio wiggles. The data were analyzed using the model of Philip Hardee of helical oscillating jets. It was found that the oscillations are generated by the binary perturbations at the foot of the jet, and that they propagate outward with the speed of 0.85 c. This is much slower that the relativistic jet speed. The result supports the spine-sheath concept of a relativistic jet where a fast spine propagates inside a slow sheath.

Valtonen also continued to work in Galactic dynamics with Aleksandr Mylläri (St George's University) and others. The question they asked whether it is possible to identify the Solar Siblings, the members of the Sun's birth cluster, after more than 20 Galactic revolutions. They found that approximately 10% of the original siblings are still within 100 pc from us. Therefore it is a worthwhile project to search for the individual members of the birth cluster. This will be done in the next few years with GAIA data.

With Pekka Teerikorpi (Tuorla Observatory) and others, Valtonen continued the study of the environments of the Local Group, determining the value of the dark energy locally. They found that the local value is the same as the global value within observational uncertainty. It implies that General Relativity is a valid description also of the dark energy. They also tested General Relativity at the strong field limit, and found that the primary body in OJ287 satisfies the no-hair theorems of black holes, and thus is a black hole most certainly. This is the first case where a body which has been called a black hole, has actually been shown be one, according to the criteria of General Relativity. This again supports the correctness of General Relativity.

ATLAS OF RESONANCE RINGS AS KNOWN IN THE S4G (ARRAKIS)

Sébastien Comerón and coauthors made use of the Spitzer Survey of Stellar Structure in Galaxies (S^4G) to study resonance rings in local galaxies. The output of their work is the Atlas of Resonance Rings as Known In the S4G (ARRAKIS). The S4G is made of 3.6 μm and 4.5 μm images taken using the Spitzer Space Telescope. The survey includes 2352 galaxies selected to have a radial velocity $v_{radio} < 3000$ km/s, to have an AB magnitude $m_{3.6,corr} < 15.5$ mag, to have a diameter $D > 1$ arcmin, and to be away from the Galactic plane ($|b| > 30^o$).

Resonance rings are the consequence of the rearrangement of material in discs by bars and other non-axisymmetries. Gas gets collected at certain galaxy radii until it reaches high density. Regions with high gas density start forming stars and a resonance ring is formed. Rings are tracers of the underlying galaxy dynamics. Outer rings are usually linked to the Outer Lindblad Resonance and are twice as large as the bar, inner rings are related to the Ultra-Harmonic Resonance and are slightly larger than the bar, and nuclear rings are linked to the Inner Lindblad Resonances and are well inside the bar.

The authors have approximated the ring shape as ellipses (Fig. 5). In ARRAKIS, they give the ring major and minor axis as well as its position angle. One of the products of the S^4G pipelines is the orientation of the galaxies. From that, intrinsic ring major axis, minor axis, and orientations can be also derived. These ring properties are also given in ARRAKIS. Also, it contains information on the orientation and ellipticity of bars in the ringed galaxies in the S^4G. ARRAKIS contains data on 724 ringed galaxies. The authors find that 16±1 % of S^4G galaxies have an outer ring and that 35±1 % of the galaxies have an inner ring. Outer rings were usually found in galaxies with Hubble stages between T = -1 and T = 4. Inner rings were found in a broader range (between T = -1 and T = 7).

Inner rings have been thought to have an intrinsic orientation parallel to that of the bar. In ARRAKIS it is shown that this is true only for ~50 % of inner rings. ARRAKIS shows that around a half of the inner rings, especially those in later Hubble stages, are oriented at random with respect to the bar. The discovery of such a large fraction of inner rings with a random orientation with respect to the bar is a new and unexpected result. The cause for those misaligned rings my be the presence of spiral modes that are decoupled from the bar and dominate the Fourier amplitude spectrum at the ring radius.

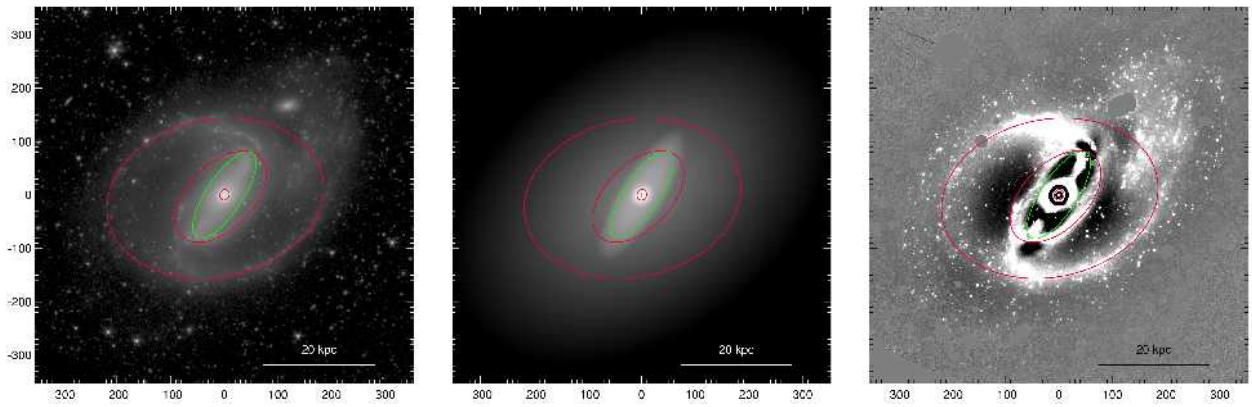

Fig. 5 Left: Original S^4G image of NGC 1097. **Middle**: model of the galaxy. **Right**: model-subtracted image of the galaxy where some structures like rings appear contrast-enhanced. The rings, as fitted in ARRAKIS, are indicate by red ellipses. The bar contour is indicated by a green ellipse.

DWARF EARLY-TYPE DISK GALAXIES

Dwarf early-type disk galaxies (dEs) are a critical piece of information for understanding hierarchical clustering that forms the structures, e.g. galaxies, in the Universe. An important question is are the dwarfs merger-built structures, in a similar manner as bright ellipticals, or transformed from late-type spirals by secular evolutionary processes in dense galaxy environments. In both cases the galaxies seen presently as dEs must have lost most of their gas, but the mechanisms are different. In the merger scenario supernova feedback plays an important role, whereas in the secular evolution scenario different stripping mechanisms in galaxy clusters are dominant. Answering the above question is important in cosmology, giving hints of the state of the universe at the epoch of galaxy formation.

Using deep near-IR images obtained for the Virgo cluster, **Eija Laurikainen** and collaborators found support of the hypothesis in which dEs are transformed from late-type spirals (Janz, Laurikainen et al. 2014, ApJ, in press). Deep near-IR images were obtained for a complete magnitude-limited sample of early-type dwarfs in Virgo, covering a large magnitude range (-19 < Mr < -16 mag), forming part of SMAKCED project. Based on 2D multi-component structural decompositions for these galaxies, they found that only 1/3 of the galaxies have simple one-component profiles. The rest of the systems typically have inner and outer components. They compared the magnitudes and scale parameters of the bulges and disks in bright galaxies (Fig. 6). The inner components of dEs were found to be systematically larger and brighter than the bulges of S0s and spirals, suggesting that they are not bulges in a usual sense. The outer components resemble quite closely the disks of late-type spirals. They suggest that the multi-component structures in dEs are mostly features in the disks, having the origin in the environmental processes.

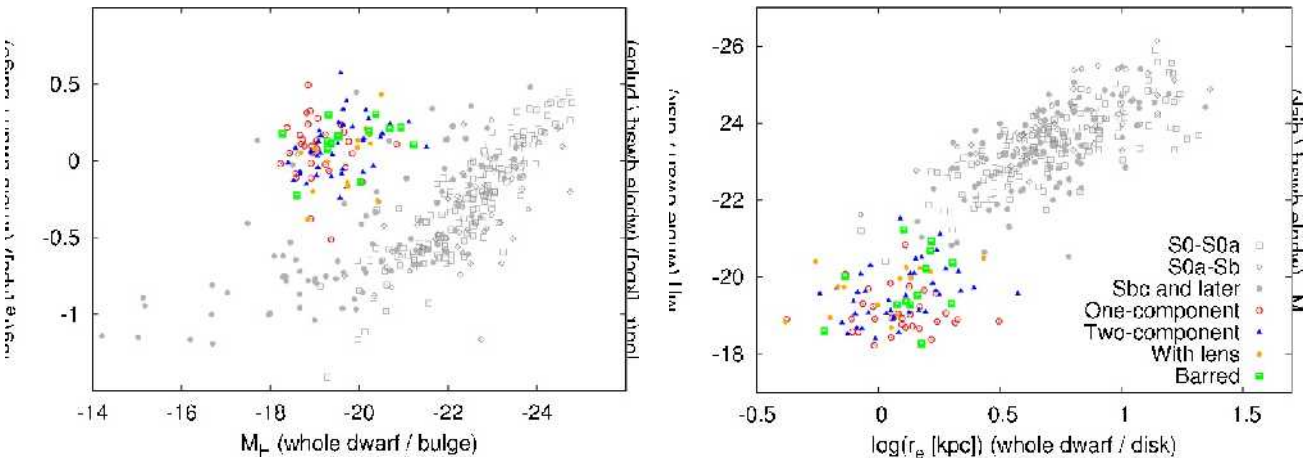

Fig. 6: the total H-band magnitudes (**left**) and effective radii (**right**) of the dwarf galaxies are compared with those of the bulges and disks in bright galaxies (from Janz et al. 2014). For the dwarfs shown separately are the one- and two-component galaxies, and those having bars and lenses.

SUPER STAR CLUSTERS IN LUMINOUS INFRARED GALAXIES

Super star clusters (SSCs) are typically found in interacting galaxies and trace an extreme form of star formation. **Jari Kotilainen** and **Seppo Mattila** are collaborating in a K-band imaging study of SSC candidates in a statistical sample of ~40 local luminous infrared galaxies (LIRGs) using two adaptive optics instruments: NACO on the ESO VLT and ALTAIR/NIRI on the Gemini North. In addition to facilitating SSC detections in obscured environments (see example in Fig. 7), this work

introduces SSC studies in hosts with higher star-formation rates (SFRs) than most previous studies.

In Randriamanakoto et al. 2013 MNRAS 431 554, they find that the luminosity functions (LFs) of the clusters are reasonably well-fitted by a single power law with values of the index α ranging between 1.5 and 2.4 with an average value of $\alpha \approx 1.9$. This value appears to be less steep than the average $\alpha \approx 2.2$ in normal spiral galaxies. Due to the host galaxy distances involved (median distance ~70 Mpc), blending effects have to be taken into account and were investigated using Monte Carlo simulations of blending effects for LFs and a photometric SSC analysis of the well-studied Antenna system, which is artificially redshifted to the distance of their sample (Fig. 8). While blending tends to flatten LFs, the analysis shows that $\Delta\alpha$ is less than ~0.1 in their sample. The simulations also show that in the luminosity range $M_K < -13$ considered, the extracted SSC luminosities are generally dominated by a single dominant star cluster rather than several knots of star formation. They also present resolution- and distance-dependent SSC surface-density confusion limits and show how blending rates and aperture sizes affect the LFs. The smallest possible apertures should be used in crowded regions.

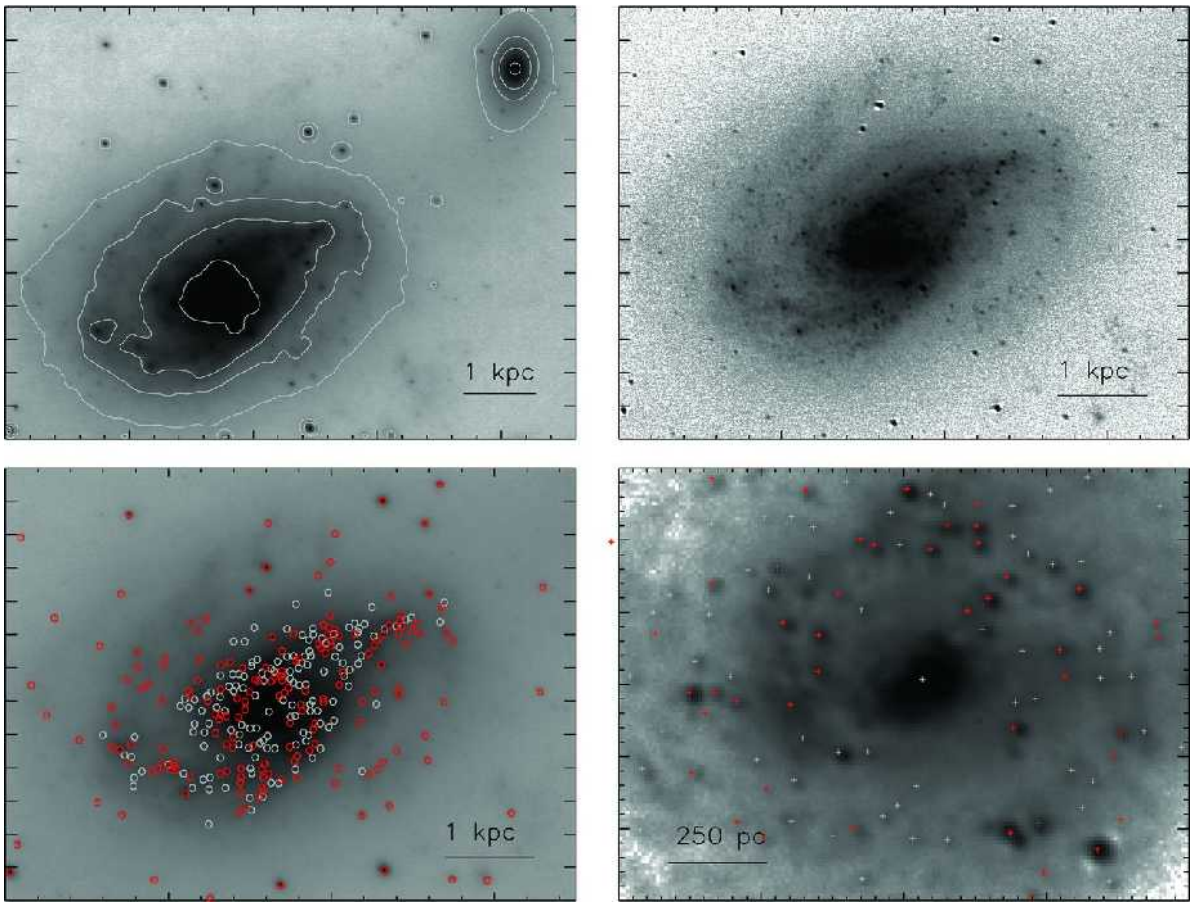

Fig. 7 The NACO field of one of the LIRGs studied, IRAS 18293–3413. **Top left**: the field of the whole interacting system with contours demarcating the four selected background regions for completeness analysis. **Top right**: a slightly smaller field around the primary galaxy is shown after unsharp masking. The SSC detections are made from this image. **Lower left:** all SSC candidate detections are overlaid as white on the original image (where the photometry is performed), while those that meet all the SSC candidate selection criteria are shown as red. **Lower right**: same as previous, but only for a zoomed-in region around the nucleus. Small tick marks are in 1-arcsec units, except in the last panel where they are in 0.1-arcsec units.

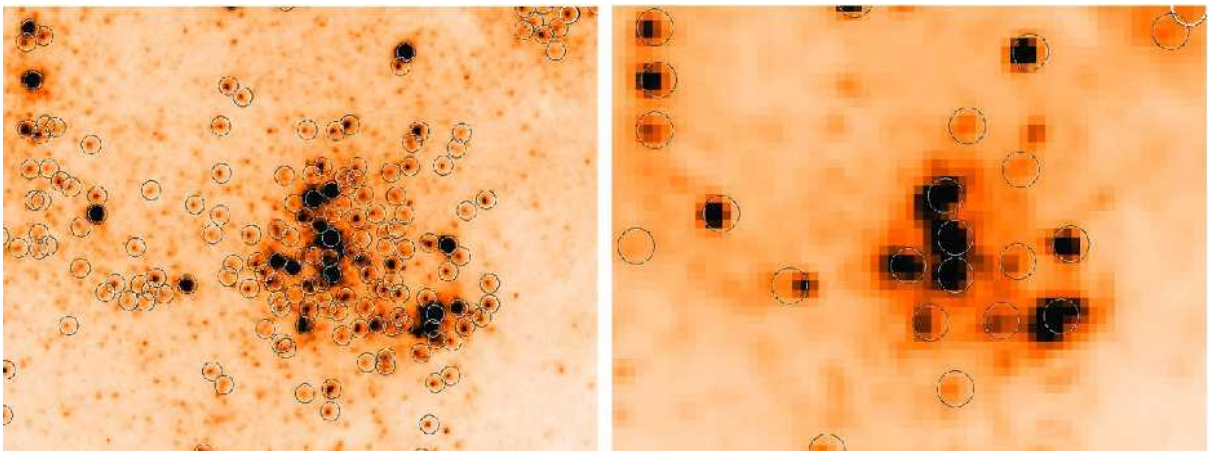

Fig. 8: A 10 arcsec by 8 arcsec (1.1 kpc by 0.9 kpc) region in the HST I-band image within the Antenna (region E in Whitmore et al. 2010). **Left**: the original image with ∼160 SSC candidates detected. **Right**: the image after moving the galaxy four times further away. Only ∼20 SSCs are now detected due to blending, though the brighter population remains relatively unchanged.

In Randriamanakoto et al. 2013 ApJ 775 L38, they established a relation between the brightest super star cluster (SSC) magnitude in a galaxy and the host star formation rate (SFR) for the first time in the near-infrared (NIR). While expanding the observed relation to longer wavelengths, less affected by extinction effects, it also pushes to higher SFRs. The relation they find, MK ~ -2.6log SFR, is similar to that derived previously in the optical and at lower SFRs. It does not, however, fit the optical relation with a single optical to NIR color conversion, suggesting systematic extinction and/or age effects. While the relation is broadly consistent with a size-of-sample explanation, they argue physical reasons for the relation are likely as well. In particular, the scatter in the relation is smaller than expected from pure random sampling strongly suggesting physical constraints. They also derive a quantifiable relation tying together cluster-internal effects and host SFR properties to possibly explain the observed brightest SSC magnitude versus SFR dependency.

GLOBULAR CLUSTER SYSTEMS IN ISOLATED ELLIPTICAL GALAXIES

The globular cluster (GC) systems of isolated elliptical galaxies have only recently begun to be studied in detail, and may exhibit morphological connections to the evolutionary histories of their hosts. **Ricardo Salinas** and collaborators presented the first wide-field photometric analysis of the GC systems of the isolated ellipticals NGC 3585 and NGC 5812 down to R ~24 mag. The GC systems are characterized, with each system displaying both the "Universal" blue peak, and a red peak, but each with differing strengths. The total number of GCs in each system, and their specific frequencies, are estimated. The GC colours and specific frequencies are highly indicative that the host galaxy environment plays a role in shaping its GC system. The authors produce, and subtract, accurate models of each galaxy, revealing interesting underlying features, including the first definitive evidence that NGC 5812 is interacting with a dwarf companion galaxy. From the galaxy models they also determine surface brightness and colour profiles. Both colour profiles appear quite flat and they discuss the apparent youth of NGC 3585 in the context of this work.

There is strong evidence that globular cluster systems (GCSs) of massive galaxies are largely assembled by infall/accretion processes. Therefore, we expect the GCSs of isolated elliptical galaxies to be poor. Although not completely isolated, NGC 7507 is a massive field elliptical galaxy

with an apparently very low dark matter content. **Ricardo Salinas** and collaborators have determined the richness, the colour distribution, and the structural properties of the GCS of NGC 7507. They performed wide-field photometry with the MOSAIC II camera at the 4m-Blanco telescope (CTIO, Chile). The authors identify three subpopulations with colour peaks. The bluest population may represent the old, metal-poor component. This interpretation is supported by its shallow density profile. The red population is more concentrated, resembling the galaxy light. The intermediate-colour population is strongly peaked in colour, and they interpret this population as the signature of a starburst whose age depends on the metallicity, but should be quite old, since no signatures of a merger are identifiable. In addition, they find a main sequence in the stellar foreground population, which they attribute to the Sagittarius dwarf tidal stream. The extraordinarily poor GCS of NGC 7507, a massive elliptical galaxy, is an illustration of how important the environmental conditions are for producing rich GCSs.

ISM, STAR FORMATION AND STELLAR ASTROPHYSICS

INTERSTELLAR POLARIZATION MAP OF THE HIGH GALACTIC LATITUDE SKY

Interstellar polarization of starlight at high galactic latitudes gives information on the direction of the local Galactic magnetic field and the distribution of cosmic dust in wide "windows" perpendicular to the Galactic plane. New polarization data obtained with the remotely controlled 60 cm KVA telescope at La Palma allowed **Andrei Berdyugin, Vlippu Piirola** and collaborators to construct high-latitude polarization maps with resolution and sky coverage high enough to examine in detail the distribution of the interstellar polarization and the direction of the Galactic magnetic field in this part of the sky.

In 2004 – 2012, they measured the polarization for more than 2400 stars at distances of up to 600 pc and within 60^o and 30^o from the north and south Galactic poles and built detailed polarization maps of the high galactic latitude regions. The new interstellar polarization maps give wider and higher resolution views around the Galactic poles than all other previous maps. The major patterns in the maps are significant asymmetries in the polarization, one in the northern sky directly across the local spiral and the second between the northern and southern Galactic hemispheres. We confirm that there is significantly more interstellar polarization at high southern latitudes than at high northern latitudes within the local spiral. We made a comparison of our optical polarization map with the proposed models using local dust- and gas shells: Weaver's Loop I super-bubble (Weaver, 1979); Wolleben's two-bubble model (Wolleben, 2007); the interaction ring between the Local Bubble and the Loop I super-bubble (Egger & Aschenbach, 1995). This comparison reveals interesting features (see Fig. 9): (1) The optical and radio polarizations are lower in the eastern than in the western branch of Loop I, which may be caused by a weaker effective magnetic field in the eastern part where the diffuse IRAS emission is bright; this illustrates that low optical polarization does not always imply little dust. (2) We can see a clear signature of the western side of Wolleben's S2 shell (at $35^o < l < 55^o$), while there is no alignment of the polarization directions along the suggested wall of S2 in the eastern part, though the alignment along S1 is visible. (3) In the upper parts of the suggested interaction zone between the Local Bubble and the Loop I super-bubble our data show polarizations aligned along the zone contour. The week and rather randomly directed polarizations measured previously in the eastern part of this region (Santos et al., 2011) may reflect the shorter distances (< 250 pc) in the investigated sample of stars.

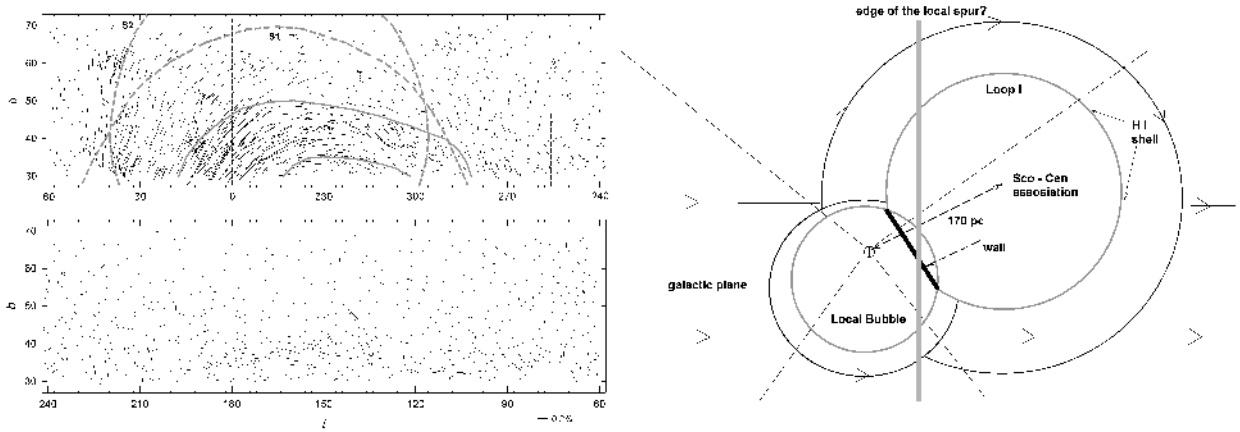

Fig. 9, left: Map of interstellar polarization at high northern galactic latitudes in rectangular projection. The map shows the latitude range from 30° to 70°. The length of the bar is proportional to the value of polarization P. Thin vertical dashed lines show the eastern ($255^o < l < 300^o$), central ($300^o < l < 360^o$), and western ($0^o < l < 45^o$) latitude zones of the magnetic loop. Thick dashed lines show the outer walls of Wolleben's S1 and S2 shells (Wolleben, 2007) and the thick solid line shows the contour of the interaction ring between the Local Bubble and Loop I (Egger & Aschenbach, 1995) **Right**: Sketch of our local Galactic environment with the deformed magnetic field (from Vallee, 2004). The areas covered by our observations are within the cones shown with the dashed lines. The approximate position of the edge of the Local spur is drawn with the thick vertical line.

GAMMA-RAY FLARES IN THE CRAB NEBULA

The Crab Nebula (Fig. 10) is a remnant of a supernova which was seen to explode in 1054 A.D. Since it is relatively close to us (approx. 2000 pc), it can be studied in great detail and it has been widely used to test theories in many fields of astrophysics. One of the exciting features of the Crab nebula are the "wisps": elongated emission features near the Crab Pulsar which change in shape and brightness over timescales of only a few weeks (Fig. 10). Recently there have appeared a number of papers aiming to explain the formation and evolution of the wisps using magnetohydrodynamical (MHD) simulations. According to these models the pulsar generates an outwards moving wind with a speed close to the speed of light. When this wind hits the surrounding plasma, a shock front is formed and particles in the wind are accelerated. The accelerated particles emit synchrotron radiation which is observed as the wisps.

Although these models can explain the general characteristics of the Crab Nebula synchrotron emission, there is one aspect they cannot quite explain yet: very rapid gamma-ray flares. The Crab Nebula is usually a very stable source of gamma-rays, but about once a year a huge increase (up to 30 times from the stable level) lasting about a week is observed. The exact location of the flare cannot be pinpointed by gamma-ray telescopes due to their low resolution.

In order to characterize the evolution of the wisps and other emission features near the pulsar and to study their possible connection to the gamma-ray flares, **Kari Nilsson** and collaborators started to monitor the Crab Nebula in the optical using the NOT and in X-rays using the Chandra X-ray observatory. The results reported in Schweizer et al. (2013, MNRAS, 433, 3325) cover the monitoring period from October 2010 to September 2012 and consists of 24 optical and 22 X-ray images.

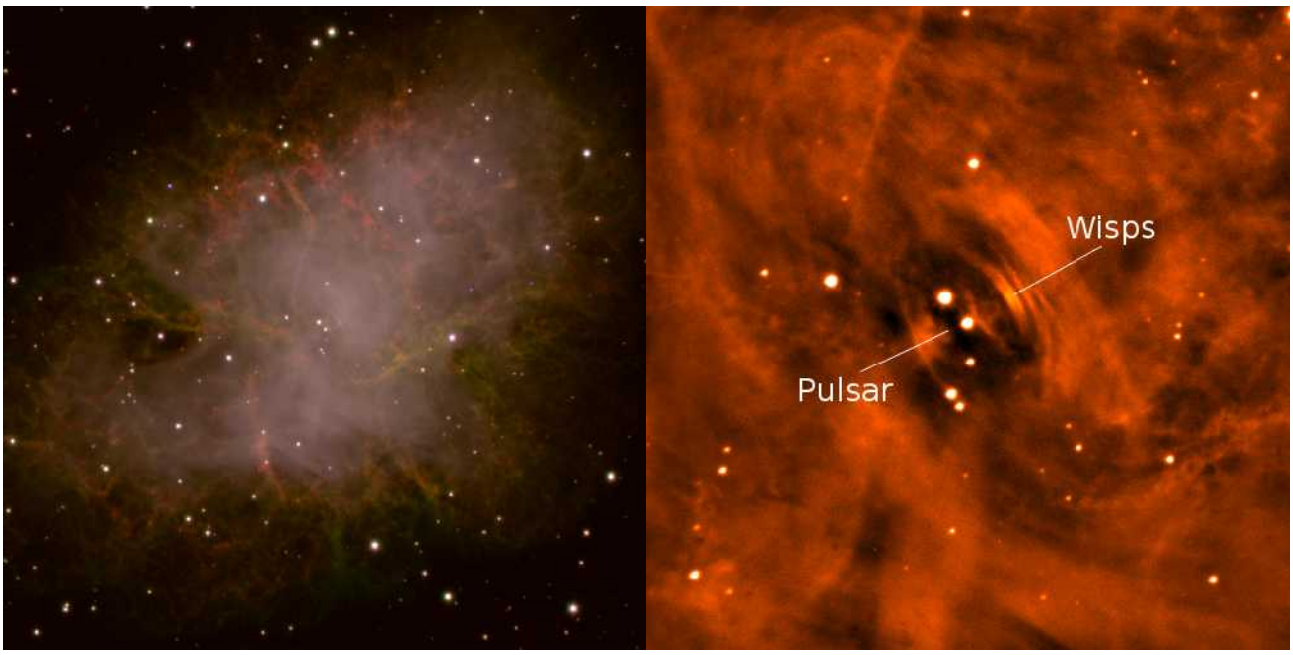

Fig. 10: Left: A color image of the Crab Nebula obtained during the FINCA observing school in fall 2013. **Right**: An I-band image of the central Crab Nebula obtained with the Nordic Optical Telescope (NOT). The field size is 1.6 x 1.6 arcmin.

During the monitoring we observed two events of a new wisp forming about 8 arcsec NW of the pulsar and moving away from it with projected velocities of 0.1-0.4 times the velocity of light. Although the frequency of new wisps is similar to the frequency of gamma-ray flares and the April 2011 flare roughly coincides with a formation of a new wisp, the connection between the gamma-ray flares and creation of new wisps could not be established. Further monitoring is required (and being carried out) to study the connection further.

During the monitoring the emergence and evolution of the wisps looked roughly similar, but there were small differences. Firstly, in the radial direction the X-ray emission of the wisps occurred approx. 0.5 arcsec closer to the pulsar than the optical emission. Secondly, by analyzing the azimuthal brightness distribution of the wisps and applying a simple synchrotron model we concluded that in the X-rays the derived Doppler boosting factors were consistent with the MHD model prediction while in the optical the boosting factors exceeded the predicted value by a factor of 3. Both findings imply that some features of the wisp emission mechanism is are probably not fully understood.

PESSTO: PUBLIC ESO SPECTROSCOPIC SURVEY FOR TRANSIENT OBJECTS

ESO public surveys are the largest programs that are running at ESO telescopes. These very large programmes last for several years and release the observed raw data immediately to the public via the ESO science archive. The PESSTO program, led by Queen's University Belfast (QUB), started in 2012 being one of the only two public spectroscopic surveys granted by ESO. It is a 4+1 year program at ESO/NTT with 90 observing nights per year using both the optical (EFOSC2) and near-infrared (SofI) instruments. The key science case of PESSTO is to study in detail peculiar supernovae and other optical transients, and to provide a legacy database of high-quality spectra of these events for the scientific community. In total, PESSTO aims to provide spectroscopic time

series for 150 selected supernovae and to classify 2000 new transients. During the first year of operation PESSTO classified 263 transients and followed up in detail 33 of them. All classification spectra were reduced and made publicly available within 12 hours from the observation and recently the first PESSTO data release was published offering the final reduction products of the obtained spectra during the first year.

The international PESSTO collaboration consists of researchers from 23 different institutes. The supernova researchers at FINCA are actively participating in the programme and were in charge of the August/September 2013 observing run, with **Erkki Kankare** and Tuomas Kangas (Tuorla Observatory/NOT) carrying out the observations and **Seppo Mattila** and Cosimo Inserra (QUB) processing the data. During the observing run multiple supernovae were monitored and 34 new transients were classified and reported in 8 Astronomer's Telegrams. During the August/September run the FINCA group also initiated and took charge of a follow-up campaign of a peculiar narrow-line supernova 2013fc (Kangas et al. in preparation).

The main interests of PESSTO include such rare events as intrinsically very luminous or sub-luminous supernovae, rapidly evolving transients and peculiar transients with a history of sporadic outbursts. Supernova 2009ip is a scientific highlight example of the PESSTO follow-up in the latter category (Fig. 11). The major 2009 outburst of a massive luminous blue variable star in NGC 7259 was initially incorrectly classified as a supernova. However, the event showed an evolution inconsistent with a supernova explosion and in 2012 the transient displayed two consecutive episodes of re-brightening. The target was closely monitored in PESSTO, with the researchers of FINCA covering near-infrared photometry with the NOT. The results were reported in Pastorello et al. (2013, ApJ, 767, 1) and Fraser et al. (2013, MNRAS, 433, 1312). However, it is still uncertain if the 2012 explosion was a genuine core-collapse event or a non-terminal outburst of the progenitor star. PESSTO is continuing the monitoring of this peculiar transient to further study its true nature, which is closely related to the stellar evolution of some of the most massive stars that will enter into a luminous blue variable phase during their life cycle.

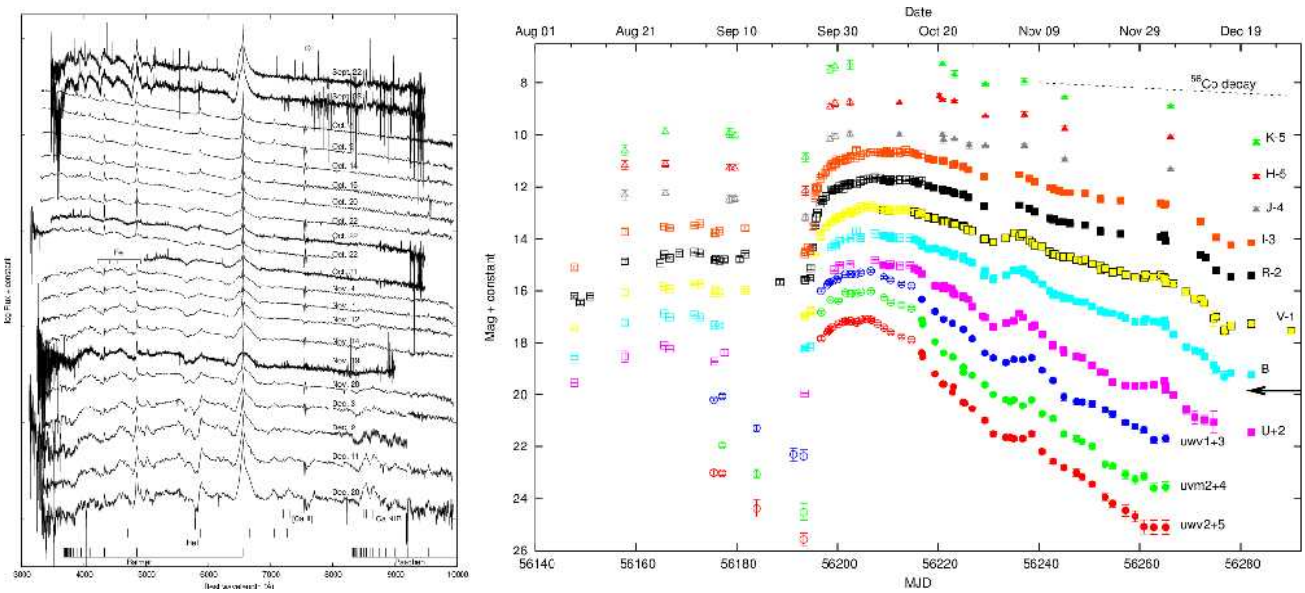

Fig. 11: From Fraser et al. (2013, MNRAS, 433, 1312) the spectroscopic time series (left) and the photometric multi-band evolution (right) of the peculiar supernova 2009ip with majority of the data obtained in the PESSTO programme (www.pessto.org).

STUDIES OF SUPER-LUMINOUS STELLAR EXPLOSIONS

Seppo Mattila and **Erkki Kankare** from FINCA and the University of Turku Ph.D. student Tuomas Kangas participated in an international research project studying the origin of the brightest explosions of the Universe. In the work led by researchers from Queen's University Belfast, two extremely rare, super-luminous supernovae were followed-up and studied in detail. According to current theories, such supernovae originate from some of the most massive stars in the Universe which explode as so called 'pair-instability' supernovae (PISN).

For about a year, the international team of scientists observed the slow fading of these supernovae with a range of different telescopes at ultraviolet, optical and infrared wavelengths. The researchers from FINCA used the 2.5m NOT at infrared wavelengths invisible to the human eye. These observations were compared with models for PISNe and also with models for explosions powered by a neutron star with a very strong and rapidly rotating magnetic field, magnetar, born in the explosion (see Fig. 12). The findings suggest the origin of these two supernovae to be better explained by magnetar powered explosions. The research was published in Nicholl et al. (2013, Nature, 502, 346).

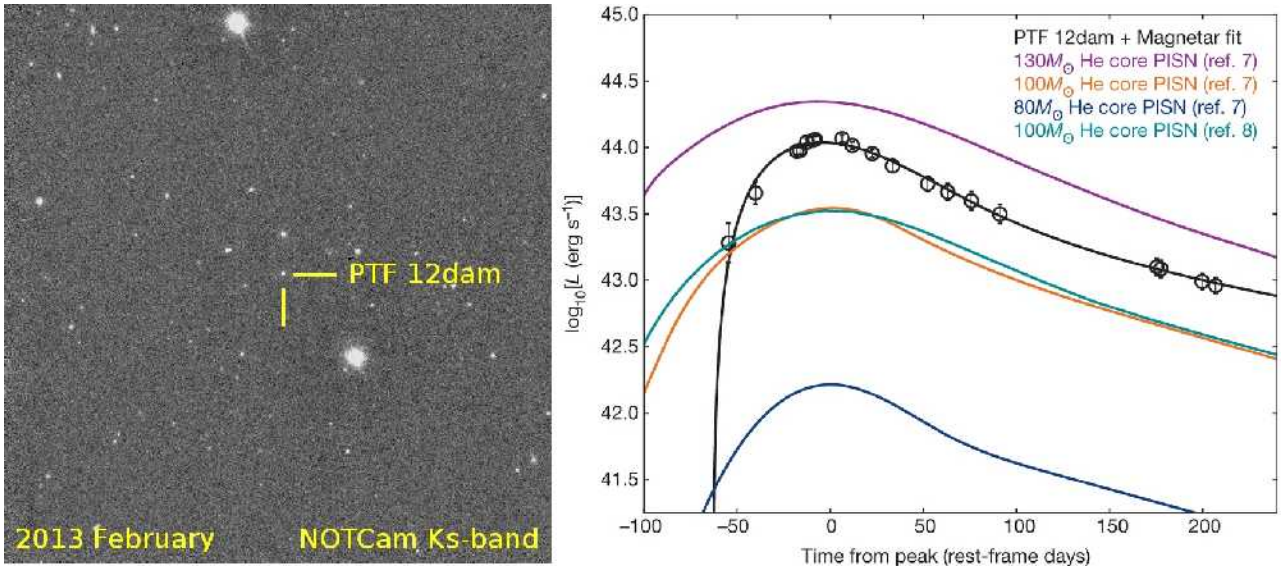

Fig. 12: **Left**: Near-infrared Ks-band image of the super-luminous supernova PTF 12dam observed with the NOT in February 2013 (left). **Right**: Bolometric (ultraviolet + optical + infrared) light curve of the supernova compared with models for pair-instability supernovae (PISN) and with a magnetar powered model.

SUPERNOVAE AND RADIO TRANSIENTS IN M82

International team of astronomers lead by **Seppo Mattila** and including Cristina Romero-Cañizales from Tuorla Observatory investigated the nature of the radio supernova 2008iz and a second radio transient (43.78+59.3) within the nuclear regions of the prototypical starburst galaxy M82. For this they made use of high spatial resolution images obtained using an adaptive optics system on the 8m Gemini-North Telescope together with archival data from the Hubble Space Telescope. Using image subtraction techniques the team was able to recover a near-infrared transient source coincident with both objects (see Figure 13). The infrared brightness of SN 2008iz was found to be consistent with those of normal core-collapse supernovae allowing for a modest amount of extinction. The nature of the 43.78+59.3 transient remains still elusive, and on the basis of the available data, an extremely

bright microquasar from a high-mass X-ray binary, was considered as the most plausible scenario. This work was reported in Mattila et al., MNRAS, 2013, 431, 2050.

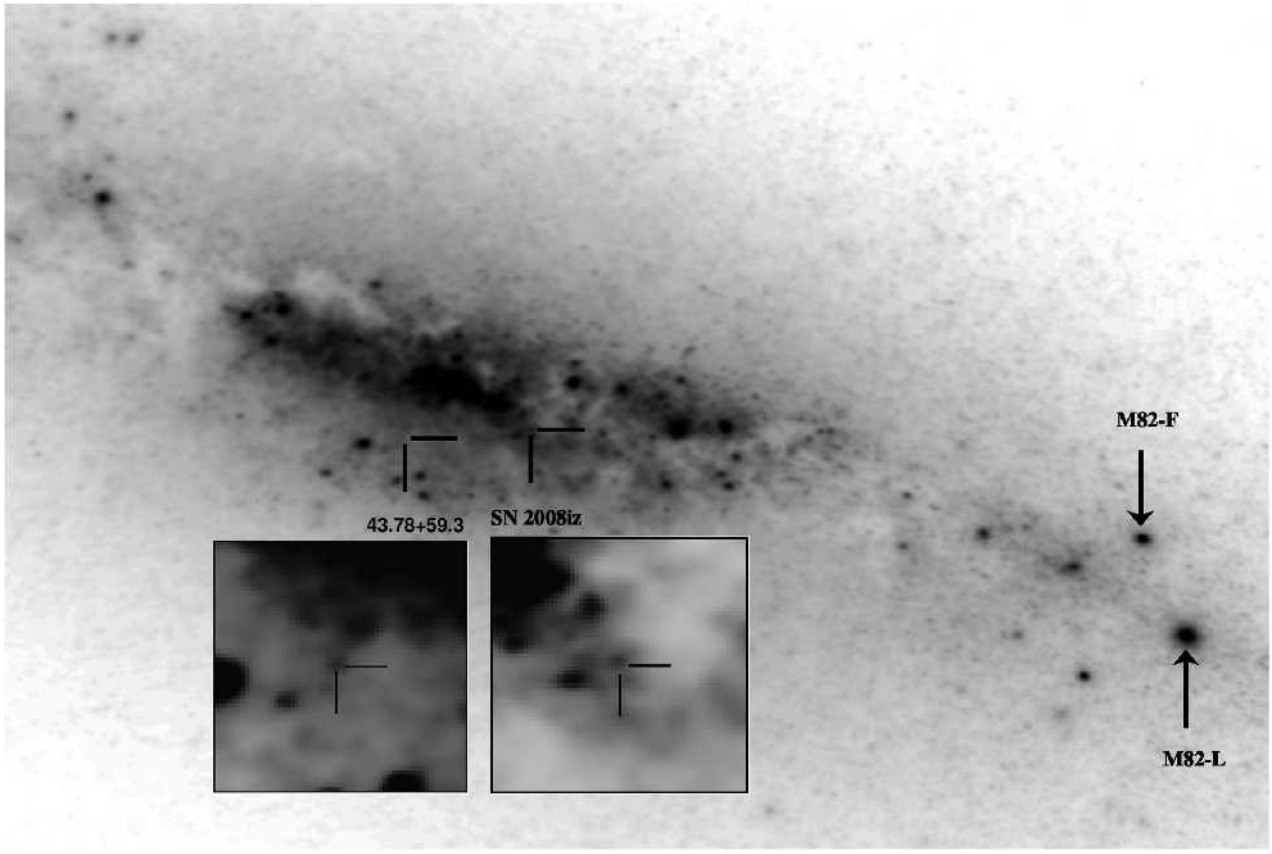

Fig. 13: A 50"x33" region of the K-band Gemini-N Altair/NIRI image of the M 82 nuclear regions. The sites of SN 2008iz and the 43.78+59.3 transient are shown in the 3"x3" subimages.

ACTIVE SUNS

Thomas Hackman continued research in the project "Active Suns", funded by the University of Helsinki. The observational part of this research consists of studying spot activity of late-type stars, based on Doppler imaging using spectroscopy and spectropolarimetry, and time-series analysis of photometry. The methods utilise the fact that large spots and magnetic field structures on the surface of a star will produce measurable variations in the brightness and photospheric spectral lines.

The results combining Doppler images and photometric time series analysis of the magnetically active giant FK Comae were published (Hackman et al. 2013). Clear proof of differential rotation can be seen in the photometric light curve (Fig. 14). Furthermore cases of fast changes in the spot configuration were studied and indications of an azimuthal dynamo wave were seen.

The studies of the RS CVn star II Peg were continued with a Zeeman-Doppler imaging analysis (Kochukhov et al. 2013) , that showed the the star probably has an α^2 -type dynamo, and a photometric time series analysis (Lindborg et al. 2013) providing further proof for the azimuthal dynamo wave discovered earlier (see e.g. Hackman et al. 2011). This azimuthal dynamo wave is an analogue to the latitudinal dynamo wave that causes the butterfly diagramme of sunspots.

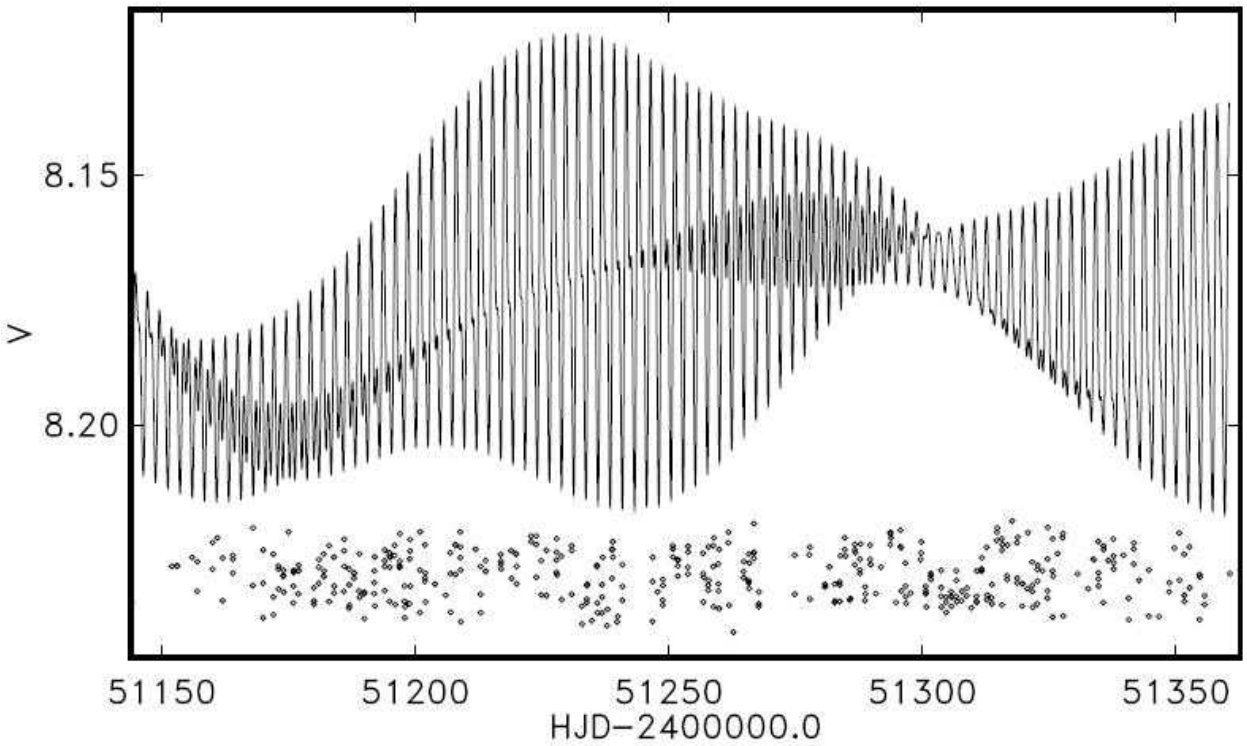

Fig. 14. Evolving light curve of FK Com. The line is a Carrier fit modelled for the photometric data and the points below show the residuals. The changing amplitude follows an interference pattern expected for differential rotation. This is explained by that two or several spots at different latitudes have slightly different angular velocities

Hackman also supervised the Doppler imaging study of DI Psc (Lindborg et al. 2014) and participated in the photometric time series analysis of the RS CVn binary s Gem and a study of a element abundance spots on the HgMn star HD11753 (Korhonen et al. 2013). These and previous studies show, that although stars are in different evolutionary states, the magnetic activity is mainly dependent on the rotation velocity and depth of the convection zone. Thus, even evolved late type stars can be used as analogues of the young Sun.

STELLAR ACTIVITY AS NOISE IN EXOPLANET DETECTION

With the recent boom in exoplanet discoveries, and increasingly more precise observations, planet hunters are pushing the limits of exoplanet detection and coming closer to finding also small, rocky planets orbiting in the Habitable Zone about their stars using radial velocity methods. M dwarfs are becoming prime targets in this search due in part to their ubiquity, and also because their small masses and low luminosities should make detection of habitable zone planets easier. However, many M dwarfs show high levels of activity. When this activity manifests itself as dark spots on the stellar surface, it results in spectral line profile changes that can mimic radial velocity variations.

Heidi Korhonen together with an international team of scientists, with Jan Marie Andersen from the University of Boston as the main collaborator and including **Thomas Hackman** from FINCA, has been investigating the effect of stellar activity to exoplanet detection with radial velocity method. The team has developed as realistic methods as possible for studying the effects of activity, and allowing obtaining statistical information. As an example, an investigation of the effects of the so-called starspot caused radial velocity 'jitter' on the detection and characterization of potentially

habitable planet around an M dwarf star is high-lighted.

Thirty random spot maps for cases where 0.3%, 3%, 10%, and 30% of the stellar surface is covered with spots are created. Three different spot size distributions are used in the spot configuration, resulting in a total of 90 spot maps per spot coverage. Synthetic spectral line profiles are created from each spot map and radial velocity contribution from a habitable zone planet is added to the spectra. Radial velocity is calculated from these synthetic spectra, resulting in a radial velocity curve that includes the planetary contribution and spot jitter as a function of time. The radial velocity curves are analyzed using Markov Chain Monte Carlo algorithms, similarly as is used in exoplanet searches. The recovered planetary parameters are compared to the known input parameters.

In Fig. 15, an example using a planet that has a period of 21.2 days orbiting a 0.57 solar mass M dwarf is shown. This period corresponds to an orbital radius that would put the planet well inside the classically defined habitable zone. The input period is well recovered from this map. As can be seen, the individual measurements from spotted cases can give very varying period measurements, even if the mean of the 90 different spot configurations is within one standard deviation from the real input period. Still, this investigation shows that even relatively small amounts of stellar activity (at the level of solar activity maximum) can cause errors in the planetary parameters obtained from radial velocity measurements. The impact to the recovered orbital eccentricity is even larger, with increasing spot coverage causing spurious eccentricity detections.

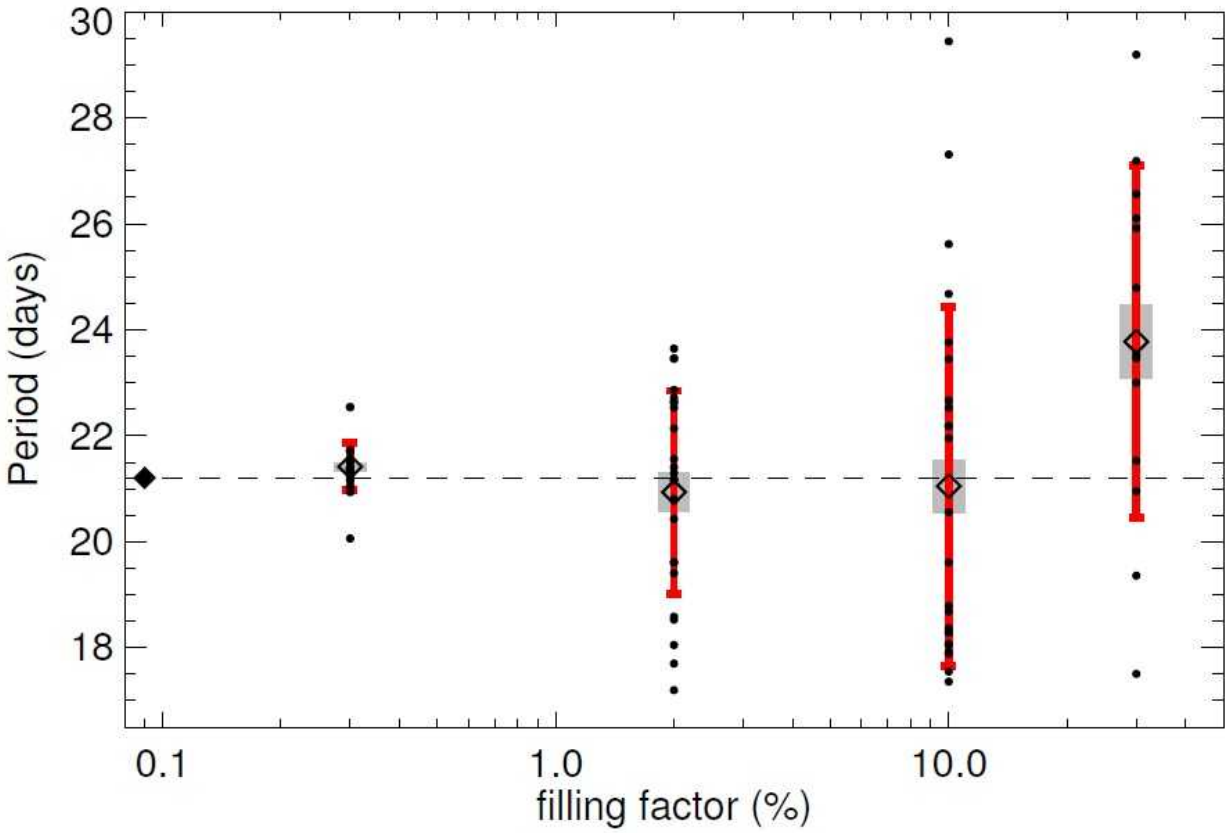

Fig. 15: The results for the exoplanet period searches when different fractions of the stellar surface is covered in spots. Dashed line gives the input period and filled circles the individual measurements from different spot configurations. The large diamond symbols give the mean period for each spot coverage fraction obtained from the 90 different spot maps. The red error-bars are the standard deviation from the individual measurements for each spot coverage. As a test of the method, also a map of zero spot coverage is created.

ON THE ORIGIN OF CYCLOTRON LINES IN THE SPECTRA OF X-RAY PULSARS

X-ray pulsars are neutron stars in binary systems accreting matter usually from a massive companion. These neutron stars have a sufficiently strong magnetic field, which channels accreting gas towards magnetic poles. Strong magnetic field modifies the observed X-ray spectrum often manifesting as the line-like absorption features, the so-called cyclotron lines. Such cyclotron resonance scattering features (CRSF), sometimes also with harmonics, are observed in the spectra of several X-ray pulsars, and can show significant changes in the line energy with the pulsar luminosity. In a case of bright sources, the line centroid energy is anti-correlated with the luminosity.

Such a behaviour is often associated with the onset and growth of the accretion column, which is believed to be the origin of the observed emission and the cyclotron lines. However, this scenario inevitably implies large gradient of the magnetic field strength within the line-forming region, and it makes the formation of the observed line-like features problematic. Moreover, the observed variation of the cyclotron line energy is much smaller than could be anticipated for the corresponding luminosity changes.

International team of astronomers (including **Sergey Tsygankov** from FINCA) argues that a more physically realistic situation is that the cyclotron line forms when the radiation emitted by the accretion column is reflected from the neutron star surface (Fig. 16). The idea is based on the facts that a substantial part of column luminosity is intercepted by the neutron star surface and the reflected radiation should contain absorption features. The reflection model was developed and applied to explain the observed variations of the cyclotron line energy in a bright X-ray pulsar V 0332+53 over a wide range of luminosities (Fig. 17). The model has profound implications for the interpretation of the data on the cyclotron line observed in X-ray pulsars.

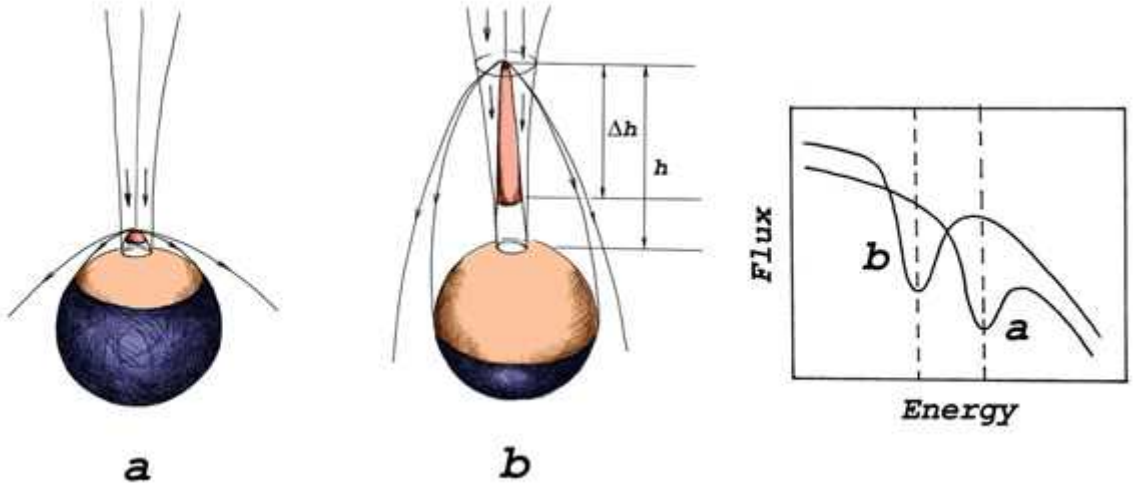

Fig.16: Accreting X-ray pulsar geometry and the emergent spectrum. The larger is the luminosity, the higher is the accretion column, the larger illuminated fraction of the neutron star surface, the weaker the average magnetic field, and the smaller the cyclotron line energy.

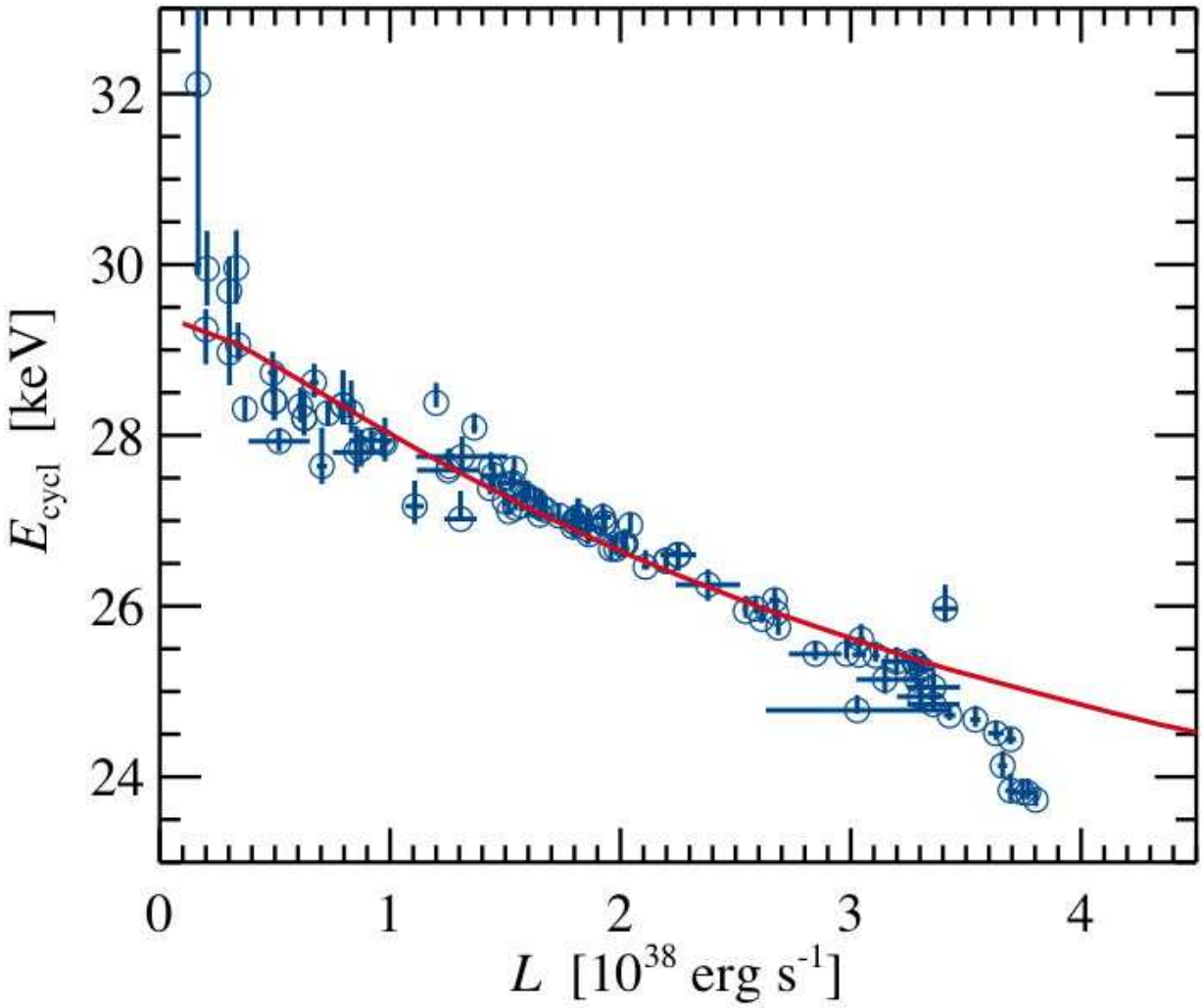

Fig.17: Dependence of the cyclotron line energy on the luminosity in the X-ray pulsar V 0332+53 (circles with the error bars) and the best-fit theoretical relation obtained with the model (solid line).

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PERSONNEL IN 2013 (stationed at the University of Turku, unless otherwise mentioned):

Director:	Jari Kotilainen
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University Researchers:	Andrei Berdyugin
	Roberto De Propris (from 1.10.2013)
	Lauri Haikala (Helsinki)
	Pasi Hakala
	Jorma Harju (Helsinki)
	Heidi Korhonen (on leave of absence until 31.7.2013)
	Eija Laurikainen (Oulu)
	Seppo Mattila
	Kari Nilsson
	Vilppu Piirola
Post-doctoral Researchers:	Sebastien Comeron (Oulu; from 1.8.2013)
	Thomas Hackman (Helsinki)
	Erkki Kankare (from 1.4.2013)
	Jonathan Leon-Tavares (Turku + Aalto)
	Elina Lindfors
	Andrew Mason (from 1.6.2013)
	Elina Nieppola (on leave of absence until 31.1.2013; Aalto)
	Veli-Matti Pelkonen (Helsinki)
	Ricardo Salinas (until 31.7.2013)
	Sergey Tsygankov (Oulu)

TEACHING IN 2013

The researchers of FINCA give a number of courses in their Universities. The basic courses are taught every year, while intermediate and advanced courses are given on average once in two years. Many courses are given in English if required.

Basic level courses:

Veli-Matti Pelkonen, Havaitsevan tähtiteteen peruskurssi I (Basic course in optical astronomy), University of Helsinki, 4 credits (co-lecturer)

Intermediate level courses:

Sebastien Comeron: "Galaxies", 5 credits, University of Oulu

Jari Kotilainen: Havaitseva tähtitiede III (Observational methods in astronomy III), University of Turku, 4 credits

Kari Nilsson: Tähtien rakenne ja kehitys I (Stellar structure and evolution I; in Finnish), University of Turku, 6 credits

Veli-Matti Pelkonen: Tähtien rakenne ja kehitys, University of Helsinki, 5 credits (co-lecturer)

Advanced level courses:

Seppo Mattila, Heidi Korhonen, Erkki Kankare, Kari Nilsson, Andrew Mason (lecturers and/or tutors): Practical astronomy course with the Nordic Optical Telescope, University of Turku and University of Helsinki, 6 credits (Turku) / 5 credits (Helsinki)

Elina Lindfors, Astroparticle physics, 4 credits, University of Turku

Seppo Mattila: Interstellar physics, University of Turku, 4 credit points

COMPLETED THESES IN 2013

Anders Hammer Holm, Jesper Jul Jensen, and Mikkel Juhl Hobert, "Exoplanets in Multiple Star Systems", University of Copenhagen, 15 credits, BSc thesis (supervisor: **Heidi Korhonen**)

Rasmus Bugge and Simon Arent Vedel, "Exoplanetary Atmospheres and Mass-estimation of Kepler-14b using the Radial Velocity Method", University of Copenhagen, 15 credits, BSc thesis (supervisor: **Heidi Korhonen**)

Joachim Janz, PhD thesis, Double degree between the Universities of Oulu and Heidelberg: "Puzzling nature of dwarf-sized gas-poor disk galaxies" (Principal supervisor: **Eija Laurikainen**)

Alabi Adebusola: Globular Cluster Bimodality in Isolated Elliptical Galaxies, Msc thesis, University of Turku, accepted 05/2013 (supervisor: **Ricardo Salinas**)

Erkki Kankare, University of Turku, Ph.D. thesis "Supernovae in dense and dusty environments" (Supervisor: **Seppo Mattila**)

Jimit Sanghvi, University of Turku, "The low-mass end of the black hole – host galaxy mass relation in quasars at $0.5 < z < 1.0$", Msc thesis, accepted 11/2013 (supervisor: **Jari Kotilainen**)

MEMBERSHIPS IN SOC/LOC OF CONFERENCES AND OTHER COMMITTEES

Thomas Hackman:

chair for the NOT Observing Programmes Committee and the Instrument User Group on High-Resolution Optical Spectroscopy.

Heidi Korhonen:

- Member of the ESO Observing Programme Committee stellar panel in P93

- Member of the OPTICON common telescope Time Allocation Committee

- External referee of PhD dissertation of Ian Waite: Magnetic Fields of Young Solar-Type Stars, University of Southern Queensland, Australia

- Board member of the OPTICON working group 13 "Enhancing Community Skills"

- Member of the IAU working group "Impact of Magnetic Activity on Solar and Stellar Environments"

Jari Kotilainen,
- Finnish delegate, ESO Council
- Member of SOC, European Week of Astronomy and Space Science (EWASS), Turku, 8.-13.7.2013
- SOC chair, Symposium 10: "The co-Evolution of Black Holes and Galaxies", EWASS, Turku, 8.-13.7.2013
- SOC chair, Special Session 13: "Starburst galaxies now and then with ALMA", EWASS, Turku, 8.-13.7.2013

Eija Laurikainen:
- SOC: 12-16.8.2013 "Structure and Dynamics of Disk Galaxies", Arkansas
- SOC+LOC: DAGAL Oulu meeting 4-7.3.2013
- SOC+LOC: SMAKSED meeting: 8-9.3.2013

Elina Lindfors:
- Workshop "Extragalactic Gamma-Ray Astronomy with the Cherenkov Telescope Array", March 2013, Local Organizer and Chair of SOC
- MAGIC Collaboration Meeting June 2013, Local Organizer
- EWASS, European Week of Astronomy and Space Science July 2013, member of LOC
Symposium: - "Gamma-ray sky in the era of Fermi and Cherenkov Telescopes" at EWASS 2013, Chair of SOC

Seppo Mattila:
- External Examiner for the Ph.D. thesis of Stacey Habergham at Liverpool John Moores University, 1.2.2013

- Member of the board of the Doctoral Programme in Physical and Chemical Sciences of the Univ. of Turku graduate school (UTUGS)
- Substitute member of the Nordic Optical Telescope OPC
- Main organizer and the chair of the SOC in "Deaths of Massive Stars as Supernovae and Gamma-ray bursts" Symposium as a part of the European Week of Astronomy and Space Science (EWASS), 10-11.7.2013, Turku

Kari Nilsson:
- EWASS 2013, LOC

Sergey Tsygankov:
- Member of SOC: Symposium "Extreme physics of neutron stars" / The European Week of Astronomy and Space Science 2013

CONFERENCE PRESENTATIONS AND SEMINAR TALKS
(I)= invited talk; (O) – oral presentation; (P) – poster

Sebastien Comeron:
- "The origin of Thick Discs and Some Comparisons on the Results on the Thick Disc in the Milky Way with Those in Nearby Galaxies", 7th Korean Astrophysics Workshop on Dynamics of Disc Galaxies, Seoul, Republic of Korea, 21.-24.10.2013 (I)
- "A deeper look on thick discs using data from the Spitzer Survey of Stellar Structure in Galaxies (S^{4}G)", Uppsala University, Sweden, 12.12.2013
- "Is dark matter the most valid explanation for the mass which is missing in the Universe?", Uppsala University, Sweden, 13.12.2013

Thomas Hackman:
- Differential Rotation and Magnetism across the HR Diagram, NORDITA (Stockholm), 8.-12.4.2013, key scientist (O)

Erkki Kankare:
- European Week of Astronomy and Space Science (EWASS) 2013 S8, 8-12 July 2013, Turku, "Core-collapse supernovae in luminous infrared galaxies" (O)
- 2 September 2013, Pontificia Universidad Catolica de Chile, "Supernovae in Dense and Dusty Environments"

Heidi Korhonen:
- Gravitational microlensing 101 years from theory to practise, 10-13.2.2013, Doha, Qatar, "Effect of stellar activity on detectability of exoplanets" (O)
- Invitation only meeting Seismology of Stellar Coronal Flares, 21-24.5.2014, Leiden, the Netherlands, "Observing stellar photospheric activity" (O)
- Putting A Stars into Context: Evolution, Environment, and Related Stars, 3.-7.6.2013, Moscow, Russia, "Element spots in HgMn stars" (I)
- EWASS 2013, Symposium 7: Stellar magnetic activity across the HR diagram, 10.-11.7.2013, Turku, Finland, "Magnetism and cycles in late-type stars" (I)
- IAU Symposium 302 Magnetic Fields Throughout the Stellar Evolution, 25.-30.8.2013, Biarritz, France, "Surface magnetism of cool giant and supergiant stars" (I)
- 18.10.2013, Tuorla Observatory, "Stellar activity and its effect on exoplanets and their detection"

- 19.10.2013 Turku Science Days: "Eksoplaneetat: toista maata etsimässä" (in Finnish; outreach)
- 5.11.2013, University of Michigan, "Stellar activity and exoplanets"

Jari Kotilainen:
- 'Huipulta huipulle jo vuodesta 1962: ESO', Tuorla Observatory, 11.5.2013 (outreach; visit by Tampere Ursa)
- 'ESO, FINCA and Finnish Astronomy', Tuorla Observatory, 25.6.2013 (Visit by a delegation of the Chinese Academy of Sciences)
- 'The host galaxies of low-redshift quasars in the SDSS Stripe 82', 11.7.2013, EWASS2013 Symposium 10: The co-evolution of Black Holes and Galaxies, Turku, Finland (O)
- “Quasar host galaxies and environments in the nearby Universe”, Galaxy Evolution Over Five Decades, Cambridge, U.K., 2.-6.9.2013 (O)
- “Cool gas around quasars”, Tuorla Observatory seminar, 15.11.2013

Eija Laurikainen:
- 7th Korean Astrophysics Workshop on Dynamics of Disk Galaxies, 21-24.10.2013, Seoul, South-Korea: Pipeline fitting of S4G galaxies (I)
- Deconstructing Galaxies - Structure and Morphology in the Era of Large Surveys, 18-22.12., 2013, Santiago de Chile, Chile: Barred galaxies (I)

Elina Lindfors:
- talk at "First Nordic CTA meeting", Stockholm: "CTA and AGN" March 2013 (I)
- talk at "Extragalactic Gamma-Ray Astronomy with the Cherenkov Telescope Array", Muonio: "Very High Energy Gamma-rays from Flat Spectrum radio quasars" March 2013 (O)
- institute seminar, University of Jyväskylä: Cherenkov Telescope Array, April 2013
- Seminar, Tuorla Observatory: "VHE gamma-ray emission from Flat Spectrum Radio Quasars observed by the MAGIC telescopes", April 2013
- talk at "Gamma-ray sky in the era of Fermi and Cherenkov Telescopes": VHE gamma-ray emission from Flat Spectrum Radio Quasars observed by the MAGIC telescopes, July 2013 (O)

Seppo Mattila:
- 'Shaping E-ELT Science and Instrumentation', 25-28 February, Ismaning, 'Adaptive Optics-assisted detection and study of supernovae' (O)
- 31.1.2013, Liverpool John Moores University, 'Supernovae in starbursts and LIRGs'
- 22.3.2013, Tuorla Observatory, 'The origin of supernovae and their use as probes of the cosmic star formation'

Kari Nilsson:
- EWASS 2013, 8-12.7.2013, Turku, "Multi-wavelength monitoring of the Crab Nebula" (O)
- 26.4.2013, Tuorla Observatory, "Crab Nebula wisps"

Veli-Matti Pelkonen:
- 221st AAS Meeting, Long Beach, USA, 5. - 10.1.2013, "Bolocam survey of a sample of Planck cold clumps" (P)
- Herschel PACS and SPIRE Mapmaking Workshop, ESAC, Madrid, Spain, 28.-31.1.2013, "Galactic Cold Cores" (I)
- Cold Cores Meeting, Toulouse, France, 17.-19.4.2013, "Status of the Herschel data reduction", (I)
- 15.2.2013, IRAP, Toulouse, "Grain alignment by radiative torques: Does polarization trace the

magnetic field?"
- 16.9.2013, NOT, La Palma, "Cloudshine: observing the interstellar clouds in NIR scattered light"
- 2.12.2013, University of Oulu, "Cloud- and coreshine: Observing interstellar dust with near-infrared scattering"
- 3.12.2013, Oulunsalon Lukio (Oulunsalo High School), "Tähtitieteen tutkijana" (As an astronomer)

Ricardo Salinas:
- 24.7.2013 , Universidad Católica de Chile, "The globular cluster system of isolated ellipticals"
- 29.7.2013, Universidad Diego Portales, "The globular cluster system of isolated ellipticals"

Sergey Tsygankov:
- The European Week of Astronomy and Space Science 2013, Symposium "Extreme physics of neutron stars", July 10-12, 2013, Turku, Finland: "Power spectra of transient X-ray pulsars: estimation of the neutron stars magnetic field", (O)

RESEARCH VISITS TO FOREIGN INSTITUTES AND HOSTS OF VISITORS TO FINCA

Thomas Hackman:
- NORDITA, Stockholm, 8. – 18.4.2013, visit to: Axel Brandenburg (NORDITA), Rainer Arlt (AIP)

Erkki Kankare:
- Astronomical Observatory of Padova, 29-30.4.2013, PESSTO collaboration meeting
- ESO La Silla Observatory, August/September 2013, NTT observing run
- Pontificia Universidad Catolica de Chile, 2-3.9.2013, Cristina Romero-Canizales & Franz Bauer

Heidi Korhonen:
- University of Michigan, 3-8.11, 2013, collaborating with John Monnier and Rachael Roettenbacher

Jari Kotilainen:
- host of Emanuele Farina, University of Insubria, Como, Italy, 10.-20.6.2013
- host of Petri Väisänen, SAAO, Cape Town, South Africa, 1.-31.7.2013

Eija Laurikainen:
- 24-26.1.2013, Thorsten Lisker, University of Heidelberg, visit in Oulu
- 24-26.1.2013, Laura Ferrarese, University of Herzberg Institute of Astropsysics, visit in Oulu
- 27-31.5.2013, Reynier Peletier, University of Groningen, lectures on stellar populations held in Oulu

Elina Lindfors:
- The Kavli Institute for Cosmological Physics (KICP) at the University of Chicago (CTA Consortium Meeting), May 28-June 1, 2013
- Universidad Complutense Madrid, November 18-22, 2013
- host to: Talvikki Hovatta Owens Valley Radio Observatory, Caltech, 1-12 July, 2013

Seppo Mattila:
- Astrophysics Research Institute, Liverpool John Moores University, 31.1.-1.2.2013, Dr. Phil James

- Astronomical Observatory of Padova, 29-30.4. 2013, PESSTO collaboration meeting
- Department of Astronomy, Stockholm University, 21.10.2013, Prof. Peter Lundqvist
- Niels Bohr Institute, 18.12.2013, NOT Transient Explorer "Pre Kick-off" meeting (Prof. Johan Fynbo; Dr. Michael Andersen)
- 22-23.2.2013., Dr Bruno Leibundgut, European Southern Observatory, 2 days
- 9-12.5.2013, Prof. Peter Lundqvist, Stockholm University, 4 days
- 20-24.5.2013, Dr. Stuart Ryder, Australian Astronomical Observatory, 5 days

Kari Nilsson:
- University of Leiden, 13-15.5.2013, Euclid Consortium Meeting

Veli-Matti Pelkonen:
- IPAC/Caltech, 11- 26.1.2013, Peregrine McGehee & Roberta Paladini
- Toulouse, 8 – 18.2.2013, Isabelle Ristorcelli & Ludovic Montier
- IPAC/Caltech, 28.8. - 11.9.2013, Peregrine McGehee & Roberta Paladini

Ricardo Salinas:
- 22-26.7.2013, Universidad Católica de Chile, visiting Prof. Marcio Catelan

Sergey Tsygankov:
- Institut für Astronomie und Astrophysik, Kepler Center for Astro and Particle Physics, Universität Tübingen, Sand 1, D-72076 Tübingen, Germany, 5-12.10.2013, Victor Doroshenko
- 16-24.5. 2013 Victor Doroshenko, Institut für Astronomie und Astrophysik, Kepler Center for Astro and Particle Physics, Universität Tübingen, Sand 1, D-72076 Tübingen, Germany, 9 days

FINNISH CENTRE FOR ASTRONOMY WITH ESO (FINCA)
REFEREED PUBLICATIONS IN YEAR 2013

[01] Acharya, B. S.; Actis, M.; Aghajani, T.; Agnetta, G.; Aguilar, J.; Aharonian, F.; Ajello, M.; Akhperjanian, A.; Alcubierre, M.; Aleksić, J. et al. (incl. **Lindfors,E**.), 2013: Introducing the CTA concept. - Astroparticle Physics, Volume 43, p. 3-18

[02] Aleksić, J.; Antonelli, L. A.; Antoranz, P.; Asensio, M.; Backes, M.; Barres de Almeida, U.; Barrio, J. A.; Becerra González, J.; Bednarek, W.; Berger, K. et al. (incl. **Lindfors,E**., **Nilsson.K.**), 2013: Very high energy gamma-ray observation of the peculiar transient event Swift J1644+57 with the MAGIC telescopes and AGILE - Astronomy & Astrophysics, Volume 552, id.A112, 6 pp.

[03] Aleksić, J.; Antonelli, L. A.; Antoranz, P.; Asensio, M.; Backes, M.; Barres de Almeida, U.; Barrio, J. A.; Bednarek, W.; Berger, K.; Bernardini, E. et al. (incl. **Lindfors,E., Nilsson,K**.), 2013: The simultaneous low state spectral energy distribution of 1ES 2344+514 from radio to very high energies - Astronomy & Astrophysics, Volume 556, id.A67, 28 pp.

[04] Aleksić, J.; Antonelli, L. A.; Antoranz, P.; Asensio, M.; Barres de Almeida, U.; Barrio, J. A.; Becerra González, J.; Bednarek, W.; Berger, K.; Bernardini, E.;et al. (incl. **Lindfors,E., Nilsson,K**.),, 2013: Observations of the magnetars 4U 0142+61 and 1E 2259+586 with the MAGIC telescopes - Astronomy & Astrophysics, Volume 549, id.A23, 4 pp.

[05] Andersson, B.-G.; **Piirola, V.**; De Buizer, J.; Clemens, D. P.; Uomoto, A.; Charcos-Llorens, M.; Geballe, T. R.; Lazarian, A.; Hoang, T.; Vornanen, T., 2013: Evidence for H_2 Formation Driven Dust Grain Alignment in IC 63 - The Astrophysical Journal, Volume 775, Issue 2, article id. 84, 16 pp.

[06] Arellano Ferro, A.; Bramich, D. M.; Figuera Jaimes, R.; Giridhar, Sunetra; Kains, N.; Kuppuswamy, K.; Jørgensen, U. G.; Alsubai, K. A.; Andersen, J. M.; Bozza, V. et al. (incl. **Korhonen,H.**), 2013: A detailed census of variable stars in the globular cluster NGC 6333 (M9) from CCD differential photometry - Monthly Notices of the Royal Astronomical Society, Volume 434, Issue 2, pp.1220-1238

[07] Arlen, T.; Aune, T.; Beilicke, M.; Benbow, W.; Bouvier, A.; Buckley, J. H.; Bugaev, V.; Cesarini, A.; Ciupik, L.; Connolly, M. P.; et al. (incl. **Nieppola,E**.), 2013: Rapid TeV Gamma-Ray Flaring of BL Lacertae - The Astrophysical Journal, Volume 762, Issue 2, article id. 92, 13 pp.

[08] Benítez, E.; Méndez-Abreu, J.; Fuentes-Carrera, I.; Cruz-González, I.; Martínez, B.; López-Martin, L.; Jiménez-Bailón, E.; Chavushyan, V.; **León-Tavares, J.,** 2013: Characterization of a Sample of Intermediate-type AGNs. I. Spectroscopic Properties and Serendipitous Discovery of New Dual AGNs - The Astrophysical Journal, Volume 763, Issue 1, article id. 36, 13 pp.

[09] Benítez, E.; Méndez-Abreu, J.; Fuentes-Carrera, I.; Cruz-González, I.; Martínez, B.; López-Martin, L.; Jiménez-Bailón, E.; Chavushyan, V.; **León-Tavares, J.,** 2013: Characterization of

a Sample of Intermediate-type Active Galactic Nuclei. II. Host Bulge Properties and Black Hole Mass Estimates - The Astrophysical Journal, Volume 763, Issue 2, article id. 136, 13 pp.

[10] Bhatta, G.; Webb, J. R.; Hollingsworth, H.; Dhalla, S.; Khanuja, A.; Bachev, R.; Blinov, D. A.; Böttcher, M.; Bravo Calle, O. J. A.; Calcidese, P.; et al. (incl. **Lindfors,E., Nilsson,K**.),, 2013: The 72-h WEBT microvariability observation of blazar S5 0716 + 714 in 2009 - Astronomy & Astrophysics, Volume 558, id.A92, 10 pp.

[11] Boldin, P. A.; **Tsygankov, S. S.**; Lutovinov, A. A., 2013: On timing and spectral characteristics of the X-ray pulsar 4U 0115+63: Evolution of the pulsation period and the cyclotron line energy - Astronomy Letters, Volume 39, Issue 6, pp.375-388

[12] Caso, J. P.; Richtler, T.; Bassino, L. P.; **Salinas, R.**; Lane, R. R.; Romanowsky, A., 2013: The paucity of globular clusters around the field elliptical NGC 7507 - Astronomy & Astrophysics, Volume 555, id.A56, 8 pp.

[13] Chernin, A. D.; Bisnovatyi-Kogan, G. S.; Teerikorpi, P.; **Valtonen, M. J**.; Byrd, G. G.; Merafina, M., 2013: Dark energy and the structure of the Coma cluster of galaxies - Astronomy & Astrophysics, Volume 553, id.A101, 4 pp.

[14] Cisternas, M.; Gadotti, D. A.; Knapen, J. H.; Kim, T.; Díaz-García, S.; **Laurikainen, E.**; Salo, H.; González-Martín, O.; Ho, L. C.; Elmegreen, B. G.; et al., 2013: X-Ray Nuclear Activity in S^4G Barred Galaxies: No Link between Bar Strength and Co-occurrent Supermassive Black Hole Fueling. - The Astrophysical Journal, Volume 776, Issue 1, article id. 50, 15 pp.

[15] **Comerón, S.**, 2013: Inner rings in disc galaxies: dead or alive - Astronomy & Astrophysics, Volume 555, id.L4, 9 pp.

[16] Cornelisse, R.; Kotze, M. M.; Casares, J.; Charles, P. A.; **Hakala, P. J.**, 2013: The origin of the tilted disc in the low-mass X-ray binary GR Mus (XB 1254-690) - Monthly Notices of the Royal Astronomical Society, Volume 436, Issue 1, p.910-920.

[17] Farina, E. P.; Falomo, R.; Decarli, R.; Treves, A.; **Kotilainen, J. K.**, 2013: On the cool gaseous haloes of quasars - Monthly Notices of the Royal Astronomical Society, Volume 429, Issue 2, p.1267-1277

[18] Farina, E. P.; Falomo, R.; Treves, A.; Decarli, R.; **Kotilainen, J.**; Scarpa, R., 2013: Reclassification of the nearest quasar pair candidate: SDSS J15244+3032-RXS J15244+3032 - Astrophysics and Space Science, Volume 345, Issue 1, pp.199-202

[19] Fraser, M.; Inserra, C.; Jerkstrand, A.; Kotak, R.; Pignata, G.; Benetti, S.; Botticella, M-T; Bufano, F.; Childress, M.; **Mattila, S.** et al., 2013: SN 2009ip à la PESSTO: no evidence for core collapse yet - Monthly Notices of the Royal Astronomical Society, Volume 433, Issue 2, p.1312-1337

[20] Gahm, G. F.; Persson, C. M.; Mäkelä, M. M.; **Haikala, L. K.**, 2013: Mass and motion of g lobulettes in the Rosette Nebula - Astronomy & Astrophysics, Volume 555, id.A57, 17 pp

[21] Grebenev, S. A.; Lutovinov, A. A.; **Tsygankov, S. S.;** Mereminskiy, I. A., 2013: Deep hard X-ray survey of the Large Magellanic Cloud - Monthly Notices of the Royal Astronomical Society, Volume 428, Issue 1, p.50-57

[22] **Hackman, T**.; Pelt, J.; Mantere, M. J.; Jetsu, L.; **Korhonen, H.**; Granzer, T.; Kajatkari, P.; Lehtinen, J.; Strassmeier, K. G., 2013: Flip-flops of FK Comae Berenices - Astronomy & Astrophysics, Volume 553, id.A40, 13 pp.

[23] Hardegree-Ullman, E.; **Harju, J.**; Juvela, M.; Sipilä, O.; Whittet, D. C. B.; Hotzel, S., 2013: Chemical and Physical Conditions in Molecular Cloud Core DC 000.4-19.5 (SL42) in Corona Australis - The Astrophysical Journal, Volume 763, Issue 1, article id. 45, 12 pp.

[24] Hudec, R.; Bašta, M.; Pihajoki, P.; **Valtonen, M.,** 2013: The historical 1900 and 1913 outbursts of the binary blazar candidate OJ287 - Astronomy & Astrophysics, Volume 559, id.A20, 9 pp.

[25] Jeffery, C. S.; Ramsay, G.; Naslim, N.; Carrera, R.; Greiss, S.; Barclay, T.; Karjalainen, R.; Brooks, A.; **Hakala, P.**, 2013: KIC 10449976: discovery of an extreme helium subdwarf in the Kepler field - Monthly Notices of the Royal Astronomical Society, Volume 429, Issue 4, pp.3207-3213

[26] Kains, N.; Bramich, D. M.; Arellano Ferro, A.; Figuera Jaimes, R.; Jørgensen, U. G.; Giridhar, S.; Penny, M. T.; Alsubai, K. A.; Andersen, J. M.; Bozza, V. et al. (incl. **Korhonen,H.**), 2013: Estimating the parameters of globular cluster M 30 (NGC 7099) from time-series photometry - Astronomy & Astrophysics, Volume 555, id.A36, 15 pp.

[27] Kangas, T.; **Mattila, S.; Kankare, E.; Kotilainen, J. K.**; Väisänen, P.; Greimel, R.; Takalo, A., 2013: Spatial distributions of core-collapse supernovae in infrared-bright galaxies - Monthly Notices of the Royal Astronomical Society, Volume 436, Issue 4, pp. 3464 - 3479

[28] Kettula, K.; **Nevalainen, J.**; Miller, E. D., 2013: Cross-calibration of Suzaku/XIS and XMM-Newton/EPIC using galaxy clusters - Astronomy & Astrophysics, Volume 552, id.A47, 23 pp.

[29] Kochukhov, O.; Mantere, M. J.; **Hackman, T.**; Ilyin, I., 2013: Magnetic field topology of the RS CVn star II Pegasi - Astronomy & Astrophysics, Volume 550, id.A84, 19 pp.

[30] **Korhonen, H.**; González, J. F.; Briquet, M.; Flores Soriano, M.; Hubrig, S.; Savanov, I.; **Hackman, T.**; Ilyin, I. V.; Eulaers, E.; Pessemier, W., 2013: Chemical surface inhomogeneities in late B-type stars with Hg and Mn peculiarity. I. Spot evolution in HD 11753 on short and long time scales - Astronomy & Astrophysics, Volume 553, id.A27, 16 pp.

[31] Koulouridis, E.; Plionis, M.; Chavushyan, V.; Dultzin, D.; Krongold, Y.; Georgantopoulos, I.; **León-Tavares, J.**, 2013: Activity of the Seyfert galaxy neighbours - Astronomy & Astrophysics, Volume 552, id.A135, 16 pp.

[32] Kővári, Zs.; **Korhonen, H.**; Strassmeier, K. G.; Weber, M.; Kriskovics, L.; Savanov, I., 2013: Doppler imaging of stellar surface structure. XXIV. The lithium-rich single K-giants DP Canum Venaticorum and DI Piscium - Astronomy & Astrophysics, Volume 551, id.A2, 11 pp.

[33] Landoni, M.; Falomo, R.; Treves, A.; Sbarufatti, B.; Barattini, M.; Decarli, R.; **Kotilainen, J**., 2013: ESO Very Large Telescope Optical Spectroscopy of BL Lacertae Objects. IV. New Spectra and Properties of the Full Sample - The Astronomical Journal, Volume 145, Issue 4, article id. 114, 12 pp.

[34] Lane, R. R.; **Salinas, R.**; Richtler, T., 2013: Isolated ellipticals and their globular cluster systems. I. Washington photometry of NGC 3585 and NGC 5812 - Astronomy & Astrophysics, Volume 549, id.A148, 19 pp.

[35] Larsson, J.; Fransson, C.; Kjaer, K.; Jerkstrand, A.; Kirshner, R. P.; Leibundgut, B.; Lundqvist, P.; **Mattila, S.**; McCray, R.; Sollerman, J.; et al., 2013: The Morphology of the Ejecta in Supernova 1987A: A Study over Time and Wavelength - The Astrophysical Journal, Volume 768, Issue 1, article id. 89, 17 pp

[36] **Laurikainen, E.**; Salo, H.; Athanassoula, E.; Bosma, A.; Buta, R.; Janz, J., 2013: Statistics of the structure components in S0s: implications for bar-induced secular evolution - Monthly Notices of the Royal Astronomical Society, Volume 430, Issue 4, p.3489-3509

[37] **León-Tavares, J.**; Chavushyan, V.; Patiño-Álvarez, V.; Valtaoja, E.; Arshakian, T. G.; Popović, L. Č.; Tornikoski, M.; Lobanov, A.; Carramiñana, A.; Carrasco, L.; Lähteenmäki, A., 2013: Flare-like Variability of the Mg II λ2800 Emission Line in the Γ-Ray Blazar 3C 454.3 - The Astrophysical Journal Letters, Volume 763, Issue 2, article id. L36, 6 pp

[38] Lindborg, M.; Mantere, M. J.; Olspert, N.; Pelt, J.; **Hackman, T**.; Henry, G. W.; Jetsu, L.; Strassmeier, K. G., 2013: Multiperiodicity, modulations and flip-flops in variable star light curves. II. Analysis of II Pegasus photometry during 1979-2010 - Astronomy & Astrophysics, Volume 559, id.A97, 10 pp.

[39] Lundqvist, P.; **Mattila, S.**; Sollerman, J.; Kozma, C.; Baron, E.; Cox, N. L. J.; Fransson, C.; Leibundgut, B.; Spyromilio, J., 2013: Hydrogen and helium in the spectra of Type Ia supernovae - Monthly Notices of the Royal Astronomical Society, Volume 435, Issue 1, p.329-345

[40] Lutovinov, A. A.; Mironov, A. I.; Burenin, R. A.; Revnivtsev, M. G.; **Tsygankov, S. S.**; Pavlinsky, M. N.; Korobtsev, I. V.; Eselevich, M. V., 2013: Identification of four X-ray sources from the INTEGRAL and Swift catalogs - Astronomy Letters, Volume 39, Issue 8, pp.513-522

[41] Lutovinov, A. A.; Revnivtsev, M. G.; **Tsygankov, S. S.;** Krivonos, R. A., 2013: Population of persistent high-mass X-ray binaries in the Milky Way - Monthly Notices of the Royal Astronomical Society, Volume 431, Issue 1, p.327-341

[42] Malinen, J.; Juvela, M.; **Pelkonen, V.-M.**; Rawlings, M. G., 2013: Mapping of interstellar clouds with infrared light scattered from dust: TMC-1N - Astronomy & Astrophysics, Volume 558, id.A44, 15 pp.

[43] **Mattila, S.;** Fraser, M.; Smartt, S. J.; Meikle, W. P. S.; Romero-Cañizales, C.; Crockett, R. M.; Stephens, A., 2013: Supernovae and radio transients in M82 - Monthly Notices of the Royal Astronomical Society, Volume 431, Issue 3, p.2050-2062

[44] **Medvedev, A.S.**; Poutanen, J, 2013: Young rotation-powered pulsars as ultraluminous X-ray sources - Monthly Notices of the Royal Astronomical Society, Volume 431, Issue 3, p.2690-2702

[45] Muñoz-Mateos, J. C.; Sheth, K.; Gil de Paz, A.; Meidt, S.; Athanassoula, E.; Bosma, A.; Comerón, S.; Elmegreen, D. M.; Elmegreen, B. G.; Erroz-Ferrer, S.; et al., (incl. **Laurikainen,E**.) 2013: The Impact of Bars on Disk Breaks as Probed by S^4G Imaging - The Astrophysical Journal, Volume 771, Issue 1, article id. 59, 30 pp.

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[47] Nicholl, M.; Smartt, S. J.; Jerkstrand, A.; Inserra, C.; McCrum, M.; Kotak, R.; Fraser, M.; Wright, D.; Chen, T.-W.; Smith, K.; et al., (incl. **Mattila, S., Kankare, E.**) 2013: Slowly fading super-luminous supernovae that are not pair-instability explosions - Nature, Volume 502, Issue 7471, pp. 346-349

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