FINNISH CENTRE FOR ASTRONOMY WITH ESO (FINCA)

ANNUAL REPORT 2010

Contact information:

Finnish Centre for Astronomy with ESO (FINCA)
University of Turku
Väisäläntie 20
FI-21500 PIIKKIÖ
Finland
Email: finca@utu.fi
WWW: http://finca.utu.fi

Director:
Jari Kotilainen
Tel. +358-2-3338250
Fax: +358-2-2433767
Email: jari.kotilainen@utu.fi

Contents

Foreword

Finland became a member of the European Southern Observatory (ESO) on 7th July 2004. The mandate of ESO, founded in 1962, is to create and operate *"...an observatory equipped with powerful instruments in the Southern Hemisphere and to promote and organise co-operation in astronomical research..."*. The headquarters of ESO are located in Garching, Germany, and it operates three world-class observatories in Chile. ESO has currently 14 member states.

The entry fee of Finland to join ESO was ~13 MEur and the annual membership fee is ~2 MEur in 2010. Efficient and comprehensive utilisation of this investment made by Finland to ESO requires coordinated co-operation between all the Finnish universities engaged in astronomical research.

For that purpose, the University of Helsinki, the University of Oulu, the Aalto University (Helsinki) and the University of Turku founded a national astronomy research institute, the Finnish Centre for Astronomy with ESO (FINCA). It started operations 1.1.2010 in the University of Turku, in the premises of Tuorla Observatory. FINCA has offices also in all the other participating universities.

The mandate of FINCA is:

1. to take care of coordinating Finnish co-operation with ESO by networking into the international ESO infrastructure and projects;
2. to practice and promote high quality basic and applied research in astronomy, and ESO-related technological development work related to astronomy, and to participate in researcher training in astronomy; and
3. to foster and implement ESO-related co-operation and joint projects of Finnish universities in the field of 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 is an independent Special Unit within 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. The chair of the Board is Leo Takalo (University of Turku). A Scientific Advisory Board (SAB) consisting of seven foreign members, oversees the functioning of FINCA. The chairman of the SAB is Prof. Johannes Andersen (University of Copenhagen and NOT).

The main part of the funding of FINCA comes from the governmental budget through the Ministry of Education and Culture. FINCA also obtains funding from the participating universities, and from other sources, such as the Academy of Finland, and the Technology Development Centre TEKES.

FINCA collaborates with university departments and has highly qualified personnel and fruitful contacts with ESO. FINCA scientists have given lecture courses at the graduate level and supervised thesis work. FINCA has organized seminars and conferences, and has started a visitors' program. During the first year of operation of FINCA, several significant results have already brought FINCA scientists to the attention of the international scientific community. The Institute has taken its place at the forefront of Finnish research.

Jari Kotilainen
Director of FINCA

FINCA Research Highlights in 2010

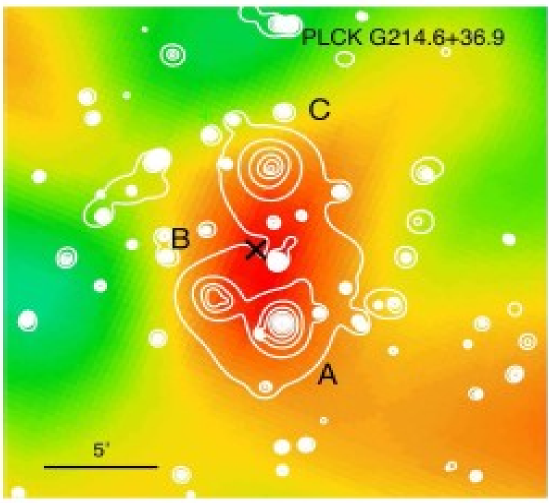
Galaxies and Cosmology

Large-scale structure

The observed large-scale structure of the universe resembles a huge web-like network of galaxies and voids between them (Jõeveer & Einasto 1978, Tarenghi et al. 1978). Together with complex gas-dynamical processes the hierarchical evolution of the dark matter concentrations produces observed web-like network of galaxies, groups of galaxies, clusters and finally superclusters of galaxies – the largest density enhancements in the Universe.

Global luminosity density field of galaxies (based on 2dF (Two-degree-field Galaxy Redshift Survey) and SDSS-DR7 (Sloan Digital Sky Survey), smoothed at supercluster scales provides effective way to extract individual superclusters from the overall galaxy field and thereby to study their spatial distribution. Together with observations made by different wavelengths luminosity density field method allows also to study more detail superclusters ICM (ionized intra-cluster medium) content. This work has been done by **P. Heinämäki** in close collaboration with Tartu observatory cosmology group. Luminosity density field method provides several applications to study large scales structure of the universe; supercluster properties, quasars large scale environment etc. (e.g. Einasto et al. 2010, Lietzen et al. 2009 and references there in). One interesting application is the use of Sunyaev Zel'dovich effect (SZ) together with knowledge of the large scale structure to trace cosmic large-scale structure and inter-cluster gas embedded in it.

The largest secondary contribution to the CMB comes from galaxy clusters via the SZ effect, outcome of the inverse Compton scattering of CMB photons by the hot electrons in the ICM. While net SZ flux from clusters is insensitive of the redshift, Planck satellite provides an all-sky survey of rich clusters via the thermal SZ effect up to z ~1. In this process cross-correlation with other observations (Optical, X-ray, IR) is needed, for validation of the SZ cluster candidates and to provide complementary and new information of the clusters large scale environment. According to theory SZ signal supercluster scales is assumed to rise from the individual clusters and theoretically predicted, but observationally not proven additional signal from inter-clusters gas in superclusters.



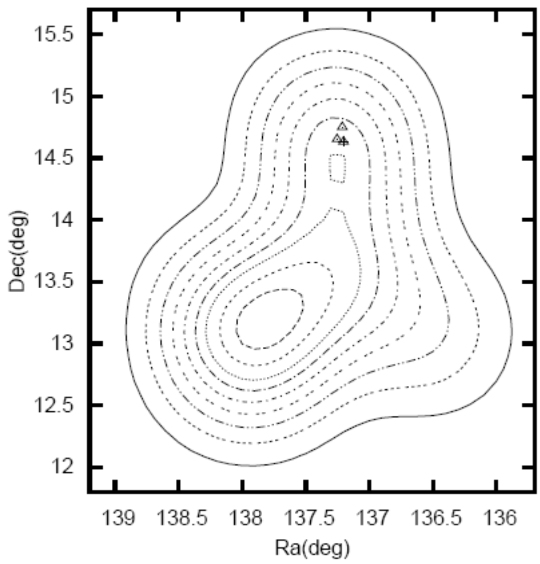


Fig. 1: **Left**: The triple system PLCK G214.6+37.0 observed by SZ map (bright orange) and XMM-Newton image (contours), which likely forms the core of a larger-scale supercluster, **Right**: projected luminosity density map of the supercluster candidate. Triangles are X-ray sources and cross is the SZ source (arXiv:1101.2025).

New light for this question may be provided by recent Planck SZ observation together with XMM Newton and our supercluster data which confirmed the first supercluster to be discovered through its SZ-effect. Analysis based on luminosity density field and superclusters catalogue (Liivamägi et al. 2010) suggests the presence of supercluster $M\sim10^{15} M_{\odot}$ at z~0.45 (arXiv:1101.2025 and **Fig. 1**).

Clusters of galaxies

J. Nevalainen has coordinated an effort to cross-calibrate the effective area of X-ray satellites/instruments XMM-Newton/EPIC and Chandra/ACIS using clusters of galaxies (Nevalainen et al., 2010). The work was performed in the context of International Astronomical Consortium for High Energy Calibration (IACHEC). The work yielded a good agreement between the instruments in the hard energy band, which lends confidence to the analysis carried out with these instruments in this band. However, there are significant systematic problems with the calibration of the soft band of the instruments. Currently the reasons for these problems are unknown but anyhow our results enable the quantification of these uncertainties and their propagation to the scientific analysis carried out.

The X-ray emission of a cluster of galaxies is dominated by Bremsstrahlung from the isothermal bulk of the intergalactic matter. However, evidence of additional emission components in the cluster X-ray spectra has accumulated over the last few years. We examined the excess X-ray emission in A3112 cluster of galaxies using XIS instrument onboard Suzaku satellite (Lehto et al., 2010). We found significant excess emission on top of the isothermal component. We attribute it to a multi-temperature plasma which originates from the accretion of groups of galaxies by the A3112 cluster.

In the cores of clusters of galaxies the cooling time scale of Bremsstrahlung emission is short compared to the age of the cluster due to high central density of the intergalactic matter. Thus, significant central cooling occurs in most clusters. The effect of the cooling is reduced by some heating mechanism present in the cluster cores. Currently several possibilities remain open for the heating mechanism, including heat conduction and cluster merger effects. Nevalainen has been studying the heating mechanism due to jets of the Active Galactic Nuclei present in most cluster cores. The AGN feedback mechanism involves turbulent motion of the intergalactic matter which will produce an observable broadening effect on the prominent Fe XXV emission line in the X-ray spectrum. Using XMM-Newton MOS instruments, we have preliminarily derived very stringent upper limits on the turbulent broadening for a sample of clusters of galaxies. This may provide useful constraints on the AGN feedback mechanism and particularly yield information on the viscocity of the intergalactic matter.

Co-evolution of black holes and galaxies

Quasars are massive black holes (10^{6}-$10^{10} M_{\odot}$) which experience dramatic accretion of gas from their host galaxies. This process normally generates intense electromagnetic radiation, therefore, the luminosity of a quasar can be several orders of magnitude larger than that of the entire host galaxy. This allows us to study the properties of accreting black holes in distant galaxies. Moreover, quasars represent excellent probes of the Universe throughout >90 % of its age. It has become increasingly clear that black holes play a key role in galaxy formation and evolution. The most important evidence for a close connection between black hole growth and galaxy evolution comes from the observed correlations between black hole mass and the bulge luminosity, mass and velocity dispersion of the host galaxy (e.g. the $M_{BH}\,\sigma$-relation). Despite the fact that black holes contain only about 0.1% of the mass of their host bulge, their growth is evidently constrained very tightly by the kiloparsec-scale properties of their environment.

J. Kotilainen and collaborators have studied the evolution of the black hole – host galaxy relation as a function of cosmic time in a large sample of quasars from z = 3 to the present epoch (i.e. over 85 % of the age of the Universe). They have derived the black hole masses of the quasars from single-epoch spectra assuming virial equilibrium in the broad-line region, and host galaxy luminosities and inferred masses from imaging. They find that in the sampled redshift range, the M(BH)-L(host) relation remains nearly unchanged. On the other hand, taking into account the ageing of the stellar population, they find that the M(BH)/M(host) ratio Γ increases by a factor of ~7 from z = 0 to z = 3 (**Fig. 2**). They show that Γ evolves with z regardless of the radio loudness and luminosity of the quasar. They propose that the most massive black holes, living their quasar phase at high redshift, become extremely rare objects in host galaxies of similar mass in the Local Universe.

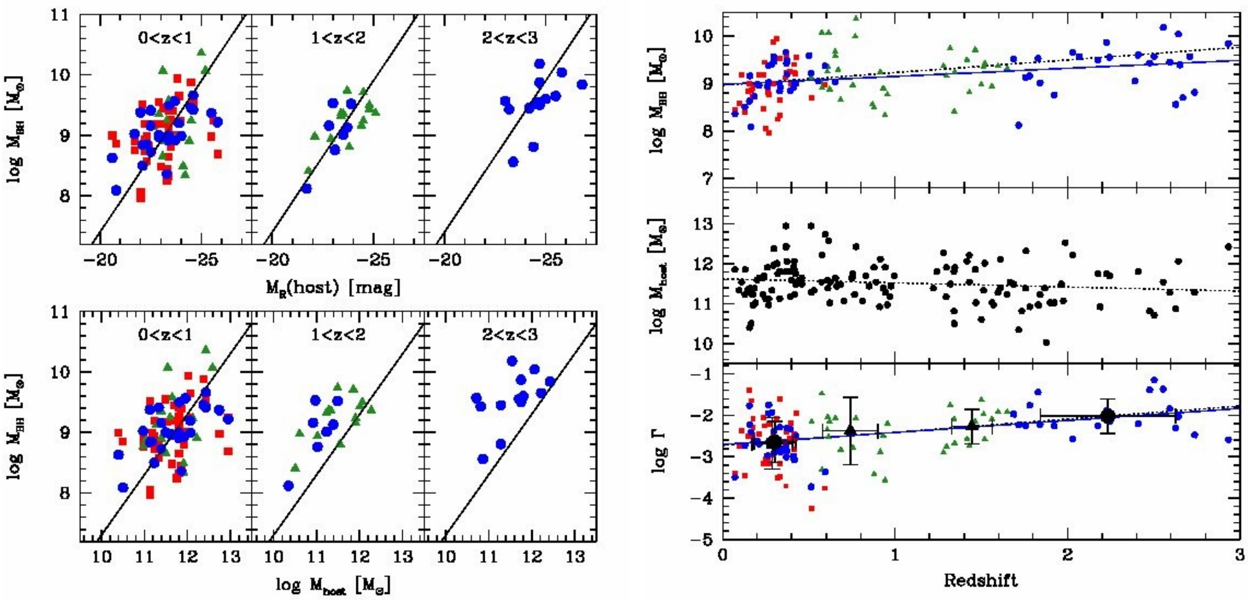


Fig. 2 (left). The M(BH)-L(host) and M(BH)-M(host) relations in three redshift bins. Squares, triangles and circles mark quasars in which M(BH) is derived from Hβ, Mg II and C IV, respectively. The solid line is the Bettoni et al. (2003) relation. No significant redshift evolution is observed when comparing M(BH) with the observed host galaxy luminosities. On the other hand, a clear offset is apparent in the M(BH)-M(host) relationship as a function of the redshift. **(right)**. The redshift dependence of M(BH) (top panel), M(host) (middle panel) and their ratio Γ (bottom panel). The best linear fits are plotted. The average points with rms as error bars of the Hβ subsample (big square), of the low- and high-*z* C IV data (big circles) and of the Mg II data with z<1 and z>1 (big triangles) are also shown.

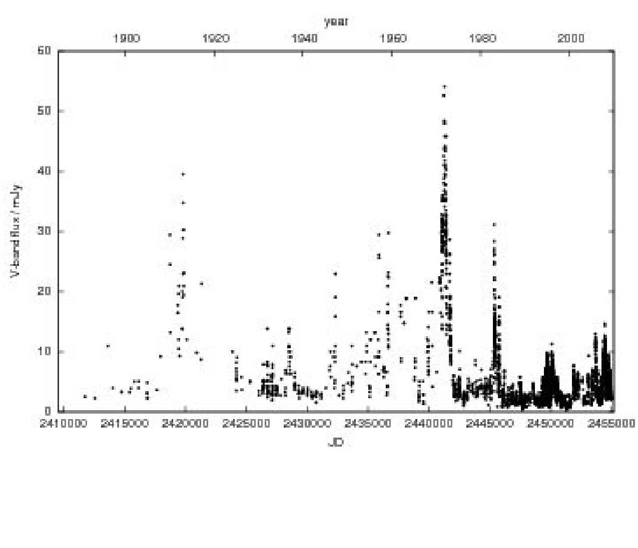
Monitoring of OJ 287

OJ 287 is an intriguing active galactic nucleus (AGN) at a distance of 4 billion light years. What makes it different from other AGN is that outbursts at roughly 12 year intervals have been observed from it during the past 100 years (**Fig. 3**). This behavior has led to a model where two supermassive black holes orbit each other in the nucleus of OJ 287 with a period of ~12 years. The most detailed model so far (see e.g. Valtonen et al. 2008, Nature, 452, 851) infers the primary component to be very massive (1.8 x 10^{10} $M_{\odot}$) and the orbit of the secondary to be highly eccentric (e = 0.663). It was predicted that a double-peaked outburst should occur again in 2005-08. **K. Nilsson** and collaborators therefore set out to monitor the total flux, polarization and spectral lines of OJ 287 to derive the exact time of the outbursts and to study it in unprecedented detail.

The total flux and polarization monitoring were conducted as international campaigns involving 18 telescopes in 2005-09. We collected 2238 photometric and 400 polarimetric data points (Villforth et al. 2010, MNRAS, 402, 2087). Three major flares were observed. The second flare in September 2007 occurred precisely at the predicted time with the correct polarization signature thus lending support to the Valtonen et al. model. In addition to the major flares, the light curve shows incessant variability both in total flux and polarization. However, a stable component in polarization was found, which was interpreted as arising from a quiescent component of the jet. This component remains stable at least in time scales of a few years.

We also used the ESO VLT-UT1 (Antu) and FORS2 to monitor the broad line region of OJ 287 in 2005-08. This region is thought to consist of gas clouds moving at high velocities (several thousand km/s) close to the central black hole. Based on the Valtonen et al. model the closest distance of the secondary black hole was estimated to be of the same order as the average distance of the broad line region clouds and hence changes in their velocity field might be observable. These observations are very challenging, however, owing to the extreme weakness of emission lines in OJ 287.

We observed the broad Hα line region of OJ 287 during seven epochs in 2005-08 (**Fig. 3**). Unfortunately, the line luminosity of OJ 287 was ~10 times lower than in 1985 when the broad Hα line was previously detected. As a result, the line was detected only during 2 out of 7 epochs. The data are consistent with no change in the position or width of the broad Hα line. The flux of the line, however, is clearly variable by a factor of ten during the past 20 years. We were also able to make the most precise measurement of the broad line region width so far, 4200+-500 km/s.



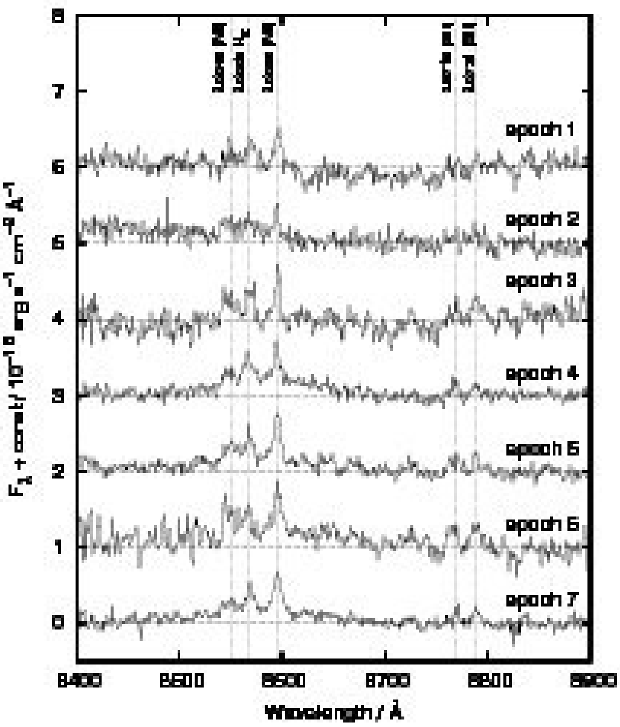


Fig. 3 (**above**): Historical V-band light curve of OJ 287. (**right**): Hα line region of OJ 287 on seven epochs in 2005-08. The broad Hα line is detected in epochs 4 and 7.

Planck-related science and multiwavelength correlations of AGN

E. Nieppola has continued her work as a part of the Metsähovi Planck team. Planck is an ESA mission with the main task of measuring the cosmic background radiation. As a by-product, it provides full-sky maps of all radio sources in 9 frequencies between 30 and 857 GHz. The Metsähovi team is focussing on active galactic nuclei (AGN).

The first scientific data product of Planck, the Early Release Compact Source Catalogue (ERCSC) was released for the internal use of the Planck community in August 2010. Its final publication to the whole community by the Planck Science Team was scheduled in January 2011, along with a set of early Planck papers based on its data. Thus, in fall 2010 the Metsähovi group was preparing the manuscript ”Planck early results: Spectral energy distributions and radio continuum spectra of northern extragalactic radio sources”. The main goal of the paper is to present the radio spectra and spectral energy distributions obtained combining the sorely-needed sub-mm data from Planck with the data provided by the collaboration of ground-based observatories in other wavelengths, as well as the satellite observatories Fermi and Swift. With these simultaneous radio spectra, with unprecedented detail, it is in some cases possible to discern the individual components of synchrotron emission making up the total radio spectrum of AGN. These components were tentatively modelled with a new numerical code, which will be properly presented in a later Planck-related paper expected in 2012. Also, the Metsähovi team found indications of surprisingly flat high-frequency (> 100 GHz) radio spectra. The distribution of the spectral indices was compatible with a very hard original electron distribution, even s =1.5 instead of the canonical 2.5.

The Metsähovi Planck project has also been granted observing time from the APEX telescope. Operating at the same frequency with Planck, it gives important variability information on AGN, as well as offers an excellent opportunity for follow-up of unidentified Planck sources. A proposal for continued observing time in the summer 2011 period (PI: Nieppola) was submitted in October 2010.

In addition to Planck-related science, Nieppola worked at an ongoing project of investigating the relationship between the gamma-ray data from Fermi satellite and 37 GHz data from the Metsähovi telescope. Correlation studies between gamma and radio bands are conducted mostly to establish whether emission in these wavelengths is produced co-spatially, or whether the gamma-rays originate nearer to the AGN central region. The preliminary results from the Metsähovi team, presented in an international conference “Fermi meets Jansky – AGN in radio and gamma-rays” in Bonn in June 2010, indicate that co-spatial origin is likely.

Structure, stellar populations and kinematics of galaxies

The research of **E. Laurikainen** has focused on three projects: (1) NIRS0S, which is a Near-IR imaging survey of 200 lenticular galaxies (S0s), (2) the 'Spitzer Survey of Stellar Structure in Galaxies' (S4G, PI Sheth, Caltech), in which Laurikainen is a core-team member, and (3) a project studying stellar populations and kinematics of early-type dwarf galaxies in the Virgo cluster (SMAKCED, coordinated by Lisker, Heidelberg). For NIRS0S the observations are completed. In SMAKCED we are collecting observations at many ground-based telescopes, including VLT and

NTT at ESO. The main responsible of the imaging observations is Janz, who is doing PhD thesis under the supervision of Laurikainen (other supervisors Lisker and Salo). The satellite observations are under progress: in total the project has obtained 630 hours of observing time.

The results of NIRS0S will be largely discussed in the new edition of the book 'Planets, Stars and Stellar Systems' (galaxy section written by Buta). The most important results of NIRS0S obtained in 2010 were (Laurikainen et al. 2010; **Fig. 4**): the scaling parameters of bulges and disks in S0s suggest that S0 bulges most probably are not formed from hierarchical mergers, implying that S0s could be stripped spirals. Also, the lower bar fraction in S0s, compared to that in spirals, suggests that this evolution must have happened in conjunction with evolution due to bars. The NIRS0S atlas is currently a manuscript, in which we will present morphological classification of S0s. It goes beyond the earlier classifications, in particular concerning lenses, which are suggested to be imprints of secular evolution in S0s. In SMAKCED a large database of 70 galaxies has been collected in 2010, and detailed multi-component structure analysis has been made by Janz.

In the S4G-project Laurikainen and Salo (University of Oulu), are leading one of the four main data analysis pipelines, related to structural decompositions of galaxies. During the last year significant progress was made, nearly half of the galaxies been done. Some interesting results were also obtained: mass maps of the galaxies were created, derived from the mid-infrared images at 3.6mu (Meidt et al. submitted). This is important since the method used eliminates the contaminants emitted by other sources than the photospheres of the old stellar population, which allows using the images for dynamical studies. Progress is made also while investigating galaxies that appear edge-on in the sky plane: the first results by Comeron et al. hint to the fact that thick disks might be more massive than thin disks, which needs to be explained in the formative processes of galaxies.

How are long lasting spiral arms created is an enigmatic problem which has been difficult to answer. Bars have been obvious candidates but the connection between bars and spirals has appeared to be difficult to show. A new light was cast by us (Salo et al. 2010) who showed that such a correlation indeed exists if the bar forcing and spiral strength are compared locally.

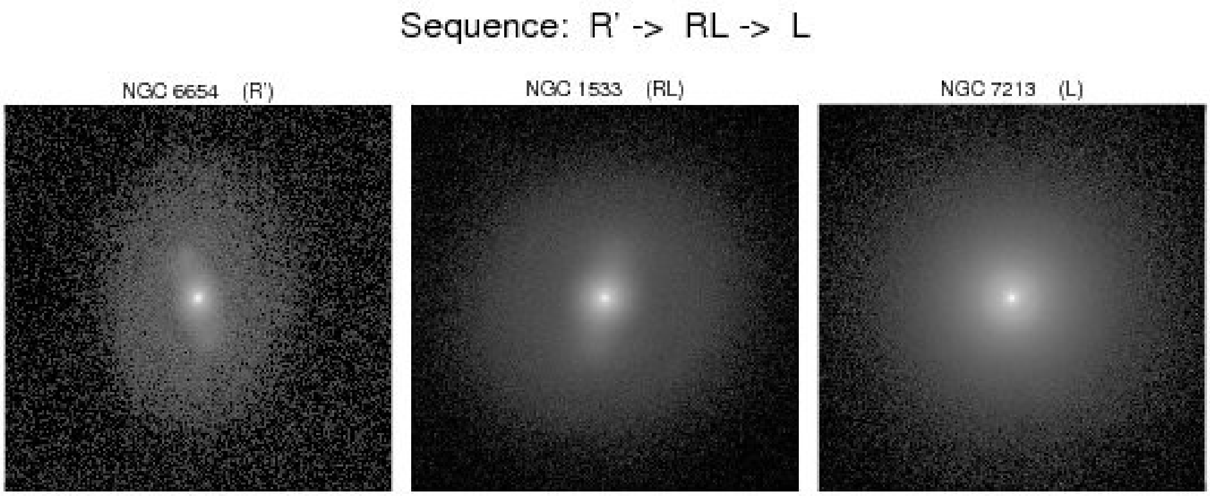
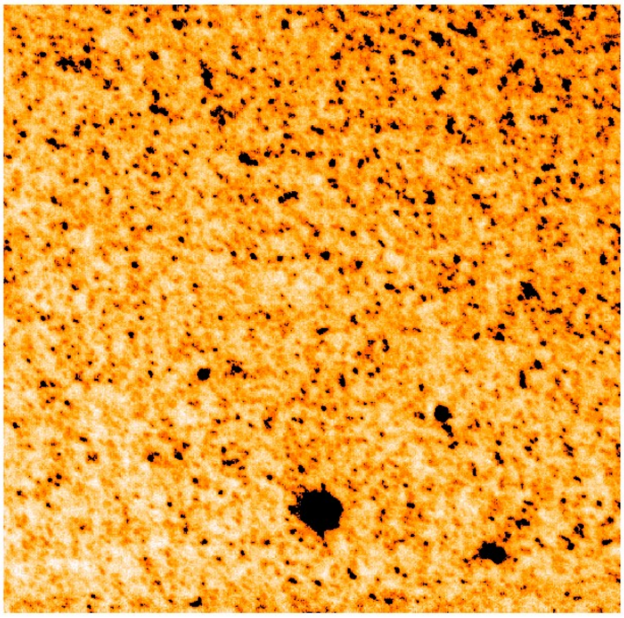


Fig. 4: Deep Ks-band images of one Sa galaxy (NGC 6654) and two lenticulars (NGC 1533, NGC 7213), obtained at NTT/ESO. The galaxies show a tentative sequence illustrating possible formation of an outer lens, starting from

winding of the spirals arms, and ending up to a featureles lens (from Laurikainen et al. 2010).

The inner halo of M 87: a first direct view of the red-giant population

Together with PhD student Sarah Bird (Tuorla Observatory) and collaborators Bill Harris (McMaster University) and John Blakeslee (Herzberg Institute of Astrophysics), **C. Flynn** has analysed an unusually long exposure of the well known Southern hemisphere galaxy M87. The images were taken with the Hubble Space Telescope, and were exposed for more than 27 hours. The images were taken in two colour bands (V and I). The exposure was aimed not at the heart of the galaxy, where the stars are too close together to distinguish, but in a region 40 thousand light years from the center (**Fig. 5**). For the first time, individual so-called red giant stars have been detected in the galaxy. These are stars which have finished burning Hydrogen in their cores, as the Sun does, and have begun to process Helium instead. They are very bright, and this is useful for measuring the distances to nearby galaxies. Tens of thousands of red giants were found in the images, and from the so-called 'tip of the red giant branch' method, in which the very brightest giants are utilised, we found that M87 is at a distance of 54 million light years from us (with an uncertainty of about 5 %), a value which sits well with other, independent studies. In addition, we were able to measure the distribution of the metal content of the stars (where 'metals' are all elements other than Hydrogen and Helium), an important constraint on the way such galaxies form and develop. The observations are part of an ongoing study of the properties of the outer regions of nearby giant galaxies.



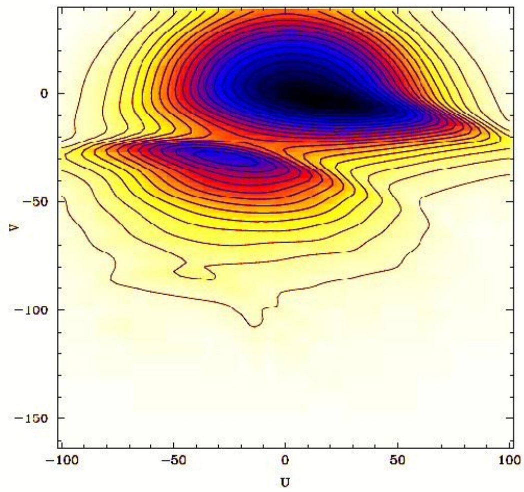


Fig. 5: (**left**) Image of the outer regions of the nearby giant elliptical galaxy M87. The stars are so close together that they essentially all overlap, so that special care is needed to measure their brightnesses. The brighter stars appear here as black, with the dimmest stars in orange on a white background. This is the first view of so called red-giant stars in this quite distant galaxy, and permit its distance to be estimated as 54 million light years from Earth.
Fig. 6: (**right**) The distribution of velocities of nearby stars, relative to their general rotation around the Galactic center, is shown for a particular model of the Galactic bar. Were there no bar, the stellar velocities would be symmetrically distributed, but in the present of a bar, several features arise in velocity space due to resonances between the rotation rate of the bar and the rotation of the stars around the center of the Galaxy. Simulations like these have been used to study the effect on nearby stars of bars with a range of mass, rotation rate, alignment angle and size.

The Milky Way's bar and its effects on stars near the Sun

It has been know for many years that the central regions of the Milky Way galaxy contain a long, thin structure of stars and gas called the "Galactic bar". Recently, observations suggest that a second bar may have been identified in the Galactic center, the so called 'long bar', which is longer and much flatter than the traditional Galactic bar, but has a similar mass. Together with PhD student Esko Gardner (Tuorla Observatory), **C. Flynn** looked at the possible effects that such a long bar would have on stars near the Sun. Either bar, if they rotate at an appropriate speed, can affect the distribution of the velocities of nearby stars, causing some such stars to form "stellar streams". In such streams, stellar motions are no longer randomly distributed relative to a general rotation around the Milky Way center, but can become coherent over long distances. Gardner and Flynn have modeled theoretically the effects of the central bars on nearby stars, and show that not only the well known bar but also the new 'long bar' can produce patterns on the distribution of velocities which are a reasonable match to what is actually observed in nearby stars, and in particular the 'Hercules' stream (**Fig. 6**). They have also found a stellar stream in their simulations which it is tempting to match with the 'Arcturus' stream, the first time such an identification has been made.

Stellar Astrophysics

Early stages of low- and high-mass star formation

New stars form in dense interstellar clouds of gas and dust called molecular clouds. The actual sites where the process of star formation takes place are the dense clumps and cores deeply embedded in molecular clouds. The details of the star formation process are complex and not completely understood. Thus, determining the physical and chemical properties of molecular cloud cores is necessary for a better understanding of how stars are formed.

O. Miettinen and collaborators have recently studied the physical and chemical characteristics of dense cores in the Orion B giant molecular cloud using ESO/APEX molecular-line observations (Miettinen et al. 2010, A\&A, 524, A91). The target sources reside in the Orion B9 star-forming region which we have previously mapped in the submm dust continuum emission using the LABOCA bolometer array on APEX, see **Fig. 7** (Miettinen et al. 2009, A\&A, 500, 845). For instance, the gas kinetic temperature in the cores was found to be ~9.4-13.9 K, and the core masses were found to be in the range of ~2-8 solar masses. The cores are characterised by subsonic, or at most transonic, non-thermal turbulent motions. The virial-parameter analysis showed that the starless cores in the region are likely to be gravitationally bound, i.e., prestellar in nature, and are thus likely to form low-mass solar-type stars at some point in the future. The results of our studies provide constraints on the initial conditions and early stages of clustered star formation, which is the dominant mode of star formation in our Galaxy.

Despite its importance, the process of high-mass star formation is still poorly understood. However, some of the infrared dark clouds (IRDCs) are likely to represent the earliest stages of high-mass star/star cluster formation. In particular, some of the IRDCs may harbour high-mass starless cores (HMSCs), which provide the best targets to study the initial conditions of high-mass star formation. To better understand the nature of such sources, we have carried out a molecular-line study of a sample of massive clumps within IRDCs using APEX observations (Miettinen et al. 2011).

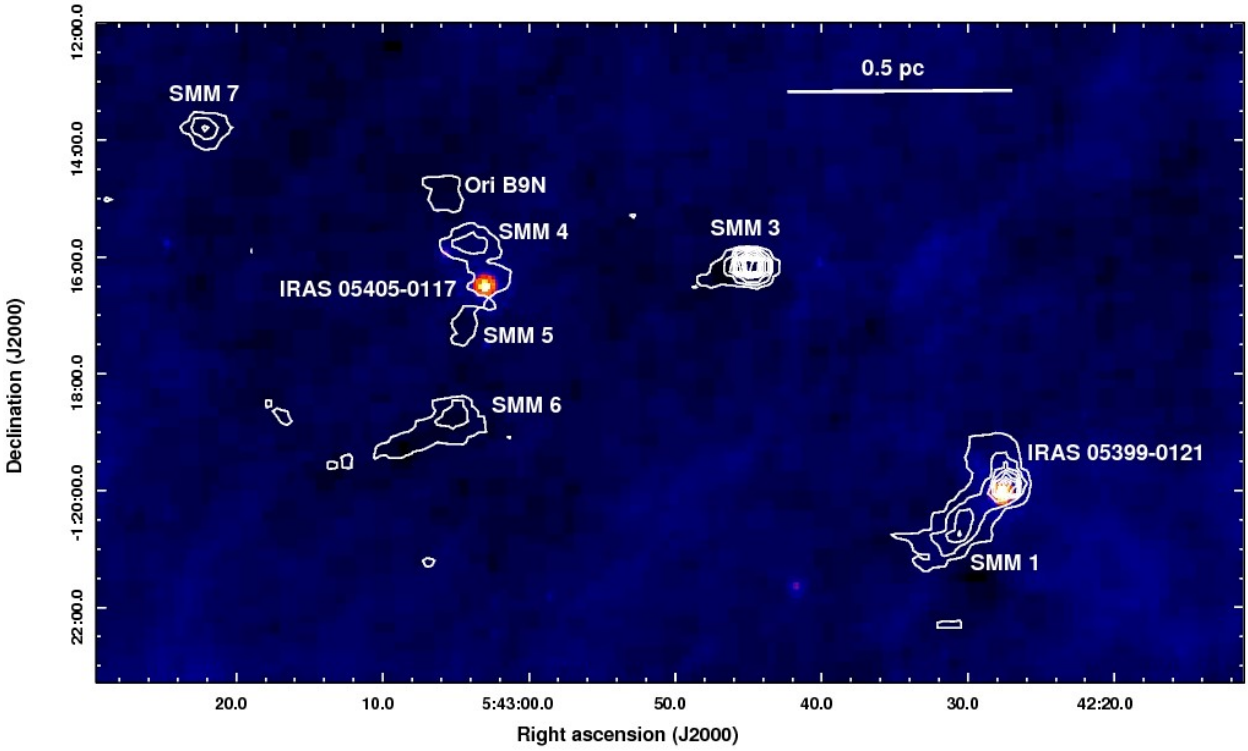


Fig.7: Spitzer/MIPS 24 micron image of the central part of Orion B9 overlaid with contours showing the LABOCA submm dust continuum emission. The scale bar corresponding to 0.5 pc is shown in the top right. The cores were studied in the papers by Miettinen et al. (2009, 2010).

Cygnus X-3 and other X-ray binaries

From June through December 2010 **D. Hannikainen** continued to work on Cygnus X-3 with Karri Koljonen (Metsähovi), and on a handful of X-ray binaries towards the Galactic Center observed with the INTEGRAL satellite, with Petri Savolainen (Metsähovi). Cygnus X-3 is an intriguing X-ray binary, in that it has a high-mass companion but an orbital period of only 4.8 hours, reminiscent of low-mass X-ray binaries. Additionally, it is a source of relativistic jets, and has exhibited the strongest radio flares amongst X-ray binaries, besides also being a very bright X-ray source. Mr. Koljonen's work has concentrated on trying to understand various spectral behavioral patterns in Cygnus X-3 using a multi-wavelength approach, but in 2010 he started to focus also on its temporal properties. Cygnus X-3 is 'switched on' all the time, with varying levels and modes of activity in the X-ray and radio. Some early attempts were made at understanding the X-ray temporal behavior, but after some promising initial results in the early- to mid-1980s, most efforts along this line were dropped. Some studies were effectuated, but resulted inconclusive, primarily due to the complications in fully interpreting the X-ray behavior. Mr. Koljonen re-examined RXTE X-ray data, and identified previously overlooked instances of quasiperiodic oscillations. These are all associated with periods of major radio flaring in Cygnus X-3, and hence are most probably associated with jet formation. We are currently in the process of formulating physical scenarios in which these QPOs arise for Cygnus X-3, with one paper submitted and another in preparation.

Mr. Savolainen has continued the work he started for his Master's thesis, ie Xray/gamma-ray studies of low-mass X-ray binaries towards the Galactic Center. These X-ray binaries are nominally divided into two categories, the Z and the Atoll sources, with a few sources straddling both classes. This classification is based on the paths traced in X-ray color-color diagrams, and is due to differing accretion modes most probably dependent on the nature of the non-degenerate companion. Savolainen has explored these accretion processes, involving transition and spreading layers on the surface of the neutron star amongst other things, using X-ray data from a multitude of instruments, including those on INTEGRAL, RXTE, and Swift, with the aim of identifying the specific differences in behavior between a Z source, an Atoll source, and an ‘in-between’ source. This work is currently being pursued at the Harvard-Smithsonian Center for Astrophysics, where Mr. Savolainen is a Pre-doctoral Fellow, and we have several papers in preparation. All of the above work has been presented at several international conferences between August and October 2010.

Rapid Temporal Survey (RATS)

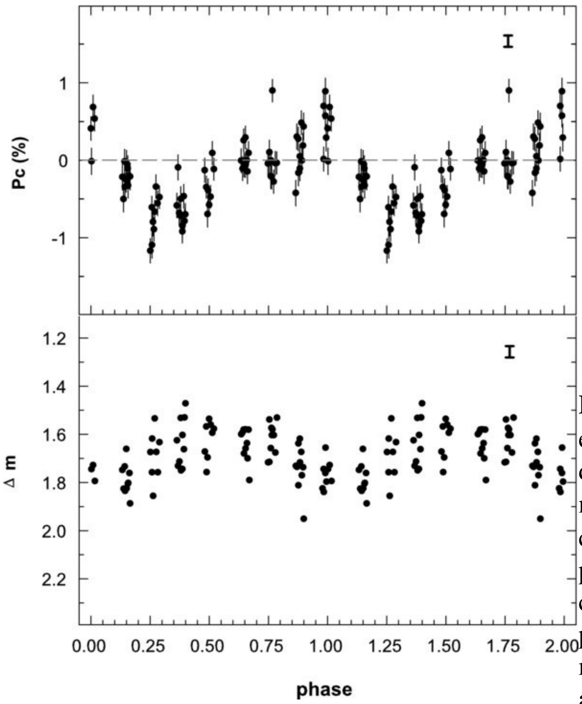
P. Hakala has continued to participate in the RApid Temporal Survey (RATS), initiated by Ramsay & Hakala in 2005. This survey obtains high time resolution wide field optical images of regions near the galactic plane in order to search for short period variable stars and binaries. The survey has been carried out using the 2.5m Isaac Newton Telescope on La Palma and the ESO 2.2m telescope on La Silla, Chile. It's is still a unique survey given its high time resolution of 1 minute and depth down to V=22.5mag. Thus it samples the optical sky in quite new parameter space, never attempted before.

So far we have covered about 40 square degrees of the sky and obtained light curves of about 5 million stars, including discoveries of some rare types of variable stars like sdB pulsators. Even if the survey proper is now over in terms of observations, the analysis of the full light curve database is still underway with emphasis now on detecting non-periodic events, like planet transits and relativistic microlensing events. Also, we expect to continue the spectroscopic classification follow-up programme using both the L Palma and ESO resources still for some time.

Magnetic cataclysmic variables

S. Katajainen and collaborators have continued studies of magnetic Cataclysmic Variables (CVs). Particularly they have been concentrating to find new subclasses among CVs where the magnetic accretion would occur, in addition to those subclasses which are already known to as "magnetic" CVs, i.e. Polars (AM Hercules stars) and Intermediate Polars (DQ Hercules stars).

They have also continued their previous studies to reveal more highly magnetic systems among Intermediate Polars(IPs), where previously only few targets were known to be strongly magnetic. They have found in their analysis of VLT-data several new systems which emits circularly polarized light, and where polarization level is up to few percentages. This is well known to be due to the cyclotron emission process, which itself is a manifest of a strong magnetic field above the compact central star, which is a white dwarf. The magnetic field which are able to produce such high circular polarization levels, are in order of millions of Gausses. Here are shown two examples of such systems, in **Fig**. **8 (left)** circular polarization found in IP system UU Col and in **Fig**. **8 (right)** polarization in NY Lup. After their latest results, the number of Ips emitting circularly polarized light is now 10, which corresponds about 1/3 of all know IPs. The main question here is if those IPs and Polars (the very strongly magnetic CVs) will have a commom origin and common evolutionary paths, and particularly the question: are IPs the progenitors of Polars?



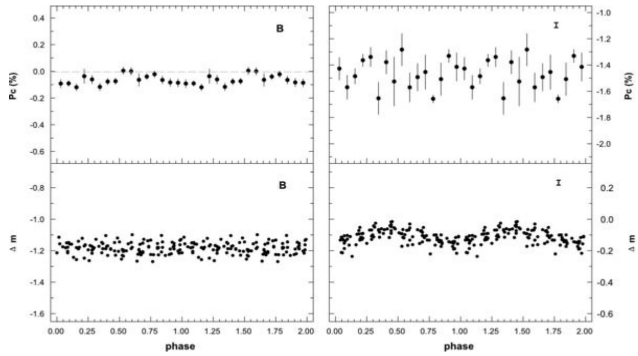


Fig. 8. (left): Circular polarization of UU Col in the I-band. The error bars correspond to one sigma uncertainties. Bottom: differential photometry of UU Col in the I-band. Observations are made using VLT and FORS. **(right):** Above: Circular polarization curves of NY Lup in the B-band and I-band, averaged into 16 phase bins and plotted against WD spin phase. The error bars correspond to one sigma uncertainties. Bottom: differential photometry of NY Lup in the B-band and I-band. Observations are made using VLT and FORS. (Figures adapted from Katajainen et al., 2010)

They have also got new observations from polarization in SW Sex stars, one subclass of CVs. They got two observing runs at the Nordic Optical Telescope (NOT) in 2010 in Canary Island, La Palma in April and in October 2010. This data is being analyzed right now, together with their previous data from ESO La Silla observatories. Tentatively results show that there are also systems among SW Sex stars where magnetic controlled accretion is in an important role, and that emphasis the hypothesis that SW Sex stars might be progenitors for Polars.

In addition to IPs, and SW Sex stars they have also studied AM CVn stars. They are ultra-compact binary systems, and they are binaries where there's a white dwarf as a primary component and a compact helium star (or another white dwarf) rotating as a secondary star. Their orbital periods are the shortest what are known in any binary stars, in some most extreme examples, the orbital period is in the range of 5 - 10 minutes. These systems are also very strong sources for gravitational waves in the sky, which will be possible to observe within few years when the NASA/ESA LISA satellite will be launched. They have observed these stars searching hints of circular polarization and thus evidences of their magnetic nature. They have got two observing runs at the NOT in La Palma for these studies (in Febr 2010, and febr 2011) and in addition to this, they got also observing time at the ESO VLT telescope in the next period P87 to perform spectropolarimetry for a sample of the brightest AM CVn stars.

Stellar magnetic activity

Two of the most powerful tools to observe stellar magnetic activity on late-type stars are Doppler imaging and time series analysis of stellar photometry. The methods are based on that large spots on the surface of a star will produce measurable variations in the brightness and photospheric spectral lines. In Doppler imaging the surface structure, e.g. a temperature or magnetic field map, is recovered applying inversion methods on a series of high resolution spectrometric or spectropolarimetric observations. By applying time series analysis on stellar light curves one can study both short and long term variations in the spot activity of the star.

In 2010 **T. Hackman** and collaborators applied Doppler imaging on the RS CVn star II Peg (**Fig. 9**). The observations were collected with the SOFIN spectrograph mounted at the Nordic Optical Telescope and our time series spans from 1994-2010. The resulting temperature maps in general show one or two large spot regions at high latitudes. The longitude of the main spot region clearly drifts in the frame of the rotation period , which is locked to the orbital period in this binary star. The drift can be explained by a dynamo wave propagating in the longitudinal direction (Lindborg et al. 2011, A&A, 526, A44). After 2004 there is a clear weakening of the spot activity, which could be a consequence of cyclic behaviour (Hackman et al., in prep.). We also started a cooperation with the Uppsala University to use the HARPSpol spectropolarimeter at the ESO 3.6 m telescope to obtain Stokes I,Q, U and V observations of active stars. This data will be used for Zeeman Doppler imaging, i.e. mapping of the surface magnetic fields.

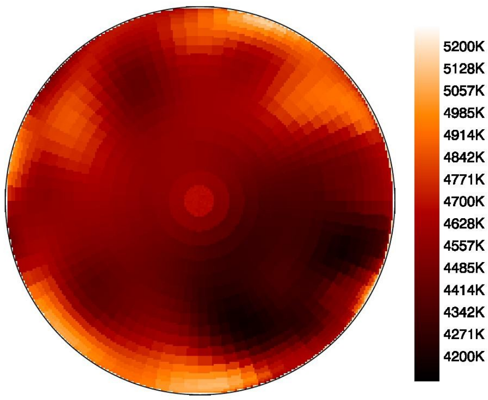


Fig. 9.. Doppler imaging surface temperature map of the RS CVn star II Peg viewed pole on. Two large spots or spot regions can be seen. The observations were obtained with the SOFIN@NOT spectrograph. in July 2007.

A new period analysis method, the CPS (Continuous Period Search), was developed for studying stellar light curves. With the CPS we can analyse both long and short term variations in the photometry of late-type stars. The method was applied to the young solar analogue HD 116956 using Johnson V-photometry collected with the T3 0.4 m automatic photoelectric telescope (APT) at Fairborn Observatory during 1998-2010. The results show that the activity of the star is concentrated to two active longitudes which have remained stable during the full 12 years of observations (**Fig. 10**). In addition variations in the photometric rotation period indicate differential rotation (Lehtinen et al. 2011, A&A, 527, 136).

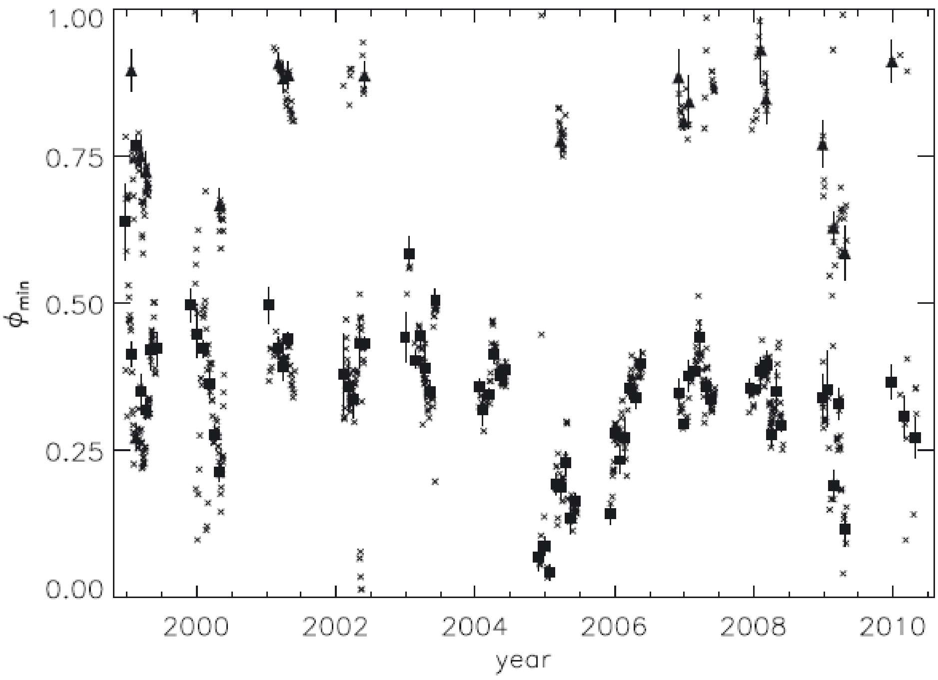


Fig. 10. Minimum phases $\phi_{min,1}$ and $\phi_{min,2}$ with the constant period ephemeris $HJD_{al} = 2\,451\,176.94 + P_{al}E$, where $P_{al} = 7.4816$ days. Estimates from independent datasets are denoted as squares (primary minima) and triangles (secondary minima) with error bars. Estimates from the rest of the datasets are denoted with small crosses.

GJ 841B—The Second DQ White Dwarf with Polarized CH Molecular Bands

DQ white dwarfs are a subclass of helium (DB) white dwarfs that show atomic and molecular features in their spectra. In this subclass the atomic carbon lines and molecular bands are the only visible features so, in order to deduce physical conditions in these stars, we need to model these carbon features as accurately as possible.

Especially interesting is the magnetic nature of these stars. So far only one normal magnetic DQ white dwarf, G 99-37, was known (Angel 1974). Berdyugina et al (2005 & 2007) modelled the intensity and Stokes V spectra of this object and found a surface temperature of 6300 K and a magnetic field strength of 7.3 MG. Their method is based on molecular magnetic dichroism. That is, in the presence of a magnetic field, the molecular transitions are altered so that they produce non-zero polarization.

To study the incidence of magnetism in this class of white dwarfs, **V. Piirola,** T. Vornanen (Tuorla) and collaborators did a spectropolarimetric survey of bright DQ WDs to look for polarization. After observing 12 new targets they have found one new magnetic DQ WD, GJ 841B (**Fig. 11**). This white dwarf is very similar to G 99-37, only its magnetic field is weaker (1.3 MG). It is interesting to note that in both of these stars it is actually features of CH mocule that are polarized and these are the only two stars where CH has been found. In most DQs, the only molecule visible in the optical part of the spectrum is C_2.

To find out if the simultaneous existance of a strong magnetic field and CH is just a coincidence, they are continuing their survey to find more polarized DQ WDs. This search is largely done with ESO's VLT because the white dwarfs are faint and spectropolarimetric observations require a lot of optics, which in turn means heavy light losses in the optical system. The discovery of the second polarized DQ white dwarf was done with FORS. They also use the Nordic Optical Telescope to search among northern objects.

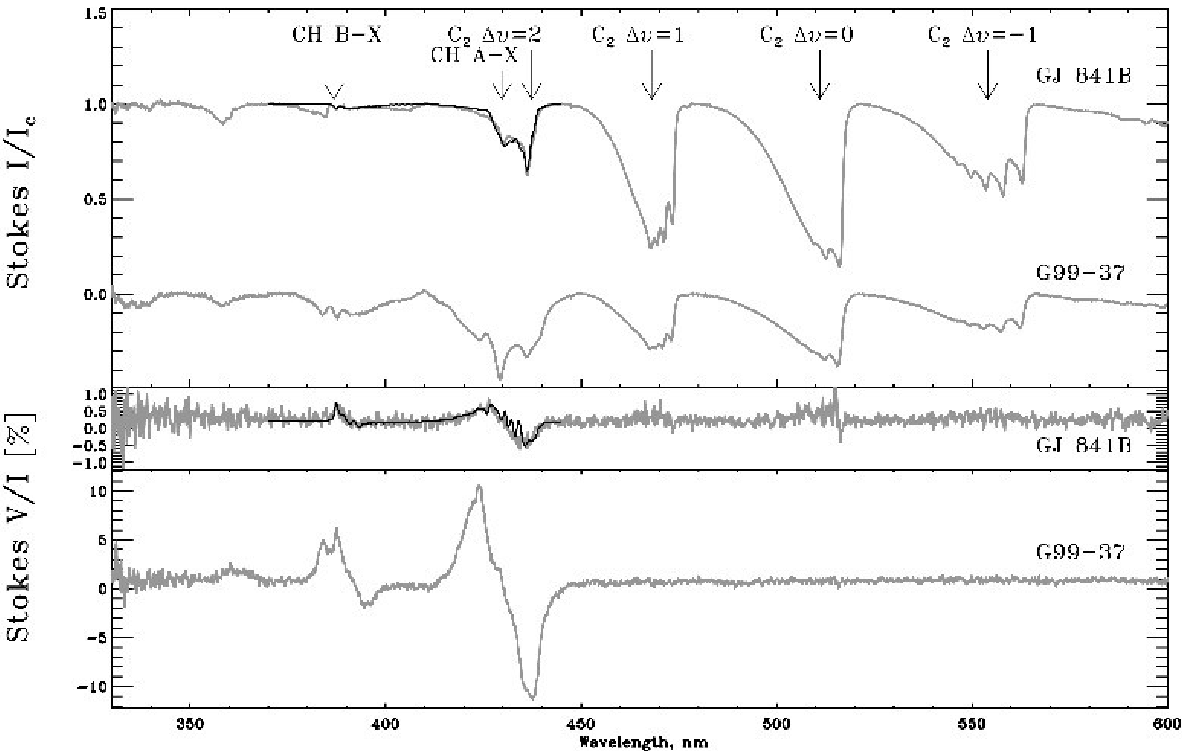


Fig. 11: Intensity and circular polarization spectra of GJ 841B and G 99-37, the only two DQ WDs with CH features in their spectra. Both show strong polarization signatures. Spectra of GJ 841B include a model fit with T=6100 K and B=1.3 MG.

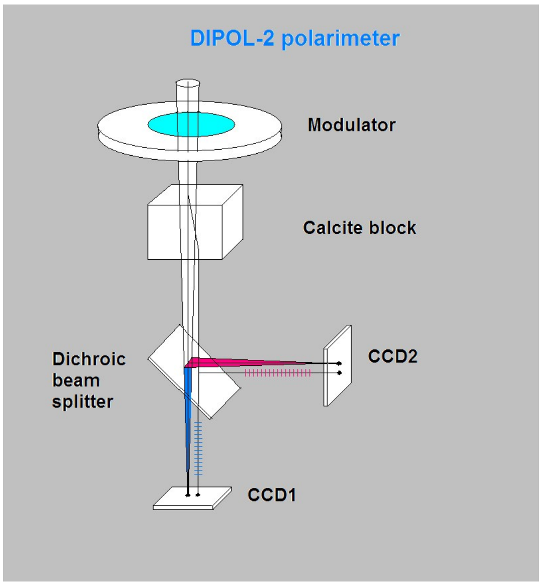
Instrumentation and Methods

High Precision Polarimeter DIPOL-2

V. Piirola received a grant from Kiepenheuer-Institut Fuer Sonnenphysik (KIS, Freiburg, Germany) to construct a new highly sensitive polarimeter. Simultaneous measurements in two spectral passbands (B, R) are carried out by using a colour selective beam splitter (dichroic filter) to direct light onto two CCD detectors (**Fig. 12**). Fast readout (< 1 s) of the CCDs and state of-the-art, thinned back illuminated, detectors with high quantum efficiency (peaking at > 90 %), make DIPOL-2 a powerful instrument. The number of optical elements is kept at the minimum, which ensures good throughput and keeps effects from instrumental polarization very small.

Adding a second dichroic provides a third beam in the visible (V), which can be used for high precision autoguiding in the most demanding applications, or for simultaneous three-colour (BVR) linear and circular polarimetry (**Fig. 12**). This mode is particularly useful for targets where the wavelength dependence carries important information on physical processes responsible for the observed polarization (scattering by molecules or dust, emission processes in magnetized plasma, etc.), especially if the object is rapidly variable, e.g., due to a short orbital cycle, or spin period.

One of the main goals for the instrument is to study light scattered by the atmosphere of 'hot Jupiter'-type exoplanets, i.e., relatively massive planets orbiting close to the central star. This research is done in collaboration with prof. Svetlana Berdyugina (KIS), and the University of Hawaii, who will operate a 80 cm robotic telescope on Haleakala observatory, Maui. This telescope provides us with large amount of observing time, needed for the high S/N long term monitoring of exoplanets and other periodic systems, e.g., strongly interacting binary stars. The polarimeter head is lightweight (< 10 kg) and could be easily transported to other observing sites (ESO). The advantages of DIPOL-2 over the existing ESO polarization facilities are the better throughput and stability, and the much higher speed, thanks to the order of magnitude faster readout of the CCDs.



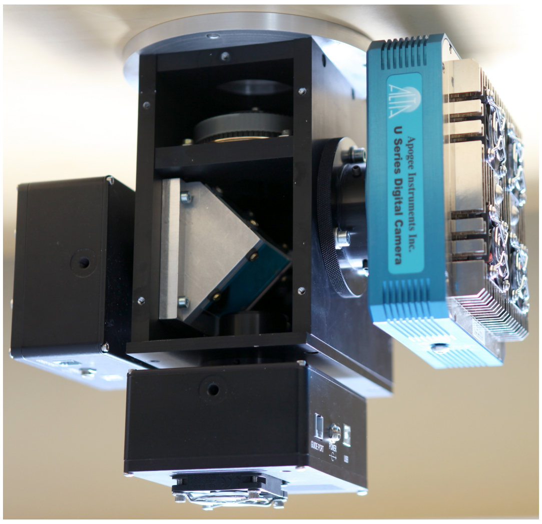


Fig. 12 (left). The scheme of the DIPOL-2 polarimeter. Rotatable superachromatic l/2 retarder plate modulates the relative intensity of the two polarized beams produced by the calcite crystal, with an amount proportional to the degree of linear polarization of the incoming radiation. The passband is divided by a dichroic mirror on two beams: blue and red. The fluxes of the two polarized stellar images in two channels are measured with two highly sensitive cooled CCD s. **(right).** DIPOL-2 polarimeter head, showing (from top) the polarization modulator unit (rotatable retarder plate and calcite plate), the dichroics unit dividing the light onto three CCDs: the blue, the visible, and the red.

Organization and Personnel in 2010

The Institute Board

Chairman: Leo Takalo, Docent (University of Turku)
Vice Chairman: Heikki Salo, Professor (University of Oulu)
Members: Pasi Hakala, Docent (University of Turku, FINCA staff)
Juhani Huovelin, Docent (University of Helsinki)
Hannu Koskinen, Professor (University of Helsinki)
Jorma Kyyrä, Vice Rector (Aalto University, Helsinki)
Juri Poutanen, Professor (University of Oulu)
Aimo Sillanpää, Docent (University of Turku)
Merja Tornikoski, Professor (Aalto University, Helsinki)

The Scientific Advisory Board

Chairman: Prof. Johannes Andersen (Nordic Optical Telescope, Spain)
Members: Dr. Susanne Aalto (Chalmers University of Technology, Gothenburg, Sweden)
Prof. Claes Fransson (Stockholm University, Sweden)
Prof. Johan Knapen (Instituto de Astrofisica de Canarias, La Laguna, Spain)
Dr. Bruno Leibundgut, European Southern Observatory, Garching, Germany)
Prof. Nikolai Piskunov (University of Uppsala, Sweden)
Dr. Marianne Vestergaard (University of Copenhagen, Denmark)

Personnel in 2010 (stationed at the University of Turku, unless otherwise mentioned.)

Director:
Jari Kotilainen (from 1.1.2010)

University Researchers:
Chris Flynn (from 1.3.2010; on leave of absence from 1.8.2010)
Thomas Hackman (1.8. - 31.12.2010; Helsinki)
Pasi Hakala (from 1.3.2010)
Diana Hannikainen (1.6. - 31.12.2010; Aalto)
Pekka Heinämäki (1.8. - 31.12.2010)
Eija Laurikainen (1.4. - 31.12.2010; Oulu)
Seppo Mikkola (1.7. - 31.12.2010)
Jukka Nevalainen (1.8. - 31.12.2010; Helsinki)
Kari Nilsson (from 1.3.2010)
Vilppu Piirola (from 1.3.2010)

Post-doctoral Researchers:
Sebastien Comeron (1.12. - 31.12.2010; Oulu)
Seppo Katajainen (1.7. - 31.12.2010)
Oskari Miettinen (1.8. - 31.12.2010; Helsinki)
Elina Nieppola (1.6. - 31.12.2010; Aalto)

PhD students:
Kalle Karhunen (from 1.11.2010)

Teaching in 2010

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.

Introductory courses:
Thomas **Hackman**: Universum nu (= Universe now), University of Helsinki, 4 credit units

Intermediate courses:
Seppo **Katajainen**: Observational methods in astronomy II (radio and high energy astronomy)
Jari **Kotilainen**: Observational methods in astronomy III (Infrared astronomy), Department of Physics and Astronomy, University of Turku, 4 credit units

Advanced courses:
Thomas **Hackman**: Johdatus asiantuntijatehtäviin (= Introduction to Expert Tasks), University of Helsinki, 5 credit units
Seppo **Katajainen**: ESO Telescopes and instrumentation, University of Turku
Kari **Nilsson**: Astrophysics I, Department of Physics and Astronomy, University of Turku, 8 credit units

Theses completed in 2010

Veli-Matti **Kittilä**, Master of Science (M.Sc.): Kinematics of bulges of spiral galaxies (supervised by Dr. **Laurikainen** and Prof. Salo), University of Oulu

Heidi **Yli-Kankahila**, Bachelor of Science (B.Sc.): WHIM - the missing baryons of the Universe? (supervised by Dr. **Nevalainen**), University of Helsinki

Organizing committees of conferences

Pekka **Heinämäki**, organizer, Tuorla-Tartu annual meeting 2010: observational cosmology, Tuorla Observatory, 2-3 September 2010

Jari **Kotilainen**, organizer, Opening seminar of FINCA, University of Turku, 16.9.2010

Jari **Kotilainen**, member of SOC, Nordic Workshop on ALMA first science opportunities, Copenhagen, Denmark, 26.-27.8.2010

Conference presentations abroad

(I)= invited talk; (O) – oral presentation; (P) – poster

Chris **Flynn**: Science with HERMES Workshop: 28-29 September 2010, Epping, Sydney, Australia
Helium enrichment in the cosmos and HERMES (O)

Pasi **Hakala**: ULX-meeting, ESA-ESAC, Villafranca, Spain, May 2010, no contrib.
Leicester university 50 years of space science (invited only), July 2010, no contrib.

Diana **Hannikainrn**, Astrophysics of Neutron Stars 2010, August 2–6, 2010, Çeşme, Turkey, ‘Disentangling the Z and Atoll sources: results from a NS LMXB survey with INTEGRAL’ (P)

Diana **Hannikainen**, IAU Symposium 275 ‘Jets at All Scales’, 13 – 17 September 2010, Buenos Aires,Argentina, ‘The Disk/Jet Connection in the Enigmatic Microquasar Cygnus X-3’ (O)

Diana **Hannikainen**, "THE RESTLESS GAMMA-RAY UNIVERSE" 8th INTEGRAL Workshop, 27 – 30 September 2010, Dublin, Ireland, ‘Understanding Cygnus X-3 through Multiwavelength Studies’ (O)

Diana **Hannikainen**, "THE RESTLESS GAMMA-RAY UNIVERSE" 8th INTEGRAL Workshop, 27 – 30 September 2010, Dublin, Ireland, ‘A new approach to the disk/jet connection in the enigmatic microquasar Cygnus X-3’ (P)

Diana **Hannikainen**, "THE RESTLESS GAMMA-RAY UNIVERSE" 8th INTEGRAL Workshop, 27 – 30 September 2010, Dublin, Ireland, ‘A comparison between the spectral and long-term timing properties of GX 3+1, GX 5-1 and GX 13+1’ (P)

Diana **Hannikainen**, The XI Russian-Finnish Radio Astronomy Symposium, October 18–22, 2010, Pushchino, Russia, ‘Seeking a Unified Model of Neutron Star Low-Mass X-ray Binaries’ (O)

Seppo **Katajainen**: Physics of Accreting Compact Binaries, 26.-30.7.2010, Kyoto University, Kyoto, Japan: "Circular Polarization in Intermediate Polars and other Interacting Close Binary Stars" (O)

Jari **Kotilainen**: Nordic Astrophysics 2010 meeting, Visby, Sweden, 25.-28.5.2010: Summary talk “Evolution of Black Holes and Galaxies” (I)

Jari **Kotilainen**: Nordic Astrophysics 2010 meeting, Visby, Sweden, 25.-28.5.2010: “The black hole – bulge relation in high redshift quasars” (O)

Jari **Kotilainen**: Puzzles of Galactic Nuclei, MPE, Garching, Germany, 28.-30.6.2010: “Co-evolution of black holes and galaxies” (O)

Jari **Kotilainen**: Nordic Workshop on ALMA first science opportunities, Copenhagen, Denmark, 26.-27.8.2010: “High redshift quasar host galaxies with ALMA” (O)

Jari **Kotilainen**: Evolution of galaxies, their central black holes and their large-scale environment, Potsdam, Germany, 20.-24.9.2010: “Cosmological evolution of the black hole – bulge relation in quasar host galaxies” (P)

Eija **Laurikainen**: S4G Spitzer space telescope project science meeting, 17.9-23.10.2010, Lake Arrowhead (USA), leader of one session: "Properties of S0s using Multi-component

Decompositions" (O) and "Origin of Early type Dwarf Galaxies" (O).

Eija **Laurikainen**: SMAKCED project science meeting, 15-16.2.2010, Heidelberg (Germany), leader of one session: "Scaling Relations using NIRS0S+OSUBSGS Surveys" (O)

Jukka **Nevalainen**: Tuorla-Tartu annual meeting 2010: observational cosmology', September 2010, Tuorla Observatory, Turku, Finland: “Megaparsec-scale magnetic field in Ophiuchus cluster of galaxies” (I)

Jukka **Nevalainen**: New Hard X-ray Mission Observatory: 1st International Conference, November 2010, Universitat de Valencia, Valencia, Spain: “Inverse Compton emission in Clusters of Galaxies” (I)

Elina **Nieppola**: Fermi meets Jansky: AGN in radio and gamma-rays, Max-Planck-Institute für Radioastronomie, Bonn, Germany, 21-23 June 2010. "Correlations between the Fermi/LAT gamma-ray and 37 GHz radio properties of AGN averaged over 11 months" (P)

Elina **Nieppola**: XI Russian-Finnish Symposium on Radio Astronomy, Pushchino, Moscow Oblast, Russia, Oct 18-22, 2010. "Correlations between the Fermi/LAT and 37 GHz bands for Metsähovi AGN" (O)

Kari **Nilsson**: Tuorla-Tartu annual meeting 2010: Observational Cosmology, 3.9.2010, Tuorla Observatory, "Polarization survey of SDSS BL Lac candidates" (O)

Seminars at Finnish institutes

Sebastian **Comeron**: “Secular evolution in spiral galaxies: resonance rings and thick disks”, 24.11.2010, Department of Physics, University of Oulu

Thomas **Hackman**: “Universum -astronomens laboratorium” (in Swedish), 9.10.2010, Vantaa, invited presentation at the Autumn meeting of MAOL (Union of teachers in mathemetical sciences)

Thomas **Hackman**: “Doppler imaging”, 20.12.2010, University of Helsinki, research group seminar presentation

Pasi **Hakala**: FINCA opening seminar, 16.9.2010: ”ESO opportunities for X-ray binaries”

Diana **Hannikainen**, Astronomer's Days 2010, June 2–4, 2010, Kangasala, Finland, ’Seeking a Unified Model of Neutron Star Low-Mass X-ray Binaries

Seppo **Katajainen**: Finnish Astronomical Society Astronomer's Days, 2.-4.6.2010, Kangasala: "Polarization observations using ESO telescopes & instruments"

Jari **Kotilainen**: Tuorla Observatory, University of Turku, 5.2.2010: “Black holes”

Jari **Kotilainen**: Astronomers Days 2010, 2.-4.6.2010: “Co-evolution of black holes and galaxies”

Jari **Kotilainen**: Astronomers Days 2010, 2.-4.6.2010: “Introducing the Finnish Centre for Astronomy with ESO (FINCA)”

Jari **Kotilainen**: FINCA opening seminar, 16.9.2010: FINCA and Finnish astronomy

Jari **Kotilainen**: Tuorla-Tartu annual meeting 2010: observational cosmology, Tuorla Observatory, 2.-3.2010: **“**ESO: a crash course for cosmologists”

Eija **Laurikainen**: FINCA opening seminar, 16.9.2010, University of Turku: "Secular Evolution of Galaxies from ESO and Spitzer Infrared Surveys"

Jukka **Nevalainen**: Magnetic field and relativistic electrons in the Ophiuchus clusters of galaxies, 17.9.2010, University of Helsinki.

Elina **Nieppola**: Astronomers' Days 2010, Kangasala, Jun 2-4, 2010

Vilppu **Piirola**: Tuorla observatory, 23.4.2010, "Polarimetric analysis of binary stars"

Research visits to foreign institutes

Diana **Hannikainen**, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA October 24–29, 2010

Diana **Hannikainen**, Purdue University, West Lafayette, IN November 8–10, 2010

Diana **Hannikainen**, University of Florida, Gainesville, FL November 16–19, 2010

Pekka **Heinämäki**, 7.-11.11.2010, Planck collaboration meeting, Bologna, Italy

Seppo **Katajainen**, 29.-30.4.2010, ESO Users Committee Meeting, Garching, Germany.

Seppo **Katajainen**, 10.-15.10.2010, St. Petersburg State University, Russia, FIRST researcher mobility visit

Jari **Kotilainen**, 5.11.2010, OPTICON Time Allocation Committee meeting, Amsterdam, Netherlands.

Jari **Kotilainen**, 6.-10.12.2010, Observatory of Padova, University of Padova, Italy.

Oskari **Miettinen**, 13.-14.12.2010, Onsala Space Observatory, Sweden: “Designing and preparing ALMA Early Science phase proposals” -workshop

Kari **Nilsson**, 11.-15.2010, Landessternwarte Heidelberg, University of Heidelberg, Germany.

Committee memberships

Thomas **Hackman**: Nordic Optical telescope, member of the OPC

Thomas **Hackman**: Nordic Optical Telescope, chair of the Instrument user group o High-Resolution Optical Spectroscopy

Thomas **Hackman**: University of Helsinki, member of "Nämnden för Svensk vuxenutbildning" (Board for Swedish adult education)

Thomas **Hackman**: Univerisity of Helsinki, member of "Tähtitieteen opetuksen kehittämistyöryhmä" (Group for development of astronomy teaching)

Pasi **Hakala**: XMM-Newton observing time committee

Diana **Hannikainen**, Member of the jury, PhD examination, CEA Saclay, France, October 2010

Diana **Hannikainen**, Scientific Committee, International Workshop on Radiation Imaging Detectors

Seppo **Katajainen**, member, ESO Users Committee

Jari **Kotilainen**, member of the OPTICON time allocation committee

Oskari **Miettinen**, member of the Programme committee, Physics Days 2011, Helsinki

Public Relations and Media

Thomas **Hackman**: 9.10. and 3.12.2010: TV interviews on astronomy, FST programme "Min morgon"

Jari **Kotilainen**: interview at the Book Fair of Turku, 3.10.2010: ESO and FINCA

Jari **Kotilainen**, member of the ESO Science Outreach Network (ESON)

Publications by FINCA Personnel in 2010

The authors with FINCA affiliation are typed in boldface.

Refereed Publications:

Aleksić, J. et al. (incl. **Nilsson, K.**): **Detection of Very High Energy γ-ray Emission from the Perseus Cluster Head-Tail Galaxy IC 310 by the MAGIC Telescopes.** *The Astrophysical Journal Letters 723(2): L207-L212 (2010).*

Aleksić, J. et al. (incl. **Nilsson, K.**): **Search for an extended VHE γ-ray emission from Mrk 421 and Mrk 501 with the MAGIC Telescope.** *Astronomy and Astrophysics 524, A77 (2010)*

Aleksić, J. et al. (incl. **Nilsson, K**.): **MAGIC Upper Limits for Two Milagro-detected Bright Fermi Sources in the Region of SNR G65.1+0.6.** *The Astrophysical Journal 725(2): 1629-1632 (2010)*

Beardmore, A. P.; Osborne, J. P.; Page, K. L.; Schwarz, G.; Starrfield, S.; **Hakala, P.**; Ness, J.-U.; Balman, S. & Wagner, R. M.: **Swift observations of CSS081007:030559+054715**. *Astronomische Nachrichten, 331 (2): 156-159 (2010)*

Bird, S.; Harris, W. E.; Blakeslee, J. P. & **Flynn, C**. : **The inner halo of M 87: a first direct view of the red-giant population.** *Astronomy and Astrophysics 524, A71 (2010)*

Buta, R.; **Laurikainen, E.**; Salo, H. & Knapen, J. H. : **Decreased Frequency of Strong Bars in S0 Galaxies: Evidence for Secular Evolution?** *The Astrophysical Journal 721(1):259-266 (2010)*

Buta, R.J. et al. (incl. **Laurikainen, E**., **Comeron, S**.): **Mid-infrared Galaxy Morphology from the Spitzer Survey of Stellar Structure in Galaxies (S^4G): The Imprint of the De Vaucouleurs Revised Hubble-Sandage Classification System at 3.6 µm.** *The Astrophysical Journal Supplement, 190(1): 147-165 (2010)*

Decarli, R.; Falomo, R.; Treves, A.; **Kotilainen, J.K**.; Labita, M. & Scarpa, R.: **The quasar M(BH)-M(host) relation through cosmic time - I. Data set and black hole masses.** *Monthly Notices of the Royal Astronomical Society 402(4): 2441-2452 (2010)*

Decarli, R.; Falomo, R.; Treves, A.; Labita, M.; **Kotilainen, J.K.** & Scarpa, R.: **The quasar M(BH)-M(host) relation through cosmic time - II. Evidence for evolution from z = 3 to the present age.** *Monthly Notices of the Royal Astronomical Society 402(4): 2453-2461 (2010)*

Einasto, M. et al. (incl. **Heinämäki, P**.): **The Sloan great wall. Rich clusters.** *Astronomy and Astrophysics 522, A92 (2010)*

Frisch,P.C.; Andersson, B.-G.; Berdyugin,A.; Funsten, H.O.; Magalhaes, A.M.; McComas, D.J.;

Piirola, V.; Schwadron, N.A.; Slavin, J.D. & Wiktorowicz,S.J. : **Comparisons of the Interstellar Magnetic Field Directions Obtained from the IBEX Ribbon and Interstellar Polarizations.** *The Astrophysical Journal, 724 (2), 1473-1479 (2010)*

Gardner, E. & **Flynn, C.** : **Probing the Galaxy's bars via the Hercules stream.** *Monthly Notices of the Royal Astronomical Society, 405 (1): 545-552 (2010)*

Gardner, E. & **Flynn, C.** : **Erratum - Probing the Galaxy's bars via the Hercules stream.** *Monthly Notices of the Royal Astronomical Society, 406 (1): 701-704 (2010)*

Grouchy, R. D.; Buta, R. J.; Salo, H. & **Laurikainen, E. : Ring Star Formation Rates in Barred and Nonbarred Galaxies.** *The Astronomical Journal 139(6):2465-2493 (2010)*

Katajainen, S.; Butters, O.; Norton, A. J.; Lehto, H. J.; **Piirola, V**. & Berdyugin, A. : **Discovery of Polarized Emission from Two Soft X-ray-emitting Intermediate Polars: UU Col and NY Lup.** *The Astrophysical Journal 724 (1): 165-170 (2010)*

Koljonen,K.I.I.; **Hannikainen,D.C**.; McCollough,M.L.; Pooley,G.G. & Trushkin,S.A. : **The hardness-intensity diagram of Cygnus X-3: revisiting the radio/X-ray states.** *Monthly Notices of the Royal Astronomical Society, 406(1), 307-319 (2010)*

Laurikainen, E.; Salo, H.; Buta, R.; Knapen, J. H. & **Comerón, S.** : **Photometric scaling relations of lenticular and spiral galaxies.** *Monthly Notices of the Royal Astronomical Society 405(2):1089-1118.*

Lehto, T.; **Nevalainen, J.;** Bonamente, M.; Ota, N. & Kaastra, J. : **Suzaku observations of X-ray excess emission in the cluster of galaxies A 3112.** *Astronomy and Astrophysics 524, 70-78 (2010)*

Miettinen, O. & Harju, J.: **LABOCA mapping of the infrared dark cloud MSXDC G304.74+01.32.** *Astronomy and Astrophysics, 520, A102 (2010)*

Miettinen, O.; Harju, J.; Haikala, L. K. & Juvela, M.: **Physical properties of dense cores in Orion B9.** *Astronomy and Astrophysics 524, A91 (2010)*

Nevalainen, J.; David, L. & Guainazzi, M.: **Cross-calibrating X-ray detectors with clusters of galaxies: an IACHEC study.** *Astronomy and Astrophysics 523, 22-47 (2010)*

Nilsson, K.; Takalo, L. O.; Lehto, H. J. & Sillanpää, A.: **Hα monitoring of OJ 287 in 2005-08.** *Astronomy and Astrophysics 516, A60 (2010)*

Portinari, L.; Casagrande, L & **Flynn, C**.: **Revisiting $\Delta Y/\Delta Z$ from multiple main sequences in globular clusters: insight from nearby stars.** *Monthly Notices of the Royal Astronomical Society 406(3): 1570-1582 (2010)*

Raiteri, C. M. et al. (incl. **Nilsson, K**.): **Another look at the BL Lacertae flux and spectral variability. Observations by GASP-WEBT, XMM-Newton, and Swift in 2008-2009.**

Astronomy and Astrophysics 524, A43 (2010)

Reipurth, B.; **Mikkola, S**.; Connelley, M. & Valtonen, M.: **Orphaned Protostars.** *The Astrophysical Journal Letters 725(1):L56-L61 (2010)*

Salo, H.; **Laurikainen, E.**; Buta, R. & Knapen, J. H.: **Bars do Drive Spiral Density Waves.** *The Astrophysical Journal Letters 715(1):L56-L61 (2010)*

Sheth, K. et al. (incl. **Laurikainen, E**., **Comeron, S.**): **The Spitzer Survey of Stellar Structure in Galaxies (S^4 G).** *Publications of the Astronomical Society of the Pacific, 122(898), 1397-1414 (2010)*

Vornanen,T.; Berdyugina,S.V.; Berdyugin,A.V. & **Piirola,V.**: **GJ 841B—the Second DQ White Dwarf With Polarized CH Molecular Bands.** *The Astrophysical Journal Letters, 720(1), L52-L55 (2010)*

Väisänen, P.; **Kotilainen, J.K**.; Juvela, M.; Mattila, K.; Efstathiou, A. & Kahanpää, J.: **A far-infrared survey at the North Galactic Pole - I. Nearby star-forming galaxies and effect of confused sources on source counts.** *Monthly Notices of the Royal Astronomical Society 401(3): 1587-1601 (2010)*

Conference Proceedings and other Non-Refereed Publications:

Casagrande, L.; Portinari, L. & **Flynn, C**.: **Revisiting the helium abundance in globular clusters with multiple main sequences.** *Light Elements in the Universe, Proceedings of the International Astronomical Union, IAU Symposium, 268: 129-134 (2010)*

Foschini, L. et al. (incl. **Nieppola, E**.): **Relativistic jets in Narrow-Line Seyfert 1.** *IAU Symposium 275 "Jets at all Scales", Buenos Aires, Argentina (2010)*

Frisch, P. C.,; Andersson, B.,; Berdyugin, A.,; Funsten, H. O.,; Magalhaes, M.,; McComas, D. J.,; **Piirola, V.**,; Schwadron, N. A.,; Slavin, J. D. & Wiktorowicz, S. J.: **Comparisons of the Interstellar Magnetic Field Directions obtained from the IBEX Ribbon and Interstellar Polarization Measurements.** *American Geophysical Union Fall 2010, SH21B-1817 (2010)*

Innanen, K.A. & **Flynn, C.**: **The Radial Velocity, Space Motion, and Galactic Orbit of GJ 754.** *Journal of the Royal Astronomical Society of Canada, 104 (6): 223 (2010)*

Katajainen, S.,; Lehto, H.J.,; **Piirola, V.**,; Berdyugin, A.,; Norton, A. & Butters, O..: **Polarization in Soft X-ray Intermediate Polars** *BINARIES - KEY TO COMPREHENSION OF THE UNIVERSE (eds. Andrej Prsa and Miloslav Zejda), ASP Conference series 435, 237 (2010)*

Kotilainen, J.K.; Decarli, R.; Falomo, R.; Treves, A.; Labita, M. & Scarpa, R.: **Co-Evolution of Supermassive Black Holes and Their Host Galaxies.** *Co-Evolution of Central Black Holes and Galaxies. Proceedings of the International Astronomical Union, IAU Symposium, 267: 34-39 (2010)*

Laine, S.J.; Holley-Bockelmann, K.; Zaritsky, D.; van der Marel, R. P.; Siopis, C.; Gutiérrez, C. M. & **Kotilainen, J**.: **Survivability of Realistic Satellite Galaxies Near Host Galaxies.** *Bulletin of the American Astronomical Society, 42: 368 (2010)*

León-Tavares, J.,; Valtaoja, E:, Tornikoski, M.,; Lähteenmäki, A. & **Nieppola, E**.: **The connection between gamma-ray emission and radio flares in Fermi/LAT blazars.** *Proceedings, Fermi meets Jansky - AGN in radio and gamma-rays: 93-96.* (2010)

Nieppola, E.,; Tornikoski,M.,; Valtaoja, E.,; León-Tavares, J.,; Hovatta, T.,; Lähteenmäki, A. & Tammi, J.: **Correlations between the Fermi/LAT gamma-ray and 37 GHz radio properties averaged over 11 months.** *Proceedings, Fermi meets Jansky - AGN in radio and gamma-rays: 89-92.* (2010)

Piirola, V. : **Polarimetric Analysis of Binary Stars.** *BINARIES - KEY TO COMPREHENSION OF THE UNIVERSE (eds. Andrej Prsa and Miloslav Zejda), ASP Conference series 435, 225 (2010)*

Savolainen,P.; **Hannikainen,D.C.**; Paizis,A.; Farinelli,R.; Kuulkers,E. & Vilhu,O.: **INTEGRAL long-term monitoring results on persistently bright NS LMXBs.** *X-ray astronomy 2009; present status, multi-wavelength approach and future perspectives. AIP Conference Proceedings 1248: 199-200 (2010)*

Sbarufatti, B.; Treves, A.; Decarli, R.; Veronesi, A.; **Kotilainen, J.K**.; Ciprini, S.; Falomo, R. & Romano, P.: **ESO VLT Optical Spectroscopy of BL Lac Objects IV.** *Accretion and Ejection in AGN: a Global View (eds. L. Maraschi, G. Ghisellini, R. Della Ceca and F. Tavecchio): 213 (2010)*

Tornikoski, M.,; **Nieppola, E.**,; Valtaoja, E.,; León-Tavares, J. & Lähteenmäki, A.: **Study of a complete sample of radio-bright AGNs: properties of gamma-ray bright and gamma-ray faint radio sources in the first year of Fermi operations.** *Proceedings, Fermi meets Jansky - AGN in radio and gamma-rays: 85-88. (2010)*

Valtaoja, E.,; Tornikoski, M.,; León-Tavares, J.,; **Nieppola, E.**,; Lähteenmäki, A.,; Tammi, J. & Hovatta, T..: **From EGRET to Fermi: mm-radio data and the origin of gamma-ray emission.** *Proceedings, Fermi meets Jansky - AGN in radio and gamma-rays: 73-76. (2010)*

Valtonen, M.J.; Savolainen,T.; Wiik,K.; **Nilsson,K**.; Takalo,L.; Sillanpää,A.; Lehto,H. & **Mikkola, S.: Variation of the Jet Angle of OJ287 in the Binary Black Hole Model.** *American Astronomical Society, AAS Meeting 216, 304.07 (2010)*