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10 –12 mei 2000, Dalfsen

NAC 2000

55th Dutch Astronomers Conference

10 –12 May 2000, Dalfsen

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Posters

Comets and their origin

Jane Luu

Leiden Observatory

The scientific interest in comets stems from the fact that they are some of the most primitive bodies in the solar system and as such can tell us something about the solar nebula and the early days of the solar system. Where do they come from? Do they contain unprocessed interstellar material? I will discuss our understanding of comets, their origin, and their implications for the formation of the solar system.

DOT: recent results and future plans

P. Sütterlin

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DOT, the Dutch Open Telescope located in the Observatorio del Roque de los Muchachos on the Canary island of La Palma, has started scientific work in autumn 1999. Already this first observation, part of a joint campaign with three other Canary Island telescopes and the SOHO and TRACE missions, showed the extraordinary quality of the data taken with DOT. Some highlights will be shown.
Currently, the post focus instrumentation of DOT is being redesigned, leading to a multichannel setup (Ca K, G-band, two continua, Hα profile at 7 wavelengths). All channels will use speckle masking image processing which will allow to reach the theoretical resolution limit of the optics, 0.2 arcsec in the G-band, even at moderate seeing conditions.

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A single vortex in an accretion disk

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A single vortex in a two-dimensional polytropic Keplerian shear flow is studied numerically. Stable, anticyclonic, vortices can exist with width/height ratio not much larger than unity and Reynolds number of order unity. The vortex excites two trailing spiral shocks, one inward and one outward. The simulation shows the properties of an isolated structure in an accretion disk. We discuss the implications on accretion

Publication status: A&A, submitted

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1 Hz quasi-periodic oscillations in dippers

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With the Rossi X-ray Timing Explorer (RXTE) we have recently discovered a new phenomenon in three different X-ray dip sources (4U 1323−62, EXO 0748−676, and 4U 1746–37). The new phenomenon consists of quasi-periodic oscillations in the X-ray flux with frequencies varying (so far) between 0.5 and 2.5 Hz, frequencies that are not seen in other LMXBs. The oscillations are relatively coherent (Q∼3.5) and have amplitudes that are quite large (∼10% rms), uniquely do **not** decrease towards lower photon energy, and as a fraction of the total flux do not change whether they are observed in or out of the dips, or even during the 10–50-fold increase in flux during X-ray bursts. This is different from the properties of any other oscillation observed in LMXBs and clearly demonstrates the oscillations are produced by quasi-periodic obscuration of the central emitting regions.

Publication status: Jonker et al., 1999, ApJ 511, L41; Homan et al., 1999, ApJ 516, L91; Jonker et al., 2000, ApJ 531, 453

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WSRT studies of microlensing and scintillation in ultra-compact radio AGN

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We have recently detected uncorrelated radio variability in the two components of the radio gravitational lens CLASS B1600+434: a z=1.6 quasar split by an intervening edge-on disk system. The variations, which typically occur on weekly timescales, must be extrinsic and are almost certainly due to radio-microlensing by compact objects in the halo of the foreground lens which has a redshift of z=0.4. Some very recent results and the implications of this discovery will be discussed.
In another object, the z=0.54 quasar J1819+3845, we find the most rapid variability ever discovered in an extragalactic radio source: up to 20% per minute ! In this object the variations are due to interstellar scintillation by turbulence in a rather nearby screen (possibly associated with the local Hot Bubble). Observations over a timescale of one year are reported. Via the 'velocity parallax' method we have determined the transverse velocity of this screen. The quasar has now been seen for up to one year with a brightness temperature (10^{13} K) well above the inverse Compton Catastrophe limit. This poses serious problems in conventional interpretation of AGN radio cores which will be briefly discussed.

Publication status: ApJL, 2000, 529,65; A&A, submitted (astro-ph 0004112); in prep.

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Determining H_0 from gravitational lens PG 1115+080: systematic uncertainties in the lens models

D. Pronk, H. Zhao

Sterrewacht Leiden

In principle, the Hubble constant can be derived from the timedelays that exist between different images in a gravitationally lensed system. However, the result is highly sensitive to assumptions and systematic uncertainties in the lensing models.
We have found a new broad class of lensing models, with unrestricted radial profile, and allowing for non-elliptical and non-scale-free lenses. For these models, the lensing equations can be linearized, making it much easier to find a good fit to observations or to explore the parameter space.
We apply the models to PG 1115+080, and use it to show that the measured image positions and time delays do not uniquely determine the Hubble constant.

Publication status: article submitted to MNRAS, also astro-ph/0003050

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Mapping the beam of a pulsar

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The study of drifting subpulses if very useful in trying to understand this mechanisms. A recently published break-through observation of PSR B0943+10 might provide a link between theory and observations, since it made it possible to map the polar cap of this pulsar. In this talk I will discuss this result, it's implications and some recent observations done with PuMa at WSRT.

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A search for optical counterparts to two Anomalous X-ray pulsars.

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We present deep photometric Keck images of the fields of the Anomalous X-ray pulsars 1E 2259+58.6 and 4U 0142+61. Improved X-ray positions are derived using archival *ROSAT* observations. No object is found within the corresponding X-ray error circle for 1E 2259+58.6 down to limiting magnitudes R$= 25.7$ and I$= 24.3$ and we conclude that it is unlikely that it is accreting matter from a disk, unless it is in an extremely compact binary. Within the X-ray error circles of 4U 0142+61 however, we do find an V$= 25.5$ mag object, that has unusual photometric colours, V-R$= 0.5$ and R-I$= 1.3$.

Publication status: A&A, in press; A&A, in preparation

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The structure of the local Universe and the coldness of the cosmic flow

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Unlike the substantial coherent bulk motion in which our local patch of the Cosmos is participating, the amplitude of the random motions around this large scale flow seems to be surprisingly low. Attempts to invoke global explanations to account for this coldness of the local cosmic velocity field have not yet been succesfull. Here we propose a different view on this cosmic dilemma, stressing the repercussions of our cosmic neighbourhood embodying a rather uncharacteristic region of the Cosmos. Suspended between two huge mass concentrations, the Great Attractor region and the Perseus-Pisces chain, we find ourselves in a region of relatively low density yet with a very strong tidal shear. By means of constrained realizations of our local Universe, based on Wiener-filtered reconstructions inferred from the Mark III catalogue of galaxy peculiar velocities, we show that indeed this configuration may induce locally cold regions. Hence, the coldness of the local flow may be a cosmic variance effect.

An H I disk in NGC 4261; first science with the JIVE data processor

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We report on high sensitivity, spectral line VLBI observations of the H I absorption feature in the radio galaxy NGC 4261. This source is a famous HST object, with a 240 pc radius circumnuclear disk and evidence for a $4.9 \times 10^8 \mathrm{M}_\odot$ central black hole. Although the H I absorption is only detectable on the most sensitive baseline, it can be unambiguously associated with the counterjet and is interpreted to originate in a thin atomic circumnuclear disk. This structure is probably a continuation of the dusty accretion disk inferred from HST imaging, which could be feeding the massive black hole. H I column densities in front of the counterjet of the order of $10^{21}(T_{\rm sp}/100\,\mathrm{K})$ cm^{-2} are derived, consistent with X-ray data and VLBI scale free-free absorption. The data presented are the result of the first scientific project processed on the new EVN MkIV data processor at JIVE, Dwingeloo.

Publication status: 2000, A&A 354, L45

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Nuclei of nearby radio-loud ellipticals

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We study the nuclei of a complete sample of 21 nearby ($D < 70h^{-1}\mathrm{Mpc}$) Fanaroff & Riley Type I galaxies using HST/WFPC2 broad- and narrowband filters. The galaxies typically resemble normal ellipticals except for the presence of small ($\sim 1''$) central disks or lanes of dust and emission gas. Disks have outlines which closely resemble ellipses, while lanes are warped filaments. Disks are invariably well aligned with the stellar major axis while lanes are not. We describe possible scenarios to explain this effect. Several nuclei show unresolved nuclear blue emission. We argue this emission is non-thermal in nature. We constrain the relative orientations of the disk-jet systems using VLBI jet imaging and dust morphology. We present preliminary results from a follow-up study of the emission gas using HST/STIS to determine the masses of the central black holes and constrain ionization mechanisms. We conclude with a brief discussion on the implication of the results for unifying schemes of FR I and BL Lac galaxies.

Publication status: Verdoes Kleijn et al. 1999, AJ, 118, 2592 and in preparation

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Instrumentation prospects for ING La Palma

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I will give an overview of the instrumentation prospects for the near future at the Isaac Newton Group of Telescopes (ING) in La Palma, with particular emphasis on multi-object fibre spectroscopy over wide fields, and on the near-infrared imaging and adaptive optics capabilities being offered on the 4.2m William Herschel Telescope. I will show first science results from ING's near-infrared camera, INGRID, which was successfully commissioned in March 2000, and which can be used for deep NIR imaging over relatively large fields. INGRID will be the first detector for NAOMI, ING's adaptive optics system to be available soon. NAOMI will give near-diffraction-limited imaging in the NIR and significantly improved resolution in the optical. I will describe the scientific expectations of NAOMI, and outline future upgrade paths, which include the use of the multi-object spectrograph OASIS.

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Discovery of a massive equatorial torus in the η Carinae stellar system

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The enigmatic object η Carinae is believed to represent an important, but short-lived, unstable phase in the life of the most massive stars, occuring shortly before they explode as supernovae or collapse directly to black holes. The putative binary system believed to constitute η Carinae survived an outburst in the previous century that lasted 20 years; and which created a nebula with pronounced bipolar lobes that together contain about 2.5 solar masses of material. The nebula also exhibits an equatorial 'waist' containing about 0.5 solar masses. The physical mechanisms responsible for the outburst and the bipolar geometry are not understood.
Here we report infrared observations (spectroscopy and imaging) that reveal the presence of about 15 solar masses of material, located in an equatorial torus. The massive torus may have been created through highly non-conservative mass transfer, which removed the entire

envolope of one of the stars, leaving an unstable core that erupted in the nineteenth century. The collision of the erupted material with the pre-existing torus provides a natural explanation for the bipolar shape of the nebula.

Publication status: Nature, 1999, Vol. 402, 502

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First detection of CH_3 in the interstellar medium

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Observations with the Short Wavelength Spectrometer (SWS) onboard of the Infrared Space Observatory (ISO) have led to the first detection of the methyl radical CH_3 in the interstellar medium. The ν_2 Q-branch at 16.5 micron and the R(0) line at 16 micron have been unambiguously detected toward the Galactic Center. The analysis of the measured bands gives a column density of $8\,10^{14}$ cm^{-2} and an excitation temperature of 17 K. While the temperature is consistent with measurements of other molecular species, the column density is so high that it remains unexplained with current chemical models.

Publication status: ApJ Letters, submitted

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Crystallinity versus mass-loss rate in Asymptotic Giant Branch stars

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Asymptotic Giant Branch (AGB) stars are solar-type stars in the late stages of stellar evolution, developing a stellar wind of 10^{-8} - 10^{-3} $M_{\odot}$ yr^{-1}. The mass-loss rate is believed to increase while the star is evolving along the AGB. Dust formation occurs in the outflows of AGB stars; these stars are the main contributors of dust to the interstellar medium.
ISO observations have shown that O-rich AGB stars exhibit crystalline silicate features in their spectra only if their mass-loss rate is higher than a certain threshold value. Usually, this is interpreted as evidence that crystalline silicates are not present in the dust shells of low mass-loss rate objects. In this study, radiative transfer model calculations have been performed to provide an alternative explanation to the lack of crystalline silicate features in the spectrum of low mass-loss rate AGB stars. Due to the resulting temperature difference between amorphous and crystalline silicates, it is possible to hide up to 20% of crystalline silicates in the circumstellar dust shell. This puts the process of dust formation around AGB stars and the composition of the dust in the interstellar medium in a different light.

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Experimental light scattering by olivine and Allende meteorite particles

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Olivine particles occur in many astronomical objects, such as comets, asteroids, circumstellar envelopes and planetary nebulae. Often, the light scattering properties of these particles are required for the interpretation of observations of these objects. Therefore, we have measured the scattering matrix as a function of the scattering angle, θ, of Mg-rich olivine particles and of Allende meteorite particles (consisting mainly of iron-rich olivine) at λ=442 nm and 633 nm. A good illustration of the importance of the scattering matrix is the element ratio $-F_{12}(\theta)/F_{11}(\theta)$, which in practice equals the degree of linear polarization for unpolarized incident light. We compare the measured $-F_{12}(\theta)/F_{11}(\theta)$ with polarization vs phase angle plots of comets and asteroids and find that the results of the measurements and the observations are remarkably similar. This enables us to interpret differences in the polarization vs phase angle plots of comets in terms of differences in size and/or color of cometary particles.

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s-process nucleosynthesis in post-AGB stars

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Surface abundance analyses of single post-AGB stars are not only able to clarify the evolutionary status of the objects themselves, but can also help to constrain theoretical chemical AGB models. A survey of recent results shows that among the post-AGB stars, only those showing the 21μm feature in their IR-spectrum, are conform to standard post-3rd dredge-up theory.
A homogeneous study of six single 21μm stars shows that these objects are carbon and s-process enhanced. A strong correlation is found between the total s-process enrichment and the neutron irradiation. On the other hand, the expected anti-correlation between metallicity and neutron irradiation shows a large *intrinsic* scatter. These results suggest that also other fundamental parameters determine the AGB nucleosynthesis.

Publication status: Van Winckel & Reyniers 2000, A&A 354, 135

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First astrophysical results of the LETGS on the Chandra X-ray Observatory

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The Low Energy Transmission Grating Spectrometer (LETGS) on board the Chandra X-ray Observatory provides us with new exciting astrophysical results. Already during the calibration fase of the LETGS it was possible to extract astrophysical results from the high resolution x-ray spectra of some sources. These results will be shown, in connection with the status of the calibration and the influence of the ongoing calibration on the results. With a diversity of emission lines, continuum emission and absorption features the full power of high resolution x-ray spectra will be demonstrated as a technique to address temperature and density of coronal stars, physics and chemistry of the interstellar medium, and to address processes in Active Galactic Nuclei.

Publication status: Various stages of publication in ApJL, A&AL and ApJ

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Formation and evolution of close double white dwarfs

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Close double white dwarfs are the final products of many binaries. Currently 14 are known. Of these, three are double helium white dwarfs of which the masses of both components are determined. These helium white dwarfs used to be the cores of giants which obey a unique core mass - radius relation, which allows us to reconstruct the complete binary evolution of these systems. We find that the two standard scenario's for the formation of close double white dwarfs do not work. We therefore suggest a different type of mass transfer with which we can explain these three systems.
We applied this change in the way mass transfer is treated in a population synthesis for close double white dwarfs. We find that we can reproduce the observed population of double white dwarfs satisfactory only if, in modelling the selection effects, we assume that the latest cooling models for low-mass white dwarfs overestimate the luminosity for white dwarfs below 0.3 solar masses.

Publication status: A&A, submitted

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Orbital evolution of eccentric binary systems due to resonant excitation of stellar oscillations

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The orbit in which the components of a stellar binary revolve evolves as a result of the mutual perturbations that the objects force on each other. Energy and angular momentum is exchanged between the stars and the orbit, causing the orbital period and eccentricity to change. In describing this tidal interaction we take into account that the forced perturbations may correspond to eigenmodes of the stars; in such a case the rate of evolution will be much higher. By decomposing the tidal potential of an eccentric orbit into its harmonic components we can investigate how in the course of orbital evolution this orbital spectrum interacts with the stellar spectra of eigenmodes. The case in which one or both stars are forced to spin in such a way that a mode is resonantly excited for a prolonged period of time is shown to be quite common; these periods of 'resonance locking' can significantly enhance the rate of orbital decay.

Publication status: A&A, submitted

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Massive stars in the bulge of M51: a new mode of star formation?

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We have detected a number of bright points in the bulge of the interacting galaxy M51 (Whirlpool) in HST/WFPC2 images in six filters. The energy distribution and the magnitude of the points show that they are either very bright stars with masses in the range of 40 to 120 $M_\odot$, or very small clusters of $10^3 M_\odot$, dominated by one or few bright stars. The distribution of the objects in the HR diagram shows that they are mainly stars, rather than clusters. This indicates that the conditions in the bulge of M51 are favorable for the formation of (almost) single massive stars. We will discuss these conditions and the consequences.

Asteroseismology with future space missions

Conny Aerts

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In this talk we first of all explain what is meant by the term ‘asteroseismology’. This research area is developed with the specific aim to probe stellar interiors, a task that is not easy since only the outer layers of a star contribute to the observations. We show the power of seismological techniques by means of successful applications so far. Further, we explore the possibilities to apply seismology to main-sequence stars. Knowing the internal structure of such objects is important, since they still have a long and interesting life ahead of them. The current ground-based data sets of non-radial pulsators along the main sequence turn out to be insufficient due to a too short time-base and/or a too limited detection treshold. In view of the importance of seismology, the international astronomical community is currently preparing several seismological space missions. We will highlight these and point out how they can increase our knowledge of stellar interiors during the next decade.

Mode identification from line profile variations

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Time series of spectra of non-radial pulsating stars contain undoubtfully a wealth of information about the interior of the star. Developing techniques to extract this information, and confronting these observations with the theoretically predicted ones will lead to very interesting asteroseismological results.
Next to the determination of the pulsation frequencies, the most important step is mode identification, i.e. the assignment of the degree l and azimuthal number m of the spherical harmonic Y_l^m that describes the non-radial pulsation.
This key-ability in the information extraction process requires a lot of creativity and is not yet fully developed. The techniques invented up to now suffer from rather severe restrictions and none give an idea of the uncertainty on the estimated parameters.
We will recapitulate briefly the existing techniques and their strong and weak points in order to indicate the direction in which we want improvement. Currently we are developing a mode identification technique based on moments of the line profile but with a statistically justified error estimation. We report on the progresses made so far in this ongoing research.

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Supersonic brownian motion

Vincent Icke & Yvonne Simis

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When low-mass stars die, they pass through the limbo of the Asymptotic Giant Branch (AGB). In this phase, dust condenses in the stellar atmosphere. The radiation of the dying star accelerates the dust to very high speed, driving the atmosphere out as an AGB-wind. This raises a fascinating problem in kinetic theory: the motion of highly accelerated particles in a surrounding bath of gas atoms. The situation is very far from equilibrium, but surprisingly this allows a very simple treatment of the problem. The coupling of this microphysics to macroscopic phenomena (transport, momentum transfer, hydrodynamics) produces new dynamica effects in the stellar atmospere, as shown in the presentation by Simis.

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Quasi-periodic shells in dust forming AGB winds

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Recent observations of Post–AGB objects (IRC+10216) and Planetary Nebulae (e.g. CRL 2688, the "Egg Nebula") have revealed the presence of concentric shells around them. The spacing of the shells around IRC+10216 corresponds to a time interval of 200–800 years, which is much longer than the characteristic time scale of stellar pulsation. So far, it has been suggested that binarity and/or magnetic fields could explain the shells. We present a mechanism that enables a single star, without magnetic field, to eject shells at the observed time scale.
In the atmosphere of an AGB star, solid particles will form if the density is sufficiently high and the temperature is sufficiently low. These grains are subject to radiation pressure and will move away from the star. Drifting grains will collide with the gas, thereby transfering momentum. We have simulated this process with time–dependent hydrodynamics in which gas and dust are treated as separate, but coupled, fluids. It was known before that an equilibrium state, in which gas and grains are accelerated equally can establish. In stationary calculations, this equilibrium state is the only solution. We combine a two fluid approach with time–dependent hydrodynamics and a new, analytical, implementation of the momentum transfer rate. We find that (non–equilibrium) grain drift causes the dust to successively pile up and flow, leading to quasi periodic oscillations in the outflow that resemble the observed shells around P-AGB objects and PNe.

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Evolution of close binary systems

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Close binary systems constitute the progenitors of Type Ia supernovae, but also of Type Ib/c supernovae, of neutron star and black hole binaries, and likely of gamma ray bursts. This talk indends to highlight the state-of-the-art of modelling these progenitors, and to emphasize several unsolved problems concerning their evolution, e.g. the formation of contact, the onset of non-conservative evolution, and the angular momentum balance during mass transfer.

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Synthetic spectra of cool stars observed with the ISO Short-Wavelength Spectrometer: improving the models and the calibration of the instrument

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The modeling and interpretation of the ISO-SWS *(Infrared Space Observatory - Short Wavelength Spectrometer)* data require an accurate calibration of the spectrometers (Schaeidt et al., 1996, A&A 315, L55). In the SWS spectral region (2.38-45.2 μm) the primary standard calibration candles are bright, mostly cool, stars. The better the behaviour of these calibration sources in the infrared is known, the more accurate the spectrometers can be calibrated. ISO offered the first opportunity to obtain continuous mid-infrared spectra between 2.38 and 45.2 μm at a spectral resolving power ~ 1500, not polluted by any molecular absorptions of the earth's atmosphere. Therefore our knowledge on the mid-infrared behaviour of the stellar calibration sources is limited. Refining the synthetic reference spectra used to calibrate the SWS can only be done by refining the model atmospheres of the stars. A full exploitation of the ISO data can therefore only result from an iterative process in which both accurate observations and new modeling are involved.
Precisely because this research entailed an iterative process in which both theoretical developments on the model spectra and calibration

improvements on the spectral reduction are involved, we had to be extremely careful not to confuse technical detector problems with astrophysical issues. Several precautions are elaborated on and the impact on both the calibration of the instrument and the modeling of the atmosphere of cool stars is discussed.

Publication status: A&A, submitted; PhD. Thesis, University of Leuven

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Magnetic fields in early-type stars

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Magnetic fields are undoubtedly present in all stars, but in the most massive stars (with spectral type O and B) they are very difficult to measure. Sofar, only a few B stars and no O star have detected fields. In these type of stars the expected strength is typically 100 G, which is at the edge of current detection methods. Nevertheless, the presence of these fields is very strongly suspected, because this is the most likely mechanism to account for the widely observed variable wind behavior. The observed rotational modulation of the winds, combined with the extreme sensitivity of the part of the wind just above the photosphere to weak magnetic fields, strongly justify this hypothesis.
A summary will be given of the indirect evidence of the presence of magnetic fields in early-type stars, and the results obtained sofar. In particular, the discovery of the weakest field detected yet in an upper mainsequence star (β Cephei B1 III) will be highlighted.

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The longest thermonuclear X-ray burst ever observed?

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During a BeppoSAX Wide Field Camera observation of the Galactic Center, a strong enhancement in the intensity of the X-ray burster 4U 1735-44 was observed. This enhancement, which lasted about 4 hrs, shows characteristics of thermonuclear burning on a neutron star surface. This would make it longest such X-ray burst ever observed. We present the analysis of this burst, and discuss possible explanations for the long duration of such a burst.

Publication status: A&A Letters, accepted

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Catching massive stars at birth

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The mechanism by which the most massive (OB) stars form is poorly understood. This is in a large part due to the lack of observations covering the formation and early evolutionary stages of massive stars. The newly born stars are still deeply embedded in their natal molecular cloud and obscured from visual detection, because of the tens to hundreds of magnitudes extinction. As soon as the massive star is formed, it starts ionizing its close environment creating an ultra-compact H II region (UCHII). The intense ultraviolet radiation is absorbed by dust and transformed into infrared and radio emission. At these longer wavelengths the extinction is strongly reduced and the infrared and radio emission is able to penetrate the natal cloud.
The goal of our project is to detect the photospheres of the OB stars ionizing UCHIIs and to determine their stellar parameters, such as surface temperature, luminosity, composition, and mass. Obviously, this is impossible at optical wavelengths, but also at mid-infrared and radio wavelengths the central star cannot be directly observed due to the intense emission of the surrounding gas and heated dust. The only chance to detect their photospheres is to observe in the near-infrared ($\sim 1-5$ μm). With multi-color imaging the candidate OB stars are selected. The definitive classification of these reddened stars as young OB stars has to come from high S/N near-infrared spectroscopy.

Physical and chemical structure of regions of massive star formation

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We present submillimeter (JCMT, OVRO) and infrared (ISO + ground-based) observations of 14 massive ($L = 10^4 - 10^5$ $L_\odot$; $d \sim$kpc) stars which do not yet have H II regions, but which are still embedded in envelopes of ~ 100 $M_\odot$ of dust and molecular gas. Based on models of the temperature and density structure of these envelopes on $10^2 - 10^5$ AU scales, we show that both the pre-stellar conditions and the mechanism of envelope dispersal are significantly different from regions of low-mass star formation. The importance of molecular abundances and gas/solid ratios as evolutionary markers is highlighted. The abundances of several molecules are found to be enhanced in the warm gas close to the star, due to (i) passive freeze-out and evaporation (e.g., CO); (ij) production by grain surface reactions (e.g., CH_3OH); (iij) high-temperature gas-phase chemistry (e.g., HCN). The models also allow the most accurate determination yet of the cosmic-ray ionization rate, and the first outside the Solar neighbourhood.

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The composition and evolution of the circumstellar disks around Herbig Ae/Be stars.

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Herbig Ae/Be stars (HAEBE) are young stellar objects with a mass between $\sim 2 - 10$ $M_{\odot}$. They represent the final stage of pre-main-sequence evolution of stars in this mass range. HAEBE stars are surrounded by a gas and dust envelope and/or disk and may be the precursors of young main-sequence β-Pictoris and Vega-type stars. These latter systems are surrounded by debris disks which are thought to contain planetary bodies, implying that the circumstellar matter around HAEBE stars represent an early phase in the formation of planets. We will present a discussion of the ISO-SWS spectra of a sample of Herbig Ae/Be stars, immediately focusing on the 10 μm spectral region. The 10 μm flux is dominated by the emission of (amorphous) silicate dust grains around these stars. From the shape of the silicate emission band we will derive parameters such as grain size and composition and will discuss the implications for the evolution of the Herbig Ae/Be systems.

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The importance of multiple scattering in hot star winds

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We present mass-loss rates for massive stars over a wide range of stellar parameters. We have derived a mass-loss recipe for two sides of the bi-stability jump around spectral type B1, where the mass loss changes dramatically.
We will show that there is good agreement between our predicted mass-loss rates that take *multiple scattering* into account, and the observations for O stars. Comparison between observed and new theoretical wind momenta shows that these can in principle provide distances of luminous O stars in distant stellar systems.
We argue that our theoretical mass-loss formalism is reliable and we recommend that it be used in future evolutionary calculations.

Publication status: Astronomy & Astrophysics, submitted

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The impact of close binary evolution on the 'WR bump' properties of HII regions.

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The observation of a broad emission feature around 4650 Å in the spectra of some HII galaxies is generally attributed to the presence of Wolf-Rayet (WR) stars. The main contribution to this feature (the so-called 'Wolf-Rayet bump') comes from the HeII 4686 Å WR emission line. More recently, higher resolution data of some of these 'WR galaxies' also show evidence of the CIV 5808 Å emission line, which is prominent in WC type stars. When compared to the latest single star evolution synthesis models, the presence of either of these emission features in a spectrum is commonly interpreted as being indicative of a very young starburst, i.e. 5 Myrs or less. However, this need not be the case if the burst contains a non-negligible fraction of binaries. As already shown in Van Bever & Vanbeveren (1998, A&A 334, 21) and Van Bever et al. (1999, NewA 4, 173) concerning EW(H_β), interacting binaries are able to extend the period during which massive stars are present in a starburst, and in this way also all the emission features that are associated to them. Here we present the results of calculations made with our Population Synthesis Code showing the evolution with age of the equivalent widths of the HeII 4686Å and CIV 5808Å emission lines, for starbursts containing a significant number of interacting binaries. The main conclusion again being that one needs to be careful when deducing starburst ages from comparing observations with single star models only!

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Jet bending: observations and theory

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A lot of jets of active galaxies show features that can be explained by interaction between the jet and a cloud in the intergalactic medium. We can roughly classify the jet-cloud interactions into three categories. In the first category the jet terminates at the cloud like a car against a wall. The material of the jet flares in all directions and the collimation of the jet is entirely destroyed at the terminal point. In the second category the jet goes straight through the cloud and the only interaction between the jet and the cloud is at the contact surfaces where the cloud enwraps the jet. In these two categories the jet or the cloud prevails entirely. In general however there will be some balance between the influences the cloud exerts on the jet and vice versa. These cases form the third category.
In the beginning of the probable evolutionary track of the interaction the tip of the jet will arrive at the cloud and terminates there (Category I). Over time the jet eats its way through the cloud. During this period the jet can be terminated inside the cloud or leave the cloud with an angle to its original direction (Category III). Finally the jet reaches the other side of the cloud and will go straight through the cloud as long the jet and the cloud remain (Category II).
In a lot of cases of Category III the jet escapes the cloud at an angle to its original direction. After a short description of the three categories, I will focus on the theoretical models for this bending and compare these to simulations and observations. An example of a widely accepted model is the “Dentist Drill” model of Schreuer (1982). If space and time allow it I will at the end discuss an attempt to observe a few jet-cloud interactions with long VLBI-baselines. Unfortunately using these baselines to study this phenomenon is problematic due to the fact that the observed sources are completely resolved at these baselines.

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Spectroscopy and photometry of γ Doradus candidate stars

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The γ Dor stars have become a very lively subject. It is now accepted as a new class of variable stars, and might be of strong interests for asteroseismologic space missions (MOST, MONS, COROT, Eddington).
We present the new results of several photometric and spectroscopic campaigns done in Chile and in South Africa on γ Dor stars. Our goals are (1) to check if the observed variability is of the γ Dor nature and exclude other reasons for the variability (e.g. ellipsoidal variations), (2) to derive the frequency spectrum of the stars, (3) to confirm the presence of high-order g-modes in the targets, (4) and ultimately to identify the pulsation modes.

Publication status: Astronomy and Astrophysics, in press and in preparation

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Infrared H I Lines in Herbig Ae/Be stars

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We present the results of spectroscopic observations of infrared H I lines with the *Infrared Space Observatory* (ISO) in a sample of 25 Herbig Ae/Be Stars. Resulting H I line fluxes or upper limit to the line flux were compared with Hα line fluxes and kinematics of the hydrogen gas from this line, as well as with radio continuum fluxes of the stars in our sample. The correlations that were found between the infrared line fluxes, the infrared and the optical line fluxes and the infrared line flux and the radio continuum flux were compared to those expected for Case B recombination and to a simple wind model. In general, the relative line fluxes were found to deviate from the Case B predictions, suggesting that the observed H I emission emanates in a region of moderate to high density, such as a disk or a wind.

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Frederik Kaiser (1808-1872) and the modernisation of Dutch astronomy

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Frederik Kaiser was the director of Leiden Observatory from 1837 until his death in 1872. His contributions to astronomical practice include the foundation of a new, completely up-to-date observatory building in Leiden, and the introduction of statistics and precision measurements in daily practice at the observatory. Moreover he was the author of several bestselling books on popular astronomy.
Probably Frederik Kaiser played a crucial role in the revival of Dutch astronomy in the second half of the 19th century.
This project aims at a description and explanation of Kaiser's activities in science, organisation and popularisation, in the context of national and international developments in 19th-century astronomy.

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The CH out-of-plane bending modes of PAH molecules in astrophysical environments

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We present $10-15$ μm spectra of a sample of H II regions, YSO's and evolved stars that show strong unidentified infrared emission features, obtained with the ISO/SWS spectrograph onboard ISO. These spectra reveal a plethora of emission features with bands at 11.0, 11.2, 12.0, 12.7, 13.5 and 14.2 μm. These features are observed to vary considerably in relative strength to each-other from source to source. In particular, the $10-15$ μm spectra of the evolved stars are dominated by the 11.2 μm band while for H II regions the 12.7 is typically as strong as the 11.2 band. Analysing the ISO data we find a good correlation between the 11.2 μm band and the 3.3 μm band, and between the 12.7 μm and the 6.2 μm band. There is also a correlation between the ratio of the UIR bands to the total dust emission and the 12.7 over 11.2 μm ratio.
Bands in the $10-15$ μm spectra region are due to CH out-of-plane (OOP) bending modes of polycyclic aromatic hydrocarbons (PAHs). We summarise existing laboratory data and theoretical quantum chemical calculations of these modes for neutral and cat-ionic PAHs. Due to mode coupling, the exact peak position of these bands depends on the number of adjacent CH groups and hence the observed interstellar $10-15$ μm spectra can be used to determine the molecular structure of the interstellar PAHs emitting in the different regions. We

conclude that evolved stars predominantly inject compact $100-200$ C-atom PAHs into the ISM where they are subsequently processed, resulting in more open and uneven PAH structures.

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Nova: a high resolution public image?

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The Nova Information Centre (NIC) was formed in januari 2000 to present the Nederlandse Onderzoekschool Voor Astronomie, Nova, in a more prominent way to the media, the scientific community and the general public. Nova is the federation of all academic astronomy groups in the Netherlands, but a little known entity to outsiders. Although NIC is still 'under construction' in many respects, in the longer term we seek to achieve that Nova will become the household name for Dutch astronomy, contributing to a more favourable climate for this kind of fundamental research, and maybe even for science in general. We will present our plans for a comprehensive, popular web-site - www.astronomy.nl - samples of printed promotional material and future outreach-activities. Input from visitors to the conference, in the form of ideas, discussion or material for the website is welcome.

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Vega: ongoing accretion from the circumstellar disk?

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For decades Vega has been considered as a standard star for spectroscopy. Since the discovery of dusty material in its surroundings by the IRAS satellite in 1984 this picture has been changing slowly. Now Vega serves as the prototype of the so-called Vega-type stars – main-sequence stars showing a far-infrared excess.
This poster discusses the metal-underabundances in the photosphere of Vega in the context of an accretion model, putting Vega closer to the λ Bootis stars – a group of probably pre-main-sequence A stars that are still accreting metal poor gas from their surroundings (Holweger & Rentzsch-Holm 1995, A&A 303, 819; Holweger, Hempel & Kamp 1999, A&A 350,603). Furthermore it is shown, that in spite of the non-detection of the CO radio lines the disk around Vega can be very well composed of *gas and dust* (Kamp & Bertoldi 2000, A&A 353, 276) opening once again the question for the nature of this disk.

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A LEGO model for the black hole candidate GRS 1915+105

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We analyzed 163 observations of the black hole candidate GRS 1915+105 made with the Rossi X-ray Timing Explorer (RXTE) in the period 1996-1997. For each observation, we produced light curves and color-color diagrams. We classified the observations in 12 separate classes, based on their count rate and color characteristics. From the analysis of these classes, we reduced the variability of the source to transitions between three basic states: a hard state corresponding to the non-observability of the innermost parts of the accretion disk, and two softer states with a fully observable disk. These two soft states represent different temperatures of the accretion disk, related to different local values of the accretion rate. The transitions between these states can be extremely fast. The source moves between these three states following certain patterns and avoiding others, giving rise to a relatively large but limited number of variability classes. These results are the first step towards a linking of the properties of this exceptional source with standard black-hole systems and with accretion disk models.

Publication status: Belloni et al. 2000, A&A 355, 271

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Magnetic activity in accretion discs

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We show that *anomalous viscosity* in an accretion disc can be caused by *coronal magnetic loops* sticking out on both sides of the disc. The model puts physics into the so-called α-prescription of a Shakura-Sunyaev disc. Maxwell stresses carry angular momentum from disc matter at the inner footpoint of the loop to the outer. Transport of angular momentum through the disc is determined by the loop lengths. It becomes essentially *non-local* and has to be studied numerically. As the footpoints of a given loop follow the Keplerian flow at the respective footpoints the loop not only transports angular momentum outwards, but also expands upwards in a magnetically force-free corona. Eventually, the loop reconnects (*'flares'*) with the ambient coronal magnetic field, and releases non-thermal energy. We use a *probabilistic cellular automaton* model to monitor the local and global *transport of angular momentum*, and the *energy release in magnetic flaring* which is held to be responsible for *X-ray flickering* in accretion flows.

Publication status: A&A, submitted

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A cluster of galaxies at redshift 2.2?

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Powerful radio galaxies in the distant Universe could very well be the progenitors of the present-day brightest cluster galaxies. Observations in radio, optical and X-rays show that radio galaxy 1138–262 at redshift 2.2 is a massive galaxy embedded in a dense medium. Its very distorted optical morphology is reminiscent of a merging system. We have obtained deep narrow and broad band images of a 36 square arcminutes field around the galaxy with FORS1 at the VLT. Sixty objects in this field show a narrow band rest frame equivalent width larger than 20 Å and are therefore candidate Lyα emitting galaxies at $z = 2.2$. Subsequent multi object spectroscopy with FORS1 reveals the presence of 14 companion galaxies with similar redshifts as the radio galaxy, which might be part of the proto-cluster in formation around 1138–262.

Publication status: A&A Letter, accepted

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Long-term spectral observations of LS I +61°303

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We present the optical spectra of the periodic radio star LSI +61°303 with intermediate dispersion. The Hα emission line profile and its variation are analyzed. Variability in LSI +61°303 is observed on different timescales. During our observations the equivalent width (EW) of Hα line showed long-term variability which is likely to be associated with the 4-year period. The Hα EW changed strongly around the radio maximum, clearly displayed a maximum at phases between 0.55-0.6 and possibly both another maximum at phases around 1.0 and a minimum between radio phases 0.7-0.9. It is interesting to note that the Hα emission line in 1995 October showed unusual variation at radio phases around 0.6, where the decrease of the Hα emission accompanied by the enhancement of the emission at the red wing. These short-term and periodic phenomena can be fairly explained with the X-ray induced Hα emission by employing the orbital solution deduced from near-infrared light curves (Marti & Paredes, 1995). Thus provides some evidence for a correlation with the orbital motion of the neutron star.

Publication status: A&A, submitted

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Preliminary results on the Be star ω Ori from the MUSICOS98 campaign

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The Be star ω Ori was one of the target of the MUSICOS98 (MUlti SIte COntinuous Spectroscopy 1998) campaign : 221 spectra from this star were obtained over 22 nights with 10 telescopes around the world. The data were reduced, homogenized and the analysis is now being done. We plan to analyze several lines (HeI, Hα, SiIII triplet,...) and different algorithms are being used to study Non Radial Pulsations (NRP), in particular the new Restricted Local Cleanest (RLC). Models will also be computed. In this poster, we present the analysis of the HeI 6678 line and the preliminary results that can be drawn for the frequencies and modes of the pulsations.

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Studying the kinematics in the $z = 2.5$ radio galaxy MRC 2104-242

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High redshift radio galaxies are believed to be the progenitors of the massive elliptical galaxies we see at lower redshifts. Although these radio galaxies are at a great distance, they are very luminous and so the emission (from stars, gas, dust and plasma) can be studied in great detail.
We have obtained high-resolution spectroscopic observations of MRC2104-242 with the VLT (2 x 3hrs integration) and are now interpreting the reduced data. A fundamental question about the dynamics of high redshift radio galaxies is what the dominant source of ionization is. This is likely to be either photoionization by the active nucleus or ionization by shocks progressing through the gaseous medium surrounding the galaxy.
By comparing the measured emission line-ratios to various ionization models and studying the spatial structure in the emission-lines we hope to find an answer to this and other questions.

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Observational constraints on the evolution of powerful radio sources

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Although by now it is well known how the luminosity of stars evolve during their life, we know only very little of the luminosity evolution of je-driven powerful (typically 10^{24-32} W Hz^{-1} at GHz frequencies) radio sources as they grow larger and older. Recent models predict a steep rise, followed by a gradual decrease in radio power with increasing size. However, actually comparing such predictions with real data is difficult: Powerful radio sources grow too slow to directly witness the luminosity evolution and so we must rely on statistical methods.
According to the models, the strongest luminosity evolution is expected at linear source sizes above a Mpc, a size range for which no statistically useful samples were available until we compiled our own sample of these so-called Giant radio sources. Using this sample, and two other complete samples of radio sources, we have attempted to observationally constrain the evolution. We find that the decrease in radio power with increasing linear size is much stronger than predicted by the models, but recognize that a limited lifetime of the radio sources can resolve this discrepancy.
Finally, we also present examples of radio sources which have a more awkward evolution: Apparently these sources have 'rejuveniled' and are now forming radio lobes for the second time in their lifetime.

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Relations between timing features and colors in the X-ray binary 4U 0614+09

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Accretion in neutron star low mass X-ray binaries can be studied through the spectral and timing properties of the associated X-ray emission. We study correlations between these properties in the low mass X-ray binary 4U 0614+09 using a large (265-ks) data set obtained with the Rossi X-ray Timing Explorer. We find strong correlations between the timing properties and the position of the source in a hard X-ray color vs. intensity diagram. We suggest that the changing mass accretion rate is responsible for these correlations. Several power spectral features of 4U 0614+09 are found to be very similar to features in black hole candidates and other neutron star low mass X-ray binaries, indicating that these features might originate from the same physical processes. We also report the highest frequency quasi–periodic oscillation yet from any low mass X-ray binary at 1329 ± 4 Hz, constraining the neutron star mass in 4U 0614+09 to below 1.9 $M_{\odot}$ and its radius to below 15.2 km.

Publication status: Astrophysical Journal, refereed

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Eclipsgekte

Pim van Tend

This poster describes the eclipse madness experienced in the Stuttgart area (Germany) in August 1999. The full text in Dutch can be found at the URL below.

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Teaching the principles of astronomical instrumentation

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ASTRON employs a considerable number of technical specialists. Many of them have no previous knowledge of astronomy. We present here two informal background courses on areas of astronomical instrumentation in which ASTRON is active. The courses were written for technical staff of the Dutch HBO-level (by formal training or by experience), but we discovered that both academic staff and staff with very practical skills were also interested. We feel that university students (and therefore their teachers also) may usefully imbibe some of the concepts and the way we treat them.

Publication status: In-house publication, probably for Website later

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Line-profile variations of the spectroscopic binary κ Scorpii

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We present an analysis of the line-profile variations of the spectroscopic binary and β Cephei star κ Scorpii. We used a series of 442 high resolution, high signal-to-noise spectra gathered with the CAT/CES combination (La Silla, Chile) during eight subsequent nights in july 1997.
For the determination of the orbit, we combined these spectra with previously obtained data, covering a total timespan of 9 years. Our orbital period of 195 days is consistent with previous findings (De Mey, 1997, Ph. D Thesis, K.U.Leuven).
The complex patterns on the greyscale representations of the residual SiIII 4553 Å profiles with respect to the average profile point towards more than one (tesseral) pulsation mode. A frequency analysis of the three normalised velocity moments confirms the main frequency 5.004 c/d and the second frequency 4.867 c/d, which were derived from photometric data by Lomb and Shobbrook (1975, Mon. Not. R. astr. Soc. 255,1).
Many other frequencies appear in the power spectrum across the SiIII 4553 Å profile.

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Gaseous and stellar dynamics in IC 1459

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The peculiar elliptical galaxy IC 1459 ($M_V = -21.19$, $D = 16.5h^{-1}\mathrm{Mpc}$) has a fast counterrotating stellar core, stellar shells and ripples, a blue nuclear point source and strong radio core emission. Here we present the dynamical modeling of the kinematics of the central gas disk using FOS and WFPC2 on board HST and preliminary results from stellar dynamical modeling using CTIO spectra along five position angles. We construct dynamical models for the emission gas kinematics that include both a supermassive black hole (BH) and the stellar mass distribution. The models assume that the gas either rotates on circular orbits in an infinitesimally thin disk or resides in isotropically moving collisionless cloudlets. Both models are consistent with a BH mass in the range $\mathrm{M}_\bullet = 1\text{-}4 \times 10^8 \mathrm{M}_\odot$. Using a Schwarzschild method we model the stellar kinematics. We compare the BH mass and mass-to-light ratio inferred from the gas and stellar dynamical modeling and discuss the kinematical properties of the counterrotating stellar core.

Publication status: Verdoes Kleijn et al. 2000, AJ, submitted, and in preparation

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Transitional YSOs: candidates from flat-spectrum IRAS sources

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We are searching for Young Stellar Objects (YSOs) near the boundary between protostars and pre-main-sequence objects, what we term Transitional YSOs. We have identified a sample of 125 objects as candidate transitional YSOs on the basis of IRAS colors and the optical appearance on POSS plates. We present optical, near-IR and high-resolution IRAS images of 82 objects accessible from the Northern and 62 of the Southern Hemisphere. The objects have been classified on the basis of their morphology and spectral index.
We find that the majority of our objects are associated with star-forming regions, confirming our expectation that the bulk of these objects are YSOs. Of the 125 objects, 28 have a variety of characteristics very similar to other transitional YSOs, while another 22 show some of these characteristics.
Furthermore we have found seven objects to be good candidates for members of the Herbig Ae/Be stellar group, of which three are newly identified as such.

Publication status: 1999, A&A 352, 228

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Luminous pre-main sequence stars in het Magellanic Clouds

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We searched the EROS1 database consisting of $80\,000$ stars in the bar of the Large Magellanic Cloud (LMC) for blue objects with irregular photometric behaviour similar to Galactic Herbig AeBe (HAeBe) stars. We found 21 objects in the LMC. Moreover first results of irregular variable star search in the SMC have revealed 2 similar objects. Based on their lightcurve shape and Hα emission we classify these objects as HAeBe candidates.
In the LMC the objects are located in an area of enhanced 100μ FIR emission. The stars are concentrated in three areas and the majority of the objects are clustered round the N 120 nebular complex.
We derive the stellar parameters and find that these stars are very luminous. In the HR-diagram they are positioned even above the birthline for Galactic stars.

Publication status: Astronomy&Astrophyics, submitted

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Normal branch oscillations and subsecond kHz QPO frequency drifts in Sco X-1

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We show how the kilohertz QPO frequency drifts with the normal branch oscillations in Sco X-1 and discovered that the higher kHz QPO frequency variation up to more than 20 Hz. We also show how the amplitudes of the higher and the lower kilohertz QPO varies. At the end we dicuss the mechanism for these phenomena and constrain the models of kHz QPOs in x-ray binaries.

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ING	Isaac Newton Group, La Palma
IoA	Institute of Astronomy, Cambridge
JIVE	Joint Institute for VLBI in Europe
KUL	Katholieke Universiteit Leuven
NOVA	Nederlandse Onderzoekschool voor Astronomie
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
RUG	Rijks Universiteit Groningen
SRON	Stichting Ruimte Onderzoek Nederland
TUE	Technische Universiteit Eindhoven
UL	Universiteit Leiden
UU	Universiteit Utrecht
UvA	Universiteit van Amsterdam
VU	Vrije Universiteit Amsterdam
VUB	Vrije Universiteit Brussel