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THE MASSIVE STAR NEWSLETTER

formerly known as the hot star newsletter

*

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News

Stanislav Stefl

Thomas Rivinius

ESO

Dear colleagues,

The Active B star community has suffered a sudden and tragic loss when our friend and colleague Stanislav Stefl died in a car accident Wednesday night, June 11 in Santiago de Chile.

The working group has created a page in memory of Stan at:

http://activebstars.iag.usp.br/index.php/be-star-newsletter/volume-41/wg-matters-41/47-stan

Thomas Rivinius

Reference: N/A
Status: Other

Weblink: http://activebstars.iag.usp.br/index.php/be-star-newsletter/volume-41/wg-matters-41/47-stan

Comments:

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PAPERS

Abstracts of 11 accepted papers

The variable stellar wind of Rigel probed at high spatial and spectral resolution

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{7} Astronomisches Institut, Ruhr-Universit"at Bochum, Universit"atsstrass{}e 150, D-44801 Bochum, Germany

We present a spatially resolved, high-spectral resolution (R=12000) K-band temporal monitoring of Rigel using AMBER at the VLTI. Rigel was observed in the Bracket Gamma line and its nearby continuum in 2006-2007, and 2009-2010. These unprecedented observations were complemented by contemporaneous optical high-resolution spectroscopy. We analyse the near-IR spectra and visibilities with the 1D non-LTE radiative-transfer code CMFGEN. The differential and closure phase signal exhibit asymmetries that are interpreted as perturbations of the wind. A systematic visibility decrease is observed across the Bracket Gamma. During the 2006-2007 period the Bracket Gamma and likely the continuum forming regions were larger than in the 2009-2010 epoch. Using CMFGEN, we infer a mass-loss rate change of about 20% between the two epochs. We further find time variations in the differential visibilities and phases. The 2006-2007 period is characterized by noticeable variations of the differential visibilities in Doppler position and width and by weak variations in differential and closure phase. The 2009-2010 period is much more quiet with virtually no detectable variations in the dispersed visibilities but a strong S-shape signal is observed in differential phase coinciding with a strong ejection event discernible in the optical spectra. The differential phase signal that is sometimes detected is reminiscent of the signal computed from hydrodynamical models of corotating interaction regions. For some epochs the temporal evolution of the signal suggests the rotation of the circumstellar structures.

Reference: Manuscript accepted in the A&A Journal
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1405.0907

Comments:

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Massive open star clusters using the VVV survey III. A young massive cluster at the far edge of the Galactic bar

S. Ramírez Alegría (1,2), J. Borissova (1,2), A.N. Chené (3), E. O'Leary (3), P. Amigo (1,2), D. Minniti (2,4), R. K. Saito (5), D. Geisler (6), R. Kurtev (1,2), M. Hempel (2,4), M. Gromadzki (1), J. R. A. Clarke (1), I. Negueruela (7), A. Marco (7), C. Fierro (1,8), C. Bonatto (9), M. Catelan (2,4)

(1) Instituto de Física y Astronomía, Universidad de Valparaíso, Chile; (2) The Millennium Institute of Astrophysics (MAS), Chile; (3) Gemini North Observatory, USA; (4) Pontificia Universidad Católica de Chile, Instituto de Astrofísica, Chile; (5) Universidade Federal de Sergipe, Departamento de Física, Brazil; (6) Departamento de Astronomía, Universidad de Concepción, Chile; (7) Departamento de Física, Ingeniería de Sistemas y Teoría de la Señal, Universidad de Alicante, Spain; (8) Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional, México; (9) Universidade Federal do Rio Grande do Sul, Departamento de Astronomia, Brazil

We present the third article in a series of papers focused on young and massive clusters discovered in the VVV survey. This article is dedicated to the physical characterization of VVV CL086, using part of its OB-stellar population.
We physically characterized the cluster using JHKs near-infrared photometry from ESO public survey VVV images, using the VVV-SkZ pipeline, and near-infrared K-band spectroscopy, following the methodology presented in the first article of the series.
Individual distances for two observed stars indicate that the cluster is located at the far edge of the Galactic bar. These stars, which are probable cluster members from the statistically field-star decontaminated CMD, have spectral types between O9 and B0 V. According to our analysis, this young cluster (1.0 Myr < age < 5.0 Myr) is located at a distance of 11 kpc, and we estimate a lower limit for the cluster total mass of (2.8·10^3) solar masses. It is likely that the cluster contains even earlier and more massive stars.

Reference: Astronomy & Astrophysics, Volume 564, id.L9, 4 pp
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1403.3428

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The Close Binary Frequency of Wolf-Rayet Stars as a Function of Metallicity in M31 and M33

Kathryn F. Neugent (1) and Philip Massey (1)

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Massive star evolutionary models generally predict the correct ratio of WC-type and WN-type Wolf-Rayet stars at low metallicities, but underestimate the ratio at higher (solar and above) metallicities. One possible explanation for this failure is perhaps single-star models are not sufficient and Roche-lobe overflow in close binaries is necessary to produce the "extra" WC stars at higher metallicities. However, this would require the frequency of close massive binaries to be metallicity dependent. Here we test this hypothesis by searching for close Wolf-Rayet binaries in the high metallicity environments of M31 and the center of M33 as well as in the lower metallicity environments of the middle and outer regions of M33. After identifying ~100 Wolf-Rayet binaries based on radial velocity variations, we conclude that the close binary frequency of Wolf-Rayets is not metallicity dependent and thus other factors must be responsible for the overabundance of WC stars at high metallicities. However, our initial identifications and observations of these close binaries have already been put to good use as we are currently observing additional epochs for eventual orbit and mass determinations.

Reference: ApJ, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1405.1810

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Modelling of Sigma Scorpii, a high-mass binary with a Beta Cep variable primary component

A. Tkachenko (1), C. Aerts (1,2), K. Pavlovski (3), P. Degroote (1), P. I. Papics (1), E. Moravveji (1), H. Lehmann (4), V. Kolbas (3), and K. Clemer (1)

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High-mass binary stars are known to show an unexplained discrepancy between the dynamical masses of the individual components and those predicted by models. In this work, we study Sigma Scorpii, a double-lined spectroscopic binary system consisting of two B-type stars residing in an eccentric orbit. The more massive primary component is a Beta Cep-type pulsating variable star. Our analysis is based on a time-series of some 1000 high resolution spectra collected with the CORALIE spectrograph in 2006, 2007, and 2008. We use two different approaches to determine the orbital parameters of the star; the spectral disentangling technique is used to separate the spectral contributions of the individual components in the composite spectra. The non-LTE based spectrum analysis of the disentangled spectra reveals two stars of similar spectral type and atmospheric chemical composition. Combined with the orbital inclination angle estimate found in the literature, our orbital elements allow a mass estimate of 14.7 +/- 4.5 and 9.5 +/- 2.9 solar masses for the primary and secondary component, respectively. The primary component is found to pulsate in three independent modes, of which two are identified as fundamental and second overtone radial modes, while the third is an l = 1 non-radial mode. Seismic modelling of the pulsating component refines stellar parameters to 13.5 +0.5/-1.4 and 8.7 +0.6/-1.2 solar masses , and delivers radii of 8.95 +0.43/-0.66 and 3.90 +0.58/-0.36 solar radii for the primary and secondary, respectively. The age of the system is estimated to be ~12 Myr.

Reference: Monthly Notices of the Royal Astronomical Society (MNRAS)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1405.0924

Comments:

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Masgomas-4: Physical characterization of a double-core obscured cluster with a massive and very young stellar population.

S. Ramírez Alegría (1,2), A. Marín-Franch (3), & A. Herrero (4,5)

(1) The Millennium Institute of Astrophysics (MAS), Santiago, Chile; (2) Instituto de Astrofísica, Universidad de Valparaíso, Valparaíso, Chile; (3) Centro de Estudios de Física del Cosmos de Aragón (CEFCA), Teruel, Spain; (4) Instituto de Astrofísica de Canarias, Tenerife, Spain; (5) Departamento de Astrofísica, Universidad de La Laguna, Tenerife, Spain.

The discovery of new, obscured massive star clusters has changed our understanding of the Milky Way star-forming activity from a passive to a very active star-forming machine. The search for these obscured

clusters is strongly supported by the use of all-sky, near-IR surveys.
The main goal of the MASGOMAS project is to search for and study unknown, young, and massive star clusters in the Milky Way, using near-IR data. Here we try to determine the main physical parameters (distance, size, total mass, and age) of Masgomas-4, a new double-core obscured cluster.
Using near-IR photometry (J, H, and Ks) we selected a total of 21 stars as OB-type star candidates. Multi-object, near-IR follow-up spectroscopy allowed us to carry out the spectral classification of the OB-type candidates.
Of the 21 spectroscopically observed stars, ten are classified as OB-type stars, eight as F- to early G-type dwarf stars, and three as late-type giant stars. Spectroscopically estimated distances indicate that the OB-type stars belong to the same cluster, located at a distance of 1.90 kpc. Our spectrophotometric data confirm a very young and massive stellar population, with a clear concentration of pre-main-sequence massive candidates (Herbig Ae/Be) around one of the cluster cores. The presence of a surrounding HII cloud and the Herbig Ae/Be candidates indicate an upper age limit of 5 Myr.

Reference: A&A, accepted (05/09/14)
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1405.4494

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Discovery of a Thorne-Żytkow object in the Small Magellanic Cloud

Emily M. Levesque, Philip Massey, Anna N. Żytkow, Nidia Morrell

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Thorne-Żytkow objects (TŻOs) are a theoretical class of star in which a compact neutron star is surrounded by a large, diffuse envelope. Supergiant TŻOs are predicted to be almost identical in appearance to red supergiants (RSGs). The best features that can be used at present to distinguish TŻOs from the general RSG population are the unusually strong heavy-element and Li lines present in their spectra, products of the star's fully convective envelope linking the photosphere with the extraordinarily hot burning region in the vicinity of the neutron star core. Here we present our discovery of a TŻO candidate in the Small Magellanic Cloud. It is the first star to display the distinctive chemical profile of anomalous element enhancements thought to be unique to TŻOs. The positive detection of a TŻO will provide the first direct evidence for a completely new model of stellar interiors, a theoretically predicted fate for massive binary systems, and never-before-seen nucleosynthesis processes that would offer a new channel for Li and heavy-element production in our universe.

Reference: MNRAS Letters, in press
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1406.0001

Comments: 5 pages, 3 figures

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Discovery of X-ray pulsations from a massive star

Lidia M. Oskinova (1), Yael Naze (2),
Helge Todt (1) , David P. Huenemoerder (3),
Richard Ignace (4), Swetlana Hubrig (5), Wolf-Rainer Hamann (1)

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X-ray emission from stars much more massive than the Sun was discovered only 35 years ago. Such stars drive fast stellar winds where shocks can develop, and it is commonly assumed that the X-rays emerge from the shock-heated plasma. Many massive stars additionally pulsate. However, hitherto it was neither theoretically predicted nor observed that these pulsations would affect their X-ray emission. All X-ray pulsars known so far are associated with degenerate objects, either neutron stars or white dwarfs. Here we report the discovery of pulsating X-rays from a non-degenerate object, the massive B-type star Xi1 CMa. This star is a variable of beta Cep-type and has a strong magnetic field. Our observations with the X-ray Multi-Mirror (XMM-Newton) telescope reveal X-ray pulsations with the same period as the fundamental stellar oscillations. This discovery challenges our understanding of stellar winds from massive stars, their X-ray emission and their magnetism.

Reference: Nature Communications 5, 4024
doi:10.1038/ncomms5024
Status: Manuscript has been accepted

Weblink: arXiv:1406.0845

Comments: http://sci.esa.int/xmm-newton/54101-pulsating-x-rays-allow-xmm-newton-to-unmask-a-mysterious-star/

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Investigation of the stellar content in the western part of the Carina nebula

Brajesh Kumar, Saurabh Sharma, Jean Manfroid, Eric Gosset, Gregor Rauw, Yael Naze, and Ram Kesh Yadav

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We obtained deep $UBVRI$ H$alpha$ photometric data of the field situated to the west of the main Carina nebula and centered on WR~22. Medium-resolution optical spectroscopy of a subsample of X-ray selected objects along with archival data sets from $Chandra$, $XMM-Newton$ and 2MASS surveys were used for the present study. Different sets of color-color and color-magnitude diagrams are used to determine reddening for the region and to identify young stellar objects (YSOs) and estimate their age and mass. Our spectroscopic results indicate that the majority of the X-ray sources are late spectral type stars.
The region shows a large amount of differential reddening with minimum and maximum values of $E(B-V)$ as 0.25 and 1.1 mag, respectively. Our analysis reveals that the total-to-selective absorption ratio $R rm_{V}$ is sim3.7 pm 0.1, suggesting an abnormal grain size in the observed region. We identified 467 YSOs and studied their characteristics. The ages and masses of the 241 optically identified YSOs

range from sim0.1 to 10 Myr and sim0.3 to 4.8M$_odot$, respectively. However, the majority of them are younger than 1 Myr and have masses below 2 M$_odot$. The high mass star WR 22 does not seem to have contributed to the formation of YSOs in the CrW region. The initial mass function slope, $Gamma$, in this region is found to be -1.13 pm 0.20 in the mass range of 0.5 < M/M$_odot$ < 4.8. The K-band luminosity function slope ($alpha$) is also estimated as 0.31 pm 0.01. We also performed minimum spanning tree analysis of the YSOs in this region, which reveals that there are at least ten YSO cores associated with the molecular cloud, and that leads to an average core radius of 0.43 pc and a median branch length of 0.28 pc.

Reference: 23 pages, 19 figures, 4 tables, Accepted for publication in Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1406.0994

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Effect of rotational mixing and metallicity on the hot star wind mass-loss rates

Jiri Krticka, Jiri Kubat

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Hot star wind mass-loss rates depend on the abundance of individual elements. This dependence is usually accounted for assuming scaled solar chemical composition. However, this approach may not be justified in evolved rotating stars. The rotational mixing brings CNO-processed material to the stellar surface, increasing the abundance of nitrogen at the expense of carbon and oxygen, which potentially influences the mass-loss rates. We study the influence of the modified chemical composition resulting from the rotational mixing on the wind parameters, particularly the wind mass-loss rates. We use our NLTE wind code to predict the wind structure and compare the calculated wind mass-loss rate for the case of scaled solar chemical composition and the composition affected by the CNO cycle. We show that for a higher mass-fraction of heavier elements $Z/Z_\odot \gtrsim 0.1$ the change of chemical composition from the scaled solar to the CNO-processed scaled solar composition does not significantly affect the wind mass-loss rates. The missing line force caused by carbon and oxygen is compensated for by nitrogen line force. However, for a very low-mass fraction of heavier elements $Z/Z_\odot \lesssim 0.1$ the rotational mixing significantly affects the wind mass-loss rates. Moreover, the decrease of the mass-loss rate with metallicity is stronger at such low metallicities. We study the relevance of the wind momentum-luminosity relationship for different metallicities and show that for a metallicity $Z/Z_\odot \lesssim 0.1$ the relationship displays a large scatter, which depreciates the use of this relationship at the lowest metallicities.

Reference: Astronomy & Astrophysics, in press
Status: Manuscript has been accepted

Weblink: http://lanl.arxiv.org/abs/1406.1288

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Mass loss from inhomogeneous hot star winds III. An effective-opacity formalism for line radiative transfer in accelerating, clumped two-component media, and first results on theory and diagnostics

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Aim: To provide a fast and easy-to-use formalism for treating the reduction in effective opacity associated with optically thick clumps in an accelerating two-component medium. Method: We develop and benchmark effective-opacity laws for continuum and line radiative transfer that bridge the limits of optically thin and thick clumps. We then use this formalism to i) design a simple method for modeling and analyzing UV wind resonance lines in hot, massive stars, and ii) derive simple correction factors to the line force driving the outflows of such stars. Results: Using a vorosity-modified Sobolev with exact integration (vmSEI) method, we show that, for a given ionization factor, UV resonance doublets may be used to analytically predict the upward corrections in empirically inferred mass-loss rates associated with porosity in velocity space (a.k.a. velocity-porosity, or vorosity). However, we also show the presence of a solution degeneracy: in a two-component clumped wind with given inter-clump medium density, there are always two different solutions producing the same synthetic doublet profile. We demonstrate this by application to SiIV and PV in B and O supergiants and derive, for an inter-clump density set to 1 % of the mean density, upward empirical mass-loss corrections of typically factors of either ~5 or ~50, depending on which of the two solutions is chosen. Overall, our results indicate that this solution dichotomy severely limits the use of UV resonance lines as direct mass-loss indicators in current diagnostic models of clumped hot stellar winds. We next apply the effective line-opacity formalism to the standard CAK theory of line-driven winds. A simple vorosity correction factor to the CAK line force is derived, which for normalized velocity filling factor fvel simply scales as fvel^alpha, where alpha characterizes the slope of the CAK line-strength distribution function. By analytic and numerical hydrodynamics calculations, we further show that in cases where vorosity is important at the critical point setting the mass-loss rate, the reduced line force leads to a lower theoretical mass loss, by simply a factor fvel. On the other hand, if vorosity is important only above this critical point, the predicted mass loss is not affected, but the wind terminal speed is reduced, by a factor scaling as fvel^(alpha/(2-2alpha)). This shows that porosity in velocity space can have a significant impact not only on the diagnostics, but also on the dynamics and theory of radiatively driven winds.

Reference: Accepted for publication in Astronomy and Astrophysics. Pre-print available at ArXiv. Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1405.7800

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X-rays from wind-blown bubbles: an XMM-Newton detection of NGC 2359

Svetozar A. Zhekov

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We present an analysis of the XMM-Newton observation of the wind-blown bubble NGC 2359. This is the first detection of this object in X-rays. The X-ray emission of NGC 2359 is soft and originates from a thermal plasma with a typical temperature of kT ~ 0.2 keV. A direct comparison between the one-dimensional hydrodynamic model of wind-blown bubbles and the X-ray spectrum of NGC 2359 suggests a reduced mass-loss rate of the central star in order to provide the correct value of the observed flux. The central star of the nebula, WR 7, is an X-ray source. Its emission is similar to that of other presumably single Wolf-Rayet stars detected in X-rays. The WR 7 spectrum is well represented by the emission from a two-temperature plasma with a cool component of kT ~ 0.6 keV and a hot component of kT ~ 2.7 keV.

Reference: Monthly Notices of the Royal Astronomical Society
Status: Manuscript has been accepted

Weblink: http://arxiv.org/abs/1406.2463

Comments:

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MEETINGS

Second announcement: Magnetism and variability in O stars

17-19 September 2014

Venue: De Rode Hoed, Amsterdam, The Netherlands

Variability is a fundamental property of OB star winds. This variability is not strictly periodic, but cyclic on a timescale that scales with the estimated rotation period of the star. The underlying cause or trigger of this variability is not known.The major time-variable wind features likely find their origin close to, or at the surface of the star, and have been suggested to be connected to non-radial pulsations or bright magnetic star spots.

The past few years have shown very promising new developments, both observationally and theoretically. High-precision space-based photometry reveals rapid variations, incompatible with pulsations, but consistent with the continuous presence of co-rotating bright stellar spots. These spots could be of

magnetic origin; surface magnetic fields have recently been detected in several OB-type stars, and theoretical studies show that magnetic fields can be generated in massive stars.

Understanding the role of magnetic fields and variability in O and early B stars, in the context of their internal structure, stellar winds, and evolution, is a major challenge in massive star research. This is the focus of a 3-day conference to be held in Amsterdam, organized to mark the formal retirement of Huib Henrichs, one of the pioneers of this field of research.

Important dates:

May 15th: Second announcement and registration
June 1st: Deadline abstract submission
June 16th: Deadline block-booking hotels
July 1st: Deadline early payment registration fee
August 1st: Registration closed

Registration:

Please register for participation at your earliest convenience. In case you would like to give an oral presentation, please submit your abstract before June 1st, 2014. Payment of the registration fee can be done electronically through our website. The registration fee is 275 Euro when paid before July 1st, 2014, the fee includes coffee/tea, lunches and the conference dinner; the late registration fee is 325 Euro. The registration will close on August 1st, 2014.

Scientific programme:

We aim for 50-100 participants; rather than having a skeleton program with invited speakers, the community is invited to come forward on their own accord, and the SOC will construct a scientific programme from the input received. So far, over 40 participants have registered and provided a title for a talk or a poster; the current list already promises a very exciting scientific programme. In order to construct the preliminary programme, the participants are requested to submit an abstract (deadline June 1st, 2014) to the SOC (L.Kaper@uva.nl).

Social programme:

-Tuesday September 16:
Public lecture by Huib Henrichs
Welcome reception at Science Park
-Wednesday Sep 17 – Friday Sep 19:
Conference at De Rode Hoed
-Thursday September 18:
Conference dinner
-Saturday September 20:
Social outing

Accommodation:

Amsterdam is a touristic place, so it is recommended to make hotel reservations at your earliest convenience. We have made block bookings at some hotels near the city center (De Rode Hoed is in the city center); the deadline for these block booking (and discount) is June 16th, 2014. Amsterdam Schiphol airport is well connected to the city center by public transport.

Weblink: http://www.astro.uva.nl/ostars/

Email: ostarsws@list.uva.nl

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International Workshop on Wolf-Rayet Stars

1. - 5. June 2015

Venue: Potsdam (Germany)

This workshop is the first conference in a long time that is specifically dedicated to Wolf-Rayet stars. Considerable progress has been made meanwhile in modeling and analyzing their spectra, understanding their evolutionary context, and quantifying their feedback. Nevertheless, major questions remain heavily debated. This workshop shall bring together the experts in the field to discuss its recent progress, open issues, and future perspectives. The meeting should also motivate young scientists for joining the research on Wolf-Rayet stars with their broad astrophysical context.

Weblink: http://www.astro.physik.uni-potsdam.de/~wr2015/

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Living Together: Planets, Host Stars and Binaries

September 8-12, 2014

Venue: Litomyšl, Czech Republic

In celebration of the 100th anniversary of prof. Zdeněk Kopal birth, we are organizing a conference in his hometown with following topics:
•Evolution of angular momentum: Formation of binary stars and of planetary systems.
•Detection of planetary systems. New techniques and new results.
•Results from the space missions for binary stars and exo-planets.
•Evolution of planetary systems. Stability of planetary systems and planetary migrations.
•Internal structure of planets. Planetary atmospheres.
•Planetary systems in binary stars.
•Unsolved problems in structure and evolution of binary stars.
•Directions for further research in binary stars and exo-planets.
•Zdeněk Kopal and his legacy.

Weblink: http://astro.physics.muni.cz/kopal2014

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