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# THE MASSIVE STAR NEWSLETTER

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## Accepted Papers

### INTEGRAL-ISGRI observations of the CygOB2 region: searching for hard X-ray point sources in a region containing several non-thermal emitting massive stars

**De Becker M.[1], Rauw G.[1], Pittard J.M.[2], Sana H.[3], Stevens I.R.[4], Romero G.E.[5,6]**

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2 - School of Physics and Astronomy, The University of Leeds, Woodhouse Lane, Leeds LS2 9JT, UK

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5 - Facultad de Ciencias Astronomícas y Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque, 1900 La Plata, Argentina

6 - Instituto Argentino de Radioastronomía, C.C.5, (1894) Villa Elisa, Buenos Aires, Argentina

Aims: We analyze INTEGRAL-ISGRI data in order to probe the hard X-ray emission (above 20 keV) from point sources in the Cyg OB2 region and to investigate the putative non-thermal high-energy emission from early-type stars (Wolf-Rayet and O-type stars). Among the targets located in the field

of view, we focus on the still unidentified EGRET source 3EG 2033+4118 that may be related to massive stars known to produce non-thermal emission in the radio domain, and on the wide colliding-wind binary WR 140.
Methods: Using a large set of data obtained with the IBIS-ISGRI imager onboard INTEGRAL, we run the OSA software package in order to find point sources in the fully coded field of view of the instrument.
Results: Our data do not allow the detection of a lower-energy counterpart of 3EG J2033+4118 nor of any other new point sources in the field of view, and we derive upper limits on the high-energy flux for a few targets: 3EG J2033+4118, TeV J2032+4130, WR140, WR146 and WR147. The results are discussed in the context of the multiwavelength investigation of these objects.
Conclusions: The upper limits derived are valuable constraints for models aimed at understanding the acceleration of particles in non-thermal emitting massive stars, and of the still unidentified very-high gamma-ray source TeV J2032+4130.

**Reference: Astronomy and Astrophysics**

*On the web at:* `http://arxiv.org/abs/0707.2005`
*Preprints from:* `debecker@astro.ulg.ac.be`

## X-Rays From Massive OB Stars: Thermal Emission From Radiative Shocks

**Svetozar A. Zhekov (1) and Francesco Palla (2)**

(1) Space Research Institute, Sofia, Bulgaria

(2) INAF-Osservatorio Astrofisico di Arcetri, Firenze, Italy

Chandra gratings spectra of a sample of 15 massive OB stars were analyzed under the basic assumption that the X-ray emission is produced in an ensemble of shocks formed in the winds driven by these objects. Shocks develop either as a result of radiation-driven instabilities or due to confinement of the wind by relatively strong magnetic field, and since they are radiative, a simple model of their X-ray emission was developed that allows a direct comparison with observations. According to our model, the shock structures (clumps, complete or fractional shells) eventually become 'cold' clouds in the X-ray sky of the star. As a result, it is expected that for large covering factors of the hot clumps, there is a high probability for X-ray absorption by the 'cold' clouds, resulting in blue-shifted spectral lines. Our analysis has revealed that such a correlation indeed exists for the considered sample of OB stars. As to the temperature characteristics of the X-ray emission plasma, the studied OB stars fall in two groups: (i) one with plasma temperature limited to 0.1-0.4 keV; (ii) the other wtih X-rays produced in plasmas at considerably higher temperatures. We argue that the two groups correspond to different mechanisms for the origin of X-rays: in radiative-driven instability shocks and in magnetically-confined wind shocks, respectively.

**Reference: MNRAS**

*On the web at:* `http://arxiv.org/abs/0708.0085`
*Preprints from:* `zhekovs@colorado.edu`

## Neon Abundances from a Spitzer/IRS Survey of Wolf-Rayet Stars

**R Ignace[1], J Cassinelli[2], G Tracy[2], E Churchwell[2], H Lamers[3]**

[1] Department of Physics, Astronomy, & Geology, East Tennessee State University

[2] Department of Astronomy, University of Wisconsin

[3] Astronomical Institute, Utrecht University

We report on neon abundances derived from it Spitzer high resolution spectral data of eight Wolf-Rayet (WR) stars using the forbidden line of [ionNe3] 15.56 microns. Our targets include four WN stars of subtypes 4–7, and four WC stars of subtypes 4–7. We derive ion fraction abundances *gamma* of $Ne^{2+}$ for the winds of each star. The ion fraction abundance is a product of the ionization fraction $Q_{rmi}$ in stage $i$ and the abundance by number $calA_E$ of element $E$ relative to all nuclei. Values generally consistent with solar are obtained for the WN stars, and values in excess of solar are obtained for the WC stars.

**Reference: Astrophysical Journal**

*On the web at:* `http://www.etsu.edu/physics/ignace/pubs.html`
*Preprints from:* `ignace@etsu.edu`

## Orbital effects on the light curves of eta Car, BP Cru, and other eccentric binaries

**van Genderen, A.M.; Sterken, C.**

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2 Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

We provide observational evidence that Eta Carinae's optical and near-infrared light peak around the periastron passages are in various respects similar to the periastron effects exhibited by other eccentric binaries, and therefore may well have the same physical cause. We list the magnitude of the effect for V380 Cyg = HD187879, V346 Cen = HD101837, V1647 Sgr = HD163708, V560 Car = HD93205, BP Cru = WRA977 and Eta Car = HD93308.

**Reference: IBVS No. 5782 2007**

*On the web at:* `http://www.konkoly.hu/cgi-bin/IBVS?5782`
*Preprints from:* `csterken@vub.ac.be`

## A massive cluster of Red Supergiants at the base of the Scutum-Crux arm

**Ben Davies (1), Don F. Figer (1), Rolf-Peter Kudritzki (2), John MacKenty (3), Francisco Najarro (4) and Artemio Herrero (5)**

1: RIT 2: IfA, Hawaii 3: STScI 4: CSIC, Madrid 5: IAC, Spain

We report on the unprecedented Red Supergiant (RSG) population of a massive young cluster, located at the base of the Scutum-Crux Galactic arm. We identify candidate cluster RSGs based on it 2MASS

photometry and medium resolution spectroscopy. With follow-up high-resolution spectroscopy, we use CO-bandhead equivalent width and high-precision radial velocity measurements to identify a core grouping of 26 physically-associated RSGs – the largest such cluster known to-date. Using the stars' velocity dispersion, and their inferred luminosities in conjuction with evolutionary models, we argue that the cluster has an initial mass of $sim$40,000msun, and is therefore among the most massive in the galaxy. Further, the cluster is only a few hundred parsecs away from the cluster of 14 RSGs recently reported by Figer et al (2006). These two RSG clusters represent 20% of all known RSGs in the Galaxy, and now offer the unique opportunity to study the pre-supernova evolution of massive stars, and the Blue- to Red-Supergiant ratio at uniform metallicity. We use GLIMPSE, MIPSGAL and MAGPIS survey data to identify several objects in the field of the larger cluster which seem to be indicative of recent region-wide starburst activity at the point where the Scutum-Crux arm intercepts the Galactic bulge. Future abundance studies of these clusters will therefore permit the study of the chemical evolution and metallicity gradient of the Galaxy in the region where the disk meets the bulge.

**Reference: To appear in ApJ**

*On the web at:* `http://www.cis.rit.edu/~bxdpci/RSGC2.pdf`
*Preprints from:* `davies@cis.rit.edu`

## The Role of Evolutionary Age and Metallicity in the Formation of Classical Be Circumstellar Disks II. Assessing the Evolutionary Nature of Candidate Disk Systems

**John P. Wisniewski[1], Karen S. Bjorkman[2], Antonio M. Magalhães[3], Jon E. Bjorkman[2], Marilyn R. Meade[4], & Antonio Pereyra[3]**

1 - NASA GSFC; 2 - University of Toledo; 3 - University of Sao Paulo; 4 - University of Wisconsin

We present the first detailed imaging polarization observations of six SMC and six LMC clusters, known to have large populations of B-type stars which exhibit excess H$alpha$ emission, to constrain the evolutionary status of these stars and hence better establish links between the onset of disk formation in classical Be stars and cluster age and/or metallicity. We parameterize the interstellar polarization (ISP) along the lines of sight to these twelve clusters, thereby providing a diagnostic of the fundamental properties of the dust which characterizes their localized interstellar medium. We determine that the ISP associated with the SMC cluster NGC 330 is characterized by a modified Serkowski law with $lambda_{max}$ $sim$4500AA, indicating the presence of smaller than average dust grains. Furthermore, the morphology of the ISP associated with the LMC cluster NGC 2100 suggests that its interstellar environment is characterized by a complex magnetic field.

Removing this interstellar polarization component from our data isolates the presence of any intrinsic polarization; the wavelength dependence of this intrinsic polarization provides a diagnostic of the dominant and any secondary polarigenic agents present, enabling us to discriminate pure gas disk systems, i.e. classical Be stars, from composite gas plus dust disk systems, i.e. Herbig Ae/Be or B[e] stars. Our textitintrinsic polarization results, along with available near-IR color information, strongly supports the suggestion of Wisniewski et al. that classical Be stars are present in clusters of age 5-8 Myr, and contradict assertions that the Be phenomenon only develops in the second half of a B star's main sequence lifetime, i.e. no earlier than 10 Myr. Our data imply that a significant number of B-type stars must emerge onto the zero-age-main-sequence rotating at near-critical rotation rates,

although we can not rule out the possibility that these data instead reveal the presence of a sub-group of the Be phenomenon characterized by sub-critically rotating objects.

Comparing the polarimetric properties of our dataset to a similar survey of Galactic classical Be stars, we find that the prevalence of polarimetric Balmer jump signatures decreases with metallicity. We speculate that these results might indicate that either it is more difficult to form large disk systems in low metallicity environments, or that the average disk temperature is higher in these low metallicity environments. We have characterized the polarimetric signatures of all candidate Be stars in our data sample and find $sim$25% are unlikely to arise from true classical Be star-disk systems. This detection of such a substantial number "contaminants" suggests one should proceed with caution when attempting to determine the role of evolutionary age and/or metallicity in the Be phenomenon purely via 2-CD results.

**Reference: ApJ**

*On the web at:* `http://arxiv.org/abs/0708.0651`
*Preprints from:* `John.P.Wisniewski@nasa.gov`

## Discovery of a New Dusty B[e] Star in the Small Magellanic Cloud

**John P. Wisniewski[1], Karen S. Bjorkman[2], Jon E. Bjorkman[2], and Mark Clampin[1]**

1 - NASA GSFC; 2 - University of Toledo

We present new optical spectroscopic and archival Spitzer IRAC photometric observations of a B-type star in the SMC cluster NGC 346, NGC 346:KWBBe 200. We detect numerous Fe II, [O I], and [Fe II] lines, as well as strong P-Cygni profile H I emission lines in its optical spectrum. The star's near-IR color and optical to IR SED clearly indicate the presence of an infrared excess, consistent with the presence of gas and warm, T $sim$800 K, circumstellar dust. Based on a crude estimate of the star's luminosity and the observed spectroscopic line profile morphologies, we find that the star is likely to be a B-type supergiant. We suggest that NGC 346:KWBBe 200 is a newly discovered B[e] supergiant star, and represents the fifth such object to be identified in the SMC.

**Reference: ApJ**

*On the web at:* `http://arxiv.org/abs/0708.1030`
*Preprints from:* `John.P.Wisniewski@nasa.gov`

## Integral-Field Spectroscopy of the Post Red Supergiant IRC +10420: evidence for an axi-symmetric wind

**Ben Davies (1,2), René D. Oudmaijer (2), Kailash C. Sahu (3)**

1: RIT 2: University of Leeds 3: STScI

We present NAOMI/OASIS adaptive-optics assisted integral-field spectroscopy of the transitional massive hypergiant IRC +10420, an extreme mass-losing star apparently in the process of evolving from a Red Supergiant toward the Wolf-Rayet phase. To investigate the present-day mass-loss geometry of

the star, we study the appearance of the line-emission from the inner wind as viewed when reflected off the surrounding nebula. We find that, contrary to previous work, there is strong evidence for wind axisymmetry, based on the equivalent-width and velocity variations of H*alpha* and Fe sc ii *lambda*6516. We attribute this behaviour to the appearance of the complex line-profiles when viewed from different angles. We also speculate that the Ti sc ii emission originates in the outer nebula in a region analogous to the Strontium Filament of *eta* Carinae, based on the morphology of the line-emission. Finally, we suggest that the present-day axisymmetric wind of IRC +10420, combined with its continued blueward evolution, is evidence that the star is evolving toward the B[e] supergiant phase.

**Reference: To appear in ApJ**

*On the web at:* `http://www.cis.rit.edu/~bxdpci/pubs.html`
*Preprints from:* `davies@cis.rit.edu`

## The Struve-Sahade effect in the optical spectra of O-type binaries I. Main-sequence systems

**N. Linder (1), G. Rauw (1), H. Sana (2), M. De Becker (1), E. Gosset (1)**

(1) Institut d'Astrophysique et de Géophysique, Université de Liège, Bât. B5c, Allée du 6 Août 17, B-4000 Liège, Belgium (2) European Southern Observatory, Alonso de Cordova 3107, Vitacura, Santiago 19, Chile

We present a spectroscopic analysis of four massive binary systems that are known or are good candidates to display the Struve-Sahade effect (defined as the apparent strengthening of the secondary spectrum of the binary when the star is approaching, and the corresponding weakening of the lines when it is receding). We use high resolution optical spectra to determine new orbital solutions and spectral types of HD 165052, HD 100213, HD 159176 and DH Cep. As good knowledge of the fundamental parameters of the considered systems is necessary to examine the Struve-Sahade effect. We then study equivalent width variations in the lines of both components of these binaries during their orbital cycle. In the case of these four systems, variations appear in the equivalent widths of some lines during the orbital cycle, but the definition given above can any longer be valid, since it is now clear that the effect modifies the primary spectrum as much as the secondary spectrum. Furthermore, the lines affected, and the way in which they are affected, depend on the considered system. For at least two of them (HD 100213 and HD 159176) these variations probably reflect the ellipsoidal variable nature of the system.

**Reference: A & A, in press**

*On the web at:* `http://www.arxiv.org/abs/0708.3005`
*Preprints from:* `linder@astro.ulg.ac.be`

## On the X-ray and optical properties of the Be star HD 110432: a very hard-thermal X-ray emitter

**Raimundo Lopes de Oliveira Filho (1,2), Christian Motch (2), Myron A. Smith (3), Ignacio Negueruela (4) and Jose M. Torrejon (4)**

(1) Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Brazil; (2) Observatoire Astronomique de Strasbourg, Université Louis Pasteur, France; (3) Catholic University of America, USA; (4) Universidad de Alicante, Spain

HD 110432 is the first proposed, and best studied, member of a growing group of Be stars with X-ray properties similar to *gamma* Cas. These stars exhibit hard-thermal X-rays that are variable on all measurable timescales. This emission contrasts with the soft emission of "normal" massive stars and with the nonthermal emission of all well known Be/X-ray binaries – so far, all Be + neutron star systems. In this work we present X-ray spectral and timing properties of HD 110432 from three XMM-it Newton observations in addition to new optical spectroscopic observations. Like *gamma* Cas, the X-rays of HD 110432 appear to have a thermal origin, as supported by strongly ionized FeXXV and FeXXVI lines detected in emission. A fluorescent iron feature at 6.4 keV is present in all observations, while the FeXXVI Ly*beta* line is present in two of them. Its X-ray spectrum, complex and time variable, is well described in each observation by three thermal plasmas with temperatures ranging between 0.2–0.7, 3–6, and 16–37 keV. Thus, HD 110432 has the hottest thermal plasma of any known Be star. A sub-solar iron abundance (*sim* 0.3–0.5*times*$Z_{Fe,odot}$) is derived for the hottest plasma, while lines of less excited ions at longer wavelengths are consistent with solar abundances. The star has a moderate 0.2–12 keV luminosity of *sim* 5*times*$10^{32}$,erg,s$^{-1}$. The intensity of the X-ray emission is strongly variable. Recurrent flare-like events on time scales as short as *sim* 10 seconds are superimposed over a basal flux which varies on timescales of *sim* 5–10*times*$10^3$ seconds, followed by similarly rapid hardness variabilities. There is no evidence for coherent oscillations, and an upper limit of *sim* 2.5% is derived on the pulsed fraction for short pulsations from 0.005 to 2.5,Hz. In the optical region the strong and quasi-symmetrical profile of the H*alpha* line (EW *sim* -60 AA) as well as the detection of several metallic lines in emission strongly suggest a dense and/or large circumstellar disk. Also, the double-peaked profiles of metallic lines confirm the nearly edge-on projection of that disk noted recently by Smith & Balona. HD 110432 has several properties reminiscent of the cataclysmic variables such as a very hot X-ray temperature and some of its detailed spectral features. This suggests that it might be a Be star harbouring an accreting white dwarf. On the other hand, recent evidence of magnetic activity reported in the literature of HD 110432 suggests an interaction between the surface of the Be star and its disk can produce the X-rays.

**Reference: A&A, in press**

*On the web at:* `http://arxiv.org/abs/astro-ph/0701767`
*Preprints from:* `rlopes@astro.iag.usp.br`

## Proceedings

# Circumstellar Magnetic Field Diagnostics from Line Polarization

**Richard Ignace (1) and Kenneth G. Gayley (2)**

(1) Physics, Astronomy, and Geology, East Tennessee State University (2) Physics and Astronomy, University of Iowa

Given that dynamically significant magnetic fields in at least some massive stars have now been measured, our contribution addresses the question, to what extent can fields be directly detected in circumstellar gas? The question speaks directly to the very interesting topic of line-driving physics

coupled with magnetized plasmas, and how this coupling produces structure in the wind flow. We focus our attention on weak-field diagnostics. These come in two main types: the Hanle effect, which pertains to coherence effects for linear polarization from line scattering, and the weak longitudinal Zeeman effect, which pertains to circular polarization in lines.

**Reference: to appear in the proceedings of Clumping in Hot Star Winds**

*On the web at:* `http://lanl.arxiv.org/abs/0708.1942`
*Preprints from:* `ignace@etsu.edu`

## Physical Properties of Red Supergiants

**Philip Massey (1), Bertrand Plez (2), Emily M. Levesque (3), K. A. G. Olsen (4), David R Silva (5), and Geoffery C. Clayton (6)**

(1) Lowell Observatory; (2) GRAAL, Universite de Montellier II, CNRS; (3) Instiute for Astronomy, University of Hawaii; (4) Gemini Science Center, NOAO; (5) Thirty Meter Telescope; (6) Dept of Physics and Astronomy, Louisiana State University

Red supergiants (RSGs) are an evolved stage in the life of intermediate massive stars ($< 25M_{\odot}$). For many years their location in the H-R diagram was at variance with the evolutionary models. Using the MARCS stellar atmospheres, we have determined new effective temperatures and bolometric luminosities for RSGs in the Milky Way, LMC, and SMC, and our work has resulted in much better agreement with the evolutionary models. We have also found evidence of significant visual extinctiondue to circumstellar dust. Although in the Milky Way the RSGs contribute only a small fraction($<$1%) of the dust to the interstellar medium (ISM), in starburst galaxies or galaxies at large look-back times, we expect that RSGs may be the main dust source. We are in the process ofextending this work now to RSGs of higher and lower metallicities using the galaxies M31 and WLM.

**Reference: to appear in The Biggest, Baddest, Coolest Stars, ASP Conf Series, ed. D. Luttermoser, B. Smith, and R. Stencel**

*On the web at:* `http://www.lowell.edu/users/massey/tennmasseyp.pdf`
*Preprints from:* `Phil.Massey@lowell.edu`

## The Coolest Stars in the Clouds: Unusual Red Supergiants in the Magellanic Clouds

**Emily M. Levesque (1), Philip Massey (2), K. A. G. Olsen (3), Bertrand Plez (4)**

(1) Institute for Astronomy, University of Hawaii (2) Lowell Observatory (3) National Optical Astronomy Observatories (4) GRAAL, Universite de Montpellier II, CNRS

Red supergiants (RSGs) are a He-burning phase in the evolution of moderately high mass stars (10-25 solar masses). The evolution of these stars, particularly at low metallicities, is still poorly understood. The latest-type RSGs in the Magellanic Clouds are cooler than the current evolutionary tracks allow, occupying the region to the right of the Hayashi limit where stars are no longer in hydrodynamic equilibrium. We have discovered four Cloud RSGs in this region that display remarkably similar

unusual behavior. All of them show considerable variations in their V magnitudes and effective temperatures (and spectral types). Two of these stars, HV 11423 and [M2002] SMC 055188, have been observed in an M4.5 I state, considerably later and cooler than any other supergiant in the SMC. These stars suffer dramatic physical changes on timescales of months - when they are at their warmest, they are also brighter, more luminous, and show an increased amount of extinction. This variable extinction is characteristic of the effects of circumstellar dust, and can be connected with sporadic dust production from these stars in their cooler states. We suggest that these unusual properties are indicative of an unstable (and short-lived) evolutionary phase not previously associated with RSGs, and consider the implications such behavior could have for our understanding of the latest stages of massive star evolution in low-metallicity environments.

**Reference: to appear in The Biggest, Baddest, Coolest Stars, ASP Conf Series, ed. D. Luttermoser, B. Smith, and R. Stencel**

*On the web at:* `http://ifa.hawaii.edu/~emsque/RSGs/levesquee.pdf`
*Preprints from:* `emsque@ifa.hawaii.edu`

# Jobs

## Postdoctoral Research Position in Liège (Belgium)

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Institute of Astrophysics and Geophysics, University of Liège, Allée du 6 août, 17, B-4000 Liège, Belgium

The High-Energy Astrophysics Group of the University of Liège (Belgium) is offering a postdoctoral position to participate in the development of algorithms and software for the data processing concerning the ESA cornerstone mission GAIA. GAIA, expected to be launched in 2012, will perform an all-sky survey providing astrometry and photometry for about one billion stars, and spectroscopy for a subsample. This implies a huge data processing leading to the provisional catalogues. The Liège team is involved in the large consortium responsible for the data processing for this important mission.

The successful applicant will be expected to take responsibilities in the conception of algorithms and of the related softwares dealing with the orbital solutions for spectroscopic binary systems, with the measurements of radial velocities on the basis of GAIA spectra as well as with investigations on the possibility to perform radial velocity measurements from multiple spectra by cross-correlation with templates. The official programming language for GAIA is Java. The applicant should have a PhD in astronomy, or equivalent. Programming skill is of course requested; knowledge of Java is not a prerequisite but will be an advantage. The postdoc will benefit from the partial support of a Java expert. The successful candidate is expected to collaborate with other members of the team and to foster the researches currently performed by the team. Corresponding keywords would be: massive stars (O, Wolf-Rayet,...), massive binaries, orbital motions, winds and colliding-wind objects, optical spectroscopy and variability, X-ray spectroscopy of massive stars.

The appointment is for one year with a possible extension for a second one. The starting date will be around November 1st 2007 or a little earlier. The salary is on the official Belgian public employee pay scale.

Interested persons should send, before October 1st, 2007, their application materials including a curriculum vitae, a summary (one page max.) of past and current research activities, a motivated interest and a full publication list by mail to: Eric Gosset / Gregor Rauw, Institute of Astrophysics and Geophysics, University of Liège, Allée du 6 août, 17, B-4000 Liège, Belgium. For any further inquiry, e-mail : gosset@astro.ulg.ac.be

*Email contact:* `rauw@astro.ulg.ac.be`

*Closing date:* October 1st, 2007

## Post-Doctoral Research Associate in e-MERLIN Science Support

Prof. Raman Prinja
Department of Physics and Astronomy University College London Gower Street London WC1E 6BT England UK

Applications are invited for a 3-year post-doctoral research associate in the Astrophysics group (http://www.ucl.ac.uk/star/) at University College London (http://www.ucl.ac.uk/) to work on the development of science support tools for e-MERLIN and subsequent exploitation of observations. This Leverhulme Trust-funded position is an exciting opportunity to be involved at the early stages of the significantly upgraded e-MERLIN (www.merlin.ac.uk/e-merlin/) radio facility.

The programme is highly cross-disciplinary and involves the development of algorithms, data processing techniques and software to meet a range of applications for e-MERLIN. The research associate will be involved in the commissioning and science verification of e-MERLIN, focusing on the use of e-MERLIN to study the evolution of massive stars. The successful candidate will work with Prof. Prinja and Dr Yates at UCL, and would also be expected to spend extended periods interacting with the e-MERLIN team at Jodrell Bank (Cheshire), under the direction of Dr Garrington and Prof. Diamond.

Candidates should have a PhD or equivalent in astronomy, astrophysics or related subject, together with extensive experience in radio astronomy techniques, and research interests in star formation and evolution. The starting salary will be 26,666 plus 2,572 London Allowance. Further details can be found at www.phys.ucl.ac.uk/people/vacancies. Please contact Prof. Raman Prinja (rkp AT star.ucl.ac.uk) with any informal enquires.

Applications in the form of a full CV and a statement of research interests should be sent to Prof. Raman Prinja, Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK. Applicants should also arrange for two letters of recommendation to be sent by the deadline.

The closing date for the receipt of applications is Friday 28 September 2007.

*Email contact:* `rkp@star.ucl.ac.uk`

*Closing date:* 28 September 2007

# Postdoctoral Research Position in Supernova Studies

Dr. Schuyler Van Dyk
California Institute of Technology 1200 E. California Blvd. MS 220-6 Pasadena, CA 91125 USA

A postdoctoral position in supernova studies is available at the Spitzer Science Center located on the California Institute of Technology campus in Pasadena, California. The successful applicant will work with Dr. Schuyler Van Dyk studying supernovae, their environments in their host galaxies, and characterizing and identifying their stellar progenitors, using Hubble Space Telescope (HST) and Spitzer Space Telescope data. Preference will be given to candidates with experience in optical and/or infrared observations and data analysis. Experience with analysis of HST imaging data and interest in the astrophysics of supernovae are desirable.

The appointment will be for 2 years initially, with the potential for renewal for an additional year, contingent upon availability of funding. Start date to be determined. Qualified candidates must have a PhD prior to starting the position. Applicants should submit a curriculum vitae, list of publications, and names of and contact information for three references to Dr. Van Dyk at the above address, or at vandyk@ipac.caltech.edu, by 1 October, 2007 to receive full consideration.

Caltech is an Affirmative Action/Equal Opportunity Employer. Women, Minorities, Veterans, and Disabled Persons are encouraged to apply.

*Email contact:* `vandyk@ipac.caltech.edu`

*Closing date:* 1 October, 2007