Dear Colleagues,

It is our pleasure to present the 90th issue of the Magellanic Clouds Newsletter. Very exciting results are presented on the Magellanic Stream, and H\textsc{i} structures in general in the LMC, two papers on NGC346, work on star clusters, and a description of the near-infrared IRSF catalogue, amongst many other great results.

Three fantastic postdoctoral positions are open in institutions in the Eastern USA.

The next issue will be distributed on the 1st of February 2008; the deadline for contributions is the 31st of January.

Perhaps a bit early, but we would like to thank everyone very much for their contributions to this year's Newsletters. The Newsletter has grown substantially, and continues to do so. We wish you Happy Holidays (if you are going to have some) and a Great New Year!

Editorially Yours,
Jacco van Loon and Snežana Stanimirović
Star cluster ”infant mortality” in the Small Magellanic Cloud (Redivivus)

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The early evolution of star clusters in the Small Magellanic Cloud (SMC) has been the subject of significant recent controversy, particularly regarding the importance and length of the earliest, largely mass-independent disruption phase (referred to as ”infant mortality”). Here, we take a fresh approach to the problem, using an independent, homogeneous data set of $UBVR$ imaging observations, from which we obtain the SMC’s cluster age and mass distributions in a self-consistent manner. We conclude that the (optically selected) SMC star cluster population has undergone at most $\sim 30$ per cent ($1\sigma$) infant mortality between the age range from about $(3-10)$ Myr, to that of approximately $(40-160)$ Myr. We rule out a 90 per cent cluster mortality rate per decade of age (for the full age range up to $10^9$ yr) at a $>6\sigma$ level. We independently affirm this scenario based on the age distribution of the SMC cluster sample.

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A new calibration of Galactic Cepheid Period-Luminosity relations from B to K bands, and a comparison to LMC PL relations


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The universality of the Cepheid Period-Luminosity relations has been under discussion since metallicity effects have been assumed to play a role in the value of the intercept and, more recently, of the slope of these relations. The goal of the present study is to calibrate the Galactic PL relations in various photometric bands (from B to K) and to compare the results to the well-established PL relations in the LMC. We use a set of 59 calibrating stars, the distances of which are measured using five different distance indicators: Hubble Space Telescope and revised Hipparcos parallaxes, infrared surface brightness and interferometric Baade-Wesselink parallaxes, and classical Zero-Age-Main-Sequence-fitting parallaxes for Cepheids belonging to open clusters or OB stars associations. A detailed discussion of absorption corrections and projection factor to be used is given. We find no significant difference in the slopes of the PL relations between LMC and our Galaxy. We conclude that the Cepheid PL relations have universal slopes in all photometric bands, not depending on the galaxy under study (at least for LMC and Milky Way). The possible zero-point variation with metal content is not discussed in the present work, but an upper limit of 18.50 for the LMC distance modulus can be deduced from our data.

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A Problem with the Clustering of Recent Measures of the Distance to the Large Magellanic Cloud

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The distance to the Large Magellanic Cloud (LMC) has long been of key importance for the distance ladder and the distances to all galaxies, and as such many groups have provided measurements of its distance modulus ($\mu$) with many methods and various means of calibrating each method. Before the year 2001, the many measures spanned a wide range (roughly $18.1 < \mu < 18.8$) with the quoted error bars being substantially smaller than the spread, and hence the consensus conclusion being that many of the measures had their uncertainties being dominated by unrecognized systematic problems. In 2001, the Hubble Space Telescope Key Project (HSTKP) on the distance scale made an extensive analysis of earlier results and adopted the reasonable conclusion that the distance modulus is $18.50 \pm 0.10$ mag, and the community has generally accepted this widely popularized value. After 2002, 31 independent papers have reported new distance measures to the LMC, and these cluster tightly around $\mu = 18.50$ mag. Indeed, these measures cluster too tightly around the HSTKP value, with 68% of the measures being within $0.5-\sigma$ of 18.50 mag. A Kolmogorov-Smirnov test proves that this concentration deviates from the expected Gaussian distribution at a $>3-\sigma$ probability level. This concentration is a symptom of a worrisome problem. Interpretations considered include correlations between papers, widespread over-estimation of error bars, and bandwagon effects. This note is to alert workers in the field that this is a serious problem that should be addressed.

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The AGB stars of the intermediate-age LMC cluster NGC1846. Variability and age determination

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Aims: To investigate variability and to model the pulsational behaviour of AGB variables in the intermediate-age LMC cluster NGC1846.

Methods: Our own photometric monitoring has been combined with data from the MACHO archive to detect 22 variables among the cluster’s AGB stars and to derive pulsation periods. According to the global parameters of the cluster we construct pulsation models taking into account the effect of the C/O ratio on the atmospheric structure. In particular, we have used opacities appropriate for both O-rich stars and carbon stars in the pulsation calculations.

Results: The observed P-L-diagram of NGC1846 can be fitted using a mass of the AGB stars of about $1.8 M_\odot$. We show that the period of pulsation is increased when an AGB star turns into a carbon star. Using the mass on the AGB defined by the pulsational behaviour of our sample we derive a cluster age of $1.4 \times 10^9$ years. This is the first time the age of a cluster has been derived from the variability of its AGB stars. The carbon stars are shown to be a mixture of fundamental and first overtone radial pulsators.

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The stellar mass distribution in the giant star forming region NGC 346

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Deep F555W and F814W Hubble Space Telescope ACS images are the basis for a study of the present day mass function (PDMF) of NGC 346, the largest active star forming region in the Small Magellanic Cloud (SMC). We find a PDMF slope of $\Gamma = -1.43 \pm 0.18$ in the mass range 0.8-60 $M_\odot$, in excellent agreement with the Salpeter Initial Mass Function (IMF) in the solar neighborhood. Caveats on the conversion of the PDMF to the IMF are discussed.

The PDMF slope changes, as a function of the radial distance from the center of the NGC 346 star cluster, indicating a segregation of the most massive stars. This segregation is likely primordial considering the young age ($\approx 3$ Myr) of NGC 346, and its clumpy structure which suggests that the cluster has likely not had sufficient time to relax.

Comparing our results for NGC 346 with those derived for other star clusters in the SMC and the Milky Way (MW), we conclude that, while the star formation process might depend on the local cloud conditions, the IMF does not seem to be affected by general environmental effects such as galaxy type, metallicity, and dust content.

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NGC 346 in the Small Magellanic Cloud. III. Recent star formation and stellar clustering properties in the bright H\textsc{ii} region N 66

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In the third part of our photometric study of the star-forming region NGC 346/N 66 and its surrounding field in the Small Magellanic Cloud (SMC), we focus on the large number of low-mass pre-main sequence (PMS) stars revealed by the Hubble Space Telescope Observations with the Advanced Camera for Surveys. We investigate the origin of the observed broadening of the pre-main sequence population in the $V-J$, $V$ CMD. The most likely explanations are either the presence of differential reddening or an age spread among the young stars. Assuming the latter, simulations indicate that we cannot exclude the possibility that stars in NGC 346 might have formed in two distinct events occurring about 10 and 5 Myr ago, respectively. We find that the PMS stars are not homogeneously distributed across NGC 346, but instead are grouped in at least five different clusters. On spatial scales from 0.8\arcsec to 8\arcsec (0.24 to 2.4 pc at the distance of the SMC) the clustering of the PMS stars as computed by a two-point angular correlation function is self-similar with a power law slope $\gamma \approx -0.3$. The clustering properties are quite similar to Milky Way star forming regions like Orion OB or $\rho$ Ophi. Thus molecular cloud fragmentation in the SMC seems to proceed on the same spatial scales as in the Milky Way. This is remarkable given the differences in metallicity and hence dust content between SMC and Milky Way star forming regions.

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Pulsating B and Be stars in the Small Magellanic Cloud

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Context: The current models of stellar pulsation do not predict the presence of instability strips in the B spectral domain at very low metallicities. As the metallicity of the SMC is lower than \( Z = 0.005 \), it constitutes a very suitable object to test these predictions.

Aims: To investigate the existence of B-type pulsators at low metallicities, searching for short-term periodic variability in absorption-line B and Be stars in the SMC. The analysis has been performed in a sample of 313 B and Be stars with accurately determined fundamental astrophysical parameters.

Methods: Photometric light curves of the MACHO project have been analyzed using standard Fourier techniques and linear and non-linear least squares fitting methods. The position of the pulsating stars in the HR diagram has been used to ascertain their nature and to map the instability regions in the SMC.

Results: We have detected 9 absorption-line B stars showing short-period variability, two among them being multi-periodic. One star is a beta Cephei variable and the remaining 8 are SPB stars. The SPB instability strip in the SMC is shifted towards higher temperatures with respect to the Galaxy. In the Be star sample, 32 stars are short-period variables, 20 among them multiperiodic. 4.9% of B stars and 25.3% of Be stars are pulsating stars.

Conclusions: beta Cephei and SPB stars do exist at the SMC metallicity. The fraction of SPB stars in the SMC is similar or only slightly lower than in the Galaxy. Conversely, the fraction of pulsating Be stars in the SMC is significantly lower than in the Galaxy. As in the Galaxy, the fraction of pulsating Be stars in the SMC is much higher than the fraction of pulsating absorption-line B stars.

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The Chemical Enrichment History of the Large Magellanic Cloud

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Ca II triplet spectroscopy has been used to derive stellar metallicities for individual stars in four LMC fields situated at galactocentric distances of 3°, 5°, 6° and 8° to the north of the Bar. Observed metallicity distributions show a well defined peak, with a tail toward low metallicities. The mean metallicity remains constant until 6° ([Fe/H]~ –0.5 dex), while for the outermost field, at 8°, the mean metallicity is substantially lower than in the rest of the disk ([Fe/H]~ –0.8 dex). The combination of spectroscopy with deep CCD photometry has allowed us to break the RGB age–metallicity degeneracy and compute the ages for the objects observed spectroscopically. The obtained age–metallicity relationships for our four fields are statistically indistinguishable. We conclude that the lower mean metallicity in the outermost field is a consequence of it having a lower fraction of intermediate-age stars, which are more metal-rich than the older stars. The disk age–metallicity relationship is similar to that for clusters. However, the lack of objects with ages between 3 and 10 Gyr is not observed in the field population. Finally, we used data from the literature to derive consistently the age–metallicity relationship of the bar. Simple chemical evolution models have been used to reproduce the observed age–metallicity relationships with the purpose of investigating which mechanism has participated in the evolution of the disk and bar. We find that while the disk age–metallicity relationship is well reproduced by close-box models or models with a small degree of outflow, that of the bar is only reproduced by models with combination of infall and outflow.

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The IRSF Magellanic Clouds Point Source Catalog

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We present a near-infrared (JHKs) photometric catalog, including 14811185 point sources for a 40 deg² area of the Large Magellanic Cloud, 2769682 sources for an 11 deg² area of the Small Magellanic Cloud, and 434145 sources for a 4 deg² area of the Magellanic Bridge. The 10σ limiting magnitudes are 18.8, 17.8, and 16.6 mag at J, H, and Ks, respectively. The photometric and astrometric accuracies for bright sources are 0.03-0.04 mag and 0.100, respectively. Based on the catalog, we also present (1) spatial distributions, (2) luminosity functions, (3) color-color diagrams, and (4) color-magnitude diagrams for point sources toward the Magellanic Clouds.

Available from http://pasj.asj.or.jp/v59/n3/590315/

The Distance of the First Overtone RR Lyrae Variables in the MACHO LMC Database: A New Method to Correct for the Effects of Crowding

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Previous studies have indicated that many of the RR Lyrae Variables in the LMC have properties similar to the ones in the Galactic globular cluster M3. Assuming that the M3 RR Lyrae variables follow the same relationships among period, temperature, amplitude and Fourier phase parameter φ31 as their LMC counterparts, we have used the M3 φ31 — log P relation to identify the M3-like unevolved first overtone RR Lyrae (RR1) variables in 16 MACHO fields near the LMC bar. The temperatures of these variables were calculated from the M3 log P — log Te relation so that the extinction could be derived for each star separately. Since blended stars have lower amplitudes for a given period, the period-amplitude relation should be a useful tool for determining which stars are affected by crowding. We find that the low amplitude LMC stars are brighter than the stars that fit the M3 relation and we estimate that at least 40% of the stars are blended. Simulated data for three of the crowded stars illustrate that an unresolved companion with V ~ 20.5 could account for the observed amplitude and magnitude. We derive a corrected mean apparent magnitude ⟨V0⟩ = 19.01 ± 0.10 (extinction) ±0.02(calibration) for the 51 uncrowded unevolved M3-like RR1 variables. Assuming that the unevolved RR1 variables in M3 have a mean absolute magnitude MV = 0.52 ± 0.02 leads to an LMC distance modulus of 18.49 ± 0.11.

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Period-luminosity (PL) relations of variable red giants in the Large (LMC) and Small Magellanic Clouds (SMC) are presented. The PL diagrams are plotted in three planes: log $P$ - $K_s$, log $P$ - $W_{JK}$, and log $P$ - $W_I$, where $W_{JK}$ and $W_I$ are reddening free Wesenheit indices. Fourteen PL sequences are distinguishable, and some of them consist of three closely spaced ridges. Each of the sequences is fitted with a linear or quadratic function. The similarities and differences between the PL relations in both galaxies are discussed for four types of red giant variability: OGLE Small Amplitude Red Giants (OSARGs), Miras and Semiregular Variables (SRVs), Long Secondary Periods (LSPs) and ellipsoidal variables.

We propose a new method of separating OSARGs from non-variable stars and SRVs. The method employs the position in the reddening-free PL diagrams and the characteristic period ratios of these multiperiodic variables. The PL relations for the LMC OSARG are compared with the calculated relations for RGB models along isochrones of relevant ages and metallicities. We also compare measured periods and amplitudes of the OSARGs with predictions based on the relations valid for less luminous solar-like pulsators.

Miras and SRVs seem to follow PL relation of the same slopes in the LMC and SMC, while for LSP and ellipsoidal variables slopes in both galaxies are different. The PL sequences defined by LSP variables and binary systems overlap in the whole range of analyzed wavebands. We put forward new arguments for the binary star scenario as an explanation of the LSP variability and elaborate on it further. The measured pulsation to orbital period ratio implies nearly constant ratio of the star radius to orbital distance, $R/A \approx 0.4$, as we find. Combined effect of tidal friction and mass loss enhanced by the low-mass companion may explain why such a value is preferred.

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The poorly constrained cluster disruption time-scale in the Large Magellanic Cloud

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We use Monte-Carlo simulations, combined with homogeneously determined age and mass distributions based on multi-wavelength photometry, to constrain the cluster formation history and the rate of bound cluster disruption in the Large Magellanic Cloud (LMC) cluster system. We evolve synthetic star cluster systems formed with a power-law initial cluster mass function (ICMF) of spectral index $\alpha = -2$ assuming different cluster disruption time-scales. For each of these disruption time-scales we derive the corresponding cluster formation rate (CFR) required to reproduce the observed cluster age distribution. We then compare, in a Poissonian $\chi^2$ sense, model mass distributions and model two-dimensional distributions in log(mass) vs. log(age) space of the detected surviving clusters to the observations. Because of the bright detection limit ($M_V^{lim} \approx -4.7$ mag) above which the observed cluster sample is complete, one cannot constrain the characteristic disruption time-scale for a $10^4 \, M_\odot$ cluster, $t_{4}^{\text{dis}}$ (where the disruption time-scale depends on cluster mass as $t_{\text{dis}} = t_{4}^{\text{dis}} (M_{cl}/10^4 M_\odot)^{0.62}$), to better than $t_{4}^{\text{dis}} \geq 1$ Gyr. We conclude that the CFR has increased from 0.3 clusters Myr$^{-1}$ 5 Gyr ago, to a present rate of $(20 - 30)$ clusters Myr$^{-1}$. For older ages the derived CFR depends sensitively on our assumption of the underlying CMF shape. If we assume a universal Gaussian ICMF, then the CFR has increased steadily over a Hubble time from $\sim 1$ cluster Gyr$^{-1}$ 15 Gyr ago to its present value. If
the ICMF has always been a power law with a slope close to $\alpha = -2$, the CFR exhibits a minimum some 5 Gyr ago, which we tentatively identify with the well-known age gap in the LMC's cluster age distribution.

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Statistical analysis of neutrino events from SN 1987A neutrino burst: estimation of the electron antineutrino mass

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The method of the statistical sample moments was used for the analysis of neutrino events from SN 1987A burst in Cherenkov detectors. In particular the coefficients of correlation $Q(E, t)$ between the energies $E$ of electron antineutrinos emitted by star and the ejection instants $t$ of for neutrino events recorded by Cherenkov water detectors of KII and IMB collaborations were calculated. $Q(E, t)$ values depend on the assumed mass of neutrino. Modern model of the gravitational stellar core collapse with an accretion phase predicts the low level of such correlation $Q(E, t)$ averaged with respect to neutrino burst. On condition that empirical $Q(E, t)$ values equal the theoretical model quantities one can obtain $22 \pm 10$ eV c$^{-2}$ as an estimate of the nonzero neutrino mass. The error of this estimate implies that neutrino mass less than 2 eV c$^{-2}$ is unlikely. The laboratory data of the tritium beta-decay agree adequately with the presented astrophysical estimate provided that the anomalous structure near the end point of beta-spectrum is taken into account.

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Sub-millimeter Observations of Giant Molecular Clouds in the Large Magellanic Cloud: Temperature and Density as Determined from $J = 3 - 2$ and $J = 1 - 0$ transitions of CO

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We have carried out sub-mm $^{12}$CO($J = 3-2$) observations of 6 giant molecular clouds (GMCs) in the Large Magellanic
Cloud (LMC) with the ASTE 10m sub-mm telescope at a spatial resolution of 5 pc and very high sensitivity. We have identified 32 molecular clumps in the GMCs and revealed significant details of the warm and dense molecular gas with $n(H_2) \sim 10^{3-5} \, \text{cm}^{-3}$ and $T_{\text{kin}} \sim 60$ K. These data are combined with $^{12}\text{CO}(J = 1 - 0)$ and $^{13}\text{CO}(J = 1 - 0)$ results and compared with LVG calculations. We found that the ratio of $^{12}\text{CO}(J = 3 - 2)$ to $^{12}\text{CO}(J = 1 - 0)$ emission is sensitive to and is well correlated with the local Hα flux. We interpret that differences of clump properties represent an evolutionary sequence of GMCs in terms of density increase leading to star formation. Type I and II GMCs (starless GMCs and GMCs with HII regions only, respectively) are at the young phase of star formation where density does not yet become high enough to show active star formation and Type III GMCs (GMCs with HII regions and young star clusters) represents the later phase where the average density is increased and the GMCs are forming massive stars. The high kinetic temperature correlated with Hα flux suggests that FUV heating is dominant in the molecular gas of the LMC.

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Testing the nonlinearity of the BVIcJHKs period-luminosity relations for the Large Magellanic Cloud Cepheids

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A number of recent works have suggested that the period-luminosity (PL) relation for the Large Magellanic Cloud (LMC) Cepheids exhibits a controversial nonlinear feature with a break period at 10 days. Therefore, the aim of this Research Note is to test the linearity/nonlinearity of the PL relations for the LMC Cepheids in BVIcJHKs band, as well as in the Wesenheit functions. We show that simply comparing the long and short period slopes, together with their associate d standard deviations, leads to a strictly larger error rate than applying rigorous statistical tests such as the F-test. We applied various statistical tests to the current published LMC Cepheid data. These statistical tests include the F-test, the testimator test, and the Schwarz information criterion (SIC) method. The results from these statistical tests strongly suggest that the LMC PL relation is nonlinear in BVIcJHK band but linear in the Ks band and in the Wesenheit functions. Using the properties of period-color relations at maximum light and multi-phase relations, we believe that the nonlinear PL relation is not caused by extinction errors.

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Spectral analysis of LMC X-2 with XMM/Newton: unveiling the emission process in the extragalactic Z-source.

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We present the results of the analysis of an archival observation of LMC X-2 performed with XMM/Newton. The spectra taken by high-precision instruments have never been analyzed before. We find an X-ray position for the source that is inconsistent with the one obtained by ROSAT, but in agreement with the Einstein position and that of the optical counterpart. The correlated spectral and timing behaviour of the source suggests that the source is probably in the normal branch of its X-ray color-color diagram. The spectrum of the source can be fitted with a blackbody with a temperature 1.5 keV plus a disk blackbody at 0.8 keV. Photoelectric absorption from neutral matter has an equivalent hydrogen column of $4 \times 10^{20} \, \text{cm}^{-2}$. An emission line, which we identify as the Oviii Lyman-α line, is detected, while no feature due to iron is detected in the spectrum. We argue that the emission of this source can be straightforwardly
interpreted as a sum of the emission from a boundary layer between the NS and the disc and a blackbody component coming from the disc itself. Other canonical models that are used to fit Z-sources do not give a satisfactory fit to the data. The detection of the O\textsc{viii} emission line (and the lack of detection of lines in the iron region) can be due to the fact that the source lies in the Large Magellanic Cloud.

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Spitzer SAGE Observations of Large Magellanic Cloud Planetary Nebulae

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We present IRAC and MIPS images and photometry of a sample of previously known planetary nebulae (PNe) from the SAGE survey of the Large Magellanic Cloud (LMC) performed with the Spitzer Space Telescope. Of the 233 known PNe in the survey field, 185 objects were detected in at least two of the IRAC bands, and 161 detected in the MIPS 24 \textmu m images. Color-color and color-magnitude diagrams are presented using several combinations of IRAC, MIPS, and 2MASS magnitudes. The location of an individual PN in the color-color diagrams is seen to depend on the relative contributions of the spectral components which include molecular hydrogen, polycyclic aromatic hydrocarbons (PAHs), infrared forbidden line emission from the ionized gas, warm dust continuum, and emission directly from the central star. The sample of LMC PNe is compared to a number of Galactic PNe and found to not significantly differ in their position in color-color space. We also explore the potential value of IR PNe luminosity functions (LFs) in the LMC. IRAC LFs appear to follow the same functional form as the well-established [O\textsc{iii}] LFs although there are several PNe with observed IR magnitudes brighter than the cut-offs in these LFs.

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and from http://www.cfa.harvard.edu/irac/publications/

Structure of Supergiant Shells in the Large Magellanic Cloud

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Nine supergiant shells (SGSs) have been identified in the Large Magellanic Cloud (LMC) based on H-\alpha images, and twenty-three SGSs have been reported based on H\textsc{i} 21-cm line observations, but these sets do not always identify the same structures. We have examined the physical structure of the optically identified SGSs using H\textsc{i} channel maps
and P-V diagrams to analyze the gas kinematics. There is good evidence for seven of the nine optically identified SGSs to be true shells. Of these seven H-α SGSs, four are the ionized inner walls of H\textsubscript{i} SGSs, while three are an ionized portion of a larger and more complex H\textsubscript{i} structure. All of the H-α SGSs are identified as such because they have OB associations along the periphery or in the center, with younger OB associations more often found along the periphery. After roughly 12 Myrs, if no new OB associations have been formed a SGS will cease to be identifiable at visible wavelengths. Thus, the presence and location of ionizing sources is the main distinction between shells seen only in H\textsubscript{i} and those also seen in H-α. Based on our analysis, H-α observations alone cannot unambiguously identify SGSs, especially in distant galaxies.

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Probing Elemental Abundances in SNR 1987A Using XMM-Newton

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We report on the latest (2007 Jan) observations of supernova remnant (SNR) 1987A from the XMM-Newton mission. Since the 2003 May observations of Haberl et al. (2006), 11 emission lines have experienced increases in flux by factors \(\sim 3\) to \(10\) (6 \(\pm\) 0.6 on average), with the 775 eV line of O\textsubscript{viii} showing the greatest increase. Overall, we are able to make Gaussian fits to 17 emission lines in the RGS spectra and obtain line fluxes; we have observed 6 lines of Fe\textsubscript{xvii} and Fe\textsubscript{xviii} previously unreported by XMM-Newton. A two-shock model representing plasmas in non-equilibrium ionization is fitted to the EPIC-pn spectra, yielding temperatures of \(\sim 0.4\) and \(\sim 3\) keV, as well as elemental abundances for N, O, Ne, Mg, Si, S and Fe.

We demonstrate that the abundance ratio of N and O can be constrained to \(\leq 20\%\) accuracy (N/O = 1.17 \(\pm\) 0.20). Within the same confidence interval, the same analysis suggests that the C+N+O abundance varies from \(\sim 1.1\) to \(1.4 \times 10^{-4}\), verifying the Chandra finding by Zhekov et al. (2006) that the C+N+O abundance is lower by a factor \sim 2 compared to the value obtained in the optical/ultraviolet study by Lundqvist & Fransson (1996). Normalizing our obtained abundances by the Large Magellanic Cloud (LMC) values of Hughes, Hayashi & Koyama (1998), we find that O, Ne, Mg and Fe are under-abundant, while Si and S are over-abundant, consistent with the findings of Aschenbach (2007). Such a result has implications for both the single-star and binary accretion/merger models for the progenitor of SNR 1987A. In the context of the binary merger scenario proposed by Morris & Podsiadlowski (2006, 2007), material forming the inner, equatorial ring was expelled after the merger, implying that either our derived Fe abundance is inconsistent with typical LMC values or that iron is under-abundant at the site of Sanduleak \(-69^\circ 202\).

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IRAC Observations of CO $J = 4 \rightarrow 3$ High-Velocity Cloud in the 30 Doradus Complex in the Large Magellanic Cloud

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We present the results of $^{12}$CO $J = 2 \rightarrow 1$ observations of the X-ray–bright giant shell complex 30 Doradus in the
Large Magellanic Cloud (LMC) using the Antarctic Submillimeter Telescope and Remote Observatory (AST/RO). This is the one of the largest H\textsuperscript{ii} complexes in the Local Group. We compare the \(^{12}\text{CO} \ J = 2 \rightarrow 1\) observations against previously made \(^{12}\text{CO} \ J = 4 \rightarrow 3\) observations and analyze the spatial distribution of young stellar objects (YSOs) within the cloud using the Spitzer IRAC observations of the 30 Doradus complex. Both peaks of \(^{12}\text{CO} \ J = 2 \rightarrow 1\) and \(J = 4 \rightarrow 3\) emitting clouds coincide with the densest region of the filaments in which multiple shells are colliding. The YSOs are clustered in the southern ridge of the warm and dense molecular gas clouds traced by \(^{12}\text{CO} \ J = 4 \rightarrow 3\), indicating a filamentary structure of star formation throughout 30 Doradus. We also find an excess of Class I YSO candidates close to the clouds, which likely represent the most recent phase of star formation in this region. This is a region where the triggered star formation has actually occurred, and newly formed stars may have produced such a high-velocity outflow through interacting with the surrounding molecular cloud material.

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A Catalog of H\textsubscript{i} Clouds in the Large Magellanic Cloud

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A 21 cm neutral hydrogen interferometric survey of the Large Magellanic Cloud (LMC) combined with the Parkes multibeam H\textsubscript{i} single-dish survey clearly shows that the H\textsubscript{i} gas is distributed in the form of clumps or clouds. The H\textsubscript{i} clouds and clumps have been identified using a thresholding method with three separate brightness temperature thresholds (T\textsubscript{b}). Each catalog of H\textsubscript{i} cloud candidates shows a power-law relationship between the sizes and the velocity dispersions of the clouds roughly following the Larson law scaling \(\sigma_v \propto R^{0.3}\), with steeper indices associated with dynamically hot regions. The clouds in each catalog have roughly constant virial parameters as a function of mass, suggesting that the clouds are all in roughly the same dynamical state, but the values of the virial parameter are significantly larger than unity, showing that turbulent motions dominate gravity in these clouds. The mass distribution of the clouds is a power law with differential indices between \(-1.6\) and \(-2.0\) for the three catalogs. In contrast, the distribution of mean surface densities is a lognormal distribution.

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Topology of H\textsubscript{i} Gas Distribution in the Large Magellanic Cloud

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We have analyzed the H\textsubscript{i} aperture synthesis image of the Large Magellanic Cloud (LMC), using an objective and quantitative measure of topology to understand the H\textsubscript{i} distribution, which hosts a number of holes and clumps of various sizes, in the interstellar medium. The H\textsubscript{i} distribution shows different topologies at four different chosen
scales. At the smallest scales explored (19-29 pc), the H\textsc{i} mass is distributed in such a way that numerous clumps are embedded on top of a low-density background. At larger scales, from 73 to 194 pc, it shows a generic hole topology. These holes might have been formed mainly by stellar winds from hot stars. At scales from 240 to 340 pc, slightly above the disk scale height of the gaseous disk, major clumps in the H\textsc{i} map change the distribution to have a slight clump topology. These clumps include the giant cloud associations in the spiral arms and the thick filaments surrounding superholes. At the largest scales studied (390-485 pc), the hole topology is present again. Responsible for the hole topology at this scale are a few superholes that seem to be mainly associated with supernova explosions in the outer disk. The gaps between the bar and the spiral arms have a minor effect on the topology at this scale.

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**The Source of the Ionization along the Magellanic Stream**

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Since its discovery in 1996, the source of the bright H-\alpha emission (up to 750 mR) along the Magellanic Stream has remained a mystery. There is no evidence of ionising stars within the H\textsc{i} stream, and the extended hot halo is far too tenuous to drive strong shocks into the clouds. We now present a hydrodynamical model that explains the known properties of the H-\alpha emission and provides new insights on the lifetime of the Stream clouds. The upstream clouds are gradually disrupted due to their interaction with the hot halo gas. The clouds that follow plough into gas ablated from the upstream clouds, leading to shock ionisation at the leading edges of the downstream clouds. Since the following clouds also experience ablation, and weaker (100-200 mR) is quite extensive, a disruptive cascade must be operating along much of the Stream. In our model, the clouds are evolving on timescales of 100-200 Myr, such that the Stream must be replenished by the Magellanic Clouds at a fairly constant rate. The ablated material falls onto the Galaxy as a warm drizzle which suggests that diffuse ionized gas at $10^4$ K may be an important constituent of galactic accretion. The observed H-\alpha emission provides a new constraint on the rate of disruption of the Stream and, consequently, the infall rate of metal-poor gas onto the Galaxy. When the ionized component of the Stream is fully accounted for, the rate of gas accretion is 0.4 $M_\odot$ yr\textsuperscript{-1}, roughly twice the rate deduced from H\textsc{i} observations alone.


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**The Magellanic impact: Collision between the outer Galactic H\textsc{i} disk and the leading arms of the Magellanic stream**

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We show that collisions between the outer Galactic H\textsc{i} disk and the leading arms (LAs) of the Magellanic stream (MS) can create giant H\textsc{i} holes and chimney-like structures in the disk. Based on the results of our N-body simulations on the last 2.5 Gyr evolution of the Large and Small Magellanic Clouds (LMC and SMC, respectively) interacting with the Galaxy, we investigate when and where the LAs can pass through the Galactic plane after the MS formation. We then investigate hydrodynamical interaction between LAs and the Galactic H\textsc{i} disk (“the Magellanic impact”) by using our new hydrodynamical simulations with somewhat idealized models of the LAs. We find that about 1-3% of the initial gas mass of the SMC, which consists of the LAs, can pass through the outer part ($R = 20-35$ kpc) of the Galactic H\textsc{i} disk about 0.2 Gyr ago. We also find that the Magellanic impact can push out some fraction ($\sim 1\%$) of
Geometrodynamical Distances to the Galaxy’s Hydrogen Streams

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We present a geometrodynamical method for determining distances to orbital streams of H\textsubscript{i} gas in the Galaxy. The method makes use of our offset from the Galactic centre and assumes that the gas comprising the stream nearly follows a planar orbit about the Galactic centre. We apply this technique to the Magellanic Stream and determine the distances to all points along it; a consistency check shows that the angular momentum is approximately constant. Applying this technique to the Large Magellanic Cloud itself gives an independent distance which agrees within its accuracy of around 10%. Relaxing the demand for exact conservation of energy and angular momentum at all points along the stream allows for an increase in orbital period between the lagging end and the front end led by the Magellanic Clouds. Similar methods are applicable to other long streams of high-velocity clouds, provided they also nearly follow planar orbits; these would allow otherwise unknown distances to be determined.

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The Distances to Open Clusters from Main-Sequence Fitting. IV. Galactic Cepheids, the LMC, and the Local Distance Scale

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We derive the basic properties of seven Galactic open clusters containing Cepheids and construct their period-luminosity (P-L) relations. For our cluster main-sequence fitting we extend previous Hyades-based empirical color-temperature corrections to hotter stars using the Pleiades as a template. We use BVI\textsubscript{C}JHK\textsubscript{s} data to test the reddening law, and include metallicity effects to perform a more comprehensive study for our clusters than prior efforts. The ratio of total to selective extinction $R_V$ that we derive is consistent with expectations. Assuming the LMC P-L slopes, we find $\langle M_V \rangle = -3.93 \pm 0.07$ (statistical) $\pm 0.14$ (systematic) for 10-day period Cepheids, which is generally fainter than those in previous studies. Our results are consistent with recent HST and Hipparcos parallax studies when using the Wesenheit magnitudes $W(VI)$. Uncertainties in reddening and metallicity are the major remaining sources of error in the V-band P-L relation, but a higher precision could be obtained with deeper optical and near-infrared cluster photometry. We derive distances to NGC 4258, the LMC, and M33 of $(m - M)_0 = 29.28 \pm 0.10$, $18.34 \pm 0.06$, and $24.55 \pm 0.28$, respectively, with an additional systematic error of 0.16 mag in the P-L relations. The distance to NGC 4258 is in good agreement with the geometric distance derived from water masers [$\Delta (m - M)_0 = 0.01 \pm 0.24$]; our value for M33 is less consistent with the distance from an eclipsing binary [$\Delta (m - M)_0 = 0.37 \pm 0.34$]; our LMC distance is moderately shorter than the adopted distance in the HST Key Project, which formally implies an increase in the Hubble constant of 7%–8%.

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X-Ray Emitting Ejecta of Supernova Remnant N132D

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The brightest supernova remnant in the Magellanic Clouds, N132D, belongs to the rare class of oxygen-rich remnants, about a dozen objects that show optical emission from pure heavy-element ejecta. They originate in explosions of massive stars that produce large amounts of O, although only a tiny fraction of that O is found to emit at optical wavelengths. We report the detection of substantial amounts of O at X-ray wavelengths in a recent 100 ks Chandra ACIS observation of N132D. A comparison between subarcsecond-resolution Chandra and Hubble images reveals a good match between clumpy X-ray and optically emitting ejecta on large (but not small) scales. Ejecta spectra are dominated by strong lines of He- and H-like O; they exhibit substantial spatial variations partially caused by patchy absorption within the LMC. Because optical ejecta are concentrated in a 5 pc radius elliptical expanding shell, the detected ejecta X-ray emission also originates in this shell.

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Conference Papers

On the behaviour of B and Be stars at low metallicity

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We present new results obtained with the VLT GIRAFFE for a large sample of B and Be stars belonging to the Magellanic Clouds, i.e. at low metallicity. First, we show the effects of the metallicity of the environment on their rotation (linear, angular, and at the ZAMS). Second, we present the analysis of the effects of metallicity and evolution on the appearance of Be stars. We also new present results about the proportions of Be stars to B stars. Third, by cross-correlation with large photometric surveys such as MACHO and OGLE, we report on the detection for the first time of short-term multi-periodicity in 9 Be stars in the Small Magellanic Cloud, which can be interpreted in terms of pulsations.

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Revealing the Nature of Asymmetric Planetary Nebulae through Abundance Analysis

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The correlations between planetary nebula (PN) morphology and the nature of their progenitors are explored by examining homogeneous PN samples in the Galaxy and the Magellanic Clouds. We selected PNe with reliable abundances
from spectral analysis, and whose morphology is known, and compared the abundances of the element at variance with stellar evolution with the final yields of Asymptotic Giant Branch (AGB) stellar models. We found that most asymmetric PNe derive from the evolution of massive AGB stars both in the Galactic disk and the Magellanic Clouds.

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Star cluster life-times: dependence on mass, radius and environment

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The dissolution time ($t_{\text{dis}}$) of clusters in a tidal field does not scale with the “classical” expression for the relaxation time. First, the scaling with $N$, and hence cluster mass, is shallower due to the finite escape time of stars. Secondly, the cluster half-mass radius is of little importance. This is due to a balance between the relative tidal field strength and internal relaxation, which have an opposite effect on $t_{\text{dis}}$, but of similar magnitude. When external perturbations, such as encounters with giant molecular clouds (GMC) are important, $t_{\text{dis}}$ for an individual cluster depends strongly on radius. The mean dissolution time for a population of clusters, however, scales in the same way with mass as for the tidal field, due to the weak dependence of radius on mass. The environmental parameters that determine $t_{\text{dis}}$ are the tidal field strength and the density of molecular gas. We compare the empirically derived $t_{\text{dis}}$ of clusters in six galaxies to theoretical predictions and argue that encounters with GMCs are the dominant destruction mechanism. Finally, we discuss a number of pitfalls in the derivations of $t_{\text{dis}}$ from observations, such as incompleteness, with the cluster system of the SMC as particular example.

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CO, H\textsubscript{1}, recent Spitzer SAGE results in the Large Magellanic Cloud

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Formation of GMCs is one of the most crucial issues in galaxy evolution. I will compare CO and H\textsubscript{1} in the LMC in 3 dimensional space for the first time aiming at revealing the physical connection between GMCs and associated H\textsubscript{1} gas at a $\sim$ 40 pc scale. The present major findings are 1) [total CO intensity] $\propto$ [total H\textsubscript{1} intensity]\textsuperscript{0.8} for the 110 GMCs, and 2) the H\textsubscript{1} intensity tends to increase with the evolution of GMCs. I argue that these findings are consistent with the growth of GMCs via H\textsubscript{1} accretion over a time scale of a few $\times$ 10 Myrs. I will also discuss the role of the background stellar gravity and the dynamical compression by supershells in formation of GMCs.

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and from http://www.journals.cambridge.org/action/displayAbstract?fromPage=online&aid=972924
The Magellanic Clouds as a template for the study of stellar populations and galaxy interactions

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The Magellanic System represents one of the best places to study the formation and evolution of galaxies. Photometric surveys of various depths, areas and wavelengths have had a significant impact on our understanding of the system; however, a complete picture is still lacking. VMC (the VISTA near-infrared YJKs survey of the Magellanic System) will provide new data to derive the spatially resolved star formation history and to construct a three-dimensional map of the system. These data combined with those from other ongoing and planned surveys will give us an absolutely unique view of the system opening up the doors to truly new science!

Oral contribution, published in Elizabeth & Frederick White conference on the Magellanic System (Sydney 16-17 July 2007)
Available from arXiv:0710.3706

Analysis of the SN 1987A two-stage explosion hypothesis with account for the MSW neutrino flavour conversion

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Detection of 5 events by the Liquid Scintillation Detector (LSD) on February, 23, 1987 was interpreted in the literature as the detection of neutrinos from the first stage of the two-stage supernova collapse. We pose rigid constraints on the properties of the first stage of the collapse, taking into account neutrino flavour conversion due to the MSW-effect and general properties of supernova neutrino emission. The constraints depend on the unknown neutrino mass hierarchy and mixing angle \(\theta_{13}\).

Available from arXiv:0707.2508
Differences between the inferred star formation histories (SFHs) of star clusters and field stars seem to suggest distinct star formation processes for the two. The Small Magellanic Cloud (SMC) is an example of a galaxy where such a discrepancy is observed. We model the observed age distributions of the SMC clusters and field stars using a new population synthesis code, SPACE, that includes stellar evolution, infant mortality and cluster dissolution. We find that the two observed age distributions can be explained by a single SFH, thus eliminating the need to assume two separate mechanisms for star formation.

Available from arXiv:0711.3689

Job Adverts

Postdoctoral Scientist in Far Infrared and Millimeter-Wave Astronomy

The University of Maryland invites applications for a postdoctoral scientist position in far-infrared and millimeter-wave science at the Department of Astronomy. The successful candidate will collaborate with Prof. Alberto Bolatto on a science program based on the analysis of existing and proposed Spitzer, Herschel, and CARMA extragalactic observations. The applicant will also be expected to participate in proposing new observational projects. While the emphasis for this position will be on the exploitation and development of Spitzer and Herschel programs, candidates with background on interstellar medium astrophysics and radio, millimeter, or submillimeter-wave experience are encouraged to apply. Successful candidates are also encouraged to maintain an independent research program.

The successful applicant will be located at the University of Maryland and have access to all Maryland resources, including the CARMA millimeter-wave interferometer and the KPNO 4-meter telescope. The appointment is for two years, with the possibility of an extension to a third year. The successful applicant must have completed the requirements for the Ph.D. degree prior to arrival. Inquiries may be directed to Alberto Bolatto (bolatto@astro.umd.edu). Applicants should send a curriculum vitae, list of publications, and statement of research interests. Three letters of recommendation should be requested by the applicant and sent directly to the above address or emailed to postdocsearch@astro.umd.edu. Applications and letters must arrive by January 18, 2008 to receive full consideration. Minorities and women are particularly encouraged to apply. AAE/EOE
See also http://members.aas.org/JobReg/JobDetailPage.cfm?JobID=24169

Postdoctoral Fellow for the Spitzer SAGE Surveys

Applications are invited for up to two postdoctoral research position at the Space Telescope Science Institute starting as early as March 2008. The successful applicant will work with Dr. Karl Gordon and collaborators on studies with the Spitzer SAGE surveys of the Small and Large Magellanic Clouds with a particular emphasis on interstellar dust and star formation. The Magellanic Clouds fill a unique role in understanding interstellar medium and star formation in the Milky Way and most distant galaxies as they are close enough to study in detail and this detail can be
easily related to the global properties of each Cloud. This research will involve working with and, possible, proposing observations with Spitzer, HST, and ground based facilities. Independent research in related areas will be supported and encouraged. Research experience in the areas of interstellar dust, star formation, or dusty radiative transfer is desirable. Experience working in the Magellanic Clouds is not necessary.

The position is for two years, with a possible renewal for a third year. STScI, located on Johns Hopkins University Campus in Baltimore, Maryland, offers an excellent benefit package, competitive salaries, and a stimulating work environment. STScI’s pay is commensurate to the year of Ph.D.

Applicants are requested to complete an on-line application through our website at http://www.stsci.edu/institute/employment and attach the following materials: curriculum vitae, list of publications, and a brief statement of research interests, accomplishments, and relevant technical expertise.

Questions may be directed to kgordon@stsci.edu. Completed applications received by Feb 1, 2008 are assured of full consideration. EOE/AA/M/F/D/V

See also http://members.aas.org/JobReg/JobDetailPage.cfm?JobID=24115

Post-doctoral position with the IRS Team
Cornell University, USA

The Spitzer Infrared (IRS) Group at Cornell University invites applications for a Postdoctoral Research position with the IRS Team (PI Jim Houck). Information on the Spitzer Space Telescope and the IRS can be found at:

http://ssc.spitzer.caltech.edu and
http://isc.astro.cornell.edu/

The successful applicant will study dust formation and evolution in Local Group galaxies and help support the IRS Team’s ongoing programs. They will have access to all data obtained as part of the Team’s Guaranteed Time Observations on the Spitzer Space Telescope. The primary responsibilities will be the analysis and interpretation of spectra of evolved stars, circumstellar material, and interstellar material in the Galaxy, Large Magellanic Cloud, Small Magellanic Cloud, and other Local Group galaxies.

We are interested in innovative individuals with some background in infrared astronomy and/or spectroscopy, who work well on group activities and have the desire to contribute to the scientific end products. A Ph.D. in astronomy, physics, or a closely related field is required. The appointment will initially be for two years, contingent upon on available funding. Competitive salary will depend on experience.

To apply, please send a copy of your vita, research interests and the names of three individuals who are willing to write reference letters to Ms. Laurie McCall, Cornell University, 228 Space Sciences Building, Ithaca, NY 14853. Applications via email to lm19@cornell.edu are encouraged. For full consideration, applications should be received by December 15, 2007. However, applications will be accepted until the position is filled. Cornell University is an Equal Opportunity/Affirmative Action Employer.

See also http://isc.astro.cornell.edu/twiki/bin/view/Main/IrsJobs