THE MAGELLANIC CLOUDS NEWSLETTER
An electronic exchange on Magellanic Clouds research

Edited by Eva K. Grebel and You-Hua Chu
mcnews@astro.uiuc.edu
http://www.astro.uiuc.edu/mcnews/MCNews.html
http://www.astro.uni-bonn.de/~mcnews/

No. 21 June 8, 1998

Contents

News 1
Abstracts of 15 refereed papers 2
Job opportunity 12

News

IAU Symposium 190
NEW VIEWS OF THE MAGELLANIC CLOUDS
Victoria, Canada; 12 - 17 July 1998
http://cadcwww.hia.nrc.ca/iau190/

One month to go for IAU Symposium 190, New Views of the Magellanic Clouds!

The meetings are shaping up to be very exciting. Registrations have climbed to the 150 mark, with participants from 22 countries (Argentina, Australia, Canada, Chile, Czech Republic, France, Germany, Greece, India, Italy, Japan, Latvia, The Netherlands, New Zealand, Russia, Spain, South Africa, South Korea, Sweden, Taiwan, UK and USA). There is still room for everyone, but the organizers would appreciate having you register soon so they can plan appropriately!

Current registrants and abstracts will be listed on our Web pages by 10 June, barring unforeseen complications. Current housing information is also on the conference Web pages. We look forward to having you join us for what promises to be a wonderful scientific and social occasion.

James Hesser, David Bohlender, You-Hua Chu, Nicholas Suntzeff
Magellanic Cloud HI Data Available over Web!

Recent HI data from the Australia Telescope Compact Array and the Parkes telescopes is now available for downloading via the web. Spectral data may be downloaded for any position within the LMC and SMC. It is presently possible to download GIF files, postscript files, and ascii text files.

The data sets available are:
1. SMC Parkes and Compact Array data combined (Stanimirovic et al. 1998)
2. SMC Compact Array-only data (Staveley-Smith et al. 1997)
3. LMC Compact Array-only data (Kim et al. 1998)

HI column densities are also calculated (SMC combined data only).

The site may be accessed directly at:
or via the “links” web page of the Magellanic Clouds Newsletter. The facility is under development, so please notify problems to lstavele@atnf.csiro.au.

Lister Staveley-Smith

Editorial Change

Dominik Bomans has left our editorial team. We would like to thank him for his work on the Magellanic Clouds Newsletter and wish him success with his future endeavors.

Abstracts of Refereed Papers

Coronal C$^{+3}$ in the Large Magellanic Cloud: Evidence for a hot halo

Bart Wakker$^1$, J. Chris Howk$^1$, You-Hua Chu$^2$, Dominik Bomans$^2$, Sean D. Points$^2$
$^1$ Department of Astronomy, University of Wisconsin, 475 N Charter St, Madison, WI 53705, USA
$^2$ Department of Astronomy, University of Illinois, 1002 W Green St, Urbana, IL 61801, USA

Based on the detection of C IV absorption in five LMC stars observed with the Goddard High-Resolution Spectrograph on the Hubble Space Telescope we present the first unambiguous evidence that C$^{+3}$ exists in the Large Magellanic Cloud (LMC) away from regions where it could have been locally produced. We can exclude that this C$^{+3}$ is associated with hot early-type stars or active regions. Significant differences between the H$\alpha$ and C$^{+3}$ velocities toward our probes indicate that the H$^+$ and C$^{+3}$ are not co-spatial. Large column density variations show that the distribution of C$^{+3}$ is not uniform. The properties of the LMC CIV lines are similar but not identical to those found for the Milky Way: 45 km/s vs 73 km/s for the average FWHM, 8–12×10$^{13}$ cm$^{-2}$ vs 9–16×10$^{13}$ cm$^{-2}$ for the average column density. The H$\alpha$ vs CIV velocity differences and the similarity of the properties of the LMC and Milky Way CIV absorption suggest that at least some of the C$^{+3}$ in the LMC is in a
hot corona and that it has been produced by processes similar to those in the Milky Way. Our results show the feasibility of detecting high-ionization absorption in faint LMC stars, but more observations will be necessary before we can understand the distribution and properties of $10^5$ K gas in the LMC.

Appeared in The Astrophysical Journal 499, L87 (May 20)
For preprints, contact wakker@astro.wisc.edu

N105 in the Large Magellanic Cloud: A newly evolved $\text{H} \pi$ region

P. Ambrocio-Cruz$^{1,2}$, A. Laval$^1$, M. Marcelin$^1$, Ph. Amram$^1$, and F. Comerón$^3$

$^1$ Observatoire de Marseille, France
$^2$ Instituto de Astronomía UNAM, México
$^3$ European Southern Observatory, Garching, Germany

The detailed radial velocity field of the N105 $\text{H} \pi$ region in the Large Magellanic Cloud has been obtained for the H$\alpha$ and [O III]5007 lines with a spatial sampling of 9” and a spectral one of 16 and 7 km s$^{-1}$ respectively. The line profiles present complex splittings and broadening in several places. The peculiar velocity field and morphology indicate that N105 contains 4 bubble-shaped nebulae and two bright distinct quasi-spherical $\text{H} \pi$ regions, more or less coeval, embedded inside another one large shell nebula. They are essentially formed by the action of the stellar winds of exciting stars, probably born deep inside their parental cloud. This result is deduced from the energy input inside the ionized gas by the stellar winds of early type stars and from dynamical simulations combining the effects of stellar winds with those of high-density gradients inside the neutral gas. The size and the morphology of the $\text{H} \pi$ region are conditioned by the depth inside the natal cloud; the observed dynamic timescale of the $\text{H} \pi$ region starts at the moment of blow-out of the molecular cloud.

The kinematics of the field agrees with the expected issues of the stellar content and of the molecular studies. The position of masers and of an infrared source inside N105 and the structure of this nebula suggest that such an IR source may be the consequence of star formation triggered by the surrounding wind pressure due to the progenitors of the presently evolved stars.

Accepted by: Astronomy & Astrophysics
For preprints, contact ambrocio@mISTRAL.cnrs-mrs.fr

Star formation and shell formation in superbubble DEM 192

M.S. Oey$^1$ and S.A. Smedley$^2$

$^1$ Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, U.K.
$^2$ Dept. of Mathematics and Computer Science, University of Leicester, University Road, Leicester, LE1 7RH, U.K.

Was star formation in the OB associations, LH 51 and LH 54, triggered by the growth of the superbubble DEM 192? To examine this possibility, we investigate the stellar contents and star formation history, and model the evolution of the shell. H-R diagrams constructed from $UBV$ photometry and spectral classifications indicate highly coeval star formation, with the entire massive star population having an age of $\lesssim 2$–3 Myr. However, LH 54 is constrained to an age of $\sim 3$ Myr by the presence of a WR star, and the IMF for LH 51 suggests a lower-mass limit implying an age of 1–2 Myr. There is no
evidence of an earlier stellar population to create the superbubble, but the modeled shell kinematics are consistent with an origin due to the strongest stellar winds of LH 54. It might therefore be possible that LH 54 created the superbubble, which in turn may have triggered the creation of LH 51. Within the errors, the spatial distribution of stellar masses and IMF appear uniform within the associations.

We reinvestigate the estimates for stellar wind power $L_w(t)$, during the H-burning phase, and note that revised mass-loss rates yield a significantly different form for $L_w(t)$, and may affect stellar evolution timescales. We also model superbubble expansion into an ambient medium with a sudden, discontinuous drop in density, and find that this can easily reproduce the anomalously high shell expansion velocities seen in many superbubbles.

Accepted by: The Astronomical Journal
For preprints, contact oey@ast.cam.ac.uk

Infrared Observations of Ongoing Star Formation in the 30 Doradus Nebula and a Comparison with HST/WFPC2 Images

Mónica Rubio$^1$, Rodolfo Barbá$^2$, Nolan Walborn$^2$, Jorge García$^2$ and Miguel Roth$^3$

$^1$ Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile
$^2$ Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
$^3$ Las Campanas Observatory, The Observatories, Carnegie Institution of Washington, Casilla 601, La Serena, Chile

Intercomparisons of groundbased IR continuum and H$_2$ images with HST/WFPC2 images of the 30 Doradus Nebula reveal detailed structural relationships, which provide new information about current star formation there. Numerous stellar IR sources have been discovered in or near the bright nebular filaments west and northeast of R136; their locations are intimately connected with the nebular microstructures, as well as with young O stars in dense nebular knots whose optical spectral classifications indicate extreme youth. The H$_2$ emission predominates in the dust clouds beyond the bright nebulosity and IR sources, with respect to R136. The emerging picture suggests that a new stellar generation is being triggered by the energetic activity of the massive central cluster in the remnant interstellar material around its periphery. Comparison with the more evolved, giant shell H II region N11 in the LMC indicates a generic relationship to 30 Doradus, and that “two-stage starbursts” may be characteristic of massive star formation on this scale.

Submitted to: The Astronomical Journal
For preprints, contact rbarba@stsci.edu
Also available from the URL http://sol.stsci.edu/~rbarba/publications.html
Triggered Star Formation in the LMC4/Constellation III Region of the Large Magellanic Cloud

Y. Efremov¹ and B. Elmegreen²

¹ MSU, P.K. Sternberg Astronomical Institute, Moscow 119899, Russia
² IBM Research Division, T.J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598, USA

The origin of a regular, 600 pc-long arc of young stars and clusters in the Constellation III region of the Large Magellanic Cloud is considered. The circular form of this arc suggests that the prestellar gas was uniformly swept up by a central source of pressure. In the center of the arc are six ~ 30 My old A-type supergiant stars and a Cepheid variable of similar age, which may be related to the source of this pressure. We calculate the expansion of a bubble around a cluster of this age, and show that it could have triggered the formation of the arc at the right time and place. Surrounding the central old stars and extending well outside the young arc is the LMC4 superbubble and giant HI shell. We show how this superbubble and shell could have formed by the continued expansion of the 15 My old cavity, following star formation in the arc and the associated new pressures. The age sequence proposed here was not evident in the recent observations by Olsen et al. and Braun et al. because the first generation stars in the center of the LMC superbubble are relatively faint and scarce compared to the more substantial population of stars less than 15 My old that formed throughout the region in a second generation. These considerations lead to an examination of the origin of the LMC4/Constellation III region and other large rings in the LMC and other galaxies. Their size and circularity could be the result of low galactic shear and a thick disk, with several generations of star formation in their interiors now too faint to see.

Accepted by: Monthly Notices of the Royal Astronomical Society
For preprints, contact bge@watson.ibm.com
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9805092

Hierarchical Star Formation from the Time-Space Distribution of Star Clusters in the Large Magellanic Cloud

Y. N. Efremov¹ and B. G. Elmegreen²

¹ MSU, P.K. Sternberg Astronomical Institute, Moscow 119899, Russia
² IBM Research Division, T.J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598, USA

The average age difference between pairs of star clusters in the Large Magellanic Clouds increases with their separation as the ~ 0.35 power. This suggests that star formation is hierarchical in space and time. Small regions form stars quickly and large regions, which often contain the small regions, form stars over a longer period. A similar result found previously for Cepheid variables is statistically less certain than the cluster result.

Accepted by: Monthly Notices of the Royal Astronomical Society
For preprints, contact bge@watson.ibm.com
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9805259
HST Colour-Magnitude Diagrams of Six Old Globular Clusters in the LMC

K.A.G. Olsen¹, P.W. Hodge¹, M. Mateo², E.W. Olszewski³, R.A. Schommer⁴, N.B. Suntzeff⁴, and A.R. Walker⁴

¹University of Washington, Department of Astronomy, Seattle, WA 98195, USA
²University of Michigan, Department of Astronomy, Ann Arbor, MI 48109, USA
³University of Arizona, Steward Observatory, Tucson, AZ 85721, USA
⁴Cerro Tololo Inter-American Observatory, La Serena, Chile

We report on HST observations of six candidate old globular clusters in the Large Magellanic Cloud: NGC 1754, NGC 1835, NGC 1898, NGC 1916, NGC 2005 and NGC 2019. Deep exposures with the F555W and F814W filters provide us with colour-magnitude diagrams that reach to an apparent magnitude in V of ~25, well below the main sequence turnoff. These particular clusters are involved with significantly high LMC field star densities and care was taken to subtract the field stars from the cluster colour-magnitude diagrams accurately. In two cases there is significant variable reddening across at least part of the image, but only for NGC 1916 does the differential reddening preclude accurate measurements of the CMD characteristics. The morphologies of the colour-magnitude diagrams match well those of Galactic globular clusters of similar metallicity. All six have well-developed horizontal branches, while four clearly have stars on both sides of the RR Lyrae gap. The abundances obtained from measurements of the height of the red giant branch above the level of the horizontal branch are 0.3 dex higher, on average, than previously measured spectroscopic abundances. Detailed comparisons with Galactic globular cluster fiducials show that all six clusters are old objects, very similar in age to classical Galactic globulars such as M5, with little age spread among the clusters. This result is consistent with ages derived by measuring the magnitude difference between the horizontal branch and main sequence turnoff. We also find a similar chronology by comparing the horizontal branch morphologies and abundances with the horizontal branch evolutionary tracks of Lee, Demarque, & Zinn (1994). Our results imply that the LMC formed at the same time as the Milky Way Galaxy.

Accepted by: Monthly Notices of the Royal Astronomical Society
For preprints, contact Olsen@astro.washington.edu
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9806023

Fine structure of the red giant clump from Hipparcos data, and distance determinations based on its mean magnitude

Léo Girardi¹, Martin A.T. Groenewegen¹, Achim Weiss¹, and Maurizio Salaris²,¹

¹ Max-Planck-Institut für Astrophysik, Karl-Schwarzschild-Straße 1, D-85740 Garching bei München, Germany
² Astrophysics Research Institute, Liverpool John Moores University, Byrom Street, Liverpool L3 3AF, UK

The I-band brightness $M_I$ of clump stars is a possible distance indicator for stellar populations. Investigations have shown that $M_I$ is almost insensitive to the $(V-I)$ colour within the clump. Based on this, it was assumed that $M_I$ was insensitive to age and composition of the stellar population and therefore an ideal standard candle, which could be calibrated with local clump stars, whose absolute
brightness is known from Hipparcos parallaxes. This resulted in a distance to the LMC about 15% shorter than usually determined.

In the present paper we show that with a population synthesis approach we can reproduce the constancy of $M_I$ with colour for the local Hipparcos clump sample. Nevertheless, $M_I$ is not a constant among different populations, but depends on metallicity. As a result, the determined distance modulus to the LMC of $18.28 \pm 0.18$ mag is in better agreement with standard values. This resolves, at least partially, the controversial result obtained by the assumption of a universal value for $M_I$.

Particularly remarkable is our prediction that stars slightly heavier than the maximum mass for developing degenerate He cores, $M_{He}$, should define a secondary, clumpy structure, about 0.3 mag below the bluest extremity of the red clump. Both features are well separated in the $M_I$ vs. $V - I$ diagram of metal-rich stellar populations. Indeed, this secondary clump can be clearly identified in the Hipparcos database of stars with reliable $I$ photometry and parallax errors smaller than 10%. Since the stars in this feature should represent a narrow range of masses, their mass determination, e.g. by the use of binary systems, can provide information about the efficiency of convective overshooting from stellar cores.

Our investigation demonstrates that the RGB clump cannot be used as a distance indicator without proper knowledge and modelling of the population under investigation. In addition, there remain unsolved problems in the models, such as correct bolometric corrections and colour transformations.

Submitted to: Monthly Notices of the Royal Astronomical Society

For preprints, contact leo@mpa-garching.mpg.de

Also available from the URL http://www.mpa-garching.mpg.de/greenreports.html

The LMC distance modulus from Hipparcos RR Lyrae and classical Cepheid data

X. Luri$^{1,2}$, A.E. Gómez$^1$, J. Torra$^2$, F. Figueras$^2$, and M.O. Mennessier$^3$

$^1$ Observatoire de Paris-Meudon, D.A.S.G.A.L., URA CNRS 335, F92195 Meudon CEDEX, France
$^2$ Departament d'Astronomia i Meteorologia, Universitat de Barcelona, Avda. Diagonal 647, E08028, Barcelona, Spain
$^3$ Université Montpellier II, GRAAL, URA CNRS 1368, F34095 Montpellier CEDEX 5, France

The LM method – Luri et al. (1996) –, designed to exploit the Hipparcos data to obtain luminosity calibrations, is applied to derive luminosity calibrations for RR Lyrae and classical Cepheids. From these calibrations the distance to the Large Magellanic Cloud (LMC) is estimated. The distance moduli provided by the two calibrations are in good agreement, giving a value of $\sim 18.3^m$, while several previous calibrations using Hipparcos data provided inconsistent results between both types of stars. This result suggest that the Hubble constant should have a value of $H_0 \sim 79$ km s$^{-1}$ Mpc$^{-1}$.

Accepted by: Astronomy & Astrophysics Letters

For preprints, contact xluri@mizar.am.ub.es

Also available from the URL http://www.am.ub.es/DAM/Preprints/Luri1998a.ps.gz
Optical Gravitational Lensing Experiment.
The Distance Scale: Galactic Bulge – LMC – SMC.

A. Udalski
Warsaw University Observatory, Al. Ujazdowskie 4, 00-478 Warszawa, Poland

We analyze the mean luminosity of three samples of field RRab Lyr stars observed in the course of the OGLE microlensing experiment: 73 stars from the Galactic bulge and 110 and 128 stars from selected fields in the LMC and SMC, respectively. The fields are the same as in the recent distance determination to the Magellanic Clouds with the red clump stars method by Udalski et al (1998). We determine the relative distance scale \( d_{\text{GB}}^{RR} : d_{\text{LMC}}^{RR} : d_{\text{SMC}}^{RR} \) equal to: \( (0.194 \pm 0.010) : 1.00 : (1.30 \pm 0.08) \).

We calibrate our RR Lyr distance scale with the recent calibration of Gould and Popowski (1998) based on statistical parallaxes. We obtain the following distance moduli to the Galactic bulge, LMC and SMC: \( m - M = 14.53 \pm 0.15 \), \( m - M = 18.09 \pm 0.16 \) and \( m - M = 18.66 \pm 0.16 \) mag.

We use the RR Lyr mean V-band luminosity at the Galactic bulge metallicity as the reference brightness and analyze the mean, I-band luminosity of the red clump stars in objects with different ages and metallicities. We add to our analysis the metal poor Carina dwarf galaxy which contains old RR Lyr stars and intermediate age red clump population. We find a weak dependence of the mean red clump brightness on metallicity and we calibrate its zero point with the nearby local red clump stars measured by Hipparcos: \( M_{I}^{RC} = (0.09 \pm 0.03) \times [\text{Fe/H}]^{RC} - 0.23 \pm 0.03 \). Our revised red clump distance moduli to the Galactic bulge, LMC and SMC are \( m - M = 14.53 \pm 0.06 \), \( m - M = 18.13 \pm 0.07 \) and \( m - M = 18.63 \pm 0.07 \) mag, respectively. The distance modulus to the Carina galaxy is \( m - M = 19.84 \pm 0.07 \) mag. Excellent agreement of RR Lyr and red clump distances which have independent absolute calibrations confirms the short distance scale to the LMC.

Submitted to: Acta Astronomica
For preprints, contact udalski@sirius.astrouw.edu.pl
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9805221

Bipolar Outflows and the Evolution of Stars

Adam Frank

1 Department of Physics and Astronomy, Box 270171, University of Rochester, Rochester, NY 14627-0171, USA

Hypersonic bipolar outflows are a ubiquitous phenomena associated with both young and highly evolved stars. Observations of Planetary Nebulae, the nebulae surrounding Luminous Blue Variables such as \( \eta \) Carinae, Wolf-Rayet bubbles, the circumstellar environment of SN 1987A and Young Stellar Objects all revealed high velocity outflows with a wide range of shapes. In this paper I review the current state of our theoretical understanding of these outflows.

Beginning with Planetary Nebulae considerable progress has been made in understanding bipolar outflows as the result of stellar winds interacting with the circumstellar environment. In what has been called the “Generalized Wind Blown Bubble” (GWBB) scenario, a fast tenuous wind from the central star expands into an ambient medium with an aspherical (toroidal) density distribution. Inertial gradients due to the gaseous torus quickly lead to an expanding prolate or bipolar shell of swept-up gas bounded by strong shock waves. Numerical simulations of the GWBB scenario show a surprisingly rich variety of gasdynamical behavior, allowing models to recover many of the observed properties of stellar bipolar outflows including the development of collimated supersonic jets.
In this paper we review the physics behind the GWBB scenario in detail and consider its strengths and weakness. Alternative models involving MHD processes are also examined. Applications of these models to each of the principle classes of stellar bipolar outflow (YSO, PNe, LBV; SN87A) are then reviewed. Outstanding issues in the study of bipolar outflows are considered as are those questions which arise when the outflows are viewed as a single class of phenomena occurring across the HR diagram.

Accepted by: New Astronomy Reviews
For preprints, contact afrank@alethea.pas.rochester.edu
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9805275

WCFIELDS: A Magnetic Rotating Stellar Wind Model from Wind Compression Theory

R. Ignace\(^1\), J.P. Cassinelli\(^2\), and J.E. Bjorkman\(^3\)

\(^1\) Physics and Astronomy, Univ. of Glasgow, U.K.
\(^2\) Astronomy, Univ. of Wisconsin, USA
\(^3\) Physics and Astronomy, Univ. of Toledo, USA

A stellar wind model for a magnetic rotating star is presented. We use the semi-analytic Wind Compression model that predicts the 2-dimensional geometry of outflows from rotating stars and consider the addition of a magnetic field. In the limit of weak magnetic fields, such that the fields are unimportant in accelerating the flow, the Wind Compression model can be used to predict the magnetic field distribution throughout the wind, which is shown to follow the mass flux distribution. A compression of field lines near the equator results as the flow of material from higher latitudes brings magnetic flux toward that region. As examples, Wind Compression models with magnetic fields ("WCFIELD" models) are computed for both a Wolf-Rayet star and a Red Supergiant star. In both cases an order of magnitude enhancement of the equatorial magnetic field can result within a few stellar radii for stellar rotation rates around 20% of critical. Such enhancements could have consequences for explaining (1) non-thermal emission observed from some Wolf-Rayet winds and (2) the ring structures observed in the ejecta of SN1987A.

Accepted by: The Astrophysical Journal
For preprints, contact rico@astro.gla.ac.uk
Also available by anonymous ftp at info.astro.gla.ac.uk, cd/pub/rico/wcfields.ps
Evolved Massive Stars in the Local Group II. A New Survey for Wolf-Rayet Stars in M 33 and Its Implications for Massive Star Evolution: Evidence of the “Conti Scenario” in Action

P. Massey¹ and O. Johnson²

¹ KPNO/NOAO, P. O. 26732, Tucson, AZ 85726-6732, USA
² CFA, 60 Garden Street, Cambridge, MA, USA

We expect the evolution of massive stars to be strongly influenced by mass-loss, and hence be sensitive to metallicity. It should be possible to test this “Conti scenario” by comparing the populations of evolved massive stars among the Local Group galaxies, but such investigations have been hampered by incompleteness. In Paper I we presented results of a new survey for red supergiants (RSGs) in selected regions of the Local Group galaxies M 33, M 31, and NGC 6822. In the present paper, we survey eight fields in M 33 for Wolf-Rayet stars (WRs), using interference filter imaging with a CCD to select candidates. Follow-up spectroscopy is used to confirm 22 newly found WR stars, all of WN type. We establish that our survey would readily detect WRs as weak-lined as any known, and we conclude that our survey is essentially complete. This survey confirms suspicions that the previous photographic surveys were only 50% complete for WN-type WRs and allows us to combine the data with equally complete samples on other Local Group galaxies. We find that the relative number of WC and WN type WRs correlates extremely well with metallicity, varying by a factor of 3 with galactocentric distance within the plane of M 33, and continuing the trend to lower and higher metallicity galaxies. The WC/WN ratio within 3 kpc of the sun is slightly above this trend, and we argue that WN stars are underrepresented in this sample. The WC/WN ratio is anomalously high in IC 10, given its low metallicity, and we demonstrate that this is not due to selection effects, but is likely due to IC 10’s current status as a starburst system. We examine the spectral properties of WC stars within these galaxies, confirming the previously reported trends that the spectral lines are stronger and broader in regions of lower metallicity. We suggest that the different WC spectral subclasses do not primarily indicate different physical properties for these stars, but rather are simply a reflection of the effect that the initial metal abundances had on the stellar wind structure. Finally, we compare the luminous RSGs with WRs in these galaxies. We find that there is a very strong correlation of the relative numbers of RSGs and WRs with metallicity, in the sense predicted by Maeder, Lequeux, & Azzopardi: at lower metallicities the fraction of luminous (M bol < -7) RSGs is higher, with a factor of 6 change within the disk of M 33 (Δlog (O/H)=0.35 dex), and a factor of ~ 10 change from M 31 (or the inner portions of M 33) to NGC 6822 (Δlog (O/H)=0.5 dex). This is easily explained by the Conti scenario in terms of massive stars spending proportionately less of their He-burning lifetimes as RSGs rather than WRs at higher metallicities and hence higher mass-loss rates. Finally, we note that the presence of luminous RSGs and WRs stars is extremely well correlated for the OB associations in M 31 and M 33: where one finds one, one finds the other. To the extent that an association is strictly coeval, this argues that some stars of 15M⊙ and above indeed do go through both a RSG and WR stage. The presence of WR stars of both WN and WC type in the same associations as luminous RSGs further suggests that some WC's, at least, have gone through the RSG phase. We include an appendix providing a complete catalog of confirmed WR stars in Local Group galaxies beyond the Magellanic Clouds.

Accepted by: The Astrophysical Journal

For preprints, contact massey@noao.edu

Also available from the URL ftp://tofu.tuc.noao.edu/pub/wrpre.ps

or by anonymous ftp at tofu.tuc.noao.edu, cd pub, binary, get wrpre.ps.Z
Expected EAGLE event rate towards the Magellanic Clouds

T. Nakamura\(^1\) and R. Nishi\(^2\)

\(^1\) Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606-8502, Japan
\(^2\) Department of Physics, Kyoto University, Kyoto 606-8502, Japan

We propose to search for MACHOs by observing EAGLE (Extremely Amplified Gravitational LEnsing) events of a majority of dim stars. This search is independent of the usual one. For the detection limit of EAGLE ($\sim 20$ mag), $\sim 100 \, f \, \tau_{\text{LMC}} / 3 \times 10^{-7} \, (100 \, \text{days}/\langle \bar{t} \rangle)$ EAGLE events/y are expected to result from all the dim stars in LMC. Here $\tau_{\text{LMC}}$ and $\langle \bar{t} \rangle$ are the optical depth and the average duration of microlensing events, respectively, while $f \, (0 < f < 1)$ is a parameter depending on the unknown stellar luminosity function. The observed mean duration of EAGLE events also depends on the luminosity function and is $0.01 \sim 0.4$ times the usual duration of microlensing events, which corresponds to $1 \sim 30$ days. The follow-up observation using larger telescopes may enable us to determine the impact parameter and the true duration of the event. If $f$ is determined by another independent method, we can also determine $\tau_{\text{LMC}}$. Even if $f$ is undetermined, the detection of EAGLE events strongly suggest that MACHOs are not due to variable source stars, since EAGLE events are due to the dim main-sequence stars. Although for the SMC, the event rate is smaller by a factor of $\sim 7$, it is still a substantial number ($\sim 13 \, f \, \tau_{\text{SMC}} / 3 \times 10^{-7} \, (100 \, \text{days}/\langle \bar{t} \rangle)$ events/y).

Accepted by: Prog. Theor. Phys.

For preprints, contact nishi@tap.sphys.kyoto-u.ac.jp
Also available from the URL http://xxx.lanl.gov/abs/astro-ph/9805203

The survival of the Sgr dwarf galaxy and the flatness of the rotation curve of the Galaxy

HongSheng Zhao\(^1\)

\(^1\) Leiden Observatory, Postbus 9513, NL-2300RA Leiden, The Netherlands

How did the Sgr dwarf galaxy manage to come within 16 kpc of the Galactic center while other satellite systems of the Galaxy are all orbiting beyond 50 kpc? The consideration that its 10-Gyr-old “fluffy” core should have long been dissolved by the strong and frequent tidal shocks by the Galactic disc and halo forces us to question the assumption that it was born on the present orbit. A scenario that Sgr was deflected to its current orbit by the Magellanic Clouds after a rendezvous on the north Galactic pole $2 - 3$ Gyrs ago is examined. It is shown that both the sense and the speed of circulations of Sgr and the LMC around the Galaxy are fixed by timing the collision, and fit direct observations of the proper motions remarkably well. Furthermore the collision is very sensitive to the potential of the Galaxy between 20-100 kpc, hence provides an unconventional test of the existence and distribution of dark matter of the Galaxy. The apparent agreement of our predictions with previous data leads us to propose that the two orthogonal polar circles, traced by a dozen or so Galactic halo dwarf galaxies and globular clusters (LMC-SMC-Magellanic Stream-Draco-Ursa Minor along $l \sim 270^\circ$ and M54-Ter 7-Ter 8-Arp 2-NGC 2419-Pal 15 along $l \sim 0^\circ$), are streams of tidal relics from two ancient galaxies which were captured on two intersecting polar rosette orbits by the Galaxy. We contrast our model with
observations, and provide interpretations of the microlensing towards the LMC and the star formation history of the objects on the two polar circles.

Accepted by: The Astrophysical Journal Letters
For preprints, contact hsz@strw.strw.leidenuniv.n
Also available from the URL http://babbage.sissa.it/abs/astro-ph/9804304

Job Advertisement

Two Postdoctoral Positions
at the University of California, Irvine

Applications are invited for two postdoctoral research positions at the University of California, Irvine, to begin September 15, 1998.

The first position will involve galaxy evolution research with Prof. Tammy Smecker-Hane. The successful applicant will participate in ongoing work on the star formation and chemical evolution histories of nearby dwarf galaxies using the Hubble Space Telescope and the Keck Telescopes to obtain color-magnitude diagrams and high-resolution spectra of individual stars.

The second position will involve research with Prof. Gary Chanana in optical engineering, atmospheric optics and adaptive optics using the Keck Telescopes. Candidates with previous experience in these fields will be preferred.

For both jobs, the initial appointment will be for two years (a third year may be possible), the salary will fall in the range of $32,000 to $35,000 commensurate with experience, and some funding for independent research will be available. Candidates should send an application letter and a CV with the names of three references as soon as possible but no later than August 15, 1998 to:

Prof. Tammy Smecker-Hane or Prof. Gary Chanana
Dept. of Physics and Astronomy
4129 Reines Hall
University of California
Irvine, CA 92697-4575, USA.

If questions should arise please contact tsmecker@uci.edu or gachanana@uci.edu

UCI is an equal opportunity employer committed to excellence through diversity.