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.uni-bonn.de/~mcnews/

No. 62 January 28, 2002

CONTENTS

Abstracts of 10 refereed papers 1–8

Abstracts of Refereed Papers

HIPASS High–Velocity Clouds:
Properties of the Compact and Extended Populations


1 Research School of Astronomy and Astrophysics, ANU, Weston Creek P.O., Weston, ACT 2611, Australia.
2 Australia Telescope National Facility, CSIRO, P.O. Box 76, Epping, NSW 2121, Australia
3 Currently a Hubble Fellow at: Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, CO 80309-0389, USA
4 Sterrewacht Leiden, P.O. Box 9513, 2300 RA Leiden, The Netherlands
5 Netherlands Foundation for Research in Astronomy, P.O. Box 2, 7990 AA Dwingeloo, The Netherlands
6 Centre for Astrophysics & Supercomputing, Swinburne University, Mail #31, P.O. Box 218, Hawthorn, VIC, Australia 3122
7 University of Wales, Cardiff, Department of Physics & Astronomy, P.O. Box 913, Cardiff CF2 3YB, U.K.
8 University of Western Sydney Macarthur, Department of Physics, P.O. Box 555, Campbelltown, NSW 2560, Australia
9 School of Physics, University of Melbourne, Victoria 3010, Australia
10 University of New Mexico, Department of Physics & Astronomy, 800 Yale Blvd. NE, Albuquerque, NM 87131, USA
11 University of Manchester, Jodrell Bank Observatory, Lower Withington, Macclesfield, Cheshire, England, SK11 6QS
12 Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD, 21218, USA
13 Anglo-Australian Observatory, P.O. Box 296, Epping, NSW 1710, Australia
14 School of Physics, University of Sydney, NSW 2006, Australia
15 Department of Physics & Astronomy, University of Leicester, Leicester LE1 7RH, U.K.

A catalog of Southern anomalous–velocity H I clouds at Decl. $< +2^\circ$ is presented. This catalog is based on data from the H I Parkes All-Sky Survey (HIPASS) reprocessed with the MIMED5 procedure (Putman et al. 2002; Putman 2000), and searched with the high–velocity cloud finding algorithm described by de Heij et al. (2001). The improved sensitivity ($5\sigma: \Delta T_B = 0.04$ K), resolution ($15.5''$), and velocity range ($-500 < V_{LSR} < +500$ km s$^{-1}$) of the HIPASS data, results in a substantial increase in the number of individual clouds (1956, as well as 41 galaxies) compared to what was known from earlier Southern data. The method of cataloging the anomalous–velocity objects is described, and a catalog of key cloud parameters, including velocity, angular size, peak column density, total flux, position angle, and degree of isolation, is presented. The data are characterized into several classes of anomalous–velocity H I emission. Most high–velocity emission features, HVCs, have a filamentary morphology and are loosely organized into large complexes extending over tens of degrees. In addition, 179 compact and isolated anomalous–velocity objects, CHVCs, are identified based on their size and degree of isolation. 25% of the CHVCs originally classified by Braun & Burton (1999) are reclassified based on the HIPASS data. The properties of all the high–velocity emission features and only the CHVCs are investigated, and distinct similarities and differences are found. Both populations have typical H I masses of $\sim 4.5 \, D^2_{100} \, M_\odot$ and have similar slopes for their column density and flux distributions. On the other hand, the CHVCs appear to be clustered and the population can be broken up into three spatially distinct groups, while the entire population of clouds is more uniformly distributed with a significant percentage aligned with the the Magellanic Stream. The median velocities are $V_{GSR} = -38$ km s$^{-1}$ for the CHVCs and $-30$ km s$^{-1}$ for all of the anomalous–velocity clouds. Based on the catalog sizes, high–velocity features cover 19% of the southern sky, and CHVCs cover 1%.

Accepted by: The Astronomical Journal (Feb. 2002)

For preprints, contact mputman@casa.colorado.edu
Also available from the URL http://casa.colorado.edu/~mputman/pubs.html

A Very Sensitive 21cm Survey for Galactic High-Velocity H I

Felix J. Lockman$^1$, Edward M. Murphy$^2$, Sara Petty-Powell$^3$, and Vincent J. Urick$^4$

1 National Radio Astronomy Observatory, P.O. Box 2, Green Bank, WV 24944, USA
2 University of Virginia, Dept. of Astronomy, P.O. Box 3818 University Station, Charlottesville, VA 22903-0818, USA
3 The Evergreen State College, Physics and Astronomy, 2700 Evergreen Parkway NW, Olympia, WA 98502, USA
4 Bloomsburg University, Physics Department, 400 East 2nd St., Bloomsburg, PA 17815, USA

Very sensitive H I 21cm observations have been made in 860 directions at $\delta \geq -43$ deg in search of weak, Galactic, high-velocity H I emission lines at moderate and high Galactic latitudes. One-third of the observations were made toward extragalactic objects that are visible at optical and UV wavelengths. The median rms noise in the survey spectra is 3.4 mK, resulting in a median 4 $\sigma$ detection
level of $N_{HI} = 8 \times 10^{17}$ cm$^{-2}$ averaged over the 21' beam of the telescope. High-velocity H i emission is detected in 37% of the directions; about half of the lines could not have been detected in previous surveys. The median FWHM of detected lines is 30.3 km s$^{-1}$. High-velocity H i lines are seen down to the sensitivity limit of the survey implying that there are likely lines at still lower values of $N_{HI}$. The weakest lines have a kinematics and distribution on the sky similar to that of the strong lines, and thus do not appear to be a new population. Most of the emission originates from objects which are extended over several degrees; only a few appear to be compact sources. At least 75%, and possibly as many as 90%, of the lines are associated with one of the major high-velocity complexes. With the increased sensitivity of this survey, the Magellanic Stream is seen to extend at least 10 deg to higher Galactic latitude than previously thought and to be more extended in longitude as well. Wright’s Cloud near M33 has an extended low-$N_{HI}$ component in the direction of the Magellanic Stream. The bright H i features which have dominated most surveys may be mere clumps within larger structures, and not independent objects. Although there are many lines with low column density, their numbers do not increase as rapidly as $N_{HI}^{-1}$, so most of the H i mass in the high-velocity cloud phenomenon likely resides in the more prominent clouds.

Accepted by: The Astrophysical Journal Supplement Series (June 2002)
For preprints, contact jlockman@nrao.edu
Also available from the URL astro-ph0201039

A FUSE Survey of Interstellar O VI Absorption
in the Small Magellanic Cloud

Charles G. Hoopes$^1$, Kenneth R. Sembach$^{1,2}$, J. Christopher Howk$^3$, Blair D. Savage$^3$, and Alex W. Fullerton$^{1,4}$

$^1$ Department of Physics and Astronomy, Johns Hopkins University, 3400 N. Charles St., Baltimore, MD 21218, USA
$^2$ Current address: Space Telescope Science Institute, 3700 San Martin Dr., Baltimore, MD 21218, USA
$^3$ Department of Astronomy, University of Wisconsin-Madison, 475 North Charter Street, Madison, WI 53706, USA
$^4$ Department of Physics and Astronomy, University of Victoria, P.O. Box 3055, Victoria, BC V8W 3P6, Canada

We present the results of a Far Ultraviolet Spectroscopic Explorer (FUSE) survey of O VI 1031.93 Å
and 1037.62 Å absorption toward 18 OB stars in the Small Magellanic Cloud (SMC). The FUSE data are of very high quality, allowing a detailed study of the coronal temperature gas in the SMC. We find that O VI is ubiquitous in the SMC, with a detection along every sight line. The average value of the O VI column density in the SMC is log $N$(O VI) = 14.53. This value is 1.7 times higher than the average value for the Milky Way halo (perpendicular to the Galactic plane) of log $N_{\perp}$(O VI) = 14.29 found by FUSE, even though the SMC has much lower metallicity than the Galaxy. The column density in the SMC is higher along sight lines that lie close to star-forming regions, in particular NGC 346 in the northern part of the SMC, and to a lesser degree the southwestern complex of H II regions. This correlation with star formation suggests that local processes have an important effect on the distribution of coronal gas in the SMC. If the sight lines within NGC 346 are excluded, the mean column density for the SMC is log $N$(O VI) = 14.45, only 1.4 times higher than the Milky Way average. The standard deviation of the column densities for sight lines outside of NGC 346 is ±27%, somewhat lower than the deviation seen in the Milky Way halo. The lowest O VI column densities, log $N$(O VI) ~ 14.3, occur in the central region and in the southeastern “Wing” of the galaxy. Even these
low column densities are as high as the Milky Way average, establishing the presence of a substantial, extended component of coronal gas in the SMC. The O VI absorption is always shifted to higher velocities than the main component of lower ionization gas traced by Fe II absorption. The O VI line widths are broader than expected for pure thermal broadening at $3 \times 10^5$ K, the temperature at which the O VI peaks in abundance, so large non-thermal motions or multiple hot gas components are likely present. We discuss several mechanisms that may be able to explain the observed properties of the hot gas, including supershells, a galactic fountain, and the infall of gas previously stripped from the SMC by tidal interactions with the Milky Way and the Large Magellanic Cloud. If a galactic fountain produces the hot gas, the mass flux per unit surface area is $M/\Omega \sim 2 \times 10^{-2} M_\odot$ yr$^{-1}$ kpc$^{-2}$.

Accepted by: The Astrophysical Journal
For preprints, contact choopes@pha.jhu.edu

Centrally Peaked X-Ray Supernova Remnants in the Small Magellanic Cloud Studied with ASCA and ROSAT

Jun Yokogawa$^1$, Kensuke Imanishi$^1$, Katsuji Koyama$^1$, Mamiko Nishiuchi$^2$, Norikazu Mizuno$^3$

$^1$ Department of Physics, Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan
$^2$ Japan Atomic Energy Research Institute, Kansai Research Establishment, 8-1 Umebi-dai, Kizu-cho, Soraku-gun, Kyoto 619-0215, Japan
$^3$ Department of Astrophysics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan

This paper presents ASCA/SIS and ROSAT/HRI results of three supernova remnants (SNRs) in the Small Magellanic Cloud: 0103–726, 0045–734, and 0057–7226. The ROSAT/HRI images of these SNRs indicate that the most of the X-ray emissions are concentrated in the center region. Only from 0103–726 are faint X-rays along the radio shell also detected.

The ASCA/SIS spectra of 0103–726 and 0045–734 exhibit strong emission lines from highly ionized metals. The spectra were well-fitted with non-equilibrium ionization (NEI) plasma models. The metal abundances are found to be larger than the mean chemical compositions in the interstellar medium (ISM) of the SMC. Thus, X-rays from these two SNRs are attributable to the ejecta gas, although the ages estimated from the ionization timescale are significantly large, > $10^4$ yr. The chemical compositions are roughly consistent with the type-II supernova origin of a progenitor mass < 20$M_\odot$.

The SIS spectrum of 0057–7226 was also fitted with an NEI model of an estimated age > $6 \times 10^3$ yr. Although no constraint on the metal abundances was obtained, the rather weak emission lines are consistent with the low metal abundances in the ISM of the SMC. A possible scenario for the evolution of the morphologies and spectra of SNRs is proposed.

Accepted by: Publications of the Astronomical Society of Japan
For preprints, contact jun@cr.scphys.kyoto-u.ac.jp
Also available from the URL http://www-cr.scphys.kyoto-u.ac.jp/member/jun/job/
Observations of the unusual counterpart
to the X-ray pulsar AX J0051-733

M.J. Coe\textsuperscript{1}, N.J. Haigh\textsuperscript{1}, S.G.T. Laycock\textsuperscript{1}, I. Negueruela\textsuperscript{2} \& C.R. Kaiser\textsuperscript{1}

\textsuperscript{1} Southampton University, UK
\textsuperscript{2} Obs de Strasbourg, France

We report optical and IR observations of the ASCA X-ray pulsar system AX J0051-733. The relationship between the X-ray source and possible optical counterparts is discussed. Long term optical data from over 7 years are presented which reveal both a 1.4d modulation and an unusually rapid change in this possible binary period. Various models are discussed.

Accepted by: MNRAS
For preprints, contact mjc@astro.soton.ac.uk
Also available from the URL http://xxx.soton.ac.uk/abs/astro-ph/0201302

Pristine CNO Abundances from Magellanic Cloud B Stars
I. The LMC cluster NGC 2004 with UVES

A.J. Korn\textsuperscript{1}, S.C. Keller\textsuperscript{2}, A. Kaufer\textsuperscript{3}, N. Langer\textsuperscript{4}, N. Przybilla\textsuperscript{1}, O. Stahl\textsuperscript{5}, B. Wolf\textsuperscript{5}

\textsuperscript{1} Universitäts-Sternwarte München (USM), Scheinerstr. 1, 81679 München, Germany
\textsuperscript{2} Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94550, U.S.A.
\textsuperscript{3} European Southern Observatory, Alonso de Cordova 3107, Santiago, Chile
\textsuperscript{4} Astronomical Institute, Utrecht University, NL-3584 CC, Utrecht, The Netherlands
\textsuperscript{5} Landessternwarte Heidelberg (LSW), Königstuhl, 69115 Heidelberg, Germany

We present chemical abundances for four main sequence B stars in the young cluster NGC2004 in the Large Magellanic Cloud (LMC). Apart from H\textsc{ii} regions, unevolved OB-type stars are currently the only accessible source of present-day CNO abundances for the MCs not altered by stellar evolution. Using UVES on the VLT, we obtained spectra of sufficient resolution ($R = 20,000$) and signal-to-noise ($S/N \geq 100$) to derive abundances for a variety of elements (He, C, N, O, Mg and Si) with NLTE line formation.

This study doubles the number of main sequence B stars in the LMC with detailed chemical abundances. More importantly and in contrast to previous studies, we find no CNO abundance anomalies brought on by e.g. binary interaction or rotational mixing. Thus, this is the first time that abundances from H\textsc{ii} regions in the LMC can sensibly be cross-checked against those from B stars by excluding evolutionary effects. We confirm the H\textsc{ii}-region CNO abundances to within the errors, in particular the extraordinarily low nitrogen abundance of $\varepsilon$(N) $\approx 7.0$. Taken at face value, the nebular carbon abundance is 0.16 dex below the B-star value which could be interpreted in terms of interstellar dust depletion. Oxygen abundances from the two sources agree to within 0.03 dex.

In comparison with the Galactic thin disk at MC metallicities, the Magellanic Clouds are clearly nitrogen-poor environments.

Accepted by: Astronomy & Astrophysics
For preprints, contact ajkorn@usm.uni-muenchen.de
Magellanic Clouds stellar clusters II:
new $B,V$ CM diagrams for 6 LMC and 10 SMC clusters

A. Matteucci$^1$, V. Ripepi$^2$, E. Brocato$^3$, V. Castellani$^1$

1 Dipartimento di Fisica, Università di Pisa, Piazza Torricelli 2, 56100 Pisa, Italy
2 Osservatorio Astronomico di Capodimonte, Via Molariello 16, 80131 Napoli, Italy
3 Osservatorio Astronomico di Collurania, Via M. Maggini, 64100 Teramo, Italy

We present new CCD photometry for 6 LMC and 10 SMC stellar clusters, as taken at the ESO 1.54-m Danish Telescope in La Silla, to extend a previous investigation on Magellanic Clouds clusters based on HST snapshots. Thanks to the much larger area covered by the Danish detector, we investigate the spatial distribution of cluster stars, giving $V$, $(B-V)$ CM diagrams for both clusters and surrounding fields. Evidences for a complex history of star formation in the Clouds are outlined, showing that old field populations in both Clouds have metallicities much lower than normally adopted for them ($Z = 0.008$ and $Z = 0.004$ for LMC and SMC respectively), with SMC field stars more metal poor than in LMC. Observational data concerning the red clump of field stars in both Clouds are shortly discussed.

Accepted by: Astronomy & Astrophysics
For preprints, contact ripepi@na.astro.it

Theoretical models for Bump Cepheids

G. Bono$^1$ V. Castellani$^2$ and M. Marconi$^3$

1 Astron. Obs. of Roma, Italy
2 University of Pisa, Italy
3 Astron. Obs. of Capodimonte, Italy

We present the results of a theoretical investigation aimed at testing whether full amplitude, non-linear, convective models account for the $I$-band light curves of Bump Cepheids in the Large Magellanic Cloud (LMC). We selected two objects from the OGLE sample that show a well-defined bump along the decreasing (short-period) and the rising (long-period) branch respectively. We find that current models do reproduce the luminosity variation over the entire pulsation cycle if the adopted stellar mass is roughly 15 mass loss and convective core overshooting. Moreover, we find that the fit to the light curve of the long-period Cepheid located close to the cool edge of the instability strip requires an increase in the mixing length from 1.5 to 1.8 $\xi_p$. This suggests an increase in the efficiency of the convective transport when moving toward cooler effective temperatures. Current pulsation calculations supply a LMC distance modulus ranging from 18.48 to 18.58 mag.

Accepted by: Astrophysical Journal Letters
For preprints, contact marcella@na.astro.it
Formation of Double Rings Around Evolved Stars
Noam Soker

Univ. of Virginia, USA, and Univ. of Haifa, Israel

I propose a scenario for the formation of double-ring systems, as observed in some planetary nebulae and in the outer rings of SN 1987A. In this scenario, two jets, one jet on each side of the equatorial plane, expand into a thin, dense shell. Such a flow is expected in binary systems where the mass-losing primary undergoes an impulsive mass loss episode which forms a thin, dense shell. I assume that a small fraction of that mass is accreted onto a companion which blows the jets. Each jet accelerates shell’s material it hits sideways, forming a higher density ring. Using several simplifying assumptions, I derive an expression for the radius of the ring, which depends relatively weakly on the jets and impulsive mass loss episode properties. This shows that such a scenario is feasible. If there are several such impulsive mass loss episodes, more double rings will be formed, as observed in the planetary nebulae MyCn 18 (the Hourglass nebula). Because of the binary interaction and orbital motion, the double-ring system is displaced from the symmetry axis of the main nebula, as observed.

Submitted to: The Astrophysical Journal
For preprints, contact soker@physics.technion.ac.il
Also available from the URL astro-ph/0201306

A New Spectral Classification System for the Earliest O Stars: Definition of Type O2

Nolan R. Walborn¹, Ian D. Howarth², Daniel J. Lennon³, Philip Massey⁴, M. S. Oey⁴, Anthony F. J. Moffat⁵, Gwen Skalkowski⁵, Nidia I. Morrell⁶, Laurent Drissen⁷, and Joel Wm. Parker⁸

¹Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
²Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK
³Isaac Newton Group, Apartado 321, 38700 Santa Cruz de La Palma, Canary Islands, Spain
⁴Lowell Observatory, 1400 West Mars Hill Road, Flagstaff, AZ 86001, USA
⁵Département de Physique, Université de Montréal, C.P. 6128, Succ. Centre-Ville, Montréal, QC H3C 3J7, Canada
⁶Facultad de Ciencias Astronómicas y Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque, 1900 La Plata, Argentina
⁷Département de Physique, Université Laval, Ste-Foy, QC G1K 7P4, Canada
⁸Southwest Research Institute, 1050 Walnut Street, Suite 426, Boulder, CO 80302, USA

High-quality, blue-violet spectroscopic data are collected for 24 stars that have been classified as type O3 and that display the hallmark N IV and N V lines. A new member of the class is presented; it is the second known in the Cygnus OB2 association, and only the second in the Northern Hemisphere. New digital data are also presented for several of the other stars. Although the data are inhomogeneous, the uniform plots by subcategory reveal some interesting new relationships. Several issues concerning the classification of the hottest O-type spectra are discussed, and new digital data are presented for the five original O3 dwarfs in the Carina Nebula, in which the N IV, N V features are very weak or absent. New spectral types O2 and O3.5 are introduced here as steps toward resolving
these issues. The relationship between the derived absolute visual magnitudes and the spectroscopic
luminosity classes of the O2-O3 stars shows more scatter than at later O types, at least partly because
some overluminous dwarfs are unresolved multiple systems, and some close binary systems of relatively
low luminosity and mass emulate O3 supergiant spectra. However, it also appears that the behavior
of He II λ4686, the primary luminosity criterion at later O types, responds to other phenomena in
addition to luminosity at spectral types O2-O3. There is evidence that these spectral types may
correspond to an immediate pre-WN phase, with a correspondingly large range of luminosities and
masses. A complete census of spectra classified into the original O3 subcategories considered here (not
including intermediate O3/WN types or O3 dwarfs without N IV, N V features) totals 45 stars; 34 of
them belong to the Large Magellanic Cloud and 20 of the latter to 30 Doradus.

Accepted by: The Astronomical Journal
For preprints, contact walborn@stsci.edu
Also available from the URL ftp://ftp.boulder.swri.edu/pub/joel/o2stars/