THE MAGELLANIC CLOUDS NEWSLETTER
An electronic exchange on Magellanic Clouds research

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News

Dear Colleague,

We are pleased to present issue # 50 of the Magellanic Clouds Newsletter. Thanks to your support MCNews appears once per month with an average of 11 abstracts of refereed papers. Since its creation in late 1995 MCNews has published 497 abstracts of refereed papers, 102 abstracts of non-refereed contributions, numerous thesis abstracts, job and meeting announcements. Approximately 440 astronomers in 31 countries receive MCNews.

With your help MCNews will continue to prosper in the new millennium. We thank you for your support and contributions and look forward to many more abstracts with exciting new results.

With our best wishes for a happy, successful, and productive year 2001,

Eva Grebel & You-Hua Chu
Abstracts of Refereed Papers

AGN in the XMM-Newton first-light image as probes for the interstellar medium in the LMC

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The XMM-Newton first-light image revealed X-ray point sources which show heavily absorbed power-law spectra. The spectral indices and the probable identification of a radio counterpart for the brightest source suggest AGN shining through the interstellar gas of the Large Magellanic Cloud (LMC). The column densities derived from the X-ray spectra in combination with H\textsc{i} measurements will allow to draw conclusions on H\textsc{i} to H\textsc{2} ratios in the LMC and compare these with values found for the galactic plane.

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For preprints, contact fwh@mpm.mpg.de

The first broad-band X-ray images and spectra of the 30 Doradus region in the LMC

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We present the XMM–Newton first light image, taken in January 2000 with the EPIC pn camera during the instrument’s commissioning phase, when XMM–Newton was pointing towards the Large Magellanic Cloud (LMC). The field is rich in different kinds of X-ray sources: point sources, supernova remnants (SNRs) and diffuse X-ray emission from LMC interstellar gas. The observations are of unprecedented sensitivity, reaching a few $10^{32}$ erg/s for point sources in the LMC. We describe how
these data sets were analysed and discuss some of the spectroscopic results. For the SNR N157B the power law spectrum is clearly steeper than previously determined from ROSAT and ASCA data. The existence of a significant thermal component is evident and suggests that N157B is not a Crab–like but a composite SNR. Most puzzling is the spectrum of the LMC hot interstellar medium, which indicates a significant overabundance of Ne and Mg of a few times solar.

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Radio Pulsars in the Magellanic Clouds

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We report the results of a survey of the Small Magellanic Cloud (SMC) for radio pulsars conducted with the 20-cm multibeam receiver of the Parkes 64-meter telescope. This survey targeted a more complete region of the SMC than a previous pulsar search and had an improvement in sensitivity by a factor of about two for most pulsar periods. This survey is much more sensitive to fast young pulsars (with $P \lesssim 100$ ms) and is the first survey of the SMC with any sensitivity to millisecond pulsars. Two new pulsars were discovered in the survey, one of which is located within the SMC. The number of pulsars found in the survey is consistent with the expected number derived using several methods. We also report the serendipitous discovery of a new pulsar in the 30 Doradus region of the Large Magellanic Cloud (LMC). These discoveries bring the total number of rotation-powered pulsars currently known in the Magellanic Clouds to eight. We have also made refined timing measurements for the new discoveries as well as for three previously known LMC pulsars. The age distribution of luminous Magellanic Cloud pulsars supports the conjecture that pulsars younger than about 5 Myr are more luminous on average than older pulsars.

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Implications of the Discovery of Millisecond Pulsar in SN 1987A

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From the observation of the millisecond pulsar in SN 1987A, the following implications are obtained. 1) The pulsar spindown in SN 1987A is caused by radiating gravitational waves rather than by magnetic dipole radiation and/or relativistic pulsar winds. 2) A mildly deformed shock wave would be formed at the core-collapse and explosion in SN 1987A, which is consistent with the conclusion derived in Nagataki (2000). 3) The gravitational waves from the pulsar will be detected in (5-10) years by the Fabry-Perot-Michelson interferometer as the gravitational detector such as LIGO and TAMA. 4) The neutrino oscillation model is not a promising one for the explanation of the kick velocity of the pulsar in SN 1987A. The hydrodynamical instability model will be more favored.

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The LMC eclipsing binary HV 2274 revisited

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We reanalyse the UV/optical spectrum and optical broad-band data of the eclipsing binary HV 2274 in the LMC, and derive its distance following the method given by Guinan et al. (1998a,b) of fitting theoretical spectra to the stars' UV/optical spectrum plus optical photometry. We describe the method in detail, pointing out the various assumptions that have to be made; moreover, we discuss the systematic effects of using different sets of model atmospheres and different sets of optical photometric data. It turns out that different selections of the photometric data, the set of model atmospheres and the constraints on the value of the ratio of selective to total extinction in the V-band, result in a 25% range in distances (although some of these models have a large $\chi^2$).

For our best choice of these quantities the derived value for the reddening to HV 2274 is $E(B-V) = 0.103 \pm 0.007$, and the de-reddened distance modulus is $DM = 18.46 \pm 0.06$; the DM to the center of the LMC is found to be $18.42 \pm 0.07$. This is significantly larger than the DM of $18.30 \pm 0.07$ derived by Guinan et al. (1998a).

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The Distance to the Large Magellanic Cloud from Eclipsing Binaries II. HV 982

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We have determined the distance to a second eclipsing binary system (EB) in the Large Magellanic Cloud, HV 982 (\textsim B1 IV-V + \textsim B1 IV-V). The measurement of the distance – among other properties of the system – is based on optical photometry and spectroscopy and space-based UV/optical spectrophotometry. The analysis combines the “classical” EB study of light and radial velocity curves, which yield the stellar masses and radii, with a new analysis of the observed energy distribution, which yields the effective temperature, metallicity, and reddening of the system plus the distance “attenuation factor”, essentially (radius/distance)\textsuperscript{2}. Combining the results gives the distance to the system, which is 45.6 \pm 2.1 kpc.

This distance determination is extremely robust. It consists of a detailed study of well-understood objects (B stars) in a well-understood evolutionary phase (core H burning). The results are entirely consistent with – but do not depend on – stellar evolution calculations. There are no “zero-point” uncertainties as, for example, with the use of Cepheid variables. Neither is the result subject to sampling biases, as may affect techniques which utilize whole stellar populations, such as red giant stars. Moreover, the analysis is insensitive to stellar metallicity (although the metallicity of the stars is explicitly determined) and the effects of interstellar extinction are determined for each object studied.

After correcting for the location of HV 982, we find a distance to the optical center of the LMC’s bar of \(d_{\text{LMC}} = 45.9 \pm 2.1\) kpc or \((V_0 - M_v)_{\text{LMC}} = 18.31\) mag. This result is entirely consistent with our earlier result for the EB HV 2274, which yielded \((V_0 - M_v)_{\text{LMC}} = 18.30 \pm 0.07\) mag. These results argue strongly in favor of the “short” LMC distance scale.

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MACHO 96-LMC-2: Lensing of a Binary Source in the LMC and Constraints on the Lensing Object

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We present photometry and analysis of the microlensing alert MACHO 96-LMC-2. This event was initially detected by the MACHO Alert System, and subsequently monitored by the Global Microlensing Alert Network (GMAN). The \( \sim 3\% \) photometry provided by the GMAN follow-up effort reveals a periodic modulation in the lightcurve. We attribute this to binarity of the lensed source. Microlensing fits to a rotating binary source magnified by a single lens converge on two minima, separated by \( \Delta \chi^2 \sim 1 \). The most significant fit X1 predicts a primary which contributes \( \sim 100\% \) of the light, a dark secondary, and an orbital period \( (T) \) of \( \sim 9.2 \) days. The second fit X2 yields a binary source with two stars of roughly equal mass and luminosity, and \( T = 21.2 \) days.

Observations made with the Hubble Space Telescope (HST) resolve stellar neighbors which contribute to the MACHO object’s baseline brightness. The actual lensed object appears to lie on the upper LMC main sequence. We estimate the mass of the primary component of the binary system, \( M \sim 2 \, M_\odot \). This helps to determine the physical size of the orbiting system, and allows a measurement of the lens proper motion. For the preferred model X1, we explore the range of dark companions by assuming 0.1 \( M_\odot \) and 1.4 \( M_\odot \) objects in models X1a and X1b, respectively. We find lens velocities projected to the LMC in these models of \( \hat{\nu}_{X1a} = 18.3 \pm 3.1 \, \text{km s}^{-1} \) and \( \hat{\nu}_{X1b} = 188 \pm 32 \, \text{km s}^{-1} \). In both these cases, a likelihood analysis suggests an LMC lens is preferred over a Galactic halo lens, although only marginally so in model X1b. We also find \( \hat{\nu}_{X2} = 39.6 \pm 6.1 \, \text{km s}^{-1} \), where the likelihood for the lens location is strongly dominated by the LMC disk. In all cases, the lens mass is consistent with that of an M-dwarf. Additional spectra of the lensed source system are necessary to further constrain and/or refine the derived properties of the lensing object.

The LMC self-lensing rate contributed by 96-LMC-2 is consistent with model self-lensing rates. Thus, even if the lens is in the LMC disk, it does not rule out the possibility of Galactic halo microlenses altogether. Finally, we emphasize the unique capability of follow-up spectroscopic observations of known microlensed LMC stars, combined with the non-detection of binary source effects, to locate lenses in the Galactic halo.

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Petersen diagram for RRd stars in the Magellanic Clouds

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RRd stars from the Magellanic Clouds form a well-defined band in the Petersen diagram. We explain this observed band with our evolutionary and pulsation calculations with assumed metallicity [Fe/H] = \((-2, -1.3)\). Vast majority of RRd stars from LMC is confined to a narrower range of \((-1.7, -1.3)\). The width of the band, at specified fundamental mode period, may be explained by mass spread at given metallicity. The shape of the band reflects the path of RRd stars within the RR Lyrae instability strip. We regard the success in explaining the Petersen diagram a support for our evolutionary models, which yield, mean absolute magnitude in the mid of the instability strip, \(\langle M_V \rangle\), in the range 0.4 to 0.65 mag implying distance modulus to LMC of 18.4 mag.

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For preprints, contact blapo@fuw.edu.pl
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Young Clusters in the Magellanic Clouds II

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We present the results of a quantitative study of the degree of extension to the boundary of the classical convective core within intermediate mass stars. The basis of our empirical study is the stellar population of four young populous clusters in the Magellanic Clouds which has been detailed in Keller, Bessel & Da Costa (2000). The sample affords a meaningful comparison with theoretical scenarios with varying degrees of convective core overshoot and binary star fraction. Two critical properties of the population, the main-sequence luminosity function and the number of evolved stars, form the basis of our comparison between the observed data set and that simulated from the stellar evolutionary models. On the basis of this comparison we conclude that the case of no convective core overshoot is excluded at a 2 \(\sigma\) level.

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Reddenings and metallicities in the LMC and SMC from Strömgren CCD photometry

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The individual reddenings for B stars in two fields in the Small Magellanic Cloud (SMC) and two fields in the Large Magellanic Cloud (LMC) are determined by means of Strömgren uvby CCD photometry. In both LMC fields we find a foreground reddening of \( E(B - V) = 0.085 \pm 0.02 \), and for the SMC fields we find \( E(B - V) = 0.070 \pm 0.02 \). In addition to the foreground reddening we find contributions from reddening intrinsically in the Clouds up to \( E(B - V) \approx 0.21 \). The intrinsic contribution is not correlated with position within our \( \sim 6' \times 4.5' \) CCD fields but varies in an essentially random way. Unless the reddening is measured for a particular object, it will be uncertain by \( \pm 0.035 \) in \( E(B - V) \) (best case, far from the central bars) to more than \( \pm 0.10 \) (close to the central bars).

The Strömgren uvby photometry has been used to derive metallicities for GK giant stars in the observed fields. Adopting average redenning we obtain mean metallicities which are consistent with those found from spectroscopic studies of F and G supergiants but with a considerable scatter in the derived metallicities, from [Fe/H] \( \approx -2.0 \) to [Fe/H] \( \approx 0 \). A significant fraction of the scatter is, however, due to reddening variations rather than being intrinsic. The possible existence of high metallicity stars should be investigated further using spectroscopic methods.

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Abstracts of Non-Refereed Papers

Systematic Search for Wolf-Rayet Binaries in the Magellanic Clouds: Preliminary Results

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The Magellanic Clouds represent the best laboratories to study the metallicity effect on the late evolution of massive stars. The low ambient metallicity is expected to lower the mass-loss rate by stellar winds. Therefore, it increases the minimum mass to form Wolf-Rayet (WR) stars. Binarity is then expected to be responsible of the formation of a large fraction of WR stars in the Magellanic Clouds. We present here the rationale behind a systematic search for radial velocity variations in a subsample of WR stars both in the Small Magellanic Cloud (SMC) and the Large Magellanic Cloud (LMC). Some very preliminary results of this study are also presented and discussed. This project is the first to gather repeated spectroscopic data spread over several contiguous weeks (for 3 different epochs spread over 2 years) on a complete sub-population of WR stars (namely WNE stars) in the MC in order to detect short-period binaries (i.e., \( P < 200d \), those that should show evidence of an evolutionary interaction between the two stars) as well as medium- to moderately long-period binaries (up to 2 years).

For preprints, contact foellmi@astro.umontreal.ca
Also available from the ftp web site
ftp://www.astro.umontreal.ca/outgoing/foellmi/WRbinClouds.ps.gz

Job Opportunity

POSTDOCTORAL RESEARCH POSITION -
THE JOHNS HOPKINS UNIVERSITY

A postdoctoral research position is available to work with Dr. Luciana Bianchi at the Center for Astrophysical Sciences, The Johns Hopkins University, Baltimore, MD, USA. The position will involve modeling spectra of hot massive stars in Local Group galaxies. Significant experience in modeling photospheric plus wind spectra is required. Experience in observing/reducing spectroscopic data is a desirable plus. The program includes analysis of HST-STIS (UV to visual) spectra, ground-based and FUSE far-UV spectra of early type stars (and CSPN) in the Local Group. The candidate should have a PhD in Astronomy or closely-related degree.
The position is available immediately (1 year, renewable) and will be filled as soon as a suitable candidate is found. Interested candidates should send CV, publications list (preprints if relevant), and arrange to have three letters of reference sent to:

Dr. Luciana Bianchi  
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JHU encourages applications from women and minority candidates. AAE/EOE

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**Meeting Announcement**

**Gaseous Matter in Galaxies and Intergalactic Space**

An international conference

**Venue:** Institut d’Astrophysique de Paris (France)

**Dates:** June 19–23, 2001

**Scope and topics:**
Observational and theoretical results, with special emphasis on new data from FUSE, HST and VLT.

- Diffuse interstellar clouds in the Galactic disc
- Warm and hot diffuse gas in the Milky Way and other galaxies
- Dynamics and transport phenomena in the interstellar medium
- Interstellar media in the Magellanic Clouds and other galaxies
- Intergalactic medium at low redshifts


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