Preliminary Results of the SUNY Oswego IR LMC Survey

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Abstract:

In collaboration with the National Optical Astronomical Observatory (NOAO) and the University of Illinois, SUNY Oswego has undertaken a large infrared survey of LMC Cepheid variables in the JHKs filters with a view to providing accurate JHKs Cepheid lightcurves to OGLE LMC Cepheid variables. These observations will be useful in examining the non-linearity of the LMC Cepheid PL relation at infrared wavelengths. They will also be useful for researchers studying the geometry of the LMC and for infrared surface brightness methods aimed at reducing zero point errors on the LMC distance modulus and hence the extra-galactic distance scale. We present a preliminary analysis of new data taken from a 30 night survey of LMC Cepheids at JHKs wavelengths. These observations were made using the 1.5m telescope at CTIO plus the CPAPIR imaging camera between December 2006-December 2007.

Background:

This IR Survey consists of over 30 nights of observation of the LMC from CTIO 1.5m telescope with the CPAPIR CCD located in Chile. The observations are in the NIR bands: J – 1.25 microns, H – 1.65 microns, Ks – 2.15 microns. The object of this survey is Cepheid variable stars- stars whose luminosity vary as a function of time. The ultimate goal of this survey is to construct accurate lightcurves in the NIR bands for Cepheid variables found in the OGLE database. It has been shown using rigorous statistical tests that the LMC Cepheid PL relation is non-linear in the visual BVI filters (see figure 1 below). The break in the relation around periods of 10 days may be explained by the interaction between the hydrogen ionization front and the photosphere.

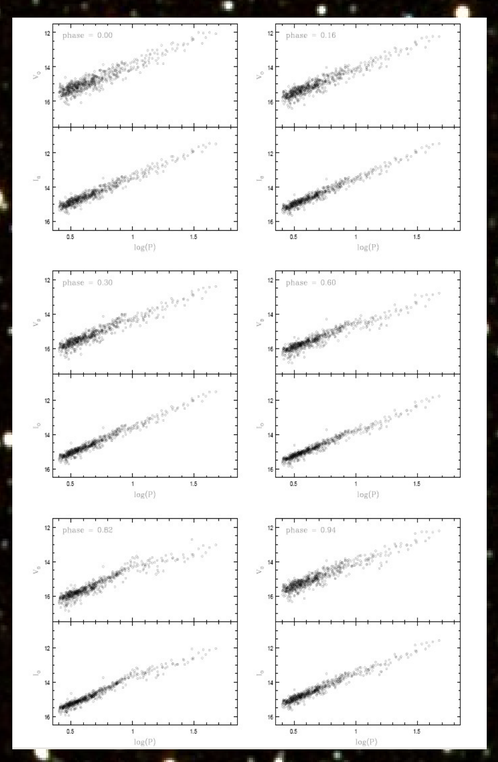


Figure 1: LMC Cepheid PL multi-phase PL relations for V and I filters

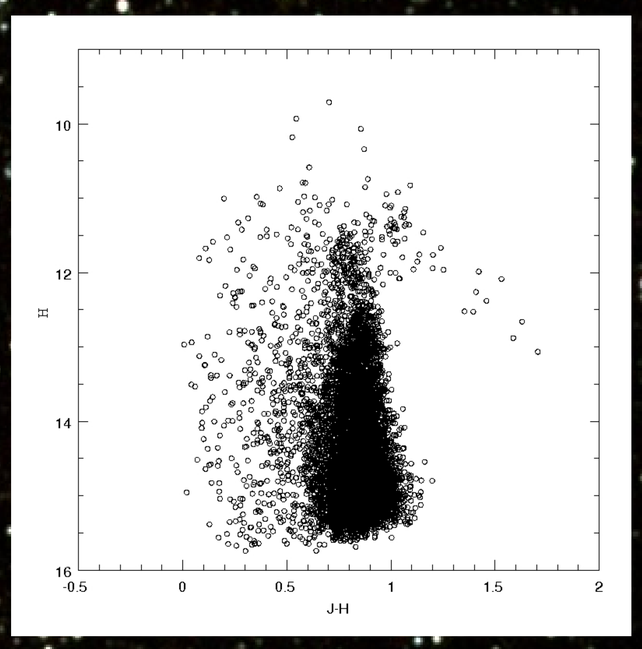


Figure 2: H, J-H Color magnitude diagram of a section of the LMC

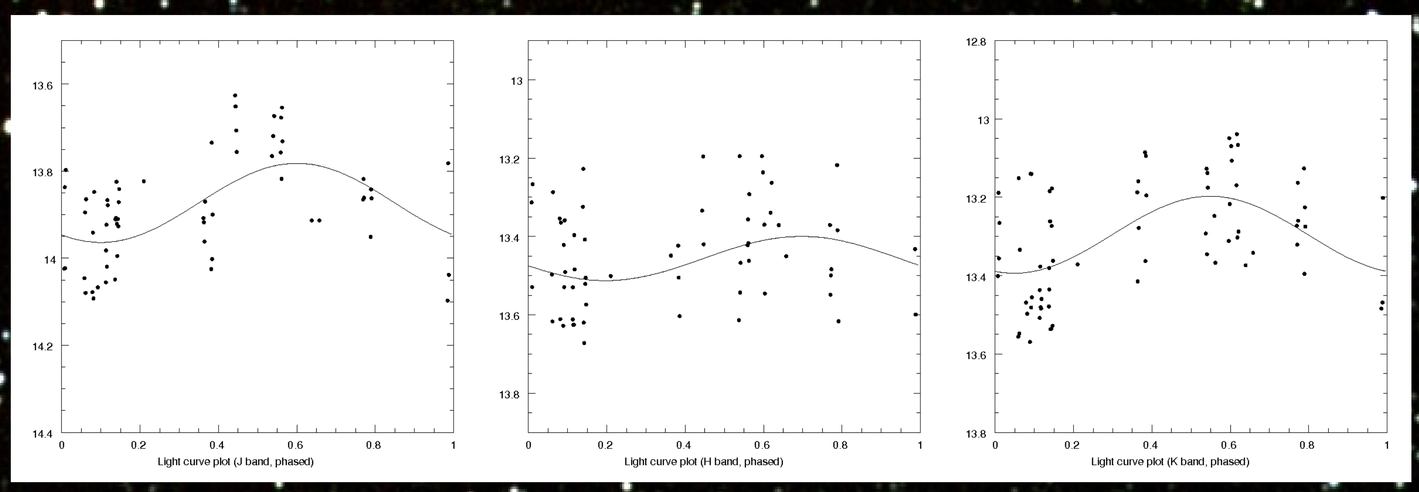


Figure 3: Preliminary JHKs filter lightcurves for a LMC Cepheid of period 6.7346 days

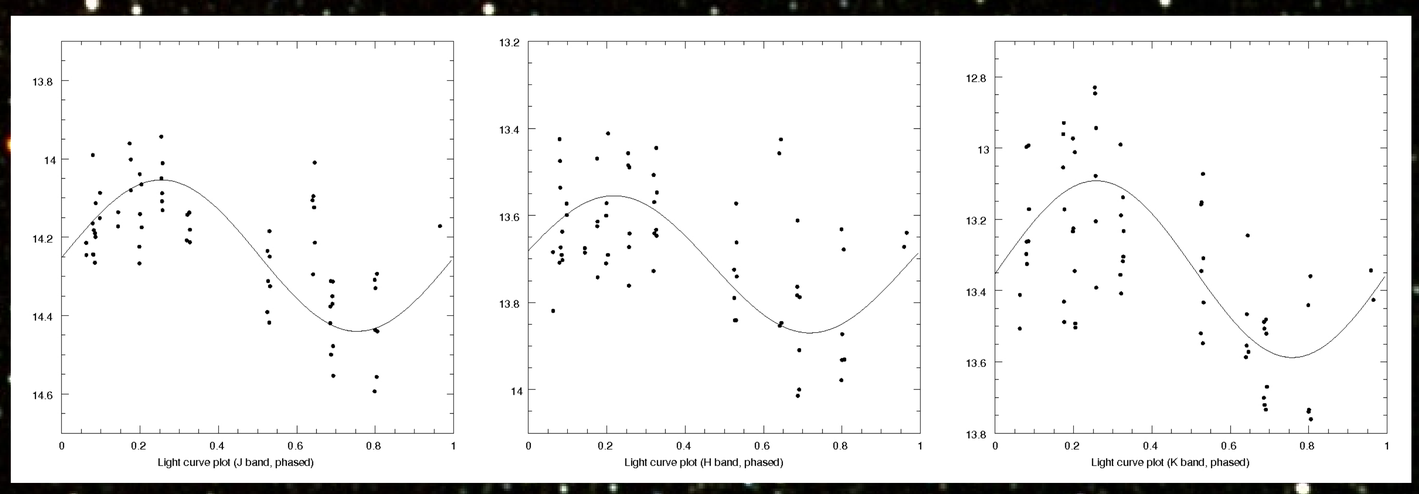
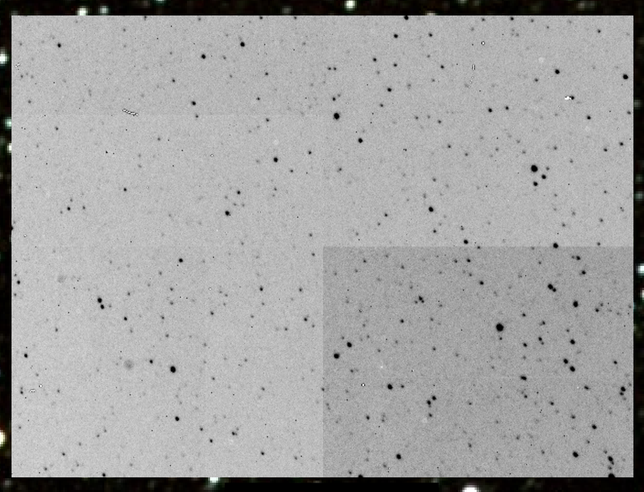
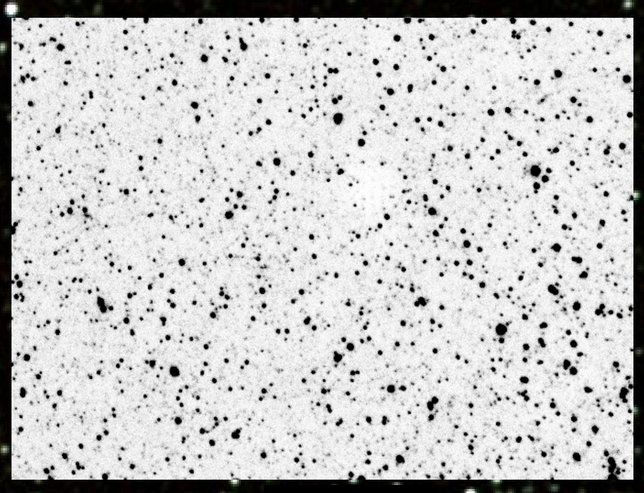


Figure 4: Preliminary JHKs filter lightcurves for a LMC Cepheid of period 24.54263 days

Background: RGB composite of a small portion of the LMC, based on our JHKs data



Raw CCD image



Final image

Data Reduction/Photometry:

1. Carried out using IRAF.
2. Master Dark, Mask frames created.
3. Master skyflat/domeflat with high S/N in each band.
4. CCDPROC used to interpolate over bad pixels.
5. Each dithered science image divided by normalized flat.
6. Sky subtraction by taking a running mean across about 15 images.
7. Median sky value added back to each pixel before photometry.
8. DAOPHOT was used to coadd 7 frames for each final frame.
9. This results in frames with a S/N ratio of about 250, 350, and 450 in the J, H, and K filters respectively.
10. Photometry with DAOPHOT.
11. PSF photometry used with aperture photometry as a guide.

Calibration and Lightcurve construction:

1. Terapix programs, Sextractor and SCAMP, were used to align each frame to a proper WCS.
2. About 1500 2MASS objects in each frame were used for the calibration.
3. For each frame, a linear relation between instrumental magnitudes and 2MASS magnitudes was found with the slope forced to be equal to 1.
4. The zero point of this relation was used to convert instrumental magnitudes to apparent magnitudes.
5. CMD diagrams produced in good agreement with 2MASS CMD's.
6. OGLE Cepheids were matched to objects in our survey producing a list of Cepheids and the variation of these magnitudes with time.
7. Sample preliminary light curves with a simple Fourier fit are shown in figures 3 and 4.

Conclusions:

Our preliminary results show the potential for constructing lightcurves with excellent phase resolution with over 25 data points for over a thousand Cepheid variable stars. Possible modification to photometry parameters should be able to reduce instrumental magnitude errors and refinements to the 2MASS calibration will enable the production of accurate lightcurves in the infrared filters to complement the OGLE LMC Cepheid lightcurves. These lightcurves will be very important to the study of the non-linearity of the near infrared period-luminosity relation for LMC Cepheids.

References:

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