EPJ Web of Conferences **152**, 01017 (2017) DOI: 10.1051/epjconf/201715201017
Wide-Field Variability Surveys: A 21st Century Perspective

Finding beat Cepheids in M33 and their use in measuring the metallicity gradient

Lawrence Short[1,⋆] and *David* Bersier[1]

[1] *Astrophysics Research Institute, Liverpool John Moores University, IC2, Liverpool Science Park, 146 Brownlow Hill, Liverpool, L3 5RF, UK*

Abstract. The period ratio between the two different pulsation modes of beat Cepheids is directly affected by the metallicity of the star. Our aim is to find all of the beat Cepheids in M33 and determine their metallicities hence allowing us to derive the metallicity gradient. To achieve this we have M33 data from the INT and the CFHT variability survey conducted by Hartman et al. (2006, [1]).

1 Introduction

Metallicity measurements are traditionally achieved by spectroscopic analysis but this can lead to considerable uncertainties. However, beat Cepheids can be used to trace metallicity because the period ratio, P_1/P_0 , is sensitive to metal abundance.

2 Data

2.1 CFHT

We have data from the M33 variability survey conducted by Hartman et al. (2006, [1]) in which they used the MegaCam instrument on the 3.6-m Canada-France-Hawaii Telescope (CFHT) with a field of view of 1 deg^2. Observations were taken in the g', r', and i' Sloan bands covering 27 nights over 17 months giving at least 33 measurements for each filter. They identified more than 36000 variable sources including over 2000 Cepheids. Using these data Beaulieu et al. (2006, [2]) discovered 5 beat Cepheids which they compared to beat Cepheids in the Milky Way, the LMC and the SMC using a Petersen diagram in order to determine their metallicity.

2.2 INT

On top of the CFHT data we have further epochs from the 2.5-m Isaac Newton Telescope (INT), La Palma. The wide field camera allowed us to cover the whole galaxy in 4 pointings. The data set consists of 48 measurements in the r' band taken on 13 nights over 19 months with fewer images in the g' and i' bands. The INT and CFHT data needs cross-calibrating which will give us $\sim$ 80 epochs to find all the variable objects in M33 and produce accurate light curves. A period search can then be applied to the cross-calibrated data in order to determine all of the Cepheids present (we are expecting 2000-3000).

⋆L.A.Short@2015.ljmu.ac.uk

DOI: 10.1051/epjconf/201715201017

3 Image subtraction

We have performed image subtraction on a single chip of the 16 from the INT images using the software HOTPANTS[1] based on the ISIS image subtraction package described by Alard & Lupton (1998, [3]) and Alard (2000, [4]). Images with the best seeing are averaged together to build a reference image. Images taken on different nights were then individually subtracted from the reference image so only objects that have changed brightness remain. See Figure 1.

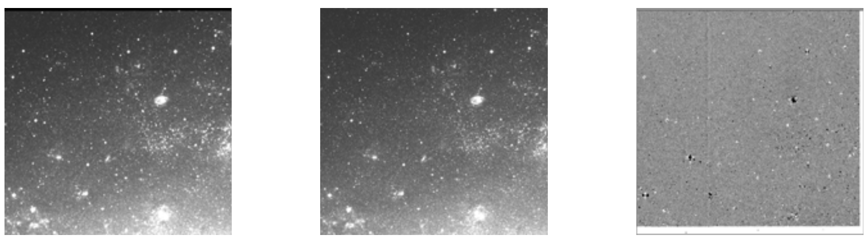

Figure 1. INT images of a small section of M33 in the r' band. Left-hand panel: Image at some epoch. Mid panel: Reference image. Right-hand panel: Resultant subtracted image.

4 Light curves

The flux of the residual pixel counts of a Cepheid found from Figure 1 for each of the subtracted images at every epoch is measured and folded with its period. Figure 2 shows the light curves of a single period Cepheid from both the INT and CFHT data.

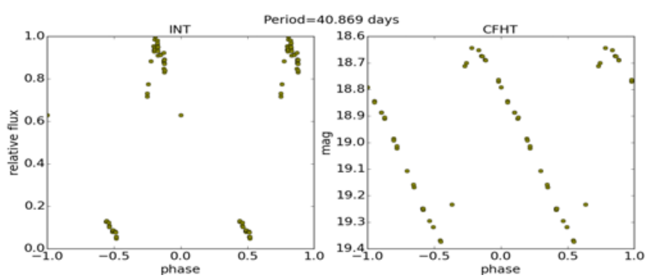

Figure 2. Comparison of folded light curves between the INT subtracted images and the CFHT data of a Cepheid.

References

[1] Hartman, J. D., Bersier, D., Stanek, K. Z., Beaulieu, J.-P., Kaluzny, J., Marquette, J.-B., Stetson, P. B., & Schwarzenberg-Czerny, A., MNRAS, **371**, 1405 (2006)

[2] Beaulieu, J.-P., Buchler, J. R., Marquette, J.-B., Hartman, J. D., & Schwarzenberg-Czerny, A., ApJL, **653**, L101 (2006)

[3] Alard, C., & Lupton, R. H., ApJ, **503**, 325 (1998)

[4] Alard, C., A&AS, **114**, 363 (2000)

[1] `www.astro.washington.edu/users/becker/v2.0`