Tracing circumstellar disks via photometric variability in the Magellanic Clouds

Viktor Zivkov (Keele University, UK and ESO Garching, Germany)
Monika Petr-Gotzens (ESO Garching, Germany), Joana Oliveira (Keele University, UK)

Abstract: Stellar accretion during the pre-main sequence phase is known to occur in non-periodic, often intense, bursts. These accretion bursts are accompanied by strong photometric brightness variations of the star, typically on time-scales of months or longer. At the same time smaller amplitude changes in the pre-main sequence star's light curve, on time scales of weeks and days, are expected due to inner disk warps and accretion columns that move into the line of sight as the star-disk system rotates. In this contribution we present our observational programme to study the photometric variability of several hundreds of PMS stars in the low metallicity environment of the Large Magellanic Clouds.

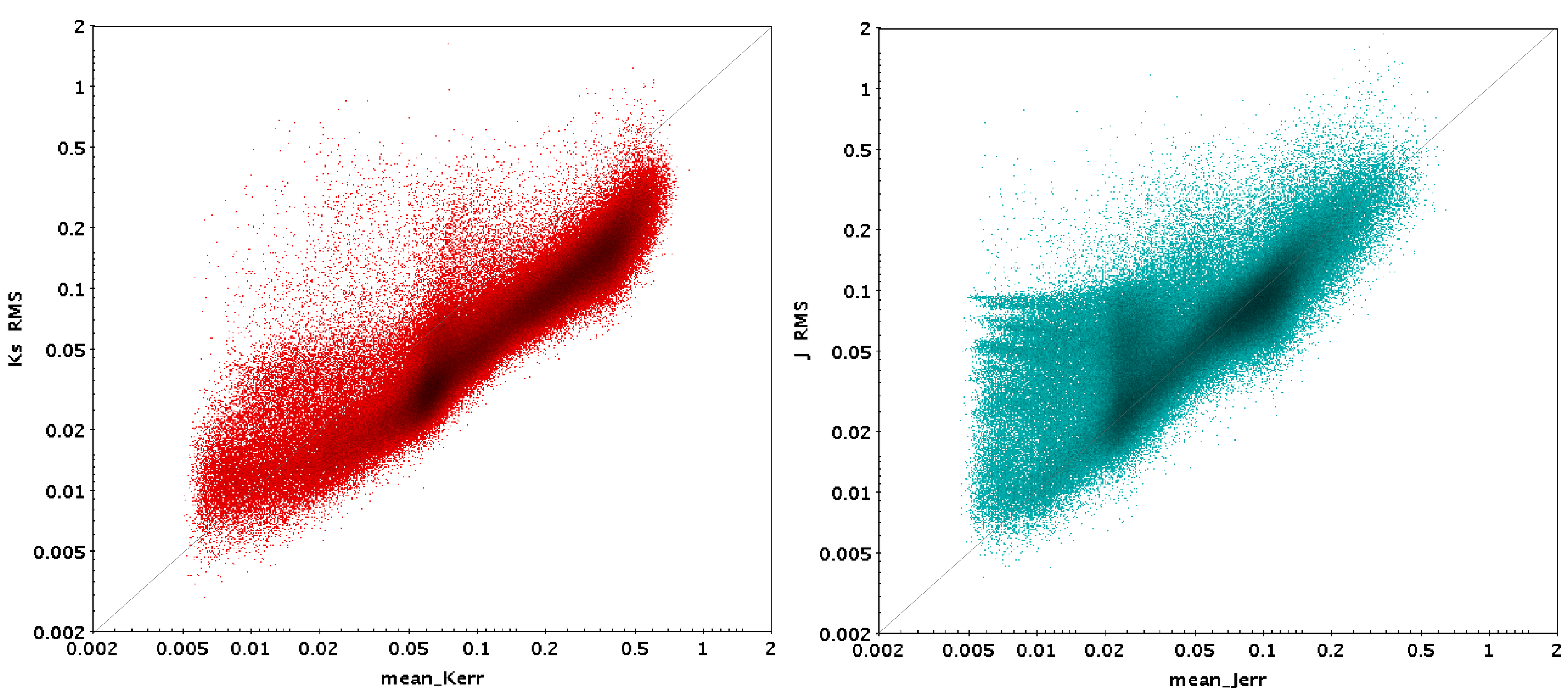
Observational data

- Sky field of 1.5x1.0 deg in the NE of the LMC, containing ~500,000 sources imaged at K_s and J (with K_s<19.5m and J<21m) with VISTA.
- Images are obtained at 150 epochs at K_s and 90 epochs at J, between 2011 and Feb 2018 (under ESO prg.ID 179.B-2003 → VMC public survey, and 0100.C-0248).
- Due to an individual epoch/image not covering the full 1.5x1.0 deg field, each source is **typically** observed at 50 epochs (K_s) and 30 epochs (J).
- PSF photometry (Rubele at al. 2012) has been performed for all the epoch images. Typical 5 σ limiting magnitudes per epoch are 19.8 (K_s) and 20.7 (J).

Data Analysis

1. Select sources with No. J_{epochs} > 10 and No. $K_{s,epochs}$ > 14 to ensure a robust and meaningful statistical analysis.
2. Investigate the photometric error behaviour (see Fig. 1)
   ===> K_s-band PSF photometry seems to overestimate the photometric error (origin not yet know)

Figure 1: Mean photometric error from PSF photometry versus the rms of the sources magnitudes



3. The statistical χ^2 value is calculated for each source as $\chi^2 = \frac{1}{N-1}\sum_{i=1}^{N}\frac{(mag_i - \overline{mag})^2}{\sigma_i^2}$ and the χ^2 distribution of all sources at K_s and J is plotted respectively (Fig. 2).

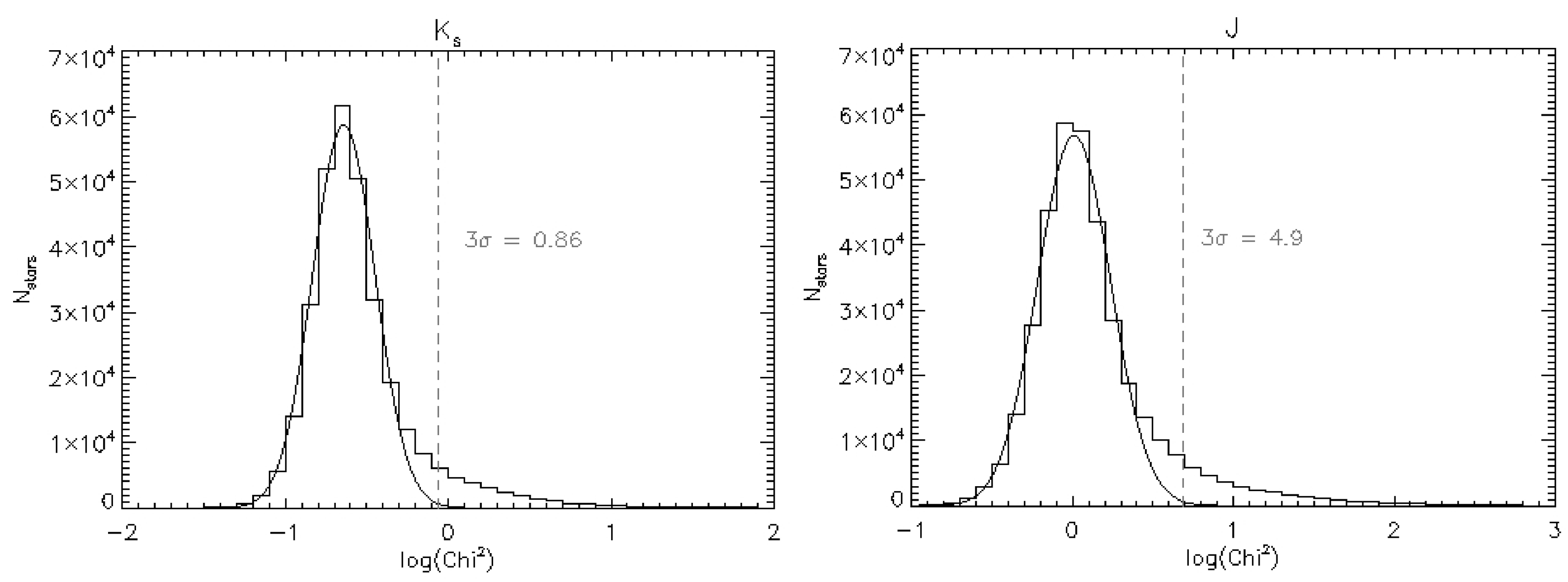
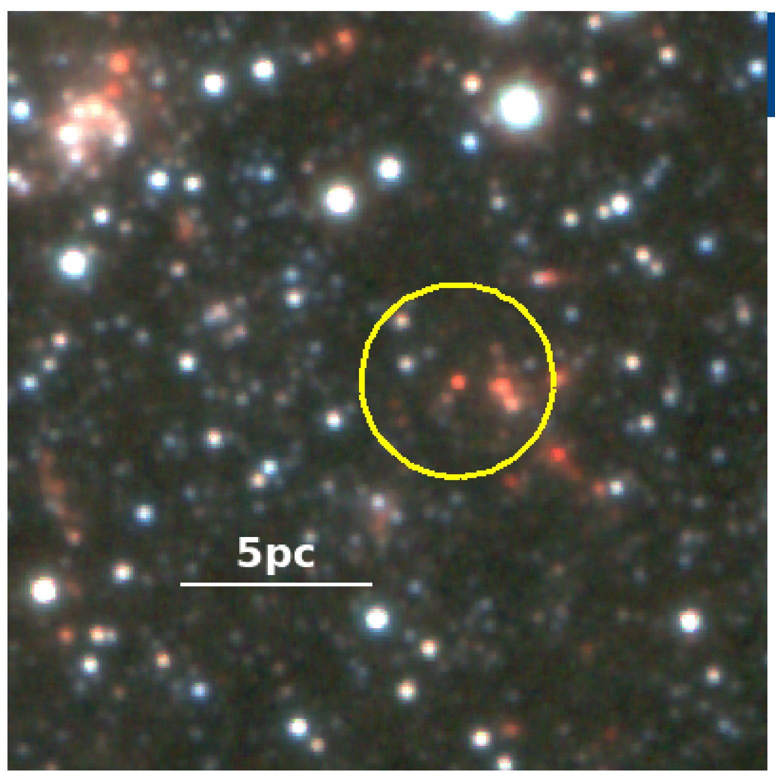
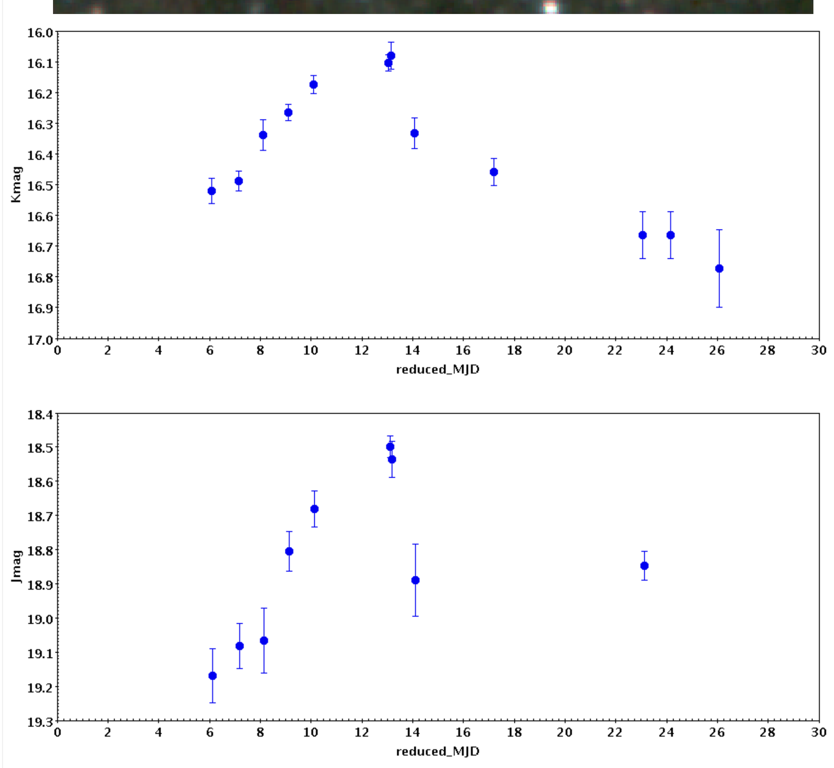


Figure 2: χ^2 distributions for the Ks (left) and J band (right) and their respective Gaussian fits. The vertical dashed line indicates our chosen threshold value.





First results

Adapting a conservative criterium of χ^2(J) > 4.9 and $\chi^2(K_s)$>0.86 to identify variables, we find a total of **15,047 candidate variables**. In the star forming region N44 we identify ~800 candidates out of which 11 are coincident with YSO catalogs from Chen et al.2009 and Seale et al. 2009 (see Figure 3).

As an example we show to the left the light curves of the YSO marked with a yellow big circle.

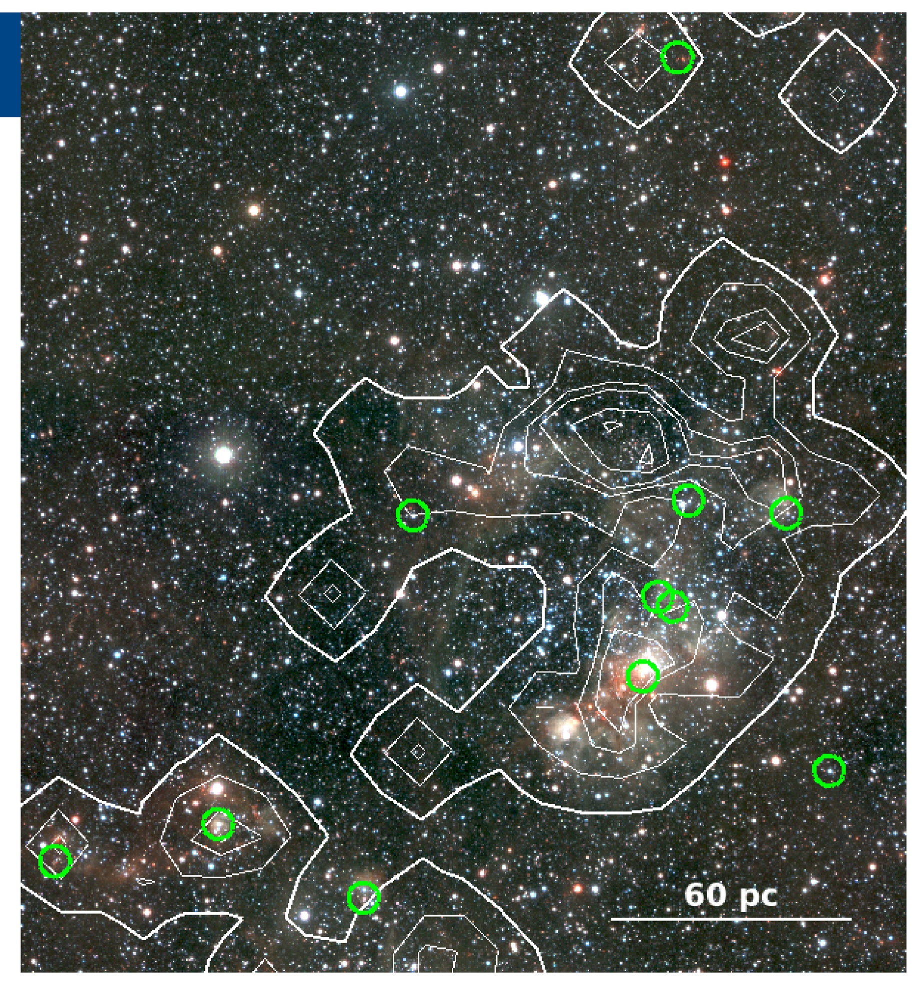


Figure 3: Variable candidates identified in our study (green circles) in the SF region N44 and that are also identified as YSOs in previous studies (Chen et al. 2009, Seale et al. 2009). White lines indicate PMS density contours (Zivkov et al. 2018)

Next steps

- Calculate the Stetson index to quantify the variability correlation between J and K_s.
- Investigate variability characteristics of young stellar populations and compare them with Galactic studies (e.g. Contreras Peña et al 2016, Rebull et al. 2014).