A multi-wavelength study on the (interesting?) high mass star forming region RCW 34

Robert J Czanik, Phd candidate
Supervisor: Prof. D.J. van der Walt
Center for space research
North-West University (South Africa)
Potchefstroom campus

INTRODUCTION:

RCW 34 is a star forming region located at 2.5 kpc in the constellation of Vela. Various observations will be conducted on RCW 34 in the NIR (IRSF), MIR (HERSCHELL – PACS and SPIRE) and optical (Imaging and MOS). These observations will be used to determine what fraction of the population are Hα emmiters, present variabilty, excess NIR emission, Li absorption-lines and excess blue optical colours.

All of the observations will be used in a Bayesian statistical model to construct a detailed star formation history for the region, determine the SFE, construct an IMF, determine how many members are part of multiple systems (binary or more). By knowing these properties for RCW 34 it will be possible to determine if there is something signifigant about it if compared to other star forming regions.

BACKGROUND:

The region, it's exciting stars (An O8.5V and two B type stars) and a group of young cluster members located in a cleared out bubble region have been studied in depth in the previous papers. There seems to be more to this region than what is given in the literature because it presents multiple epochs of star formation: (i) an associated methanol maser, (ii) the exciting stars and young young members in the bubble clearing, (iii) faint members uniformly distributed in the area surrounding RCW 34.

In a paper by van der Walt et al. (2012) it was shown that roughly 700 sources cluster above the CTT locus, in a manner that is not common for other star forming regions. Previous studies missed this part of the cluster because they were only detectable in images totaling 10 800 seconds in exposure time.

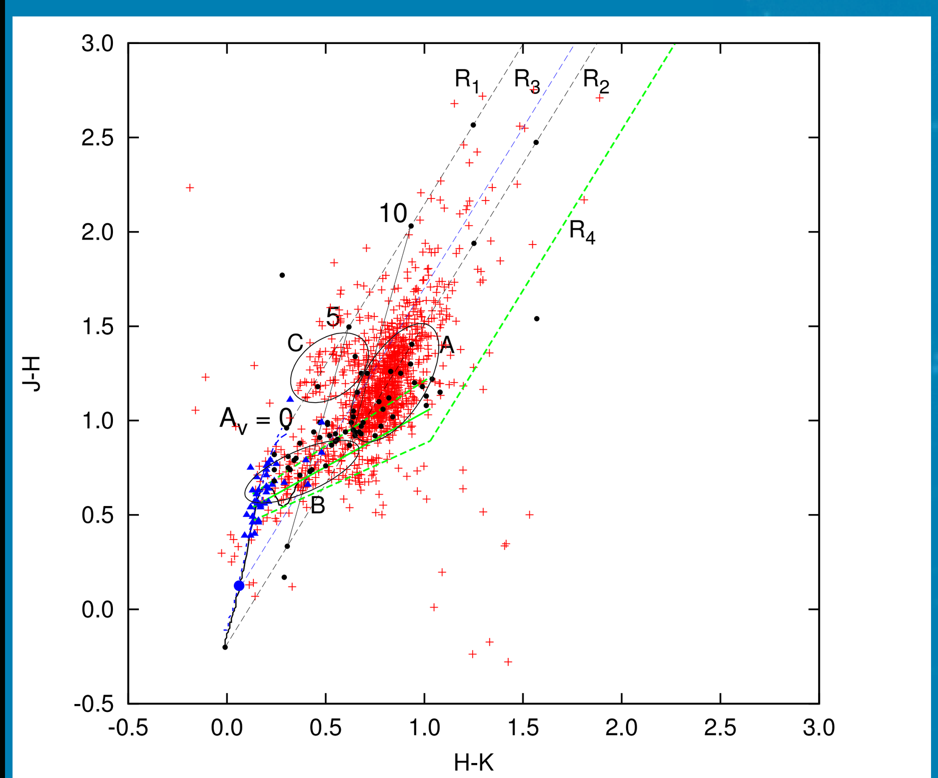

Fig. 1: Group A have roughly 700 sources that cluster above the CTT locus in a way that is not common in other star forming regions. One major goal of this study is to determine what is the cause for this clustering.

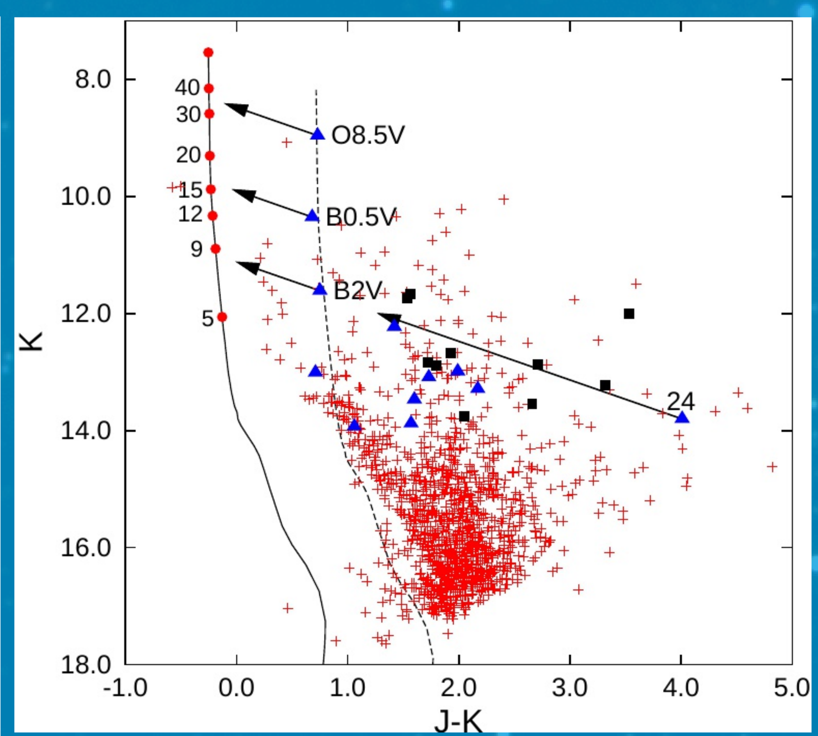

Fig. 2:The blue triangles are MS stars and the black squares are YSO, all of these sources were confirmed by Bik et al. (2011). The majority of the cluster members are faint low-mass cluster members that were missed by previous studies.

NIR PHOTOMETRIC OBSERVATIONS:

All of the observations have been conducted in 2005, 2012, 2013 and 2014 with the 1.4-m IRSF telescope using the SIRIUS camera. The time of these observations makes it possible to search for short- and long duration variability (lasting hours/days, weeks or years).

Deep imaging has been performed on an extended area around RCW 34, spanning 15.9' x 15.9'. Enabling an investigation on how far the faint, more mature PMS stars stretch out from the cluster's centre.

Fig. 3: The Infrared Survey Facility is a 1.4-m telescope that was opened on 15 November 2000. All of the images for this project were obtained with the IRSF/SIRIUS camera, it has a field of view

Fig. 4: A colour composite of the 7.7' x 7.7' deep-NIR image that was used for the analysis of figures 1 and 2. The JHKs images were median stacked using imcomb, 1280 sources were detected.

Fig. 5: This 15.9' x 15.9' mosaic was built with the MONTAGE package. There are 5097 stars that match in the JHKs bands. This extended field was observed to detemine how far the cluster extends and how many members have variability.

COLOUR-MAGNITUDE DIAGRAM FOR THE LARGER FIELD

The colour-magnitude diagram for the 2012 study had an extinction of A_v=5.1, which was calculated by dereddening the exciting stars onto the MS. For the extended study it appears that there are two groups in the field, the first is the field stars in the direction of RCW 34 which lie close to the main sequence with A_v=0; The second population has an average A_v=2.1, this may be due to the average visual extinction across the whole cluster.

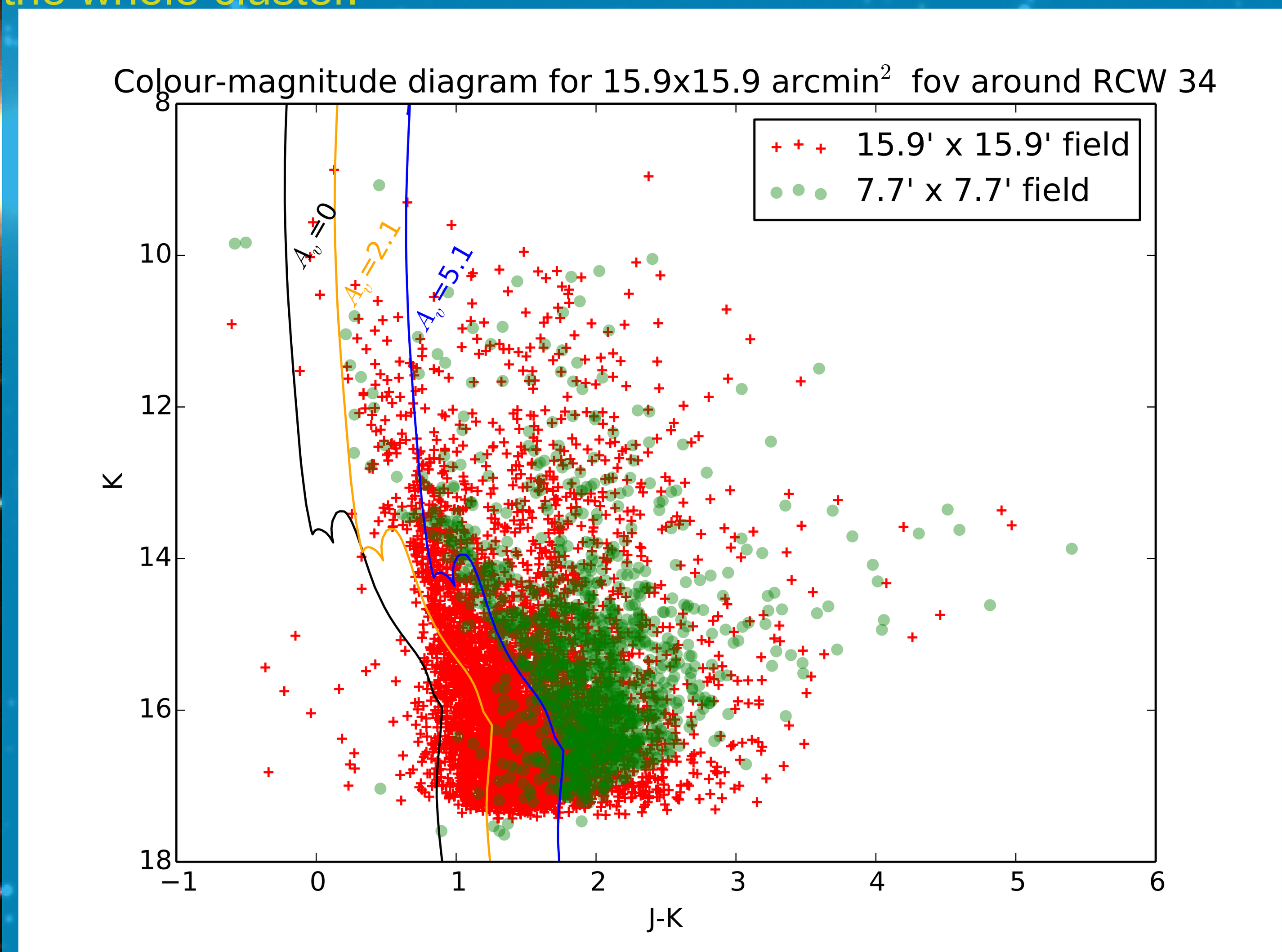

Fig. 6

COLOUR-COLOUR DIAGRAM FOR THE LARGER FIELD

The colour-colour diagram of the extended field contains many more sources than the previous deep-NIR study. This drastic increase in the number of sources may be due to lower extinction further away from the HII region.

The colours for the observed population were calibrated using 143 stars that matched between 2MASS star data and the IRSF observations, in a manner similar to the previous study. The difference between the distribution on the colour-colour diagram for the 7.7' x 7.7' and the 15.9' x 15.9' fields show that the calibration from the instrumental to 2MASS system is very sensitive to colours/magnitudes. Using calibration equations dependant on parameters that were averaged to fit for the 143 stars across the whole field instead of the 7.7' x 7.7' may be the reason why the distributions differ.

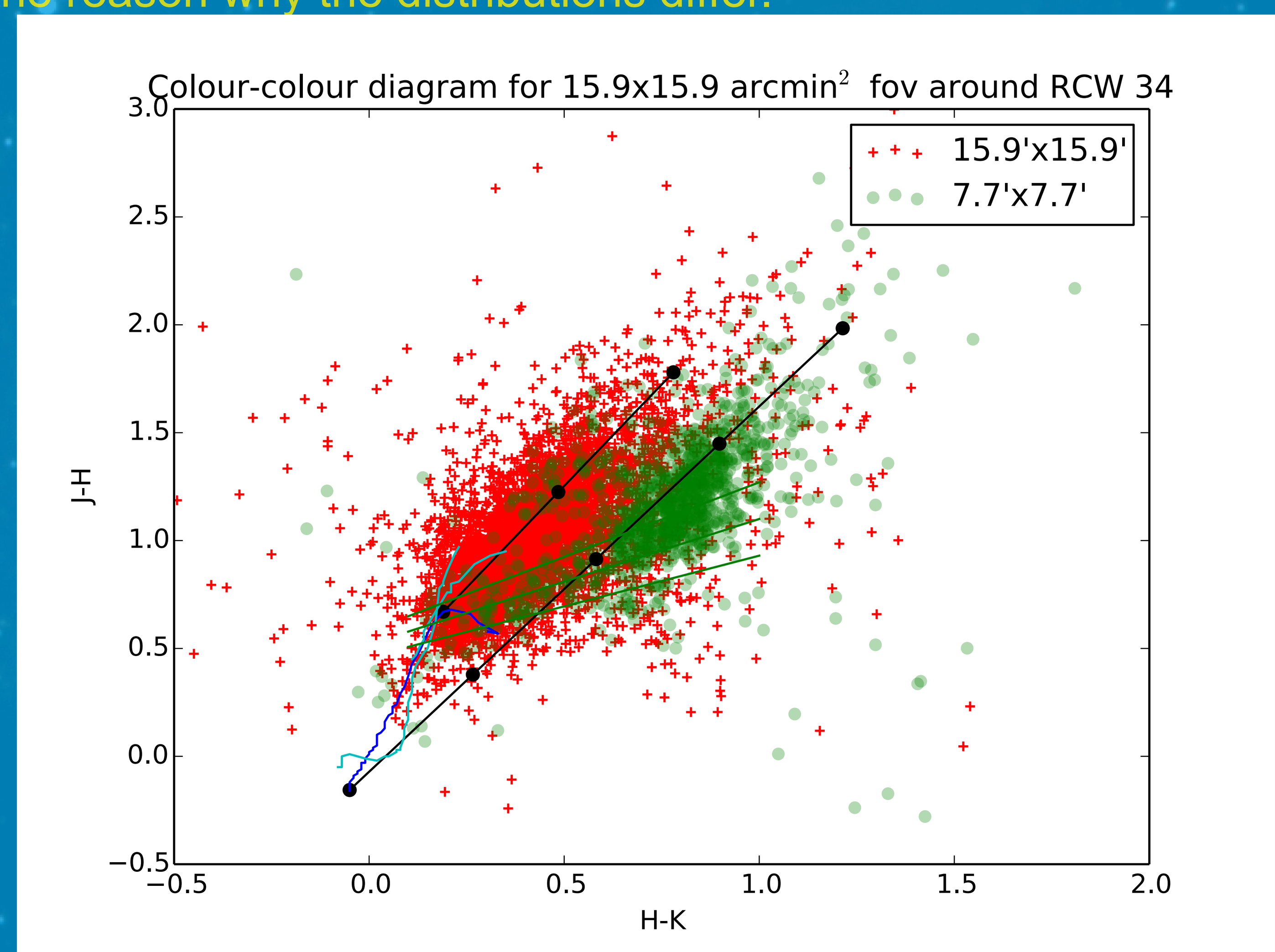

Fig. 7

SUMMARY

The colour-colour and colour-magnitude diagrams show that the calibration from the instrumental IRSF magnitudes to the apparent magnitudes of the 2MASS system is very colour-dependant. This may be the reason why the grouping on the colour-colour diagram of the sources from the extended study is not identical to that from the 2012 study.

There may be many reddened calssical T Tauri cluster members if one looks at the colour-colour diagram of the 15.9' x 15.9' field. The location allows many stars to be dereddned either onto the MS or the CTT locus.

The question to what may be the reason for the difference in the distributions between the 7.7' x 7.7' and the 15.9' x 15.9' fields is still open.

FUTURE WORK

Photometry has been performed on all of the individual images for the test of variability with a pipeline that was written in python, the analysis still needs to be conducted. By identifying field stars that are not variable the deep-NIR images can be calibrated towards an apparent IRSF photometric system and does not need to be dependant on 2mass calibration.

By using the MIR-PACS photometry in addition to the deep-NIR photometry a detailed extinction map can be constructed for the region. Using this map will make it possible to correctly determine how much excess emission each star emits and where it would lie in relation to the CTT locus on a NIR colour-colour diagram.

Optical photometry will be performed on the MONET/South (SAAO) telescope using sloan and H-alpha filters. This will show which fraction of the cluster members have H-alpha emission from an accertion disk. The colours from the broad-band optical photometry will also show which cluster members have excess blue emission, caused by matter shocking onto the PMS's surface from the accretion disk.

MOS will be performed on the sources with the H-alpha emission and the reddest NIR colours. This will be done to determine how many of these stars present a Li-absorption line.

Once all of this data has been gathered and reduced it will be possible to construct a Bayesian model. This model will be used to construct a detailed star formation history of the region, determine the IMF, SFE, initial mass of the molecular cloud, accretion rate for some culster members, test for binarity. It may also show what is the cause for the clustering of the 700 sources above the CTT locus in Fig. 1.

REFERENCES

van der Walt D.J., et al. 2012, AJ, V 144, Issue 1, id.; Bik A., et al. 2010, AJ, V 713, Issue 2, pp. 883; Heydari-Malayeri, M. 1988, A&A, V 202, no. 1-2 pp. 240; Pagani L., et al. 1993, A&A, V 275, no. 2, pp. 573; Vitone A.A., et al. 1987, A&A, V 179, no. 1-2, pp.157; Rieke, G.H. & Lebofsky, M.J. 1985, ApJ, V 288, p. 618; Hill T., et al. 2011, A&A, V 533, id. A94; Ellerbroek L.E., et al. 2013, A&A, V 558, id. A102; Bressan A., et al. 2012, MNRAS, V 427, I 1, pp. 127