AN UNUSUAL ABUNDANCE OF T TAURI STARS?

NIR STUDY OF THE SOUTHERN HIGH MASS STAR FORMING REGION RCW 34

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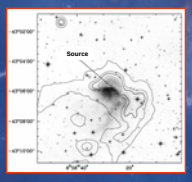
BACKGROUND ON RCW 34[1,2,3]

- Galactic southern nebula with a cometary shaped, bright HII region of dimensions ~2' x 2'
- Ionization front with a bright point source: 12th mag PMS O-star with L = 5 x 10^5 $L_\odot$ and R ≈ 23 $R_\odot$
- Star formation at the border of the ionization front
- Galactic coordinates l = 264.29 b = +1.48
- ~3 kpc towards the R-association Vela R2
- Visual extinction towards RCW 34: A_V = 4.2 mag
- The large IR excess is due to emission from circumstellar material



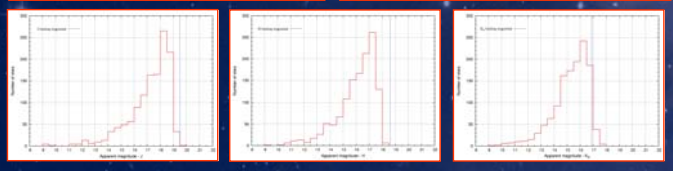
OBSERVATIONS AND DATA REDUCTION[4]

- Observed with the 1.4 m IRSF at Sutherland, South Africa in April, 2005.
- Imaged in J (1.25 μm), H (1.64 μm) and K_s (2.2 μm) bands simultaneously with the SIRIUS camera.
- Field of view is 7.8' x 7.8' and pixel scale 0.45".

36 dithered image sets, 30s exposure per snapshot → total integration time of 3 h. → **Dark frame subtraction, flat field division & sky frame subtraction done with SIRIUS pipeline in IRAF.** → **Source selection with DAOPHOT in IRAF. PSF photometry done with PHOT, PSF and ALLSTAR.**

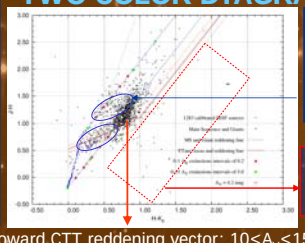
MAGNITUDE DISTRIBUTIONS

- Calibrated using 2MASS point source catalog.
- Theoretical limiting magnitudes for a 3h exposure are 19.5, 18.6 and 16.9 mag in *J*,*H* and K_S respectively.
- Apparent magnitudes binned in 0.5 mag.
- Obtained deep images: detections even fainter than the theoretical limiting magnitudes for *J* and K_S.
- Sharp turn-over at faint magnitudes due to sensitivity limits, incompleteness in detections and mass dependency of underlying Luminosity Functions.



TWO COLOR DIAGRAM

- MS and giants[6] plotted with their reddening lines.
- CTT locus and its reddening line from Meyer *et al*[3].
- A_V in steps of 5mag, and A_K in steps of 0.2 mag indicated along reddening lines. Reddening laws from Rieke & Lebofsky[7].



Two "groups" of MS/Giants[8] → foreground MS (A_V ~ 4.2mag) & foreground Giants (A_V ~ 20mag for background)

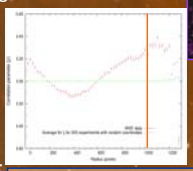
Stars with IR excess

- Majority of stars toward CTT reddening vector: 10<A_V<15 mag.
- This clustering cannot be background field stars: A_{V_GMC} + $A_{V\_interstellar}$ ≈ 10mag + 4mag ≈ 15 mag → must be inside the molecular cloud.
- If reddened MS → dereddening would result in many massive stars – only one exists for RCW 341.
- Literature: RCW 34 is known for several PMS objects[1], **seemingly CTTs?**

TWO POINT CORRELATION FUNCTION

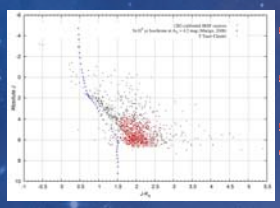
- Location of "CTT" stars on the image (right) → looks like background stars. Following previous arguments, they are not field stars → possible underlying cluster with dimensions > image frame.
- Two point correlation analysis[10]: Two-point correlation function $\xi(r_{12})$: the probability that points appear in each of the volume elements dV_1 and dV_2 at separation r_{12} $dP = n^2 dV_1 dV_2 [1 + \xi(r_{12})]$
- ξ the correlation function parameter:
- Poisson process: ξ = 0
- Significant clustering: ξ > 0
- Numeric formula: $\xi = \frac{DD_s \times RR_s}{DR_s^2} - 1$

(DD: data-data seperation; DR: data-random seperation; RR: random-random seperation).

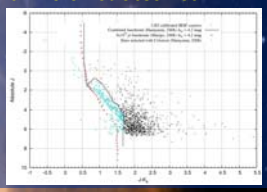


ξ shows two significant clusterings with dimensions ~ 90 arcsec and ~ 500 arcsec – the latter larger than the image size (orange line).

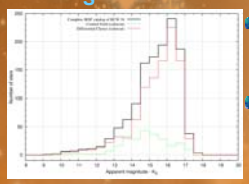
COLOR MAGNITUDE DIAGRAM



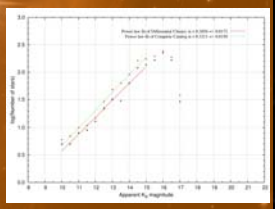
- Stars clustered on 2CD lie at low-mass PMS end of CMD.
- This is the location for CTT's among others.
- RCW 34's population is mainly PMS stars.
- To obtain the KLF – *control fields* were needed, which were not observed.
- Alternative method – *colorcut*[11].
- Used a combined isochrone from PMS, low-mass PMS and MS isochrones.
- Selected all stars bluer than the isochrone and used them as a statistical estimate for the amount of field stars.



K_S-BAND LUMINOSITY FUNCTION (KLF)



- Used the statistical estimate of field stars from the *colorcut* to draw a magnitude distribution representing the control field.
- Subtracted the "control field" from the complete distribution → obtain the **differential cluster** necessary to draw the KLF.
- The shape of the KLF approaches a power law[12] for bright stars given as $\frac{dN(K_s)}{dK_s} \propto 10^{\alpha K_s}$
- For RCW 34 **α = 0.31**
- According to (13,14) α ~ 0.17–0.33 for younger clusters (< 1 Myr) with a low-mass stellar population. Models from (15) showed α equal to 0.36, 0.24 and 0.27 for 1 Myr,5 Myr and 10 Myr respectively.



CONCLUSIONS

- RCW 34 is a special SF region with a few stars showing an IR excess, but seems as if it has an uncommon abundance in T Tauri stars.
- This possibility was confirmed by:
  - a CTT clustering on the 2CD
  - the PMS clustering on the CMD, as well as
  - the significant clustering at dimensions larger than the image frame size, indicated by the second "bump" in the Two point correlation analysis.
- A possible explanation for the above features could be the existence of an underlying, wide CTT cluster with a smaller cluster centered around the massive star.
- The KLF (α = 0.31) of RCW 34 shows that it is indeed a region of low stellar masses with an age of about of 1 Myr.
- Spectroscopic confirmation of such an underlying T Tauri cluster is necessary before any definite conclusions can be made.

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