An ongoing investigation on the ejection processes in the young open cluster NGC 6530

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INTRODUCTION

Studying mass loss in young stars is an essential part in understanding not only stellar but also disk evolution. This mass loss is usually found in the form of slower winds and powerful, highly collimated jets, and it is present in young objects across different mass ranges and evolutionary stages [1]. There are still a lot of uncertanties to address in terms of exactly which mechanisms power this mass loss and its precise impact in the evolution of young stellar objects. NGC 6530 presents an opportunity to further advance these investigations, due to showing signs of sequential star formation and a higher mass distribution [2], when compared to other clusters that have gone through similar analysis [3].

OBJECTIVES

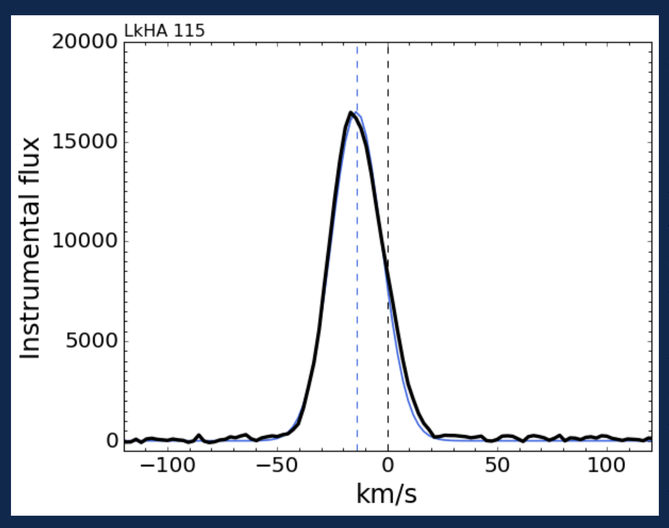
To investigate possible correlations between the properties of the [OI]6300 line, a well-known tracer of winds and jets [4], and properties of the star-disk systems in the young open cluster NGC 6530.

METHODS

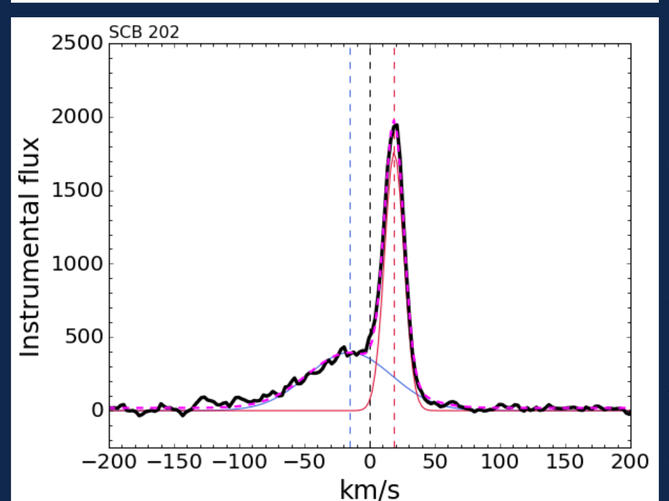
The sample consists of high resolution (R~24000) FLAMES spectra of 274 stars located in the region around NGC 6530 (the Lagoon Nebula), observed in August and September of 2017. The spectra are first decontaminated of telluric emission and absorption lines, as well as nebular emission lines, then have photospheric features removed whenever necessary. The stellar spectra go through a search for emission in the [OI]6300 line, in which a detection is considered positive in any emission with a peak above 3sigma and FWHM above the spectral resolution of 12.40km/s. Finally, line profile features are identified. This work is ongoing and we present here the preliminary results that showcase the potential of this survey.

Examples of detection found so far

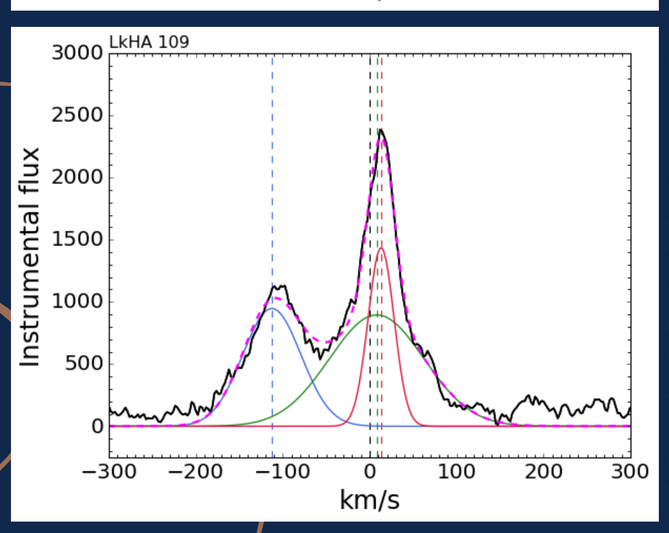
All spectra shown below have already gone through telluric correction and have been shifted to the stellar rest velocities or the mean radial velocity of the cluster, taken from [5], whenever stellar rest velocites were unable to be determined. Stellar parameters were taken from [6] to [14].



LkHα 115 is a B7 HBe star. Its profile shows what is most likely a signature of a slow wind, centered around -13km/s, marked by the blue dashed line. The stellar spectrum is shown in black, and the fit is shown in blue. The lack of a high-velocity component - as well as a lack of detection of emission in [OI] for most of the sample of hotter stars - supports the idea that the ejection process traced by the HVC of the [OI]6300 line may be closely related to the stellar magnetic fields, since B type stars are known to present much weaker magnetic fields than their cooler counterparts.



SCB 202 is a K5-6 CTTs. Its spectrum shows two distinct, very assymetric peaks: One, is the broad low-velocity component (BLVC), slightly blueshifted to around -15km/s. The second peak marks the narrow low-velocity component (NLVC), redshifted to around 18km/s, which is a considerably high redshift for a NLVC, making it necessary to obtain more precise measurements of this stars radial velocity to confirm this value. The fit for the sum of the two components is shown in the pink dashed line.



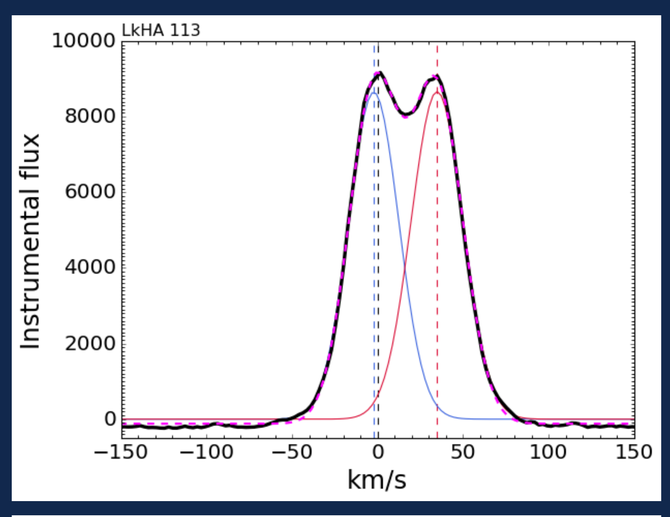
2MASS_J18035783-2425349 (LkHα 109) is a late-G CTTs. Its spectrum shows clear signatures of a jet, characterized by the high-velocity component (the HVC, shown in blue), blueshifted by around -100km/s. This profile also presents signatures of slow winds, shown by the broad low-velocity component (BLVC) in green and the narrow low-velocity component (NLVC), shown in red. Both low-velocity components are slightly redshifted by around 10km/s, which could be explained by the uncertainties in the current estimate of this system's radial velocity. The sum of the three gaussians is shown in the pink dashed line.

INITIAL RESULTS AND REMARKS

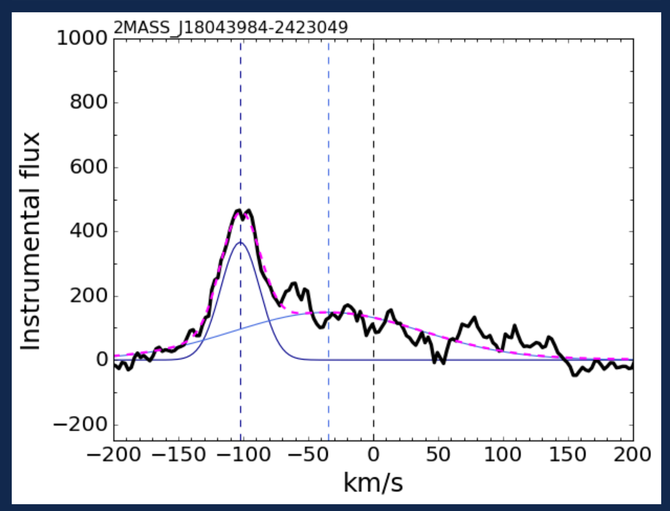
Out of the 274 stars, 57 are classified as classical T Tauri stars (CTTs), 46 are weak-line T Tauri stars (WTTs), 19 are Herbig Ae/Be stars (HAeBes), and two are Class 0/I YSOs. There are also 18 early-type stars and 46 late-type stars with no indication of stellar youth found in the literature, as well as 88 Stars with unknown spectral types, one of which is a CTTs and one which is a Class 0/I YSO. Cluster membership is still being verified. Furthermore, there are 16 stars with either unknown spectral types and/or no previous youth indicators, but that present clear signatures of emission in their spectra, meaning that this classification is not definitive and might change. Among the stars in the sample, 35 sources have emission in the [OI] line confirmed thus far, with 17 CTTs, 1 HAeBe, 1 Class 0/I YSO, as well as 16 stars with unidentified classification.

NEXT STEPS

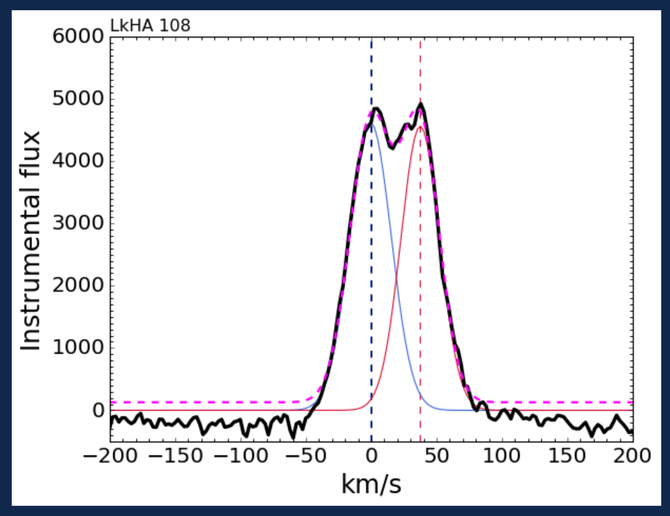
- Confirm spectral types and estimate radial velocities for all sources in which [OI] is detected
- Characterize the [OI] line profiles for all sources in which detection is confirmed and classify all of the different velocity components found in the spectra of the sample
- Analyze the kinematic properties of the line profiles and its correlations with stellar and accretion properties
- Perform a more in-depth investigation on the low velocity-components and their possible origins
- Perform more in-depth investigation on the possible origins of the two double peaked low-velocity profiles found



LkHα 113 is one of the stars with unknown spectral type. It should be noted that there is great uncertainty in the radial velocity used for this star. Since we were unable to find absorption lines in this spectrum to calculate the stellar radial velocity, this profile has been shifted to the clusters mean radial velocity of -2km/s, so as to give at least a general sense of the characteristics of the emission. Another interesting aspect of this star is that its spectrum appears to have a few other lines with a similar double-peak structure. The decomposition of the profile is shown in blue and red, while the sum of the two profiles is shown in the pink dashed line.



2MASS_J18043984-2423049 is a K6-7 CTTs. Its spectrum shows a nice example of an asymmetrical profile, composed by a jet signature (the HVC) , seen in darker blue, blueshifted by around 100km/s, and a slow wind signature (the BLVC) , seen in lighter blue, centered around slightly less than 50km/s, a high value for a BLVC, which might be due to the amount of noise in this profile. The sum of the two gaussians that make up this profile is shown in the pink dashed line.



LkHα 108 is a Classical T Tauri star. Its spectra presents a clear double-peaked [OI] profile, possibly a signature either of the disk surface or a NLVC plus a HVC projected at a low radial velocity [15]. In this case, however, the shift of the spectrum with respect to the stars estimated radial velocity of -2km/s puts one of the two peaks close to the stellar rest velocity, while the other seems redshifted by around 35km/s, which would imply that there is an asymmetric jet projected at a low radial velocity, with only the red lobe observable. The decomposition of the profile is shown in blue and red, while the sum of the two profiles is shown in the pink dashed line.

REFERENCES

[1] Edwards et al+ (2008) **[2]** Damiani+ (2018) **[3]** McGinnis+ (2018) **[4]** Hartigan (1995) **[5]** Conrad+ (2017)
[6] Venuti+ (2021) **[7]** Prisinzano+ (2019) **[8]** Wright+ (2019) **[9]** Gaia Collaboration (2018) **[10]** Pecault & Mamajek (2013)
[11] Prisinzano+ (2012) **[12]** Prisinzano+ (2007) **[13]** Arias+ (2007) **[14]** Reed (2003) **[15]** Fang+ (2019)

A special thanks to: