Resubmission of

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Date received: *proposal* *Thesis* **Panel:** **Category:**

A survey on the spectrum of Young Stellar Objects (YSOs) in the Orion Nebula Cluster

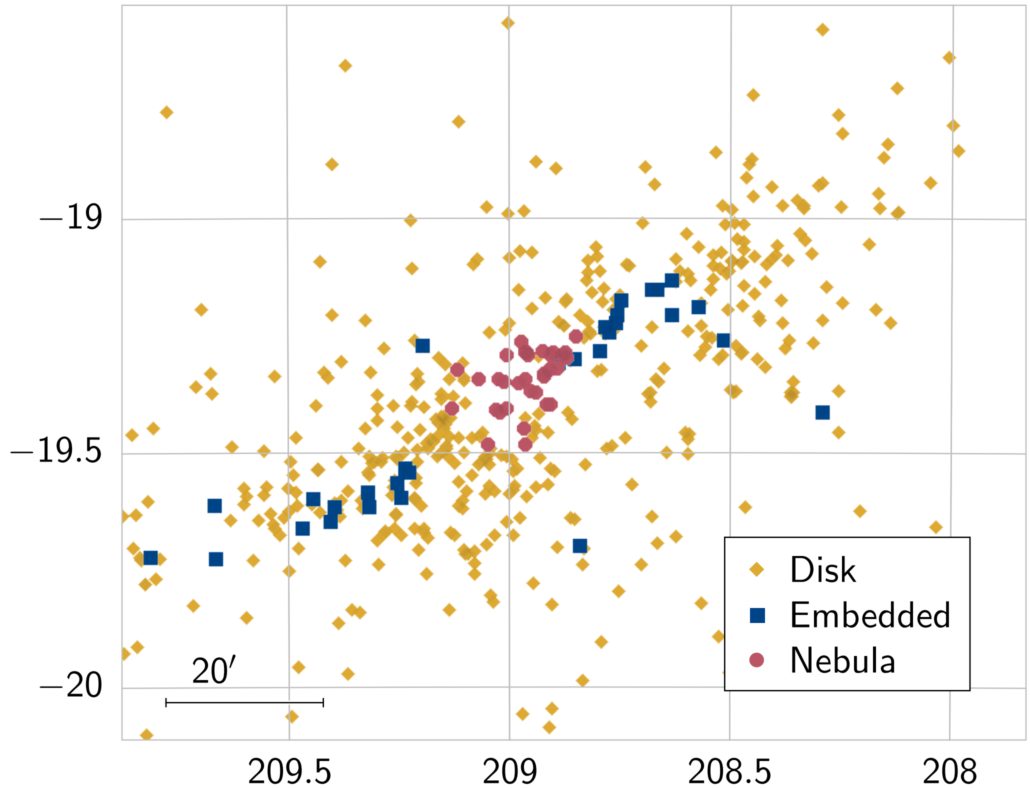

Figure 1: Disk, embedded, and nebula sources in the orion nebula region (adpated from Kounkel et al, 2023)

Scientific Justification *Be sure to include overall significance to astronomy. For standard proposals limit text to one page with figures, captions and references on no more than two additional pages.*

Orion Nebula Cluster, known for its rich population of Young Stellar Objects (YSOs), presents a unique opportunity to study star formation processes. This region's diverse star-forming environments make it ideal for analyzing the spectra of Class I and II YSOs, which are known for their stellar disks and accretion processes. We have already been able to do a low resolution spectra survey to separate the disk sources and other sources in that region (Kounkel et al, 2023). These disk sources are the possible Class I and Class II YSOs in that region. So, this specific region in the sky can be a good target to analyze spectrum to get the properties of Young Stellar Objects (YSOs). The objective of this study is to understand these accretion processes better by calculating the veiling of spectra (like Gregory et al, 2023).

Veiling: Veiling is the ratio of accretion flux to photospheric flux at a given wavelength which provides insights into the strength of accretion disks.

So, if veiling is r_λ, accretion fluf is $F_{acc,\lambda}$ and photospheric flux is $F_{phot,\lambda}$,

$$r_\lambda = F_{\mathrm{acc},\lambda}/F_{\mathrm{phot},\lambda}$$

By comparing observed spectra to established models, we aim to derive the accurate veiling of the stars which will help us classify the strength of the accretion disk. It's also possible to find out the exact temperature and density of the accretion disk by comparing with existing model (like Kwan et al, 2011).

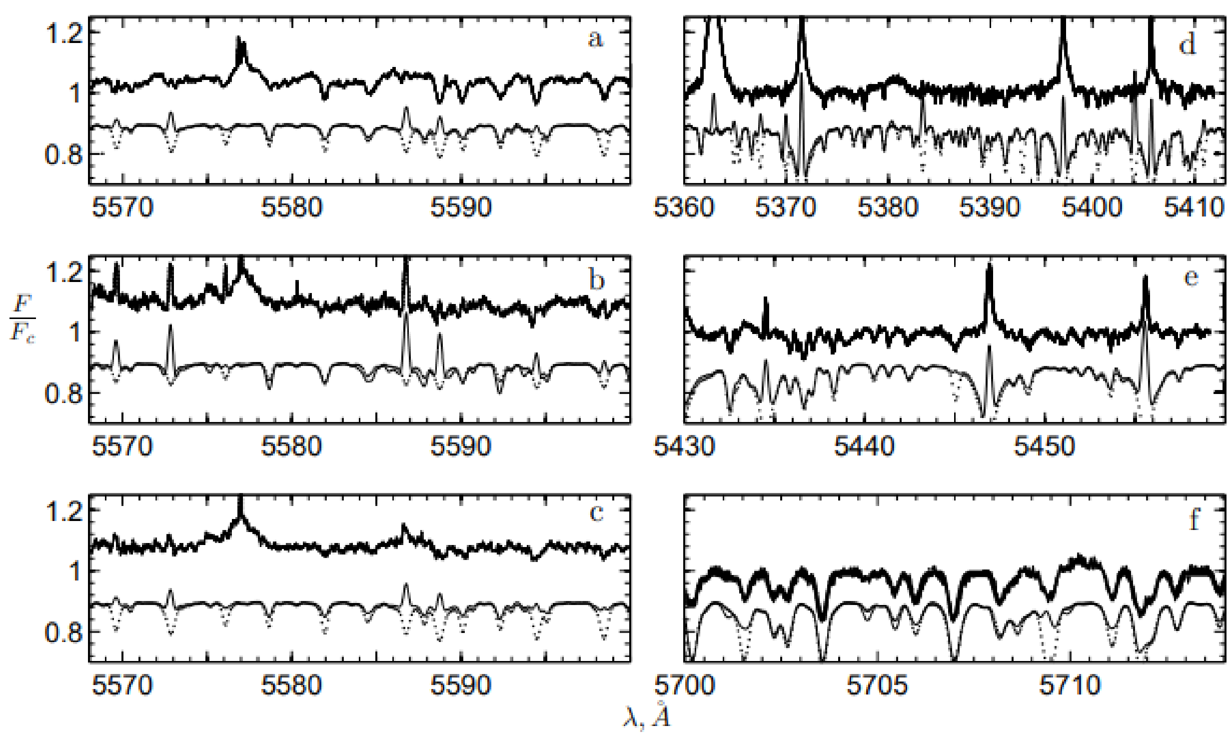

Figure 2: Calculated and observed spectra of heavily veiled six different sources (adapted from Dodin et al, 2012). The thick curve indicates the observed spectrum, while the thin solid line indicates the spectra of the models from the table. The dotted line indicates the spectra of the same models calculated by disregarding the emission in lines.

References

Dodin, A. V., & Lamzin, S. A. 2012, Astronomy Letters, 38, 649.

Gregory J. Herczeg et al 2023 ApJ 956 102.

Kounkel, M., Zari, E., Covey, K., et al. 2023b, ApJS, 266, 10.

Kwan, J., & Fischer, W. 2011, MNRAS, 411, 2383.

Experimental Design *Describe your overall observational program. How will these observations contribute toward the accomplishment of the goals outlined in the science justification?*

We are planning to use IGRINS-2, available at both Gemini North and Gemini South, for its capability in this spectral range and resolution. We are alos planning to target for a 15 magnitude limit as that will give us the best YSO spectrum considering lower exposure time based on the region (Orion nebula) that we are targetting for.

The H-band (1.49-1.80 micrometers) and K-band (1.96-2.46 micrometers) wavelength range of IGRINS-2 are ideal for studying YSOs. These bands are less affected by interstellar dust extinction, allowing us to observe regions obscured in optical wavelengths. These bands also include key spectral lines and features relevant to YSOs, such as molecular hydrogen emission, CO overtone bands, and Brackett series lines, which are essential for studying accretion processes, disk properties, and outflows.

A high spectral resolution like IGRINS 2 ($R \approx 4000$) will enable us to resolve fine spectral details, crucial for accurately measuring line profiles, velocities, and widths. This can provide insights into the kinematics of accretion disks and outflows. High resolution will also help in calculating the most accurate veiling which is vital for studying the environments around YSOs.

Also, the adequate spectral sampling in IGRINS-2 ensure that each spectral feature is well-represented across several pixels, enhancing the quality of the spectral data and allowing for precise measurements.

The Gemini telescopes' locations are advantageous for observing Orion, given the position of Orion near the celestial equator. This setup will allow a detailed spectral analysis of the YSOs, enhancing our understanding of their accretion processes and disk properties.

Galactive Coordinate	Lower limit	Upper limit
l	-20^o	-20^o
b	207^o	210^o

Table 1: The coordinate that we are targeting for

Technical Justification *Write the detailed technical justification*

The coordinate that we are targeting for is given in Table 1 (derived from Kounkel et al, 2023):

What I need to do now:

1. We're aiming for a signal to noise ratio of 100 as thta would be the best to observe the spectrum that we're targeting for. Now we can calculate the exposure time based on the signal to noise ratio, magnitude we're planning to observe, and the efficiency of the telescope:

2. Also, based on the field of view of IGRINS-2 and based on the area in the sky that we're targeting for, we may need to do multiple observations. We can calculate the number of observations based on the information that we have.

   What is your suggestions? Do I need to add anything else other than the exposure time calculation and number of observations I need to do?