Measuring accretion rates in volatile pre-main-sequence stars in NGC 2264

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Abstract

T-Tauri stars are low-mass, pre-main-sequence stars known for exhibiting significant variability on various timescales. Previous studies have characterized the morphologies of T-Tauri star light-curves from, young open cluster, NGC 2264 based on metrics for their stochasticity and symmetry. Burster stars are T-Tauri stars whose light curves evince significant brightening events in the optical is a quasi-aperiodic to aperiodic pattern over timescales of a few hours to over a week, often associated with increases in mass accretion. To investigate this, we gathered U and I band data to measure mass accretion of select Burster stars. We compared in Cody et al. (2014), Stauffer et al. (2014), and Venuti et al. (2014) and utilized U-band excess to calculate the mass accretion rates associated with 42 previously identified burster stars.

Objectives

1. Compute accretion rates for these stars
2. Are bursters still bursting after 10 years?
3. What similarities are there to the recent data, Venuti 2014?

What are Bursters?

- Displays significant brightening ('bursting') events in a quasi-aperiodic to aperiodic manner (negative asymmetry).
- Different patterns of burst events have been previously recorded
  - magnitude growth on the scale of 0.1-2.5 magnitudes, and timescales of less than a day to over a week (Cody et al. 2014).
- Hypothesized brightening events are due to interactions between the star's magnetosphere and inner disk
  - result in changes to the mass flow in accretion columns (Cody et al. 2014, Hartmann et al. 2016).

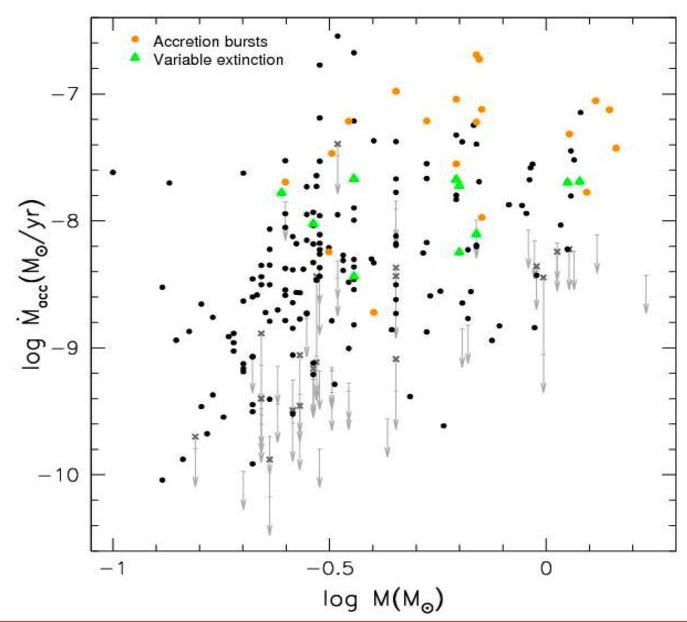


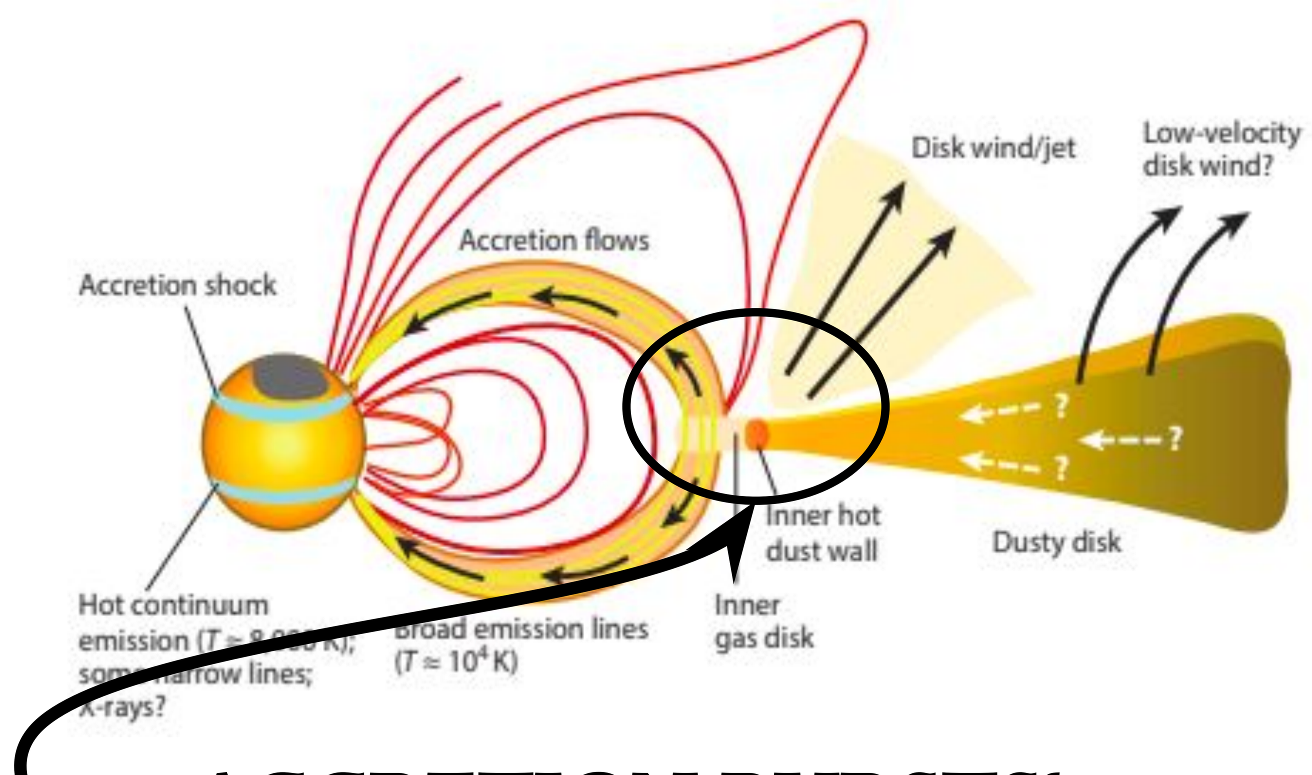
Figure 1. Displays Venuti (2014) mass accretion rate distribution as a function of stellar mass for the population of NGC 2264

What are we plotting?

- Venuti serves as a great reference in terms of mass accretion rate figures
- We can mimic their results to detect accretion activity as well as form a formidable comparison

Science Questions

1. How do **short-term mass-accretion rates change in Bursters,** if at all, on a scale of 6-7 years?
2. How much of a **relation** is there between stellar mass and mass accretion rates?



ACCRETION BURSTS!

Accretion burst are driven by the inner disk

Figure 2. Presents above are schematics of accreting stars. This figure highlights the components of accretion shock, flow as well as ejecta like disk dust and wind.

Bands

The morphological characteristics of these objects calls for inspection in multiple filters. Excess accretion from the system is optimally observed at shorter wavelengths such as ultraviolet.

- U band in order to obtain data to find the accretion rate.
- The I band filter to collect exposure of our target without the distraction of accretion.

Process

- We gathered data in the the U and I bands from February 22nd, 2021, to March 28th, 2021. One night of data used.
- The data will be binned 2x2 in order to meet storage and shorten operation time.
- U and I images were reduced from one band. This data was fed into a python code to reduce mass accretion rates where:
  - the aperture was corrected
  - Spectra → photometric point
  - Stellar parameters were used to convert accretion luminosity to accretion rate

Stars of interest

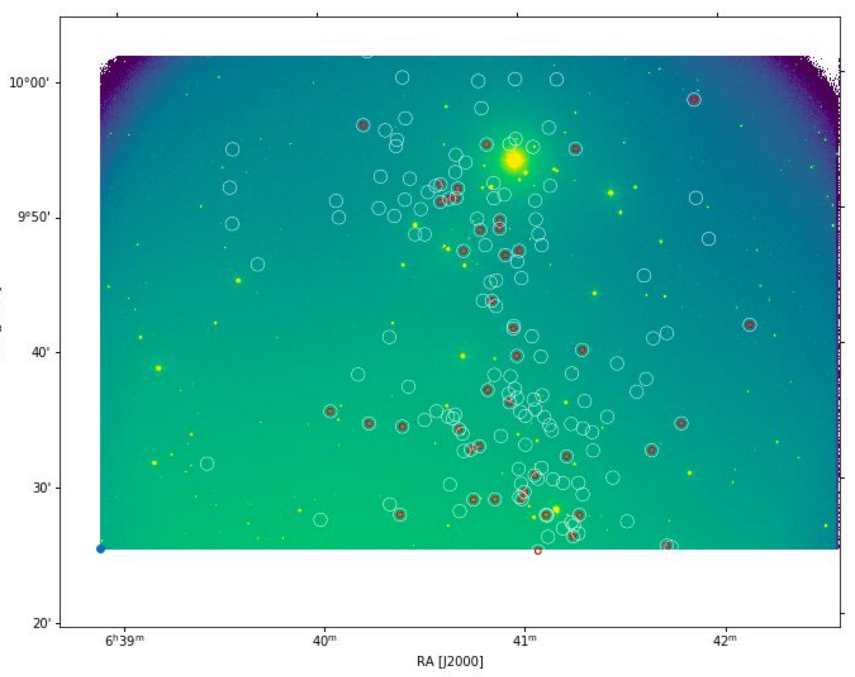


Figure 3. Displayed above is the the star cluster NGC2264 with the target stars highlighted. The red circle represent stars observed are bursters from Stauffer et al. 2014 and in white are stars of all morphology from Cody et al. 2014

Accretion Rate

$$\dot{M} \simeq \frac{L_{acc}R_*}{GM_*}\left(1-\frac{R_*}{R_{in}}\right)^{-1}$$

$\dot{M}$ the mass accretion rate where:

- L_{acc} is accretion luminosity
- R_{in} is inner disk magnetosphere truncation radii
- M_* is mass of star
- R_* is radius of star

What did we find?

- **15/42 stars examined**
- Even with the few stars recovered the **bursters are still strongly accreting**
- Data indicates a **weak negative mass - mass accretion rate relation**, but likely due to insufficient data coverage + diffuse association

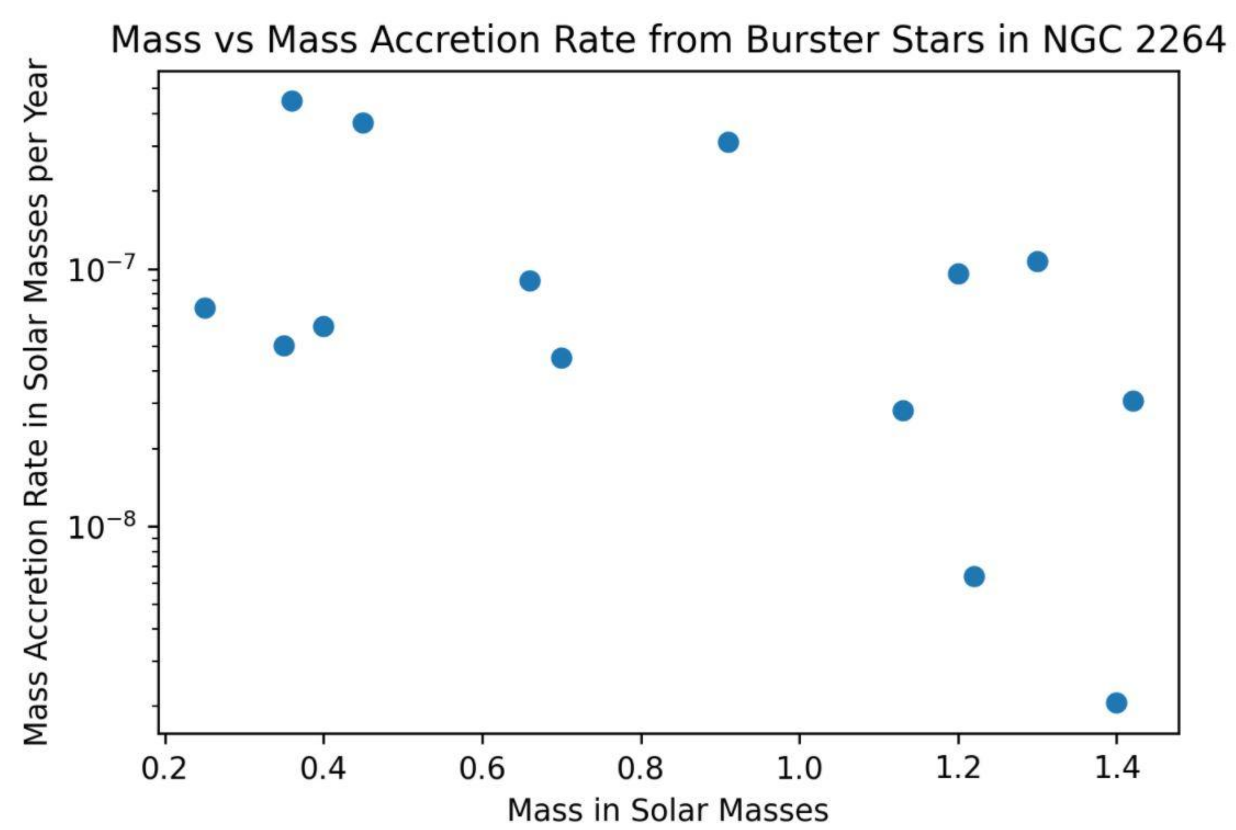


Figure 4 This is a comparison to the Venuti figure (figure 2). This figure displays a the solar masses of the star examined to the log mass accretion observed

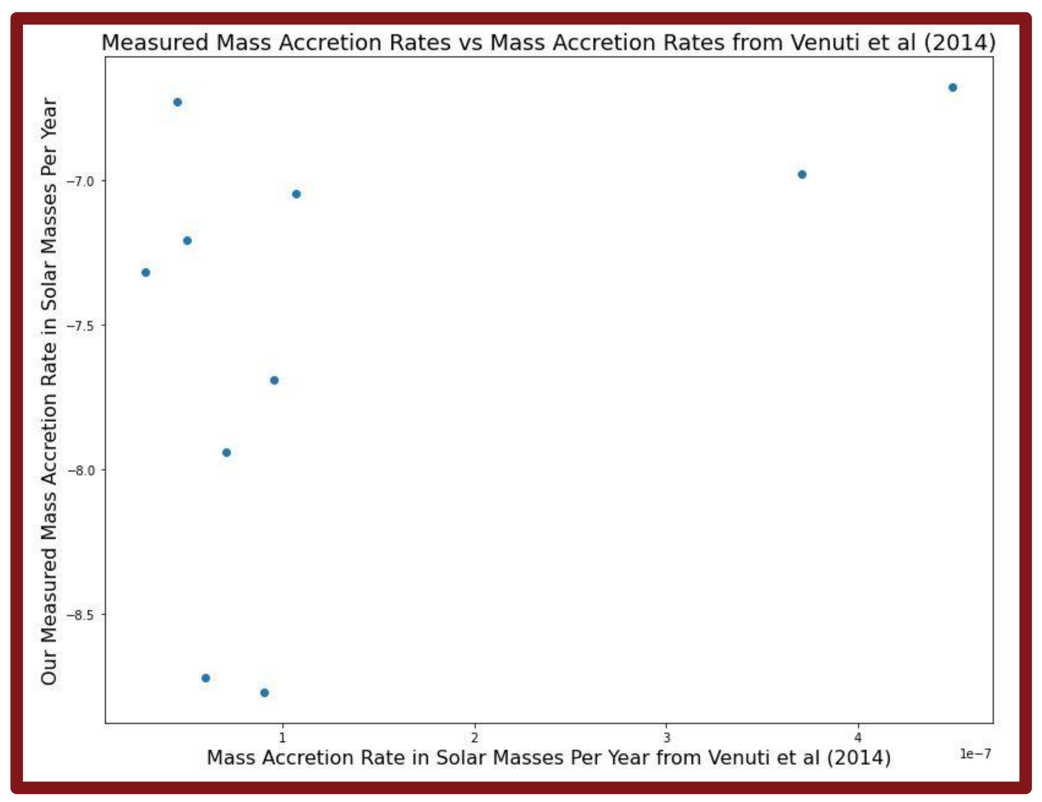


Figure 5. This is a direct comparison to the Venuti (2014) of there mass accretion rates against solar mass.

Acknowledgements

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References

[1] Stauffer 2014
[2] Cody 2014
[3] Hartmann 2016
[4] Venuti 2014