Quantifying Disk Destruction by External Photoevaporation in M17

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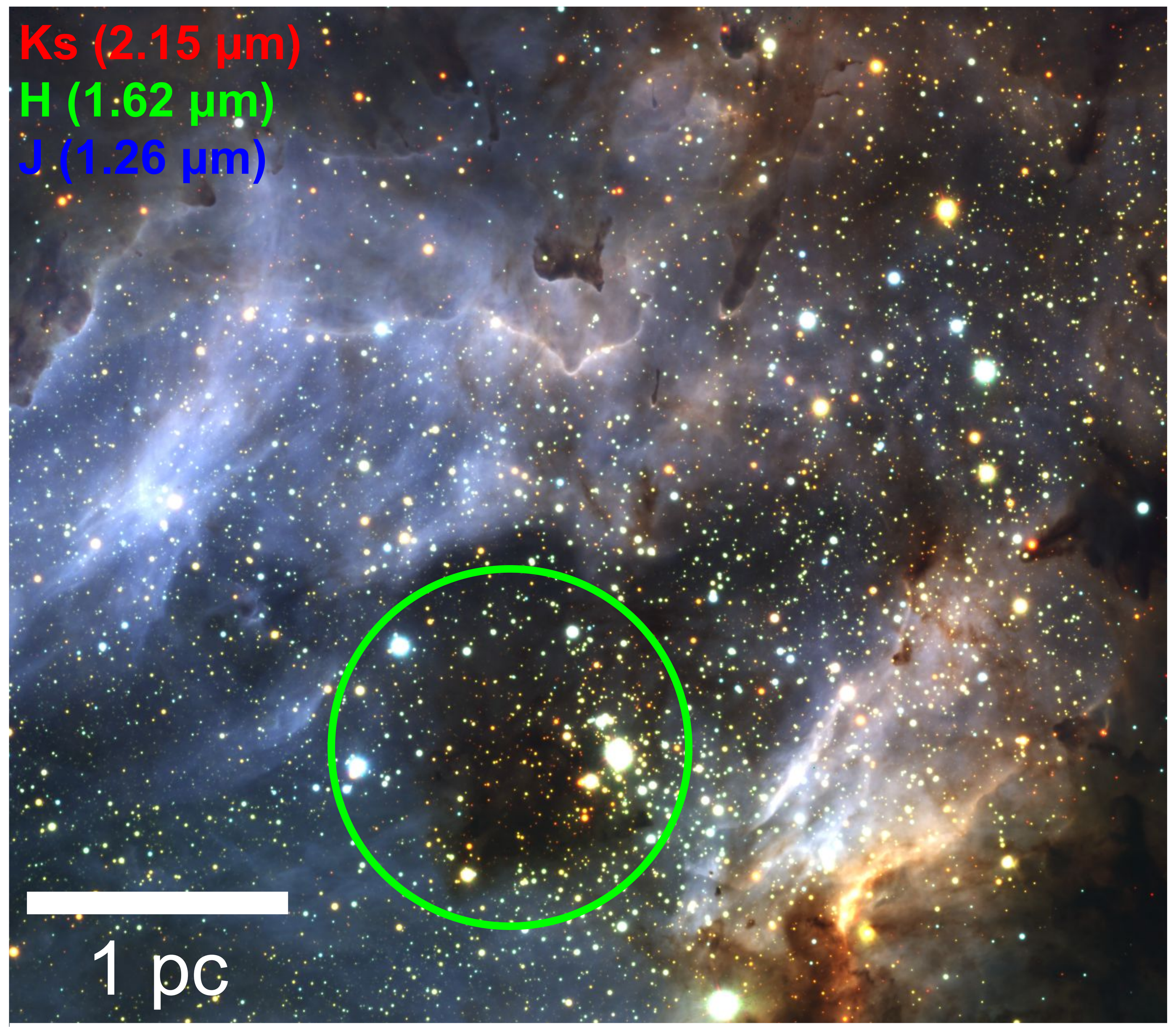


Fig. 1 *Near-Infrared JHK (1.1 - 2.5 μm) image of M17 from HAWK-I/VLT. The resolution is 0.4". More than 10,000 sources detected down to J-band magnitude of ~20.*

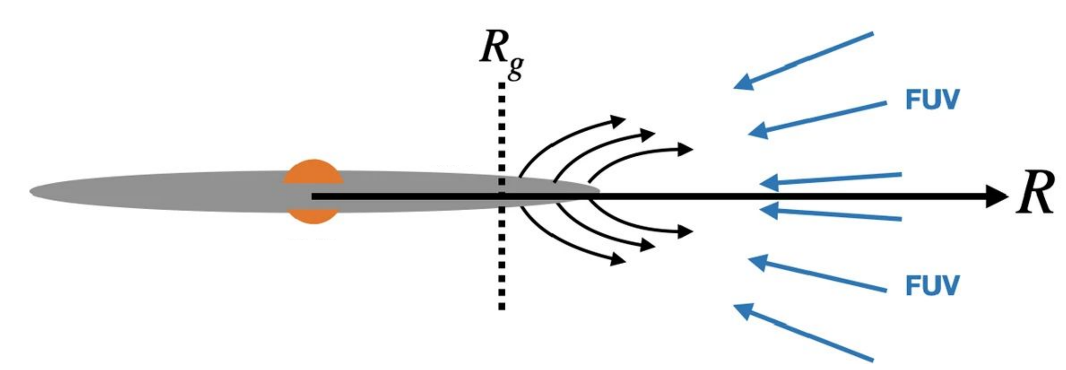


Fig. 2 *Diagram of external photoevaporation. R_g is the radius where particles are unbound from the disk and stripped by UV flux. Adapted from Winter & Haworth 2022.*

Introduction

Planets form in disks around young stellar objects (YSOs). OB stars produce UV radiation that strips away material from nearby disks through **external photoevaporation** (Fig. 2), **limiting the lifetime of disks and reducing the material available for planet formation.** The fraction of YSOs with disks decreases with age and disk destruction may be accelerated by external UV flux (Fig. 4). **The goal of this project is to extend IR excess measurements to more high-UV regions by measuring the disk fraction as a function of UV in M17 using the deepest-ever NIR survey of the region to uncover how UV radiation affects the lifetime of disks.**.

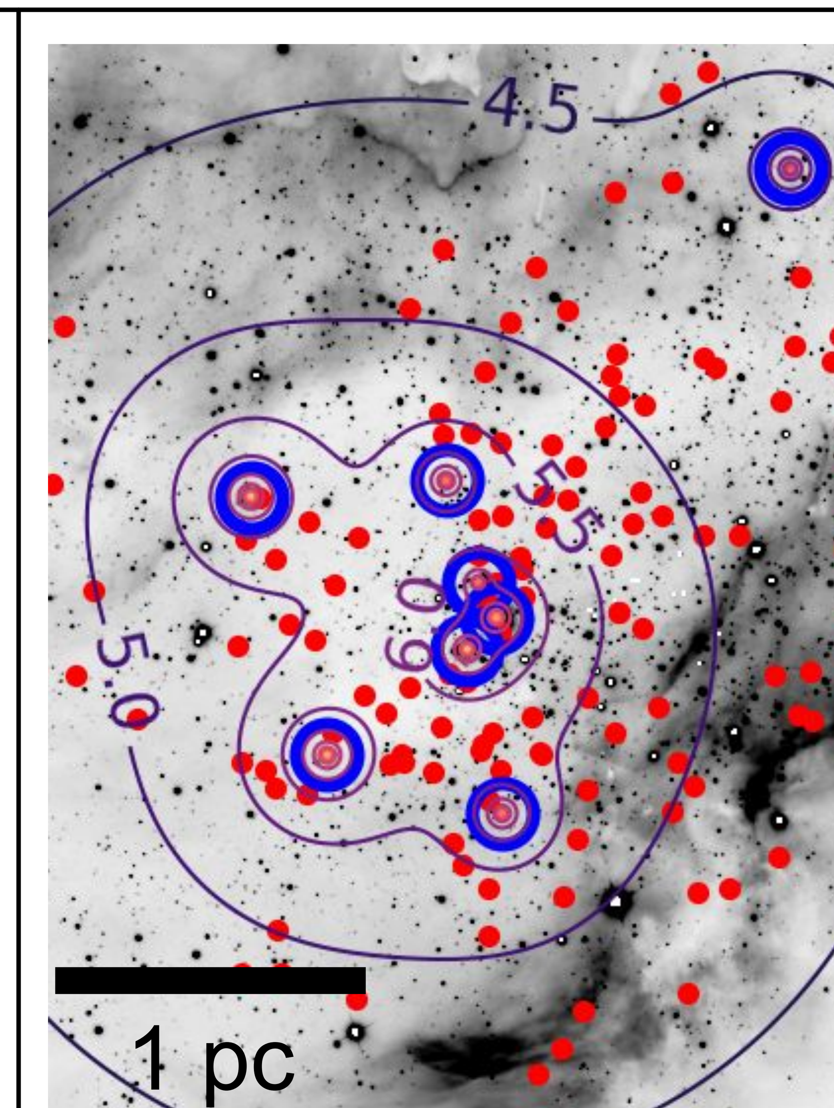
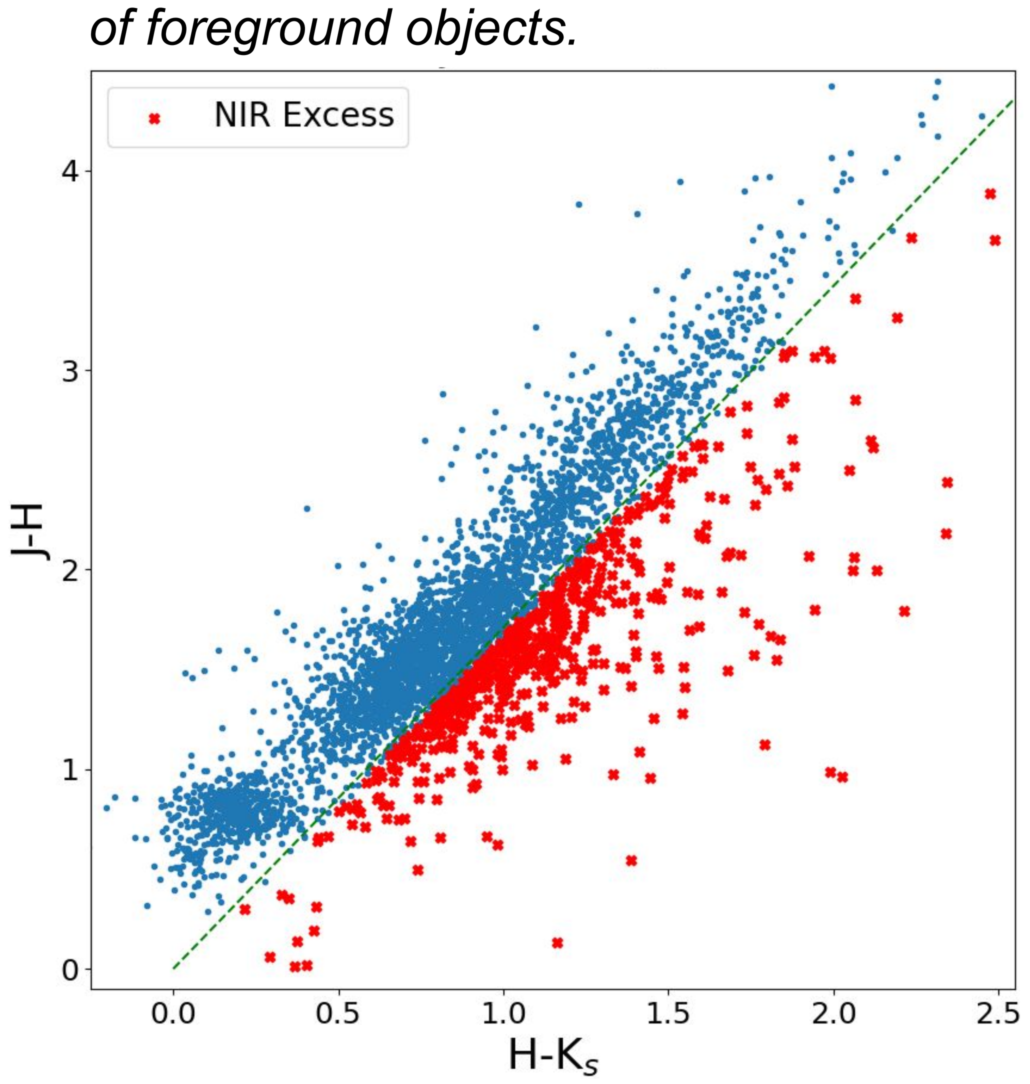


Fig. 5 *Ks-band image of M17. Dots - X-ray-selected excess sources. O stars circled in blue. Contours - UV radiation in units of log(G_0).*

IR-Excess vs. UV

We measured the UV flux incident on each IR-excess source by adding together the contributions from all O stars in M17, assuming a 2D distribution (Fig. 5). We split the sources into equal-size bins of increasing UV radiation strength. Fig. 6 shows the striking result: a **clear positive trend of excess fraction with UV radiation.** Explanations to be explored: an outward gradient in YSO age, the field star population, interstellar material shielding YSOs in highest UV environments (e.g. dark cloud in green circle in Fig. 1), and dynamical mixing causing a changing UV environment.

Fig. 3 *(J-H)-(H-Ks) color-color diagram. IR excess sources marked in red. Green dashed line: reddening slope. Isolated clump to lower left likely consists mainly of foreground objects.*



IR-Excess/Disk Fraction in M17

M17 is a young (~1 Myr), high-mass (~10^4 $M_\odot$ of gas) star-forming region at a distance of ~2 kpc. 7 O-type stars in the central ~1 pc region provide a relatively simple **correlation between UV radiation and distance to cluster center** (Fig. 1: green circle, Fig. 5). Fig. 1 shows the HAWK-I/VLT images of M17. We select (magnetically-active) YSOs by cross-matching with the MYStIX X-ray catalog (Feigelson+13). We use the PARSEC isochrone models to estimate mass, extinction, and effective temperature for the YSOs and to determine if they have infrared excess (Fig. 3). A source has IR excess (and a disk) if it falls below the reddinging slope (Meyer 97). **For all sources, we find an IR excess fraction of ~13%, and for X-ray selected YSOs, ~20%.**

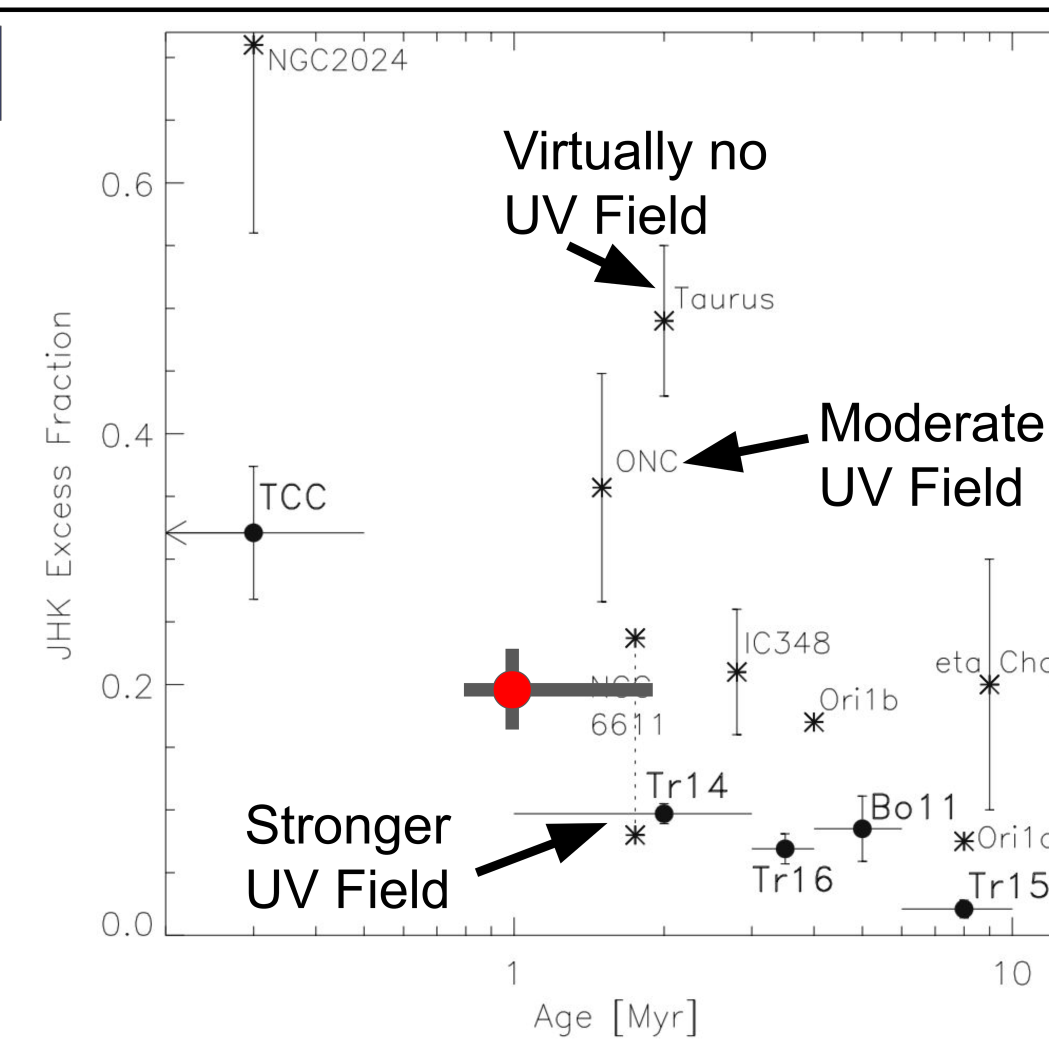


Fig. 4 *The disk fraction for nearby star- forming regions. We infer that the vertical scatter comes partially from difference in UV environments between regions. For example, ONC - only 1 O7 star, much higher disk fraction. Tr14 - 6 O7 or earlier, lower disk fraction. Adapted from Preibisch et al. 2011. M17 (this work) in red.*

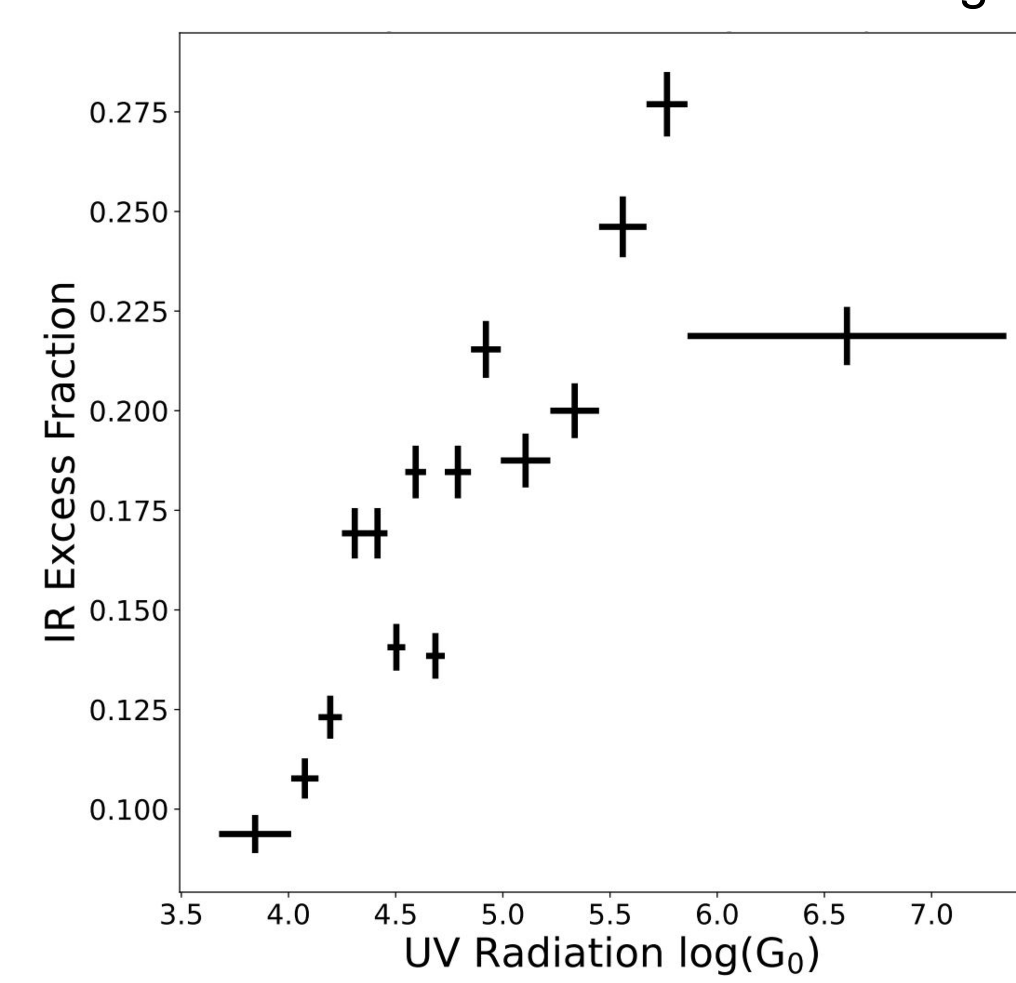


Fig. 6 ***The*** *disk fraction of X-ray selected sources in M17 as a function of total received UV radiation. Horizontal error bars represent bin width and vertical error bars represent standard √N uncertainty. The observed positive trend is unexpected, and the exact cause is unknown.*

Conclusions

- The deepest-ever NIR YSO survey of M17
- **20% YSO disk fraction, positive trend with UV flux**
- ONC: higher disk fraction, similar age, 1 O7 or earlier, less UV flux
- Tr14: lower disk fraction, similar age, 6 O7 or earlier, more UV flux