The Initial Mass Function

…of galactic stellar clusters: a science case for SASIR survey

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Initial Mass Function (IMF)

The IMF, Φ (log M) represents the number of stars per logarithmic mass interval.

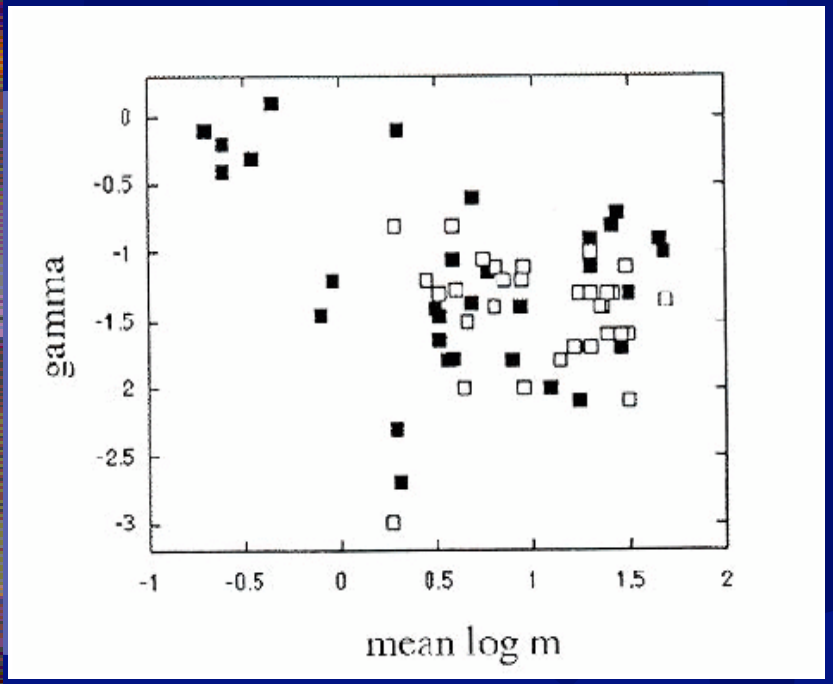
$$\Gamma = \frac{d \log \Phi(\log M)}{d \log M}$$

Γ : IMF index

Solar neighbourhood

- Salpeter 1955 $\Gamma = -1.35$ 3 – 10 $M_\odot$
- Miller & Scalo 1979 $\Gamma = -0.4$ 0.1–1 $M_\odot$; $\Gamma = -1.5$ 1–10 $M_\odot$; $\Gamma = -2.3$ > 10 $M_\odot$
- Scalo 1986 $\Gamma = -1.1$ > 10 $M_\odot$
- Kroupa et al. 1993 $\Gamma = 0.3$ to -0.85 0.08 – 0.5 $M_\odot$; $\Gamma = -1.2$ 0.5 – 1 $M_\odot$; $\Gamma = -1.7$ M > 1 $M_\odot$

IMF in our Galaxy and in other galaxies



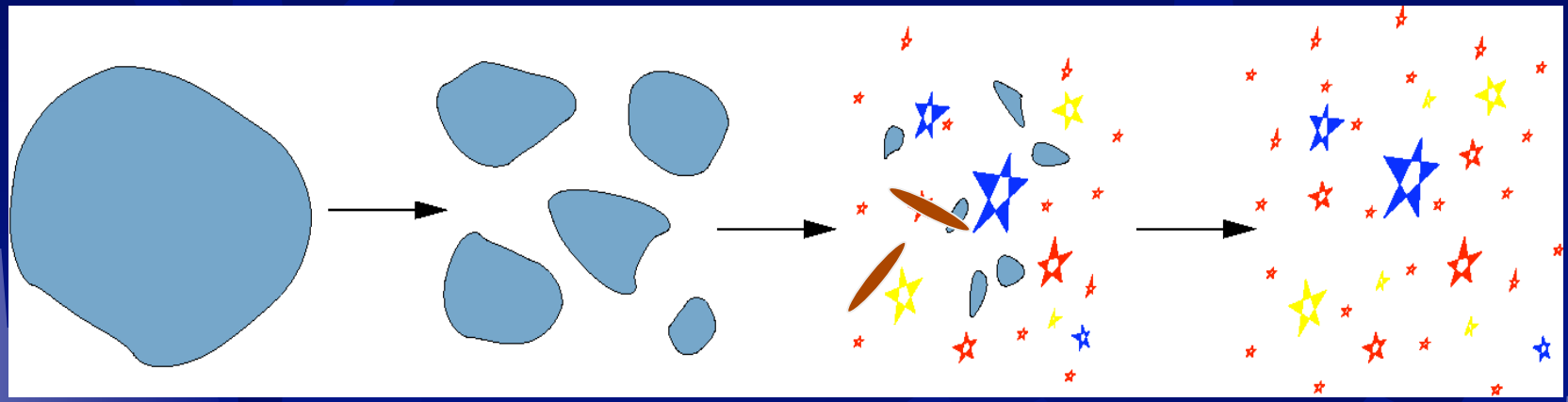
□ Galactic clusters
γ LMC clusters

- Scalo 1998:
  $\Gamma = -0.2 \pm 0.3$ 0.1-1 $M_\odot$
  $\Gamma = -1.7 \pm 0.5$ 1-10 $M_\odot$
  $\Gamma = -1.3 \pm 0.5$ 10-100 $M_\odot$
  based in several authors work

- Hunter et al. 1996 a,b with HST observations of M31 and M33:
  $\Gamma = -1.6 \pm 0.7$ 6.5 - 8 $M_\odot$
  $\Gamma = -1.4 \pm 0.5$ 6 - 15 $M_\odot$

Is IMF universal?

Young Stellar Clusters (YSCs)

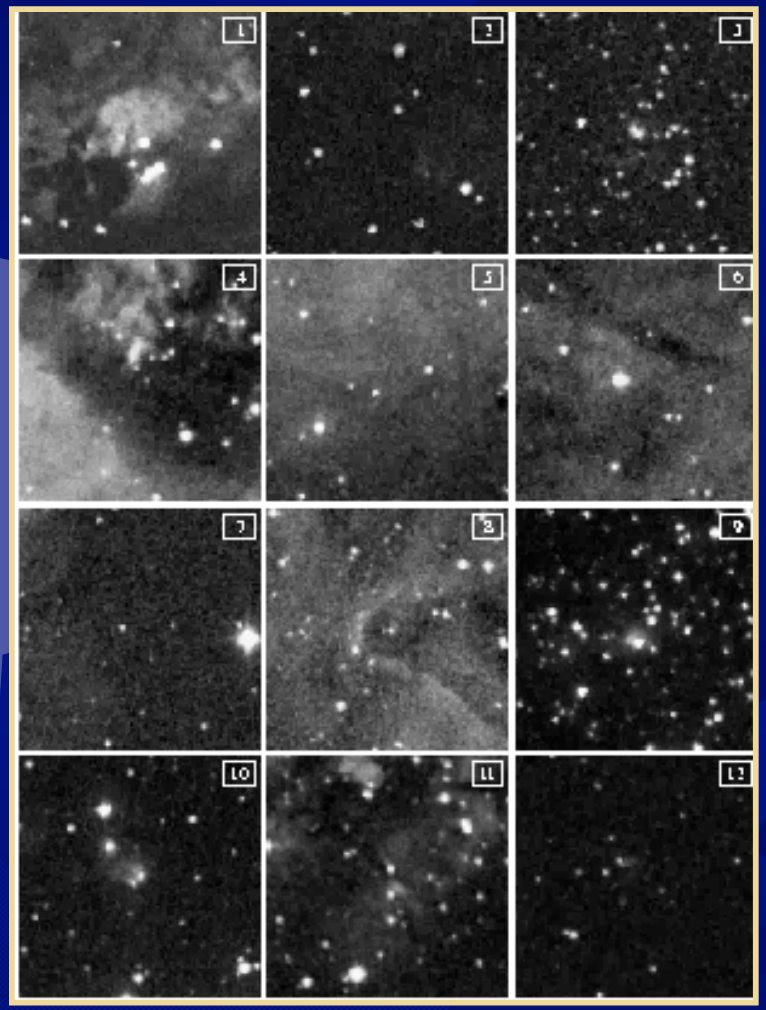


Molecular cloud | Fragmentation | YSC | Evolved cluster

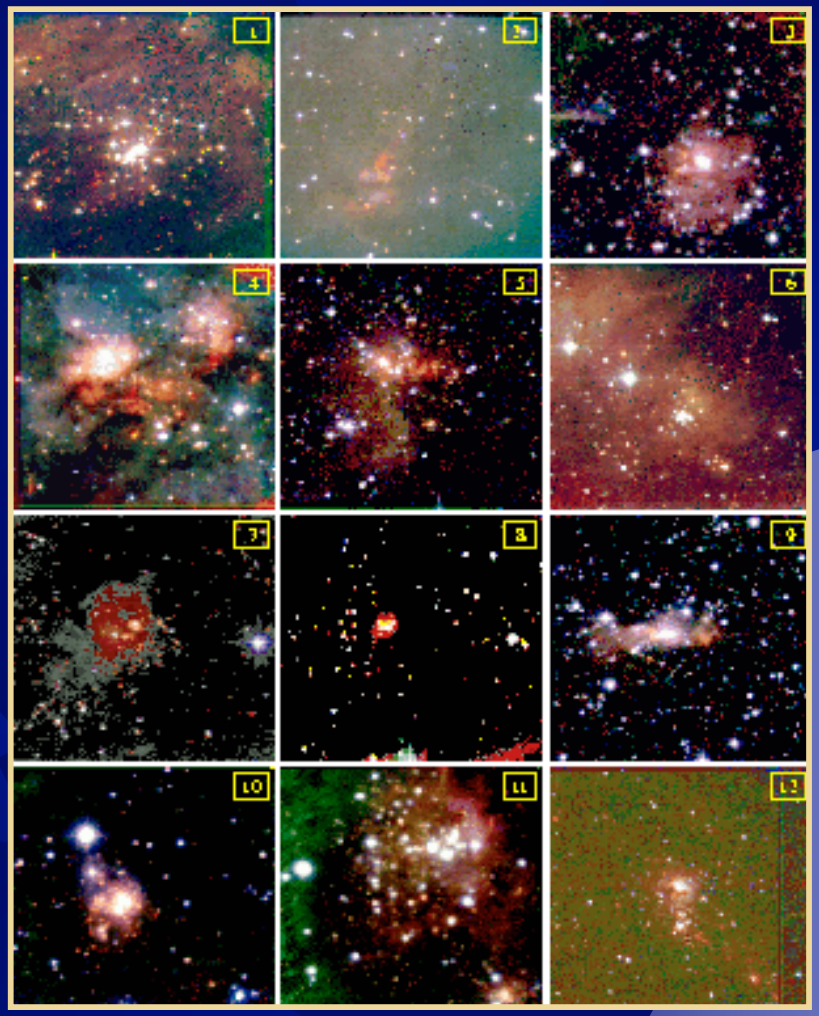
Characteristics:

- Size 0.2-2.3 pc
- Stellar content 100 ★s ~centrally concentrated
- <Σ> 50 ★/pc^2
- Age ≤ 10^7 yr
- Total mass ~ 20 - 200 $M_\odot$
- Presence of youth tracers: MC cores, YSOs, masers, bipolar outflows, H-H objects, UC HII regions, and IRAS sources.

Deeper into the interstelar medium



Visible (V)



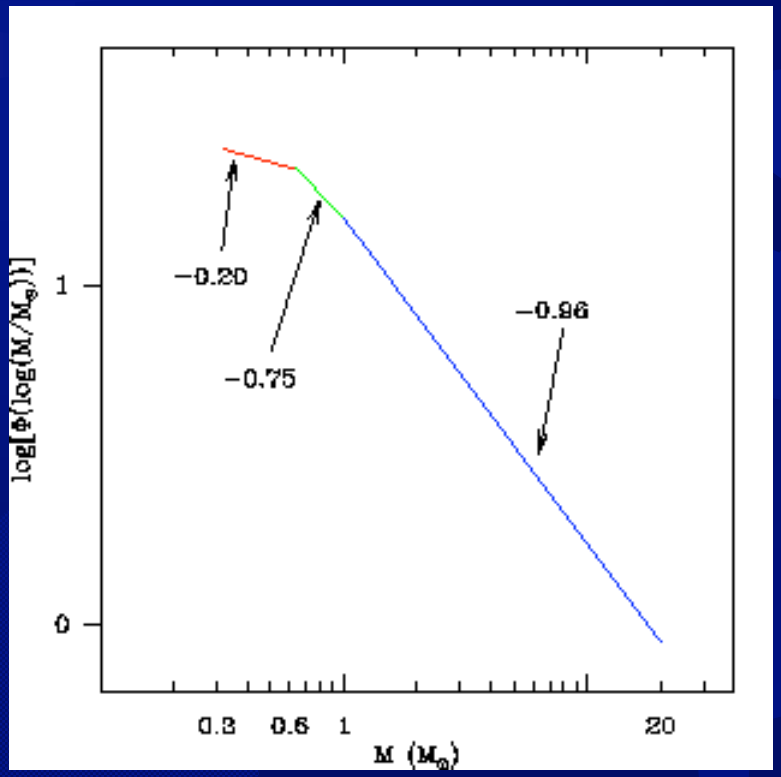
NIR (JHK)

JHK photometry of 40 YSCs with CAMILA at 2.1m SPM telescope

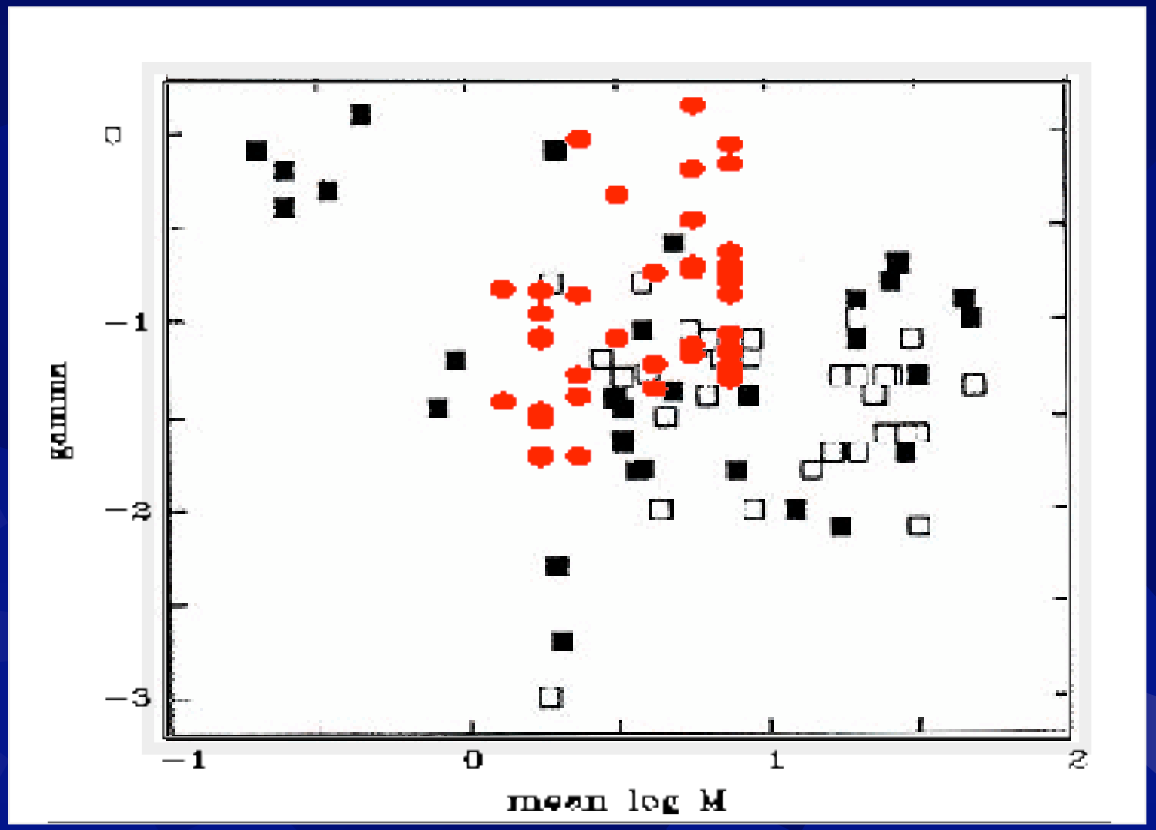
IMF in 40 YSCs at Perseus Arm

Our results suggest that the IMF in YSCs is:

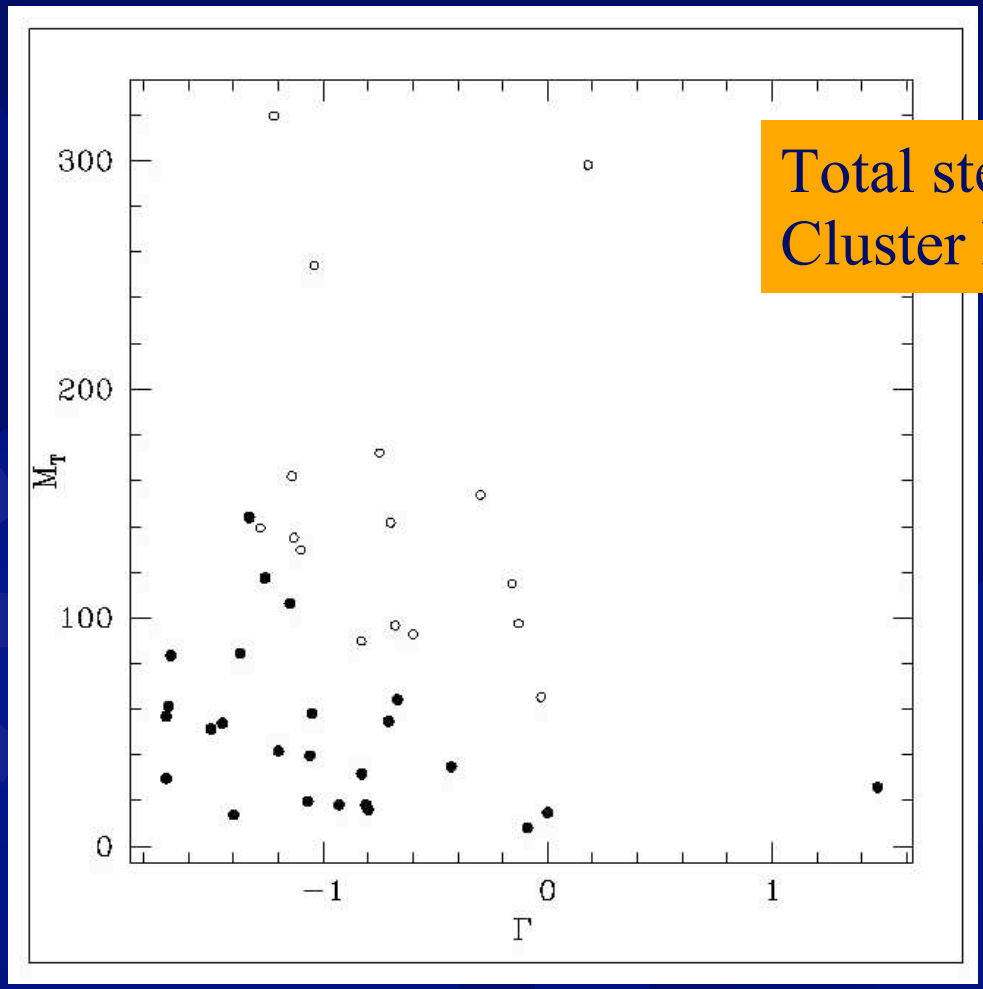
- $\Gamma = -0.20$ $\quad 0.3 < M/M_{\odot} < 0.6$ (6 YSCs)
- $\Gamma = -0.75 \pm 0.10$ $\quad 0.6 < M/M_{\odot} < 1$ (14 YSCs)
- $\Gamma = -0.96 \pm 0.14$ $\quad 1 < M/M_{\odot} < 20$ (40 YSCs)



Porras PhD thesis, 2001



- We obtained an IMF with two breaks at low mass and a slope $\Gamma \sim -1$ for $M > 1\ M_{\odot}$
- Γ values are consistent with values from literature for low and intermediate mass stars and clusters
- Variations in Γ values are most probably a combination of sampling noise, observational and systematic errors, as well as intrinsec physical properties of the clusters



Total stellar mass in a Cluster M_T vs. Γ

Intermediate-mass clusters (○) and low-mass clusters (●)

Γ ~ -0.7, M_T~150 $M_\odot$ IMF is flatter

Γ ~ -1, M_T~50 $M_\odot$ IMF is steeper and closer to

Salpeter's value

Two schools of thinking:

- The IMF is approximately Universal, maybe with exception of starburst galaxies and the Galactic center (Kroupa 2002)
- The IMF has variations not only from sampling noise, but due to initial and environmental conditions and dynamical evolution (Scalo 2004, Elmegreen 2008). If high-mass IMF is stochastic, the IMF would be expected to show even larger variations (Robberto et al. 2004)

The IMF is a fundamental ingredient to the population synthesis models and chemical enrichment models both for the Milky Way and other galaxies.

Related science with SASIR Survey

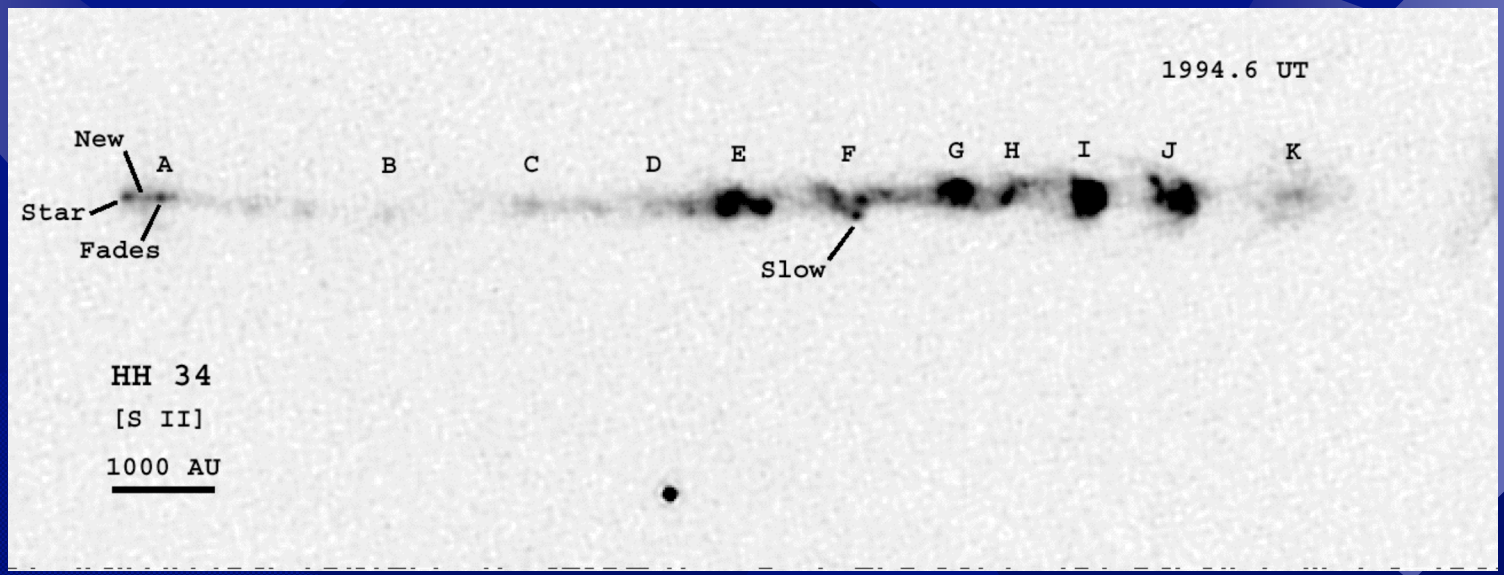
From the static observations:

- The sample of YSCs would increase considerably $\Rightarrow$ better statistics and more robust conclussions applying our method to derive IMF indices (Γ)
- Deeper coverage of ≥23 mag (AB) in all JHK vs. ~20, 19, 19 mag (AB) reached before $\Rightarrow$ stellar mass limit down to $0.1M_{\odot}$ and a more complete low-mass end
- Higher spatial resolution: 0.3”/pix vs. 0.86 “/pix of CAMILA $\Rightarrow$ to reduce/eliminate unresolved binary fraction corrections
- Y-band data to explore

Related science with SASIR Survey

From the transient observations:

- ~5% of our cluster sample have HH outflow activity. Assuming a similar rate in SASIR data, it would be possible to investigate how this HH activity contributes to the dynamical evolution of young clusters and their IMF. (Shock excited H_2 gas (2.12_m) tracing the outflows is visible in K band)



More P. Hartigan HH-movies at *http://sparky.rice.edu/~hartigan/movies.html*

Technical requirements for SASIR

- High quality photometric data
- At least 4 epochs separated by 10-12 months in order to measure proper motions of knots associated to HH-like objects.

Synergies

No synergies have been explored, but some to consider are: UKIDSS (H_2), GTC (spectrograph, MIR polarimetry), Spitzer, Herschel, LMT, ALMA,…