The question

Have the surveys based on signatures of youth (infrared excess, Hα emission, X-ray emission…) produced a complete, mass- (or luminosity-) limited census?

- *can we use it to study the IMF?*
- *and the lifetime of circumstellar disks?*
- *and the history of star formation?*
- *…?*

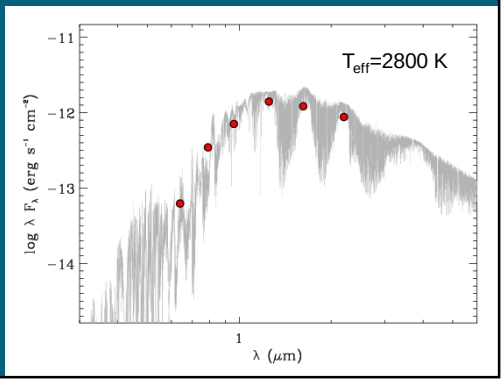
The method

Identify possible members based on photospheric properties alone

RIzJHK photometry: a good temperature indicator for T<~4000 K.

Effects of temperature and extinction well disentangled

Spectral energy distribution only weakly dependent on surface gravity



Observations

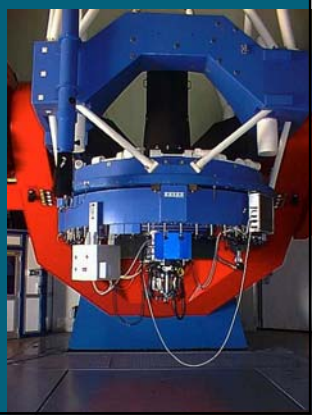
Wide Field Imager (WFI) at the La Silla 2.2m telescope

RIz imaging on 2.8 sq. degrees in Lup3 (same in Lup1, 1.1 in Lup 4) matching c2d IRAC fields

Service Mode observations in two observing seasons (2002/2003), each spreading over two months.

3σ limits: R_C=24.5, I_C=22.5, z_{WFI}=22.0

Cross-matched with 2MASS (better than 2”), 0.6-2.2 micron coverage



Deriving the properties

$$m_\lambda = M^*_\lambda(T) + 5 \log (D / R(T,age)) + (A_\lambda / A_V) A_V$$

$$m_\lambda = M^*_\lambda(T) + S + \alpha_\lambda A_V$$

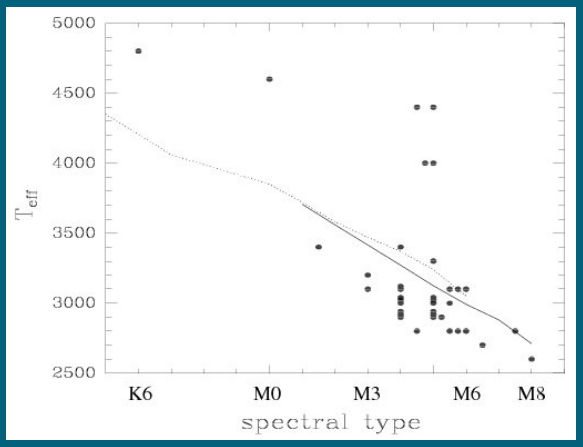
$M^*_\lambda(T)$: absolute magnitude for R=1 R_o (given by synthetic spectra)

S related to the distance modulus, and age via R

- *For main sequence and RGB stars* , R=R(T): S is directly related to D for a given T
- *For Lupus members*, D is common: S directly relates to the age via R

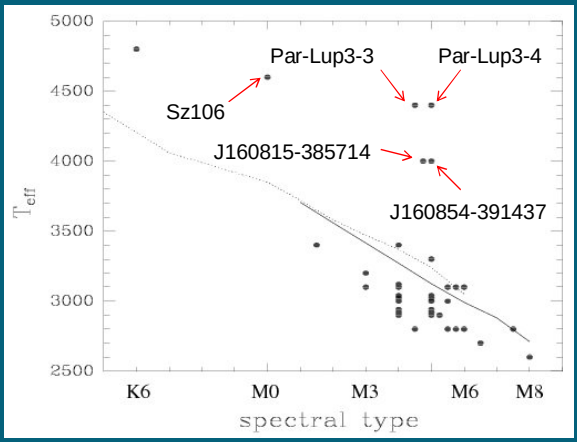
Solve for S and A_V for a range of T; adopt best fitting T

Comparing to spectral classification



Temperatures determined to +/- 200 K (<2 spectral subclasses) at T~3500 K and below

Comparing to spectral classification

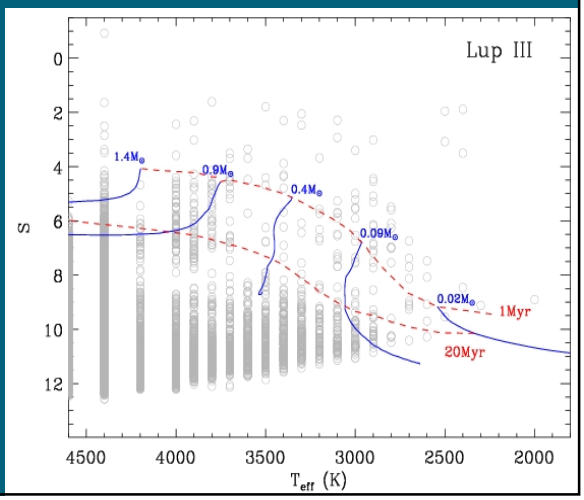


Temperatures determined to +/- 200 K (<2 spectral subclasses) at T~3500 K and below

Deriving intrinsic properties

The T_{eff} vs. S diagram is a proxy for T_{eff} vs. L for Lupus members

Evolutionary tracks easily translated to the (T_{eff}, S) diagram



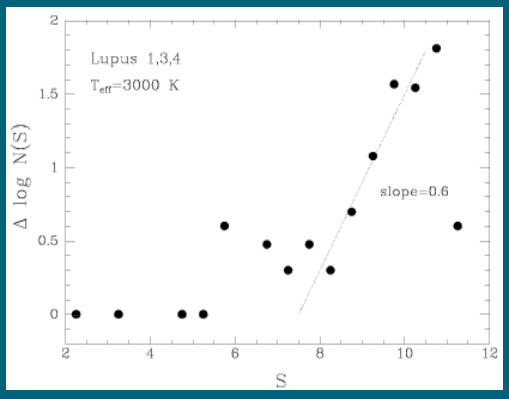
Dealing with contamination

Two sources in principle:

- Foreground M dwarfs: main source of contamination (but still moderate) below 3000 K
- Red giants: main contaminant above ~3200 K, virtually absent below 3000 K (easy to identify thanks to small S, because of small D/R)

Restricting to T<3000 K (spectral types M6 and later) yields best compromise for a non-contaminated sample.

Evidence for a non-foreground population



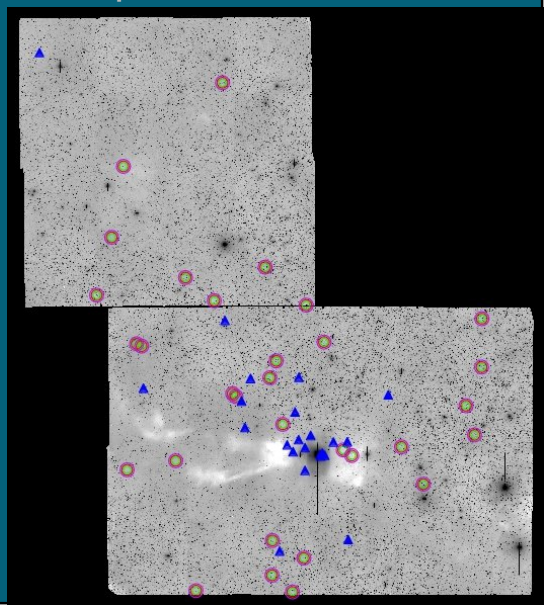
Log N(S) vs. S histogram predicts slope 0.6 for foreground stars

Excess at low S is the expected signature of the cloud members

The excess population in Lupus 3

31 previously unidentified objects with T≤ 3000 K in Lupus 3, S consistent with ages < 20 Myr : *over 3 times more than the expected contamination*

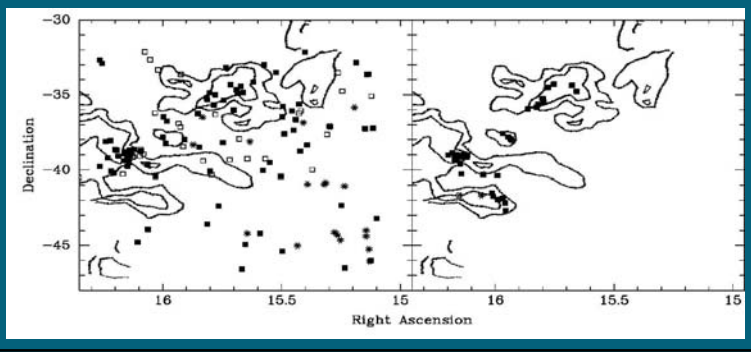
But only loosely concentrated as compared with the *bona-fide* Lupus 3 population *(object selection ensures that this is not an extinction effect!)*



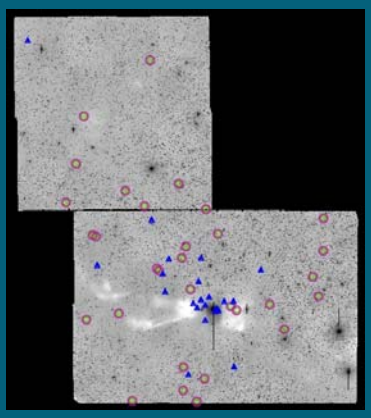
Really a Lupus 3 population?

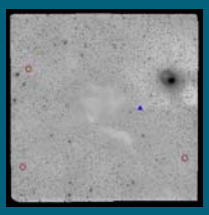
A widespread, older distribution associated with the Gould Belt was revealed by the ROSAT All-Sky Survey

S within the range of Lupus 3 members if it were older but closer…



Really a Lupus 3 population!





Lupus 4

Lupus 3

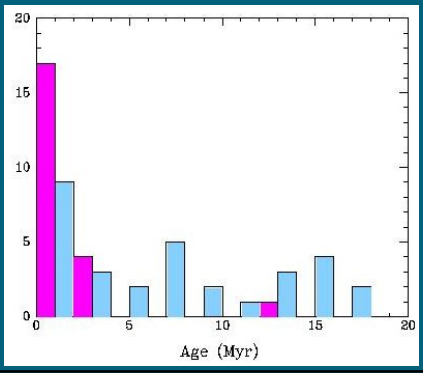
Absent in Lupus 4, only 4 degrees away

New objects also have significant reddening, indicating similar distance as Lupus 3

What are they?

Absent near the center of Lupus 3 where most bona-fide members are.

Inferred age distribution indicates large spread among new members; known YSOs have very young ages



We must be cautious with the interpretation: ~30% are expected to be foreground contaminants, but we don't know which ones.

Conclusions

Spitzer (and other identification methods) have revealed nearly everything *very young* in Lupus 3

…but star formation in Lupus 3 started long ago

YSOs older than just~2 Myr quickly become unidentifiable by methods based on signposts of youth

There is evidence for a older members, still to be characterized (remove the contamination: which are the truly young objects?)

The more massive population is even more elusive (lost in the contamination)

A long way to go before we have a full picture of star formation in Lupus 3! Spitzer has helped a lot, but we will need GAIA.