Star formation, binaries and the role of the ELT

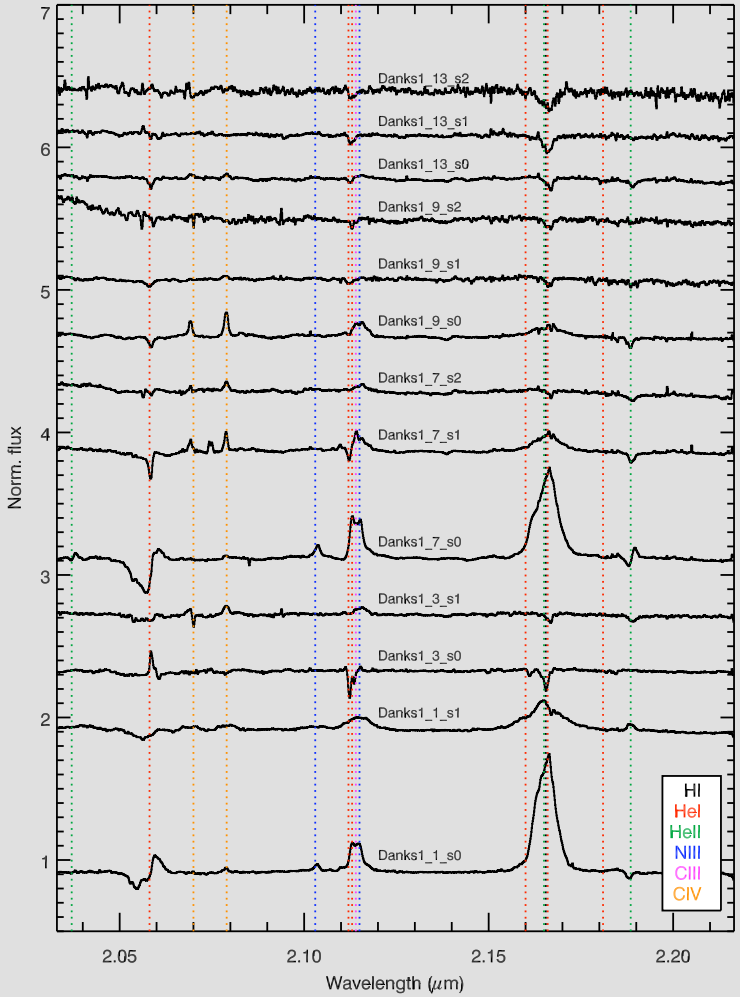
J. S. Clark (Open University)

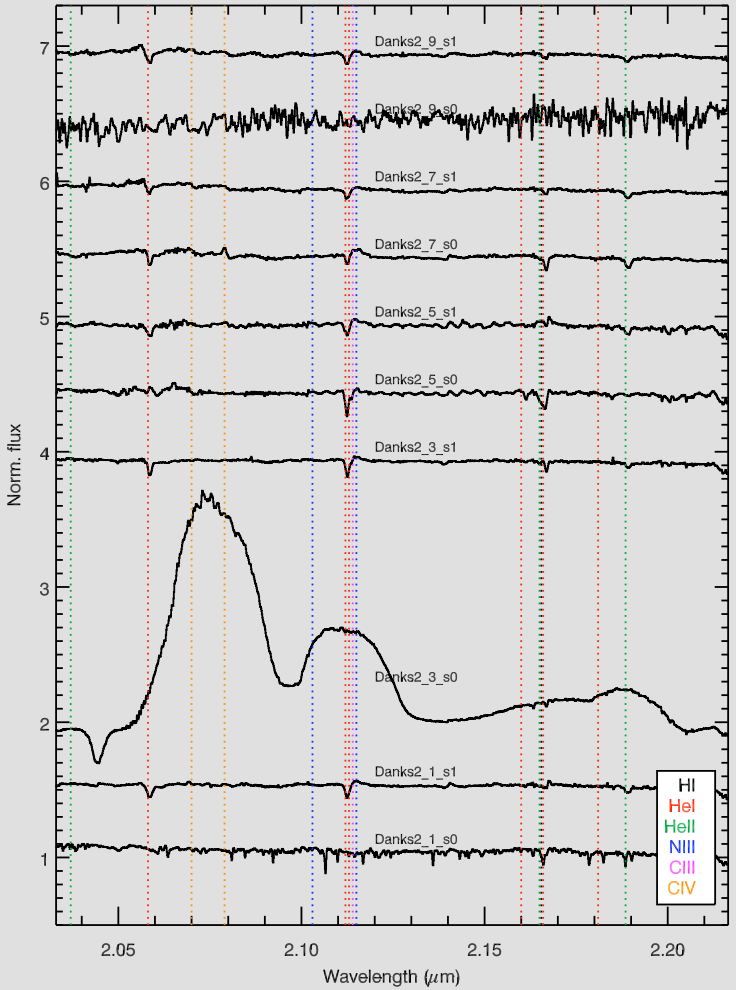
Star formation appears to be hierarchical…

Galactic star formation complexes

- Example is G305
- Centred on Dks 1 & 2
- Stellar content –
  >30 O7V stars?
- ~30pc in extent
  @4kpc
- Dks 1 & 2 difficult to study in optical due to extinction

Stellar properties of central clusters

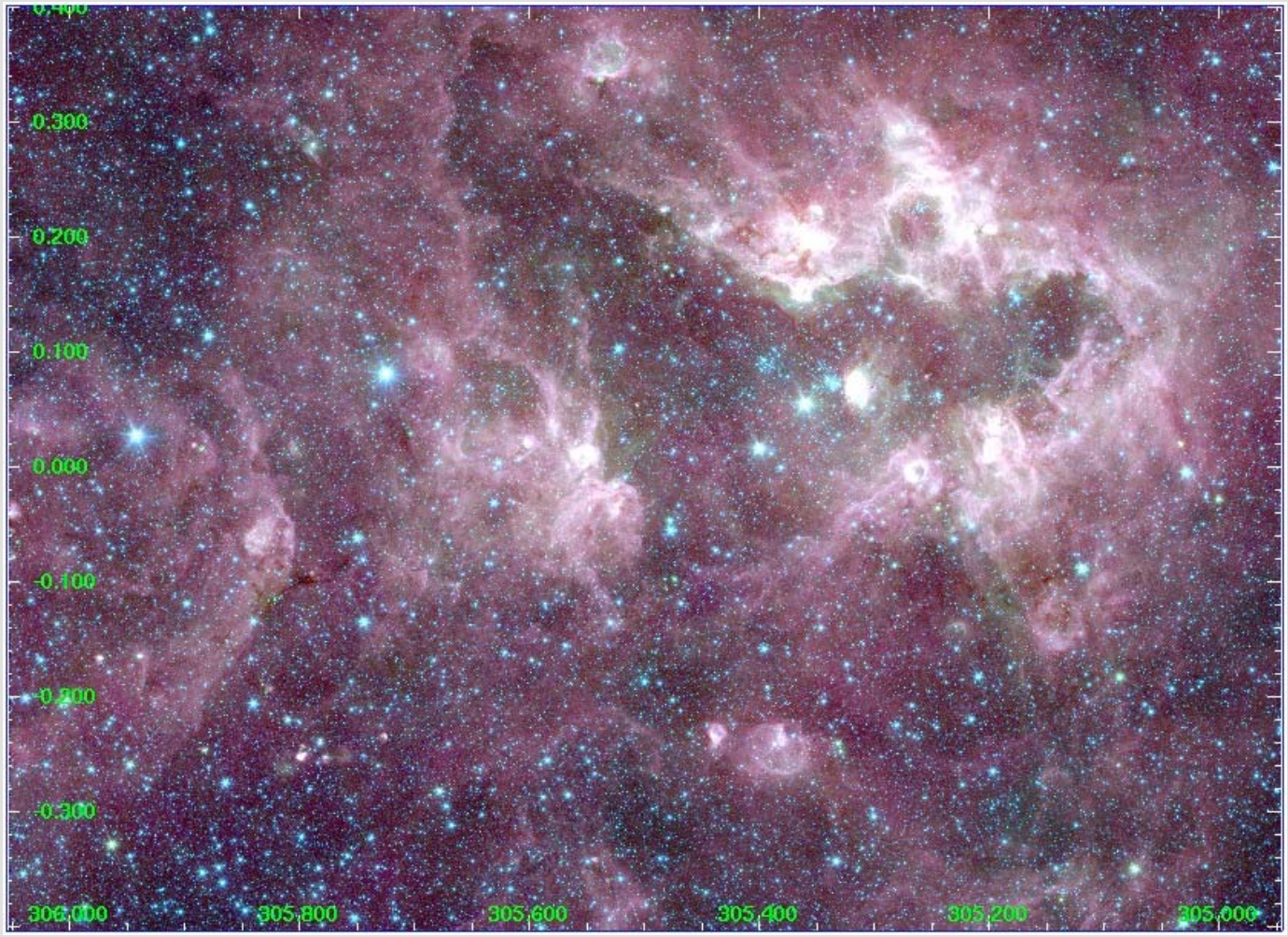




Different stellar poplns. & hence ages (Davies et al. in prep.)

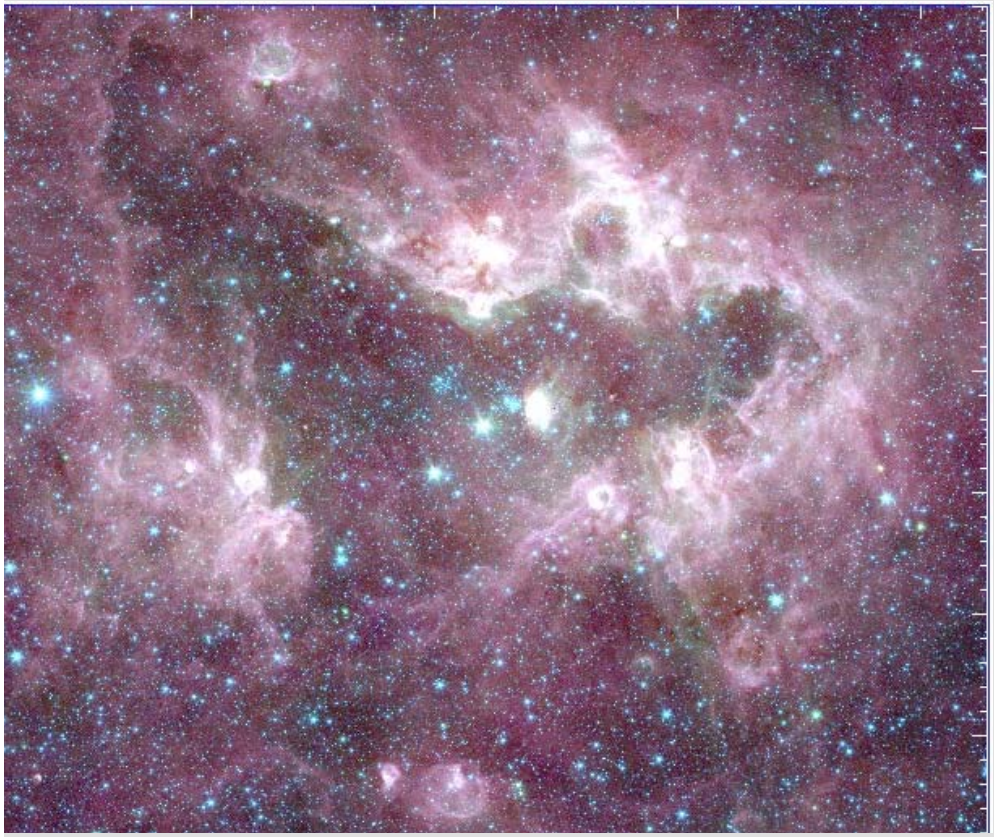
Multiwavelength synthesis

Pre-requisite to follow massive S.F. from the earliest stages:
e.g. origin of mass function and physical mechanism of SF

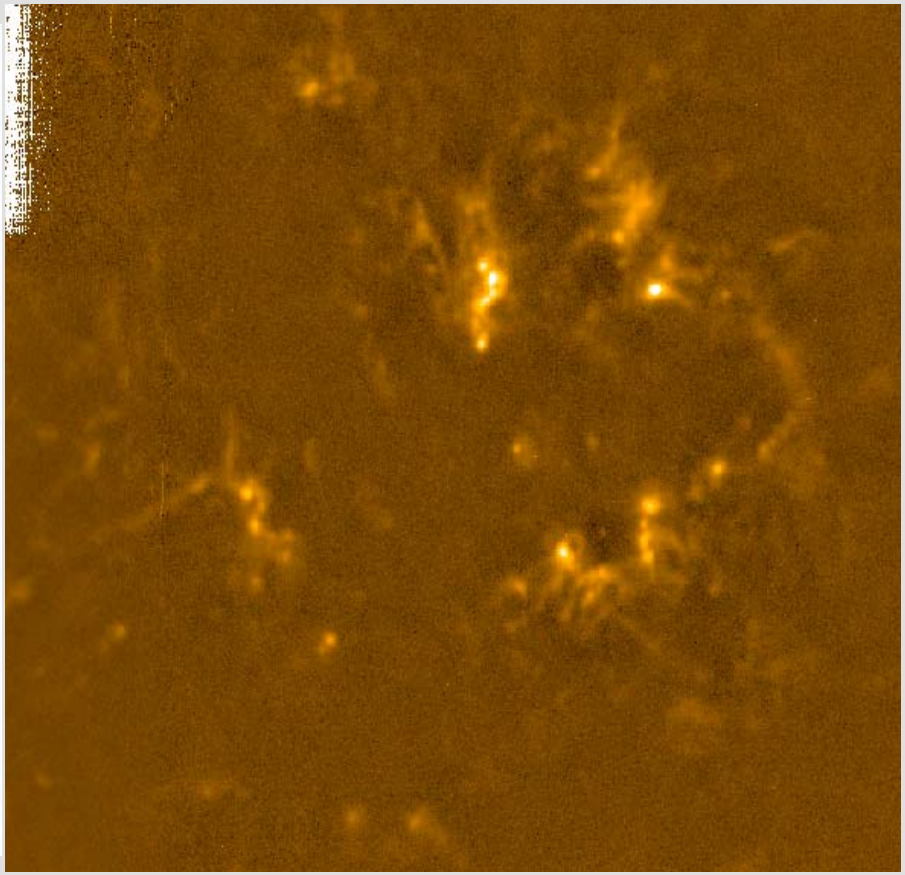


Mid-IR to sub-mm to probe earliest stages of S.F.

Current facilities yield insufficient resolution…



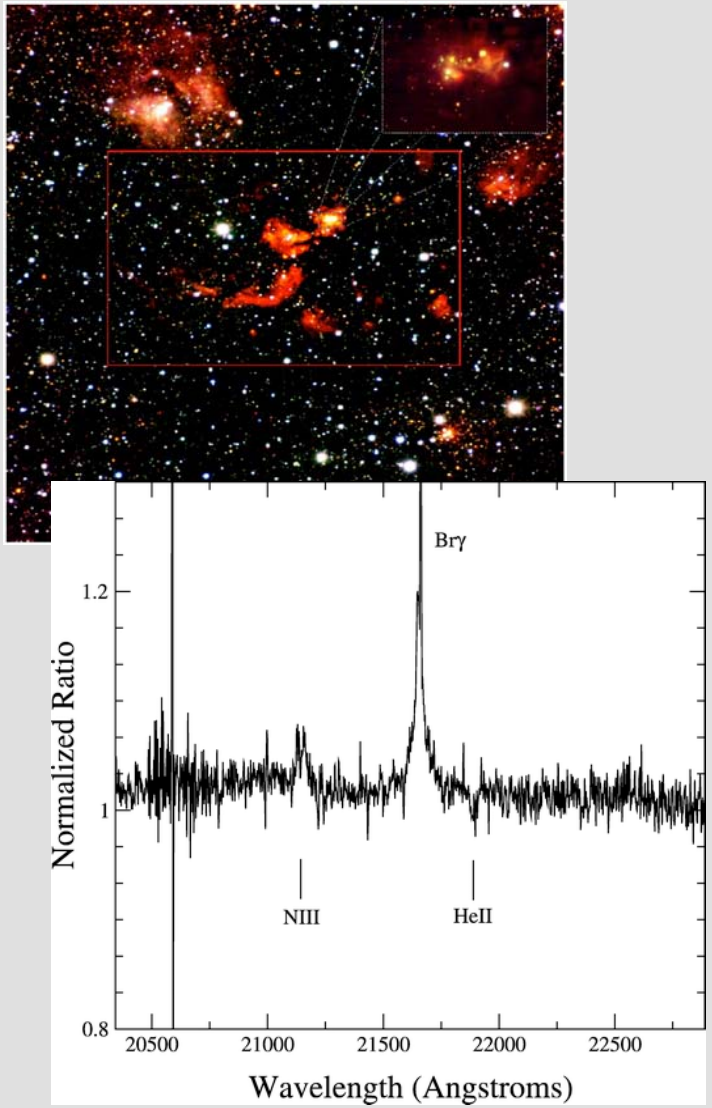
GLIMPSE/Spitzer 3-8micron: warm dust

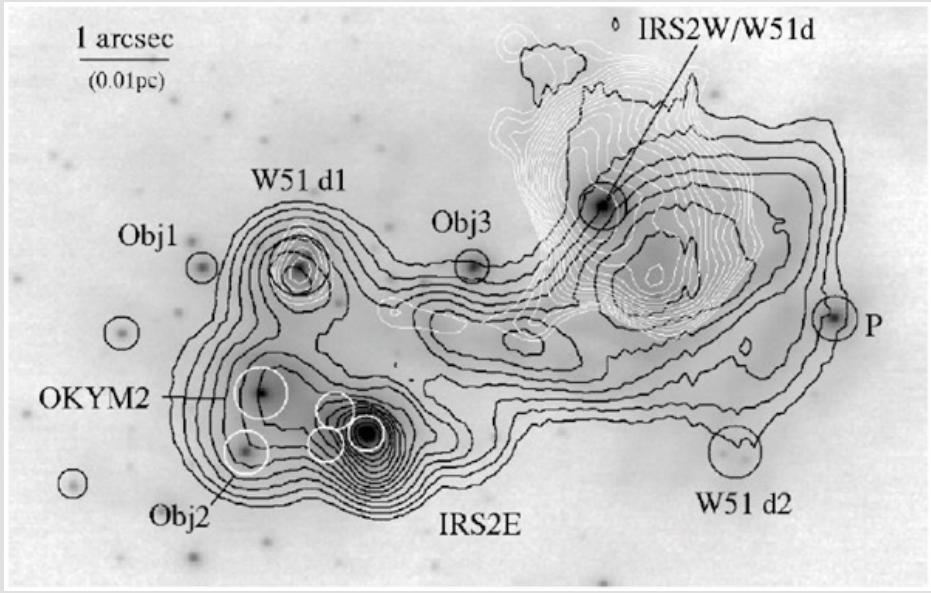


APEX/Laboca 870micron:cold dust

W51 - High spatial resolution & deep observations:

Figueredo et al. (2008) and Barbosa et al. (2008)

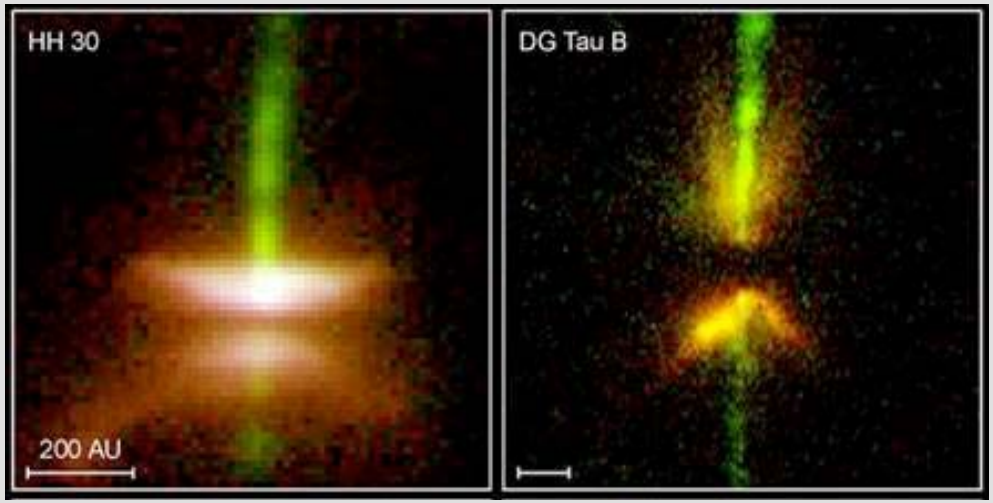




Direct observations of massive star+cluster formation

- Synthesis of ELT & ALMA probes GMC fragmentation & star (cluster) formation – info on IMF?

- Do we ever see *individual* massive star formation?



Is massive SF a scaled up version of low mass SF or is it inherently different (i.e. coalescence)?

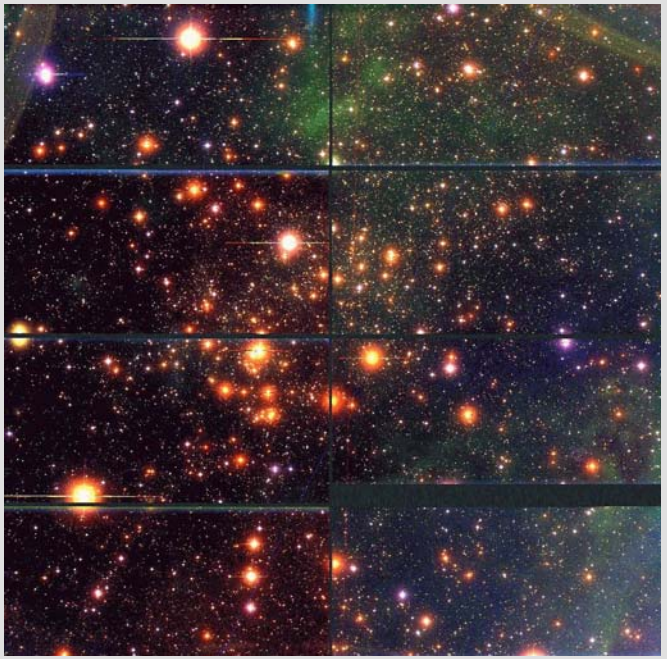
Secondary diagnostics – binary population

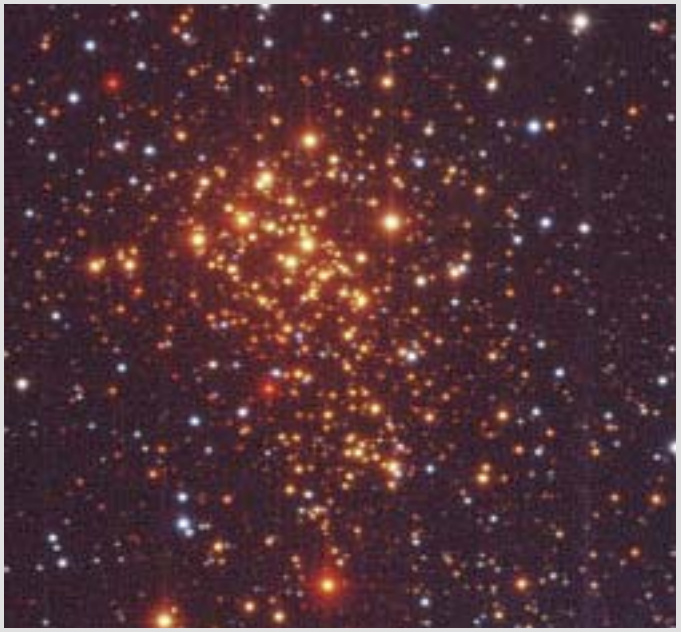
- Late M stars & brown dwarfs – 10-30%
- M stars 30-40%
- F3-G2 55%
- F7-G9 60%
- B-A >70%
- OB - ??

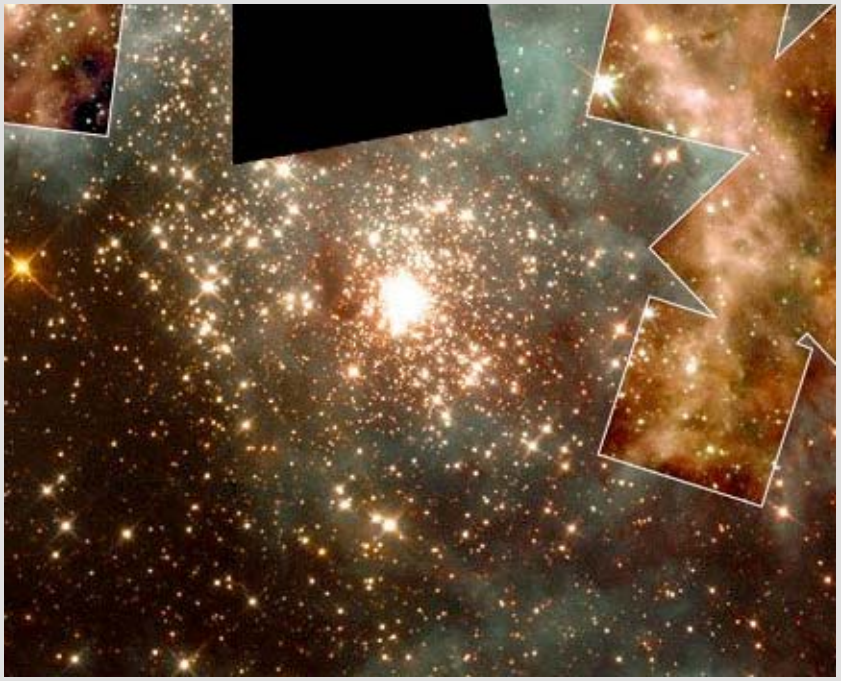
(Kouwenhoven et al. 2009 & refs. therein)

Different binary populations encode information on physics of S.F. - limited theoretical predictions

RV surveys of Cygnus OB2, Westerlund 1 & 30 Dor







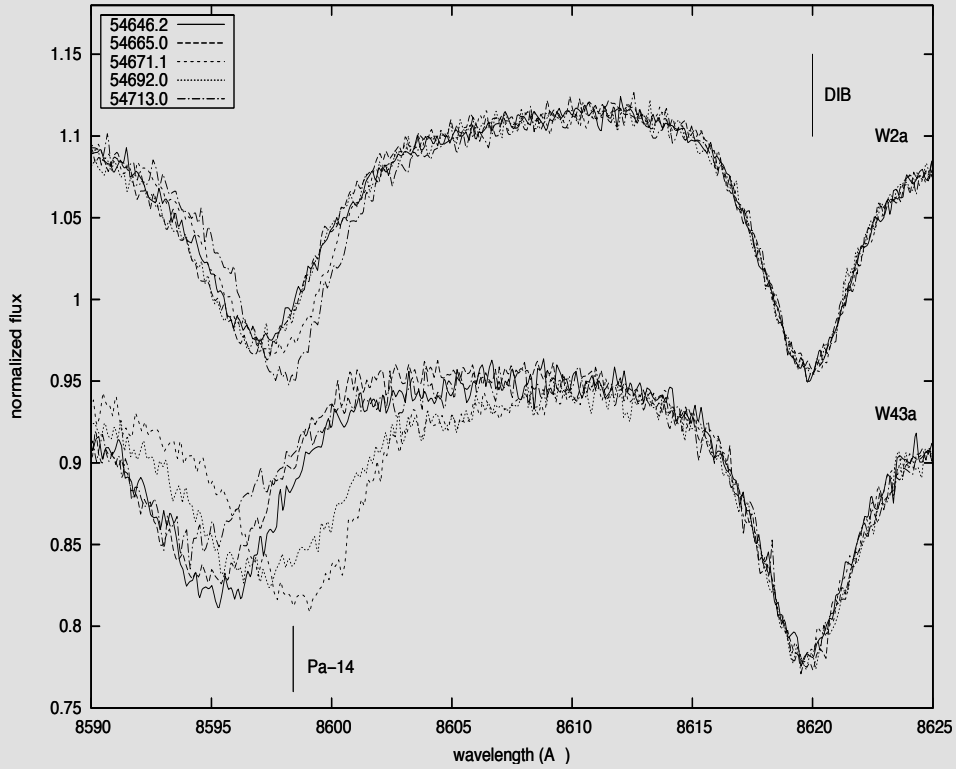
30 Dor & Wd1 require 8m (VLT/FLAMES) time

Preliminary RV survey results

- RV surveys for 30 Dor & Wd1 still to be completed

- Wd1 and Cyg OB2 give >40% binary fraction

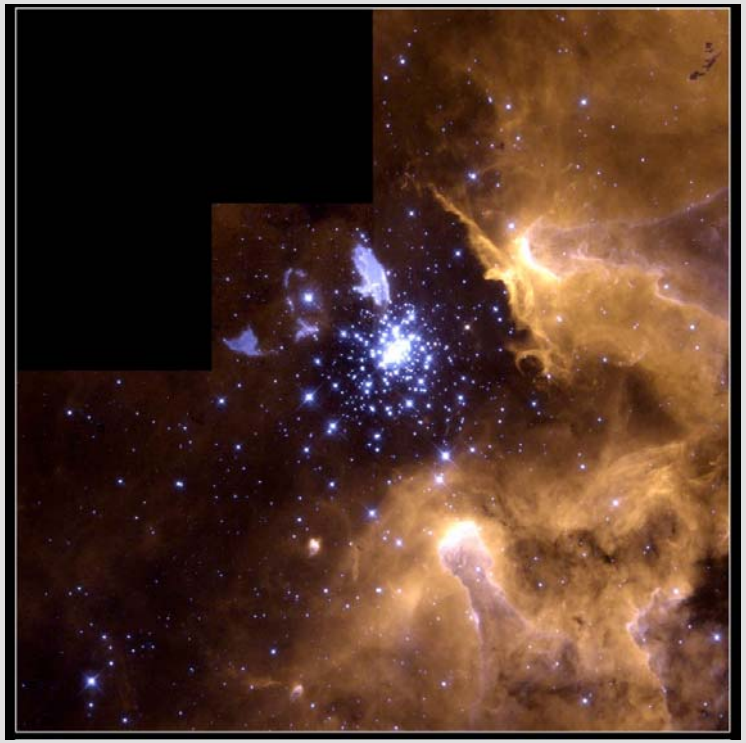
- Monte carlo results for Cyg OB2 consistent with 100% binary fraction (Kobulnicky & Fryer 2008)



Wd1- 43a (~B2 Ia)

Implications for SNe, GRB, LMXB & HMXB production channels etc…

Dynamical mass estimates from eclipsing binaries

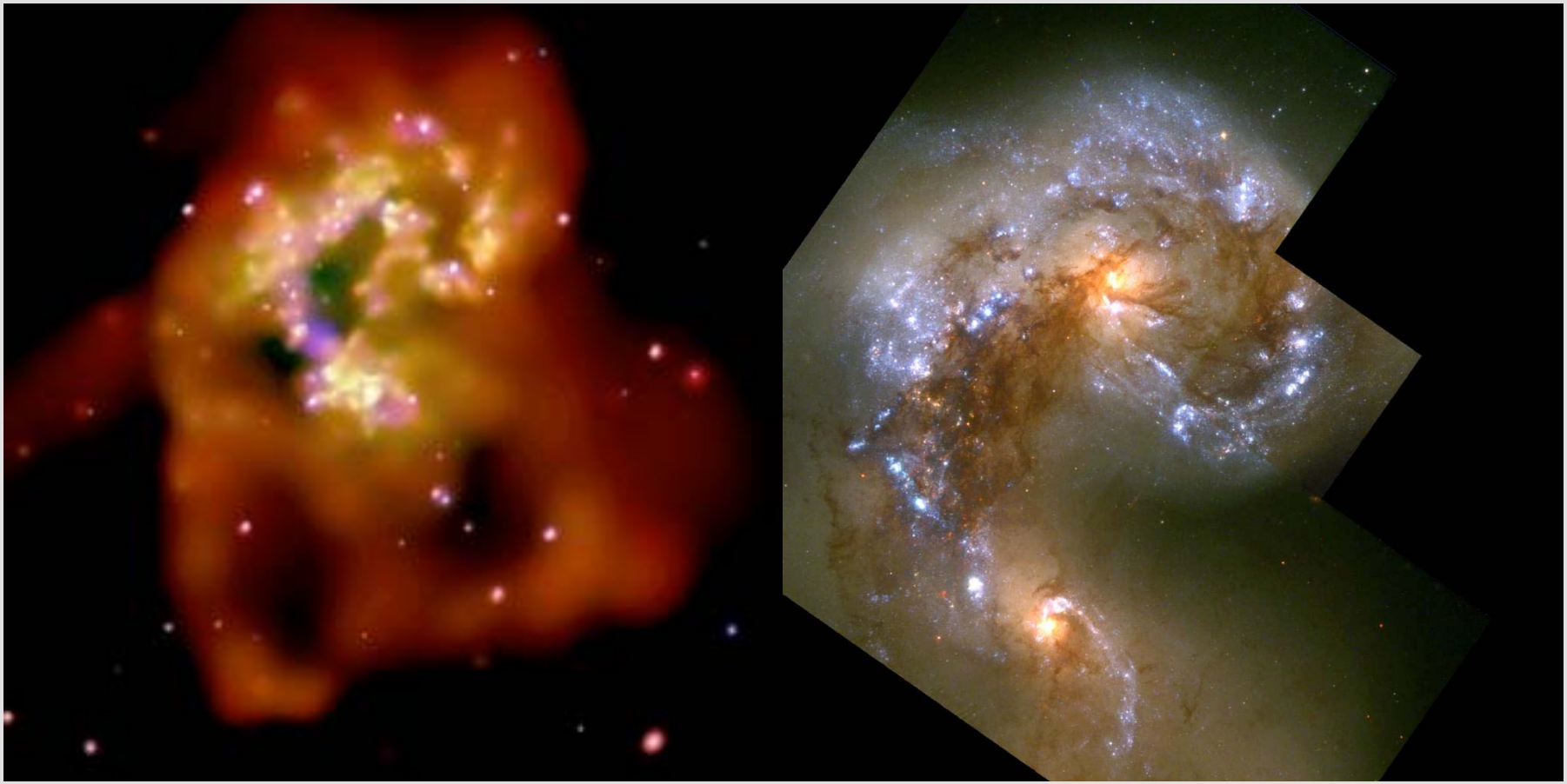


NGC3603 A-1 – 116 & 89Msun
(NGC 3603 Schnurr et al. 2008)

WR20a - 80Msun
(Wd2 - Rauw et al. 2005)

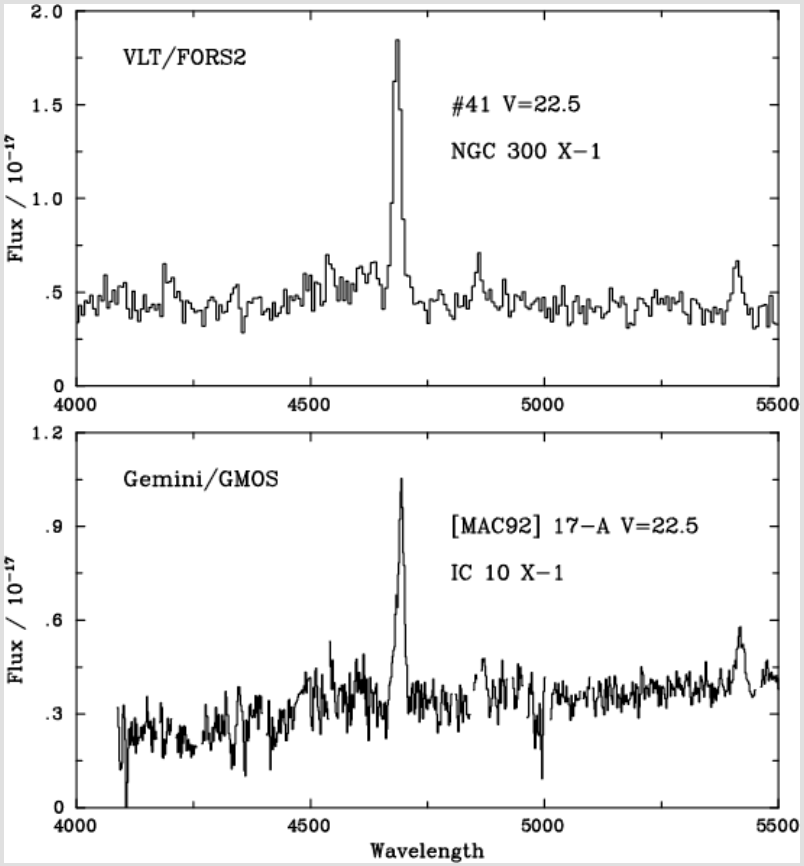
Is the maximum stellar mass identical at all metallicities?

ELT & high energy astrophysics

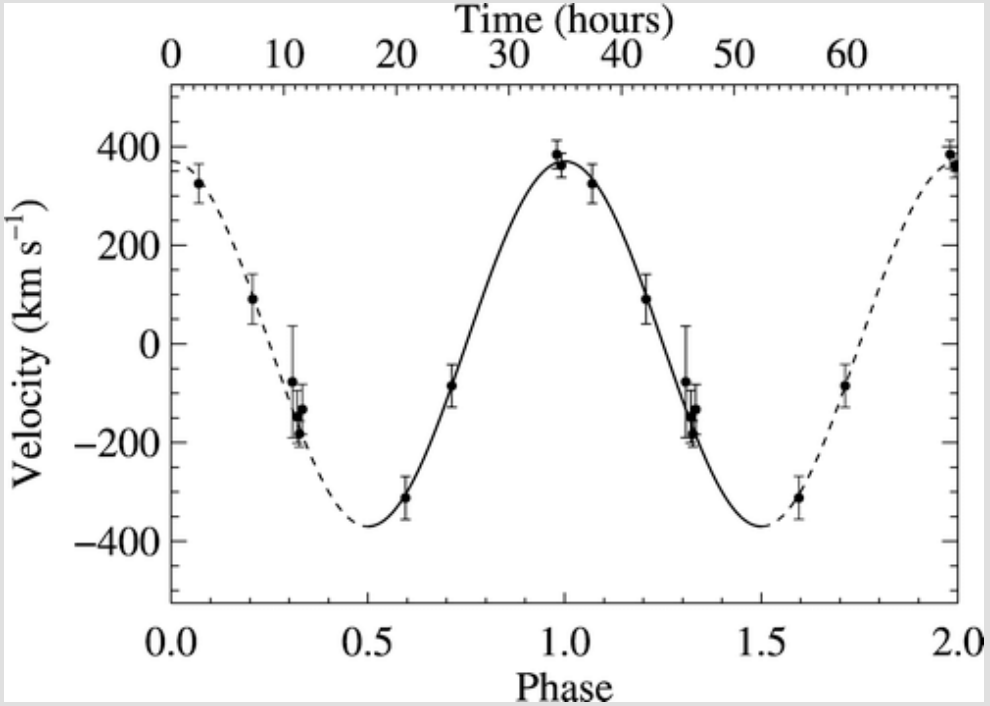


Direct connection between S.F. and production of NS & BHs

Dynamical masses of NS & BHs



IC10 X-1 & NGC 300 X-1
=WR+BH binaries
(only 2 in Galaxy)



M33 X-7 = 15.7+/-1.5 Msun BH
(Orosz et al 2007)
IC10 X-1 = 32.7+/-2.6Msun BH
(Silverman & Filippenko 2008)
NGC 300 X-1 RV survey in VLT
queue (PI Crowther)

Summary

- In conjunction with other facilities ELT will be a powerful tool for investigating star & star cluster formation.
- Will we directly detect massive protostars or will we have to rely on secondary diagnostics?
- ELT will enable us to investigate possible dependencies of SF and massive stellar evoln. as a function of metallicity
- Important for production of XRBs, NS+NS binaries, GRBs, SNe, etc…