Feedback and accretion toward proto-O-stars

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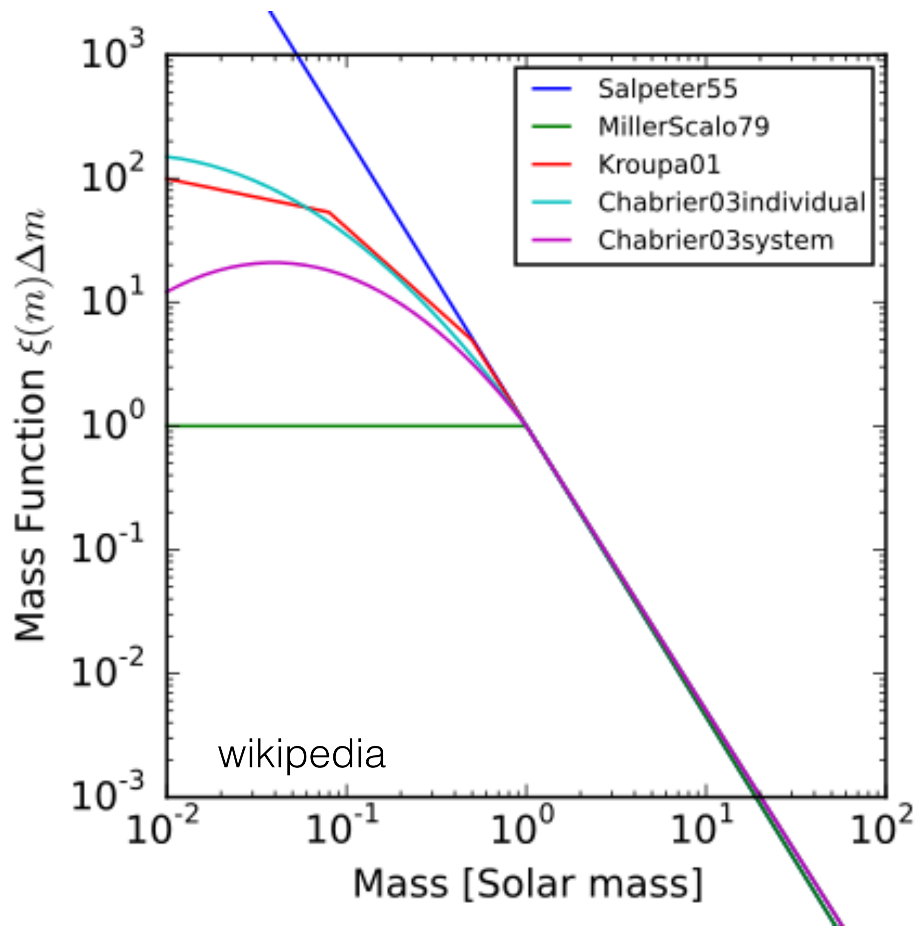
Jansky fellow

The stellar IMF is central to (almost) all aspects of astronomy

Binding of star clusters

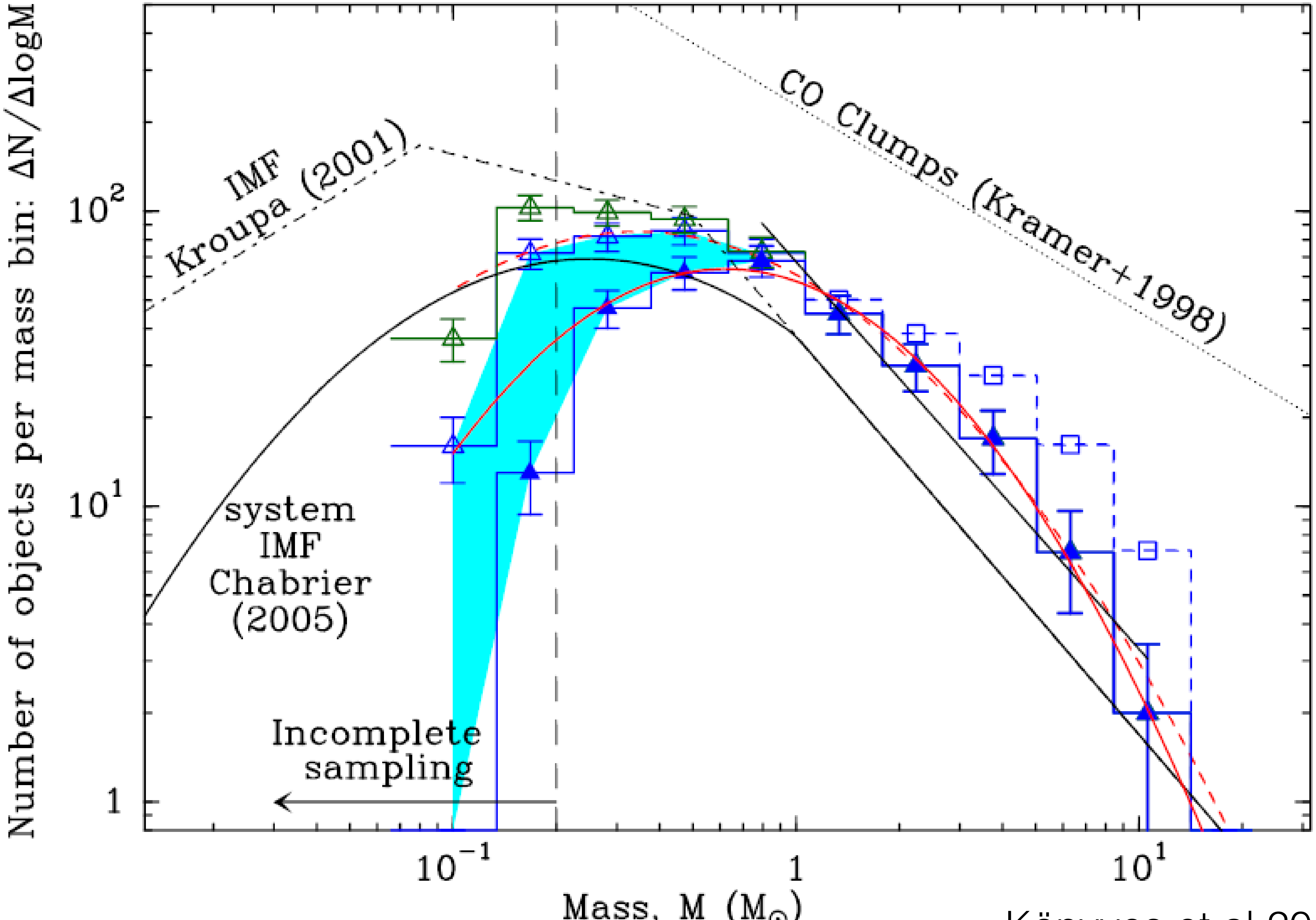
Mass/light ratio of stellar populations



Ionizing photon production (reionization?)

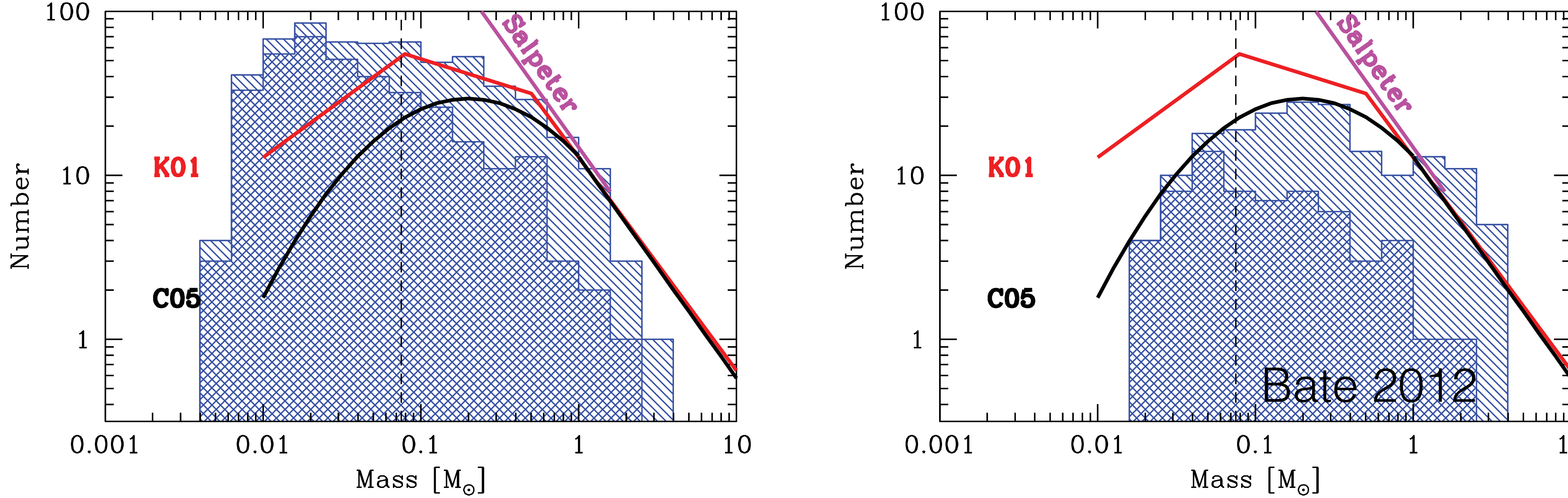
Metal enrichment

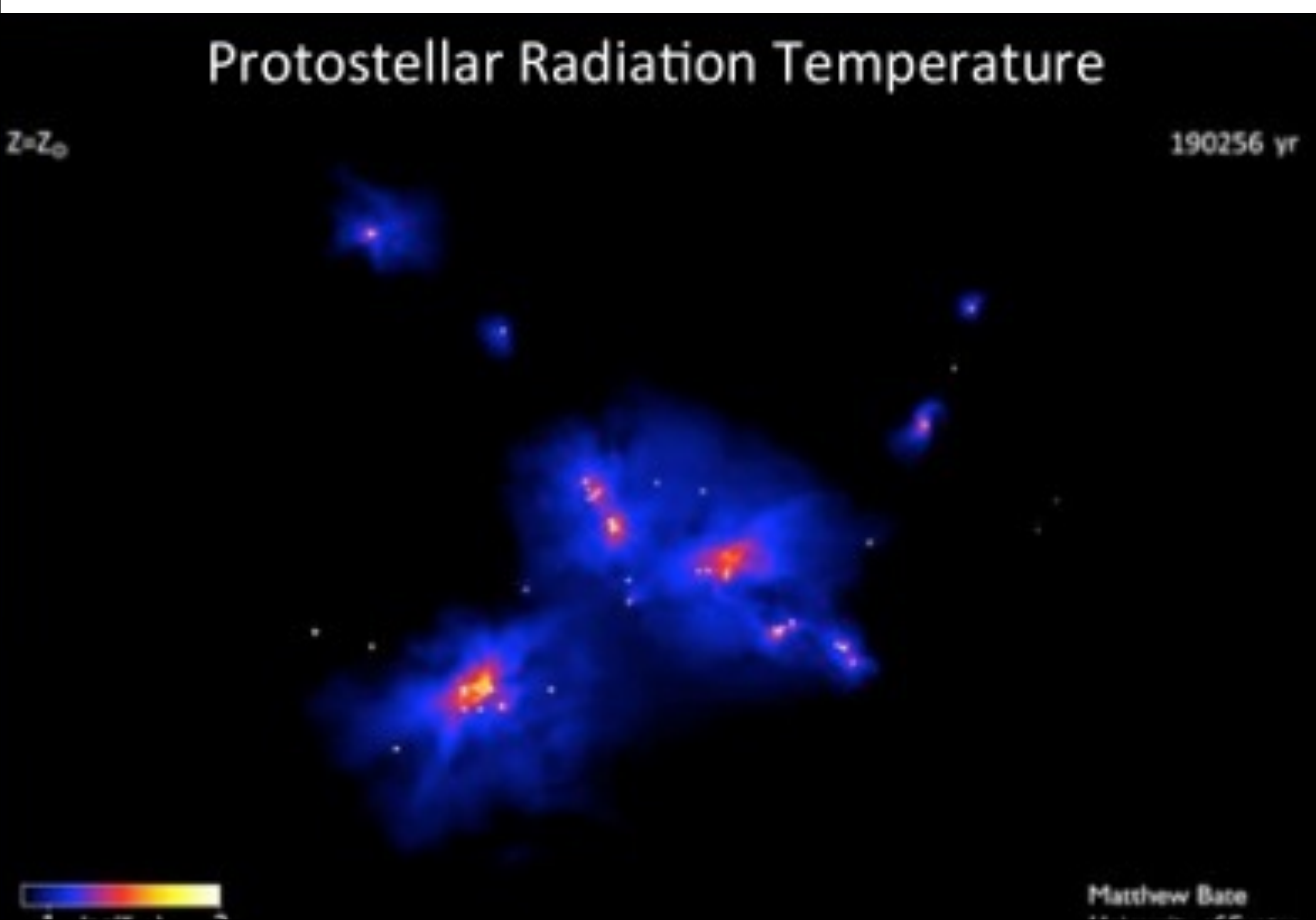
Nearby cloud observations lead to the hypothesis that the *prestellar* "Core Mass Function" maps to the stellar Initial Mass Function

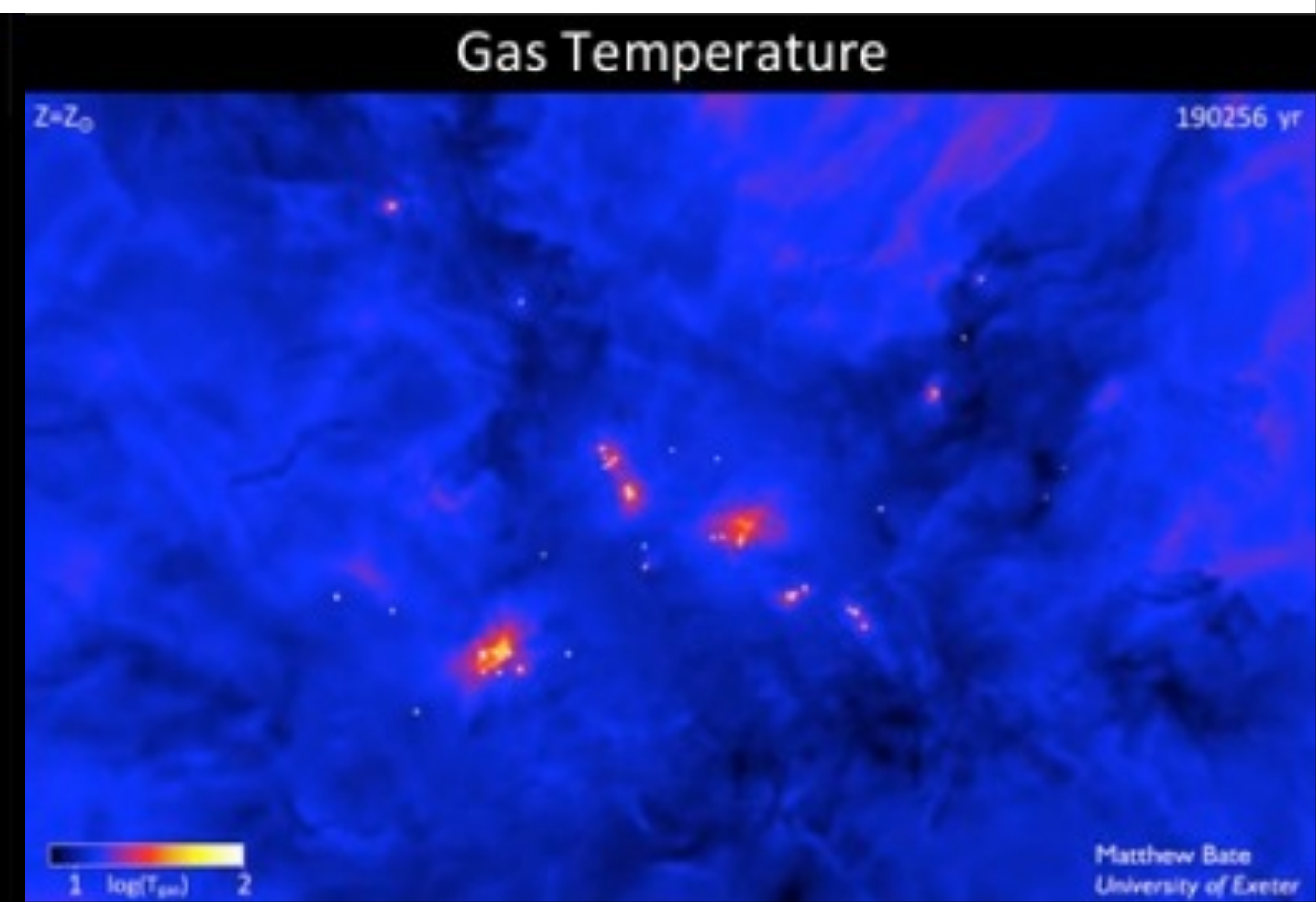


Könyves et al 2015

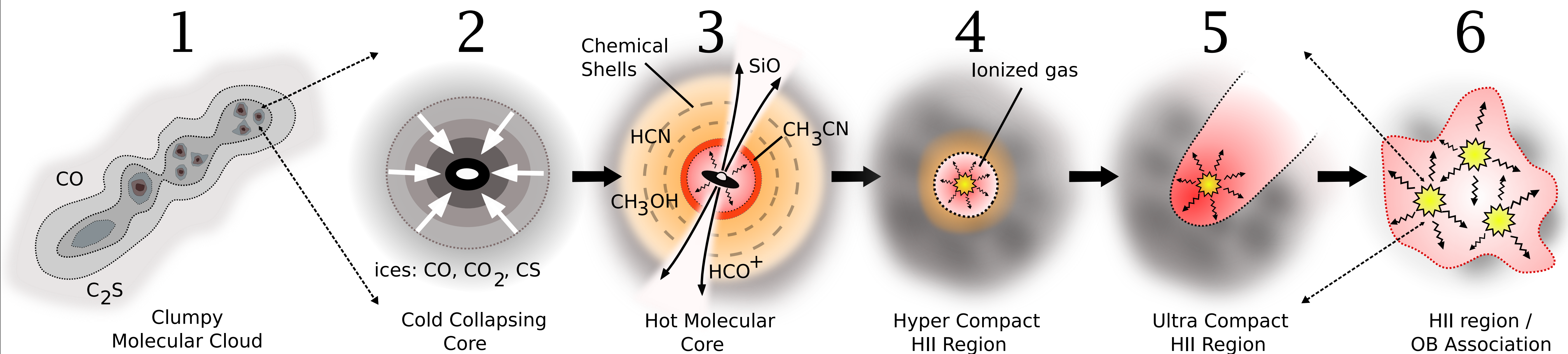
Theoretical considerations suggest that stellar thermal feedback is critical for setting the IMF







A “standard” story of high-mass star formation



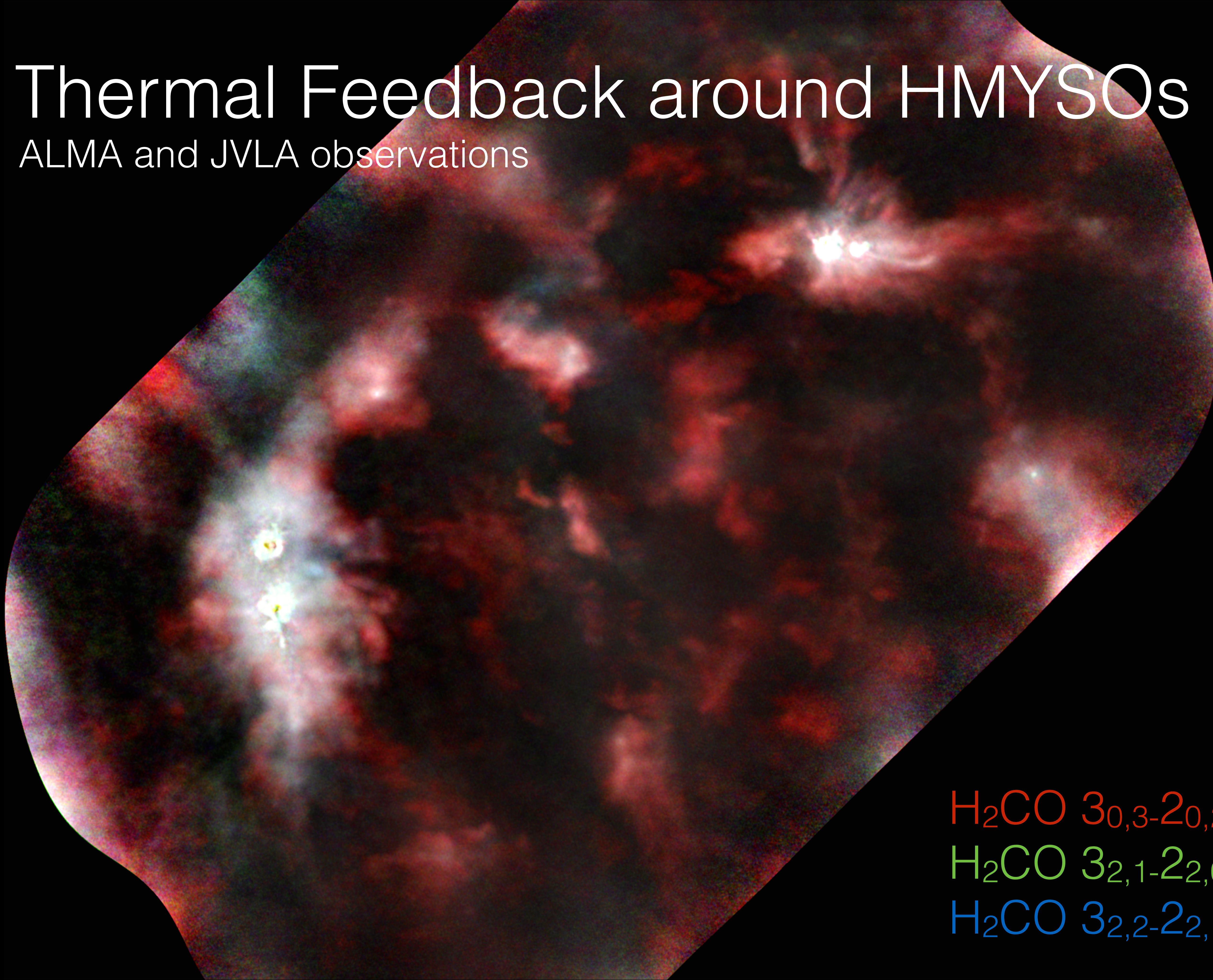
Cormac Purcell

Implicit assumptions:

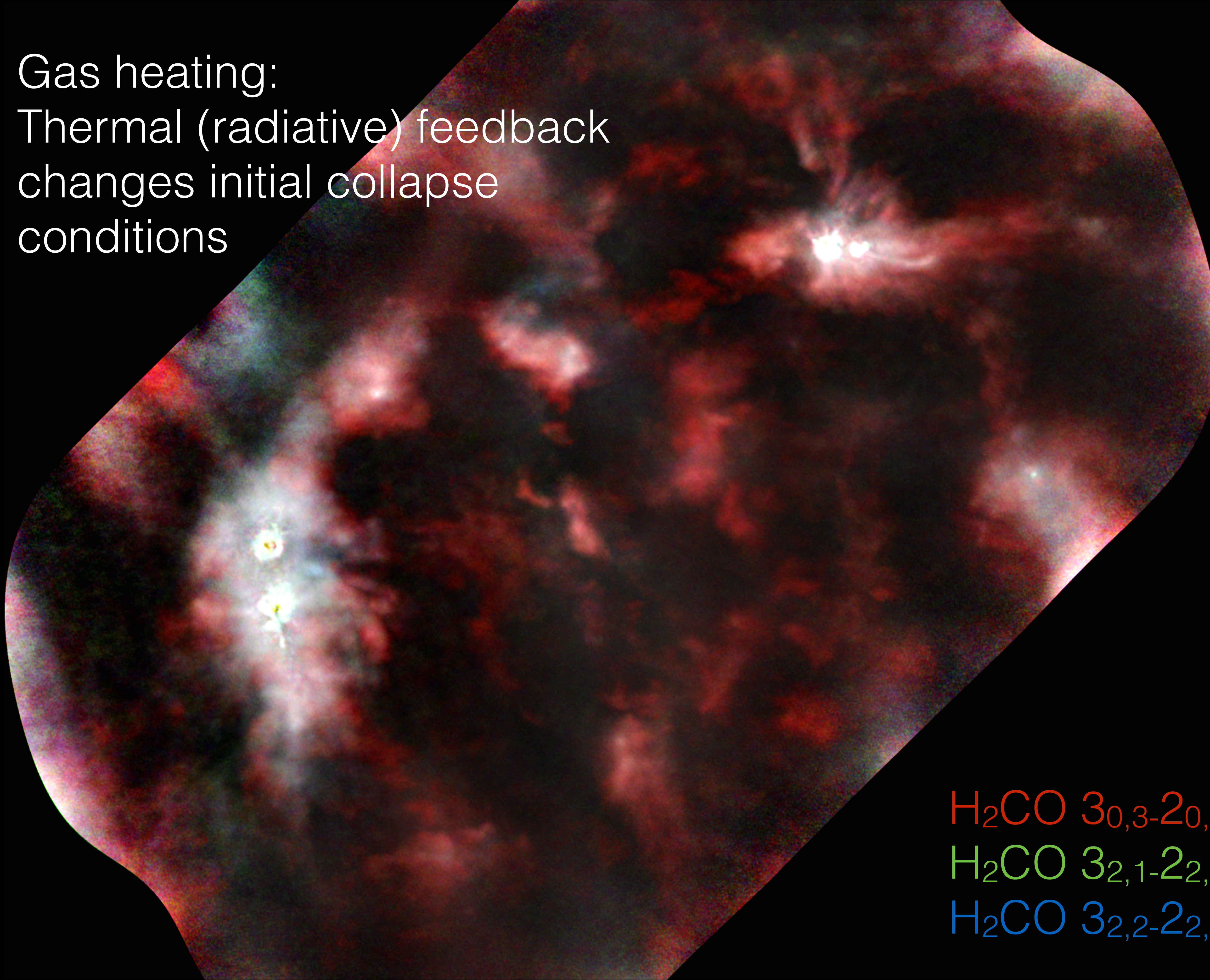
- Isolated evolution
- Core is small compared to cloud
- Accretion stops between 3 & 4
- Arrows go only one way
- Everything is roughly spherical or axisymmetric

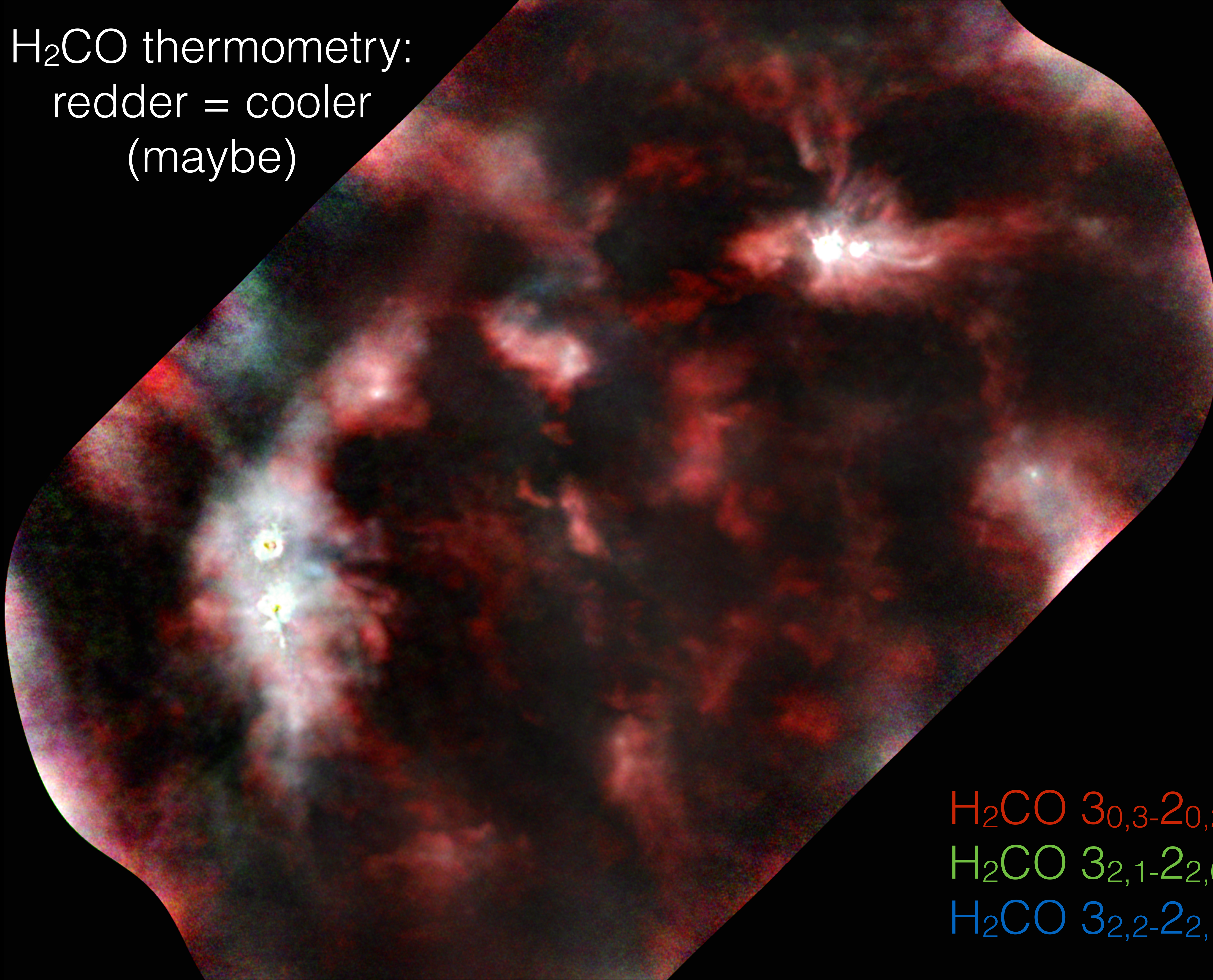
Thermal Feedback around HMYSOs

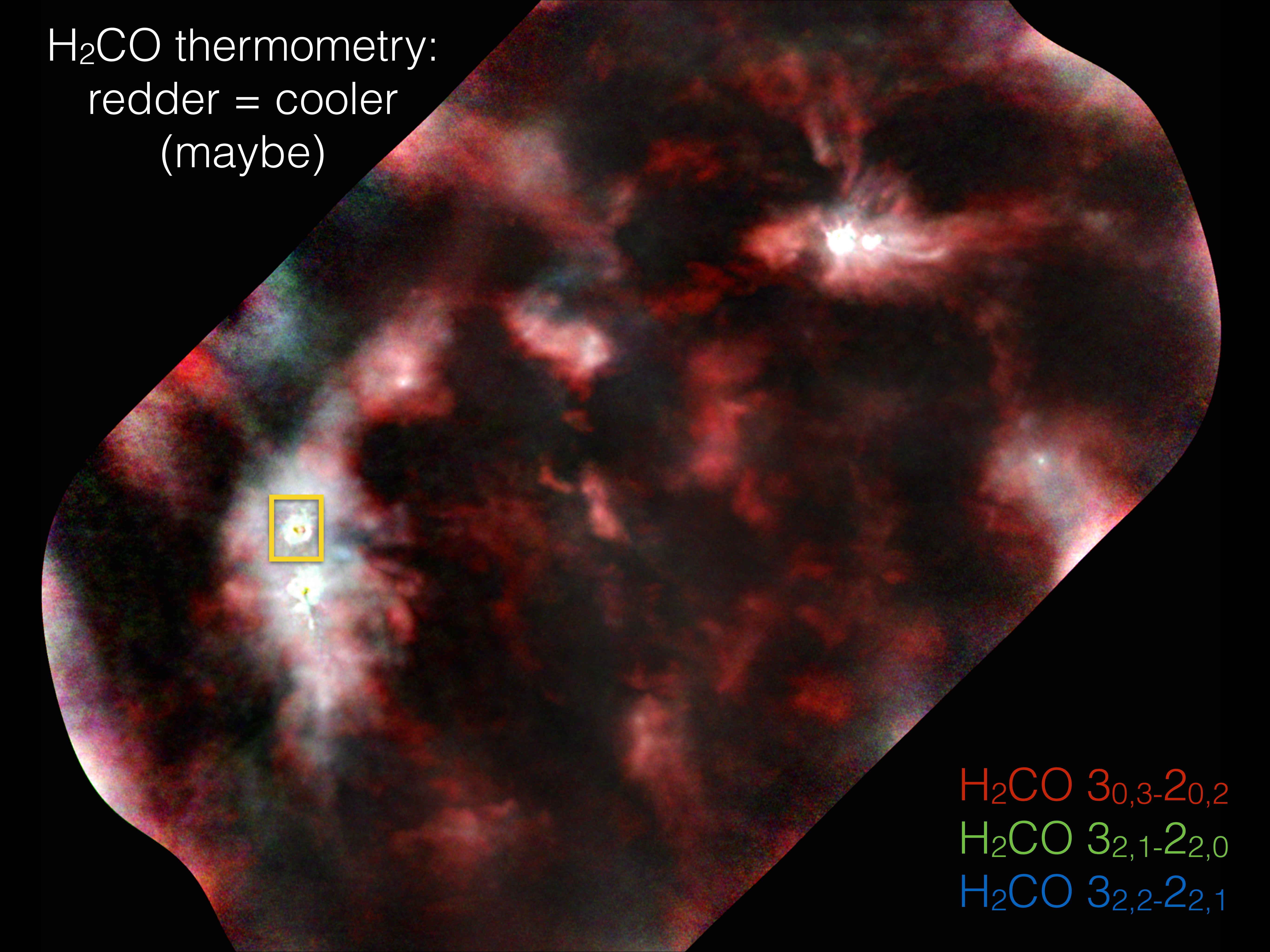
ALMA and JVLA observations



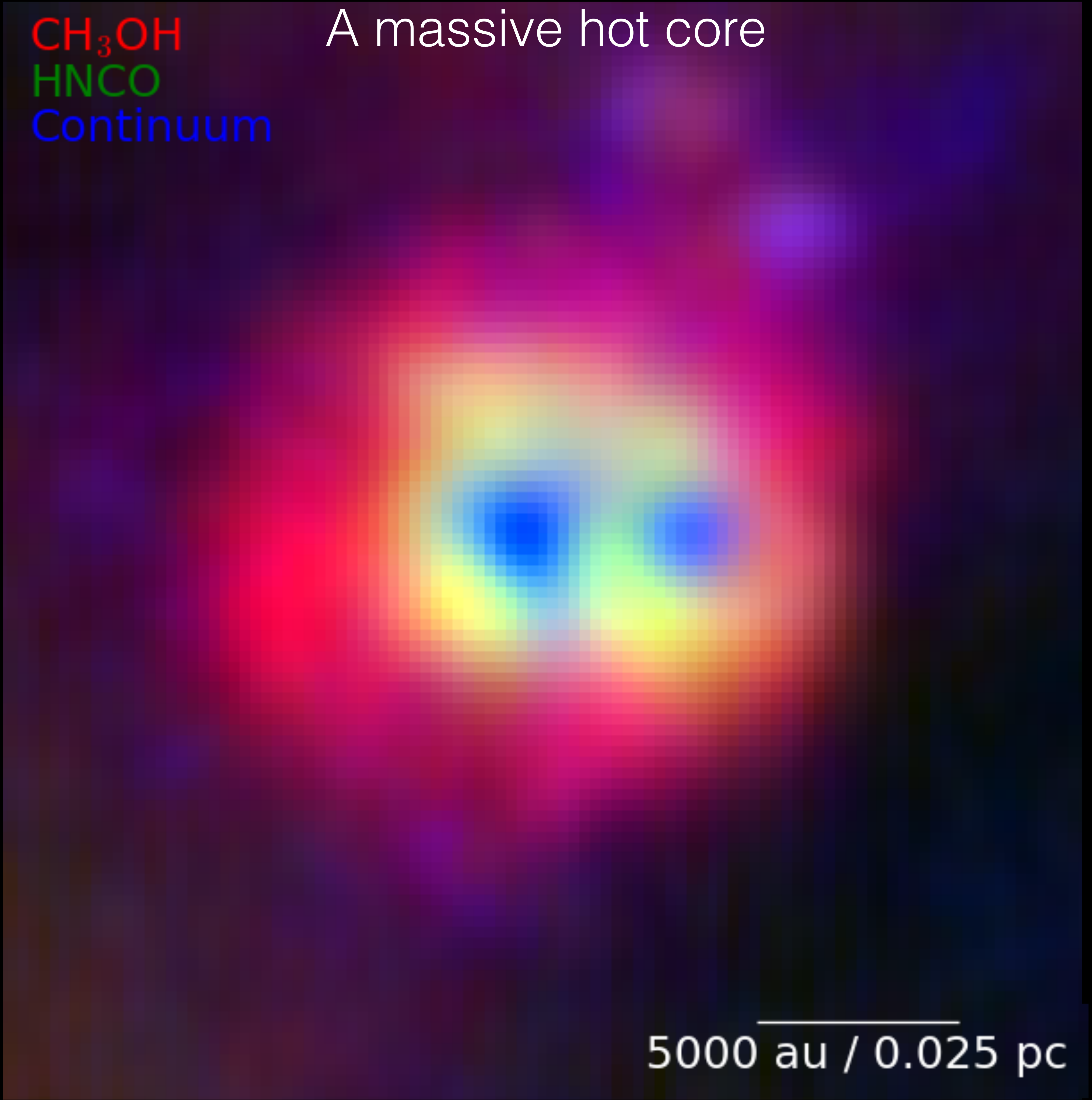
Gas heating:
Thermal (radiative) feedback changes initial collapse conditions

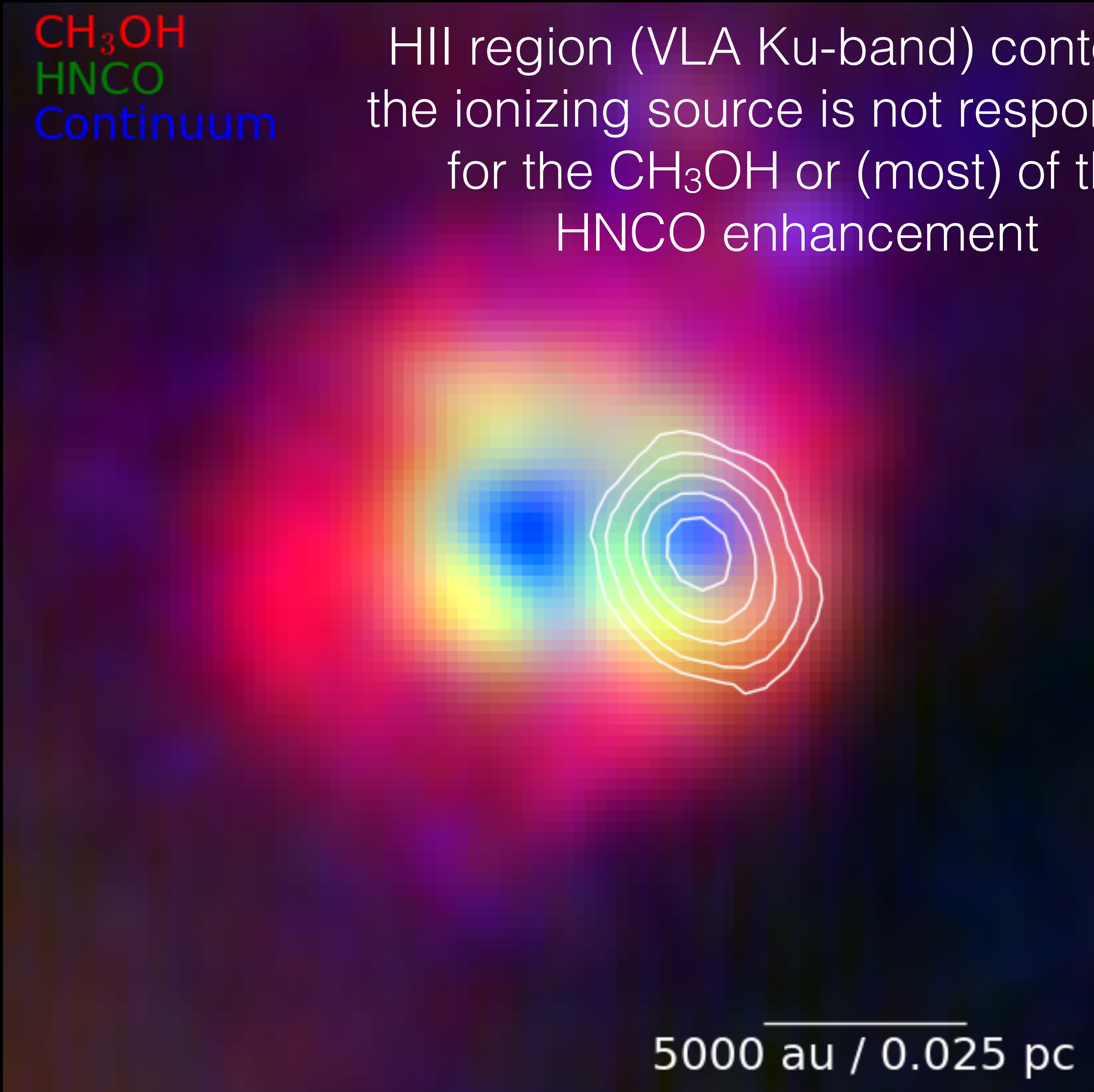



H2CO thermometry:
redder = cooler
(maybe)
H2CO 30,3-20,2
H2CO 32,1-22,0
H2CO 32,2-22,1

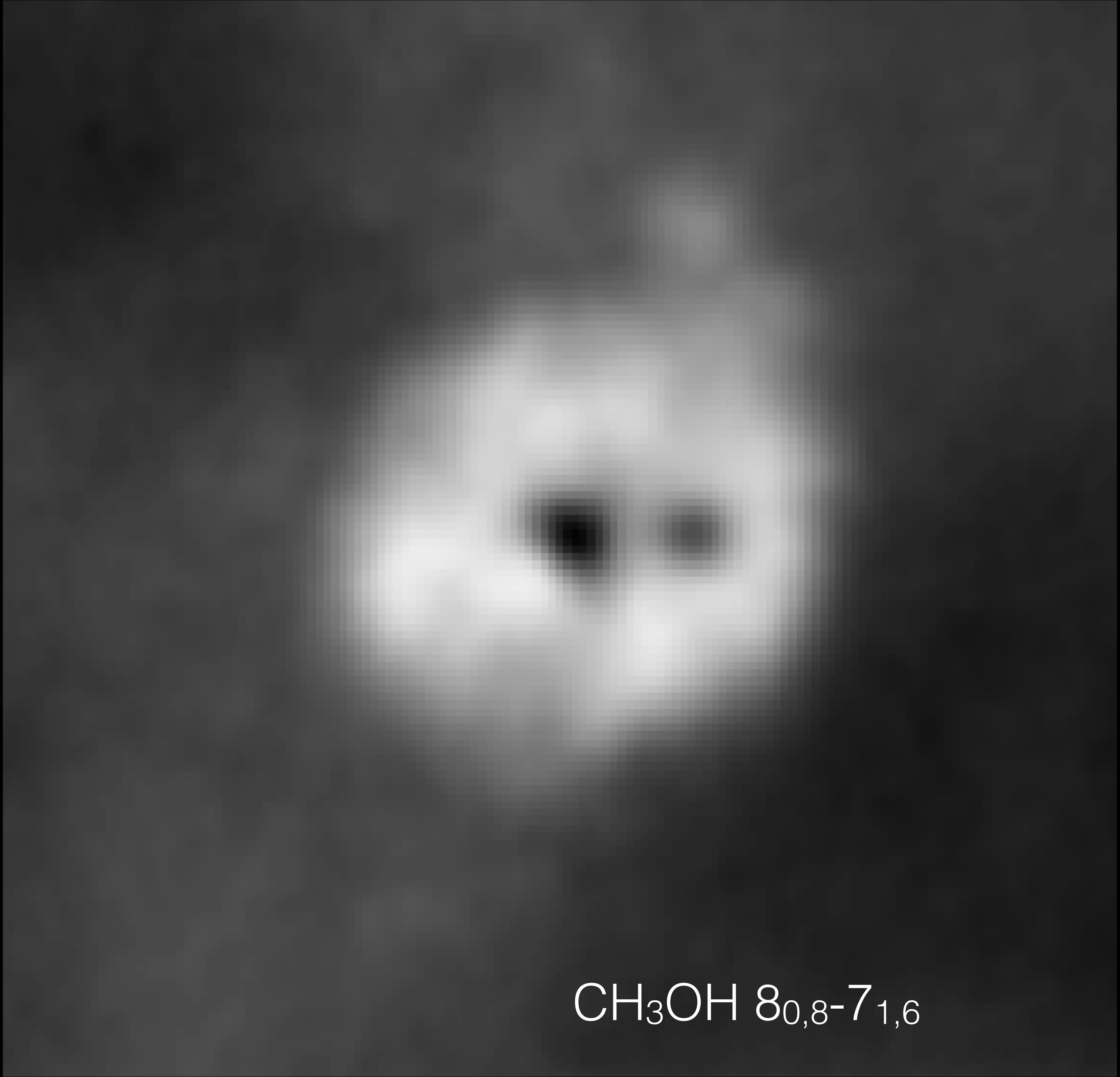

H$_2$CO thermometry:
redder = cooler
(maybe)
H$_2$CO $3_{0,3}$-$2_{0,2}$
H$_2$CO $3_{2,1}$-$2_{2,0}$
H$_2$CO $3_{2,2}$-$2_{2,1}$

A massive hot core

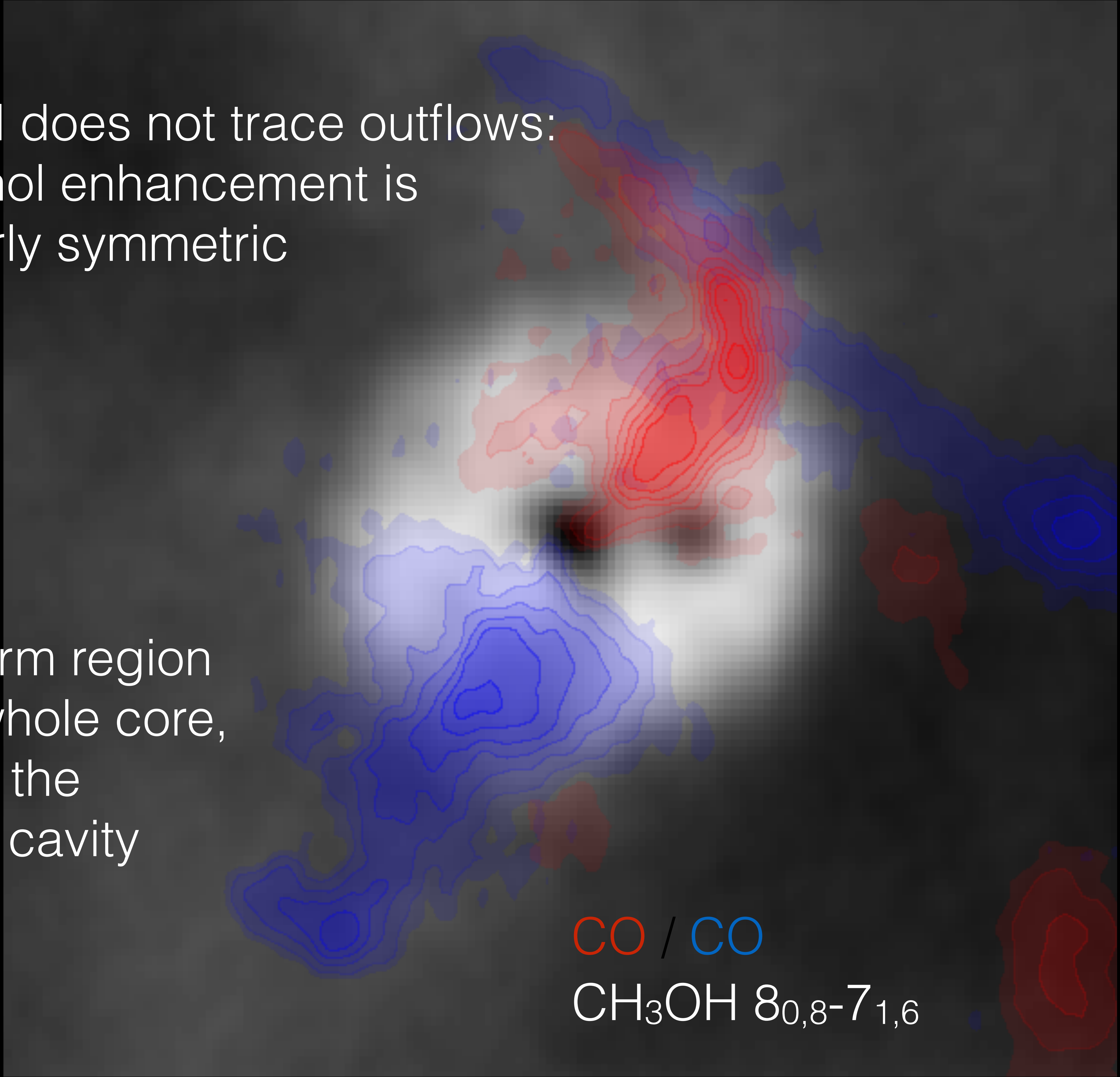




CH$_3$OH
HNCO
Continuum
HII region (VLA Ku-band) contours: the ionizing source is not responsible for the CH$_3$OH or (most) of the HNCO enhancement
5000 au / 0.025 pc


CH3OH 80,8-71,6

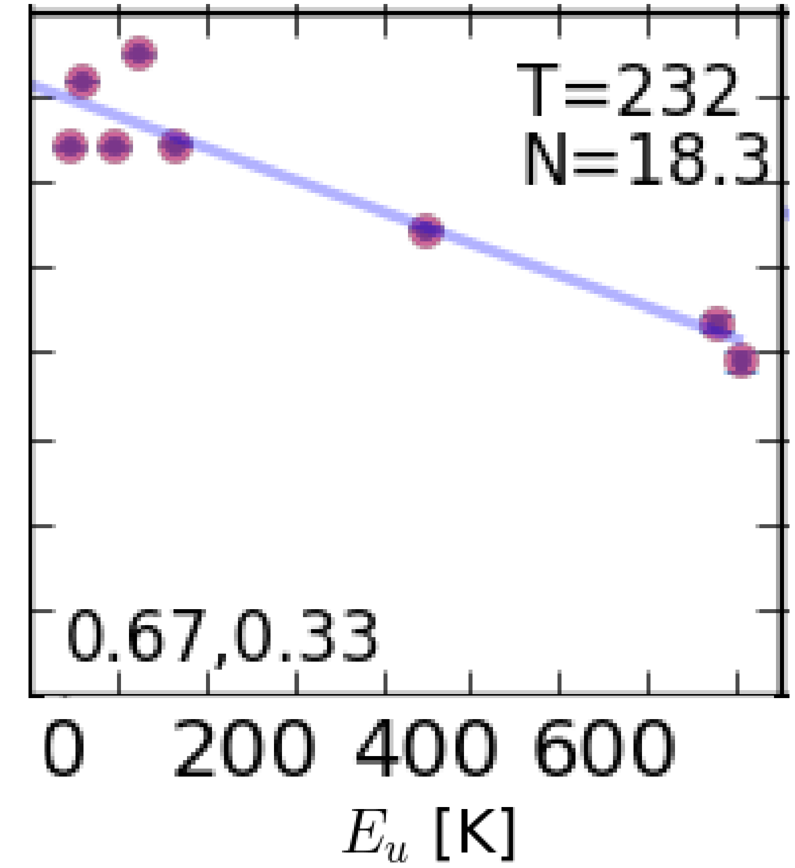
CH_3OH does not trace outflows: methanol enhancement is circularly symmetric

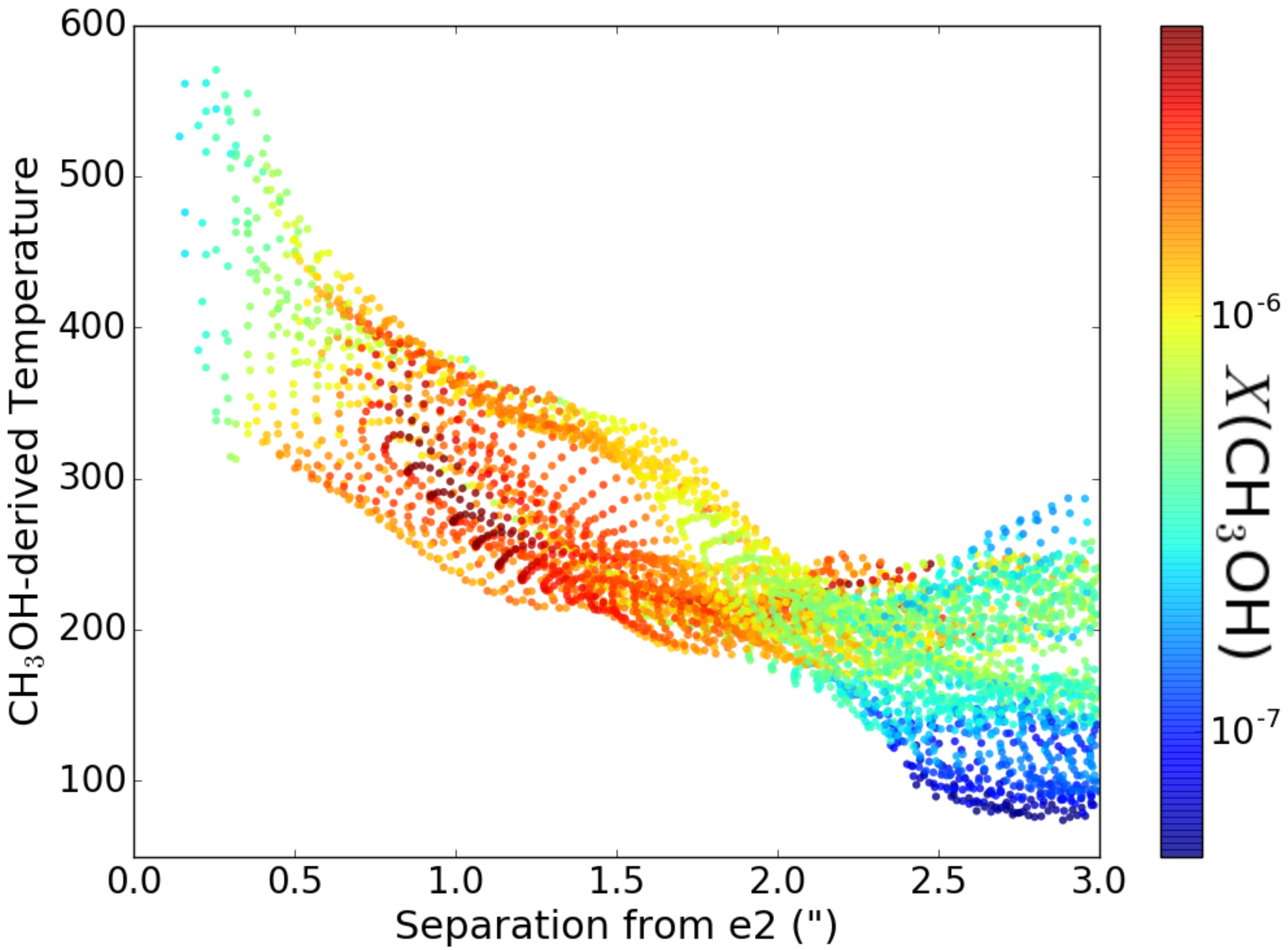


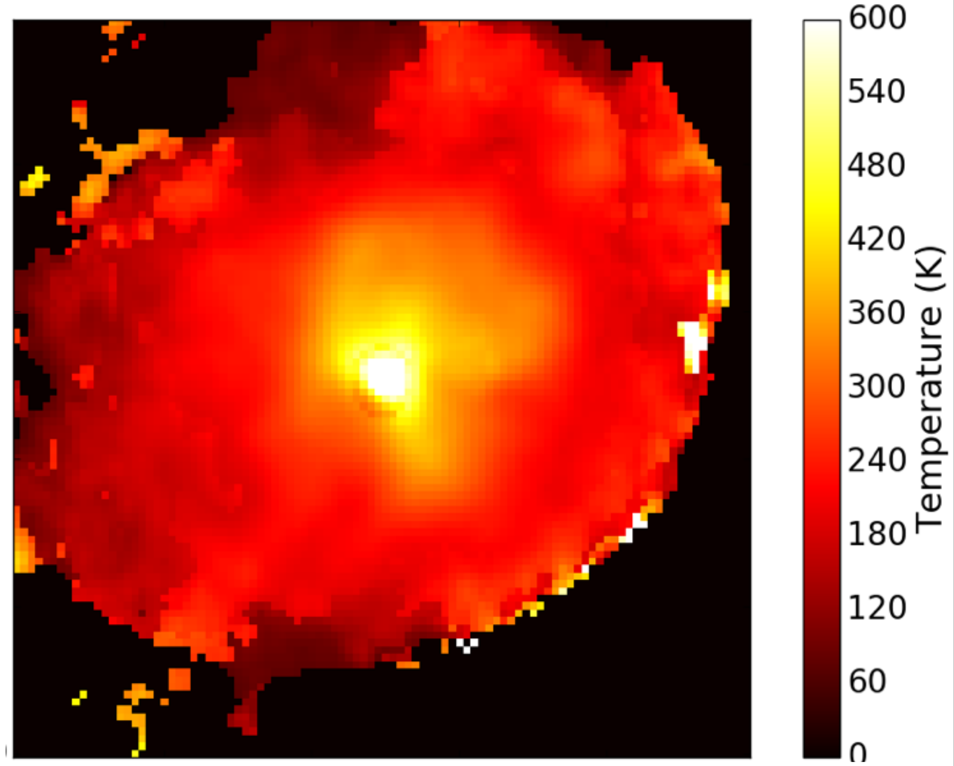
The warm region is the whole core, not just the outflow cavity

The gas around the HYMSOs is warm, 200-600 K out to r<10^4 au

(resolution ~1000 AU)

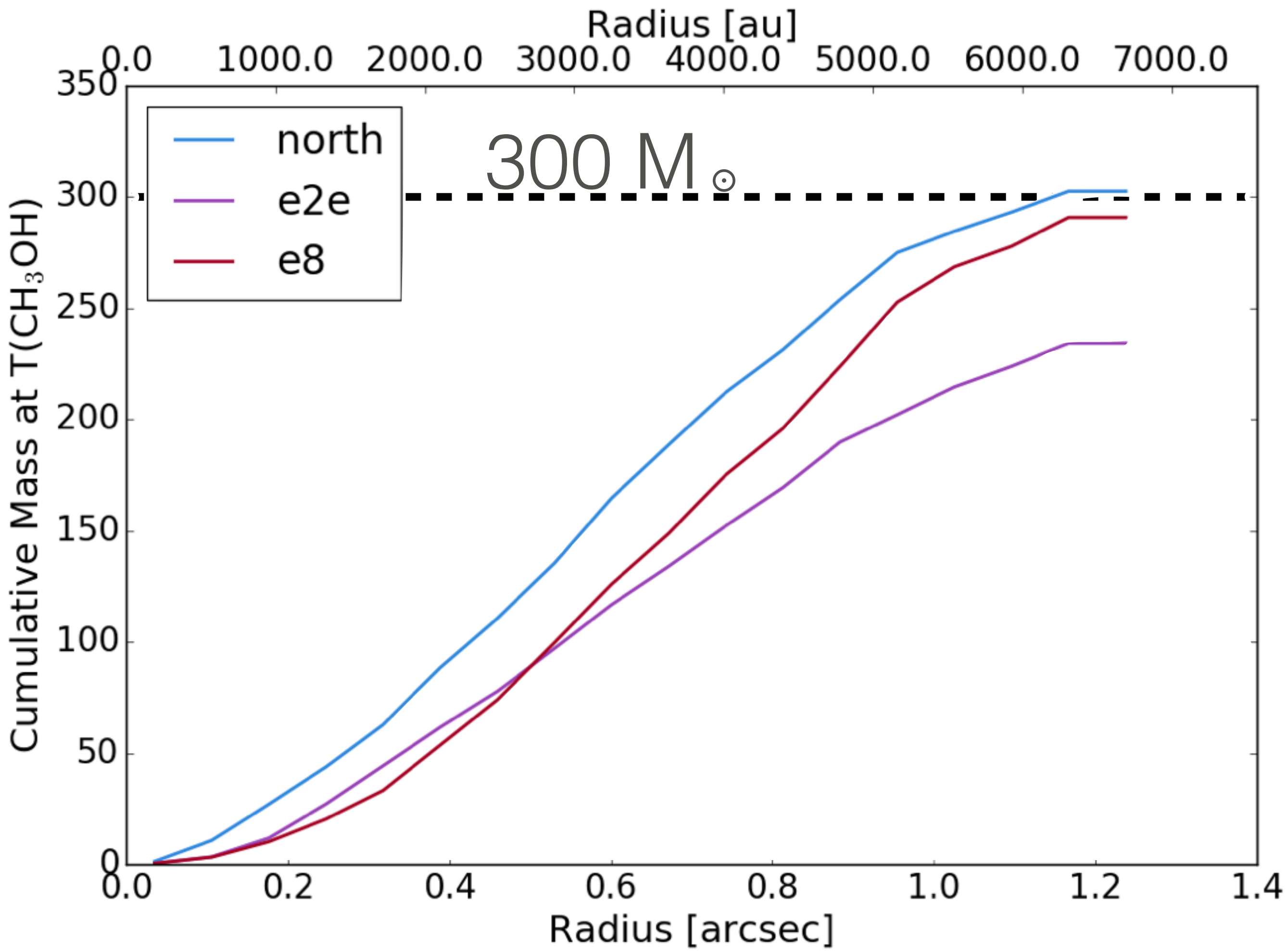




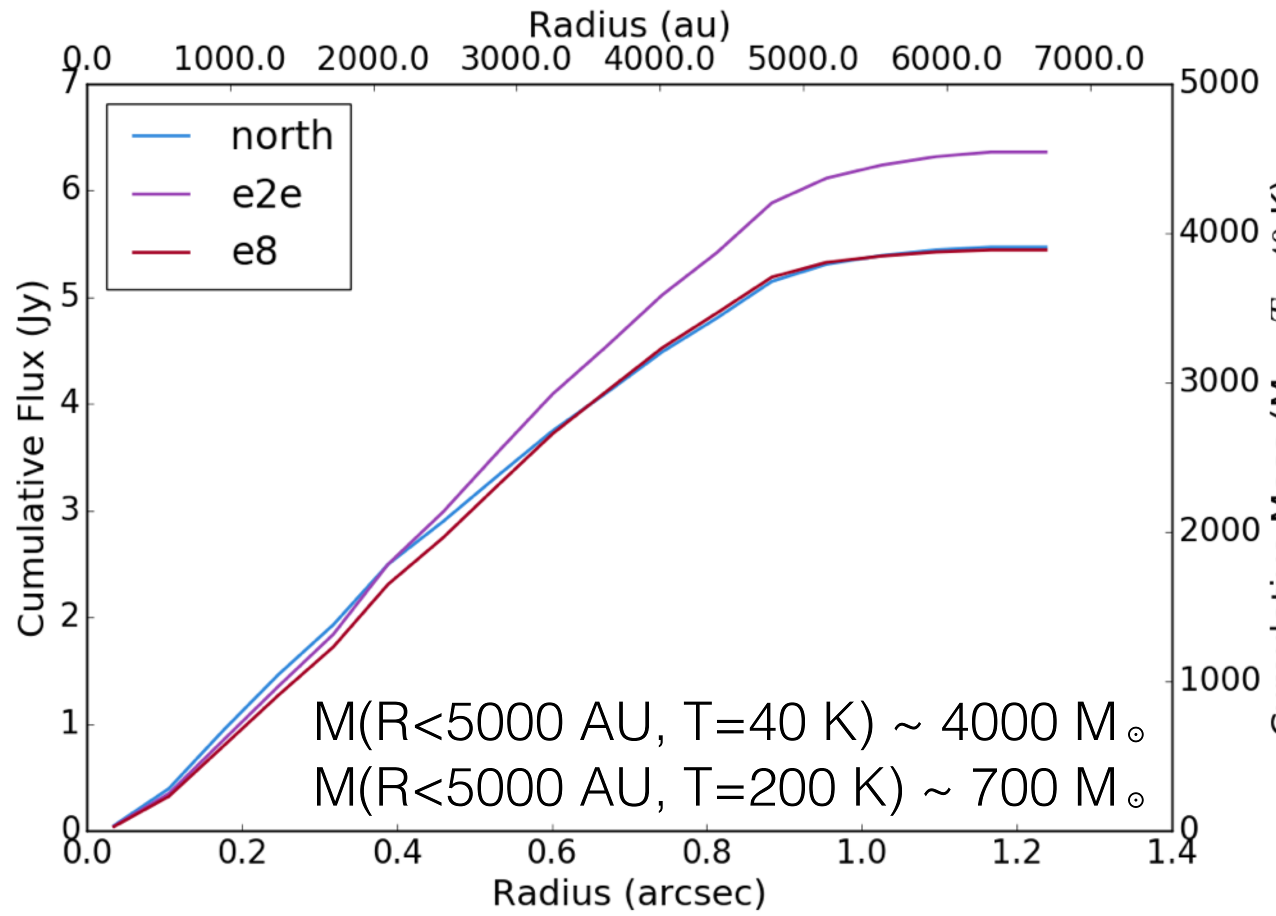


The warm gas mass is large, at least hundreds of M$_\odot$

Conservative



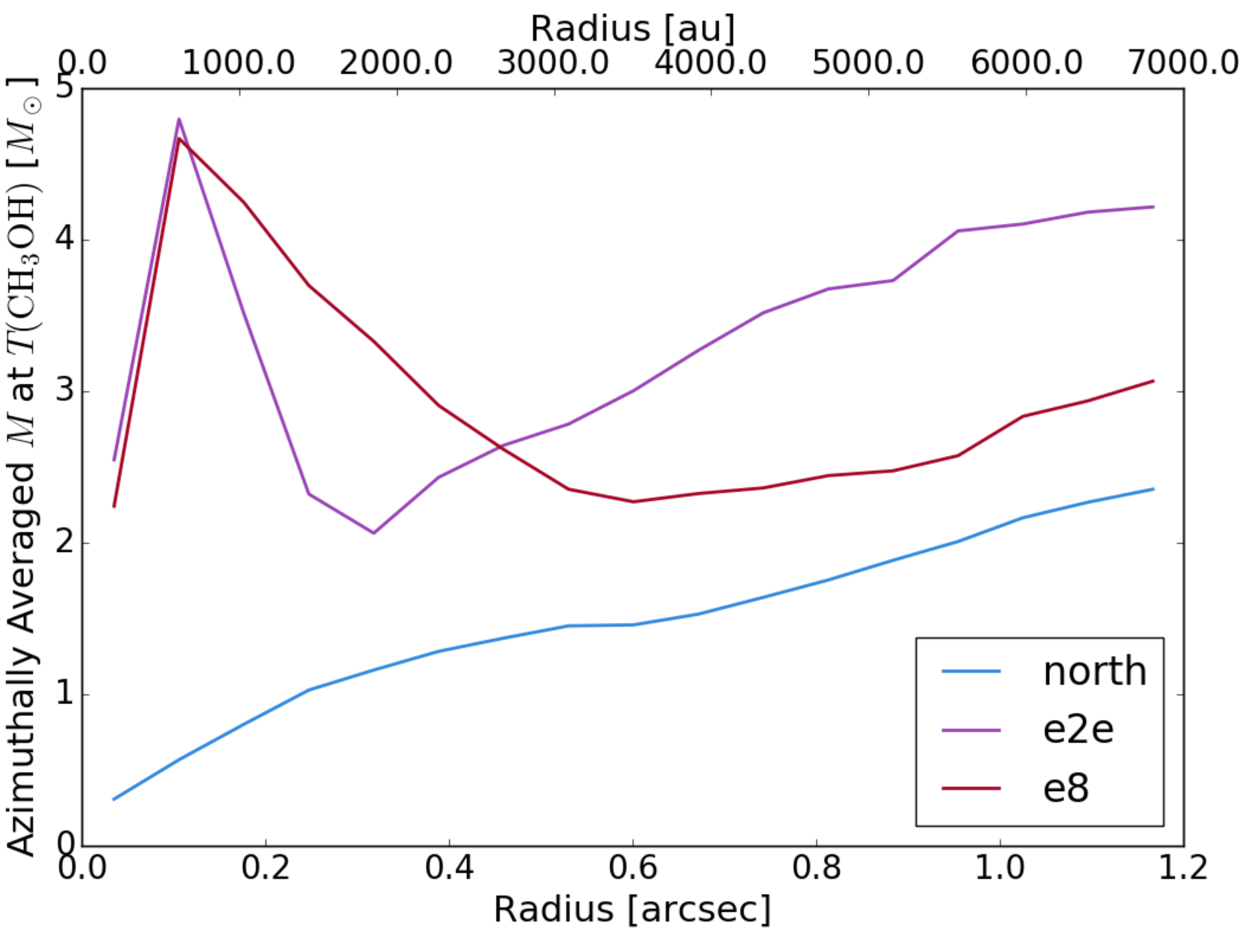
“Standard” assumptions

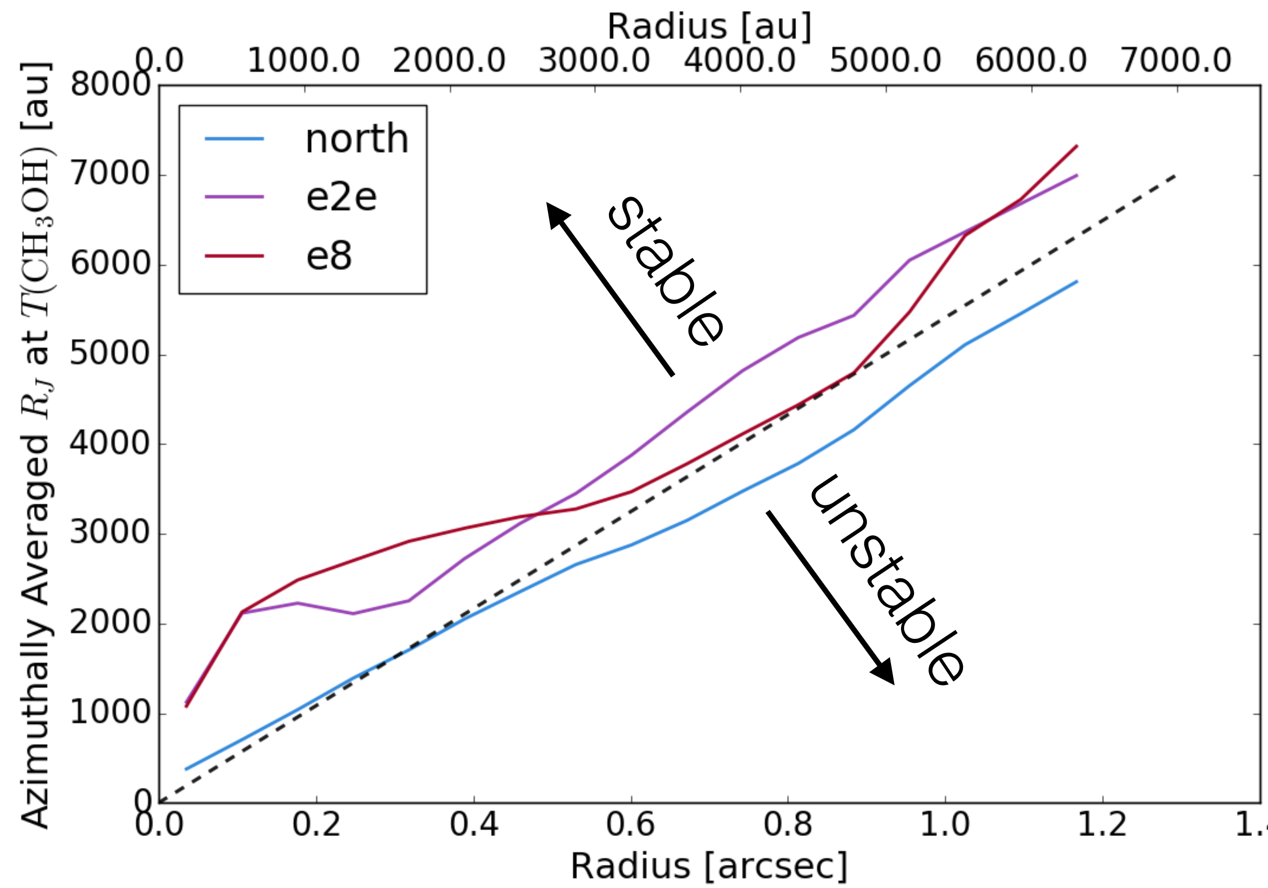


Forming MYSOs can heat enough of their surroundings to suppress fragmentation and keep a “food source” available

Warm gas:
Jeans mass is large

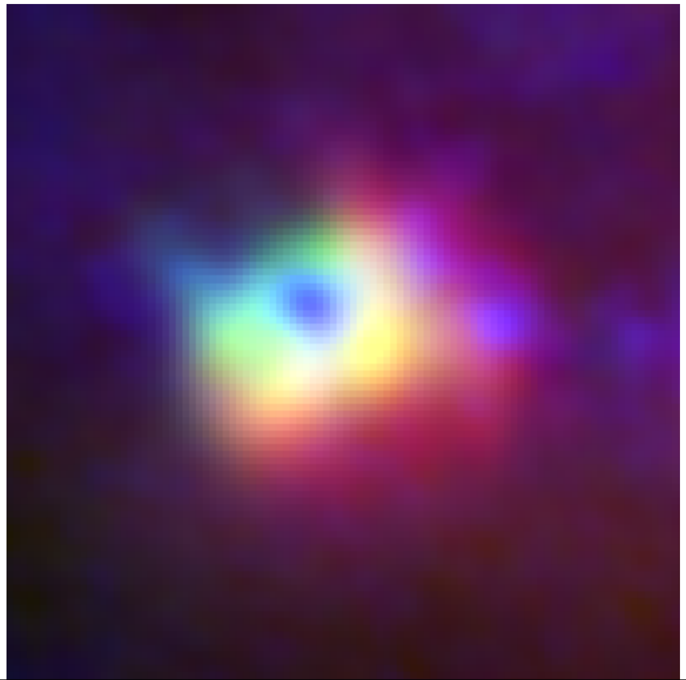
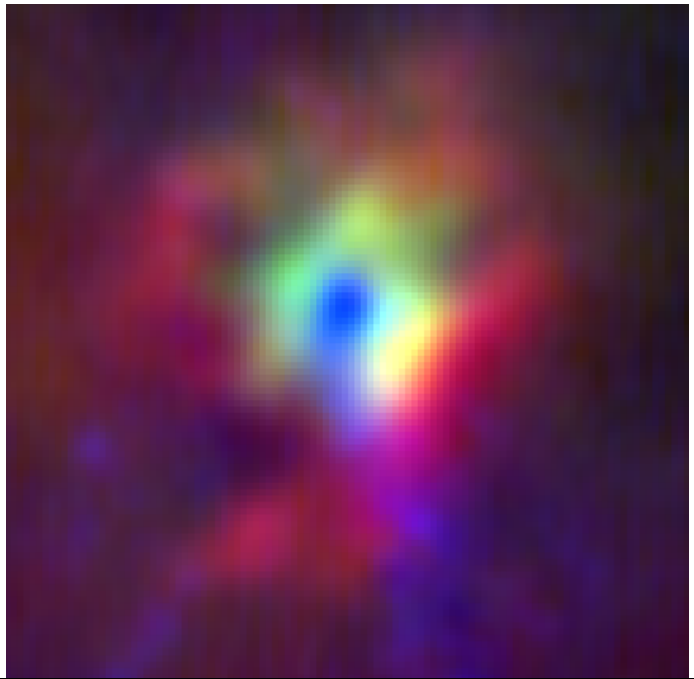
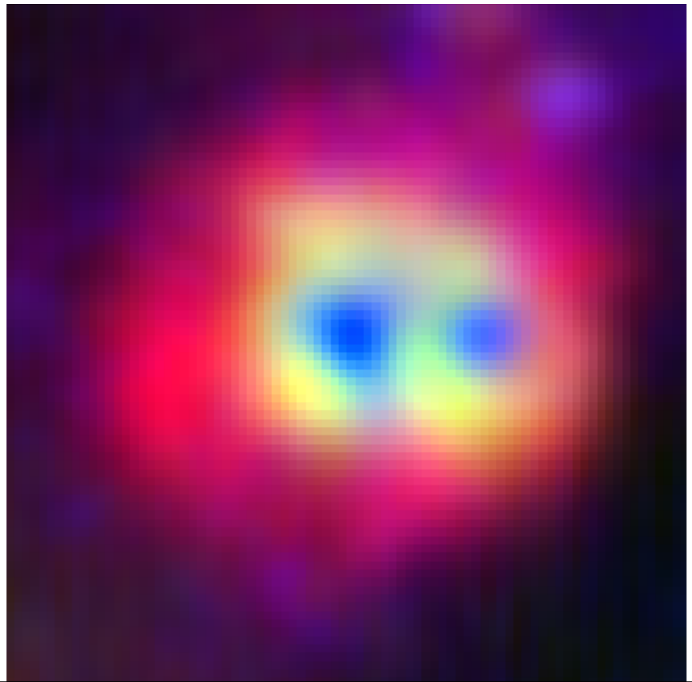
Jeans length is similar
to the core size scale:
the gas is mostly stable
against fragmentation





Stable now, but…

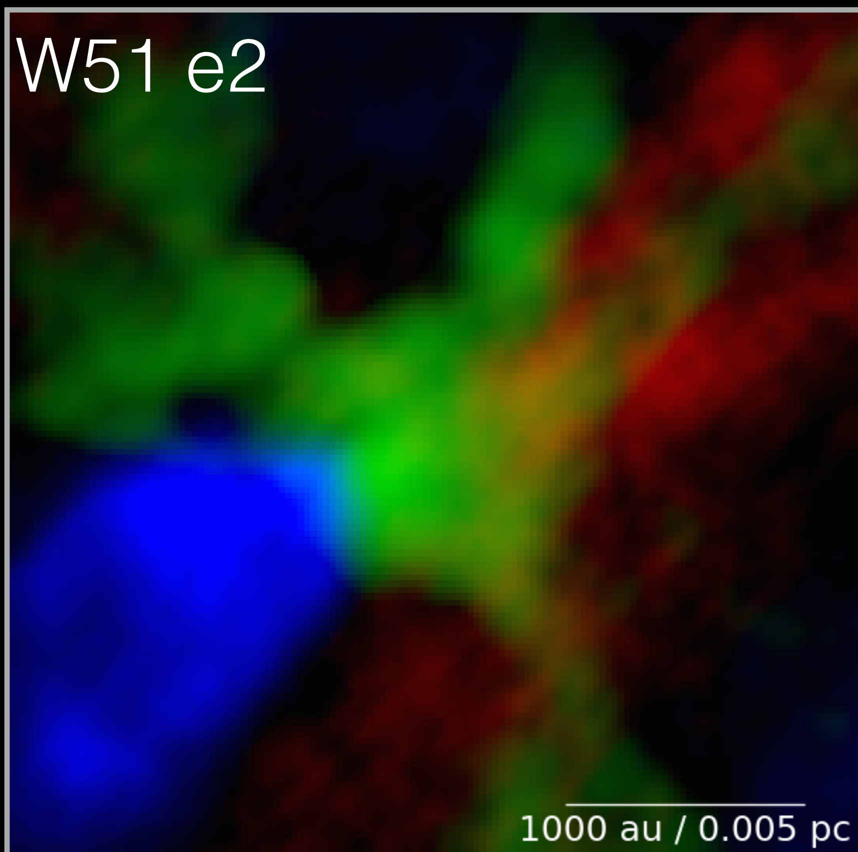
- If this gas were in a 'core' in the past, before a star formed, it would be highly unstable
  - $\lambda_J \sim T^{3/2}$, so at $T_{mol} \sim 20$, it was 30 times smaller
- At least on the high-mass end, the prestellar 'core mass function' cannot map to the IMF

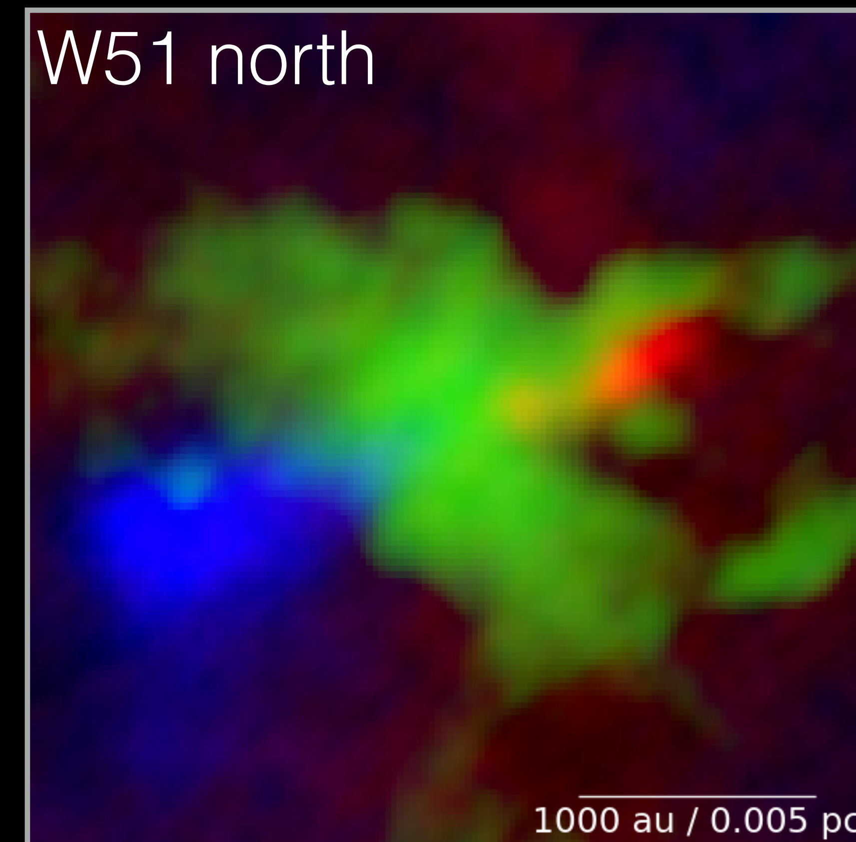
Summary:

- HMYSOs illuminate large, massive cores up to T>200K
  - Current “core” masses are $\gtrsim 250\ M_\odot$
- These cores likely did not exist as prestellar cores
- The prestellar CMF->IMF mapping doesn’t work high-mass stars

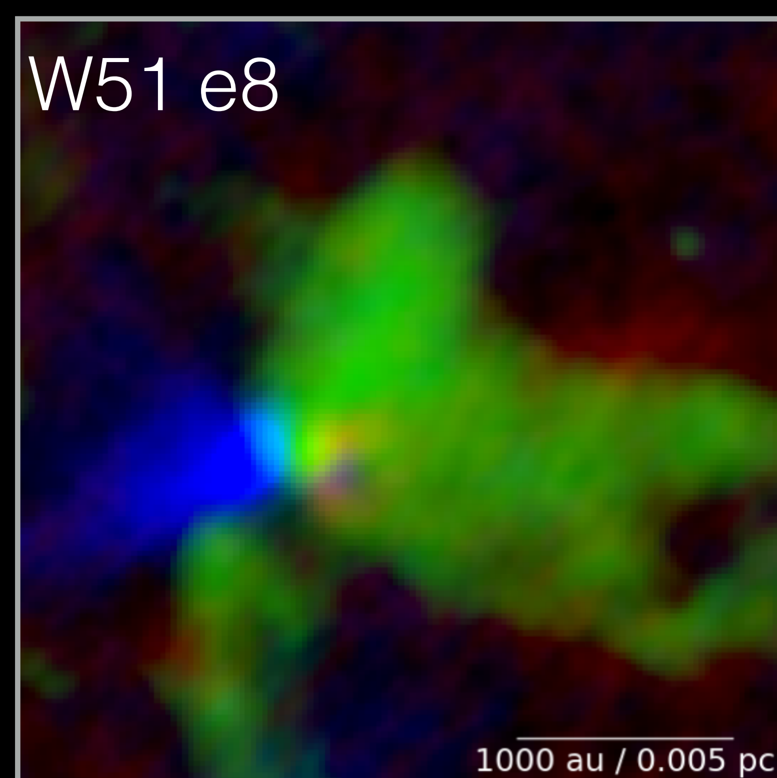
Outflows: there must be disks (but they are small)



1.3 mm
SiO SiO



1000 au
0.005 pc



Resolution 200 au