CLUES TO UNDERSTANDING THE GLOBAL STAR FORMATION RATE FROM LOCAL REGIONS

(what happens)

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Compression (shocking!) dM(tot)/dt

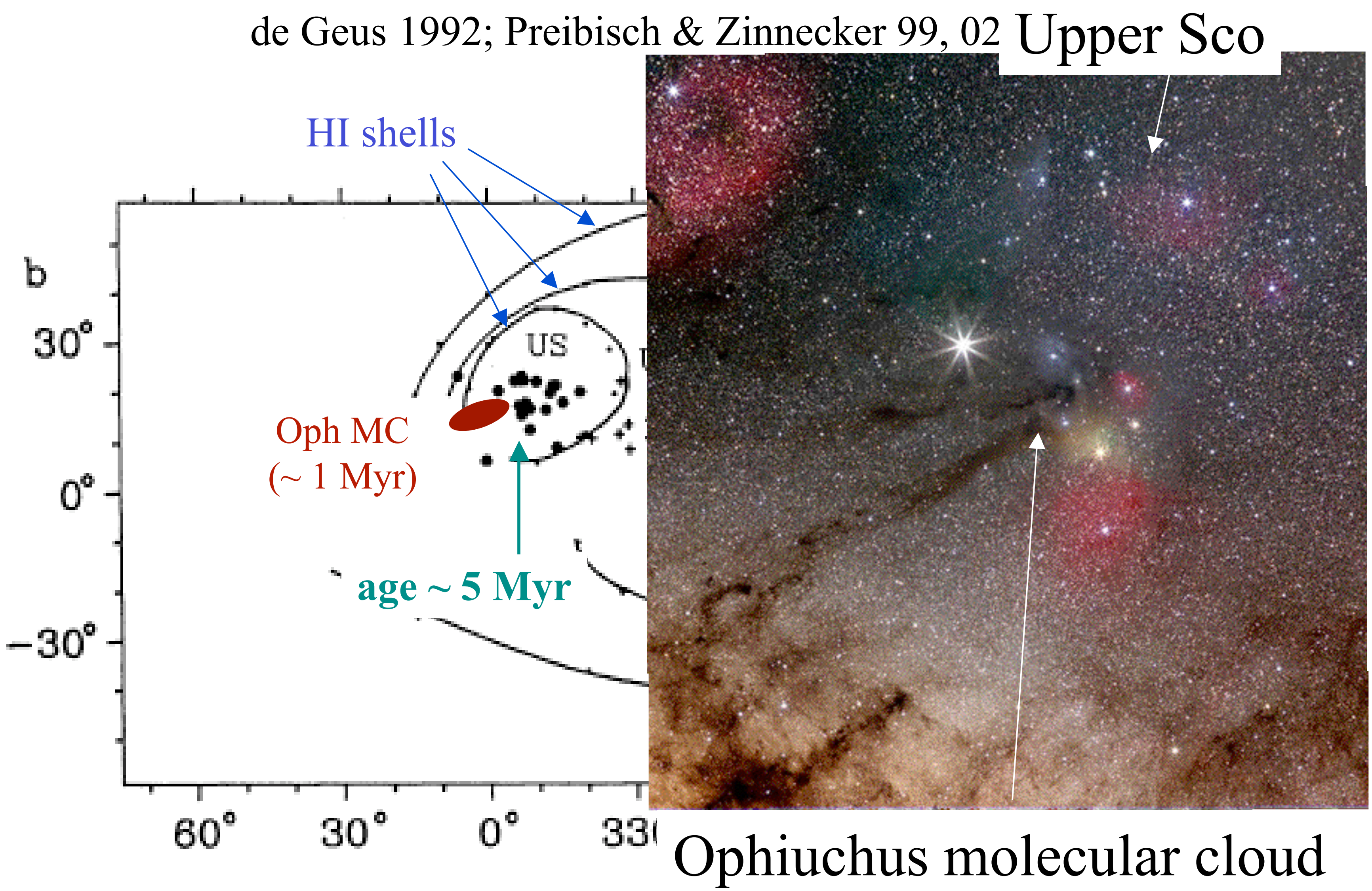
gravitational focusing

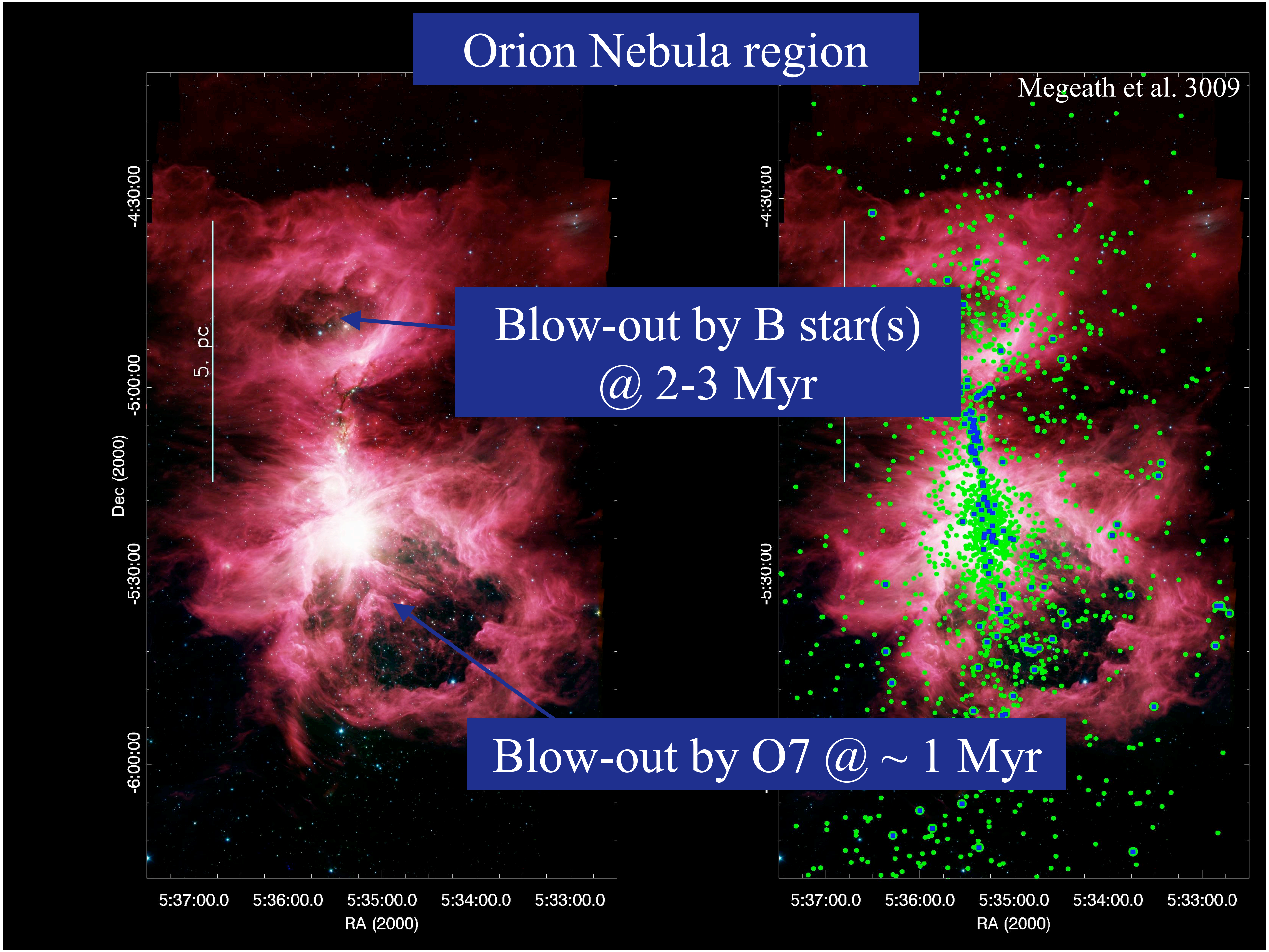
efficiency

feedback (dispersal)

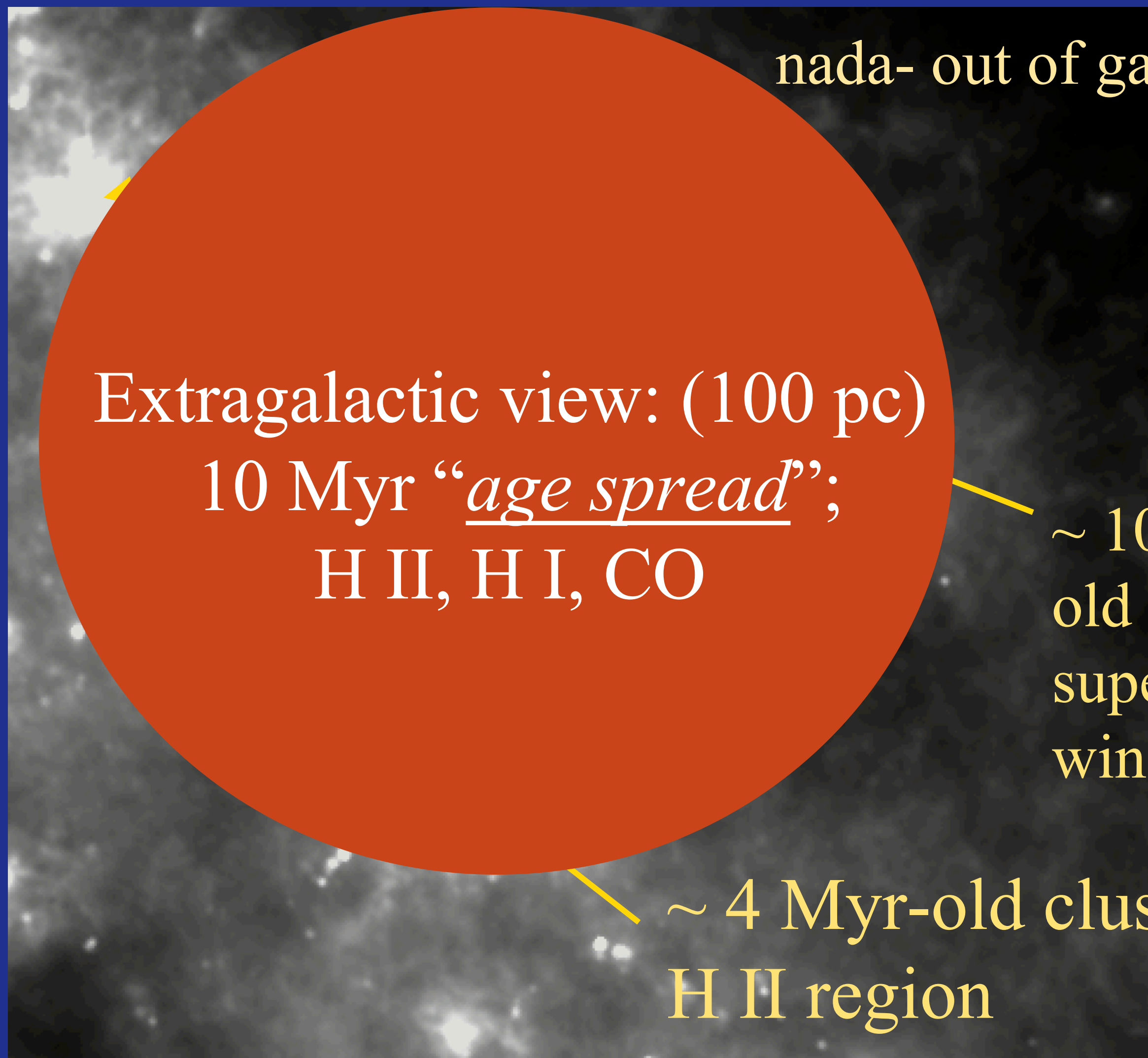
Sco OB2: quickly emptied by winds, SN

de Geus 1992; Preibisch & Zinnecker 99, 02




Orion Nebula region
Megeath et al. 3009
Blow-out by B star(s)
@ 2-3 Myr
Blow-out by O7 @ ~ 1 Myr
5. pc
Dec (2000)
-4:30:00
-5:00:00
-5:30:00
-6:00:00
5:37:00.0
5:36:00.0
5:35:00.0
5:34:00.0
5:33:00.0
RA (2000)

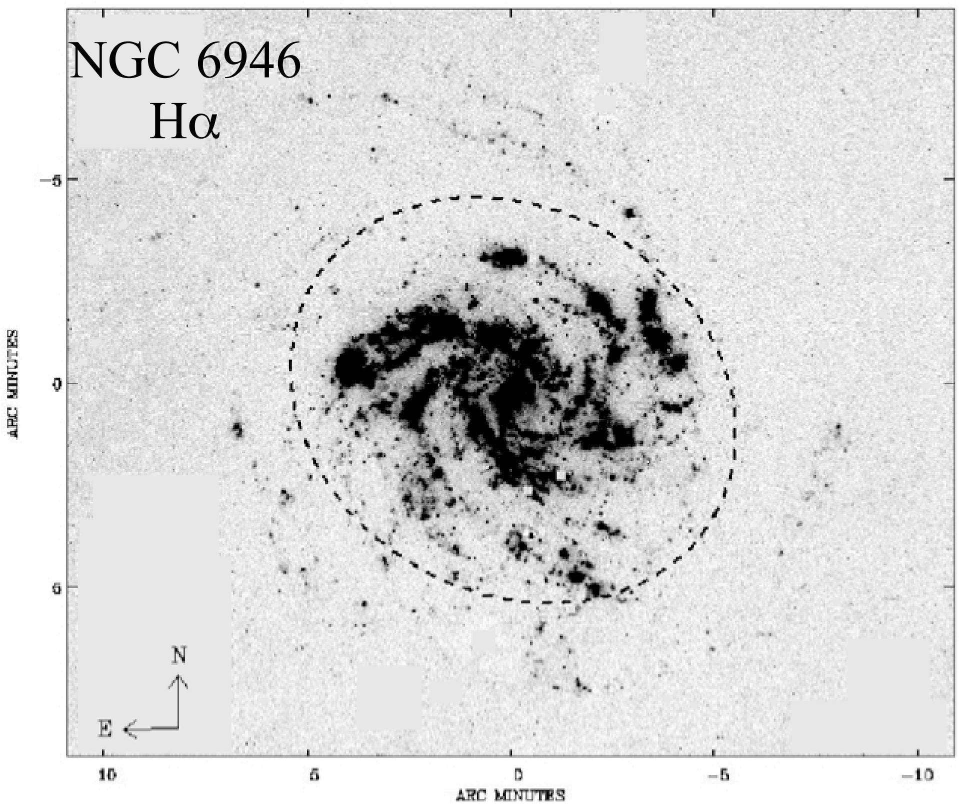
Cep OB2: supernova, H II region-driven bubbles



50 pc

100 µm IRAS dust emission

Star formation where gas is ***compressed by shocks***

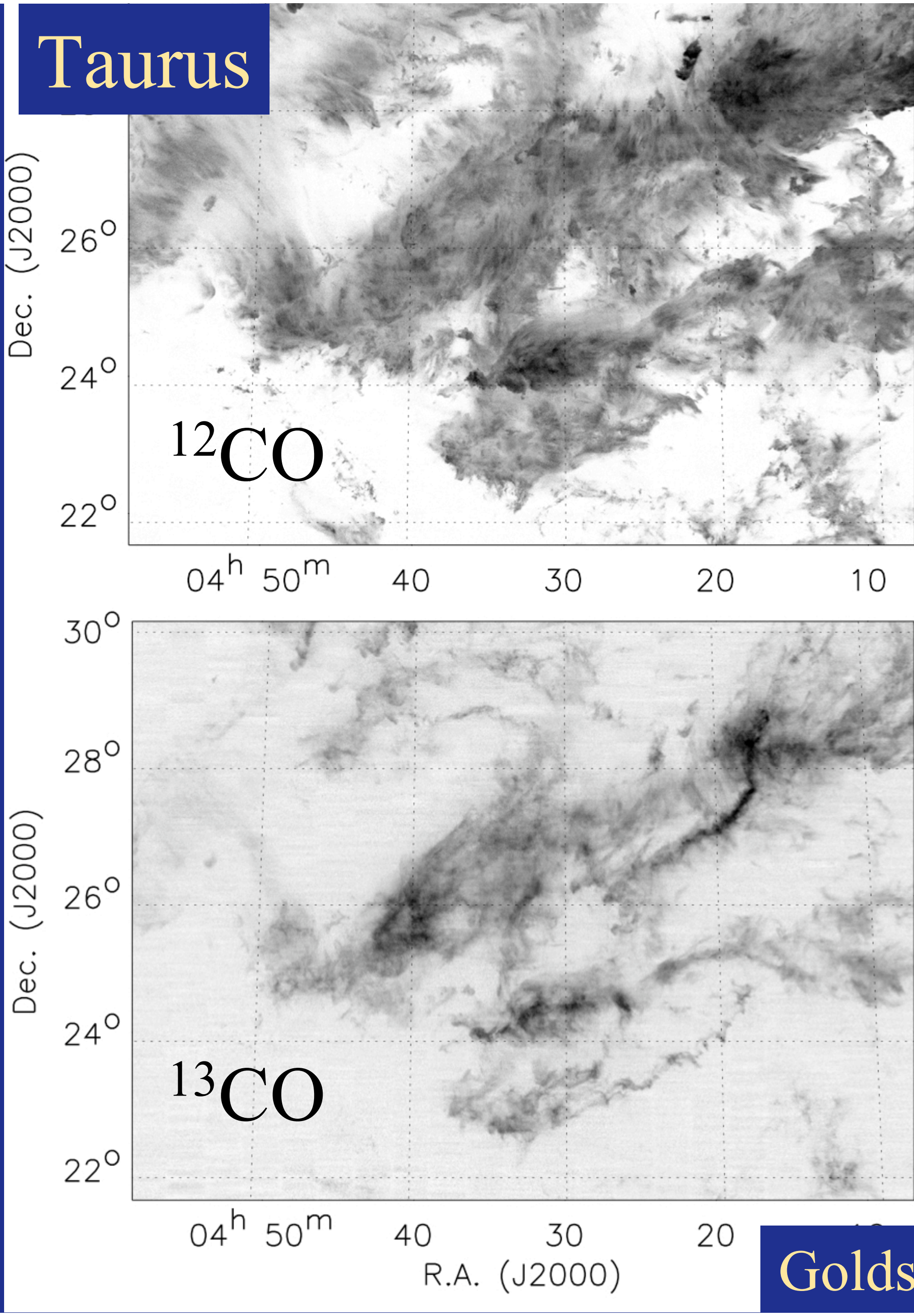


Ferguson et al. 1998

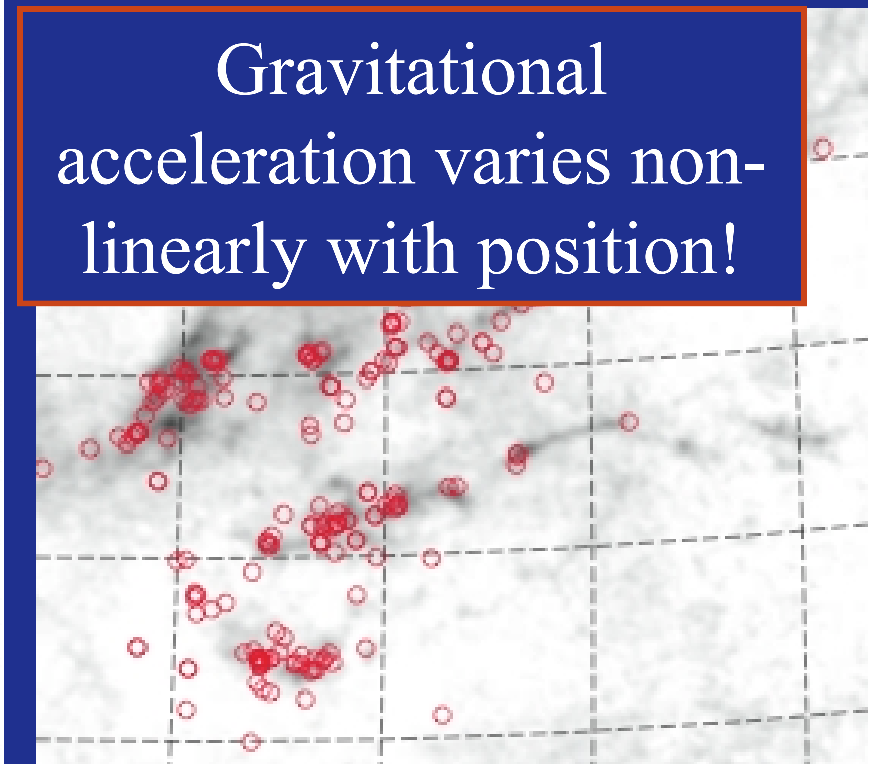
- outer disk spiral shock; not enough material to continue propagating SF
- inner disk; potential well, (Q <~ 1), more gas ⇒ more continuing SF

$$d\Sigma/dt \approx \Sigma \times \text{eff} \times [v_{orb} - v(\text{pattern})] \approx \Sigma/t_{dyn}$$

efficiency ~ 1-2% per cloud, × few triggered ⇒ 10%/orbit



High-density regions only *small* part of molecular clouds; why?

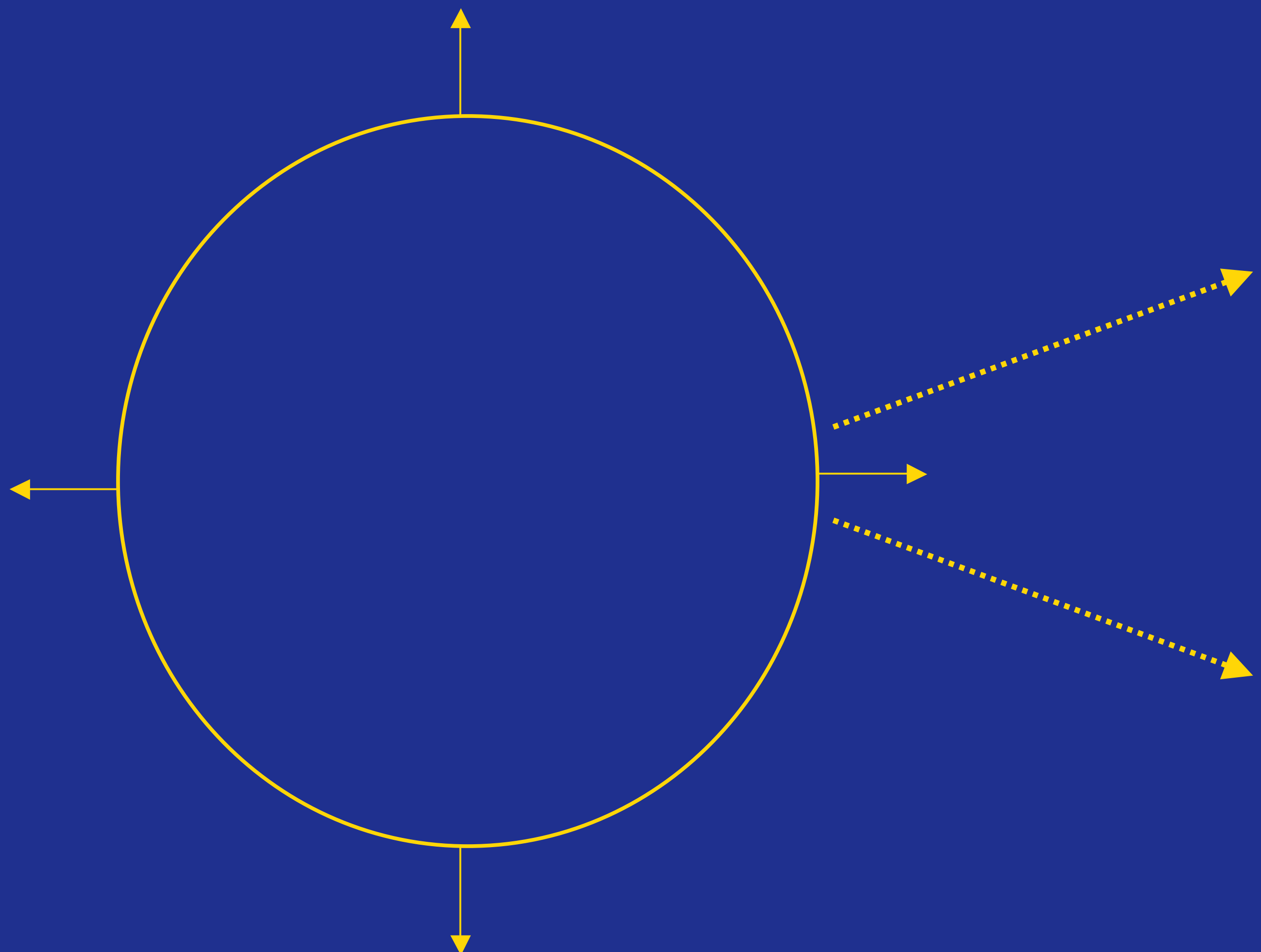


Gravitational acceleration varies non-linearly with position!

Goldsmith et al. 2008

Finite sheet evolution with gravity

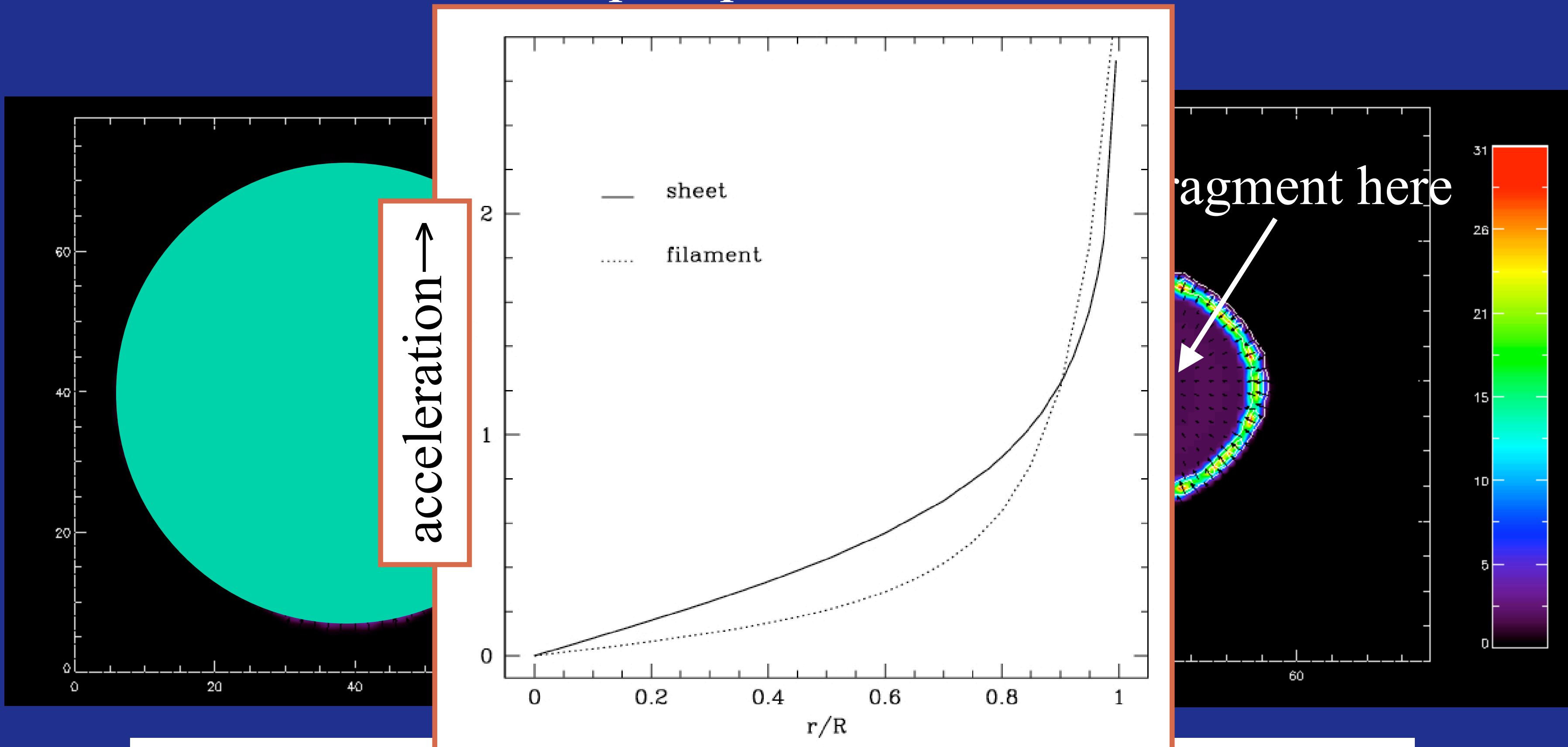
Burkert & Hartmann 04; piece of bubble wall ≈ sheet



Finite sheet evolution with gravity

uniform surface density Σ, isothermal, circular sheet:

⇒ pileup of material!

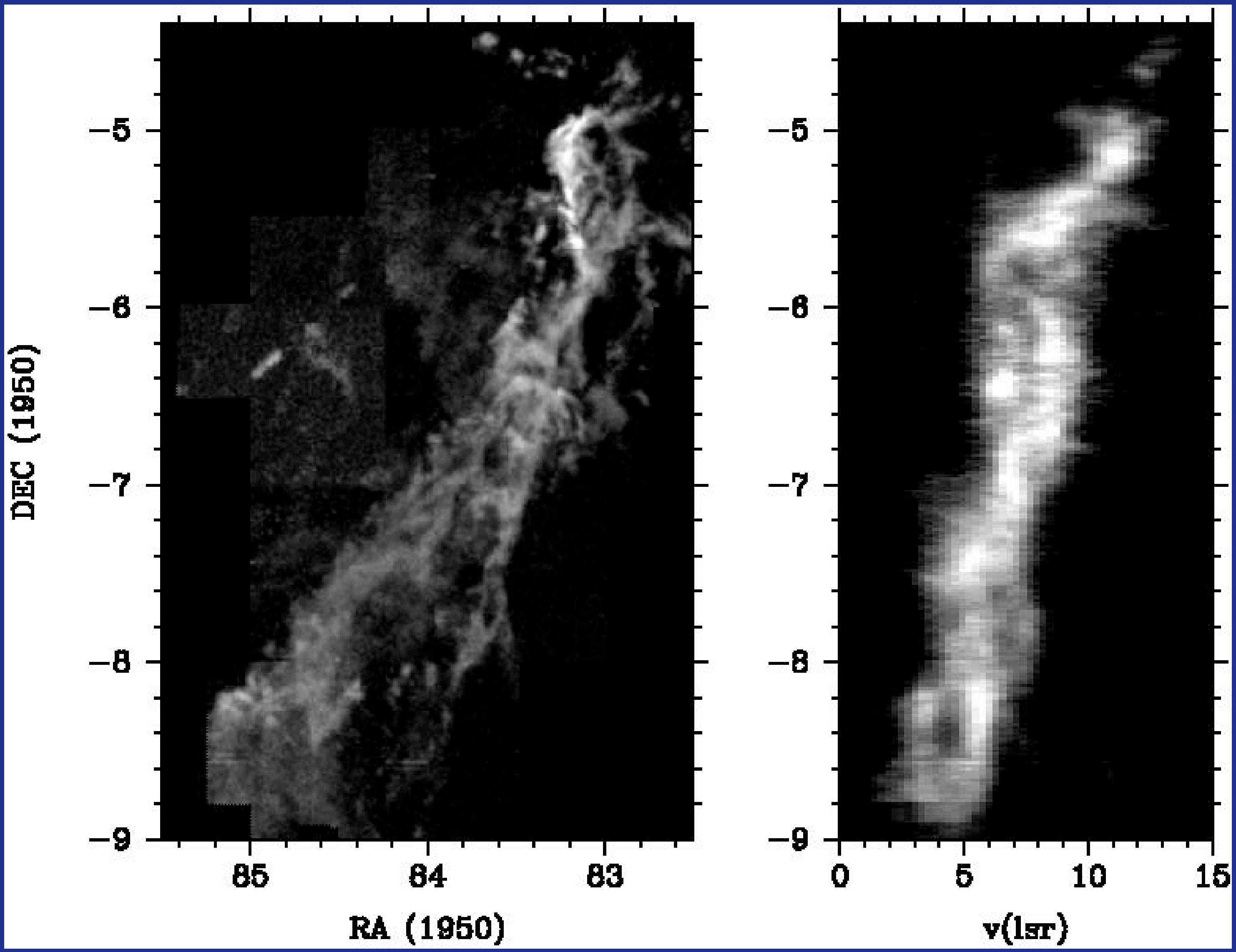


non-linear gravitational acceleration vs. position ⇒
large density contrast ⇒ low efficiency, rapid SF

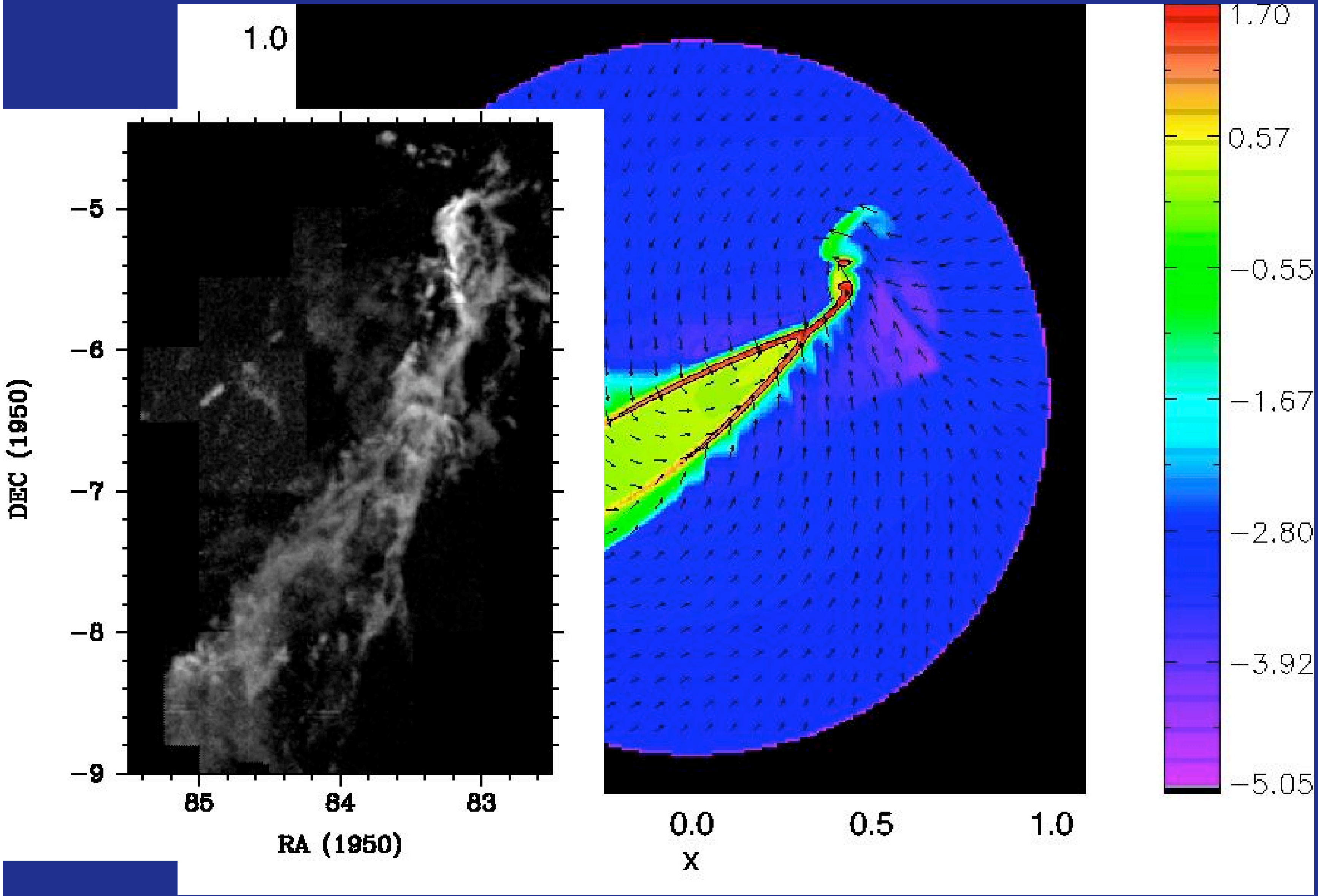
F. Heitsch et al.; sheet made by inflows with cooling, gravity (also Vazquez-Semadeni et al., Hennebelle et al.)

build up cloud over time, no sharp edge, turbulence

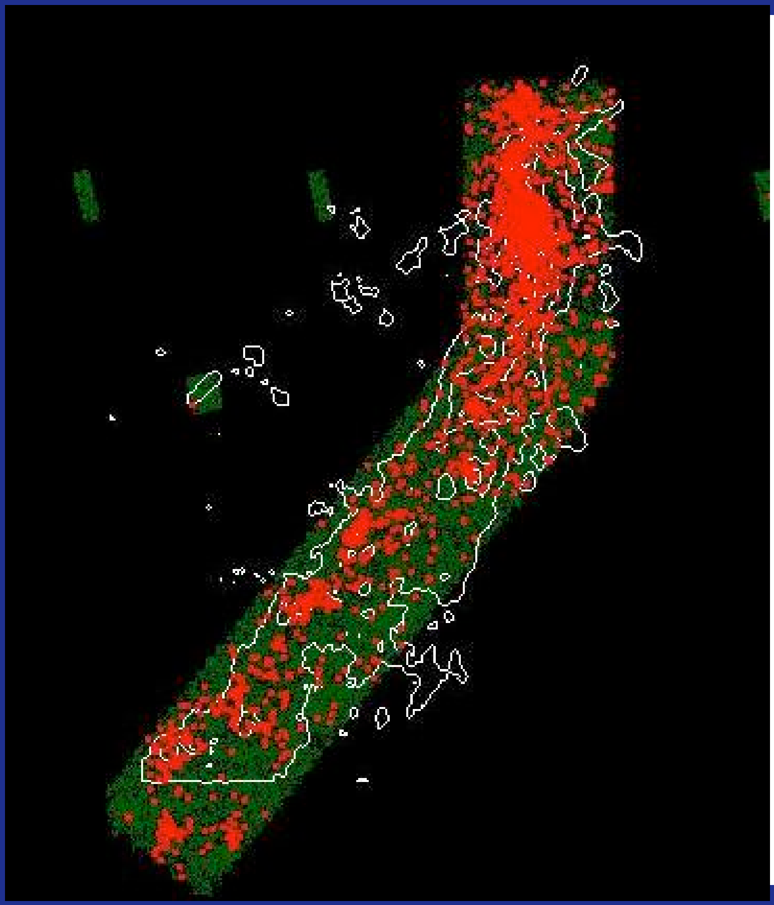
Orion A: ^{13}CO (Bally et al.)

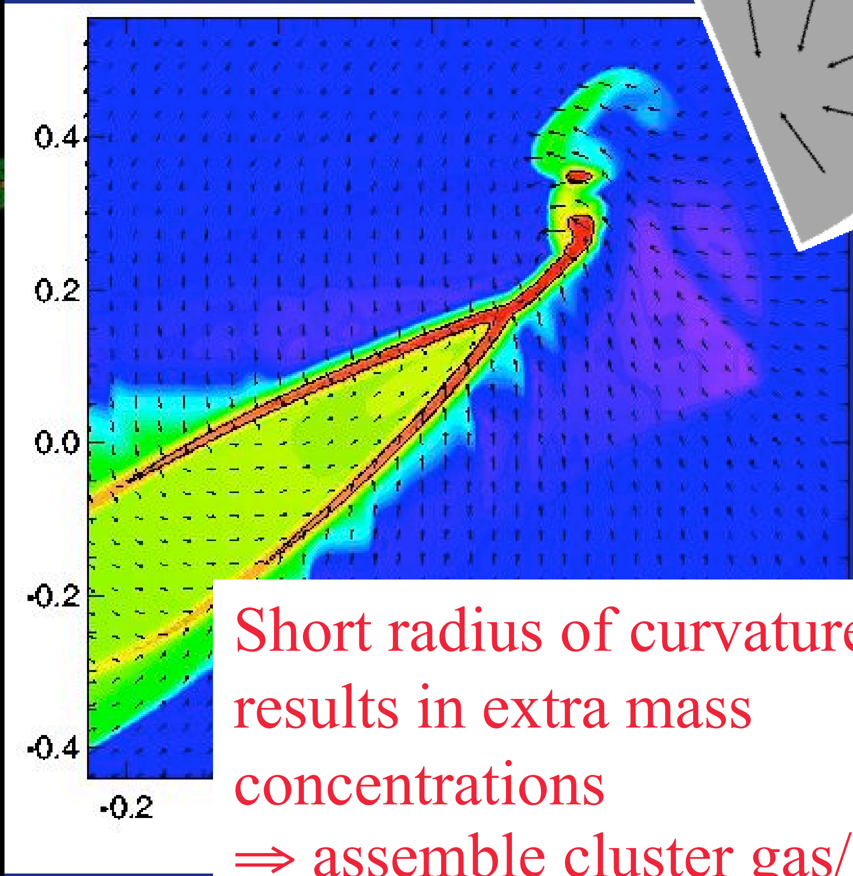


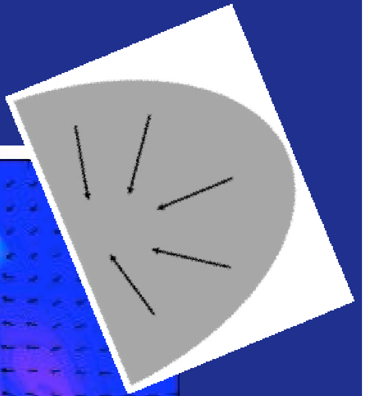
“Orion A” model (Hartmann & Burkert 2007); collapse of finite, massive, elliptical, rotating sheet



Global collapse (over ~ 2 Myr) - makes filamentary ridge, Orion Nebula cluster



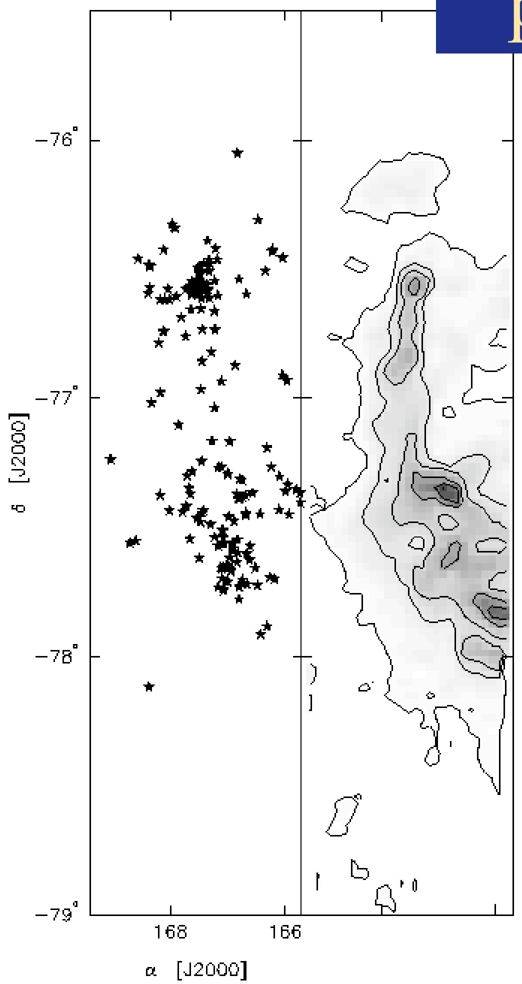




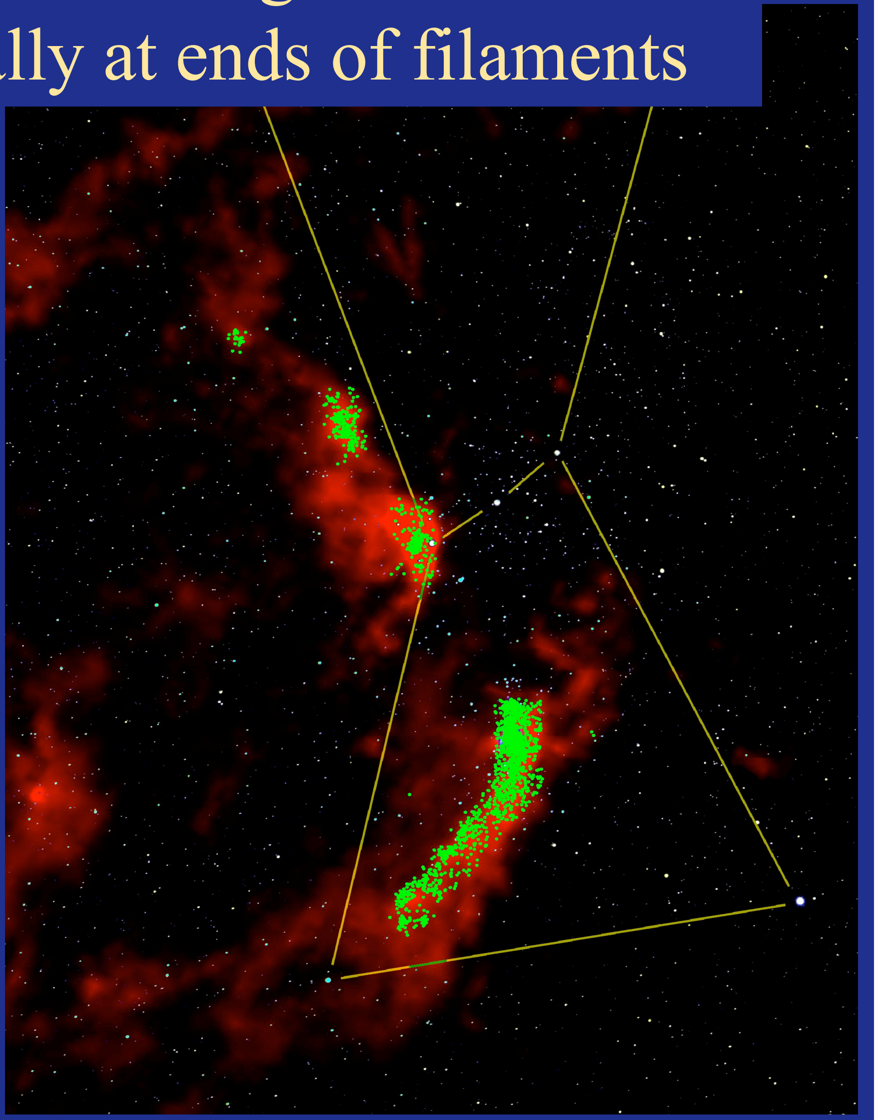
Short radius of curvature results in extra mass concentrations
⇒ assemble cluster gas/stars

gravitational focusing: clusters form preferentially at ends of filaments

Cha I

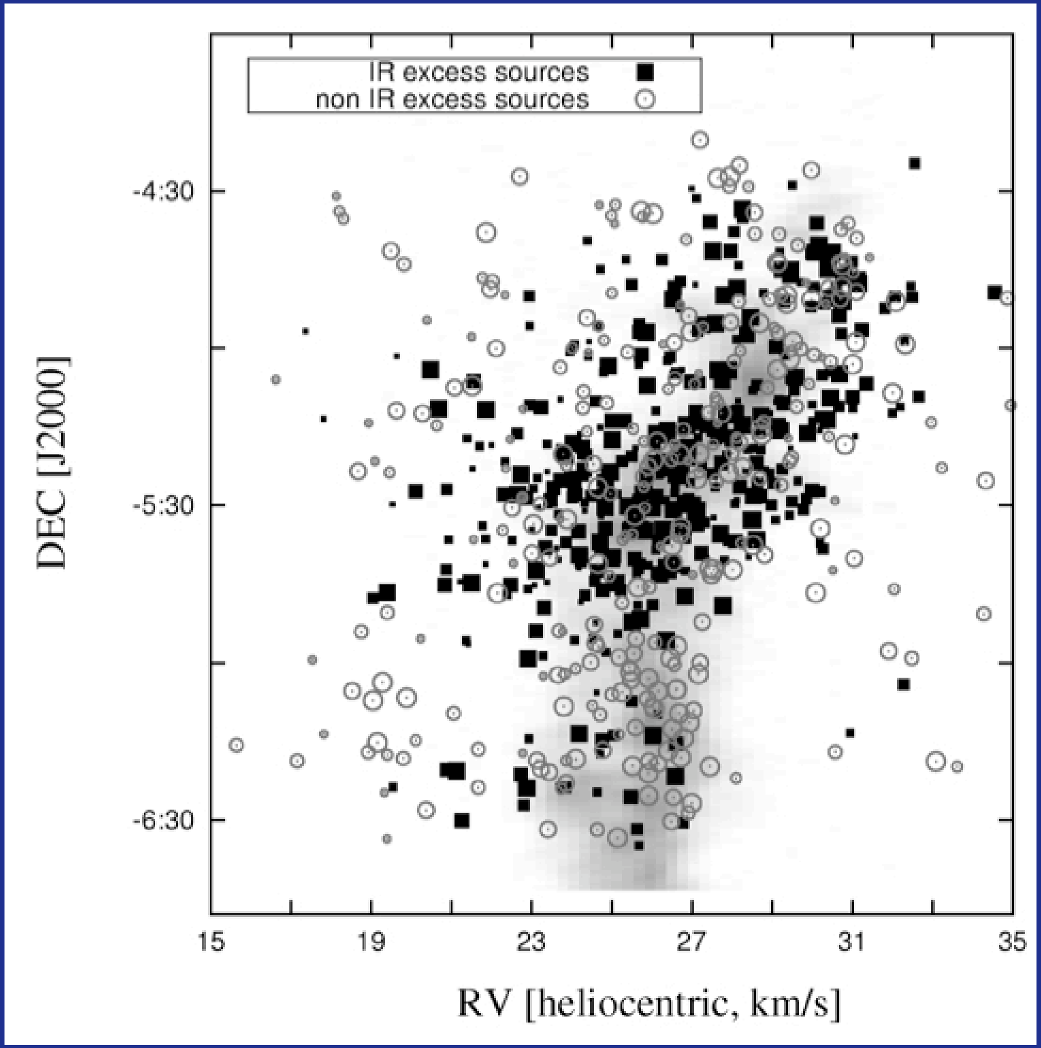


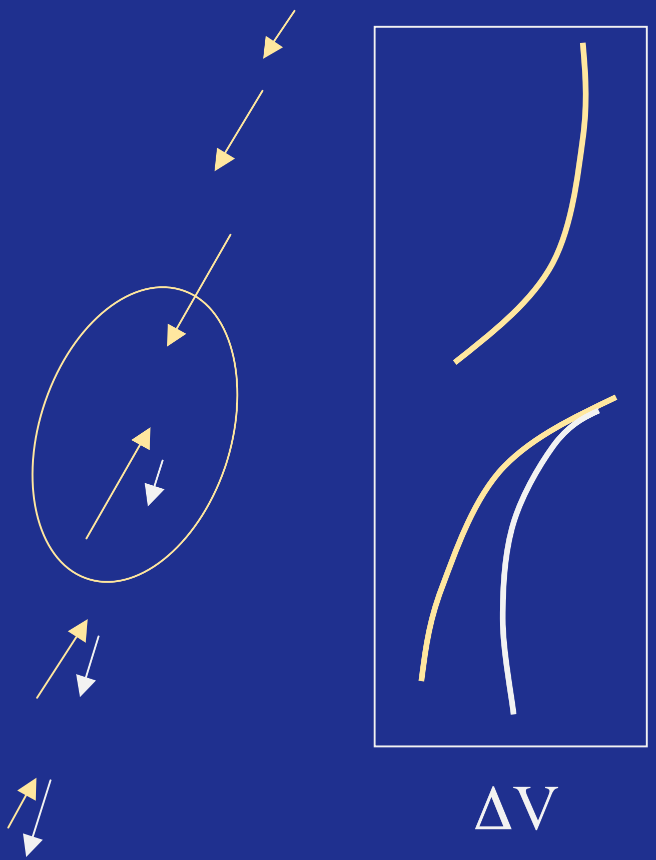
Carpenter et al. 2002



can't escape large-scale focusing by gravity

Orion Nebula cluster- kinematics of stars and gas: evidence for infall?





G. Furesz, J. Tobin, et al. 2008

E. Proszkow, F. Adams

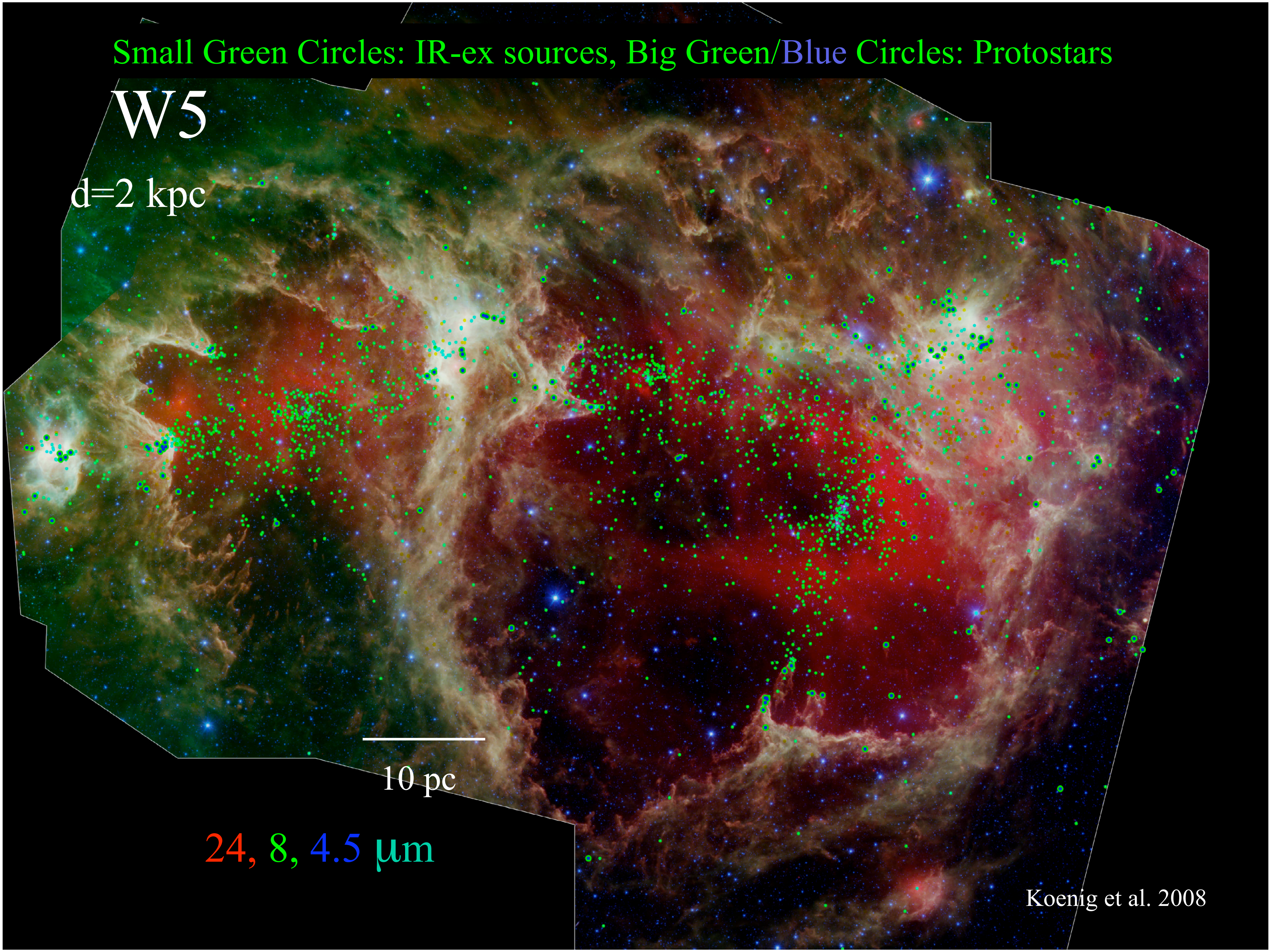
Summary: SFR set by

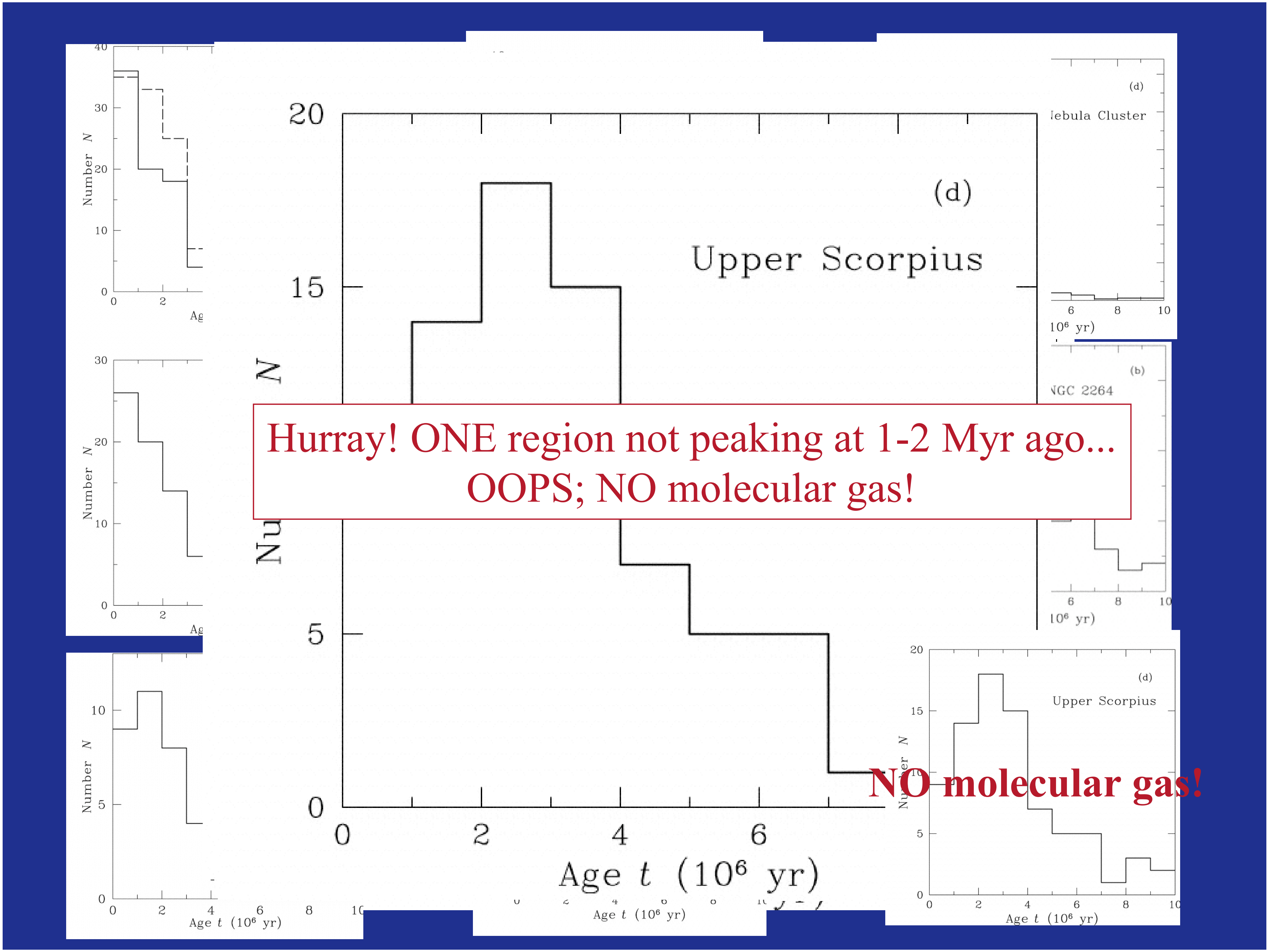
dM(tot)/dt × efficiency;

Compression (rate of)

gravitational focusing (makes low efficiency by feedback possible)

feedback (dispersal)


Small Green Circles: IR-ex sources, Big Green/Blue Circles: Protostars
W5
d=2 kpc
10 pc
24, 8, 4.5 μm
Koenig et al. 2008


Hurray! ONE region not peaking at 1-2 Myr ago...
OOPS; NO molecular gas!
NO molecular gas!
(d)
Upper Scorpius
Number N
Age t (10⁶ yr)
Nebula Cluster
NGC 2264
(b)