Winds and Radiation in Unison

A New 1D Feedback Model for Cloud Dissolution

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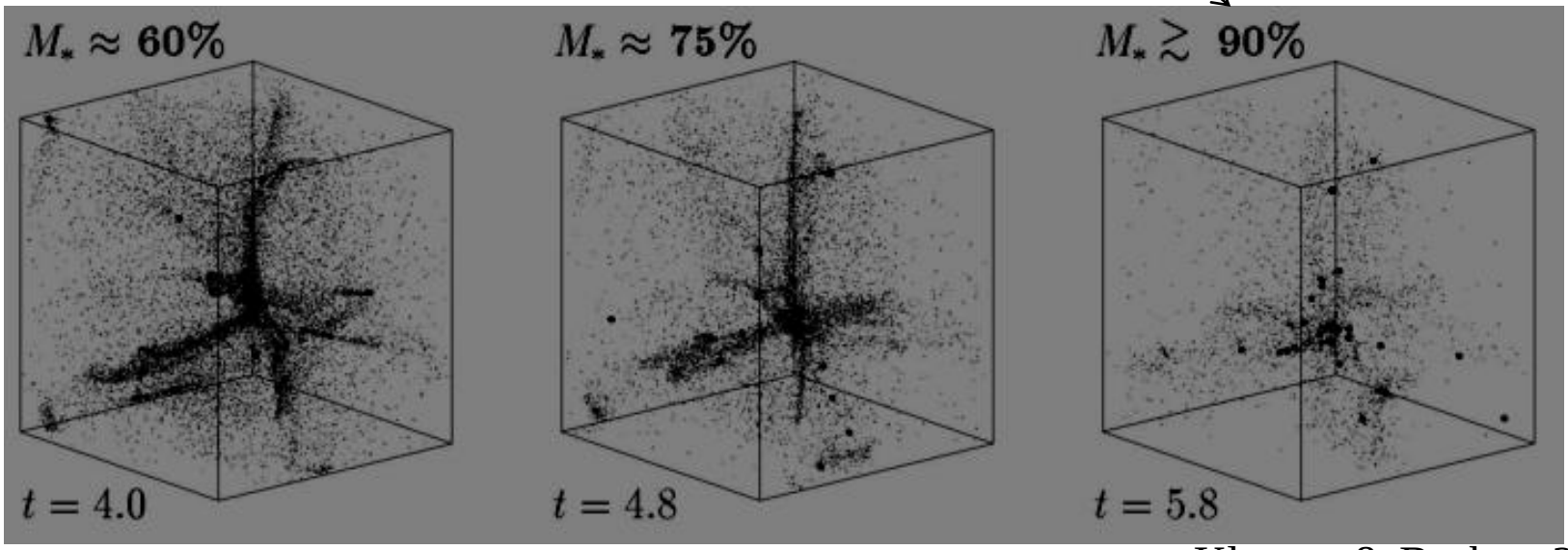
1) What is the main feedback force on cloud scale?

2) What is the minimum star formation efficiency needed to destroy molecular clouds?

3) Coupled or not: How much radiation is escaping?

Why do we worry about feedback?

- Star formation rate too high
- Star clusters too bound
- IMF is wrong



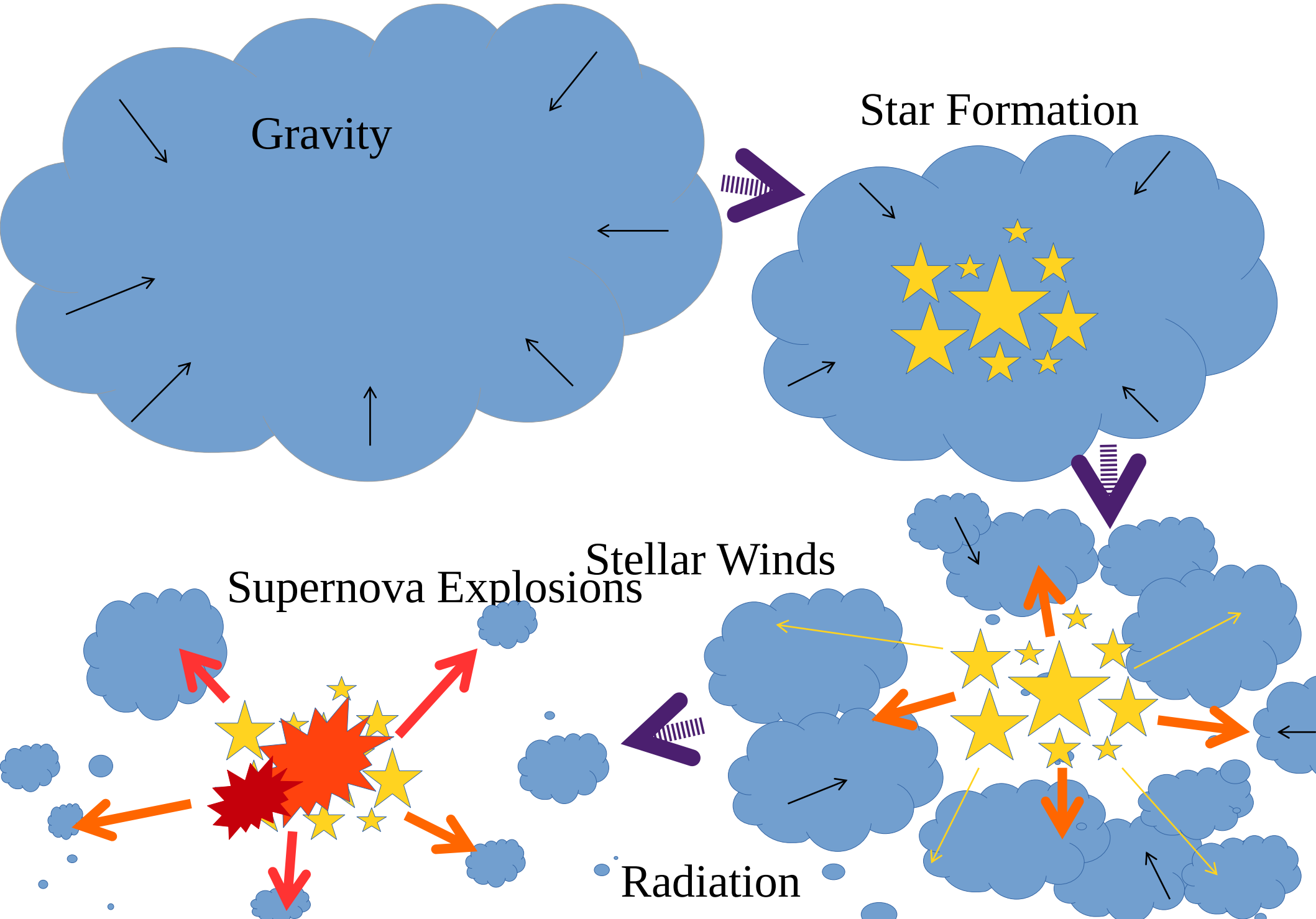
Klessen & Burkert 2001

What is stellar feedback?

- Supernovae
- Stellar Winds
- Radiation:
  - Radiation pressure
  - Thermal feedback
  - Photochemistry

www.xkcd.com

The Life of a Molecular Cloud



The model

(for massive clouds)

Rahner, Pellegrini, Glover, Klessen subm. (arXiv:1704.04240)

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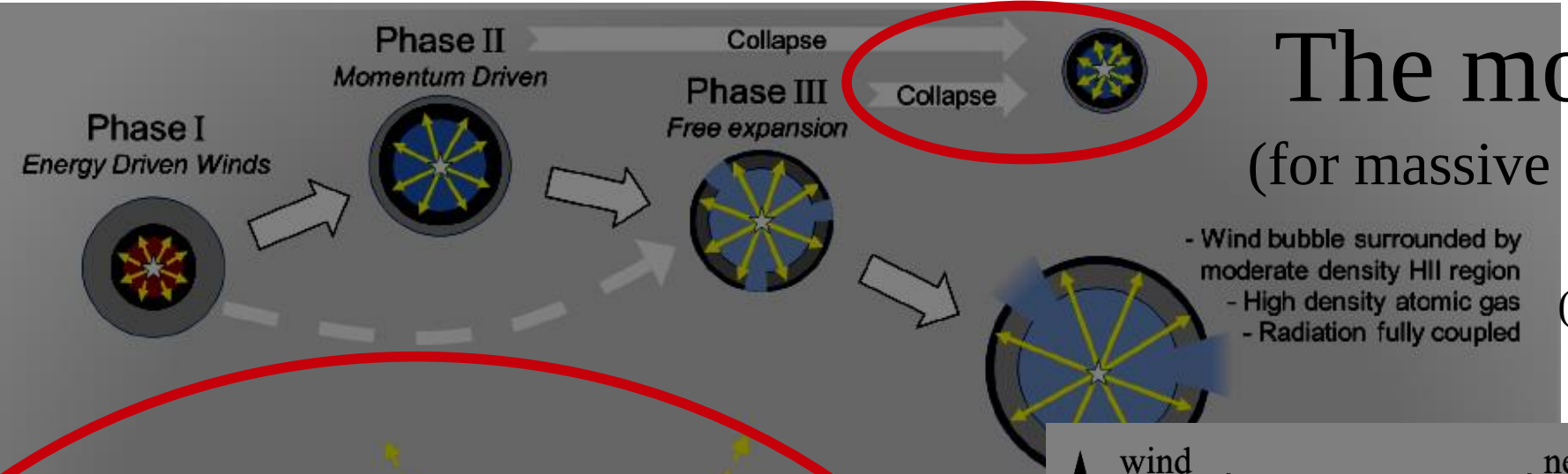
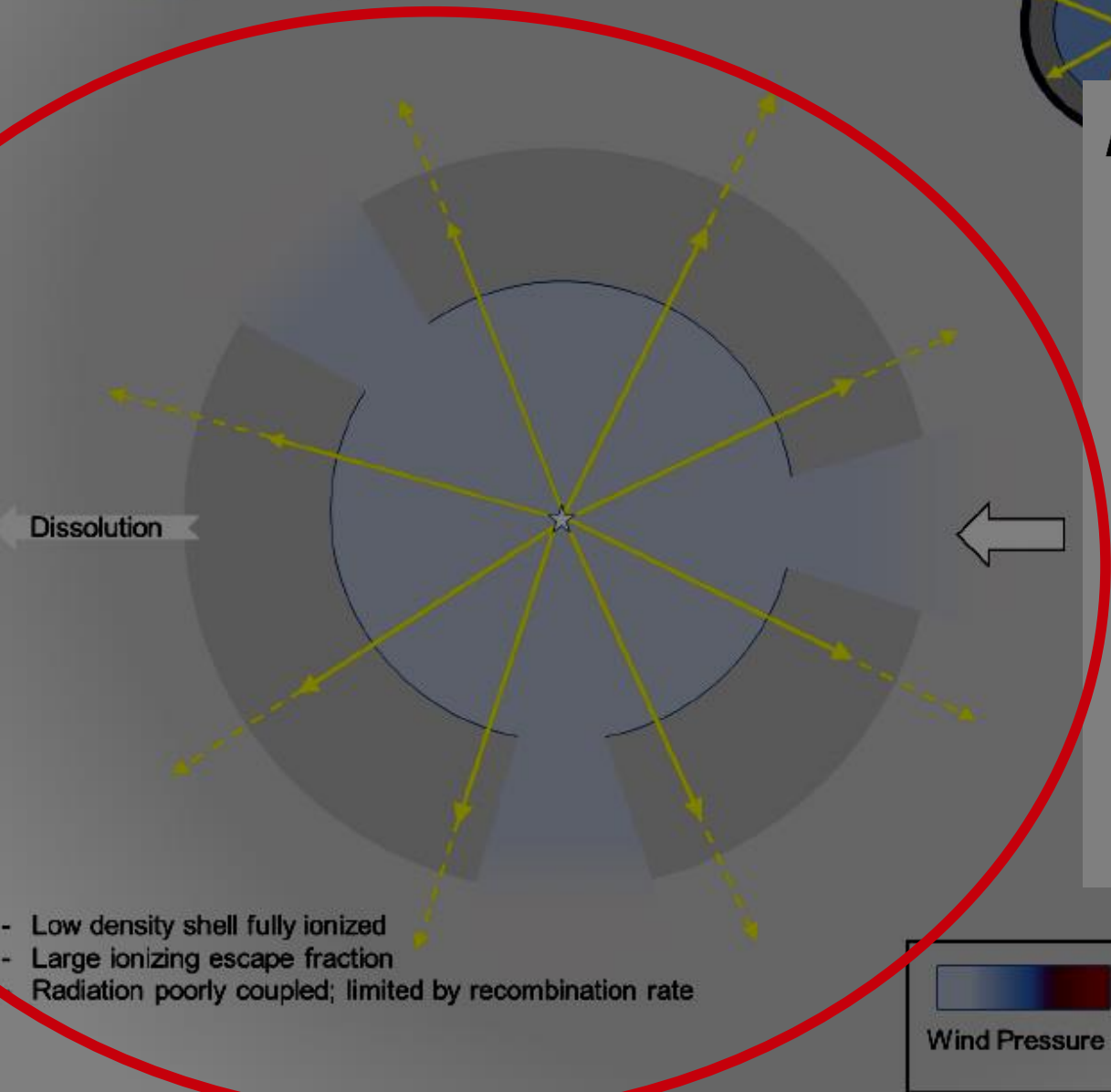
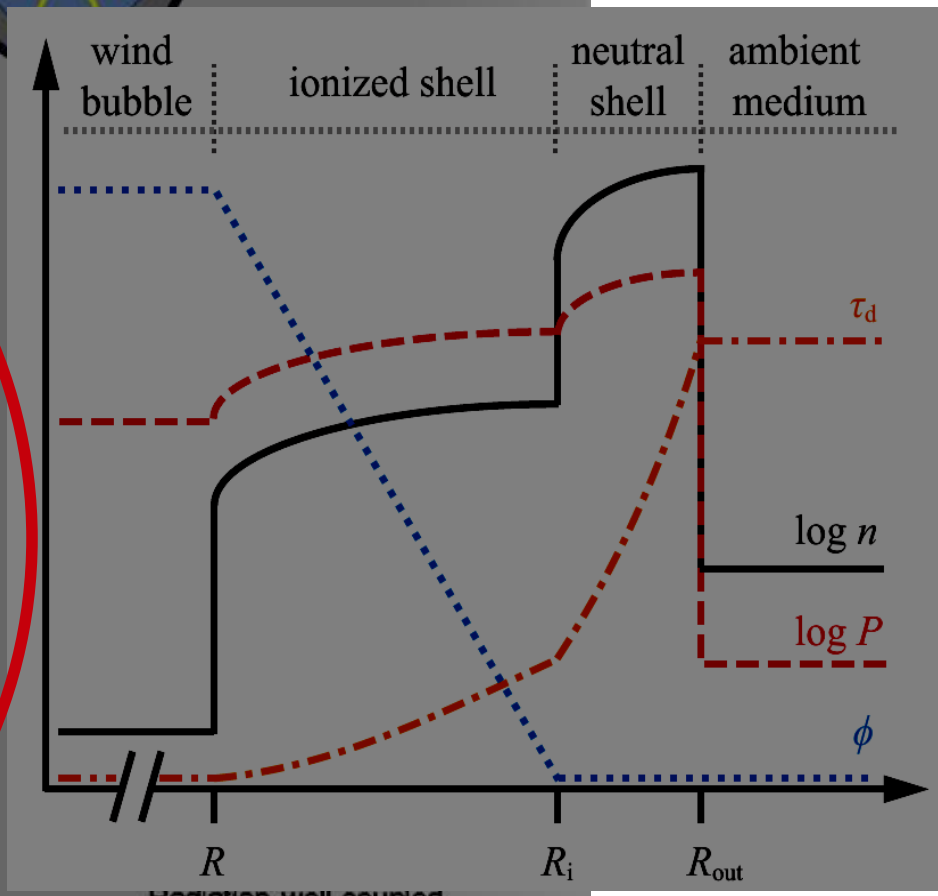


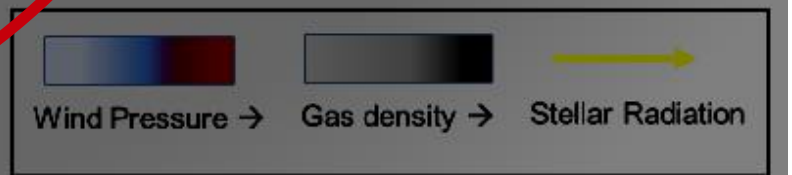
- Wind bubble surrounded by moderate density HII region
- High density atomic gas
- Radiation fully coupled

(See Draine11, Ma





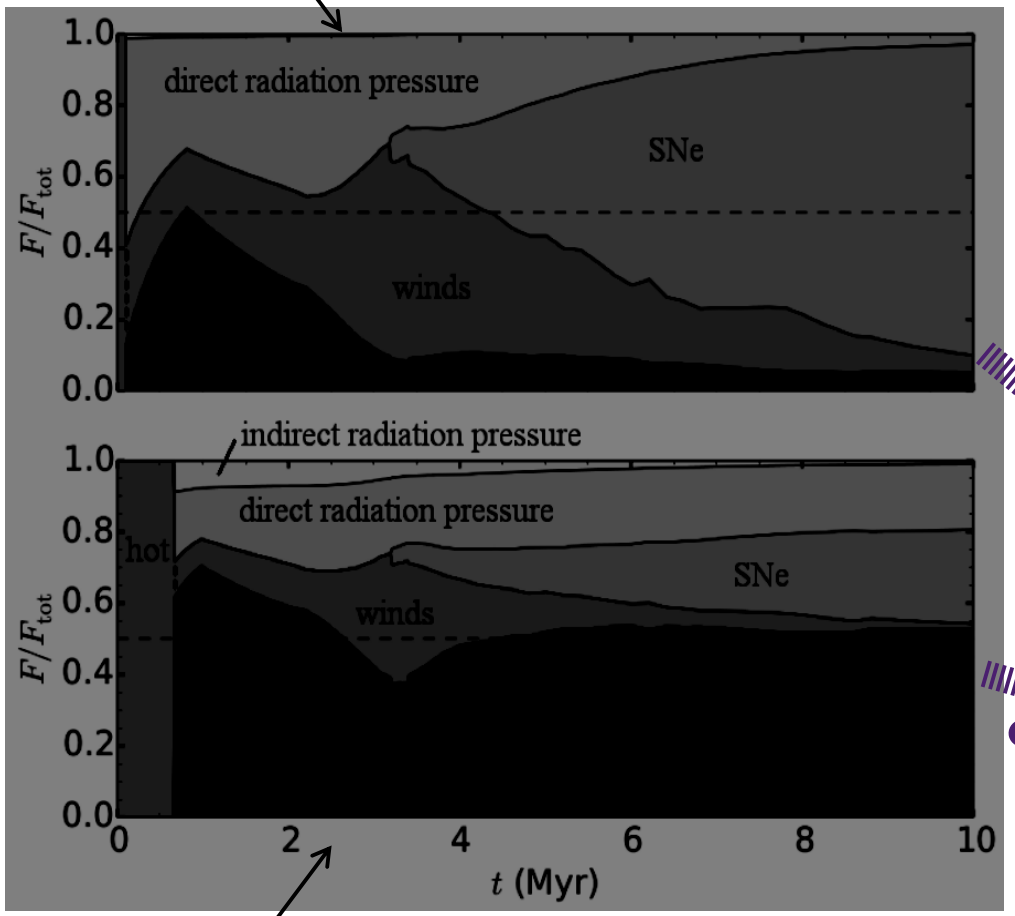
- Radiation well coupled



Rahner, Pellegrini, Glover, Klessen subm. (arXiv:1704.04240)

1) Dominating Feedback

10^5 M_{sol} cloud



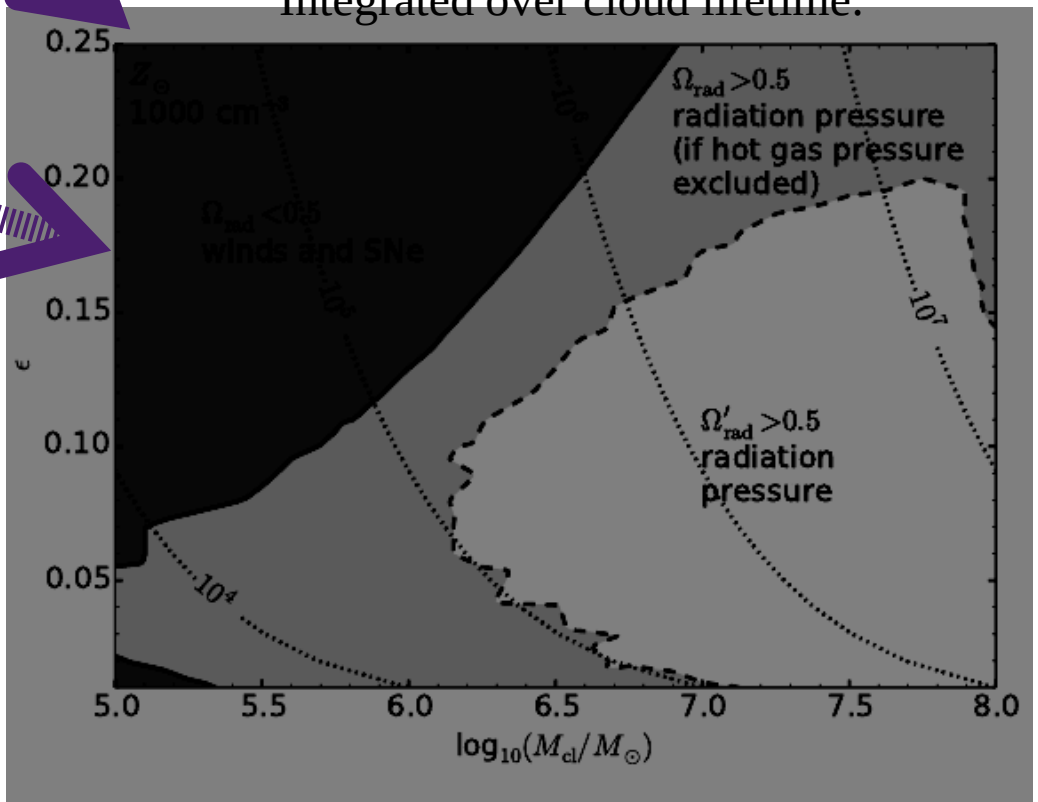
10^7 M_{sol} cloud

$$F_{ram} = F_{wind} + F_{SN} = \dot{M}_w v_w + \dot{M}_{SN} v_{SN}$$

$$F_{rad} = F_{direct} + F_{indirect} \approx f_{abs} \frac{L_{bol}}{c} (1 + \tau_{IR})$$

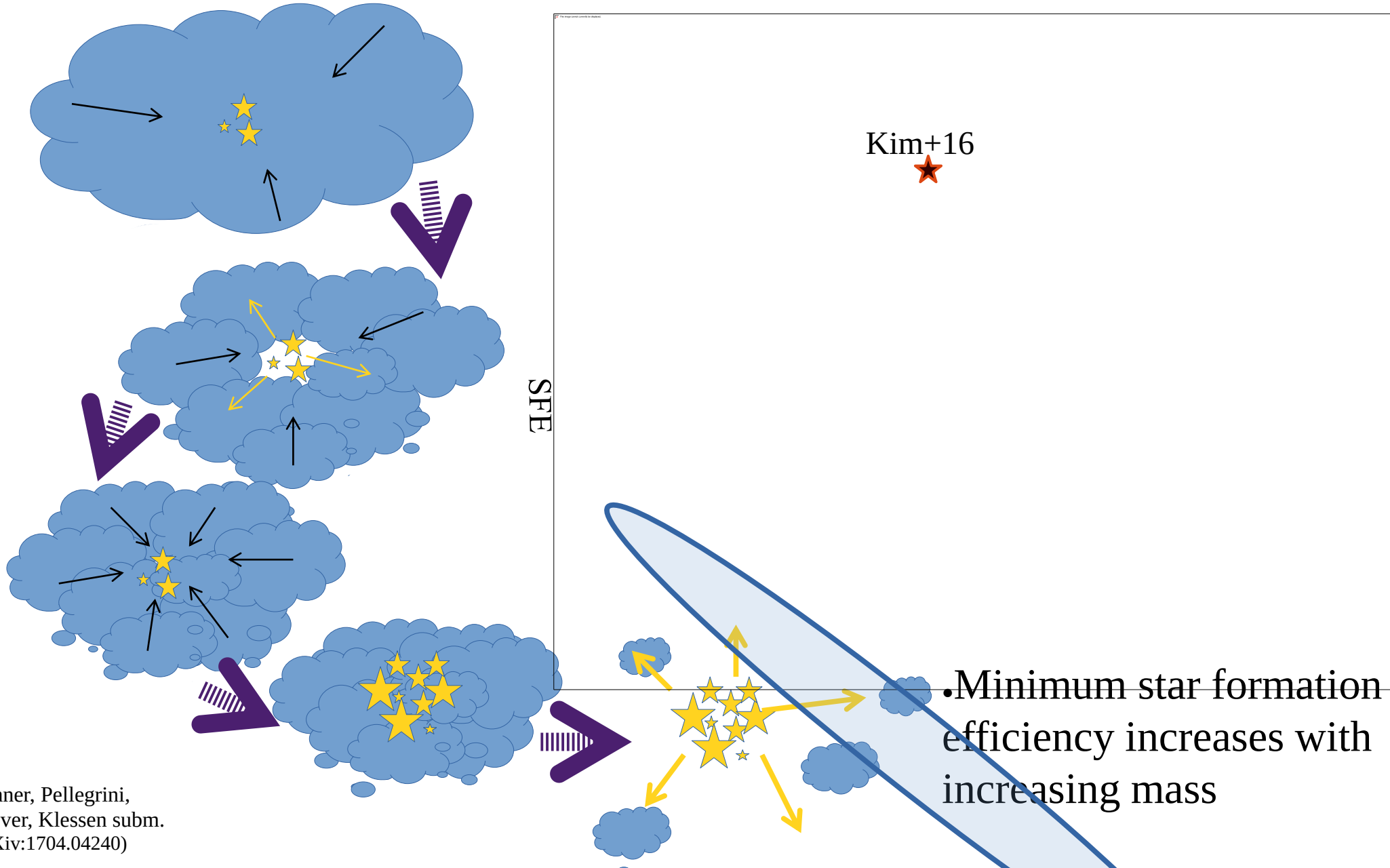
$$F_{grav} = \frac{G M_{sh}}{R^2} \left(M_* + \frac{M_{sh}}{2} \right)$$

Dominating Feedback
Integrated over cloud lifetime:



Rahner, Pellegrini,
Glover, Klessen subm.
(arXiv:1704.04240)

2) Minimum star formation efficiency

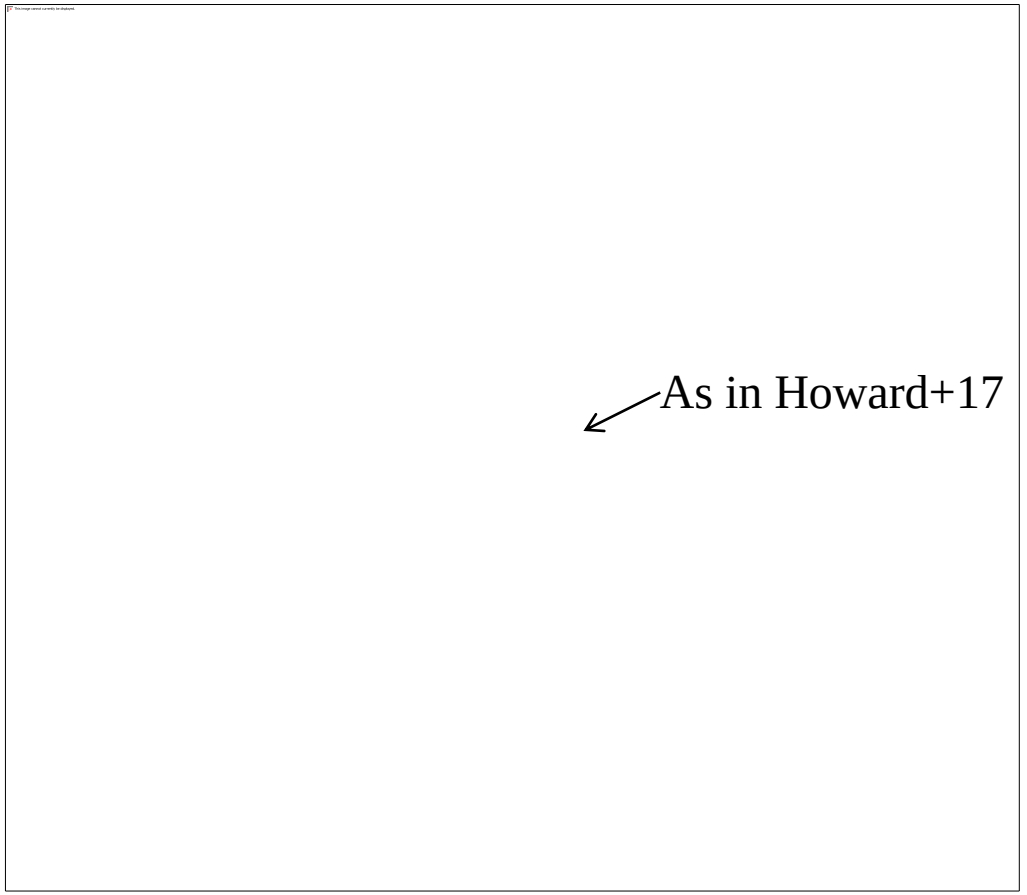


- ~~Minimum star formation~~ efficiency increases with increasing mass

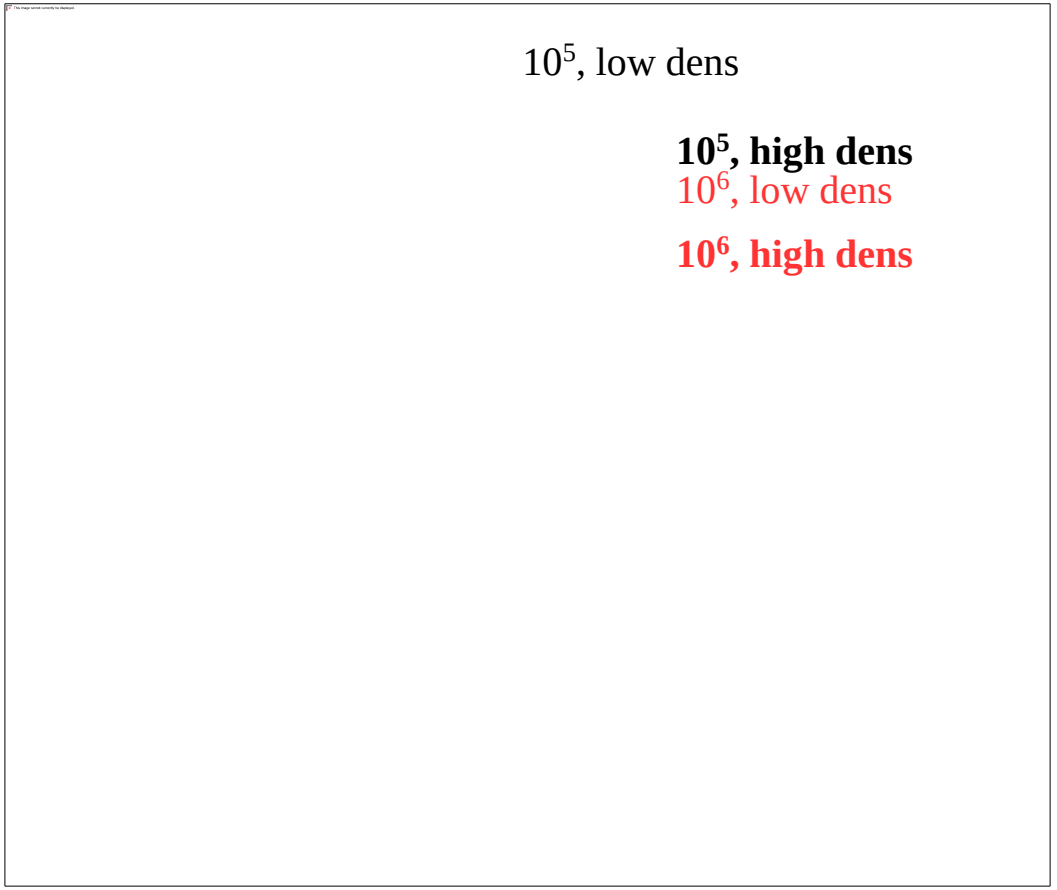
Rahner, Pellegrini, Glover, Klessen subm. (arXiv:1704.04240)

3) Escape fractions

Solar metallicity



Low metallicity (15 % solar)



- Escape fractions show variability
- Generally higher for low metallicity

Rahner, Pellegrini, Glover, Klessen subm. (arXiv:1704.04240)

Summary

- 1D code modeling cloud expansion including winds, SNe, radiation pressure, gravity **and** shell structure
- Feedback from radiation and winds/SNe is interconnected
- **There is not *the one* main source of feedback.** *When? How massive is the cloud? How dense? How massive is the star cluster?*
- **Minimum star formation efficiency increases with cloud mass** (5% - 15% for dense 10^5 - 10^7 M_o clouds)
- **Photon escape fractions are strongly time-**