UTAP Journal Club

13/June/2016 T.Hosokawa

[1] “Building up the Population III initial mass function from cosmological initial conditions”
Stacy, Bromm, & Lee, arXiv:1603.09475

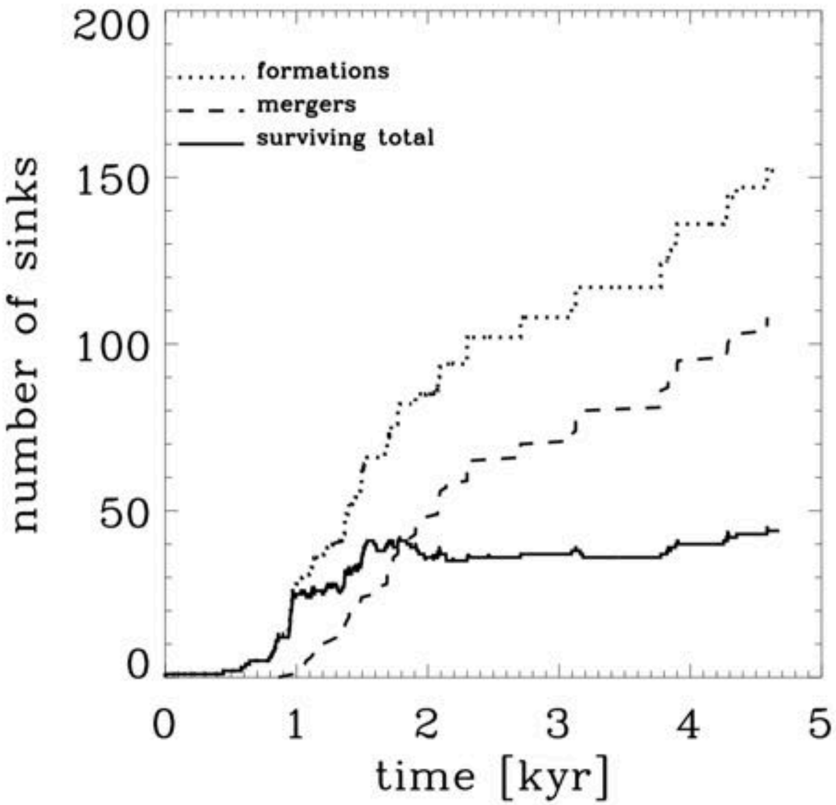
[2] “Circumstellar disks of the Most Vigorously Accreting Young Stars”
Liu et al., (2016), Science Advances, 2, e1500875

[3] “Suppression of star formation in dwarf galaxies by grain photoelectric heating”
Forbes, Krumholz, Goldbaum, & Dekel, arXiv: 1605. 00650
(Nature accepted)

論文[1]: Stacy, Bromm & Lee

+ 初代星形成降着期の3D数値simulation (〜1AU resolutionで5000年間追跡)
+ 重力不安定による円盤分裂で〜100の星(sink)が形成 (2/3は合体)
+ UV feedbackにより降着率低下
+ 計算終了時で最重量星は20$M_\odot$ (このあとさらに増える可能性あり)。
  total星質量は重い星が担う (→ top-heavy IMF)

sinkの形成率と合体率



密度分布の時間進化 (上:10^4AU、下:1000AU)

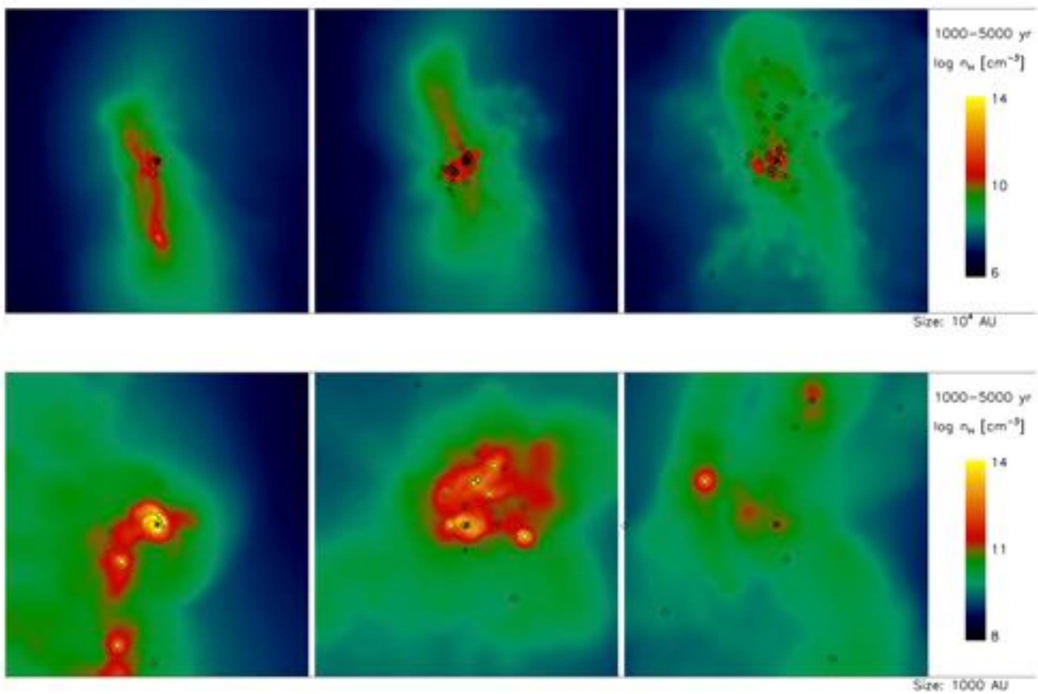
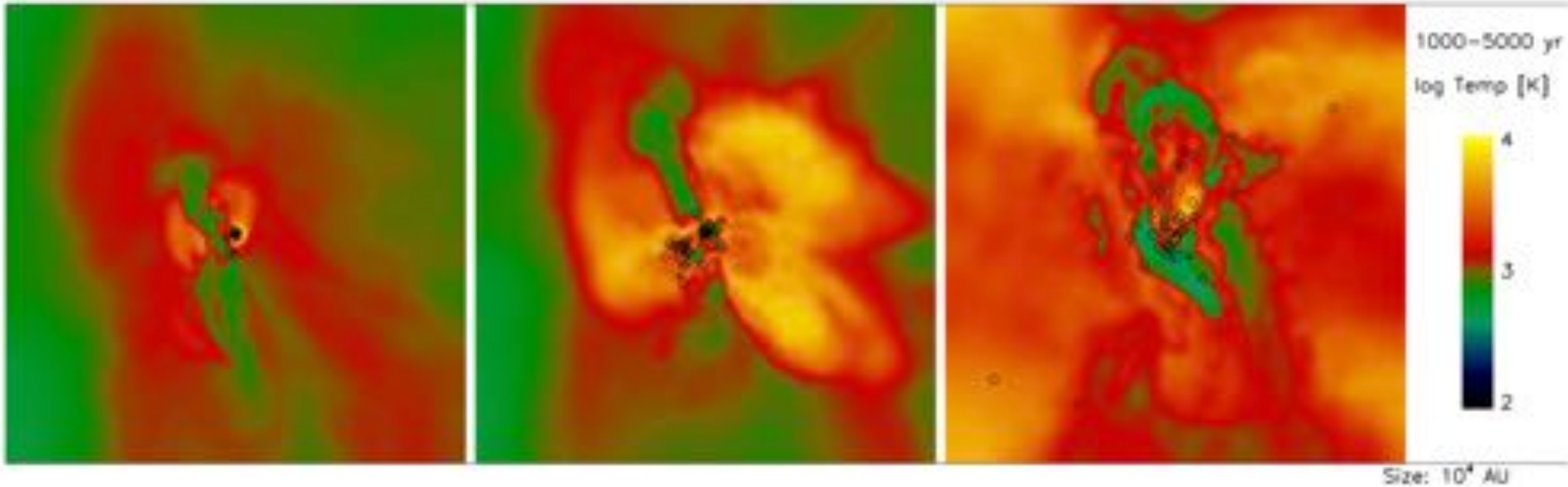
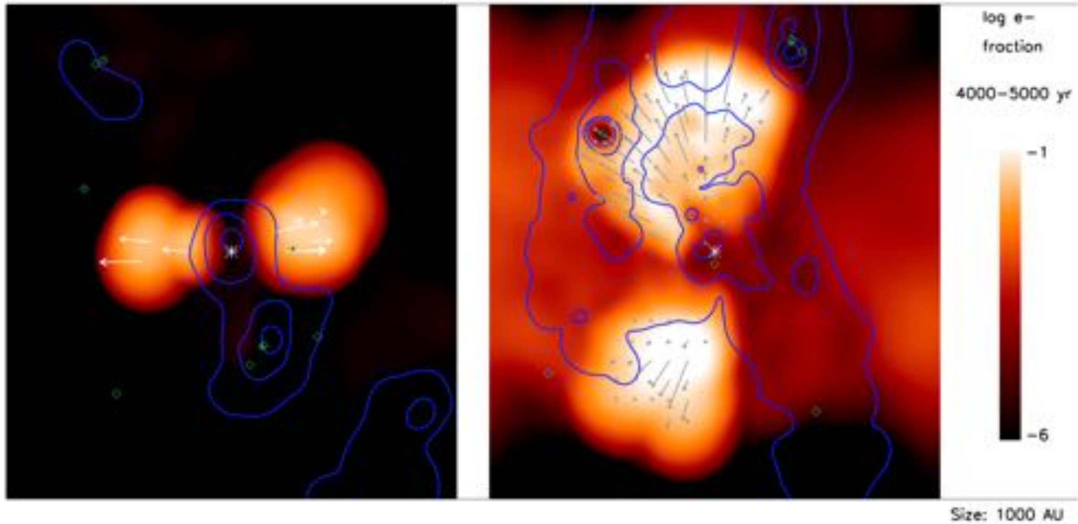


Figure 5. Density slice along the simulation x-y plane of the central 10^4 AU (top row) and 1000 AU (bottom row). From left to right, structure is shown at 1000, 2000, and 5000 yr. The asterisk marks the location of the largest sink. Diamonds represent other secondary sinks. The early elongated structure gradually collapses into two distinct clumps by 1000 yr. These later merge into a larger disk structure after 2000 yr.

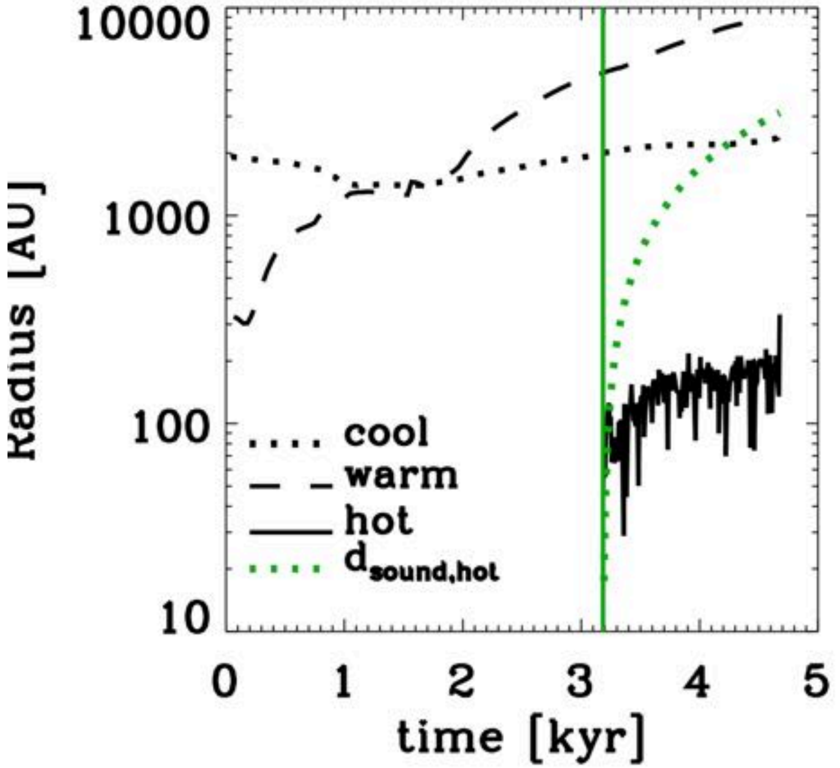
FUV光feedback(H2分子光解離)によるwarm gasの伝播

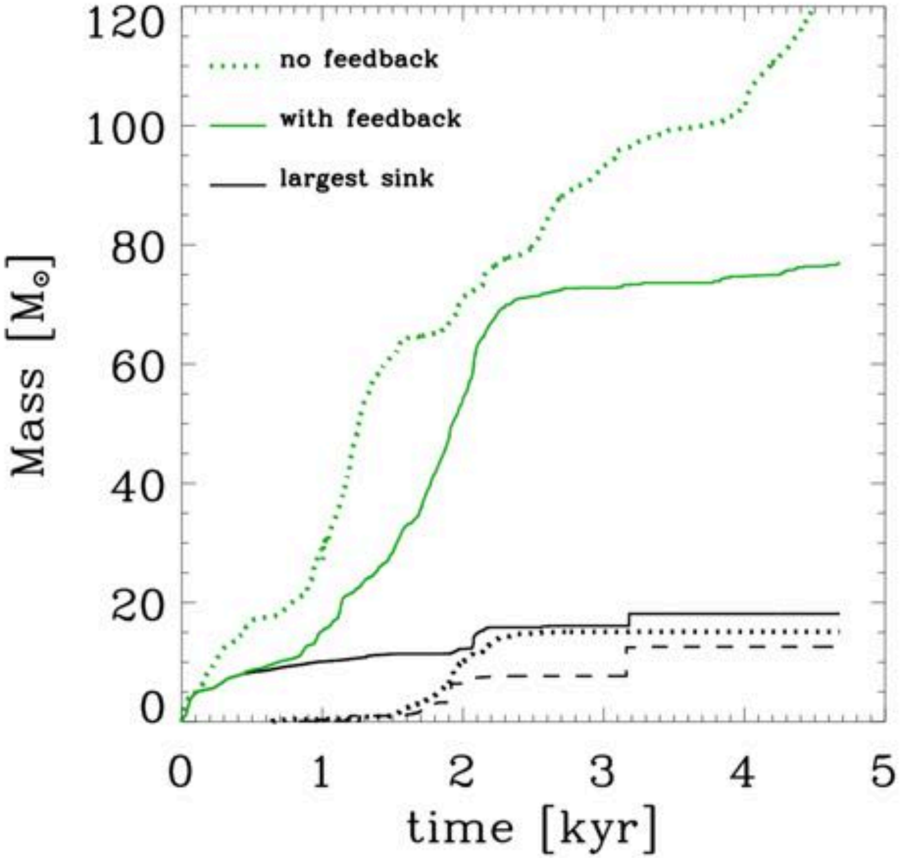


EUV光feedback(H原子光電離)によるhot gas
の生成

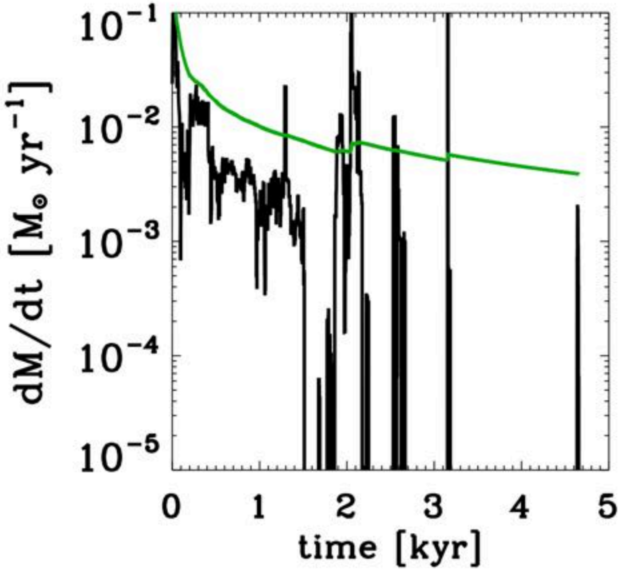


各ガス成分広がりの時間進化

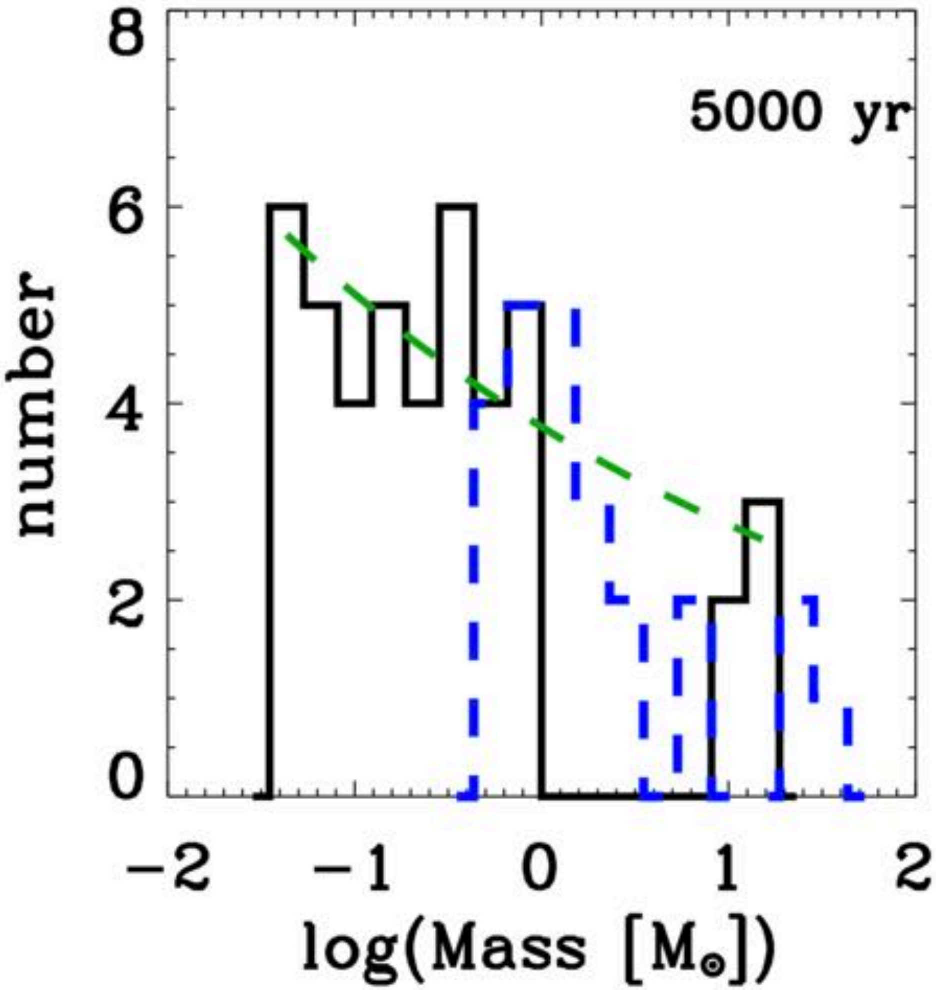




← Mass accretion histories
(feedback無/有、1st, 2nd, 3rd sinks)

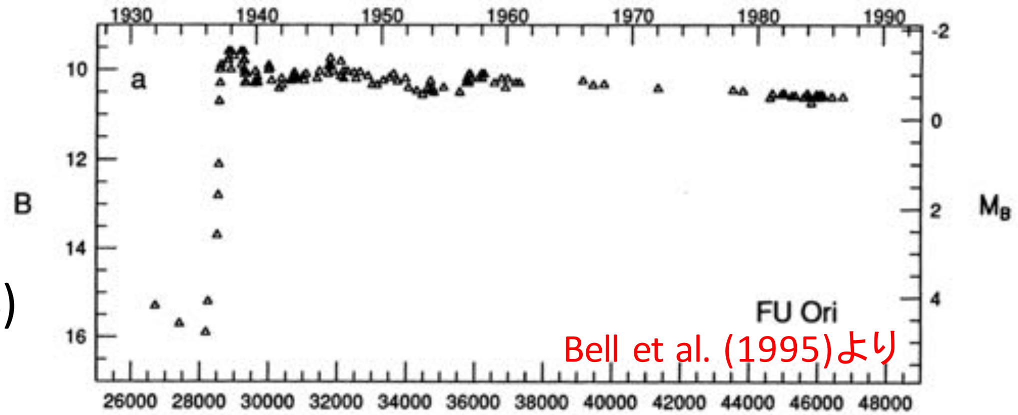


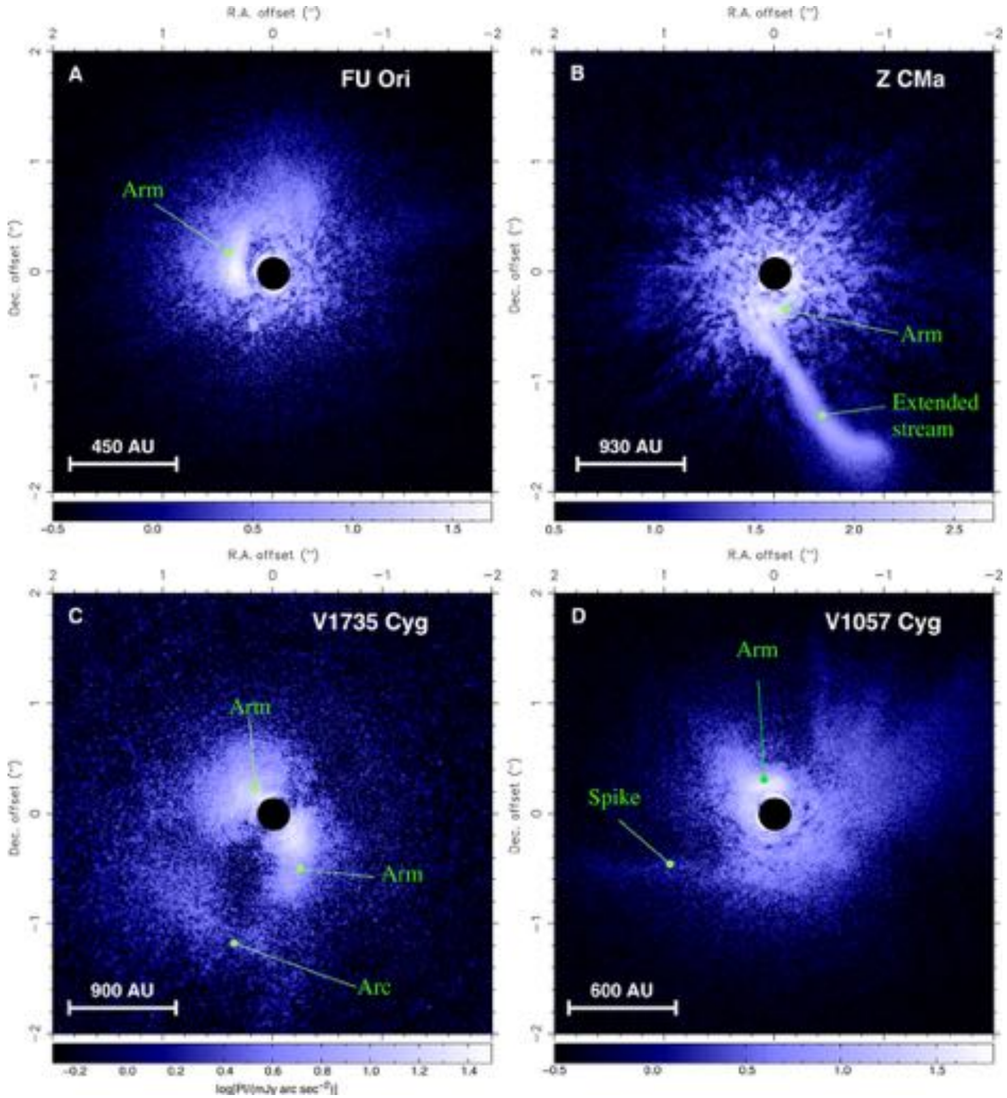
mass distribution of sinks (stars)
at the epoch of 5000 yr (final snapshot)

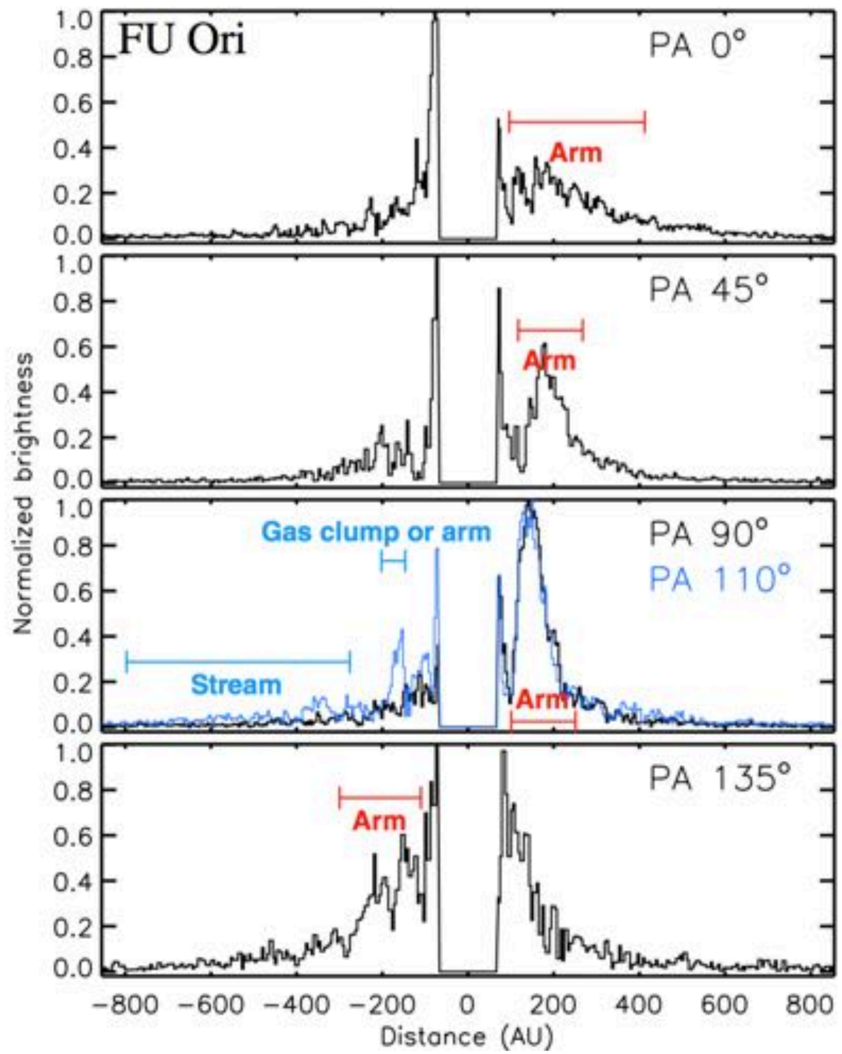


論文[2]: Liu et al.

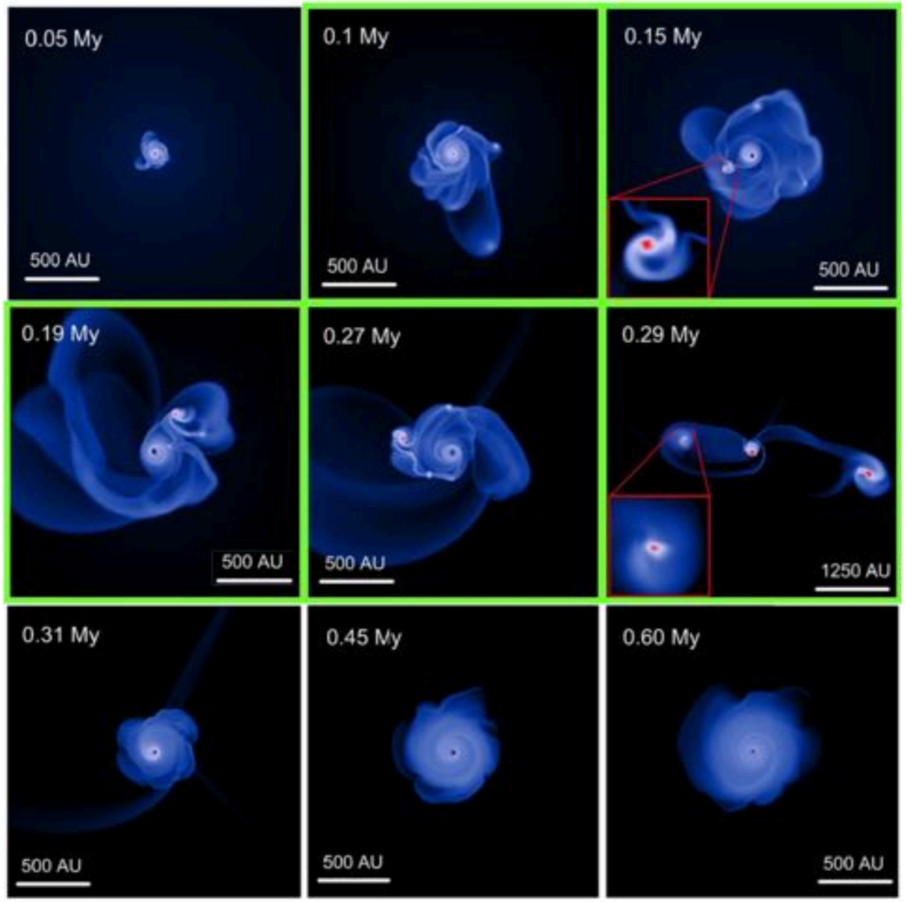
+ 突然の増光を示す低質量前主系列星:
  FU Ori天体に非軸対称構造の発達した
  星周円盤が付随(調べた4例全て)
+ すばるによるNIRダスト散乱光観測(SEEDS)
+ simulationの予想と整合的



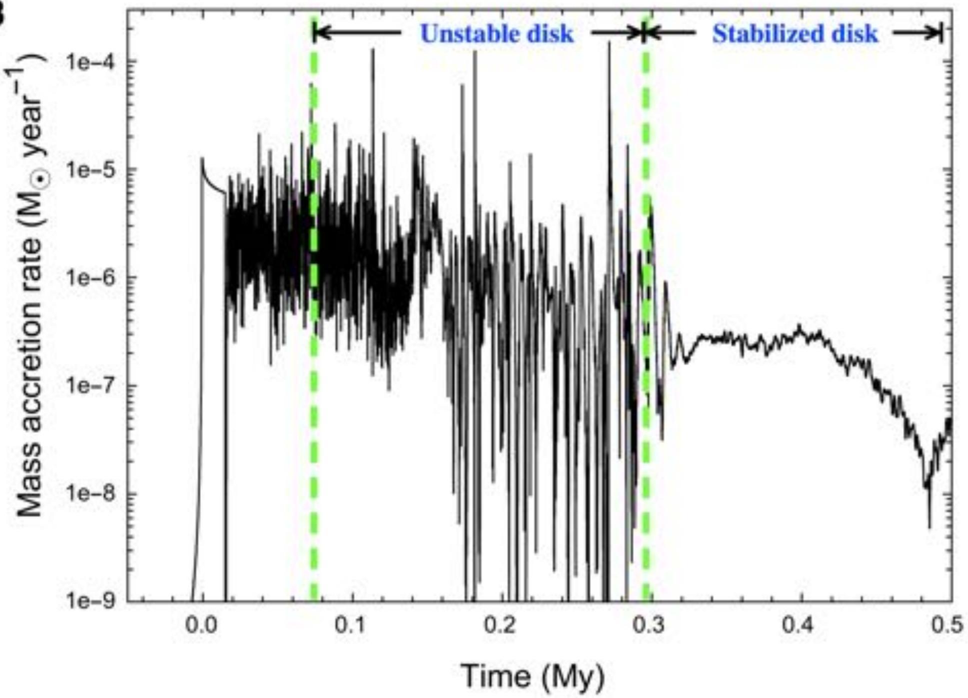


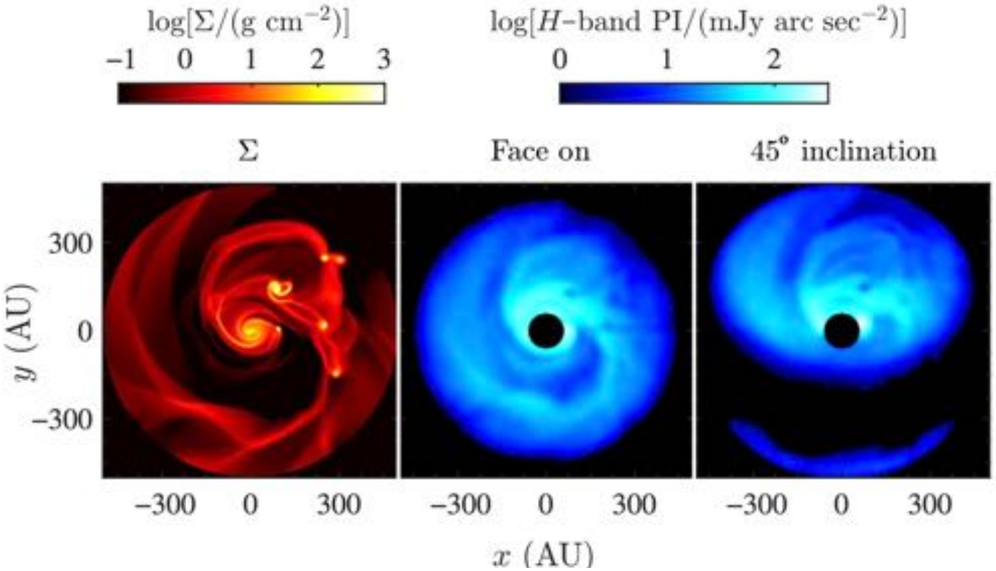


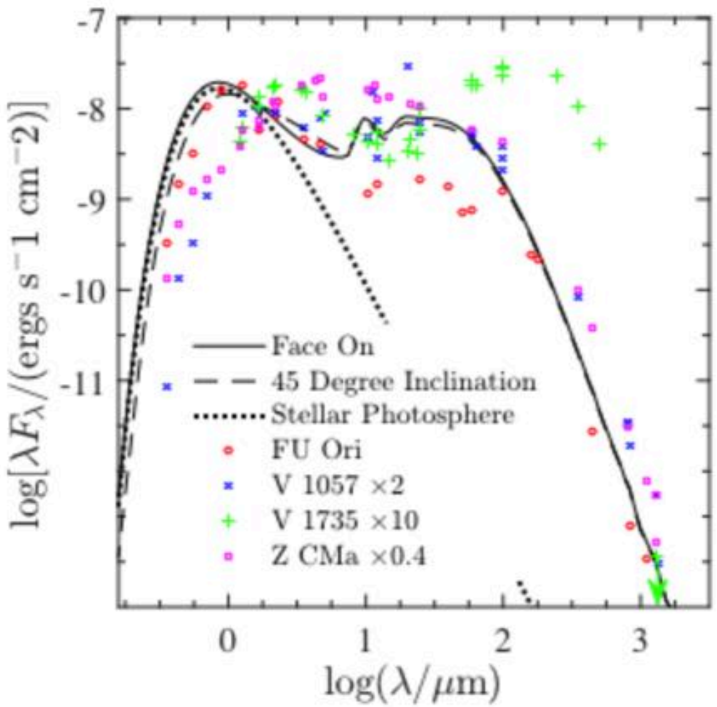
A


0.05 My
500 AU
0.1 My
500 AU
0.15 My
500 AU
0.19 My
500 AU
0.27 My
500 AU
0.29 My
1250 AU
0.31 My
500 AU
0.45 My
500 AU
0.60 My
500 AU

B

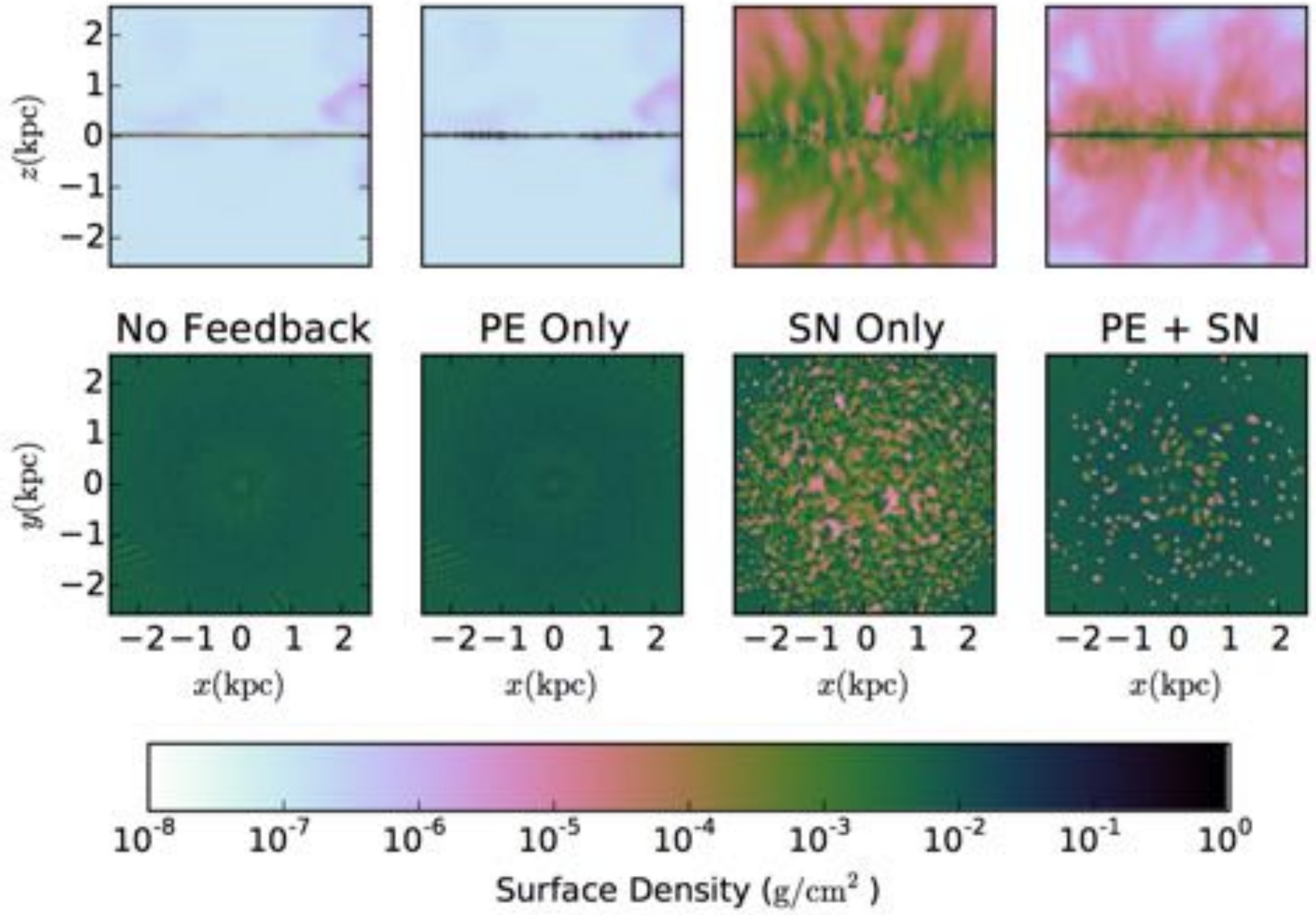

Unstable disk
Stabilized disk
Mass accretion rate (M⊙ year⁻¹)
1e−4
1e−5
1e−6
1e−7
1e−8
1e−9
0.0
0.1
0.2
0.3
0.4
0.5
Time (My)


log[Σ/(g cm⁻²)]
−1 0 1 2 3
log[H−band PI/(mJy arc sec⁻²)]
0 1 2
Σ
Face on
45° inclination
y (AU)
300
0
−300
−300 0 300
x (AU)

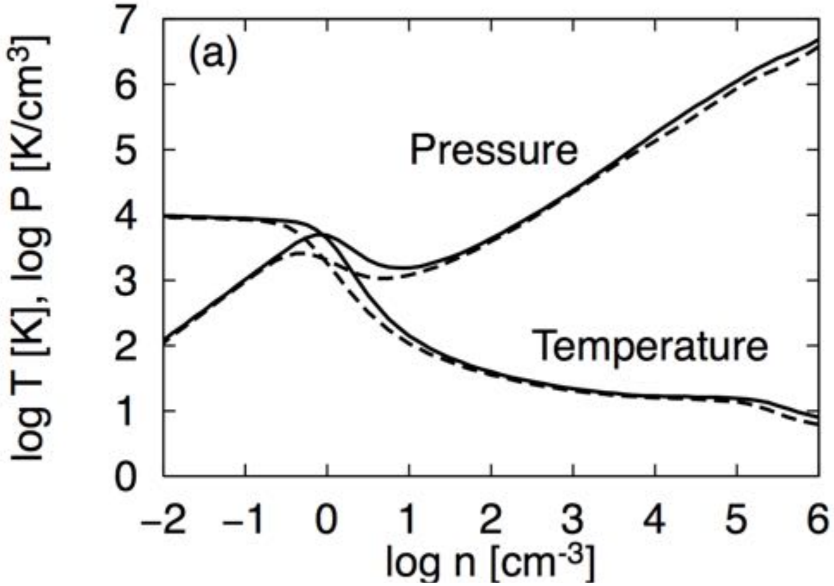

log[λF_λ/(ergs s^−1 cm^−2)]
-7
-8
-9
-10
-11
Face On
45 Degree Inclination
Stellar Photosphere
FU Ori
V 1057 ×2
V 1735 ×10
Z CMa ×0.4
0
1
2
3
log(λ/μm)

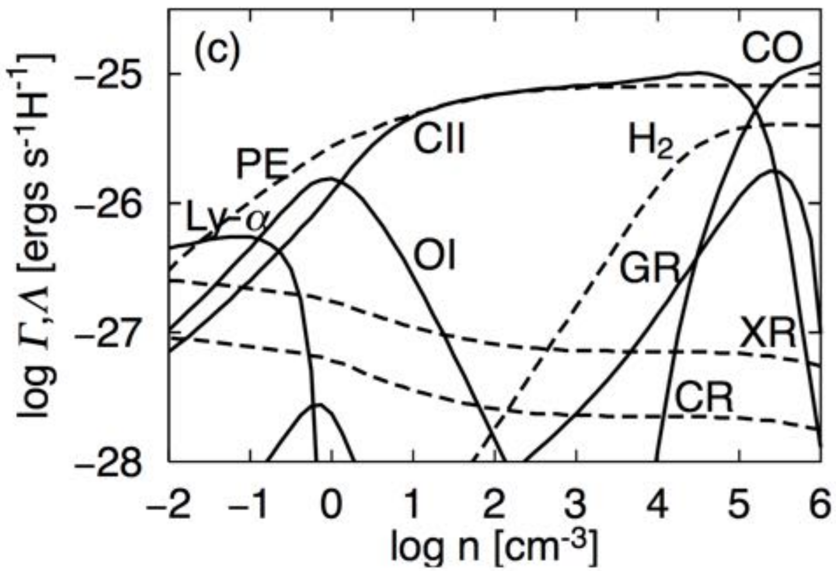
論文[3]: Forbes et al.

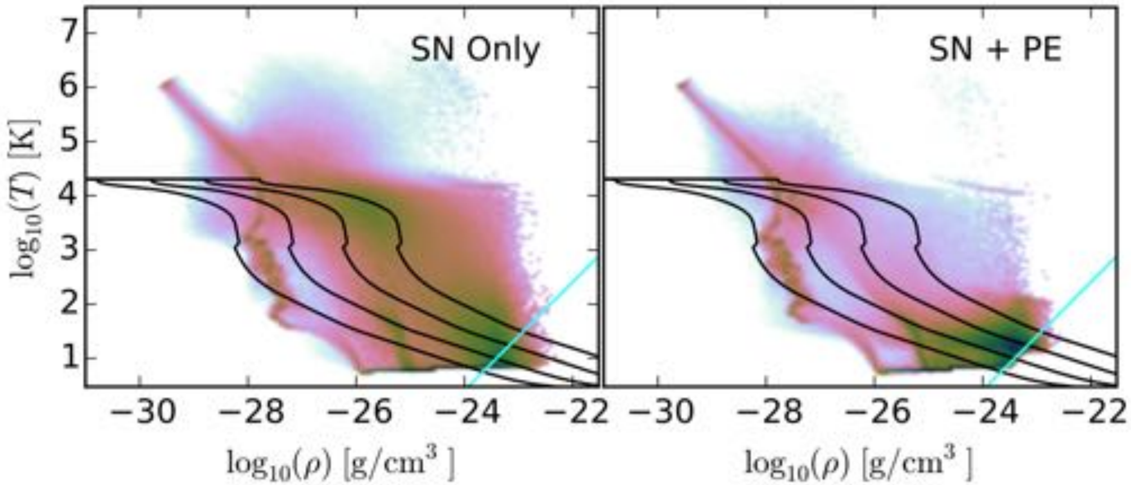
+ dwarf galaxyにおけるfeedback過程で、特に光電加熱(PE)の効果を調べた。
+ SN feedbackだけだと観測と比べて星形成率が大きくなりすぎる
+ PE feedbackが主に星形成率をcontrol。観測と合う星形成率を与えるのに必要。
  (低温・高密度のガスが過剰にできるのを阻害する)



2-phase HI mediumと
ダスト光電加熱の役割
(Koyama & Inutsuka 00より)







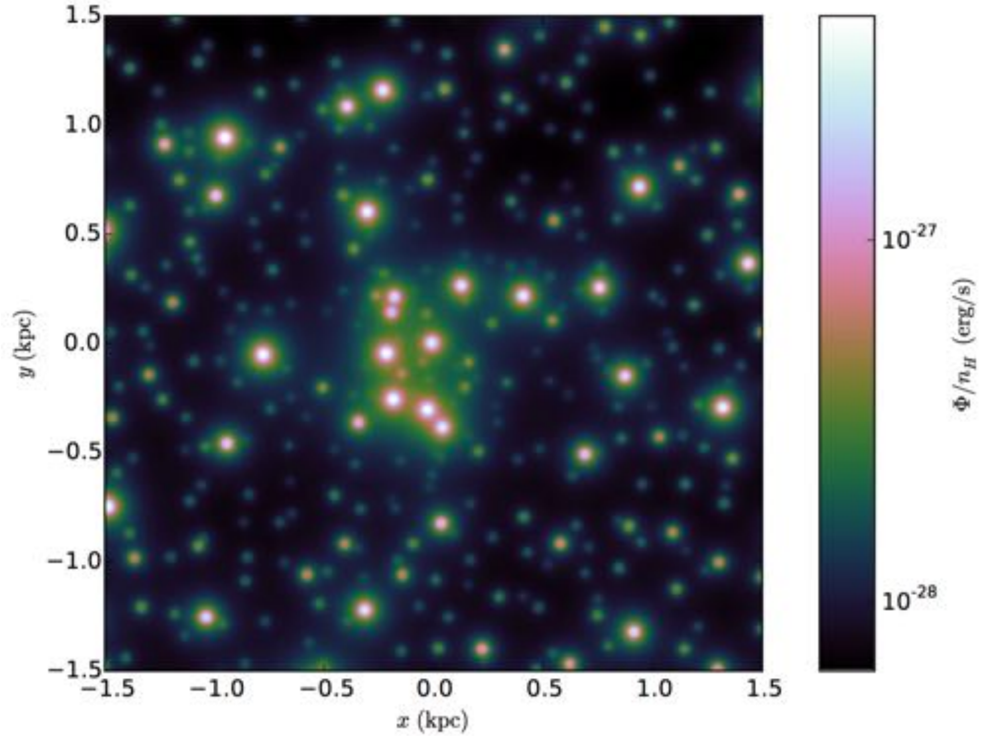


Figure 3. The photoelectric heating rate. Every young star particle in the simulation produces FUV radiation. The flux from all of these stars is summed in each cell (see Methods), yielding the volumetric heating rate shown here. Given the low surface density of young stars, this distribution is highly inhomogeneous. The low metallicity and small size of the galaxy means that the mean free path of the FUV photons is large, so the flux from each star and hence the heating rate falls off as r^{-2} from each source.

Depletion timeと星形成率の時間進化、および観測との比較