The destruction of circumstellar disks in the Trapezium cluster

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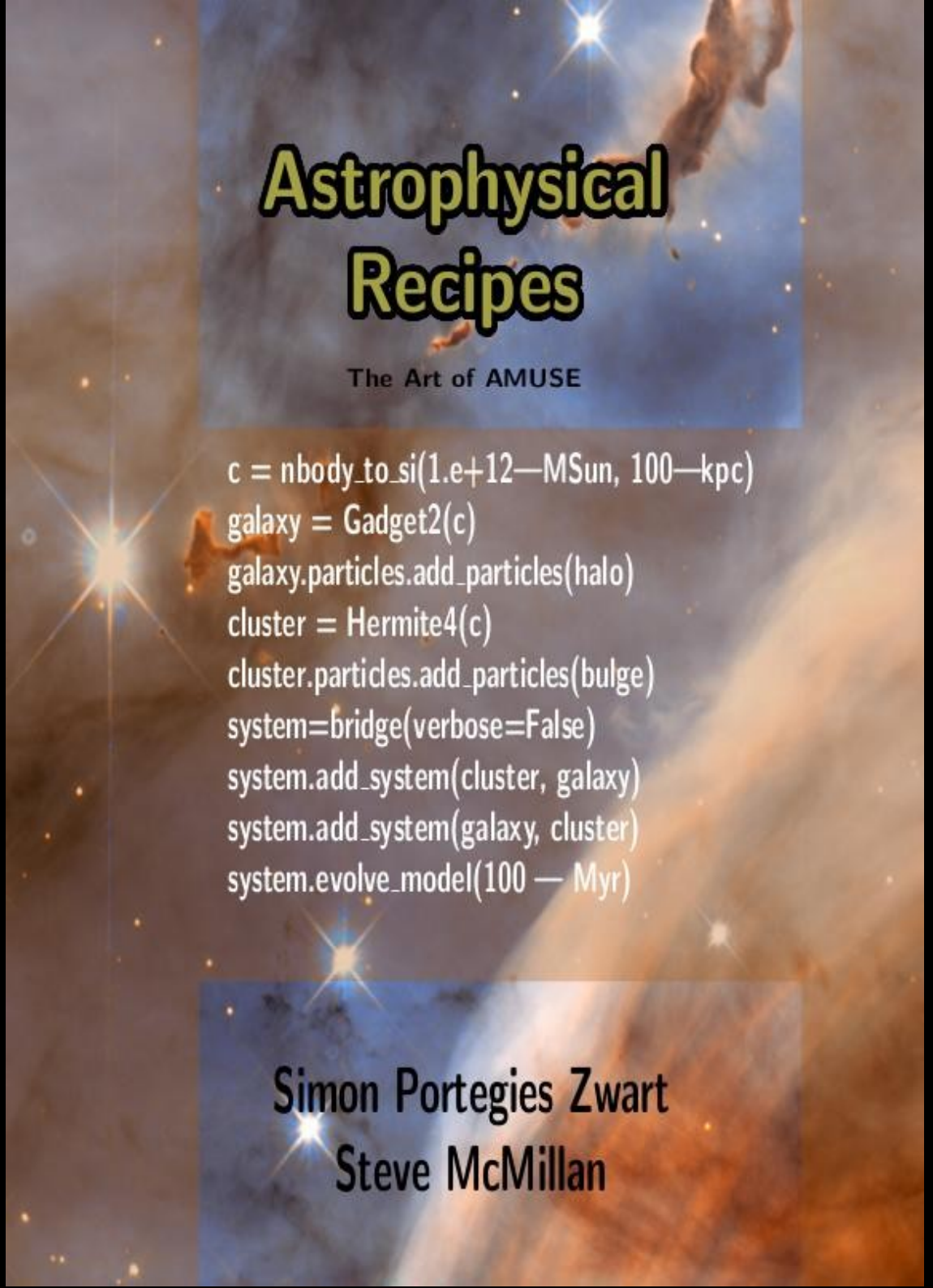
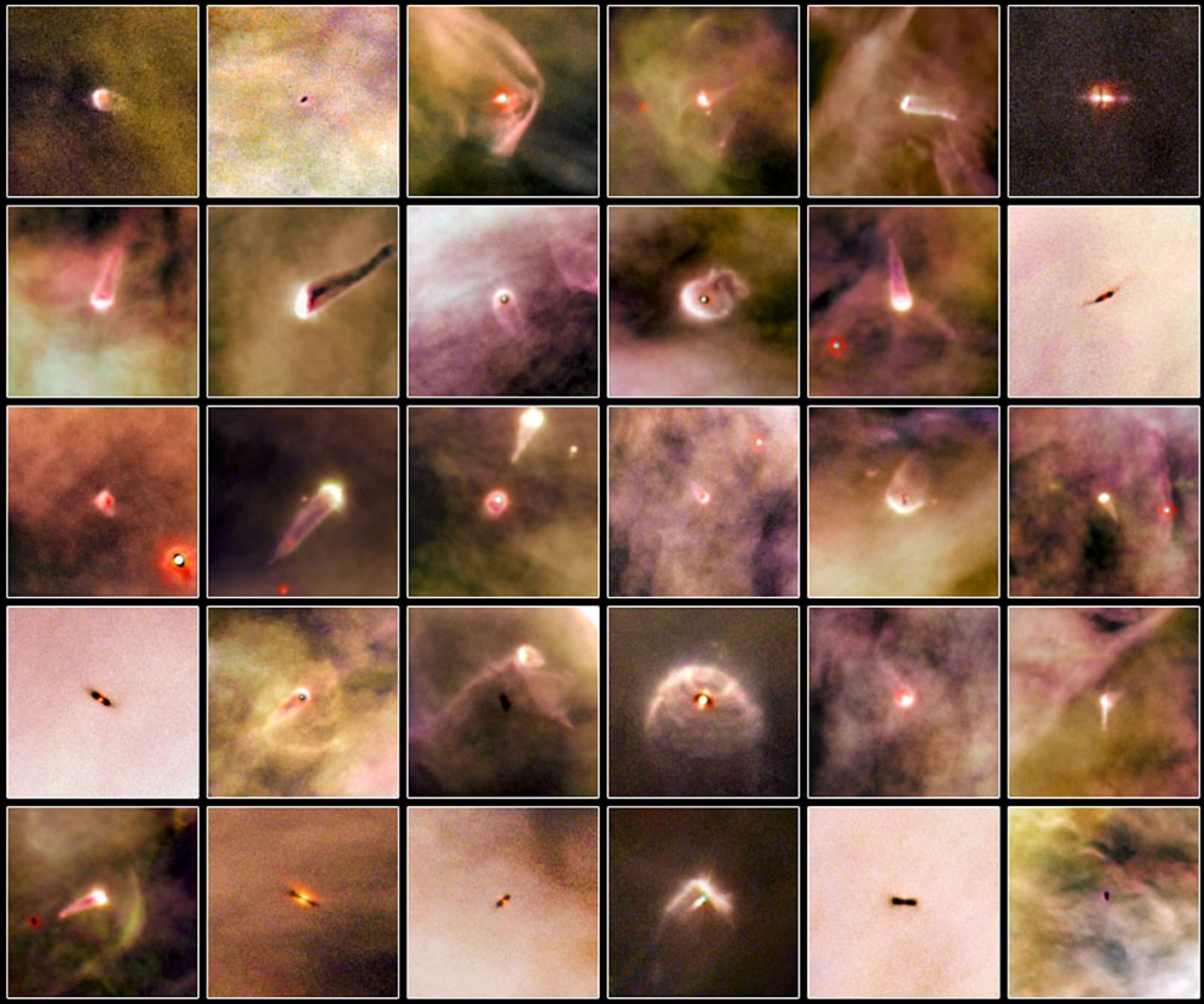
Sterrewacht Leiden

Summer 2017

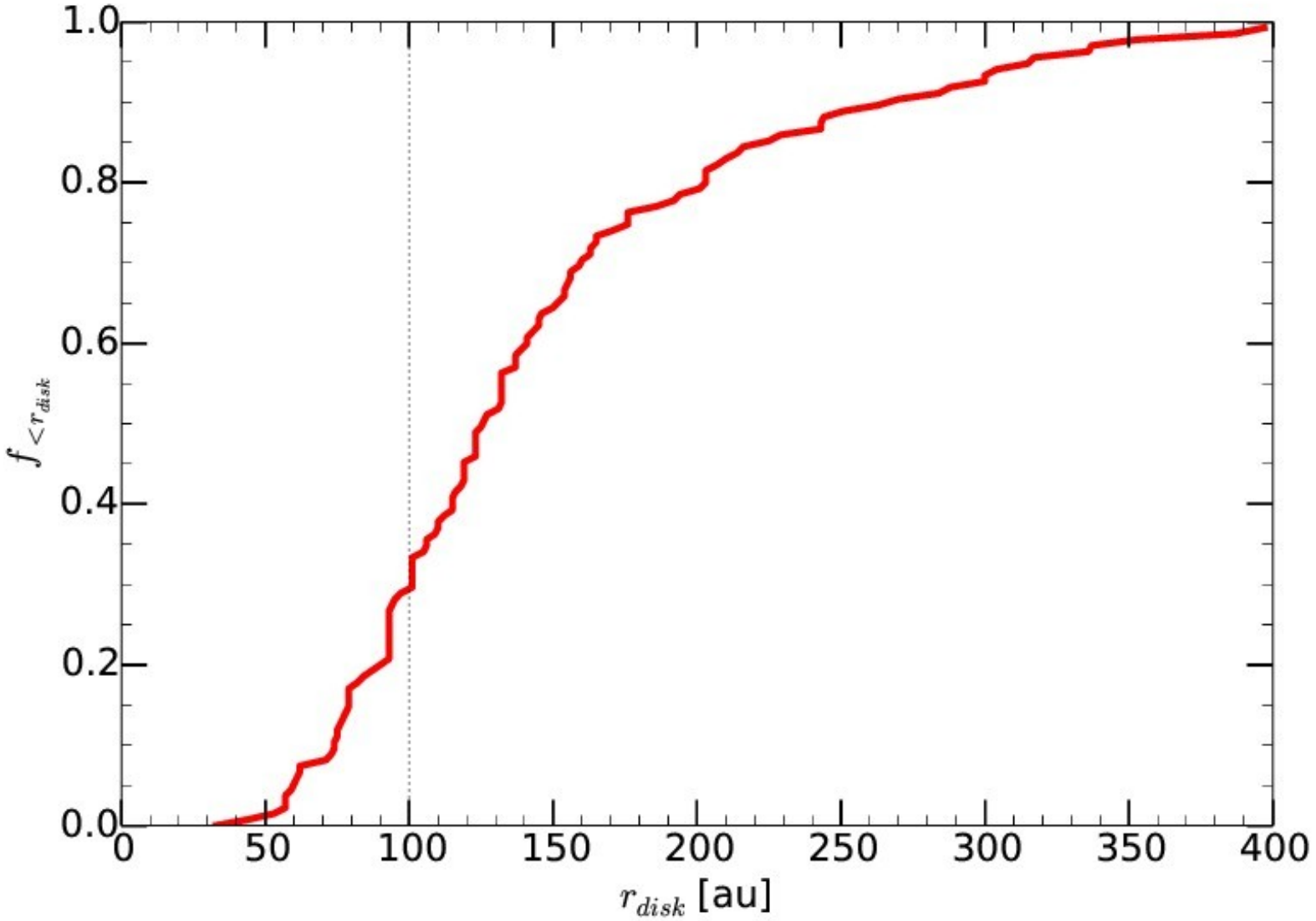


AMUSE

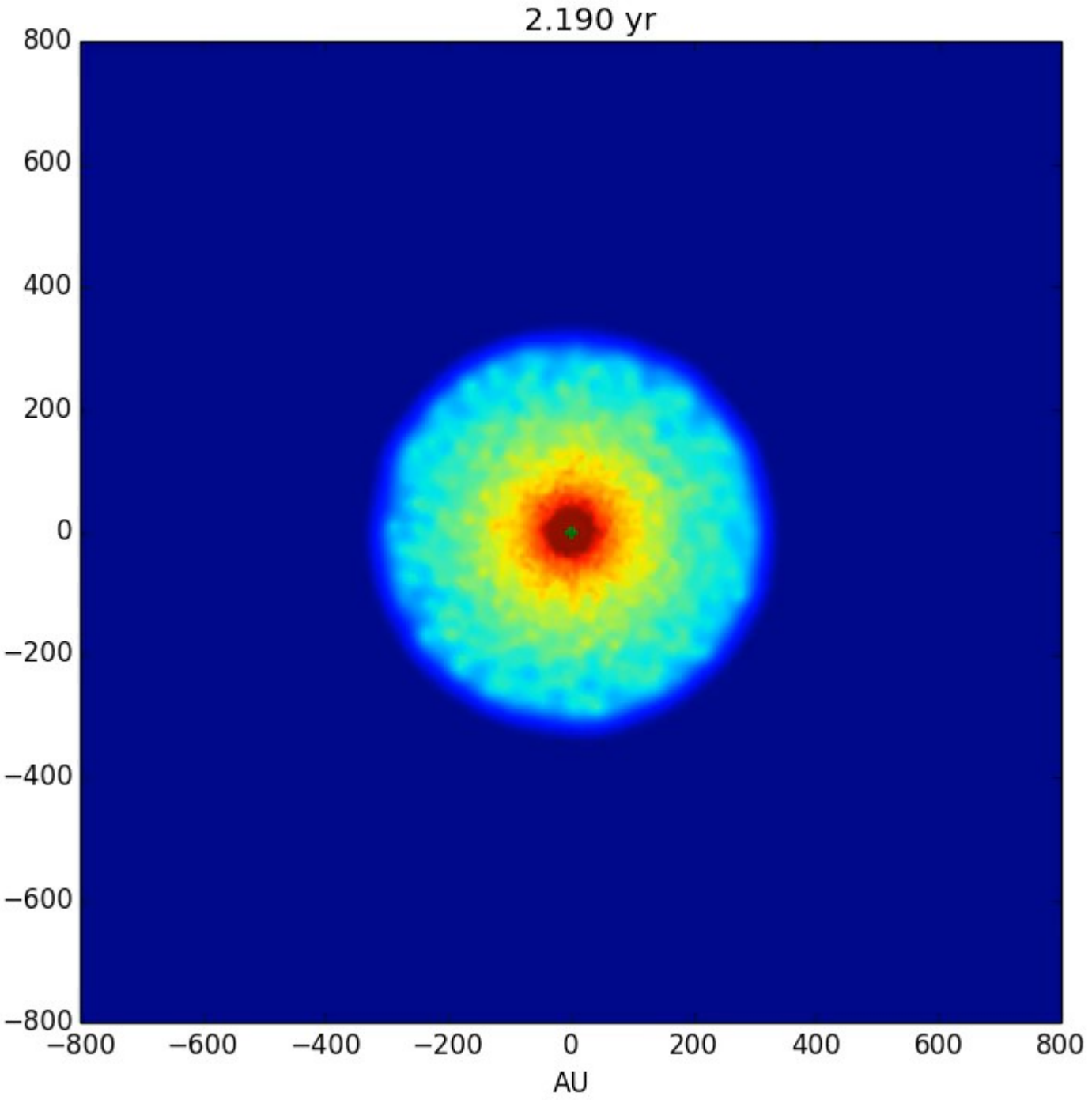

HST

Trapezium disk size distribution

HST/WFPC2 resolution 1 pixel ~45au, obs limit at about 100au



Vincente & Alves 2005



Parametrized disk evolution:

$$r_{disk} \approx \frac{1}{3} q \left(\frac{m}{M} \right)^{\frac{1}{3}}$$

$$\frac{dm}{m} \approx \frac{r^{1/2} - r_{old}^{1/2}}{r^{1/2}}$$

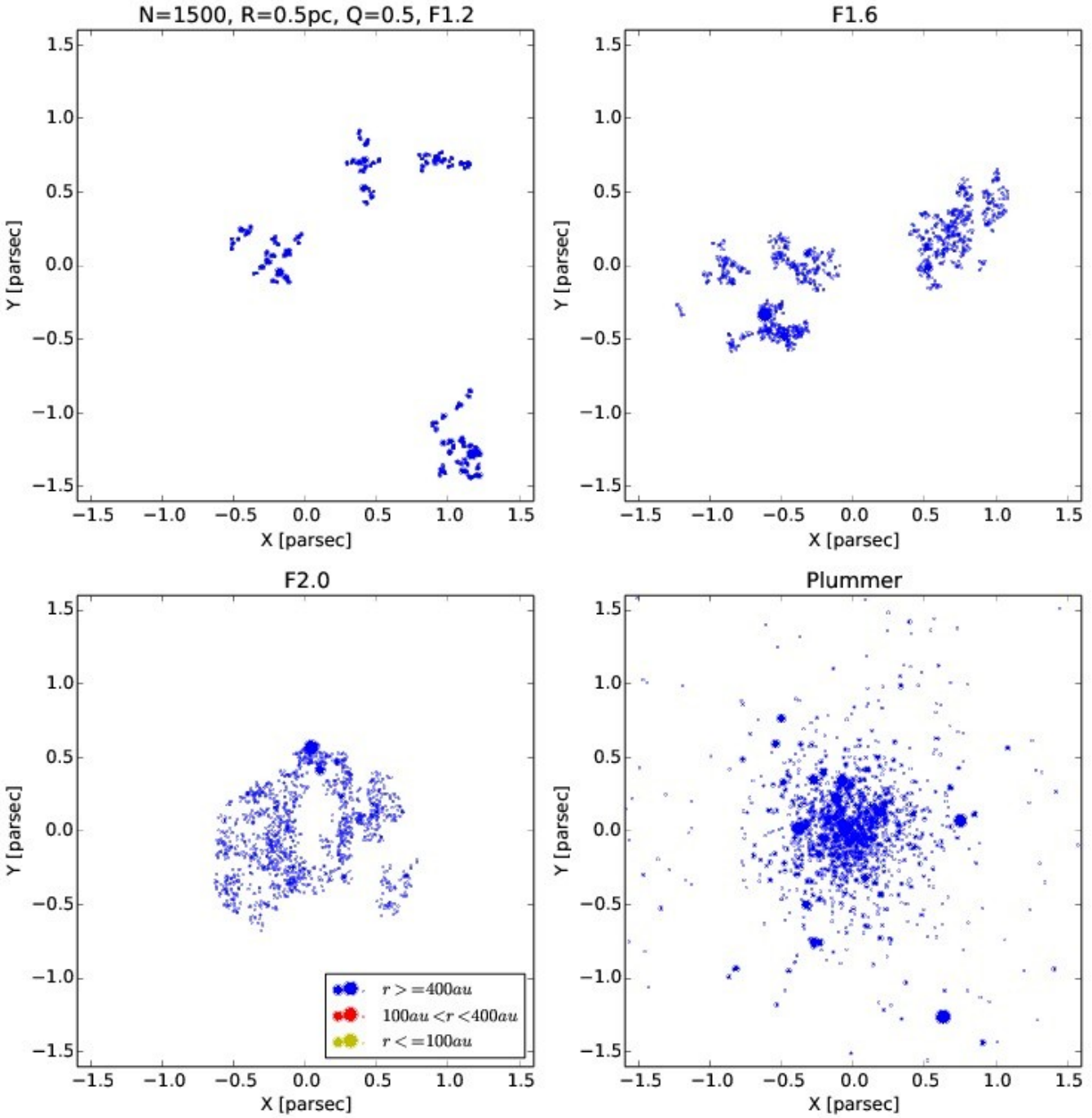
$$dm_{acc} = dm \left(\frac{m}{m+M} \right)$$

Jilkova 2016

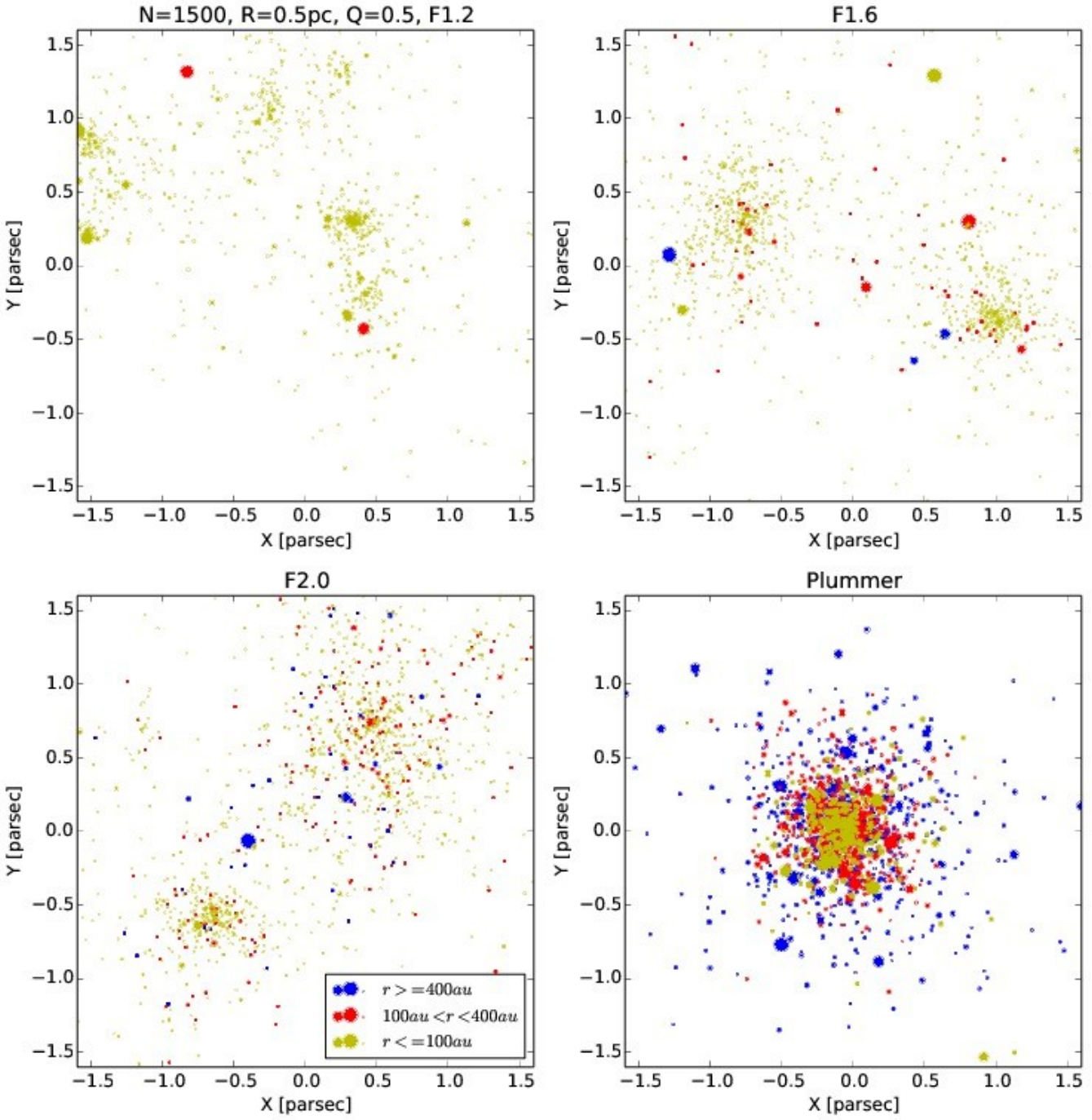

does look like a Plummer sphere
© 1998 Jerry Lodriguss

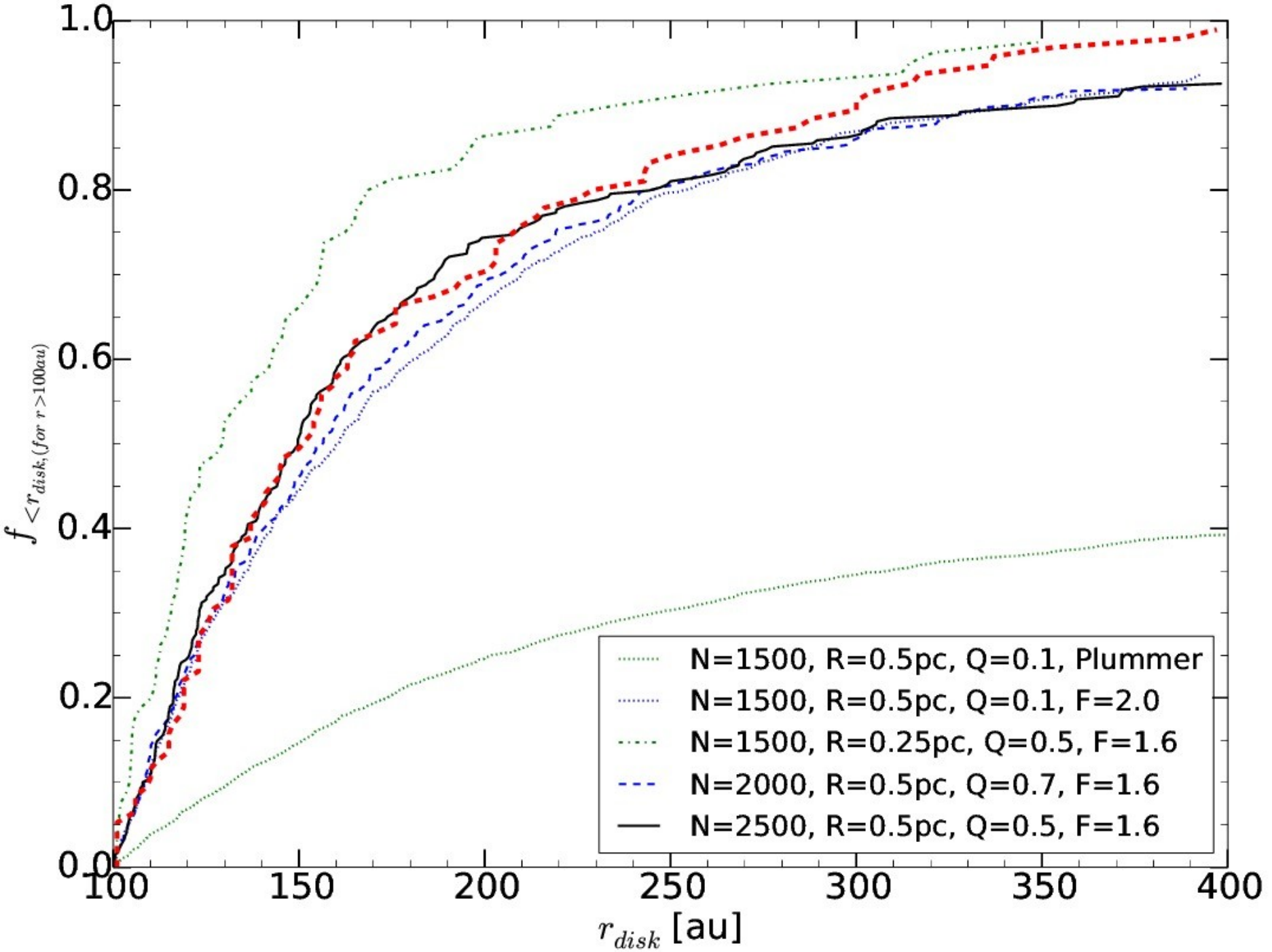

doesn't look like a Plummer sphere
NGC2070

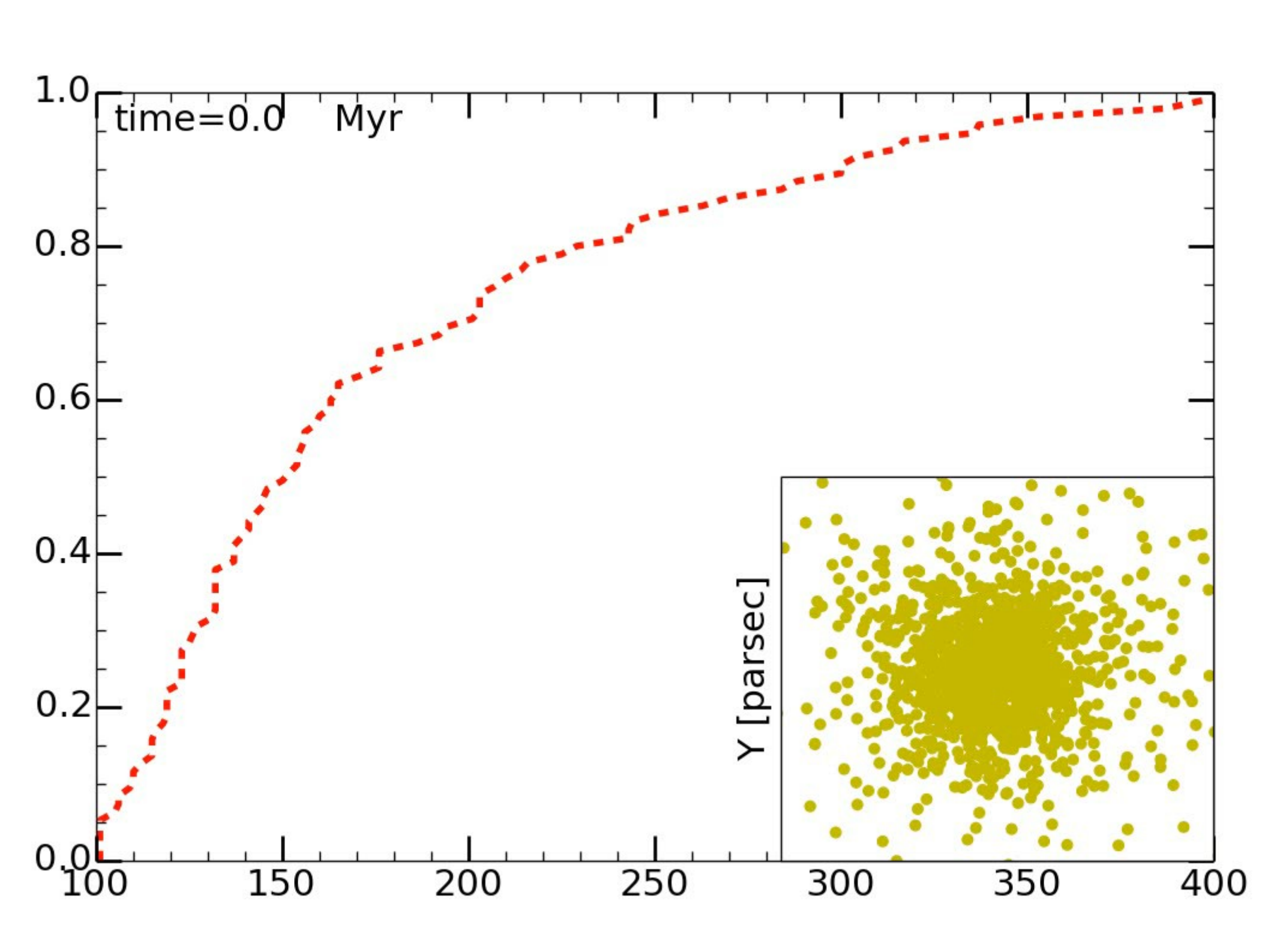
T=0Myr

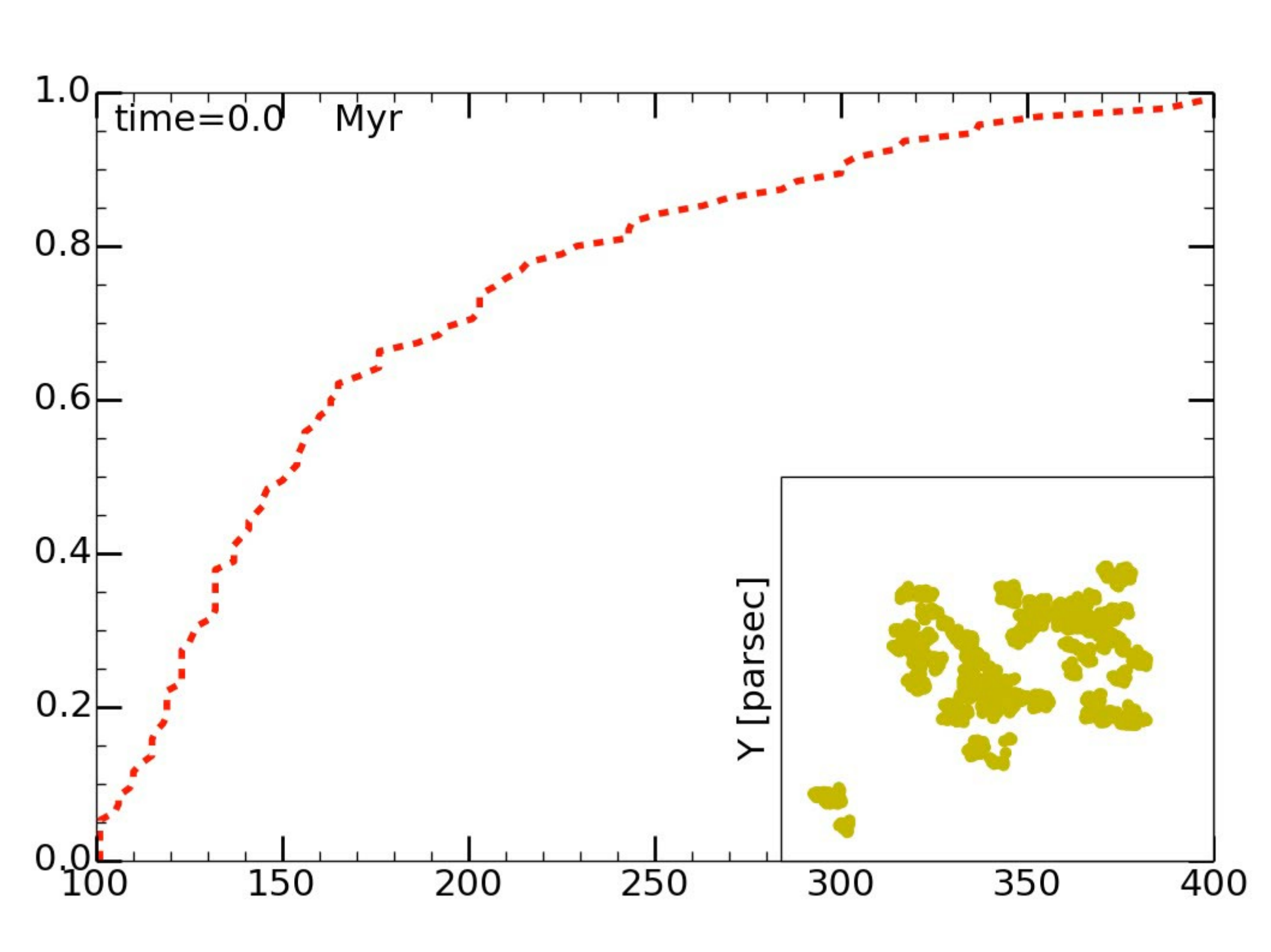

N=1500, R=0.5pc, Q=0.5, F1.2
F1.6
F2.0
Plummer
Y [parsec]
X [parsec]
$r >= 400au$
$100au < r < 400au$
$r <= 100au$

T=1Myr

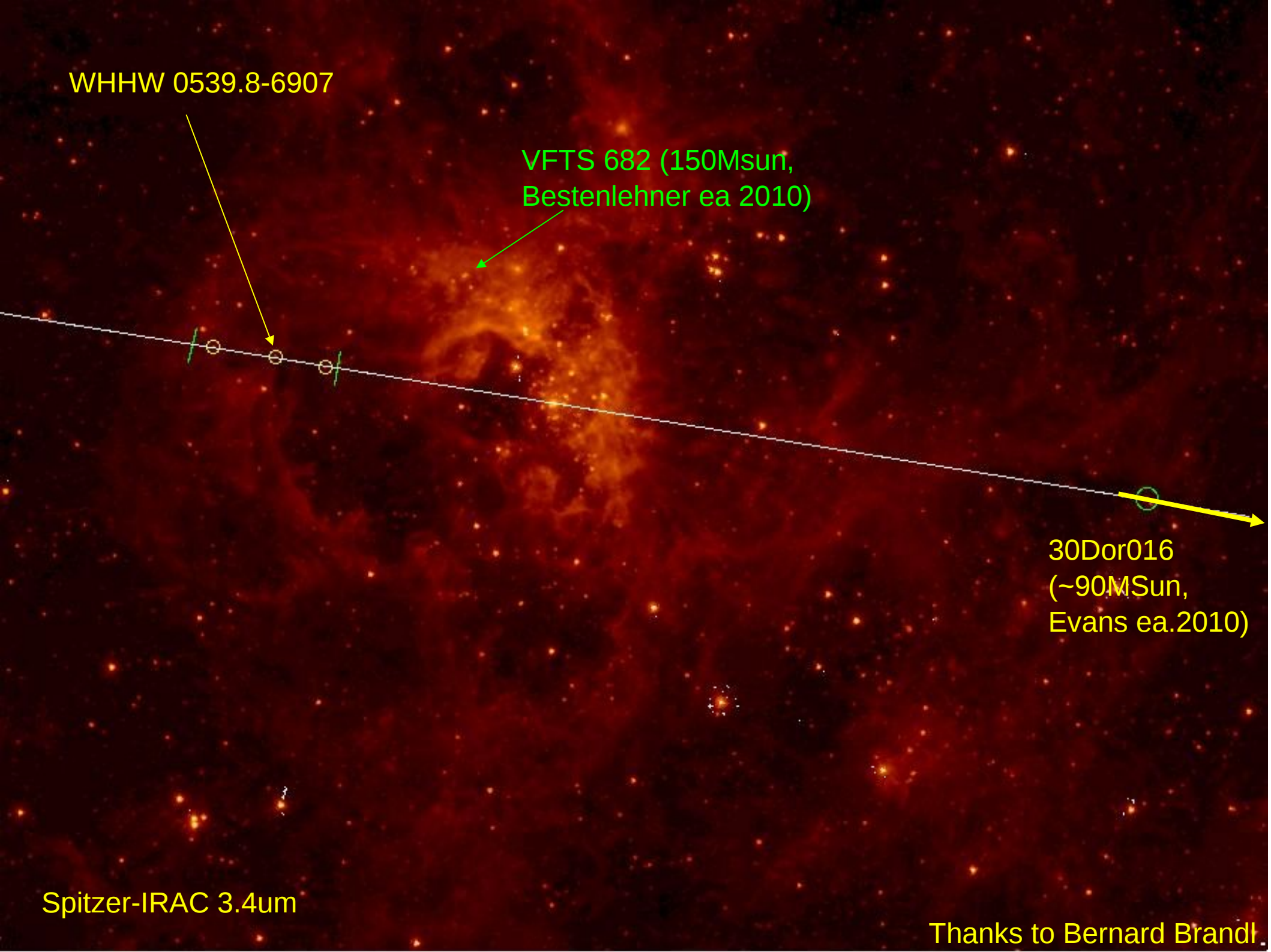

N=1500, R=0.5pc, Q=0.5, F1.2
F1.6
F2.0
Plummer
Y [parsec]
X [parsec]
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
$r >= 400au$
$100au < r < 400au$
$r <= 100au$

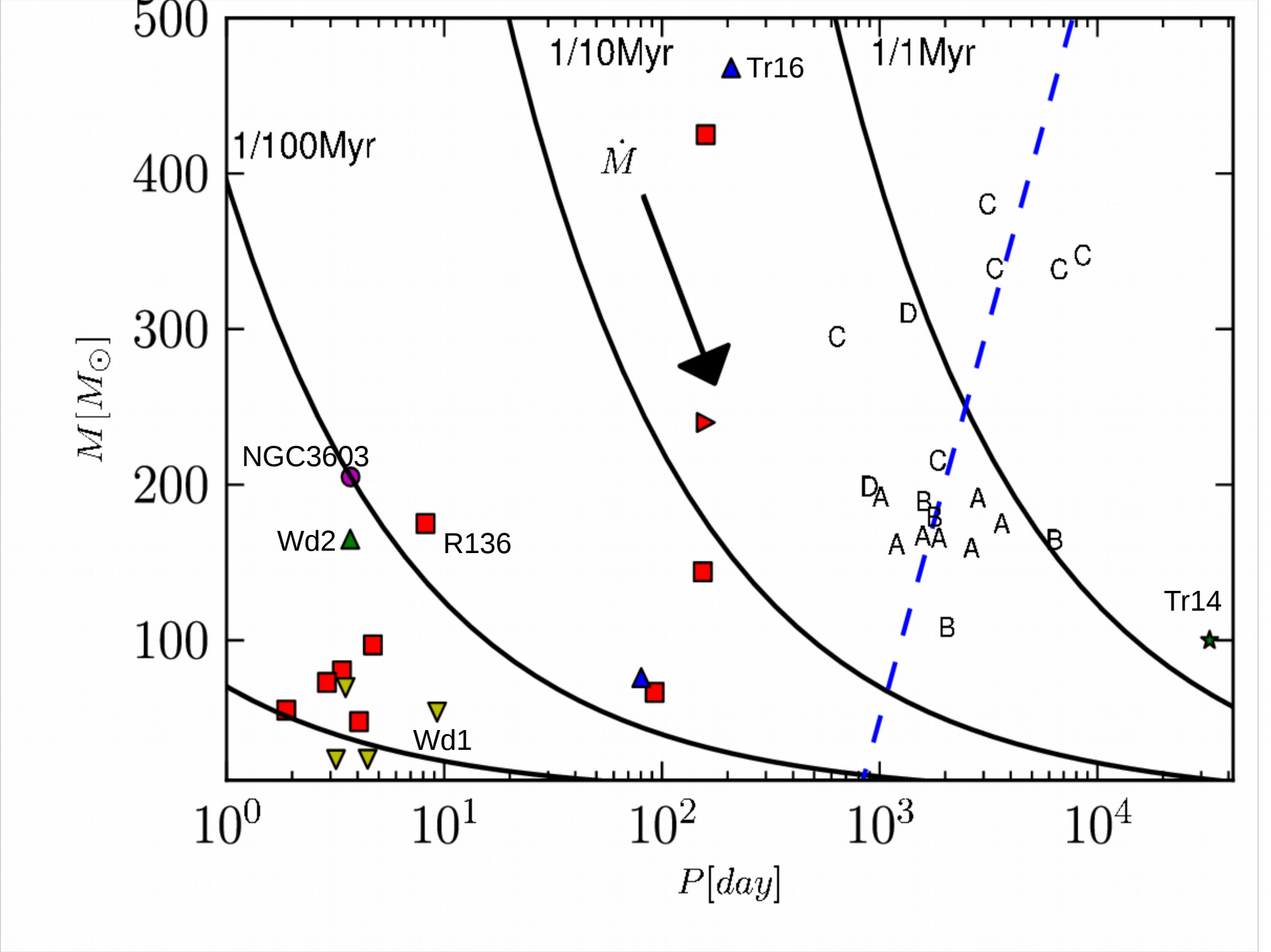

1.0
0.8
0.6
0.4
0.2
0.0
100
150
200
250
300
350
400
$f_{<r_{disk,(for\ r>100au)}}$
r_{disk} [au]
N=1500, R=0.5pc, Q=0.1, Plummer
N=1500, R=0.5pc, Q=0.1, F=2.0
N=1500, R=0.25pc, Q=0.5, F=1.6
N=2000, R=0.5pc, Q=0.7, F=1.6
N=2500, R=0.5pc, Q=0.5, F=1.6

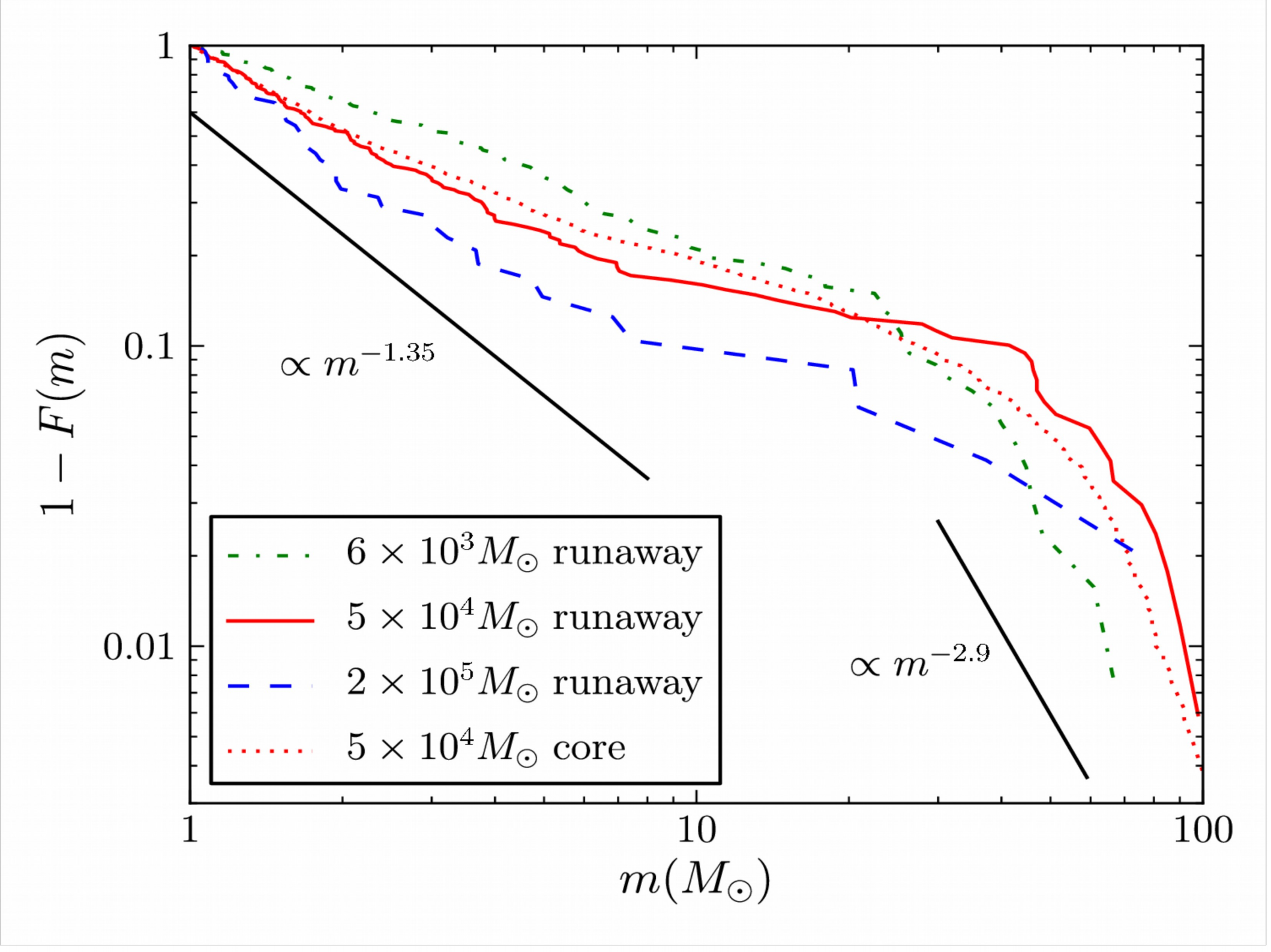

time=0.0 Myr
1.0
0.8
0.6
0.4
0.2
0.0
100
150
200
250
300
350
400
Y [parsec]

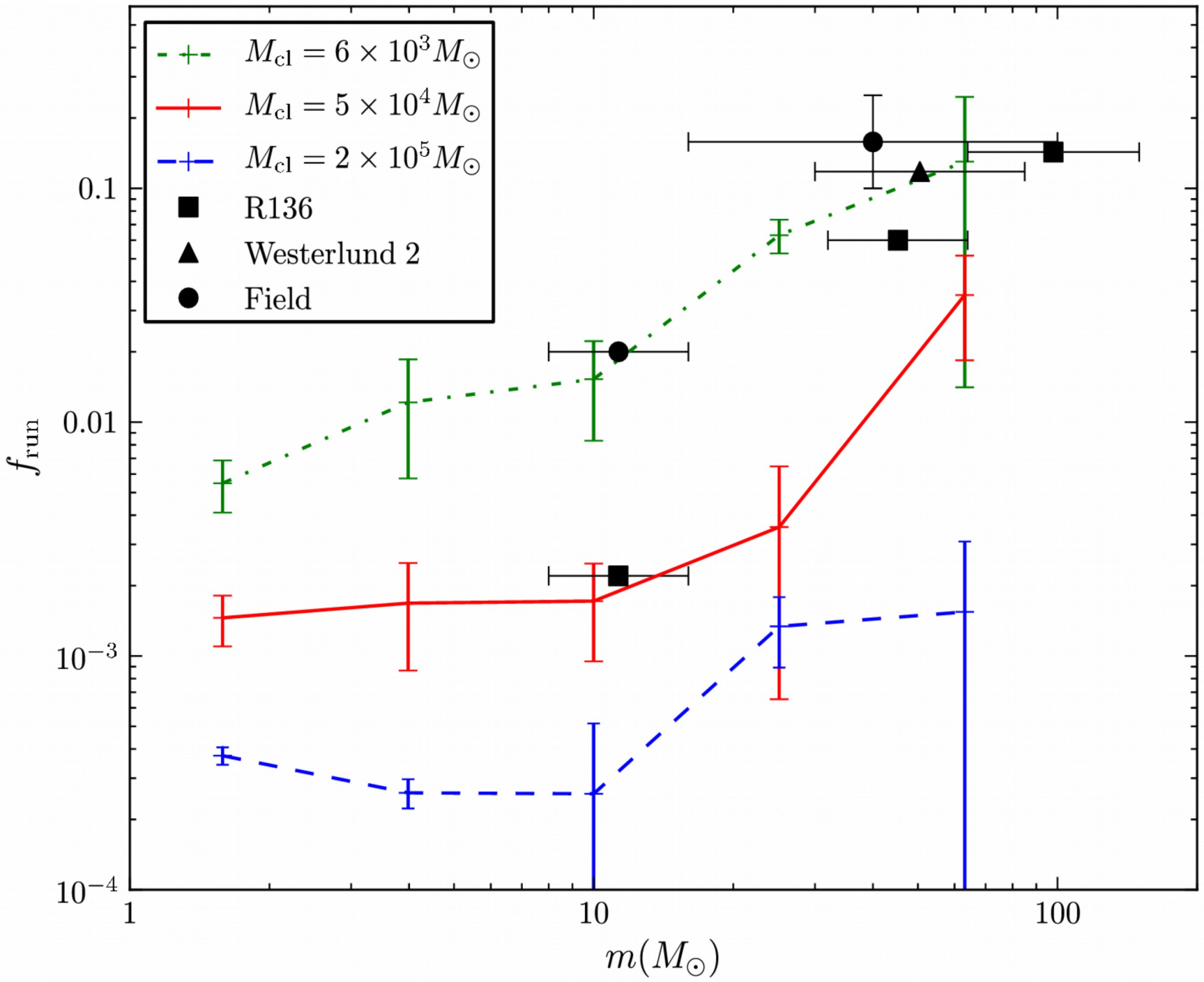

time=0.0 Myr
1.0
0.8
0.6
0.4
0.2
0.0
100
150
200
250
300
350
400
Y [parsec]


VFTS 682
VFTS682 90Msun probably ejected from R136

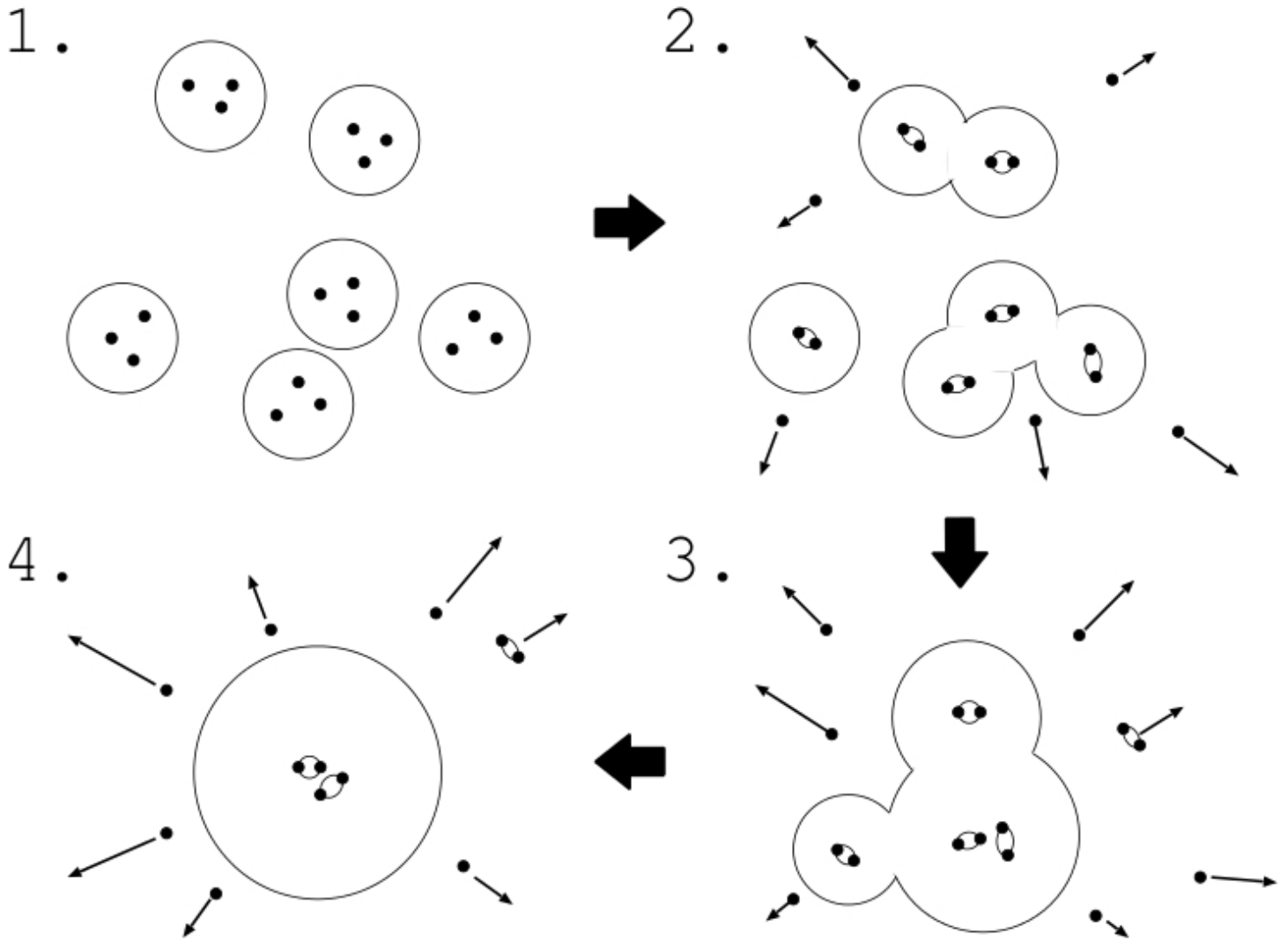

WHHW 0539.8-6907
VFTS 682 (150Msun,
Bestenlehner ea 2010)
30Dor016
(~90MSun,
Evans ea.2010)
Spitzer-IRAC 3.4um
Thanks to Bernard Brandl


1/100Myr
1/10Myr
1/1Myr
Tr16
$\dot{M}$
NGC3603
Wd2
R136
Wd1
Tr14
$M[M_\odot]$
$P[day]$
500
400
300
200
100
10^0
10^1
10^2
10^3
10^4


1
0.1
0.01
1
10
100
$1 - F(m)$
$m(M_\odot)$
$\propto m^{-1.35}$
$\propto m^{-2.9}$
$6 \times 10^3 M_\odot$ runaway
$5 \times 10^4 M_\odot$ runaway
$2 \times 10^5 M_\odot$ runaway
$5 \times 10^4 M_\odot$ core



Fujii & SPZ 2011



Cartoon of star cluster formation (Fujii etal 2012)

Conclusion

- The observed disk-size distribution is reproduced within 0.3-1Myr if the cluster formed with a few 1000 stars within 0.5pc and with a fractal dimension of F=1.6.
- Such clusters produce a high fraction of high-mass runaway stars. Consistent with the field.
- Massive star clusters form from mergers of smaller clusters.