



Can Supernovae Blast eliminate Alien Civilizations?

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Why can't we see Alien Civilizations?

This is an age-old question known as the Fermi Paradox, which still has no answer today

The simulation-based studies conducted by [1] suggest that a Kardashev-scale type III alien civilization could colonize half of the Milky Way galaxy within 25 Myr. If they come from our solar system.

Then, the simulation-based study conducted by [2] also showed that a Kardashev-scale type II alien civilizations are able to change into the type III so fast, by MW galaxy stars' rotation assistance.

Methodology

(1)

Milky Way Galaxy Simulation

MW galaxy is simulated by the Gadget 2.0.7 (N-Body Astrophysics Simulation Package)



The 10,000 star particles are used in the simulation. Each of the particle represents 10 million stars [3]. The star particles density is normalized using the NFW density profile. After that, the MW galaxy star particles position and velocity data are extracted and display them in python code.

However...

"The results in [1] and [2] still cannot resolved the Fermi Paradox"

We want to resolve this issue by Supernovae Blast

Let's simulate!

(2)

Alien Migration Algorithm



Alien civilizations are migrated by targeting nearest-neighbors (NN) unsettled star particles. The NN calculation is determined by the Eulerian distance in Eq.(1). They are sending a certain number of ships per launch period (with a constant speed) to settle the unsettled star particles. This algorithm is done in python code

$$D_s \leq [(x_s - x_u)^2 + (y_s - y_u)^2 + (z_s - z_u)^2]^{0.5} \quad (1)$$



- NN radius (Ds) = 3 pc [2]
- Ship speed = 10 km/s [2]
- Number of ships per launch period = 1 ship / 0.1 Myr [2]

(3)

Supernovae (SNe) Blast

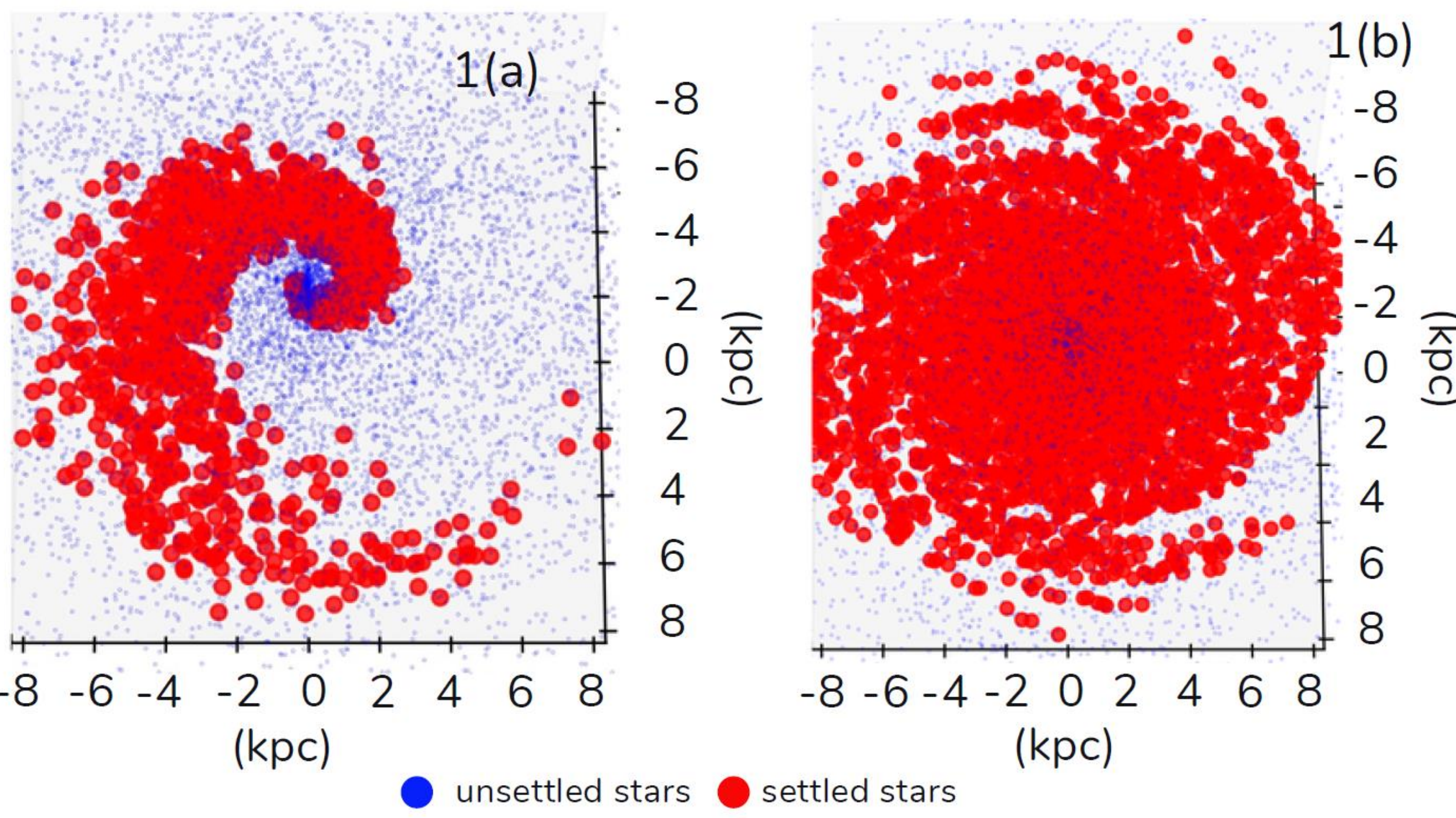
If the settled star particles are inside the SNe blast radius (Rb), the settled star particles turn to unsettled star particles (aliens are vanished). The SNe blasts are modelled to happen randomly in certain region from the MW center. Because, the SNe are typically happens in the spiral form (higher star formation rate).

- SN Blast Radius (Rb) = 0.05 kpc [4]
- SN Event Frequency = 3 event in 0.00001 Myr [5]
- Inner Radius (Ri) = 0.9 kpc [6]
- Outer Radius (Ro) = 3.0 kpc [6]

Result and Discussion

The SN event frequency as shown in [6] affects the small alien populations and agree with the results of [6]

Therefore, to see the large impact to the alien populations, the increasing of SN event frequency becomes 3 orders larger than before is included (3000 events in 0.00001 Myr)



In Fig.1, one can see the alien colonization to the MW-like galaxy. The Fig.1(a) shows the colonization without SN blast and the Fig.1(b) shows the colonization with random SN blast in certain region from the center of the MW-like galaxy.

Fig.1. The alien Colonization to the MW-like galaxy. (a) without SN and (b) with random SN blast in certain region.

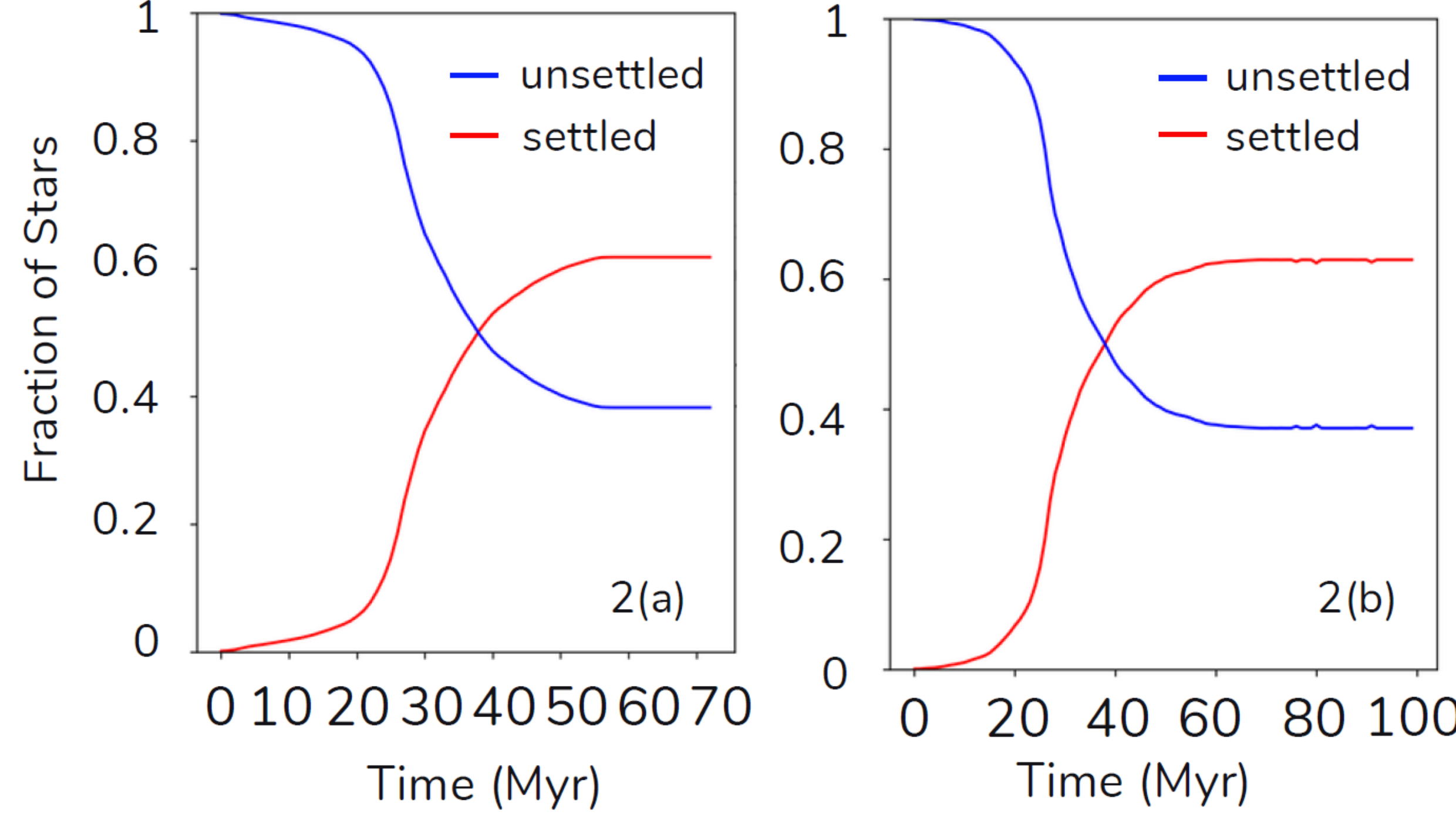


Fig.2. The relation between Fraction of Stars in a galaxy. (a) Without SN Blast (MW-like galaxy) and (b) With Random SN blast in certain region (MW-like Galaxy)

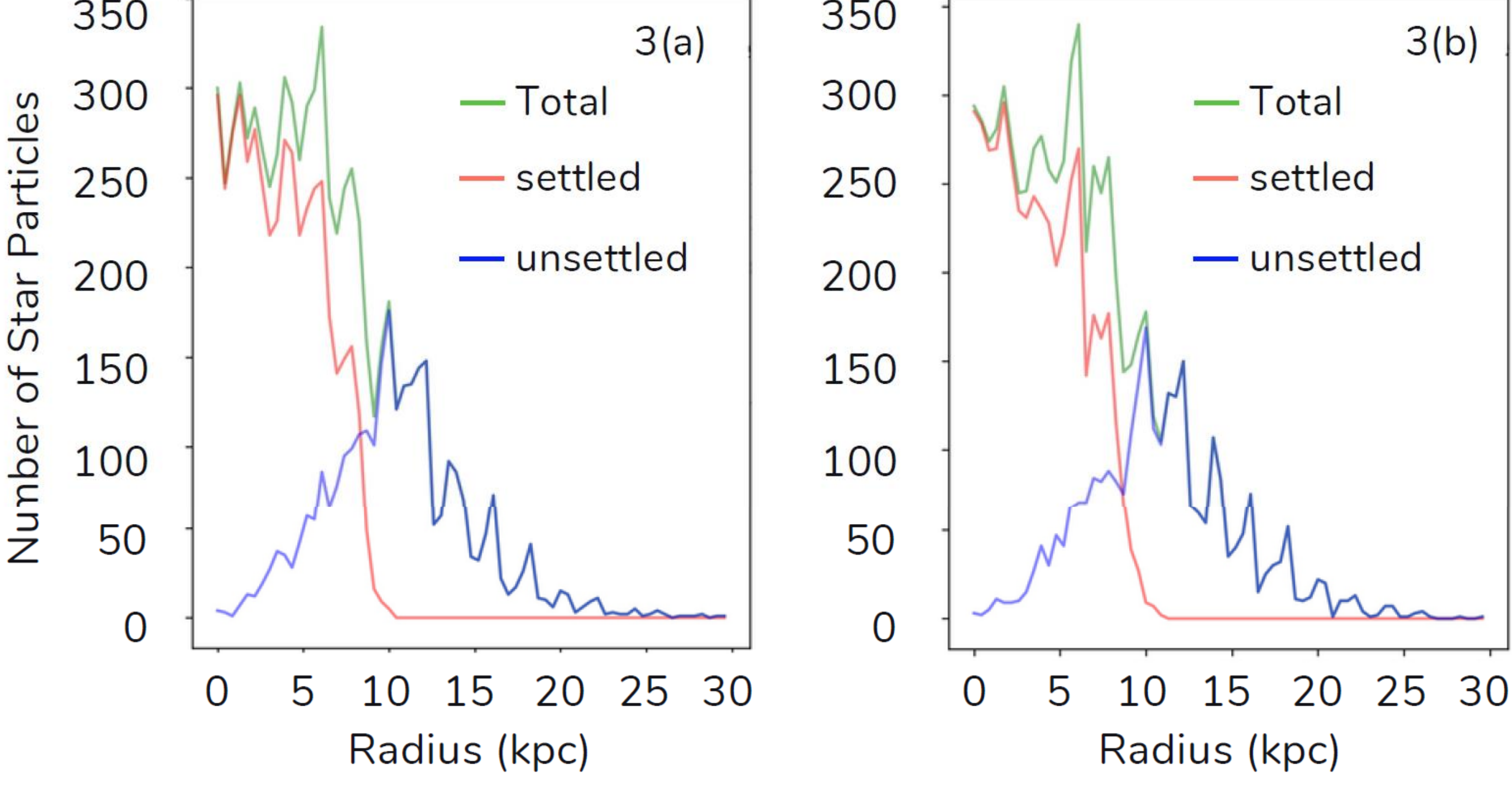


Fig.3. The Radial Distribution of Unsettled and Settled Star Particles in a Galaxy. (a) Without SN Blast (MW-like galaxy) and (b) With Random SN blast in certain region (MW-like galaxy)

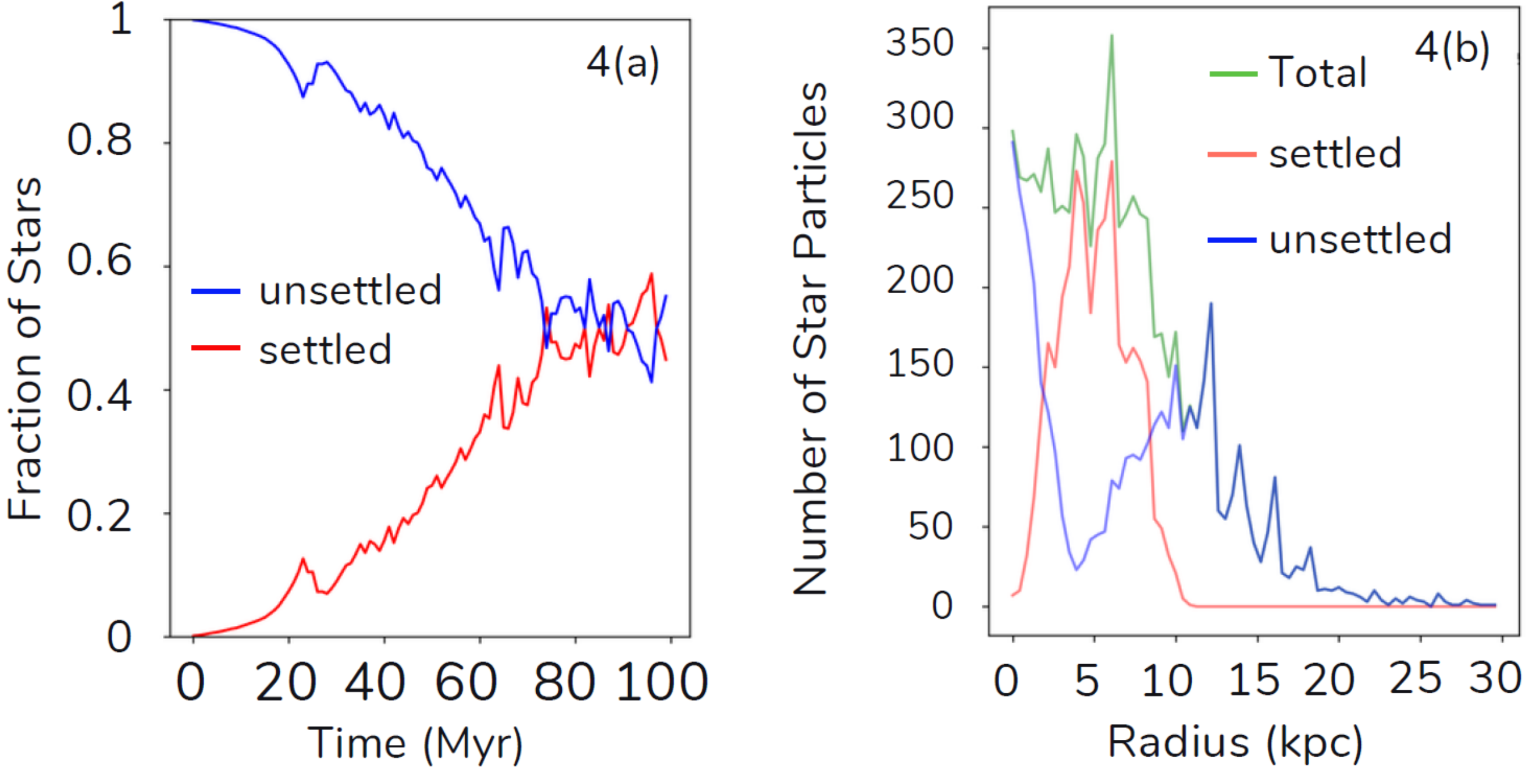


Fig.4. Alien invading the galaxy with High Supernova Blast Rate (ULIRGs): (a) Fraction of Stars and (b) Radial Distribution of Star Particles

Conclusion & Future Works

- In the MW-like galaxy, the SN blast have a minor effect in the alien populations, due to the low supernova blast rate
- By increasing the supernova blast rate by 3 orders larger like in ULIRGs, the supernova postpone the aliens invasion time from 35 Myr to 70 Myr to colonize 50% of the stars.
- For the future works, the large object like asteroids or Giant Magellanic Cloud (GMC) [5] are included to see the other factors for why we do not see aliens.

References

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