Response to referee report for manuscript ref. MN-23-2721-MJ.R1

The authors have revised the manuscript based on some of my comments. The current version is better than the previous one. However, important points which I requested in the report have not been addressed well.

We thank the referee for returning comments back to us. We will address the issues below and have ***boldfaced and italicized*** any changes made to the manuscript to differentiate from the **boldfaced** changes made to the manuscript in the first revision cycle.

1) For now, there is no evidence that neutron stars originated from Population III stars occurred within 100 Myr. In my previous report, I requested the authors to add information about the binary systems to induce the neutron star mergers within a very short time scale. Merely referring to Simon et al. (2023) is insufficient. Modeling the star formation history based on the color-magnitude diagram involves a large error, which cannot be evidence of the neutron star merger originated from Population III stars with the short time scale. Also, they just suggested r-process occurred within 500 Myr in which a lot of Population II stars can form and its stellar mass can be much larger than Population III stars. I understand some previous models considered the merger parameters extended to the short time scale. However, they did not provide a strong constraint in which Pop III neutron stars must merge within <100 Myr. In dense star clusters, the angular momentum of binary systems can be lost via three-body interaction, leading to mergers within a short time scale. On the other hand, the short-time scale merger of a pure binary system sounds very difficult. I would like to request that the authors will explain what kind of binary systems can induce the NS-NS merger within 10-100 Myr and how frequently such binary systems are likely to form.

It is true that there is limited evidence that neutron stars originating from Pop III stars can merge within 100 Myr. This is clearly a field that will require much more investigation as we continue to probe to earlier and earlier times. However, some studies have investigated these short delay time scenarios. Belczynski et al. [2018] study binary neutron star system formation and found that their models with lower minimum times have small or zero neutron star natal kicks, and thus undergo a highly efficient common envelope phase. This corresponds to a fast-formation channel for neutron star binary systems, and could possibly lead to shorter delay times. Jeon et al. [2021] also investigate the origin of r-process enhanced stars in ultra-faint dwarf galaxies and agree that the exact origin of these NSMs is unknown, and likely very rare. They employ NSM models originating from the fast-formation channel with short delay times ($\sim$5 Myr). We have added a short discussion towards the end of Section 2.2.

The authors consider the NS-NS mergers originated only from Population III stars. I understand the authors investigate an ideal case. However, the motivation of this work is to understand the origin of r-process enhanced stars in nearby dwarf galaxies. In considering the long-time history of galaxies, we cannot avoid the contribution from Population I/II stars. The authors should discuss this more carefully. Are there any possibilities that we can observe evidence of the metal enrichment solely from Population III stars? Simon et al (2023) indicated that 80% of stars formed in the early Universe. Therefore, if it is true, stars of approximately 3000 solar masses were formed in that era. Is the contribution from Population III stars significant?

Thank you for making this distinction. We agree that r-process material can be produced through alternative means, and thus we are not fully investigating the source of all r-process material in this system. We have added a statement at the top of Section 3 to emphasize that in this paper, we are only looking at r-process material from the NSM, which provides a lower limit. We also want to emphasize that we are indeed considering metal enrichment from Pop III and Pop II stars, but it is a general field in our simulation which includes more than just r-process material.

The only group of stars enriched solely by Pop III stars will be the second generation of stars whose natal gas was not enriched by metal-enriched stars. This corresponds to the initial starburst of the galaxy, and is extremely metal-poor. Using a Kroupa IMF, we find that $\sim$40% of stars formed at this early time would still be alive today. For a living stellar mass of 3,000 $M_{\odot}$, this would require an initial star formation event producing 7,500 $M_{\odot}$, which falls right in the middle of our stellar masses.

Ret II should be written after showing the formal name, “Reticulum II”.

Apologies, we have corrected this.

We again thank the referee for the insightful review that helped improve our paper.

References

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Myoungwon Jeon, Gurtina Besla, and Volker Bromm. Highly r-process enhanced stars in ultra-faint dwarf galaxies. *MNRAS*, 506(2):1850–1861, September 2021. doi: 10.1093/mnras/stab1771.