

Measuring the Binary Fraction of Type II-P/II-L Supernova Progenitor Systems

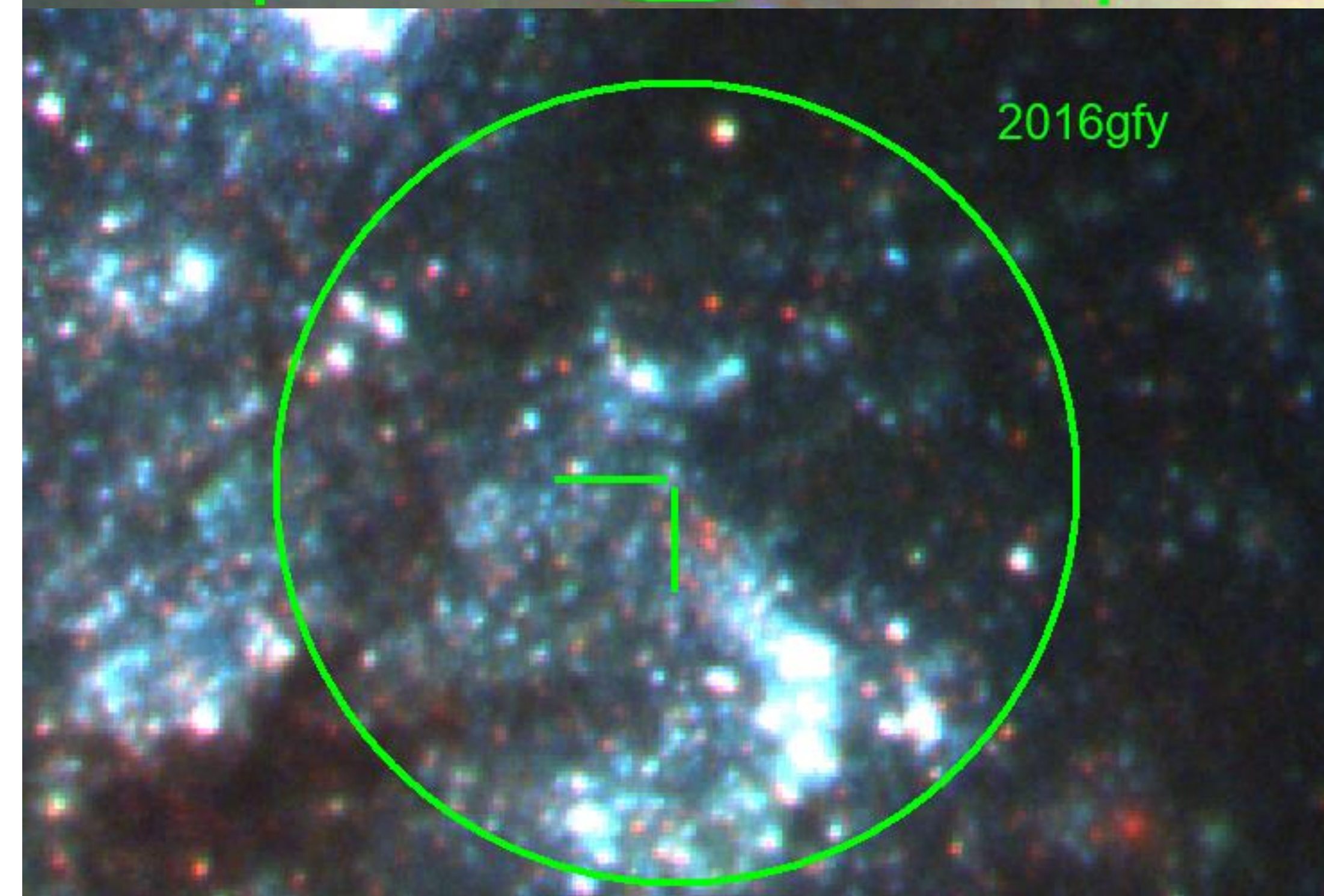
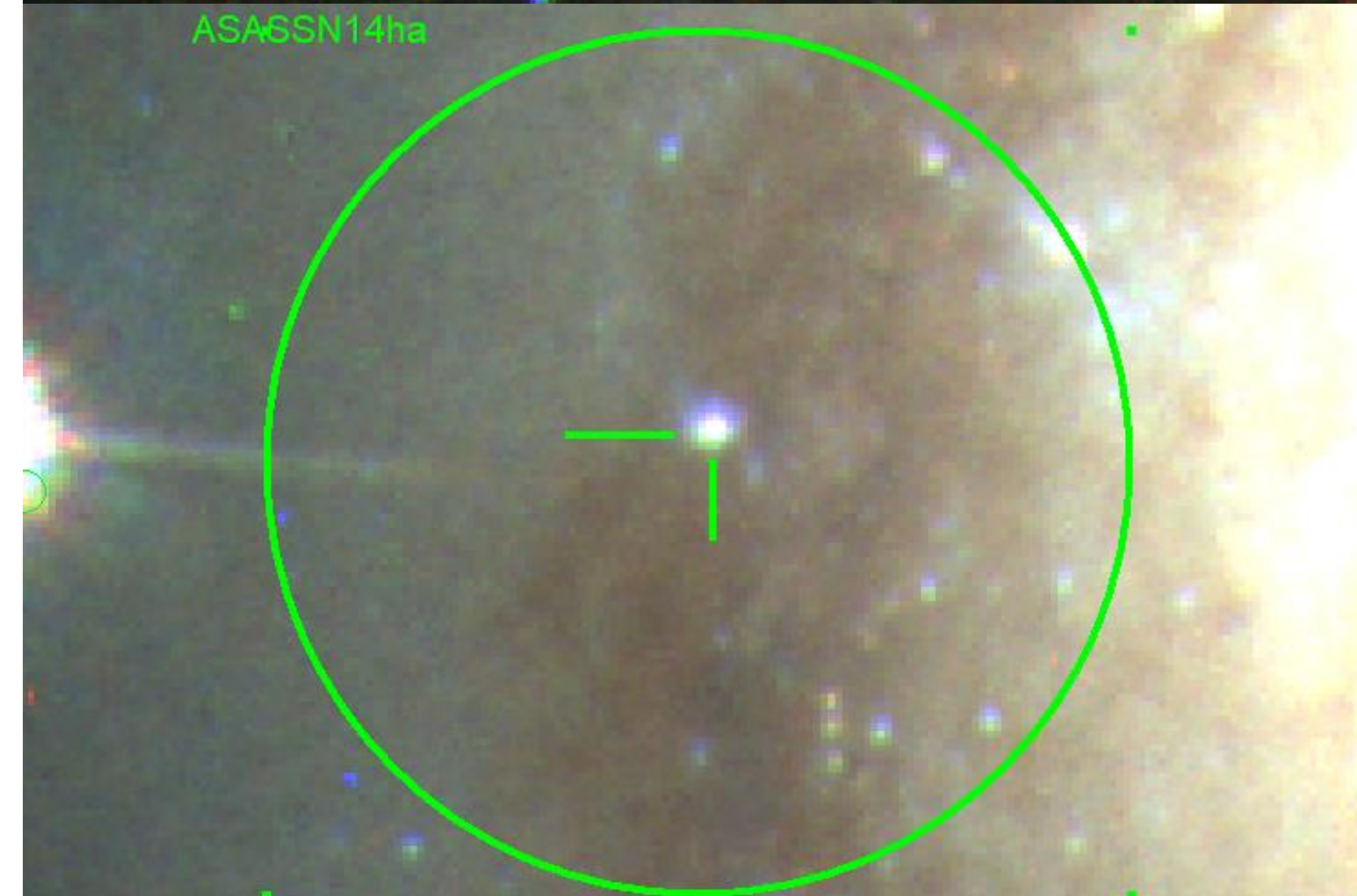
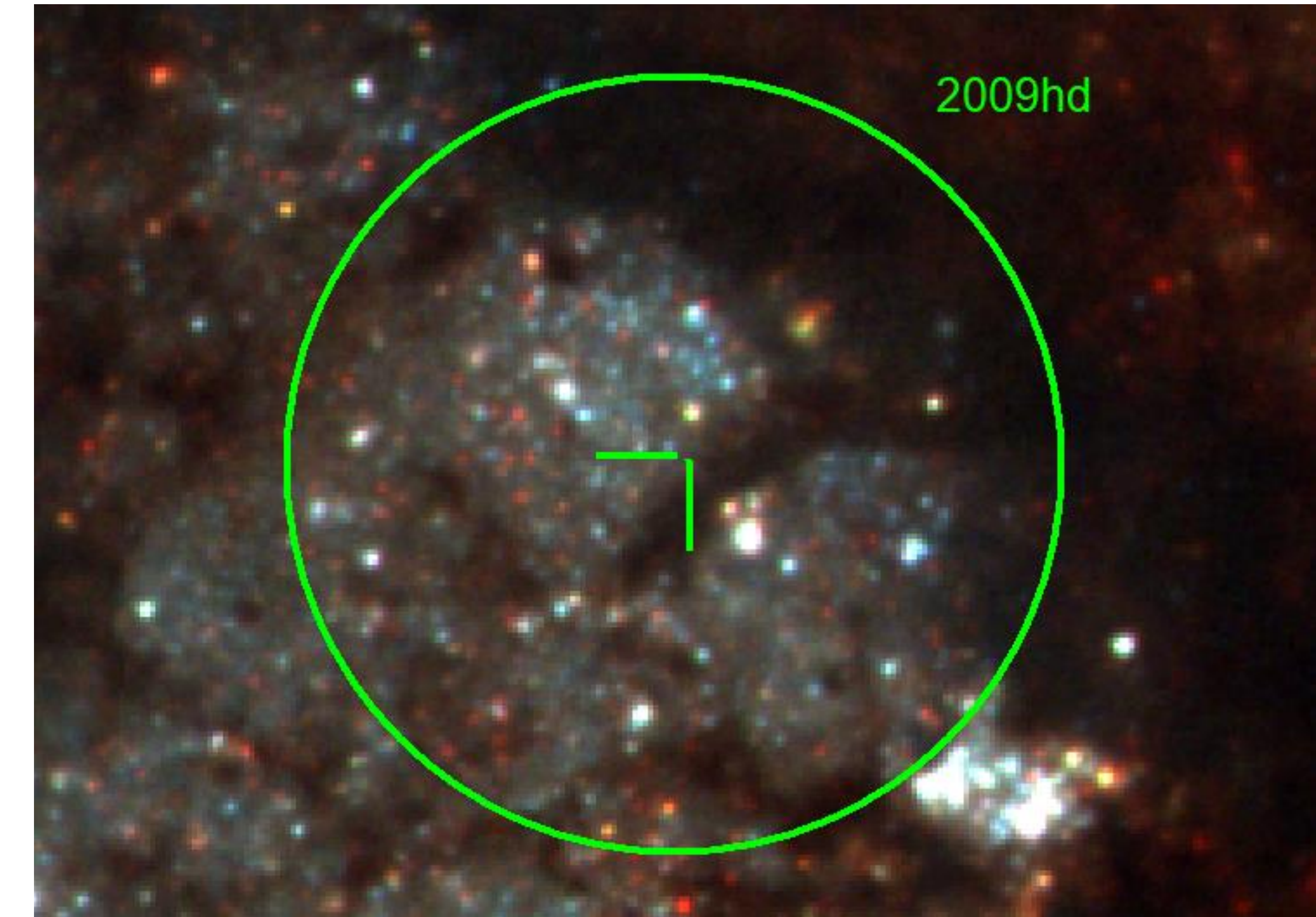
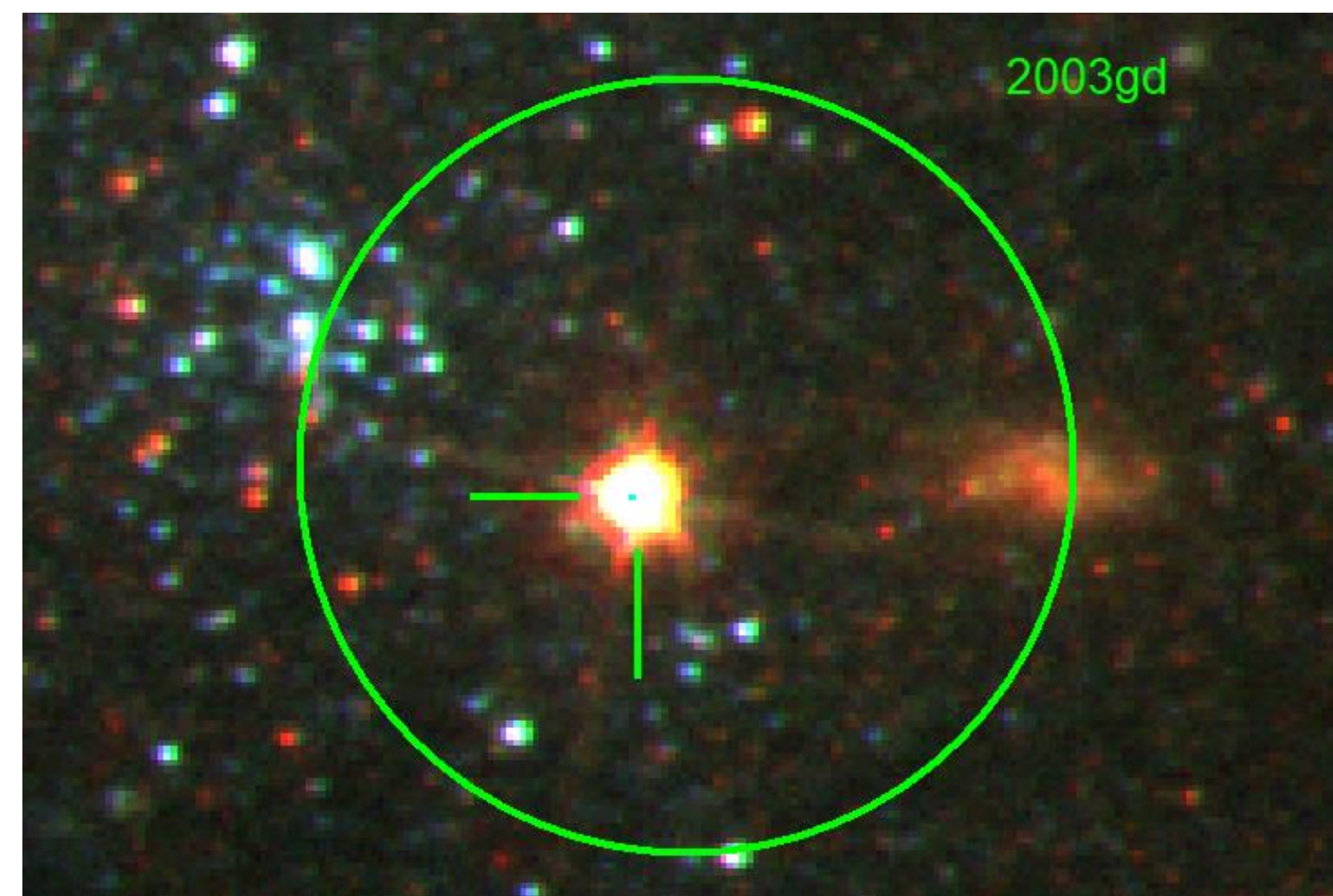
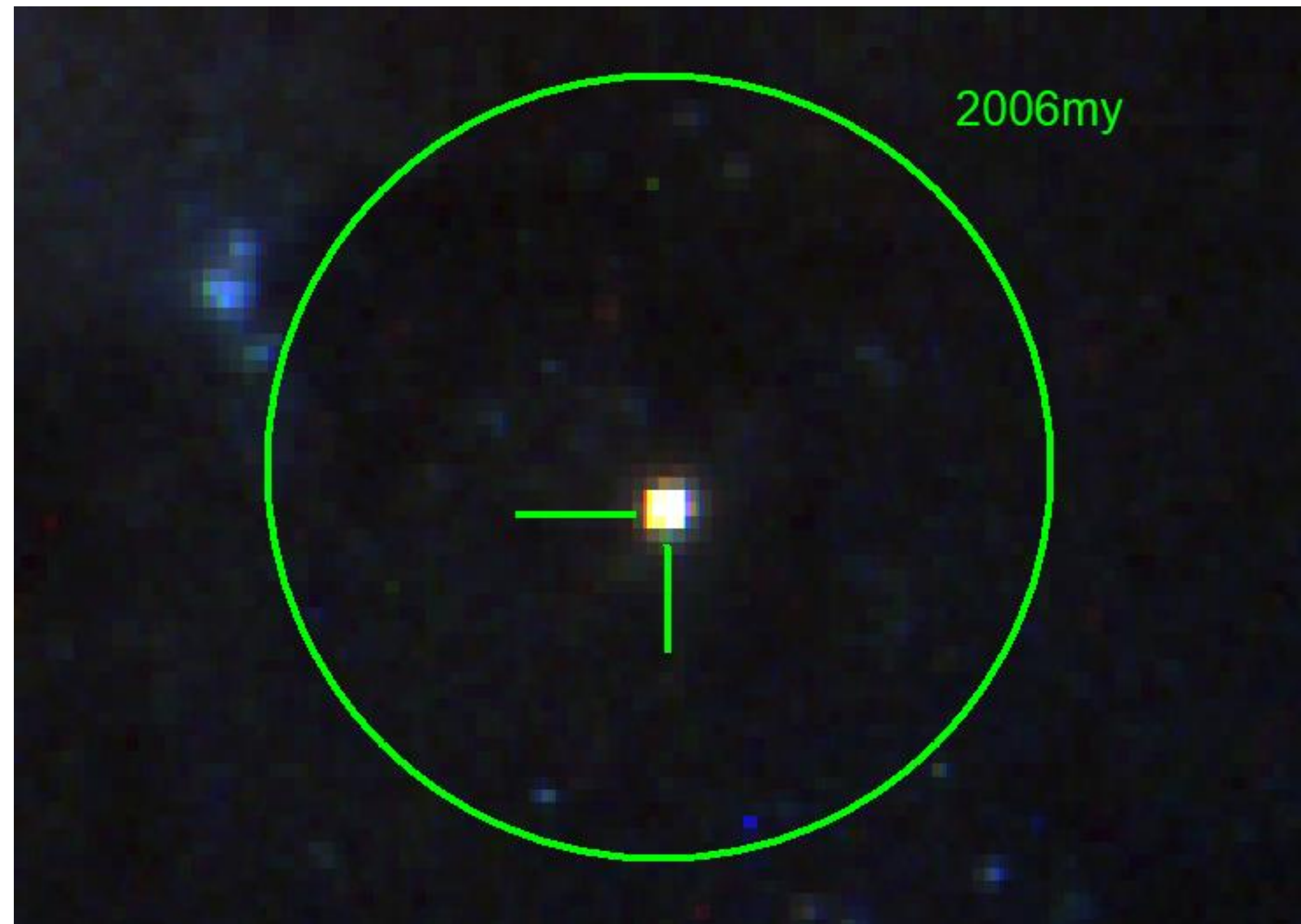
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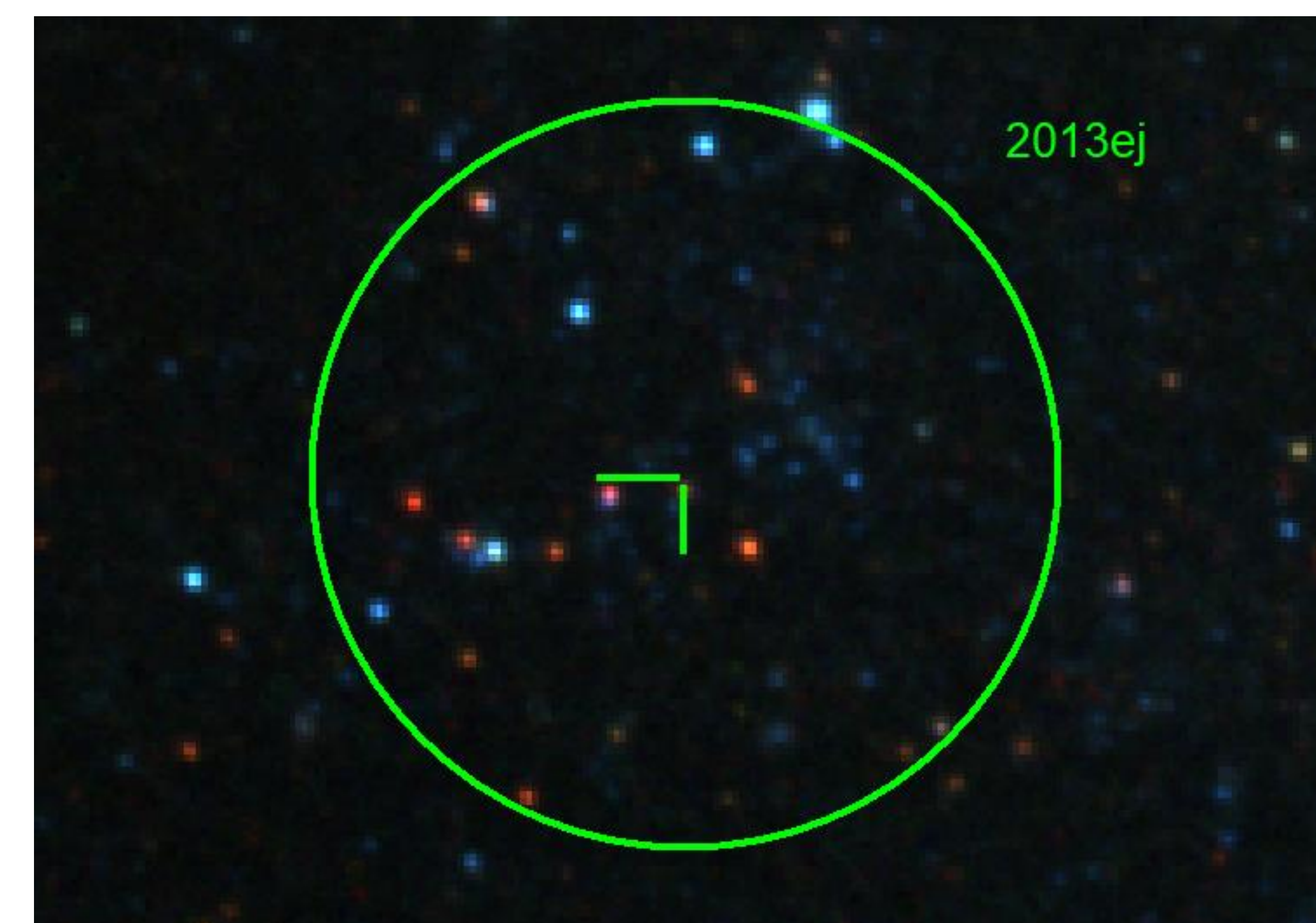
BACKGROUND

Hydrogen-rich (Type II-P and II-L) supernovae are thought to originate from single red supergiant stars. Recently, a problem known as the “red supergiant problem” has demonstrated that the mass distribution of red supergiants does not match the progenitor stars of these supernovae due to a lack of high-mass stars exploding as supernovae. One possible explanation is that higher mass stars evolve in binary systems and appear as lower mass stars when they explode due to close binary interactions. Here we perform a statistical analysis of Type II-P and II-L supernovae to measure the binary fraction of these systems.



RESULTS

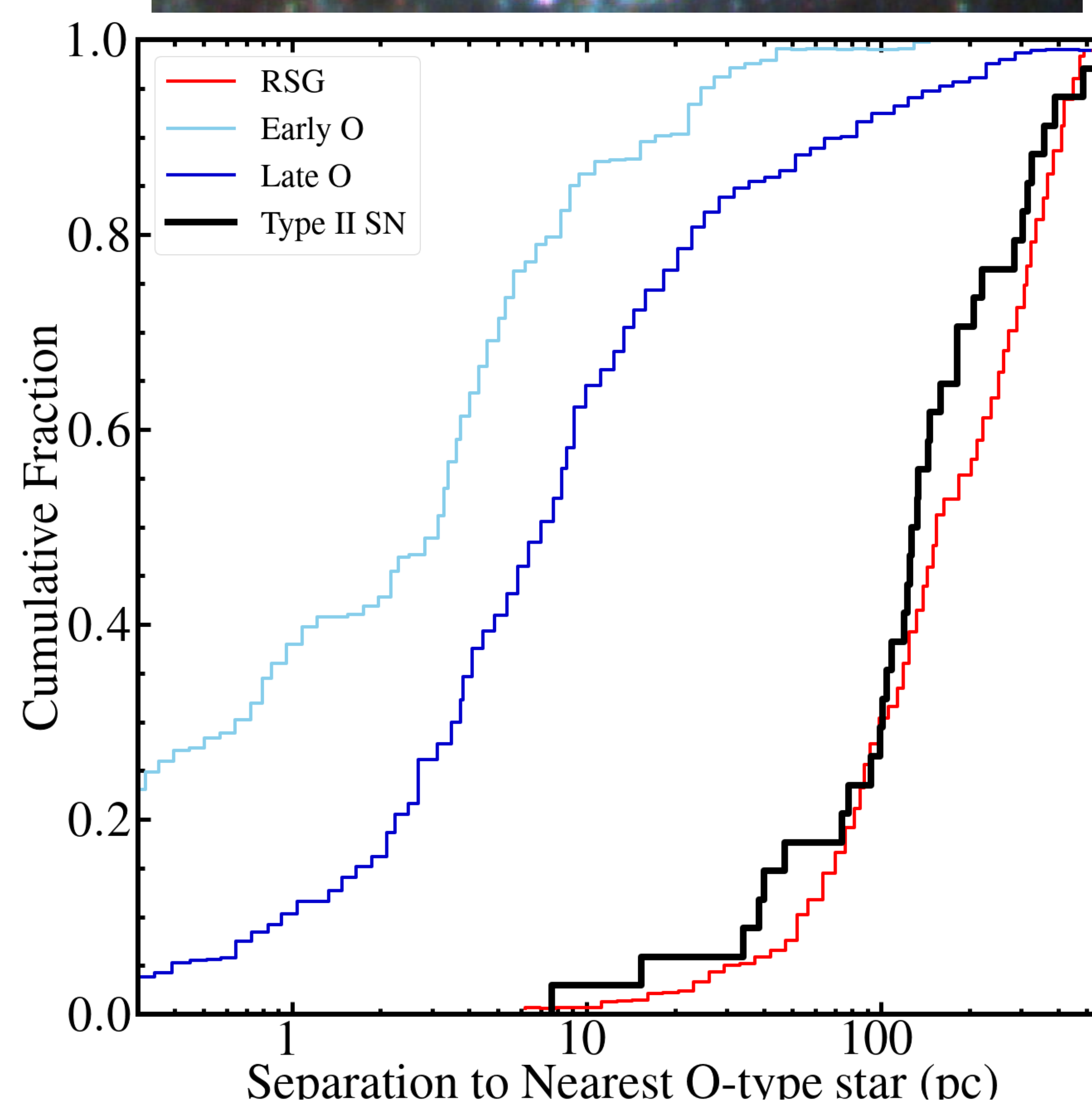
The analysis of the nearest O-type star to each Type II-P and II-L supernova reveals that binary stellar evolution has a minimal effect on the progenitors of Type II supernovae, if any at all. The overall distribution appears nearly identical to that of red supergiant stars



METHODS

In order to perform this statistical analysis, we need to find the nearest O-type star to the supernova, which is a proxy for the progenitor system's age and can be compared to the expected distribution for single stars.

- Using the `hst123.py` pipeline (Kilpatrick 2021), we downloaded, reduced and aligned all the Hubble Space telescope for supernovae within a 40 Mpc distance.
- In `SAOimageds9`, we checked the quality of the reduction of the images as well as make sure the images were properly aligned.
- Once the alignment of the images were confirmed, we analyzed the point sources in the images using source extractor (Bertin & Arnouts 1996). `SExtractor` allows us to extract photometric data from the point sources in the images.
- After obtaining this photometric data, we cross match the images in order to confirm whether an object in the image is a point source or an artifact due to noise or cosmic rays.
- After cross matching, we used the photometric data from `sExtractor` and compared them to the MIST models. By comparing our photometric data to the MIST models, we can classify the star.
- Using the nearest O-type star, we estimate the binary fraction of Type II SNe.



CONCLUSION

Although our results do not suggest that Type II supernovae are results of binary stellar evolution, there are other possibilities for these progenitors. These progenitors may be closer to O-type stars than red supergiants, implying they may come from a younger stellar population. This is counterintuitive models show that red supergiants with a mass of $M \gtrsim 18M_{\odot}$ result in failed supernovae and form black holes.

FUTURE WORK

We can also extend this statistical analysis to other types for supernovae. Although Type II-P and Type II-L supernovae may not be affected by binary stellar evolution, other supernovae may be. We can also perform a K-S test, for this and future analyses, to determine whether they are from this population for this analysis.

