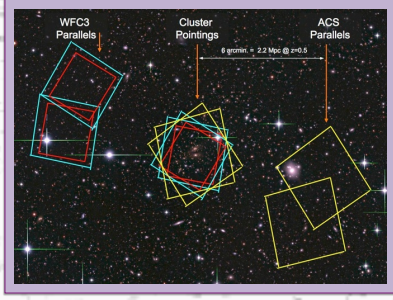
The Amateur Astronomer Supernova Detection Efficiency in CLASH

C. Li, J. Neustadt, E. H. Rogers, with O. Graur

ABSTRACT

As part of the Cluster Lensing And Supernova survey with Hubble (CLASH), we searched Hubble Space Telescope (HST) images for planted fake supernovae (SNe) to compare our detection efficiency (DE) as amateurs to that of a professional astronomer. We searched images obtained with the Wide Field Camera 3 (WFC3) on HST with the near-infrared filter F160W. The professional DE was generally higher than the amateur DE, especially fake Sne with apparent magnitude in the range $22.8 \leq m \leq 25.2$, but the amateur DE was higher for $25.2 \leq m \leq 25.8$. We also concluded that low-redshift SNe are easier to detect.

SNe Ia tend to have roughly the same peak luminosity, making them useful for measuring distances to galaxies, and therefore for calculating the expansion rate of the Universe. However, little is known about their progenitor star systems, which adds a systematic uncertainty to any distances measured with them.



CLASH observes 25 galaxy clusters with HST in order to study dark matter through weak and strong lensing. Simultaneously, CLASH conducts a SN survey of the area surrounding the galaxy cluster but distant enough so that galaxies are unaffected by weak lensing. While one of the two cameras used for CLASH, WFC3 or the Advanced Camera for Surveys (ACS), images the galaxy cluster in the primary field, the other camera images one of the surrounding (parallel) fields. Our research only involved data from WFC3 parallel fields.

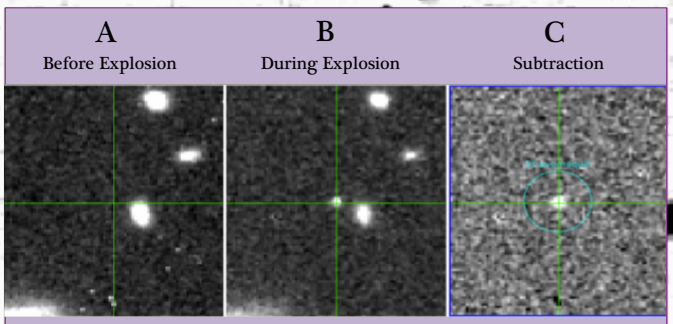


Figure 1. An area of the sky measuring 123 x 136 square arcseconds is imaged, then imaged again ~2 weeks later. The light of the earlier image (A) is subtracted from the light of the later image (B), and the new image (C) shows any differences between the two. Changes over such a short amount of time could indicate a SN. The background is one of the two WFC3 parallel fields of Abell 383.

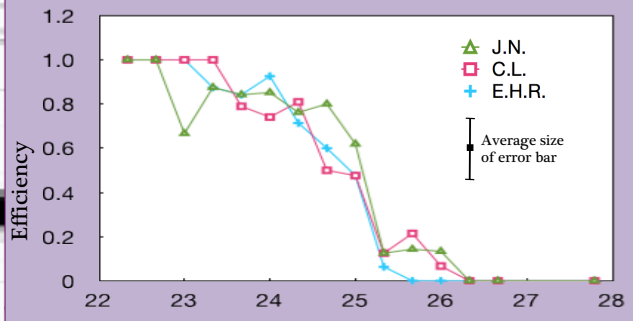


Figure 2. Fraction of fake SNe detected by amateurs J.N., C.L., and E.H.R. as a function of F160W apparent magnitude. The error bar in the legend represents the average size of the measurement uncertainty, which is approximated by a Poisson uncertainty, $\sqrt{(n)}/N$, where n is the number of fake SNe detected and N is the total number of fake SNe.

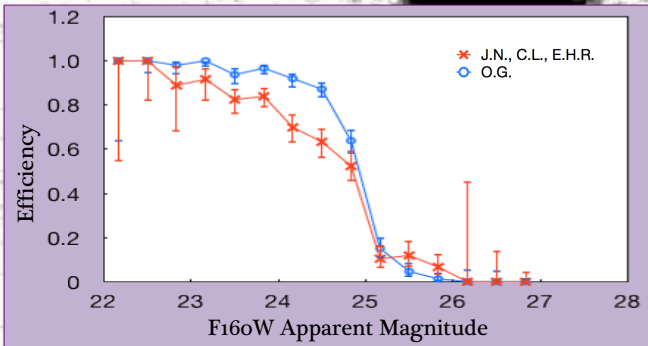


Figure 3. Combined amateur detection efficiency as a function of F160W apparent magnitude, plotted against that of a professional (O. G.). Error bars show the 68% binomial confidence region.

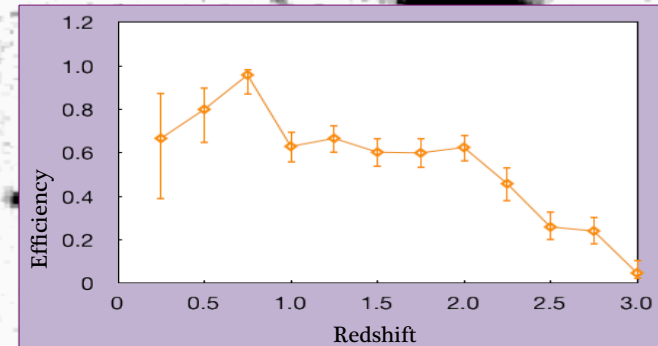


Figure 4. Fraction of fake SNe detected by the amateur group as a function of redshift. Error bars represent the 68% binomial confidence region.

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