Supernova rates in Abell galaxy clusters and implications for metallicity

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Abstract. Supernovae (SNe) play a critical role in the metal enrichment of the intra-cluster medium (ICM) in galaxy clusters. Not only are SNe the main source for metals, but they may also supply the energy to eject enriched gas from galaxies by winds. However, measurements of SN rates in galaxy clusters have not been published to date. We have initiated a program to find SNe in 163 medium-redshift ($0.06 < z < 0.2$) Abell clusters, using the Wise Observatory 1m telescope. Our program has already discovered 11 spectroscopically confirmed SNe at $z = 0.1 - 0.24$, and several unconfirmed SNe. We present the main scientific goals of this project, and discuss a novel explanation for the centrally enhanced metal abundances indicated by X-ray observations of galaxy clusters, based on the contribution of intergalactic SNe.

1 Scientific goals

Our main scientific goal is to derive SN rates as a function of various parameters such as host galaxy type and cluster environment: position within the cluster, cluster richness and cluster vs. field. SN rates can then be used to determine the current and past star formation rates in galaxy clusters [8]. Our measured SN rates can replace the assumed rates used so far in studies of metal abundances in the intracluster gas. We also intend to study the rate, distribution and properties of intergalactic SNe in galaxy clusters. We have already discovered one candidate, SN 1998fc (See fig. 1).

Our search is also sensitive to other optical transients, such as AGNs in the clusters and behind them, flares from tidal disruption of stars by dormant massive black holes in galactic nuclei and GRB afterglows. We may also detect the gravitational lensing effect of the clusters on background SNe.

2 Intergalactic SNe and metal abundances in clusters

The existence of a diffuse population of intergalactic stars is supported by a growing body of observational evidence such as intergalactic planetary nebulae in the Fornax and Virgo clusters [1], and intergalactic red giant stars in Virgo [5]. Recent

Figure 1: The Ia SN 1998fc was detected 78 Kpc from the cD galaxy of Abell 403, at the cluster redshift [6]. This may be an intergalactic SN whose progenitor star was a member of the diffuse intergalactic stellar population. Alternatively, the host may be a faint dwarf galaxy. This question could be resolved with larger number statistics of such events.

imaging of the Coma cluster reveals low surface brightness emission from a diffuse population of stars [7], the origin of which is attributed to galaxy disruption [2]. Since type Ia SNe are known to occur in all environments, there is no obvious reason to assume that such events do not happen within the intergalactic stellar population. SN 1998fc may well be such an event. The intergalactic stellar population is centrally distributed [3]. Therefore, metals produced by intergalactic Ia SNe can provide an elegant explanation for the central enhancement of metal abundances with type Ia characteristics, recently detected in galaxy clusters [4].

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