# Central abundance ratios in the Perseus cluster: not resonant scattering but SN Ia enrichment

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## 1. Introduction

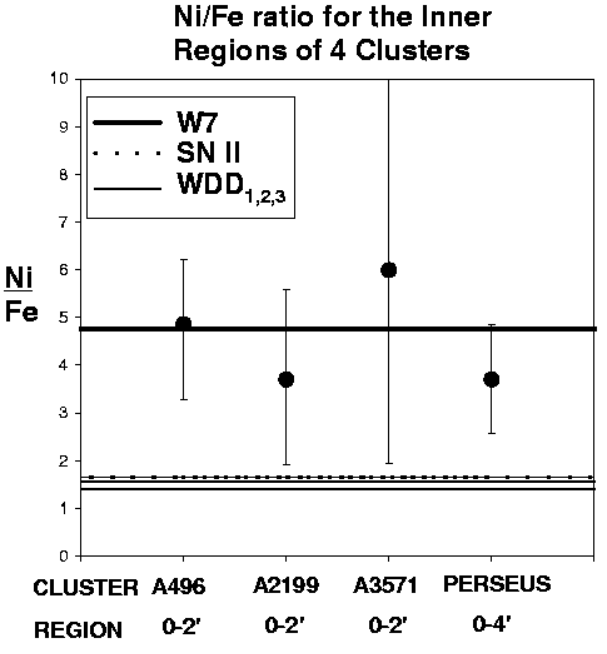
The measurements of abundances of iron and other elements are key data used in constraining models of the formation and evolution of the ICM. An important assumption in determining abundances is that the plasma is optically thin. However, resonance scattering in the Fe K$\alpha$ line could be significant in the cores of clusters (Gilfanov et al. 1987). The simplest test for resonant scattering in the Fe K$\alpha$ line is to compare the line flux with that from the Fe K$\beta$ line. If the Fe K$\beta$/Fe K$\alpha$ ratio is anomalously high then resonant scattering must be taken into account. Such anomalous ratios have been observed in data on several clusters using *ASCA* (Akimoto et al. 1997) and of the Perseus cluster using *BeppoSAX* (Molendi et al. 1998). Molendi et al. show that the Fe K$\beta$/Fe K$\alpha$ ratio is high for the inner 6 arcmin of the Perseus cluster and outside that radius decreases to the expected value for an optically thin plasma. However, the Fe K$\beta$ line is confused with the Ni K$\alpha$ line so a measurement of the Fe K$\beta$/Fe K$\alpha$ ratio requires assuming a flux in the Ni K$\alpha$ line. The results reported above assumed that the ratio of the Ni and Fe abundances is similar to the Solar value.

## 2. Results

We extracted spectra from an inner 4′ radius region of the Perseus cluster and used them to derive abundances. The central region was modelled using an isothermal component plus a cooling flow with intrinsic absorption. We used the measured abundances for the center of the Perseus cluster to estimate the fraction of Fe that originated in SN Ia. We adopted SN Ia and SN II yields from Nomoto et al. (1997a,b). We found that the Ni/Fe abundance ratio is consistent with a combination of SN II and fast flame-speed SN Ia (W7) but is inconsistent with either pure SN II or a combination of SN II and delayed detonation SN Ia (WDD). Assuming that the fast flame-speed model is correct for SN Ia we derived for each abundance ratio the mass fraction of Fe from SN Ia. All the abundance ratios are consistent with a mass fraction of $\sim 70\%$.

## 3. Conclusions

The central region of the Perseus cluster is significantly enriched with ejecta from SN Ia, which produce more than half ($\sim 65\%$) of the total iron. The observed Ni/Fe ratio is consistent with the observed ratios of other elements involving Fe, Si, Ni, and O. The Ni/Fe ratio observed is $\sim 3.7 \pm 1.1$. The Ni/Fe ratio agrees with the theoretically predicted values for SN Ia models with fast flame propagation (W7) but not with delayed detonation explosion models. This is in agreement with the results from three other clusters (Dupke & White (1999a,b); see figure). It is not necessary to invoke resonant scattering in the Fe K$\alpha$ line since the high (Fe K$\beta$+Ni K$\alpha$)/Fe K$\alpha$ ratio can be totally attributed to a high ICM contamination from SN Ia ejecta.

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