Abstract
Spiral-shaped regions of enhanced ICM surface brightness are found in some of the most relaxed systems in the Universe (e.g. A 2029). The formation of such spirals is attributed to the sloshing of a dense cool core (CC) about the bottom of the cluster’s gravitational potential well. The process is initiated by an off-axis encounter with a subcluster and is found to leave the CC fairly intact. The recent identification of cluster-wide spirals in non-cool core (NCC) clusters (A1763, A2142), however, suggests that more violent off-axis mergers may be capable of inducing core sloshing to the point of CC destruction. To further investigate this phenomenon we have analyzed a sample of systems with intermediate-to-high core entropy ($K_0 > 50$ keV cm$^2$) which do not appear to be undergoing major head-on mergers. We find numerous instances of what may be considered “ghost spirals” at the centers of the clusters, likely to have formed in conjunction with CC destruction. Such findings expand our understanding of the dynamical path to NCC formation and suggest that off-axis mergers play a greater role in establishing the CC-NCC cluster dichotomy than previously assumed.

Motivation: Gas Sloshing Spiral in Remnant Cool Core Cluster Abell 1763
A recent study of the $z$=0.23 galaxy cluster Abell 1763 (Douglass et al. submitted) revealed the presence of a large cluster-wide spiral of excess ICM emission. In contrast to the spiral formation paradigm (Markevitch & Vikhlinin 2007), Abell 1763 lacks a CC, with regions of lowest entropy in the core determined to be $K^0 = 90$ keV cm$^2$ (associated with the apex of the spiral). The absence of lower-entropy gas in a core which hosts a large ICM spiral suggests the CC was destroyed throughout spiral formation process. A similar scenario has been observed in Abell 2142 (Rossetti et al. 2013) where the phenomenon is attributed to “extreme sloshing”. Additionally, certain runs of the cluster merger simulations of ZuHone et al. (2011), show cluster-wide spirals forming in conjunction with CC-destruction. These runs are characterized by infall of a gaseous subcluster with a large initial impact parameter (1 Mpc), high initial transverse velocity (1000 km s$^{-1}$), and an intermediate mass ratio (3 : 1).

The Study
Motivated by the findings described above we have commenced a study to investigate the phenomenon of CC destruction through off-axis, slosh-inducing infall of gaseous subclusters. We have identified clusters within the ACCEPT sample of Cavagnolo et al. (2009) which had measured core entropies of $K^0 > 50$ keV cm$^2$, restricting our initial search to clusters where $L_\text{bol} > 10^{48}$ ergs s$^{-1}$. Only those clusters that displayed symmetric ICM distributions were chosen for analysis in an effort to exclude systems which may be undergoing a head-on major merger.

We present here five clusters with core entropies greater than 50 keV cm$^2$ which we found to host cluster-wide spirals. For reference we have included a sixth cluster with an intact, low-entropy CC (bottom-right). The six clusters span the redshift range of $0.20 < z < 0.38$. This initial sample can be considered a first-look and was not constructed to be statistically significant. What it does show, however, is that the dynamical transition of a cluster from CC to NCC may not be exclusively relegated to head-on major mergers. Images of residual emission were created by subtracting a 2D B-model of smooth elliptical emission which had been fitted to the data in Sherpa.