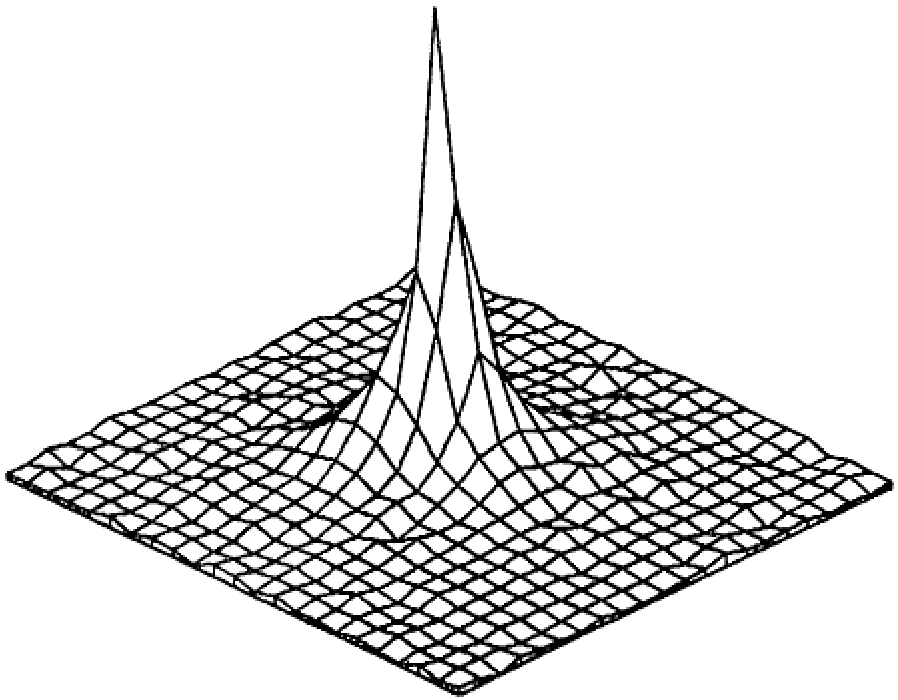
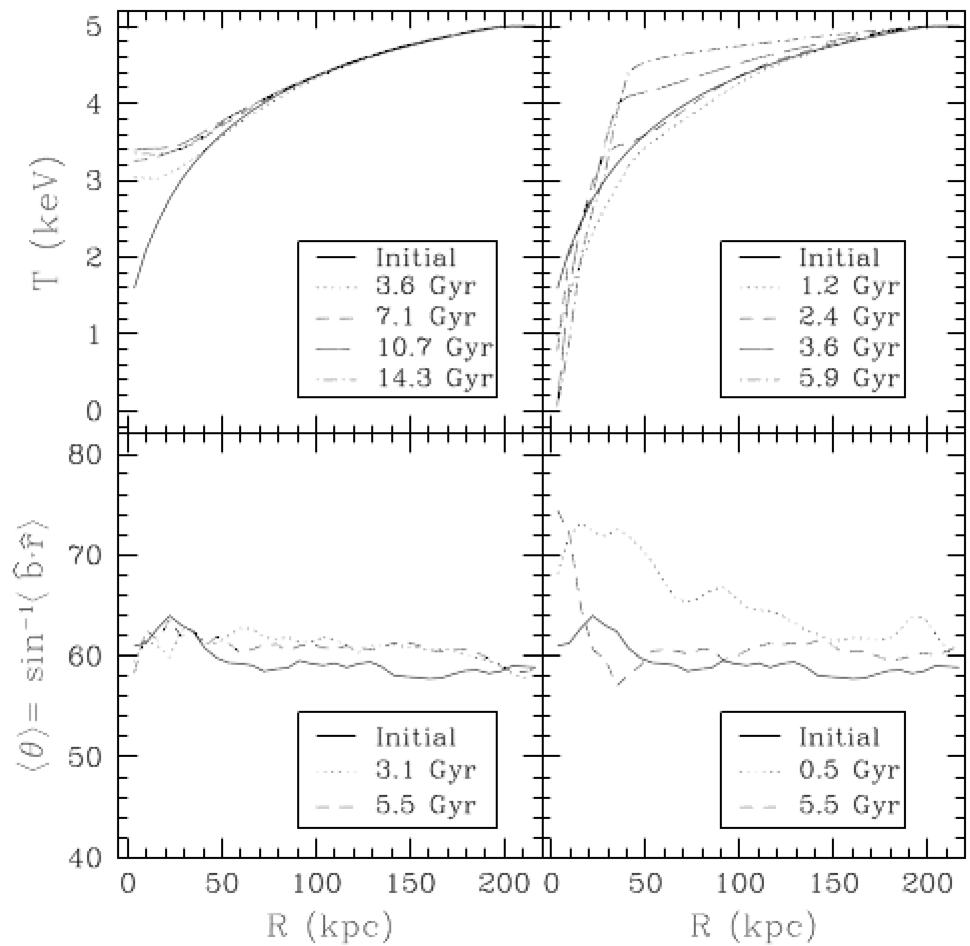


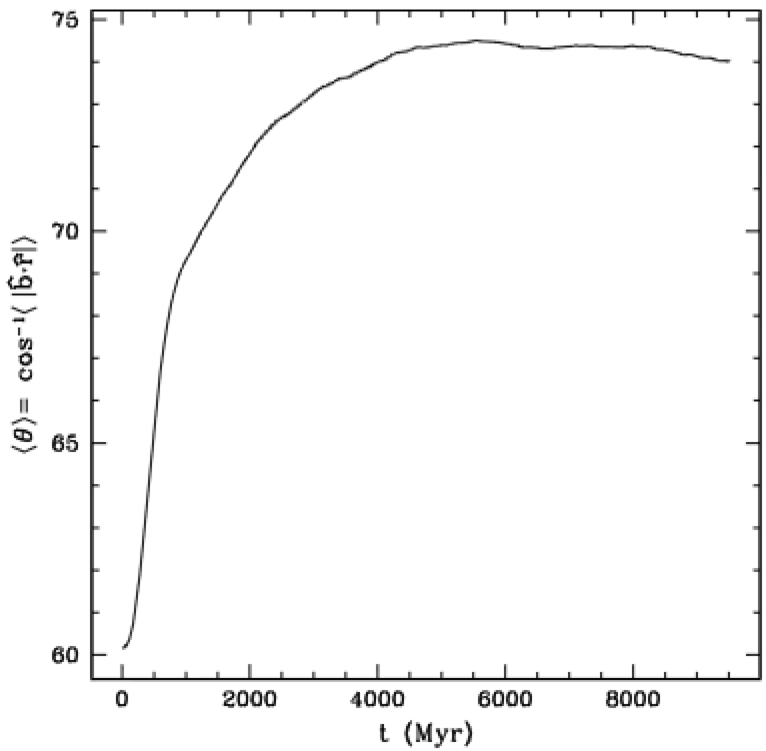
3-dimensional representation of the X-ray surface brightness of the A478 cluster as seen by the *ROSAT* HRI (White et al 1994). The pixel size is 24 arcsec which corresponds to about 60 kpc. The cooling flow extends to at least 200 kpc radius, incorporating most of the prominent peak in the figure. Much of the cluster emission lies beyond the 1.3×1.3 Mpc area shown here.

The X-ray luminosity within the cooling central regions can reach 10^45 erg/s. The resulted cooling time scale is usually shorter than 10^9 yrs. The gas temperature drops rapidly to 10^4 K, so that the cooled gas condenses onto the central galaxy. This mass deposition, however, is largely overestimated by the current cooling flow model, using the observed luminosity. This suggests a heating process is needed to replenish the cooling of the cluster cores. AGN feedback and thermal conduction are two of the most often discussed mechanisms. Left shows the detected X-ray surface brightness of the A478, as in the review paper by Fabian. AC, published in 1994.

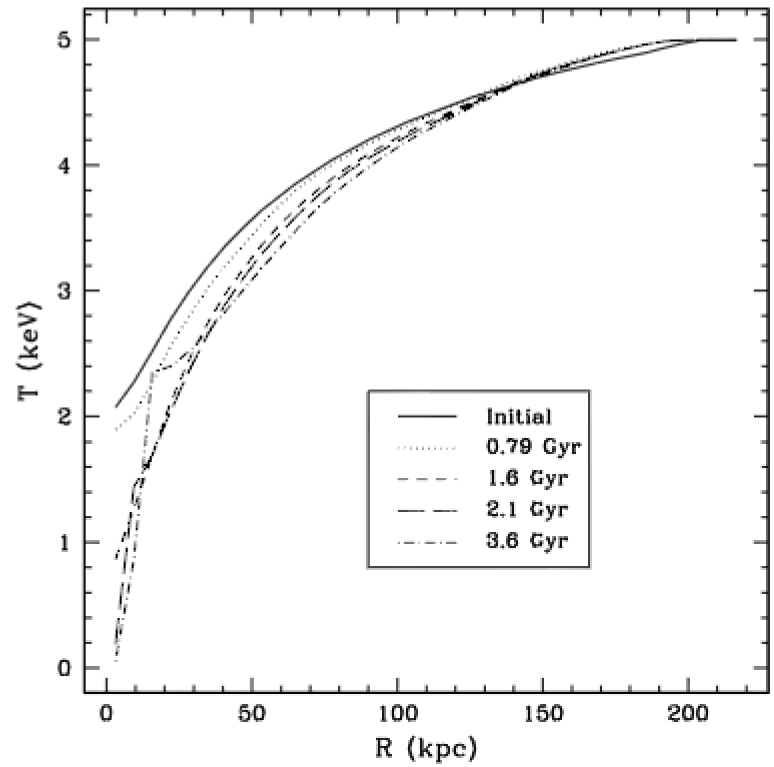
The heat conduction is regulated by the magnetic field especially when the electron gyroradius is much smaller comparing to the electron mean free path, where the thermal conduction only happens along field lines. The instabilities driven by this anisotropic property of thermal transport exist both at the outer regions and the central regions of the galaxy clusters. The former has a temperature gradient decreasing with radius, resulting in the magneto-thermal instability (MTI), the latter, with dT/dr>0, results in the heat buoyancy instability (HBI). The development of HBI is crucial to the understanding of the thermal conduction at the central regions of the galaxy, since the HBI usually results in a strong rearrangement of the magnetic field lines, which prevents the heat from flowing into the cluster core.



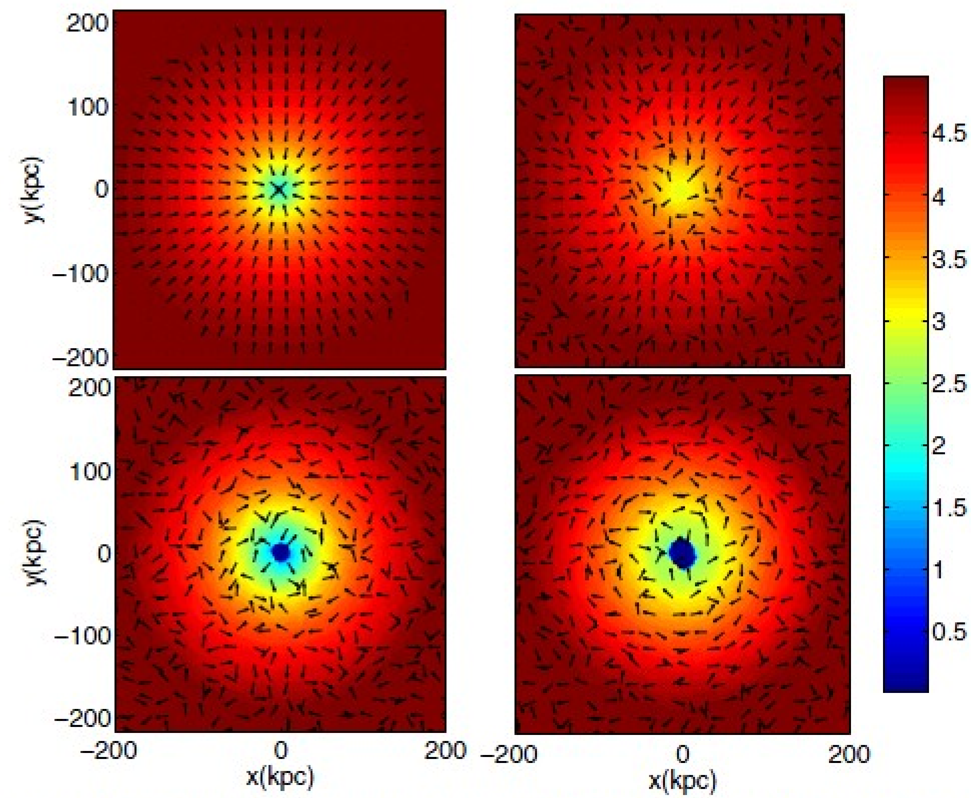
Azimuthally-averaged profiles for simulations with imposed turbulence having the same $\delta v \simeq 112\,\mathrm{km\ s^{-1}}$, but different correlation lengths. Run A (*left*) has $L = 40$ kpc, while run B (*right*) has $L = 100$ kpc (see Table 1) *Top:* Temperature profiles. *Bottom:* Magnetic field angle relative to the radial: 60° corresponds an isotropically tangled magnetic field and an effective radial conductivity $\sim 1/3$ Spitzer. Run A (*left*), with the shorter turbulent mixing time, reaches a stable state averting the cooling catastrophe. In Run B (*right*), the HBI persists, shutting off conduction and initiating a cooling catastrophe.



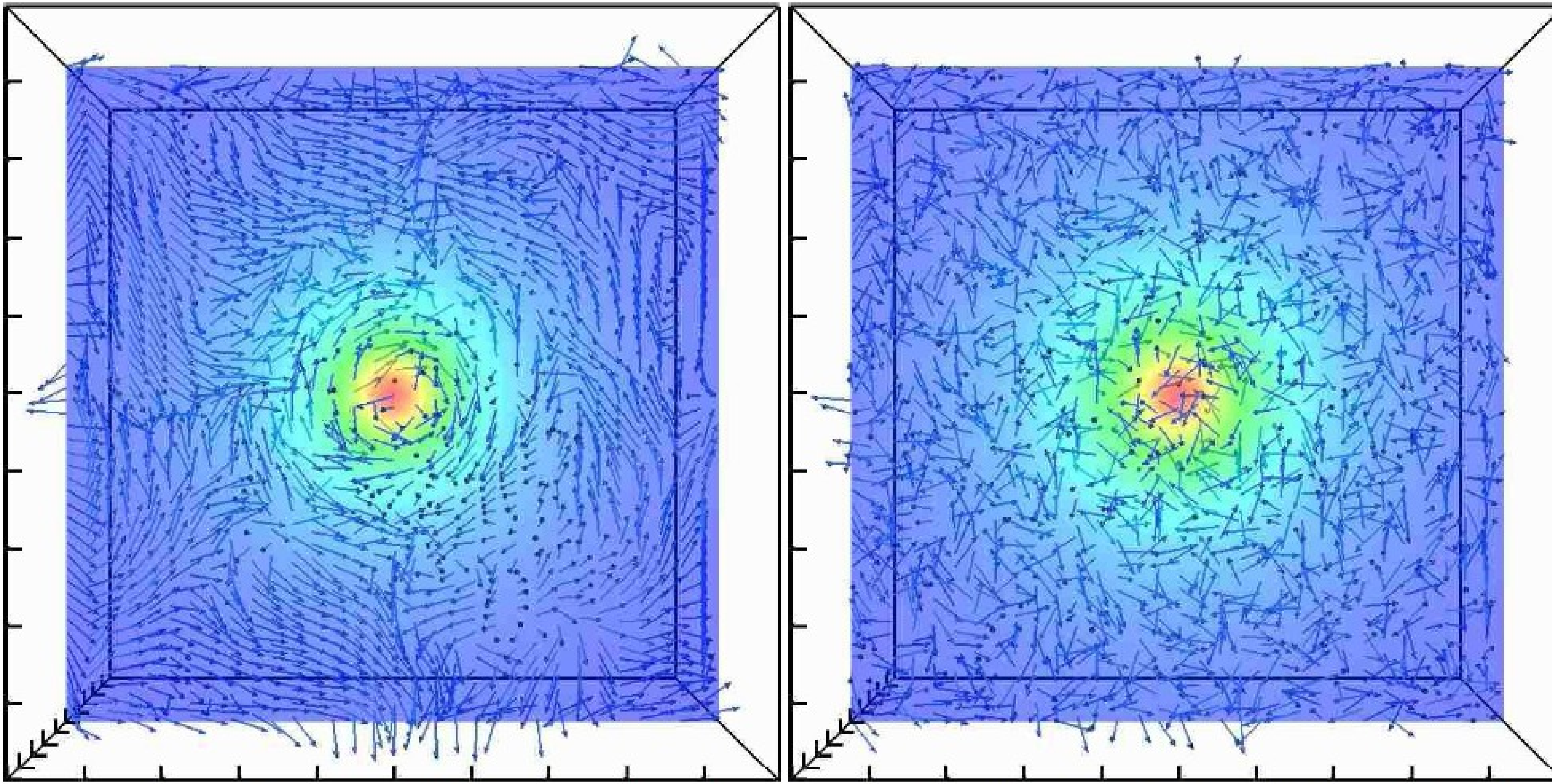
Evolution of the volume-averaged angle of the magnetic field with respect to the radial direction in run T1. $\theta = 0^{\circ}$ is radial. $\theta = 60^{\circ}$ corresponds to a random magnetic field. The magnetic field becomes significantly more azimuthal due to the HBI.



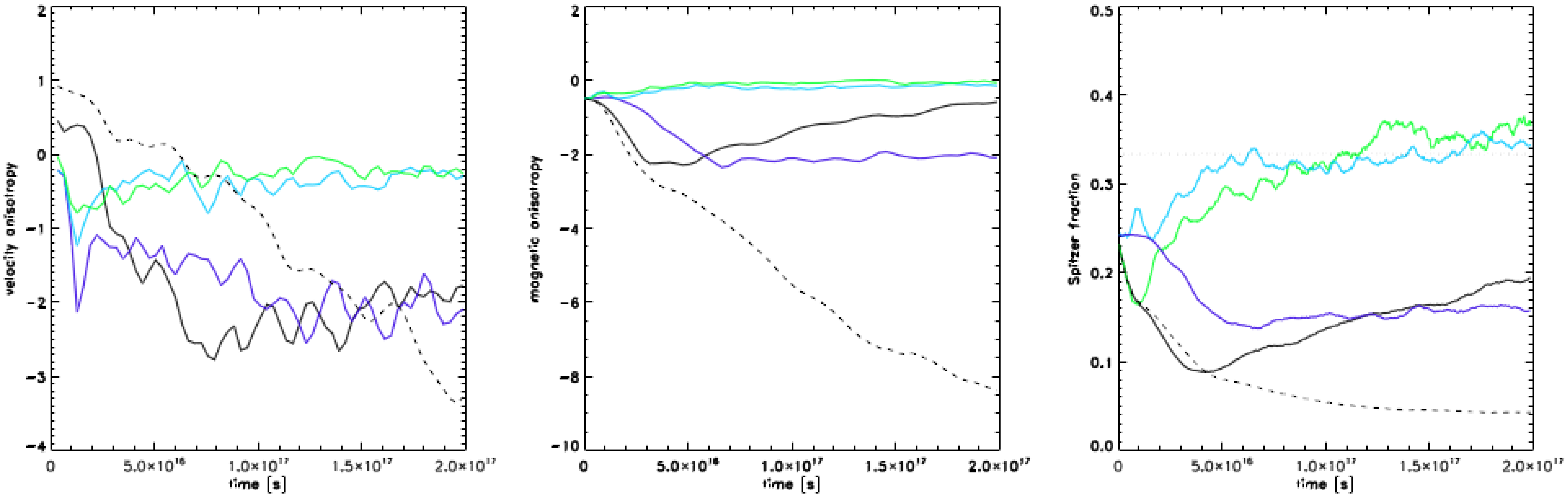
Azimuthally averaged radial temperature profiles in run T1. The HBI effectively shuts off conduction leading to the cooling catastrophe that occurs around 2.7 Gyr. The temperature is fixed at 5 keV beyond 200 kpc.



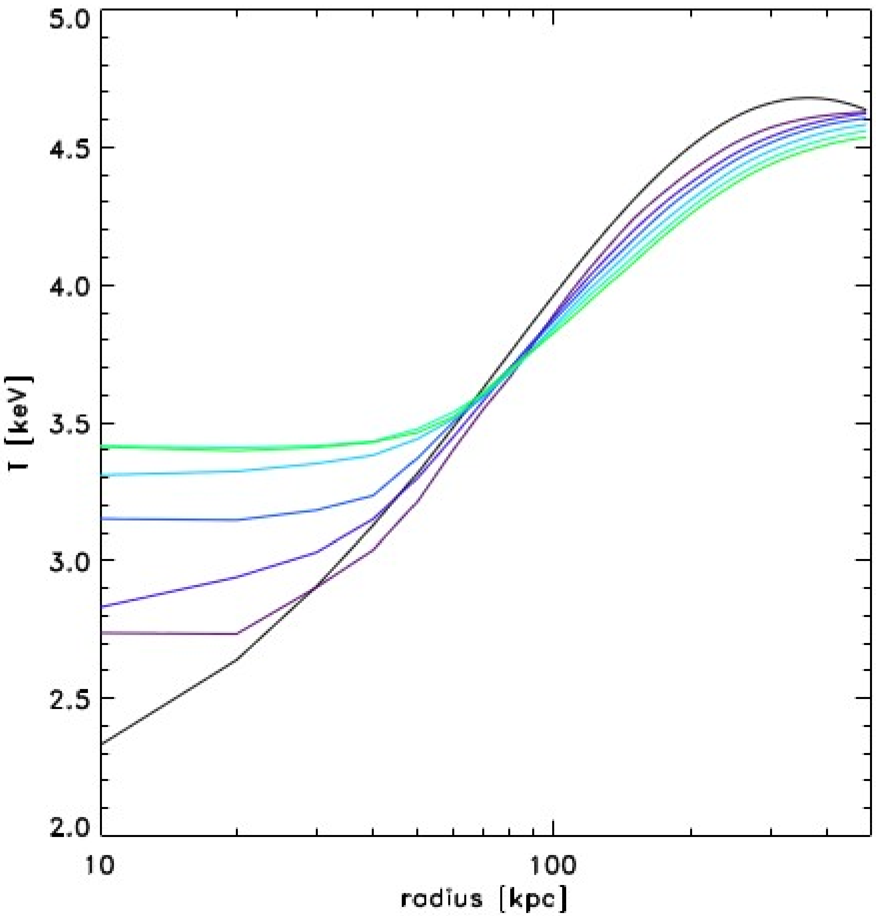
Color scale shows the temperature in keV and the arrows represent the magnetic field unit vector in the x–y plane for run R1 with an initially radial field. The plots are at $t = 0$, 1.6, 4.8, and 9.5 Gyr (from left to right and top to bottom). As the magnetic field becomes more azimuthally wrapped, the cluster core reaches the cooling floor.



Topology of the magnetic field (vectors) with superimposed gas density distribution (color background). The results are shown in the plane intersecting the cluster center. The images are ~1 Mpc on a side. Left panel corresponds to the end state of the simulation with anisotropic conduction and the right panel to the simulation involving both the anisotropic conduction and very weak subsonic turbulence.



The evolution of velocity field anisotropy (left panel), magnetic field anisotropy (middle panel) and the effective thermal conduction as a fraction of the mean Spitzer-Braginskii conduction, all averaged within the central 100 kpc. Dashed lines correspond to the unbridled HBI instability. Solid black and purple lines are for weak turbulence with and without thermal conduction, respectively. Green and blue lines correspond to stronger turbulence with and without thermal conduction, respectively. See text for more details.



Time sequence of temperature profiles for strong stirring with both thermal conduction and radiative cooling. The black curve denotes the initial state, whilst other curves are plotted every ~ 1 Gyr. Unlike the HBI case, no cooling catastrophe develops.