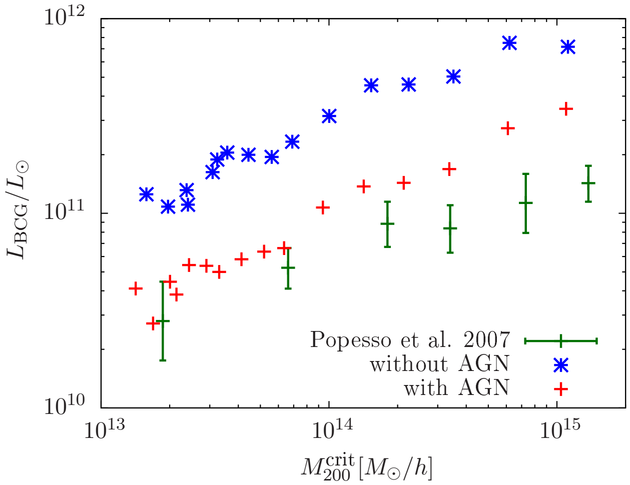

Figure 8. r-band BCG luminosity as a function of cluster mass $M_{200}^{\rm crit}$. Results are shown for runs with and without AGN feedback. *Method 1* (see Sect. 2.2) was used for finding the BCGs. Observational data (median BCG luminosities for six cluster mass bins) from Popesso et al. (2007) are shown for comparison. The AGN feedback significantly reduces the BCG luminosities and improves agreement with observations.

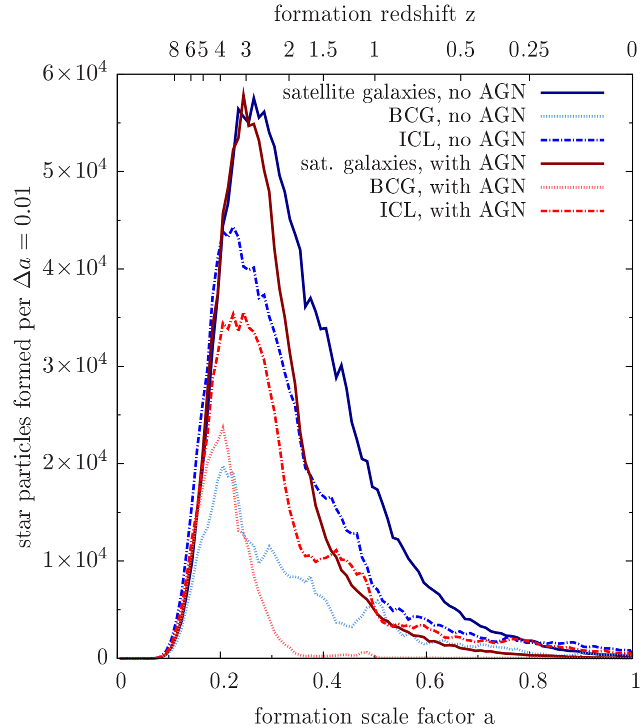

Figure 9. Distribution of the formation times of the stars in the satellite galaxies, the BCG, and the ICL of a $10^{14}\,h^{-1}M_\odot$ cluster. Results are shown for simulations with and without AGN feedback. *Method 4* was used for making a distinction between BCG and ICL. The simulations were performed at zoom factor 3 resolution (see Table 1).

is almost completely shut off at redshifts $z < 2$. It is also interesting that in the run with AGN the BCG stars form on average earlier than the stars in the satellite galaxies, which nicely agrees with the observed cosmic "down-sizing", where the mass of galaxies hosting star formation decreases with time (e.g. Cowie et al. 1996). At first, this observational finding is counterintuitive in a hierarchical structure formation scenario. However, using semi-analytic galaxy formation models, De Lucia et al. (2006) have shown that AGN feedback allows reproducing this behaviour in a ΛCDM cosmology where structure forms hierarchically. Our results indicate that the AGN feedback model in our cosmological hydrodynamical simulations operates in the same way.

We also investigated in what objects stars form that at $z = 0$ reside in a cluster's satellite galaxies, in the BCG, or the ICL. Fig. 10 shows the distribution of these stars according to the mass of the halo in which they have formed. Here, the halo mass is defined as the mass of the corresponding SUBFIND (sub-)halo. For the central galaxy of a halo this is roughly the same as $M_{200}^{\rm crit}$, but for satellite galaxies it corresponds to the smaller mass still bound within the gravitational tidal radius. The measured distributions are shown for a $M_{200}^{\rm crit} = 10^{14}\,h^{-1}M_\odot$ cluster and for runs with and without AGN.

Comparing the curves for the satellite galaxies, we can clearly see that AGN suppress star formation in halos larger than $\sim 5\times10^{10}\,h^{-1}M_\odot$. Note that for smaller halos we do not expect any difference, as in our simulations black holes are only seeded in halos that exceed this threshold mass (see Puchwein et al. 2008). This also means that in the runs with AGN the exact shape of the distribution at the low mass end will depend on the adopted threshold for the seeding.

The stars that end up in the BCG at $z = 0$ form in significantly more massive halos. This is not only due to star formation in the massive BCG itself, as for this cluster only $\sim 10\%$ and $\sim 30\%$ of the stars that reside in the BCG at $z = 0$ have formed in the BCG's main progenitor in runs with and without AGN, respectively. Instead, also the stars that are acquired during mergers with the BCG tend to be formed in more massive halos. This is not unexpected, however, since the most massive galaxies are most likely to merge with the BCG due to their shorter dynamical friction timescale. We shall return to this point in Sect. 3.3. Without AGN, there is a significant fraction of BCG stars that form in very massive halos, i.e. in halos with masses larger than $10^{13}\,h^{-1}M_\odot$. Indeed, many of these stars form in the cluster's main progenitor. On the other hand, in the run with AGN, star formation is almost completely shut off in the central galaxies of such massive halos, which again demonstrates that our model for AGN feedback can efficiently suppress strong cooling flows and excessive star formation in cluster cores.

The curves for the ICL peak at roughly the same halo mass as for the satellite galaxies. However, the halo mass distribution is somewhat broader. There is also a second peak at very high halo mass, which is mostly due to stars formed in the cluster's main progenitor. We find a similar peak for most of our simulated clusters, with a position that depends on the cluster's mass. The occurrence of this second peak is rather surprising, especially since it is also found in runs with AGN, in which there is basically no star formation in the BCG once the cluster is as massive as required by the position of the peak. This means that these stars are not formed in the BCG but somewhere else in the cluster's main halo.