Abstract

We have investigated properties of E and S0 galaxies in the central parts of the clusters HydraI (Abell 1060) and Coma (Abell 1656) using large magnitude limited samples. The investigations serve the following main purposes: (1) They add pieces to our knowledge about galaxy formation and evolution, including the formation and evolution of the stellar populations of the galaxies. (2) They help establish a good reference point at $z \approx 0$ needed for the similar studies of high redshift galaxies. (3) They help identify possible limitations in the use of the Fundamental Plane (FP) as a distance determinator.

Surface photometry and global photometric parameters are presented for 64 E and S0 galaxies in HydraI. The observations were made with the Danish 1.5 meter telescope at La Silla, equipped with the DFOSC instrument. Combined with data from the literature and data yet to be published, photometry and spectroscopy are available for 45 E and S0 galaxies in HydraI and 114 in Coma.

The FP in Gunn r is not significantly different for the HydraI and Coma samples, although differences in the $\log \sigma$ coefficient on the 10% level cannot be ruled out. For the combined sample, we find the FP to be $\log r_{\mathrm{e}} = 1.35 \log \sigma - 0.83 \log {<}I{>}_{\mathrm{e}} + \gamma$. The distribution within the FP is not significantly different for the two samples. The FP has an intrinsic scatter of 0.087 in $\log r_{\mathrm{e}}$. For the HydraI sample we find that the intrinsic scatter is not significantly different in Gunn r, Johnson B, and Johnson U. This implies that the scatter cannot be caused by variations in only the age or only the metallicity. Changes in the age must be balanced to some extent by changes in the metallicity. This is compatible with the age–metallicity–sigma relation that we find.

From the mass-to-light ratios and the line indices Mg_2 and $< \mathrm{Fe} >$, we have derived estimates of [Mg/H], [Fe/H], [Mg/Fe], and ages using stellar population models. The derived abundance ratio [Mg/Fe] increases with the velocity dispersion. This is mainly due to an increase in [Mg/H], with [Fe/H] being constant or slightly decreasing. For high velocity dispersion galaxies [Mg/Fe] is larger than solar and can reach values of 0.3 dex or more. This can be explained by an increase in the fraction of type II supernovae over type Ia supernovae with velocity dispersion. This could for example be caused by a variation in IMF slope or in the time scale for star formation. Both [Mg/H], [Fe/H], [Mg/Fe], and age show a much smaller scatter for galaxies brighter than $M_{\mathrm{r_T}} \approx -23\overset{\mathrm{m}}{.}1$ than for galaxies fainter than this magnitude. The galaxies are found to follow a tight age–metallicity–sigma relation, $[\mathrm{Mg/H}] = 1.15 \log \sigma - 0.78 \log \mathrm{age} + c$. This relation allows for a large variation in age and metallicity while still keeping the FP and the Mg_2–σ relation thin.

The FP residuals are strongly correlated with [Mg/H], [Fe/H], and age, but are not correlated with [Mg/Fe]. Therefore, age or metallicity differences can cause systematic errors in the distances determined by the FP. A weaker correlation with the local cluster density is also found.

For none of the relations studied do we find any significant differences between HydraI and Coma. This is despite the fact that Coma is 2–3 times more massive than HydraI and has a smaller fraction of spiral galaxies. This suggests that the environmental differences between rich and less rich clusters have only a small effect on the properties of the E and S0 galaxies found in clusters as rich as HydraI and Coma.