

Are Passive Spiral Galaxies truly “passive” and “spiral”? : a Near-Infrared perspective

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Passive spiral galaxies - unusual galaxies with spiral morphologies but without any sign of on-going star formation - have recently been shown to exist preferentially in cluster infalling regions. This discovery directly connects passive spiral galaxies to cluster galaxy evolution studies, such as the Butcher-Oemler effect or the morphology-density relation. Thus, detailed study of passive spiral galaxies could potentially yield new insight on the underlying physical mechanisms governing cluster galaxy evolution.

However, in previous work, passive spiral galaxies were selected from low-resolution optical images with ~ 1.5 arcsec seeing. Passive spirals could therefore be mis-identified as S0 galaxies, or as dusty-starburst galaxies which are not passive at all. To address this issue we performed deep, high-resolution, near-infrared imaging of 32 passive spiral galaxies with UKIRT.

We selected our target galaxies from 73 passive spiral galaxies presented by Goto et al. (2003). None of the 73 galaxies have any emission in [OII] or $H\alpha$ ($< 1\sigma$ in equivalent width) though all have a disc-like morphology. Of the 73 passive spiral galaxies, the 32 targets accessible during our run in September 2003 were observed in the K band using the UKIRT Fast Track Imager (UFTI). Data were taken during periods of good atmospheric transparency and with excellent seeing of ~ 0.5 arcsec. In Figure 1, we show K-band images of 16 of the 32 passive spiral galaxies.

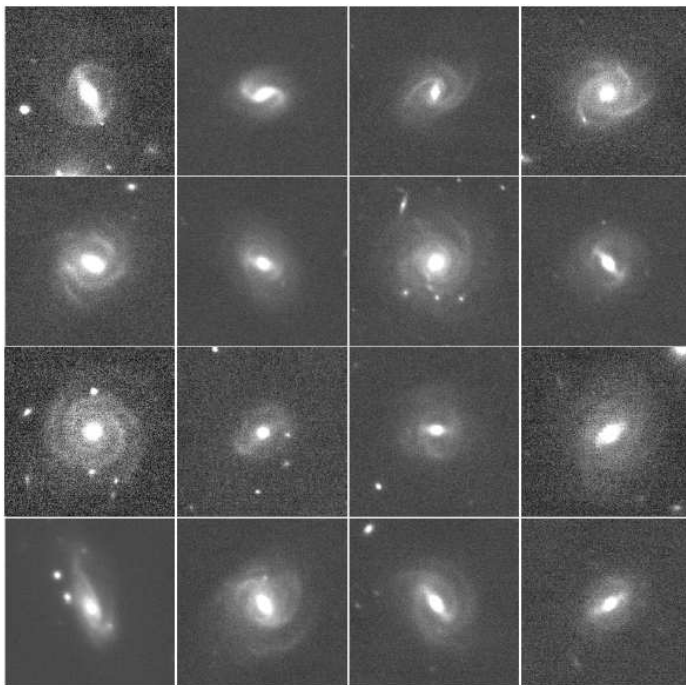


Figure 1: UKIRT K band images of passive spiral galaxies. Each image is 35x35 arcsec in size.

Although selected in poorer conditions, the deep and high resolution imaging capability of UKIRT clearly shows the discs and spiral arm structures. Thus, passive spiral galaxies are not S0s, but truly are spiral galaxies.

We used the restframe optical-infrared (r - K) colour distribution for the observed passive spiral galaxies to investigate whether they are dusty starburst galaxies or truly passive galaxies. Since the K band is less affected by dust extinction than the r band, dusty starburst galaxies are known to have redder colours in r - K by ~ 1 mag (Smail et al. 1999). Figure 2 plots g - i colour against r - K colour. Optical photometry (g , r , and i) is from the SDSS. The black circles are for passive spiral galaxies observed with UKIRT. The red squares are for early-type galaxies in the control sample. For a reference, we plot the distribution of all galaxies in the volume limited sample with K magnitudes measured with the Two Micron All Sky Survey (2MASS; Jarrett et al. 2000) as the contour.

Interestingly, compared with all galaxies (the contour), passive spiral galaxies (circles) are not redder in r - K colour. Indeed, the r - K colours of the passive spiral galaxies are indistinguishable from the early-type galaxies (squares). These results support the truly passive nature of these galaxies, since dusty starburst galaxies should have r - K colours redder by 1 magnitude than normal galaxies.

Thus, our results support the truly “passive” and “spiral” nature of these galaxies. It is very likely that passive spiral galaxies are indeed transition objects currently undergoing cluster galaxy evolution. Further studies of passive spiral galaxies will reveal the physical mechanisms governing cluster galaxy evolution.

References

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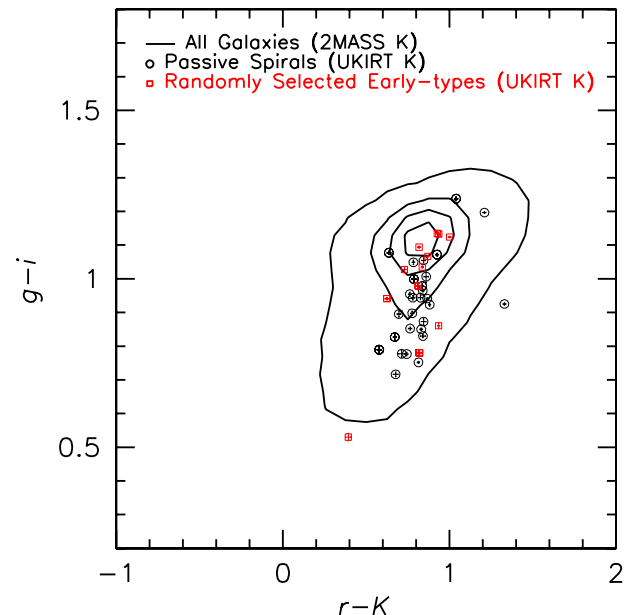


Figure 2: Restframe g - i vs. r - K two-colour diagram. The circles are for passive spirals. The squares are for the early-type galaxies in the control sample. The contours represent all galaxies in the volume limited sample with 2MASS K magnitudes.