The red sequence in proto-clusters associated with radio galaxies at $2 < z < 3$

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A proto-cluster at \( z = 2.16 \)

Subaru/MOIRCS  J 83m, Ks 55m, seeing 0.5”-0.7”
A proto-cluster at $z = 2.16$

Subaru/MOIRCS  J 83m, Ks 55m, seeing 0.5″-0.7″

PKS 1138-262
Four HzRGs fields

Subaru/Moircs (7’x4’) and NTT/SOFI (5’x5’)

<table>
<thead>
<tr>
<th>Targets</th>
<th>redshift</th>
<th>J  (min)</th>
<th>H  (min)</th>
<th>Ks (min)</th>
<th>PSF (arcsec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKS 1138-262</td>
<td>2.156</td>
<td>83</td>
<td></td>
<td>55</td>
<td>0.5~0.7</td>
</tr>
<tr>
<td>USS 1558-003</td>
<td>2.527</td>
<td>180</td>
<td></td>
<td>175</td>
<td>0.7</td>
</tr>
<tr>
<td>USS 0943-242</td>
<td>2.923</td>
<td>118</td>
<td>68</td>
<td>63</td>
<td>0.4~0.6</td>
</tr>
<tr>
<td>MRC 0316-257</td>
<td>3.130</td>
<td>78</td>
<td>60</td>
<td>55</td>
<td>0.6~0.7</td>
</tr>
</tbody>
</table>

J=23.5, H=22.3, K=22.0 (5 sigma, Vega)
DRG/JHK colour selection

Kajisawa et al. (2006)
Early-type galaxies at $z > 2$ have $J-K > 2.3$

Franx et al. 2003
DRG/JHK colour selection

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Using additional criterium $(J-K) > 2 (H-K) + 0.5$ only galaxies at $z < 3.1$

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Combined with $J-K > 1.5$, one gets also star-forming galaxies at $2.4 < z < 3.1$

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Kajisawa et al. (2006)
PKS 1138-262 (z = 2.16)  
USS 0943-242 (z = 2.92)

Statistical excess of 2~4 in comparison with GOODS-S
**Colour-magnitude diagram**

PKS 1138-262 (z = 2.16)  

Red sequence with massive \((10^{11} \, M_\odot)\) galaxies present, \(z_f \sim 4-5\)

Kodama et al. (2006)
Colour-magnitude diagram

**USS 1558-003 (z = 2.53)**

Red sequence with massive \((10^{11} \, M_\odot)\) galaxies present, \(z_f \sim 3.5\)
Colour-magnitude diagram

USS 0942-242 (z = 2.92)

Excess of red galaxies, $z_f > 4$, but no massive ($10^{11} M_\odot$) galaxies
No clear RS, but some red massive \((10^{11} \, M_\odot)\) galaxies present, \(z_f \sim 4\).
When does the RS appear?

Terlevich et al. (2001)

Ellis et al. (1997)

Blakeslee et al. (2003)

$M_*>10^{11}M_0$

$z=0$

$z=0.5$

$z=1.2$
When does the RS appear?

Blakeslee et al. (2003)

z = 3.1

Kodama et al. (2007)

z = 2.2

Kodama et al. (2006)

z = 1.2
When does the RS appear?

RS seems to appear first around $z \sim 3$

MOIRCS NIR multi-object spectroscopy allocated (again, after being weathered out two times), FORS optical multi-object spectroscopy proposed

Kodama et al. (2007)

Kodama et al. (2006)

Kodama et al. (2007)