The Eridanus Supergroup

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Outline

- What is a supergroup and why is it interesting?
- Eridanus
- Eridanus group dynamics
- Dependence of Eridanus galaxy properties on environment
- Southern GEMS Groups - Brightest Group Galaxies
- Conclusions
What is a Supergroup and Why is it Interesting?

- A supergroup is a bound group of groups that will merge to form a galaxy cluster.

- A key prediction of hierarchical structure formation is that galaxy clusters assemble at late times from the merging and accretion of smaller structures (e.g. Peebles 1970).

- We lack clear early-stage examples of clusters being assembled from an ensemble of galaxy groups.
Eridanus

- Eridanus is a cloud of galaxies ~21 Mpc away (Baker 1933, 1936; de Vaucouleurs 1975).
- Forms a filamentary structure with the Fornax cluster (da Costa et al. 1988).
- Includes previously optically classified groups of galaxies NGC 1332 and NGC 1407.
X-Ray Images

Omar & Dwarakanath (2005)
In order to study region need to define which galaxies are associated with which sub-clump/group/cluster.

Use friends-of-friends technique (Huchra & Geller 1982)

Following the prescriptions of 2PIGG (Eke et al. 2004a):
\[ \frac{\Delta \rho}{\rho} = 150 \]
\[ 2\sigma/r = 1200 \]

\[ D_0 = 0.3 \text{ Mpc} \]
\[ V_0 = 350 \text{ km s}^{-1} \]

Brough et al. 2005 (MNRAS submitted)
Velocity Distribution

NGC 1407 Group $\sigma = 372 \text{ km s}^{-1}$

Eridanus Group $\sigma = 156 \text{ km s}^{-1}$

NGC 1332 Group $\sigma = 163 \text{ km s}^{-1}$
## Derived Properties

<table>
<thead>
<tr>
<th></th>
<th>Eridanus</th>
<th>NGC 1407</th>
<th>NGC 1332</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of members</strong></td>
<td>31</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td><strong>Mean Velocity (km s⁻¹)</strong></td>
<td>1638±5</td>
<td>1658±26</td>
<td>1474±18</td>
</tr>
<tr>
<td><strong>Velocity Dispersion (km s⁻¹)</strong></td>
<td>156±23</td>
<td>372±48</td>
<td>163±35</td>
</tr>
<tr>
<td><strong>Crossing time (H₀⁻¹)</strong></td>
<td>0.06</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Virial Mass (10¹³ M☉)</strong></td>
<td>0.9</td>
<td>5.3</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>R₅₀₀ radius (Mpc)</strong></td>
<td>0.21</td>
<td>0.51</td>
<td>0.22</td>
</tr>
<tr>
<td><strong>Mᵥ/Lₖ</strong></td>
<td>27</td>
<td>230</td>
<td>82</td>
</tr>
</tbody>
</table>
2 bodies are bound if $\frac{GM}{R_v (\sin i)^{-1}} > \frac{v^2}{2}$

Repeat analysis for 3 pairs. Conservatively, probability that groups are bound is minimum of 3 probabilities - 83%.

Treating supergroup system as one-body it is also likely to be bound to Fornax at a similar probability.
**Dependence on Environment**

- Determining how this environment affects its constituent galaxies is also important.

- K magnitudes from 2MASS, B magnitudes and morphological T-types from HyperLEDA

- Apparent magnitude limited sample ($m_K<13.1$)

- **Density** ($\Sigma_5$) is calculated as the projected surface density of 5 nearest neighbours
Morphology Distribution

![Graph showing spiral fraction vs log \( \Sigma_5 \) (Mpc\(^{-2}\)) for NGC 1395, NGC 1332, and NGC 1407, with Fornax as a reference.]
Colour Distribution

![Graph showing colour distribution with markers for NGC 1395, NGC 1332, NGC 1407, and Fornax]
Brightest Group Galaxies

- Extend FOF analysis to further 13 Southern GEMS groups.

- Hierarchical structure formation predicts the brightest galaxy in the halo to be at the centre and to grow at the expense of other galaxies.

- Select BGG as brightest galaxy in K-band within $2\sigma$ of FOF group centroid.
BGG Spatial and Velocity Offset

Brough et al. 2006 (in prep)
BGG luminosity vs Group X-ray Luminosity
Fraction of Group Light in BGG
Conclusion

- BGGs of all dynamically mature groups are early-type galaxies that lie within ~0.3 $R_{500}$ and 0.6$\sigma$ of centroid.

- Luminosity of BGG increases with group X-ray luminosity and fraction of group light in BGG falls with increasing total group luminosity.

- BGGs grow by mergers at early-times. Slower than groups accrete new galaxies.
Conclusions

- NGC 1407 is a massive group at a late stage in group evolution.
- NGC 1332 is a compact group.
- Eridanus is at an early stage of its evolution.
- These groups will coalesce to form a cluster $\sim 7 \times 10^{13} M_\odot$.
- The morphologies and colours of the individual galaxies indicate that changes in galaxy properties are occurring at densities equivalent to those on the outskirts of the groups.
See no correlation of dominance $m_1-m_2$ with environment

$m_{K,1}-m_{K,2} = 1.53$, greater than that found in clusters (0.66; Lin & Mohr 2004)