THE RELATION BETWEEN
BAR FORMATION, GALAXY LUMINOSITY,
AND ENVIRONMENT

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More than 60% of all bright nearby galaxies are disc-dominated systems \((de \ Vaucouleurs \ 1963)\). Bars are seen in about 70% of them in NIR images \((Knapen \ 1999; \ Eskridge \ et \ al. \ 2000)\).

The rest-frame optical bar fraction is possibly constant out to \(z\sim1\) \((Jogee \ et \ al. \ 2004; \ Sheth \ et \ al. \ 2008)\).

Bars offer an “alternative” way to constrain the central DM content and distribution in galaxies \((Weinberg \ 1985; \ Debattista \ & \ Sellwood \ 2000)\).

Bars are efficient agents of mass redistribution. The formation of a pseudo-bulge is the possible product of bar-driven evolution \((Kormendy \ & \ Kennicutt \ 2004; \ Athanassoula \ et \ al. \ 2005)\).
Bar formation and environment

Spontaneous bars form from unstable and nearly isolated stellar disks (Hohl 1971; Sellwood 1981)

Induced bars are triggered by close interactions (Noguchi 1988; Gerin et al. 1990)

- Higher bar fraction in galaxy pairs (Elmegreen et al. 1990; Varela et al. 2004)

- Higher bar fraction in cluster cores than in outskirts (Thomson 1981; Barazza et al. 2009)

- Higher (Giuricin et al. 1993) or same bar fraction (Aguerri et al. 2009; Marinova et al. 2012) in groups and clusters with respect to the field
Elmegreen et al. 1990
## Galaxy sample

<table>
<thead>
<tr>
<th>FIELD1</th>
<th>FIELD2</th>
<th>VIRGO</th>
<th>COMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDSS volume-limited</td>
<td>SDSS volume-limited</td>
<td>SDSS within $R_{\text{vir}}$</td>
<td>SDSS Coma Treasury Survey</td>
</tr>
<tr>
<td>2389 (1604 disks)</td>
<td>352 (336 disks)</td>
<td>588 (228 disks)</td>
<td>169 (44 disks)</td>
</tr>
<tr>
<td>$-24 &lt; M_r &lt; -20$</td>
<td>$-21 &lt; M_r &lt; -13$</td>
<td>$-22 &lt; M_r &lt; -13$</td>
<td>$-23 &lt; M_r &lt; -14$</td>
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</tbody>
</table>
Identification of disks and detection of bars

Disks: Morphological classification of SDSS galaxies (*Huertas-Company et al. 2011*)
- done with learning machines
- based on concentration and asymmetry parameters
- gives probability of being E, S0, Sab, Scd

Bars: Independent visual inspection of galaxy images by two of us
- Strong (= secure) bar
- Weak (= doubtful) bar
- No bar

Bar fraction as a function of luminosity (or mass) and environment
- Overall bar fraction: bars/galaxies
- Ordinary bar fraction: bars/disks
Huertas-Company et al. 2011

\[ p(E) < 0.5 \]
strong (= secure) bar          weak (= doubtful) bar          no bar
Overall bar fraction

$M_r = -19.0$ field

$M_r = -20.5$ cluster
Sanchez-Janssen et al. 2010
Overall bar fraction

- More bars in field
- Interactions inhibit bars

- More bars in cluster
- Interactions trigger bars

Graph showing the relationship between bar fraction ($f_T$) and magnitude ($M_r$) with different color bands representing various categories.
Conclusions

Bar fraction depends on
- galaxy luminosity (or mass) \((Mendez-Abreu \ et \ al. \ 2010; \ Nair \ & \ Abraham \ 2010)\)
- environment \((\text{field} \neq \text{cluster})\)

In fainter galaxies, bar formation is inhibited by
- nature \((=\ \text{disk thickening})\) in the galaxy disks of field
- nurture \((=\ \text{interactions})\) in the galaxy disks of clusters

In brighter galaxies, bar formation is driven by
- nature \((=\ \text{instabilities})\) in the galaxy disks of field
- nurture \((=\ \text{interactions})\) in some of the galaxy disks of clusters

Controversial results are due to selection bias of galaxy samples