Galaxy Disks and Disk Galaxies

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Starbursts and the Evolution of Gas-Rich Galaxies

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Abstract.

Moderately luminous starbursts in the nearby universe often occur in disk galaxies that are at most subject to mild external perturbations. An investigation of this type of galaxy leads to a better understanding of starburst triggering mechanisms and the resulting star formation processes, and provides useful comparisons to more extreme starbursts seen at high redshifts.

1. Introduction

Intermediate scale disk galaxies with starbursts are relatively common in the nearby universe. About 5% of galaxies with $-17 < M_B < -21$ have evidence for starbursts. Many of these occur in smaller galaxies, produce blue colors and strong emission lines, and are in gas rich systems, as indicated by their relatively large fractional HI content.

The more luminous nearby blue starbursts structurally and spectroscopically resemble the faint blue compact narrow emission line galaxies (CNELGs), which become common at redshifts of $z > 0.3$ (e.g., Guzman et al. 1998). They are less well-matched to high redshift blue galaxies, which have a combination of high UV luminosities and huge star formation rates that are not common in nearby extreme starbursts. This difference probably reflects secular evolution in the lives of galaxies; for example, systems at high redshift may be subject to frequent, strong mergers that trigger hyperactive star formation (e.g. Conselice et al. 2001 in prep).

Nearby starbursts frequently show evidence for being dynamically cool, that is they contain strong spiral arms or bars, features that are found in rotationally supported galactic disks. Thus the processes that produced these starburst did not severely disrupt the disk, or the disk reformed during the starburst event. Local analogs to the CNELGs include profound starbursts arising from minor perturbations (see Figure 1).

2. Role of Interactions

Moderate interactions (glancing collisions between equals, minor mergers) are apparently the sources of many starbursts. Evidence for this includes subtle optical structural features such as wisps, faint tails, or moderately disturbed kinematics in starbursts, as well as the more ubiquitous signatures of disturbed

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HI. Furthermore, in some starbursts where an interaction is the likely trigger, the outer regions of the optical disk appear to be relatively symmetric and relaxed. Three possible explanations for this behavior are:

- Starburst durations exceed the outer disk relaxation times, typically a few rotation periods, or $\geq 0.3$ Gyr.
- Starbursts occur late during many interactions, perhaps as a result of infalling material from tidal tails (e.g., Mihos & Hernquist 1996).
- Perturbations can produce starbursts with minimal impact on outer stellar disks; e.g., by stimulating gas inflows from extended HI disks.

Our investigations of nearby starbursts lead to several conclusions:

- Blue starbursts are commonly associated with disk galaxies: Near face-on systems can transmit UV light through areas where the disk has been cleaned out by supershells, supernova, etc. (e.g. Conselice et al. 2000).
- Low inclination disks can mimic the kinematics of low mass galaxies due to their narrow line widths (Homeier & Gallagher 1999). Some intermediate redshift CNELGs could be low inclination disks of moderate mass rather than extreme dwarf starbursts.
- Undisturbed intermediate mass galaxies, such as extreme late-type and superthin spirals (e.g., Matthews et al. 1998) can be inefficient star-formers and thereby store interstellar gas, the fuel for starbursts, over cosmic time scales.
- UV-bright regions of starbursts frequently occur in features associated with disks, such as rings or arms (e.g. Conselice et al. 2000) which may represent star forming environments not yet accessible to severely disturbed high luminosity starbursts in the distant universe.

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