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Research Note

Star Formation and Activity in the Nuclei of Barred Galaxies

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Summary. The data published by Heckman et al. (1980) on a large sample of normal galactic nuclei is used to show that recent detectable star formation has occurred more frequently in the nuclei of barred compared to non-barred disk galaxies. However, the presence or absence of a bar does not enhance the detectability of low-level nuclear activity (anomalous emission lines and/or flat spectrum radio sources).

Key words: galactic nuclei – barred galaxies

I. Introduction

It has long been thought that the nuclei of barred galaxies differ to a degree from the nuclei of non-barred galaxies (e.g. Sersic and Pastoriza, 1967; Sersic, 1973). That this might be expected is suggested by the observational and theoretical work on the gas dynamics of barred galaxies (e.g. Sanders, 1977; Sancisi et al., 1979; Peterson et al., 1978) which indicate that the gas flows in highly elliptical streamlines along the bar, and hence can flow through the nucleus. Thus one might expect, for example, that activity and/or star formation might be enhanced in the nuclei of barred as compared to non-barred galaxies. The purpose of this short note is to point out that the body of spectrophotometric data on normal galactic nuclei presented by Heckman et al. (1980) and discussed in Heckman (1980a, b) supports some, but not all, of these ideas.

II. Star Formation in the Nuclei of Barred Galaxies

As qualitative indicators of on-going or recent star formation in galactic nuclei we will use the nomenclature defined in Heckman (1980a). The stellar continuum in galactic nuclei was classified into two types: K Giant (spectrum dominated by an old stellar population) and Composite (spectrum shows some evidence for the presence of a young stellar population). Furthermore, a set of galactic nuclei showing emission-lines indicative of gas being photoionized by hot stars (H II regions) was also isolated in the Heckman et al. sample.

Table 1 shows the distribution of spiral and SO galaxies in the Heckman et al. sample classified by de Vaucouleurs et al. (1976) into non-barred (type A), transition (type AB), and barred (type B) morphologies vs. their classification by Heckman (1980a) as having K Giant or Composite nuclei. The fact that only ~44% of the galaxies showing no sign of a bar (type A) have Composite-type nuclei, while ~72% of the types AB and B do is marginally statistically significant (96% confidence level).

Table 1. Type of nuclear stellar population vs. galaxy type

	Nuclear type	
Galaxy type	K Giant	Composite
A	15	12
AB/B	9	23

Table 2. Presence of a nuclear H II region vs. galaxy type

	Nuclear H II region	
Galaxy type	Yes	No
A	7	14
AB/B	19	8

Further evidence linking the presence of a bar to nuclear star formation is contained in Table 2 where galaxy-type (A, AB, B) is cross-tabulated with the presence of a nuclear H II region. Here only ~33% of the non-barred spiral galaxies in the Heckman et al. sample have a nuclear H II region, compared to ~70% of the types AB and B galaxies (significant at the 99% confidence level).

Taken together, Tables 1 and 2 suggest that the presence of a bar raises the probability for detectable nuclear star formation.

This possibility can be further checked by use of the infrared survey of normal galactic nuclei conducted by Rieke and Lebofsky (1978) at $\lambda = 10\,\mu$. The (presumably) thermal infrared emission detected from these nuclei is widely believed to be produced by dust which has been heated by the light of young stars. Rieke and Lebofsky detected 11 of the 24 spirals showing evidence for a bar, and only 4 of the 17 non-barred spirals. By itself this result is of low statistical significance, but does lend support to the other evidence discussed above.

III. Nuclear Activity

We use the criteria developed by Heckman (1980b) for the recognition of low-level activity in normal galactic nuclei: the presence

Table 3. Presence of a Liner vs. galaxy type

	Liner	
Galaxy type	Yes	No
A	13	17
AB/B	9	19

Table 4. Presence of a compact nuclear radio source vs. galaxy type

	Compact source	
Galaxy type	Yes	No
A	4	23
AB/B	4	18

of an anomalous "Low Ionization Nuclear Emission-line Region" (Liner) and/or a compact nuclear radio source.

Table 3 is a cross-tabulation of the de Vaucouleurs et al. galaxy type vs. the presence of a Liner for galaxies over the range SO–Scd in Hubble type in the Heckman et al. sample. We see that no statistically significant difference exists between the various classes. Table 4, a similar compilation for galaxies having a compact nuclear radio source, also shows no evidence for a greater rate of incidence of activity in barred galaxies.

The work of Heckman (1978) and Simkin et al. (preprint) has shown that more extreme nuclear activity (i.e. the Seyfert phenomenon) is likewise no more common in barred as compared to non-barred disk galaxies.

IV. Conclusions

We find that the presence of detectable recent and/or ongoing nuclear star formation is probably more likely in disk galaxies which have a bar than in those that do not. However, nuclear activity is apparently *not* more likely in barred systems. These findings should be examined in terms of gas flow in barred galaxies and theories of star formation and nuclear activity.

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