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TIDAL EVENTS AND GALACTIC ACTIVITY

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Summary. We report some results from recent and ongoing work which relate to the connection between nuclear activity and tidal interactions. We suggest that tidal events are in general a necessary but not sufficient condition for nuclear activation. We also suggest that nuclear activity generally develops at a 'late stage' of a tidal encounter, following star-formation and dust evaporation, and when the most obvious morphological disturbances may have disappeared.

Table 1 summarizes the quantitative results from four programs which relate to the present topic. The full details are found in the references given. Our summary comments follow:

1. QSO imaging. In an investigation of matched samples of radio-loud and radio-quiet QSOs and radio galaxies, the results (Table 1) indicate disturbances of the host galaxy (indicating tidal encounters) in essentially *all* radio-luminous objects. (In the QSOs it is harder to see the closest companions and disturbances because of the bright nuclear light source.) The fraction (or strength) of interaction is lower in the radio-quiet QSOs. There is a range of M_V and colour for the host galaxies that makes them significantly different by K-S significance tests. The sense of these differences is consistent with different amounts of star-formation in the three types of object, widespread throughout galaxies with initially similar luminosities.

2. Radio evolution. In the references given, we have argued for a general time sequence of radio source evolution from unresolved (C) to one-sided (CL) to triple (T) structures. We have looked at optical morphology of redshift-matched samples of each radio type to see if a similar time sequence is indicated. The results (Table 1) are ambiguous, indicating possible complication by the merging/passing-interaction dichotomy, by hidden close companions, or by beaming of the core radiation. However, the companion separations among T sources (increasing with radio size), and the luminosity sequence in the host galaxies (star-formation in the youngest sources) do support the scenario. The high fraction of interactions among all radio types suggest that the radio evolution of a source is more rapid than the optical.

3. H I observations. In samples of AGN, and of IR-detected galaxies, the H I profile is frequently disturbed, but more so in the clearly interacting systems. There is a correlation between the H I and IR luminosity which presumably links gas and dust. Note also that there is a higher fraction of AGN in the IR-selected sample's 'non-interacting' systems.

This may indicate that (weaker?) AGN form after the initial interaction has died away. This needs to be reconciled with the radio source evolution timescales.

4. IRAS source survey. We find that optical object types are fairly well separated in the $L_{60\mu}/L_{(25/60\mu)}$ plane (Fig 1). We have obtained optical and radio continuum images of ~80 objects covering the range of these IR parameters. In detailed studies of several of the objects, we find that the IR luminosity is approximately equal to the hidden optical luminosity of hot stars/AGN reddened by dust.

So far, the optical imaging data indicate a progression of optical interaction and dust symptoms from left to right across the diagram. This may indicate either a time sequence or a dependence on the overall initial strength or type of an interaction (or both). Table 1 indicates the quantities we are investigating in this survey, with some preliminary qualitative findings. We hope that this work may clarify the evolution of AGN and tidal events, and the role of dust and star-formation.

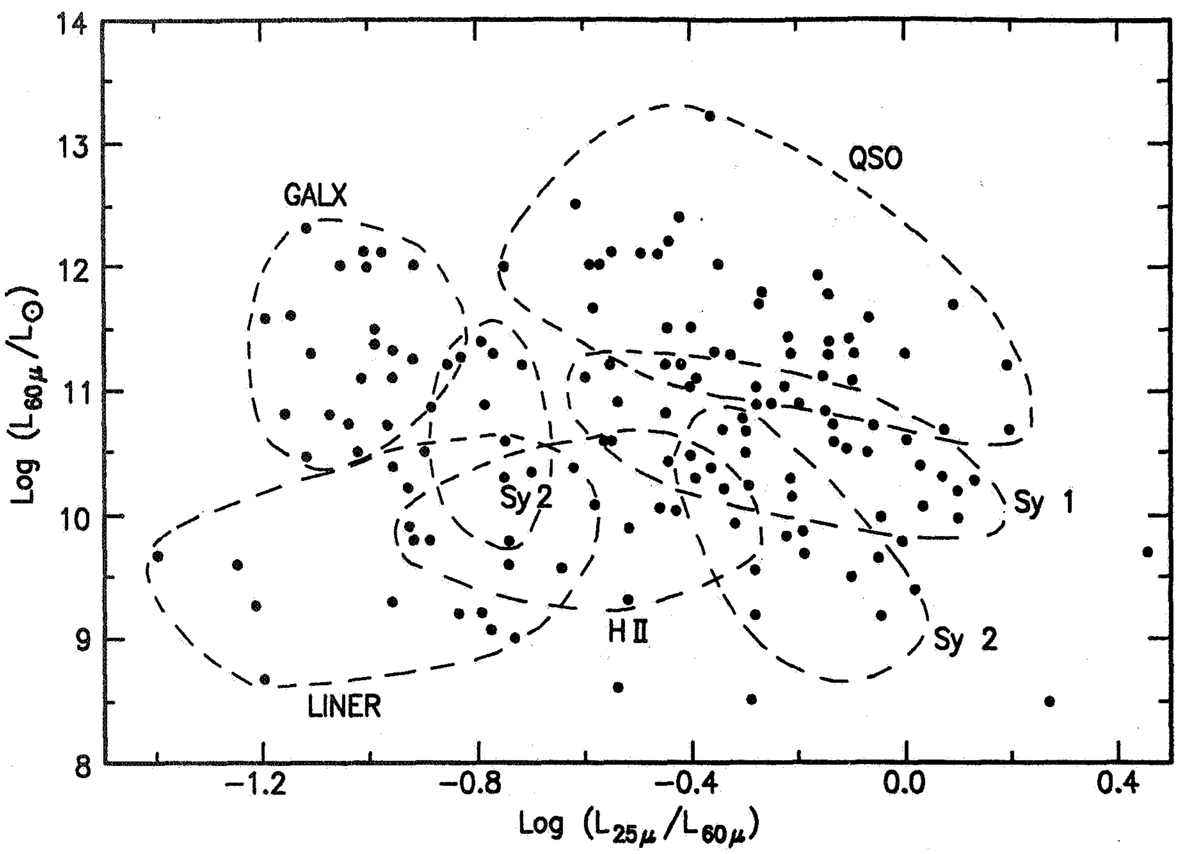

Fig 1. Objects in IR-selected survey in IR colour-luminosity plane. Outlines show where populations of optically different objects lie. We are investigating optical and radio continuum morphologies of these, as well as emission-line gas and H I dynamics, to discover the connections between the groups.

Table 1: summary of results

1. QSO optical imaging (matched samples of >100)

	Radio QSO	R-Q QSO	R-galaxy
Interacting	>68%	57%	84%
$-M_{galx}$*	22.0	20.7	21.1
$(B-R)_0$	.29	.94	.68

* *distributions significantly different*

Refs: Hutchings 1987, Hutchings, Neff, and Janson 1989

2. Evolution of radio quasars (250 radio, 50 optical)

	C	CL	T
Interacting	75%	62%	70%
$-M_{galx}$	23.1	21.9	22.2
companion (kpc)	27	17	32
# companions	3.6	8.8	7.5

Refs: Hutchings, Price and Gower 1988; Neff, Hutchings, Gower 1989; Hutchings and Neff 1990

3. H I observations of IRAS sources (50)

	Int	Non-int
H I normal	50%	69%
H I asymm	50%	31%
log (L_{HI})	2.2	1.7
AGN?	30%	85%

Refs: Hutchings, Price and Gower 1986; Hutchings 1989

4. IRAS source survey (80: radio, opt)

- Almost all are interacting or merging -

	Galaxies	NL AGN	BL AGN
Interactions	high	?	lower
Dust	high	?	lower
L_{IR}	high	range	high
α_{IR}	steep	range	flat
L_{radio}	?	?	?
population dens	?	?	?

Refs: Hutchings and Neff 1988, and ongoing

References

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