View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

# Tidal distortions in pairs of early-type galaxies

N91-16869

Ph. Prugniel
European Southern Observatory
Karl-Schwarzschild Str. 2
D-8046, Garching, Fed. Rep. of Germany

and

E. Davoust
Observatoire Midi Pyrénées
14, Av. E. Belin
F-31400, Toulouse, France

We are conducting an imaging survey of pairs of elliptical galaxies which has already produced interesting results. Some pairs present a common pattern of distortion interpreted in terms of tidal effects (Davoust and Prugniel, 1988; Prugniel et al., 1989). Other examples drawn from the literature (Borne and Hoessel, 1988; Colina and Pérez-Fournon, 1990) share the same morphology. This *Poster* presents new cases and lists the characteristics of 24 such systems.

Our pairs are drawn from a sample of binary and multiple galaxies which has in turn been extracted from the CGCG, UGC (Nilson, 1973) and VV (Vorontsov-Velyaminov, 1959) catalogues. This sample includes that of Karachentsev (1972). It contains 1800 pairs, among which 700 are S – S or mixed morphology pairs. We are working on the remainder to produce a sample of close *physical* pairs of elliptical galaxies (we also include bulge dominated S0's since the morphological discrimination from ellipticals is often ambiguous, in particular for interacting galaxies).

One of the interests of this work is to provide a sample selected on purely optical criteria, at variance with other works (e.g. Valentijn and Casertano, 1988). This will allow statistical studies of non-optical properties of these pairs (in particular radio emission).

We have so far obtained CCD-images of 125 pairs with the 2 m telescope of Pic du Midi in V and/or R. Velocities and velocity differences of 78 pairs have been obtained using the 1.93 meter telescope of Observatoire de Haute Provence and from the literature. One is an optical pair (VV 190). Eighteen of our pairs present the morphological effect described in Davoust and Prugniel (1988): the external parts of each member are stretched in opposite senses in a direction roughly perpendicular to the pair axis. The proportion of 15±4% distorted pairs confirms previous estimates.

Except for a few cases involving flattened galaxies with nearly aligned major axes which deserve careful detailed analysis (Prugniel, 1989), the apparent distortions do correspond to physical distortions. We have searched the literature for isophote maps showing this effect. In the survey of radio galaxies by Colina and Pérez-Fournon (1990), 7 out of 20 pairs show this characteristic distortion. Such a high rate (35%) suggests a relation between the strength of the interaction and radio activity (if we consider that the magnitude of the distortion is related to the strength of the interaction).

On the other hand, among the optically selected distorted pairs, 42% are radio galaxies while only 5% of all E–E Karachensev pairs are detected in radio (Stocke, 1978; this proportion rises to 7% if we only consider pairs with a separation of less than 10 kpc). This is not a rigorous statistical analysis since thresholds for radio detection and also for distortion detection are not homogeneously defined. However, the contrast is strong and we consider this as an indication for a possible relation between distortion and radio emission.

The comparison of the distributions of projected separations for distorted and undistorted pairs gives only marginal results. For 17 distorted pairs with measured radial velocities, the average separation is 9.4 kpc with a variance of 5.0 kpc, and for 74 non-distorted pairs, these values are respectively 11.0 and 10.0. The F-test allows us to reject the hypothesis of the equality of the two variances at a confidence level of 99.5%. However, the difference between the two distributions almost disappears when we reject the pairs with a velocity larger than 10000 km/s. This effect is certainly due to the cutoff in angular separation present in our sample: the average projected separation is about 30 arcsec, and only a few pairs are separated by more than 1 arcmin. Thus, the pairs within 50 Mpc and separated by more than 15 kpc are basically absent from our sample. To avoid this selection effect, Table 1 shows the proportion of distorted pairs in three bins of projected separation (assuming $H_o = 100 km/s/Mpc$).

**Table 1**

| Distance range (kpc) | Proportion of distorted pairs |
|---|---|
| 0 – 10 | 22% (12/54) |
| 10 – 15 | 17% (3/18) |
| >15 | 10% (2/19) |

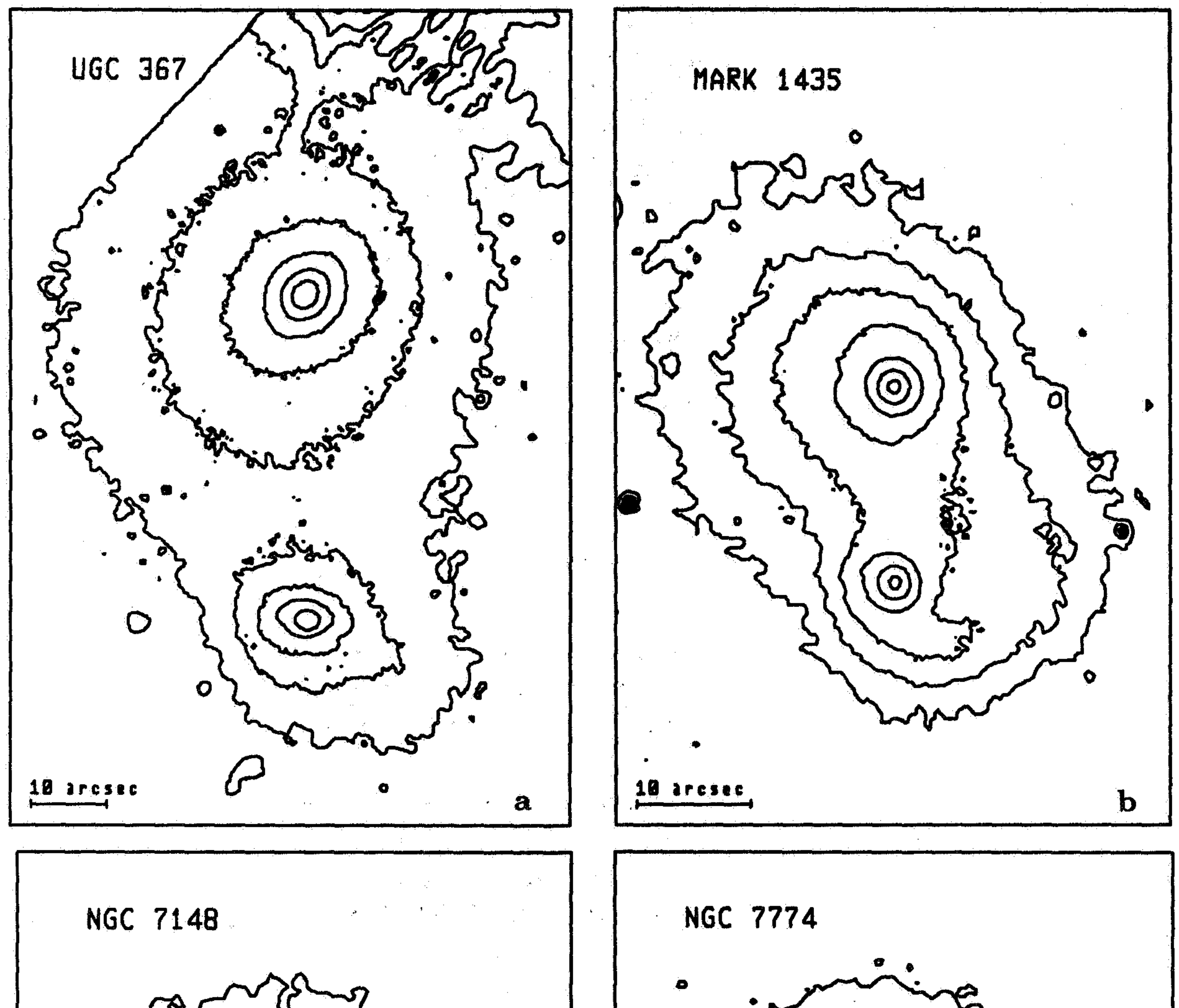
This analysis suffers from the too small statistical sample, but it strengthens the result of Stocke (1978) suggesting that both radio emission and morphological distortion are stronger in close than in loose pairs.

The isophote maps of 4 new pairs are presented in Fig. 1 and the characteristics of all known pairs are listed in Table 2.

In conclusion, we would like to stress the usefulness of distortions of this kind for establishing that binary galaxies are actually interacting, and thus good candidates for investigating other effects of interaction, such as radio emission, star formation, number of globular clusters, and possibly merging.

**Figure 1:**

**Figures 1a to 1d give the isophote maps of 4 distorted pairs: UGC 367, MRK 1435, NGC 7148 and 7774. These V-band images were taken with the 2 m telescope of Pic-du-Midi observatory. The step between each level is one magnitude. The orientation is such that the pair-axis is vertical, the large galaxy stretched toward the left and the small toward the right.**



UGC 367
10 arcsec
a
MARK 1435
10 arcsec
b
NGC 7148
5 arcsec
c
NGC 7774
10 arcsec
d

**Table 2**
distorted pairs

| Identification | Coordinates |  | Velocity | Separation |  | Effective radii |  | Lumin. | Radio | Source |
|---|---|---|---|---|---|---|---|---|---|---|
|  | $\alpha_{50}$ | $\delta_{50}$ | km $s^{-1}$ | arcsec | kpc | (1) | (2) | Ratio | Iden. |  |
| UGC 367 | 00 34.4 | 25 25 | 9620 | 42 | 19.6 | 13.3 | 6.6 | 4.8 | B2 | 1 |
| UGC 1093 | 01 29.1 | 17 19 | 8650 | 51.0 | 21.0 | 11.6 | 6.6 | 3.0 |  | 1 |
| NGC 741/2 | 01 53.8 | 05 23 | 5490 | 50 | 11 | 31.1 | 4.6 | 11.6 | 4C | 2 |
| UGC 1841 | 02 20.0 | 42 46 | 6450 | 23.7 | 7.4 |  |  | 7.0 | 3C66B | 1 |
| NGC 1044 | 02 38.4 | 08 31 | 6420 | 18.6 | 5.8 |  |  | (7) | 4C | 4 |
| NGC 1129 | 02 51.3 | 41 23 | 5150 | 25.9 | 6.5 | (85) | 3.5 | 22. |  | 1 |
| VV7.08.14 | 03 26.0 | 39 37 | 7290 | 23.2 | 8.2 |  |  | (5) | B2 | 4 |
| NGC1409/10 | 03 38.7 | -01 27 | 7400 | 7.0 | 2.5 | 14.6 | 4.7 | 4.7 |  | 1 |
| UGC 2992 | 04 11.1 | 01 38 | 5030 | 18.0 | 4.4 |  |  | 2.2 |  | 1 |
| NGC 1587/8 | 04 28.1 | 00 33 | 3800 | 59.4 | 12 | 14.0 | 4.6 | 3.8 | Radio | 2 |
| UGC 3710 | 07 06.4 | 28 45 | 7350 | 7.4 | 2.6 | 7.2 | 4.5 | 1.3 |  | 1 |
| NGC 2672/3 | 08 46.5 | 19 16 | 4300 | 33.0 | 7 | 29.4 | 4.7 | 11.5 |  | 2 |
| MRK 1435 | 10 33.6 | 55 02 | 3360 | 17.2 | 2.8 | 6.2 | 3.6 | 4.0 |  | 1 |
| NGC 4782/3 | 12 51.9 | -12 17 | 4140 | 42 | 8 | 20.0 | 16.0 | 1.6 | 3C278 | 2 |
| NGC 4893 | 12 57.7 | 37 27 | 10400 | 19.2 | 9.7 | 22.0 | 7.9 | 3.9 |  | 1 |
| NGC 5718 | 14 38.1 | 03 40 | 8260 | 60 | 24.0 |  |  | (1.5) | Radio | 3 |
| B2 inA1984 | 14 50.4 | 28 10 | 38000 | 9.8 | 18.0 |  |  | (1) | B2 | 4 |
| In A2172 | 16 15.0 | 42 34 | 39300 | 6.5 | 12.4 |  |  | (7) | B2 | 4 |
| UGC 11804/5 | 21 42.3 | 46 02 | 5600 | 33.0 | 9 |  |  | 1.4 |  | 1 |
| NGC 7148 | 21 49.8 | 03 12 |  | 13.0 |  | 6.2 | 3.0 | 3.9 |  | 1 |
| NGC 7236/7 | 22 12.3 | 13 35 | 7810 | 34.0 | 13 | 47.0 | 4.6 | 3.3 | 3C442 | 1 |
| UGC 12064 | 22 29.1 | 39 06 | 5130 | 36.0 | 12 | 8.7 | 4.6 | 3.9 | 3C449 | 2 |
| NGC 7578 | 23 14.8 | 18 26 | 12020 | 33.8 | 19.5 |  |  | (2) | Radio | 3 |
| NGC 7774 | 23 49.6 | 11 12 | 6700 | 15.5 | 5.0 | 10.8 | 5.0 | 4.0 |  | 1 |

**Notes**: Effective radii are given for the two galaxies of each pair in arcsec, values in parentheses are uncertain. The luminosity ratio is in linear flux computed from the asymptotic magnitude. Sources of images: (1) This *poster*, (2) Davoust and Prugniel (1988), (3) Arp (1966), (4) Colina and Pérez-Fournon (1990).

## References


Borne, K.D., Hoessel, J.G.: 1988, *Astrophys. J.* **330**, 51

Colina, L., Pérez-Fournon, I.: 1990, *Astrophys. J. Suppl.* **000**, 000

Davoust, E., Prugniel, Ph.: 1988, *Astron. Astrophys. Letters* **201**, L30

Karachensev, I.D.: 1972, *Commun. Special Astrophys. Obs. USSR* **7**,1

Nilson, P.: 1973, *Uppsala Astron. Annals* **6**

Prugniel, Ph., Davoust, E., Nieto, J.-L.: 1989, *Astron. Astrophys.* **222**, 5

Prugniel, Ph.: 1989, in *1st ESO/ST-ECF Data Analysis Workshop*, ed. Grosbol, P.J. *et al.*, p. 161

Stocke, J.T.: 1978, *Astron. J.* **83**, 348

Valentijn, E.A., Casertano, S.: 1988, *Astron. Astrophys.* **206**, 27

Vorontsov-Velyaminov, V.A.: 1959, *Atlas and Catalogue of Interacting Galaxies* (Sternberg State Astron. Inst., Moscow)