QUANTITATIVE MORPHOLOGY OF GALAXIES

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The construction of databases with millions of galaxies of known morphological types is important in studies of observational cosmology dealing with the origin of the Hubble sequence and the frequency and spatial distribution of galaxies of different types. Human classification of these galaxies is impossible. Automated procedures are the only practical way to proceed.

In a pilot-study (Storrie-Lombardi et al. 1992, MNRAS 259, 8) we have applied Artificial Neural Networks (ANN) to galaxy classification. Using a multilayer perceptron algorithm, we have shown that we could reproduce the ESO-LV classification (into 5 classes) at a success rate of 64 % 'perfect match'. More recently, we have shown (Naim et al. 1995a, MNRAS 274, 1107; Naim et al. 1995b, MNRAS in press; Lahav et al. 1995, Science 267, 859) that ANN can replicate the human classification of APM-selected galaxies to the same degree of agreement as that between two human experts, 1.8 T-type units. These results indicate that automated classification is already competing with human experts in accuracy, and will soon perform better (with best input parameters feeding flexible classifiers).

Morphological classification of galaxies can be put over a solid quantitative ground with classification (or decision) theory, a standard statistical procedure (e.g., Duda & Hart 1973, *Pattern Classification and Scene Analysis*). We have examined the performance of three Bayesian classifiers —Parzen Windows, k–th Nearest Neighbor, and ANN— showing that ANN produce the best results for the ESO-LV data. We have also compared the classifications produced by the classifiers. We have found that the agreement between them (75% – 89%) is much better than between them and ESO-LV (59% – 65%).

We have then identified the galaxies which were correctly classified by the 3 classifiers. We argue that these galaxies are prototypes of their morphological groups, and as such they form a sample useful for studies of galaxy parameters along the Hubble sequence. They may also be considered morphological standards for calibration of an objective morphological sequence.

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BLACK HOLES IN THE NUCLEI OF LINERS

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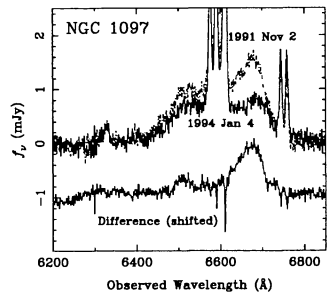
The LINER nucleus of the galaxy NGC 1097 has presented, in an observation on Nov. 1991, an unexpected broad (FWZI$\sim$ 20 000 km s^{-1}) double-peaked Hα emission-line profile, not observed in previous spectra, thus characterizing the occurrence of a transient event (Storchi-Bergmann et al. 1993, ApJ 410, L11). A similar phenomenon has been observed in the nucleus of M81 by Bower et al. (1996) in recent observations using the Space Telescope, as well as from the nucleus of Pictor A by Halpern & Eracleous (1994, ApJ 433, L17). One possible origin for this emission is an accretion event giving rise to an accretion disk around a supermassive nuclear black hole. In the case of NGC 1097, the shape of the profile, showing the red peak stronger than the blue indicates that, if the emission is from the disk, the disk cannot be circular, but may be elliptical. Such a disk could have formed from the debris released by the disruption of a star by a supermassive nuclear black hole. Such events have been theoretically predicted if there are dormant black holes in the nuclei of most massive galaxies —as expected from the peak in the QSO's distribution for $z \sim 2$ (Rees 1988, Nature, 333, 523). Follow up observations in the period Nov. 91 – Feb. 94 (see figure below) have shown significant variations, which, in the elliptical disk scenario, can be attributed to precession of the disk (Storchi-Bergmann et al. 1995, ApJ 443, 617).



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