THESIS ABSTRACTS

Topics of Galactic Evolution

By Xavier Hernandez Doring

This thesis investigates some issues in galactic evolution. The first part uses rotation curves, luminosity profiles, and disc-to-bulge ratios, taken from the literature, for a large number of low-surface-brightness and normal late-type spiral galaxies, to calibrate and test a simple model of galactic formation. The first-order galactic-formation scenario which emerges suggests that the main ingredient shaping the Hubble sequence is the initial angular momentum of galaxies. The proposition that the structure of galactic dark halos is universal in terms of a fixed density-profile is found to be consistent with observations only if this general profile is characterized by a constant density core.

The second part presents a simplified analytical calculation of the physics of dynamical friction within a constant-density dark halo. The results allow one to study the orbital evolution of massive objects in the halos of dwarf galaxies. The consequences of this are explored in terms of the relation between dwarf galactic halos and their globular-cluster systems, and the possibility of a fraction of these dark halos being made up of massive black holes.

The last part of this thesis presents a new non-parametric approach to maximum-likelihood problems based on variational calculus. This method is developed for the problem of recovering the star-formation history which generates an observed HR diagram. The validity of the technique is tested extensively using synthetic HR diagrams. The method is applied to real data using archival *HST* observations for a sample of local dSph galaxies, and the results compared to existing studies from the literature. This allows a comparative study of the star-formation histories of these interesting nearby objects. — *University of Cambridge; accepted 1998 December*

The Development of New Techniques for Integral Field Spectroscopy in Astronomy

By Matthew Alexander Kenworthy

Integral field spectroscopy (IFS) is the ability to record spectral information from all pixels in an astronomical field. Regions of interest include the cores of galaxies and images produced by gravitational lenses, where the velocities derived from the spectral lines across the whole field of view can map the dynamical conditions of gas and nebulae in these objects. Classical long-slit spectroscopy can only record a single line of information per exposure, and if more data are needed then the slit has to be rotated or moved and another exposure taken. For faint objects that require long integrations, only three or four such exposures can be taken in one night, leading to inefficient and incomplete sampling.

IFS requires new instrumentation techniques to reformat an area of sky into a long slit suitable for dispersion with a spectrograph, and new computer software to reconstruct the image of the sky for a given spectral line or region.

This thesis begins with a review of different IFS techniques, suggesting that the use of optical fibres as spatial reformatters leads to one of the simplest optical designs. Investigating the transmission properties of optical fibre leads to an efficient spectrograph design optimised for use with a dedicated fibre-feed, and

such a prototype spectrograph (called *SPIRAL — Segmented Pupil/Image Reformatting Array Lenslets*) was built and tested at the *Anglo-Australian Telescope*.

The techniques for accurately handling and positioning fibres in this prototype are presented. Subsequent developments of these techniques are then successfully used in the construction of an IFS unit and twin optical fibre-feed for the *Cambridge OH Suppression Instrument* (*COHSI*) infra-red spectrograph.

Information from IFS is in the form of a 'data cube', with flux as a function of x, y, and wavelength and this three-dimensional array of data can be interpreted in many ways. The computer data-reduction techniques are closely linked with the software needed for presentation and interpretation of the data, and IRAF programs developed for this purpose are presented along with scientific results from the *SPIRAL* spectrograph. A discussion and some simulations of cross-talk effects induced in closely packed spectra are also presented.

The supernova SN1987A and the discovery of a brown dwarf with the *SPIRAL* spectrograph demonstrates the efficiency and capability of IFS for small fields of view. This leads to the design study of a larger fibre image-reformatter, *SPIRAL'B'*, in which the techniques and methods developed with *SPIRAL* and *COHSI* are incorporated.

Many of the next generation of telescopes have plans for instruments with IFS capabilities and this thesis goes toward addressing some of the issues involved with these new and powerful instruments. — *University of Cambridge; accepted 1998 December*

Exploring the Star Formation Histories of Galaxies

By Eric F. Bell

In this thesis, I explore the star-formation histories of both spiral and elliptical galaxies.

In Part 1, I present an in-depth study of the star-formation histories of spiral galaxies with a wide range of properties. Optical and near-infrared colours are used in conjunction with up-to-date stellar-population synthesis models to constrain the ages and metallicities of my sample galaxies.

I find that age and metallicity gradients are common in spiral galaxies of all types. The age of a spiral galaxy correlates mainly with its surface brightness, and its metallicity correlates strongly with both its surface brightness and absolute magnitude. Using simple models, I demonstrate that the correlations observed in this thesis show that the star-formation history of a region within a galaxy depends primarily on its surface density, and possibly on the dynamical time. Metal-enriched outflow from low-mass galaxies seems to be required to reproduce a reasonably strong metallicity-magnitude correlation. These variations in star-formation history are a continuous function of the physical parameters: in particular, I find no evidence for a bimodal spiral-galaxy surface-brightness distribution.

In Part 2, I present a short study on the formation epoch of early-type galaxies. I developed a photometric redshift estimator optimised for redshifts $z \sim 1$. The redshift estimator provides redshifts accurate to ~ 10 per cent. This redshift estimator is then applied to a sample of morphologically-selected early-type galaxies in the northern Hubble Deep Field. Comparison of their colour-magnitude relation with a passively evolved Coma-cluster colour-magnitude relation indicates that over half of the sample must form at redshifts greater than two. — *University of Durham; accepted September 1999*