and dust at varying inclinations. Our simulations illustrate how the apparent structure behaves for different inclination and opacity. This reveals a set of superior diagnostics for the disk opacity. These include not only the integrated parameters but also the apparent disk structural parameters, the amplitude of asymmetry between the near and far sides of the major axis, and their dependence on inclination.

Our next study introduces three highly inclined spiral galaxies with large bulges; NGC 4594, NGC 5746, and NGC 1055. These galaxies offer a rare opportunity to trace the disk opacity in a very direct manner. Using the optical and near-infrared imaging data, we derive the radial distribution of the optical thickness. In all cases, the face-on optical depth is negligible in the outer regions and increases inward. The central region of NGC 4594 appears to be dust free, but the other two galaxies have dust in the central region which results in the displacement of apparent galactic center in the optical images.

The disk opacity can be also evaluated from the shape of the apparent rotation curves in edge-on galaxies. This is an independent test of dust opacity which does not involve any photometric data and associated biases. We perform multi-wavelength rotation curve observations for a sample of almost exactly edge-on spiral galaxies. When compared with HI and/or CO rotation curves, our H$\alpha$ data show that the outer regions are transparent. The opacity in the inner region may be significant in some cases, but there are rotation curves which suggest almost complete transparency across their entire disks. The H$\alpha$ and O[II] rotation curves, obtained for a dozen edge-on galaxies, also indicate that spiral galaxies are generally transparent in the outer regions.

One of the major difficulties in photometric studies of spiral galaxies, including but not confined to the opacity work, concerns the separation of disk from the central bulge component. We introduce a method of bulge-disk decomposition, which utilizes a full two-dimensional image of a galaxy, suffers far less uncertainty and manages to provide better estimates of both shape and structural parameters for each component.

The last chapter in this thesis contains an extensive photometric analysis of I-band CCD data for 1355 southern spiral galaxies. We first derive accurate structural parameters using our two-dimensional decomposition method. Various efforts were then made to minimize the selection effects and to normalize the large dispersion of intrinsic properties between galaxies. We find a strong inclination dependence for all available photometric parameters, which include isophotal diameter, total magnitude, central surface brightness, local surface brightness, and disk scalelength. The detailed behaviour of inclination dependence is consistent with the results from our other studies; *i.e.* spiral disks are transparent in the outer parts and the dust opacity gradually increases at smaller radii.

## CNO ABUNDANCES OF GLOBULAR CLUSTER GIANTS

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A major source of uncertainty in the derived ages of globular clusters is the assumed CNO abundance. A change of a factor of 3 in the amount of carbon, nitrogen and oxygen in a cluster alters the ages derived from studies of colour magnitude diagrams by 2 Gyrs. The clusters NGC 288 and 362 (with a reported age difference of about 3Gyr) have been central to recent claims of an age spread in the globular cluster system of our galaxy. To investigate the possibility that this apparent age difference may be partially caused by variations in the CNO abundances between these clusters, observations of the [OI] line at 6300 A, and the CH and CN bands near 4000 A were made using the coude echelle spectrograph on the Anglo-Australian Telescope (with a resolution of approximately 40000, and a signal to noise ratio of more than 50). These spectra have been analysed using the model atmosphere code MARCS (Gustafsson *et al.* 1975) and SSG (Bell and Gustafsson 1978). Observations were also made of a selection of stars in NGC 6752, which has a bimodal distribution in the CN band strengths on the giant branch, as well as an extremely blue Horizontal Branch (and hence is a second parameter cluster).

The derived abundance [Fe/H] for NGC 288, 362 and 6752 is –1.14, –0.97 and –1.30 respectively. For [CNO/Fe], values for each cluster were 0.29,0.19 and 0.04 respectively (relative errors on the given abundances are approximately 0.05dex and the absolute errors are apporx 0.2dex). The difference in abundances for NGC 288 and 362 are not sufficient to account for the claimed age difference. This suggests that if the age difference is 3Gyr (as claimed) then the formation of the halo lasted longer than a free fall time, ruling out a simple dissipationless collapse. Also, the values of [Fe/H] are 0.2dex higher than the values of Zinn and West (1984). If the [CNO/Fe] value is 0.2dex, then the combined effect of these abundance changes is to reduce the derived ages of the clusters by approximately 1.4Gyr (assuming currently accepted value is 15Gyr).

## DYNAMICS OF GLOBULAR CLUSTER SYSTEMS

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We examine observational aspects of different globular cluster systems to shed light on possible galaxy formation scenarios. In the first part of this work, we use low-dispersion spectra of 47 globular clusters in the cD elliptical NGC 1399 to determine the velocity dispersion of the cluster system. We find a velocity dispersion of 388 ± 54 km/s, which is significantly higher than the velocity dispersion of the stellar component of NGC 1399. We see no evidence for a radial gradient in the dispersion profile though our uncertainties do not impose strong constraints in this respect. No significant rotation of the globular cluster system is evident. In the extreme case where the clusters are assumed to be on circular orbits, we determine a lower limit on a globally-constant mass-luminosity ratio of 79 ± 20.

The velocity dispersion of the globular cluster system is very similar to the unusually low velocity dispersion of galaxies in the fornax cluster. The surface density distributions of the stellar light, globular clusters, and Fornax galaxies follow a similar power-law profile over much of the extent of the cluster. It is unclear whether this has any significance for the formation of the globular cluster system. M87, the elliptical at the center of the Virgo cluster, has very different characteristics but its globular cluster system is essentially similar to that of NGC 1399.

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