CONCLUSIONS

The study of galaxy evolution is central to our understanding of the composition and evolution of the universe. However, linking observations to theory is significantly impeded by many uncertainties, both observational and theoretical. Three issues have been addressed in this thesis: the accuracy and interpretation of measurements of the sizes of high-redshift galaxies; the more general determination of galaxy structure and the discrepancy between light distributions and stellar mass distributions; and the interpretation of observed evolutionary trends in the context of galaxy formation models.

Our main conclusions are the following:

- On average, the effective radii of quiescent galaxies at $z \sim 2$ are only ~ 1 kpc (with a signifiant spread towards smaller and larger sizes). These small sizes are not the result of surface brightness-dependent biases.
- Quiescent galaxies at $z \sim 2$ are structurally quite similar to present-day elliptical galaxies; their morphologies are smooth and follow $n \approx 4$ Sérsic profiles.
- A comparison of the surface brightness profiles of high-redshift quiescent galaxies to those of low-redshift ellipticals suggests that quiescent galaxy growth occurs in an inside-out fashion.
- The average size difference between quiescent galaxies at $z = 2$ and $z = 0$ is not a reflection of the growth of individual galaxies. The growth of high-redshift quiescent galaxies may be as low as half of this average size difference, with the remaining part driven by the addition of large, recently quenched galaxies to the quiescent population.
- Galaxy structure correlates with star formation activity at all redshifts up to $z = 2$, such that starforming galaxies are mode disk-like and more extended than quiescent galaxies.
- The overwhelming majority of galaxies has negative radial color gradients such that the cores of galaxies are redder than the outskirts. These color gradients indicate the presence of mass-to-light ratio gradients.
- The mass distributions of galaxies are on average 25% smaller than their rest-frame optical light distributions. The difference between mass-weighted

structure and light-weighted structure is independent of redshift and galaxy properties.

- Semi-analytic models robustly predict a rapid increase in the sizes of quiescent galaxies, at a rate that is close to observations. This evolution is largely driven by the growth and subsequent quenching of starforming galaxies, which evolve in lockstep with their parent halos.

- Galaxies continue to grow in mass and size after quenching. This growth is such that high-mass galaxies lie on a tight mass-size relation, due to repeated merger events. Fewer mergers occur at lower masses, as a result of which the scatter in the mass-size plane is higher.

Galaxy structure can currently be measured accurately, and at rest-frame optical wavelengths, up to $z \approx 2-3$. Over the past years it has become clear that, although the $z = 2$ universe is different in many respects, many of the most important galaxy relations were already in place. In the coming years it will become possible to extend these studies to higher redshift, using K band data from either space-based instruments such as the James Webb Telescope, or from adaptive optics-assisted ground-based telescopes. This will open up an interesting epoch to structural measurements, where starforming galaxies still dominated the galaxy population at high-mass.

Our theoretical understanding of the universe is rapidly improving. Both simulations and semi-analytic models are becoming more sophisticated, with the inclusion of complicated gas-based physics and more realistic treatments of star formation. Despite these improvements, many basic observables are still poorly reproduced, especially at high redshift. It is clear that our understanding is still lacking on many basic levels, partially due to the difficulty of comparing precise simulated quantities to more vaguely defined observed properties. Cross-pollination between observers and theorists is of key importance in order to progress in this respect.

Although trends such as size evolution can be measured with good precision and accuracy, selection of galaxy samples for such measurements is not straightforward. The ideal would be to follow the changes in individual galaxies over time. Unfortunately, making a link between progenitor galaxies and their descendants is not trivial. Currently most observational studies are based on mass-limited galaxy samples, since stellar mass is relatively easy to measure and correlates well with many other galaxy properties. However, since galaxies grow with time, redshift trends based on samples selected at constant stellar mass are not equivalent to actual galaxy evolution. Some progress has been made using galaxy samples selected at constant (cumulative) number density. This method is effective at very high stellar masses, where the rank order of galaxies tends to change very little. Finding a reliable way to trace real galaxy growth over a larger mass range is one of the key challenges still facing this field.