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Title: The extraordinary structural evolution of massive galaxies
Issue Date: 2013-11-21

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.

CURRICULUM VITAE

I was born on January 6, 1983 in Rehovot, Israel, to an Israeli mother and a Dutch father. When I was 10 months old we moved to Groningen, in the Netherlands, where I spent most of my childhood. When I was 13 years old we moved to Santa Cruz, California. I completed three years at Santa Cruz High School before we moved back to Groningen, where I graduated from the Praedinius Gymnasium in 2000. I spent a year traveling through Europe and Thailand, after which, in 2002, I started studying architecture at the Technische Universiteit Delft. After less than a year I felt a mounting desire to enter the scientific world, and made the choice to switch to astronomy at the Universiteit Leiden.

During my time as a student in Leiden I worked on a variety of interesting research projects. For my bachelor's thesis I studied the possibility of detecting high-velocity stars in the Milky Way using the GAIA satellite (with Dr. Anthony Brown and Dr. Yuri Levin). I obtained my bachelor's degree in 2007. The following year I worked on measuring the rotation curve of a galaxy using the SAURON integral-field spectrograph (with Dr. Annemarie Weijmans and Prof. dr. Tim de Zeeuw). Finally, for my master's thesis I analyzed the effects of measurement biases on future weak lensing surveys (with Dr. Henk Hoekstra).

I was fortunate enough to be selected to participate in two Honours Classes during this time. The first class had as a subject the earliest life on Earth, and was aimed at a multidisciplinary group of students from the Universiteit Leiden and the Vrije Universiteit Amsterdam. As part of this class we traveled to western Australia to investigate 3.5 billion year old fossils of bacterial life. The second class revolved around the possibilities of replicating the photosynthesis processes used by plants and algae for large-scale energy production, and culminated in a week-long workshop at the Lorentz Center at the Universiteit Leiden. Besides these activities, I worked at the science faculty's public outreach office, where I helped organize visits to the university for local high school children.

After obtaining my master's degree in August 2009 I began my doctoral research at the Sterrewacht Leiden, working with Prof. dr. Marijn Franx and Prof. dr. Pieter van Dokkum (Yale University, USA). During this time I attended several conferences, schools, and workshops, and had the opportunity to present my work at a number of institutes. During the first two years of my doctoral work I was a teaching assistant for the "Sterrenkundig Practicum 2" bachelor's course, where I helped students learn the basic skills needed for doing astronomical research, and accompanied them on observing trips to the Isaac Newton Telescope on La Palma (Spain). After this I was a teaching assistant for the "Stralingsprocessen" course, for which I led the problem solving sessions.

My interests have always ranged far and wide. I will not be continuing my astronomic research career, but will instead seek out opportunities outside the academic world.

ACKNOWLEDGEMENTS

Completing a PhD thesis is a long and difficult process, but fortunately it is not something you have to do completely by yourself. Many people have contributed to this work, directly and indirectly, for which I am very grateful.

I am lucky to have been able to work with some very talented people, from whom I have learned a lot. Over the past four years I have learned many valuable lessons from my supervisors, Marijn Franx and Pieter van Dokkum. Marijn's talent to identify issues which seem at first glance to be minor details, but more often than not turned out to be crucially important, is something which continually amazes me. Pieter has been an inexhaustible source of good ideas, and the enjoyment he gets out of scientific research is extremely infectious. Both have taught me to always keep a critical eye on my work, and have impressed upon me the supreme importance of a clear narrative when communicating my results.

These four years would not have been anywhere near as enjoyable if it weren't for all my wonderful colleagues, both in Leiden and abroad. Shannon, Jesse, Adam, Mattia, Willem, Ryan, Moein, and Maaike have made the galaxies group a great environment to work in, both scientifically and socially. I also want to acknowledge my coauthors, with whom I have greatly enjoyed working. I want to thank Rachel, Tomer, Joel, Nhung, and Erica for making my visits to Yale (as well as our many meetings in Leiden and elsewhere) unforgettable. And I want to thank all my colleagues at the Sterrewacht for many memorable lunches, borrels and coffee breaks.

I am very grateful to all my friends in Rotterdam, Amsterdam and elsewhere, for providing much-needed diversions from work. It is easy to lose touch with everyday life when working on galaxies all day, and I feel fortunate to have such a stimulating group of friends who have always been there to keep my feet on solid ground.

I want to thank my parents, Arpad and Ettie, who have always given me their full support, even when my motives might have been unclear. Without them I would have never gotten to where I am today.

And finally, I thank Hoi Kee. Living with an astronomer is not always easy, and I am supremely grateful for her love, understanding, and patience. Her support and good advice have been invaluable to me.