The Galaxy Disk in Cosmological Context
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Spatially resolved dynamics of high-z star forming galaxies

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Abstract. I report on two major programs to study the kinematic properties of galaxies at $z \sim 1.5 - 3$ with spatially resolved spectroscopy for the first time. Using the adaptive optics assisted, integral field spectrometer SINFONI on the ESO VLT, we have observed more than 70 galaxies and find compelling evidence for large, geometrically thick (turbulent), rotating disk galaxies in a majority of the objects that we can spatially resolve. It appears that these star forming disks are driven by continuous, rapid accretion of gas from their dark matter halos, and that their evolution is strongly influenced by internal, secular evolution. In contrast to the 20 submillimeter galaxies that we have investigated with the IRAM Plateau de Bure millimetre interferometer we find strong evidence for compact, major mergers. I discuss the impact of these new observations on our understanding of galaxy evolution in the early Universe.

For the SINS survey we have carried out Hα integral field spectroscopy of well-resolved, UV/optically selected star-forming galaxies at $z \sim 2$ with SINFONI on the ESO VLT. The SINS sample is representative of the majority of massive ($M_* >$ a few $10^{10} M_\odot$) star-forming galaxies at that redshift. Our data obtained with laser guide star assisted adaptive optics in good seeing show the presence of turbulent, rotating star-forming rings/disks in at least a third of the sample, plus central bulge/inner disk components in some of the best cases, whose mass fractions relative to total dynamical mass appears to scale with [NII]/Hα flux ratio and 'star formation' age. Another third of the SINS galaxies show clear signs of kinematic perturbations by a merger, while the last third appear to be compact, 'dispersion' limited systems.

Our interpretation of these data is that the buildup of the central disks and bulges of massive galaxies at $z \sim 2$ can be driven by the early secular evolution of gas-rich 'proto'-disks. High-redshift disks exhibit large random motions. This turbulence may in part be stirred up by the release of gravitational energy in the rapid 'cold' accretion flows along the filaments of the cosmic web. As a result, dynamical friction and viscous processes proceed on a time scale of < 1 Gyr, at least an order of magnitude faster than in disk galaxies at $z \sim 0$. Early secular evolution thus drives gas and stars into the central regions and can build up exponential disks and massive bulges, even without major mergers. Secular evolution along with increased efficiency of star formation at high surface densities may also help to account for the short time scales of the stellar buildup observed in massive galaxies at $z \sim 2$.

Keywords. galaxies: high-redshift – galaxies: formation – galaxies: structure – galaxies: evolution – techniques: high angular resolution

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The presentation made at the meeting can be downloaded from:
http://www.mpe.mpg.de/ppt/IAU254-RG.ppt

The results discussed here are described in the recent papers by Tacconi *et al.* (2008), Shapiro *et al.* (2008), Genzel *et al.* (2008), and Förster Schreiber *et al.* (2008).

References

Förster Schreiber, N.M., *et al.* 2008, to be submitted.
Genzel, R., Burkert, A., Bouché, N., *et al.* 2008, *ApJ* 687, 59
Shapiro, K. L., Genzel, R., Förster Schreiber, N. M., *et al.* 2008, *ApJ* 682, 231),
Tacconi, L., Genzel, R., Smail, I., *et al.* 2008, *ApJ* 680, 246

Adriaan Blaauw enjoying his return to the Strömgren residence at Carlsberg.

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