Astrophysical Institute Potsdam

Star formation in high-z QSO host galaxies

Knud Jahnke, Lutz Wisotzki

background

In the recent past different classes of AGN host galaxies were found to commonly have globally young stellar population. In the local universe this is almost universally valid both for type 2 AGN (Kaufmann et al. 2003, MNRAS, 346, 1055) and more luminous type 1 AGN (Jahnke et al. 2003, 2004a). We now extended our investigation of the stellar composition of quasar host galaxies to redshifts of z=3.

databasis

Here we combine results from our GEMS imaging survey (Rix et al. 2004, ApJS, 152, 163) with the HST ACS and ground-based Adaptive Optics with the ESO 3.6m telescope. The COMBO-17 survey (Wolf et al. 2003, A&A, 408, 499) yielded about 80 optically selected AGN in the E-CDFS that was subsequently imaged by HST in two filters. So far we studied each ~20 QSO host galaxies in the redshift range 0.5<z<1.1 (Sánchez et al. 2004) and 1.8<z<2.75 (Jahnke et al. 2004b) for their morphology and colors.

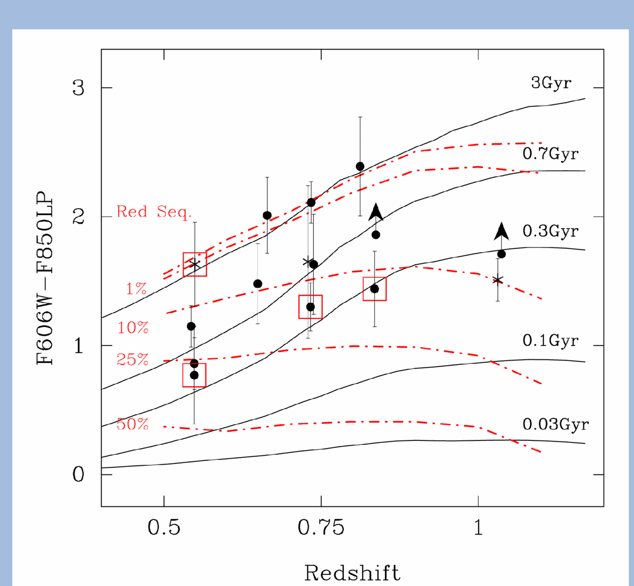
With AO we observed 3 luminous QSOs at z~2.2 from the Hamburg/ESO Survey (Wisotzki et al. 2000, A&A 358, 77) in the near infrared H band, and characterized their luminosities and scale lengths.

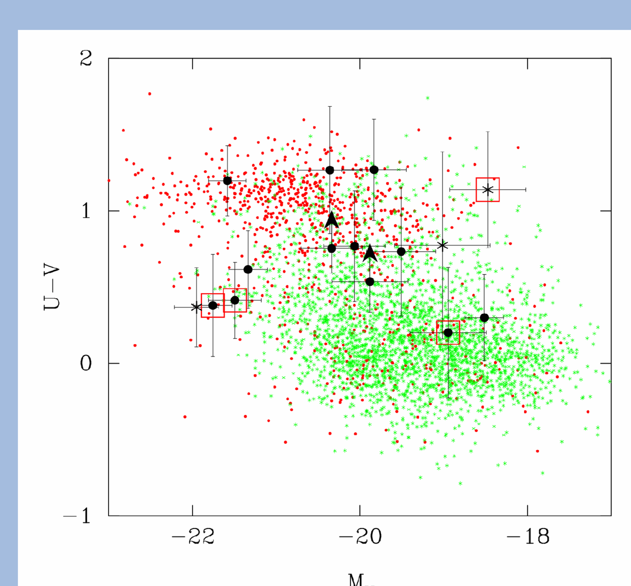
results GEMS, 0.5<z<1.1

Most of the 0.5<z<1.1 AGN hosts are early type galaxies. About 40% show distorted morphologies, pointing to recent or ongoing major merger events. A large fraction shows much bluer global optical colours than inactive early type galaxies from GEMS, but not in the range of strong starbursts. The best explanation is a stellar population mix of an old and a few percent in mass of a young (e.g. 100 Myrs) population. Only about 1/5 of the hosts shows a dominating old population.

results GEMS, 1.8<z<2.8

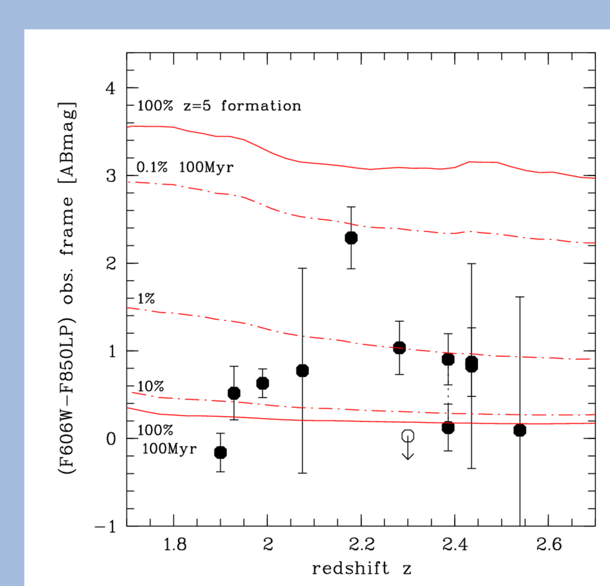
While determination of host morphologies was not possible at this redshift, we can determine individual UV-optical colors for 50% of the hosts and and red limits for the coadded rest. Colors are again inconsistent with pure old stellar populations. Either star formation is ongoing, then the SFR would be similar to that of Lyman Break Galaxies at z=2.5. Alternatively a passively fading population of e.g. 100 Myr plus (maybe) an underlying old population is possible.

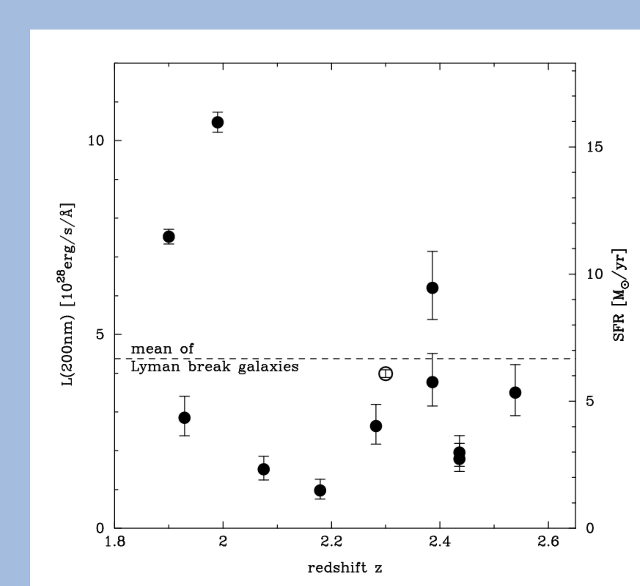




Left: Observed V-z colors for the z<1.1 hosts as a function of redshift (large symbols), compared to simple population models. The solid lines show the expected colors of single stellar populations with different ages, the dashed red lines colors of a dominant old stellar population and varying contributions from a young stellar population.

Right: Rest-frame color-magnitude distribution of the z<1.1 hosts compared to inactive galaxies from GEMS at the same redshift. The red sequence of early types (red points) is clearly identified in the field galaxy distribution (at U-V>0.8). The hosts are mainly early-type galaxies and on average bluer than the red-sequence.



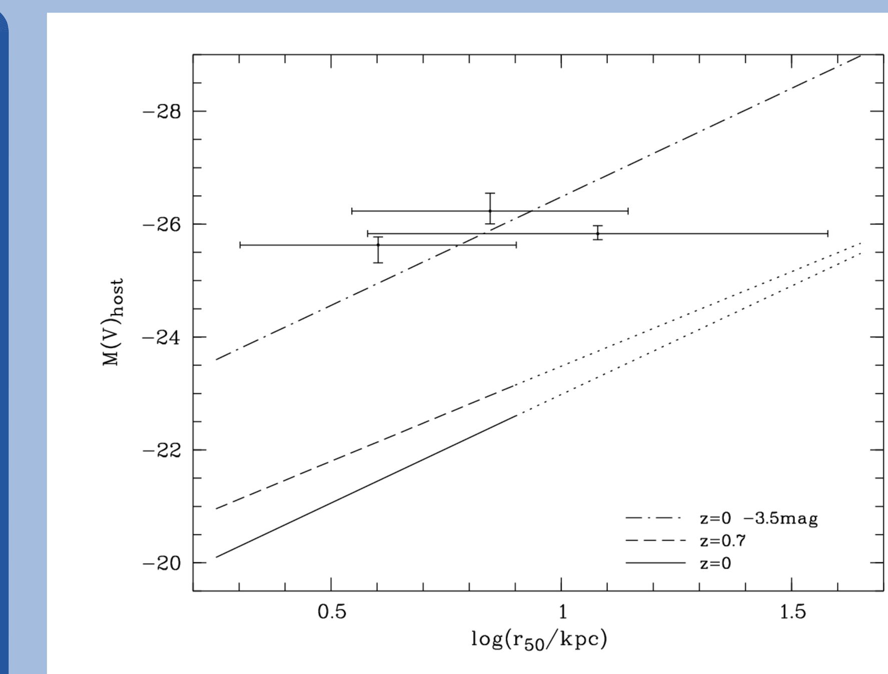


Left: Observed colors (V-z) of the z>1.8 hosts (large symbols). Overplotted are two single burst models from Bruzual & Charlot (solid lines). Upper curve: passively evolving burst from z=5, lower: burst of 100 Myr age, relative to each redshift. The dot-dashed lines are mixtures between the two, with a (from top) 0.1%, 1% and 10% fraction of mass of the 100 Myr population on top of the z=5 population.

Right: Rest frame 200nm luminosities, and potential star formation rates as derived from from the V-band, both uncorrected for dust. The horizontal dashed line is the value obtained by Erb et al. (2003, ApJ 591, 101) for Lyman break galaxies at z=2.5.

results AO, z=2.2

The three host galaxies are intriguingly luminous, especially given their relatively moderate sizes. If they are roughly ellipticals, then they show a much lower mass-to-light ratio than inactive elliptical galaxies at low redshifts, suggestive of a substantial young stellar population. If we, in the absence of colour information, simply assume that these galaxies will fade passively to reach the luminosity-size relations at low z, they would need to fade by ~3 mag to z=0.7 (4.2 Gyrs), or ~3.5 mag to z=0 (10.5 Gyrs). A single stellar population of 200-250 Myr (Bruzual & Charlot 2003, MNRAS, 344, 1000) would have this property, fading by ~2.8 mag and ~3.6 mag in these intervals, respectively. Although this involves a lot of assumptions, we conclude that we have detected the signature of a significant young stellar populations.



Luminosity-size relation of three AO observed host galaxies (symbols) at z=2.2 in the NIR, compared to literature relations. The solid line is the relation for early type galaxies at z~0 (Shen et al. 2003, MNRAS, 343, 978), the dashed line is the same relation at z~0.7 from GEMS (McIntosh et al. 2005, submitted to ApJ, astro-ph/0411772). The dot-dashed line is the z=0 relation shifted by -3.5 mag.

summary

Luminous QSOs at z>3 are also expected to have massive black holes and be mostly hosted by early type galaxies. Such galaxies should consist of - comparibly - old stars and have not much ongoing star formation. Despite this expectation **we find that the stellar composition of QSO host galaxies at 0.5<z<3 is inconsistent with being old, but point to ages of the light-dominating population of a few 100 Myrs. This is consistent with results for luminous Type 1 and 2 QSO hosts in the local universe**.

We interprete this as a **strong indication for a link of the accretion of black holes and global formation of stars in AGN hosts**. However, as for the majority of AGN hosts no major starbursts are seen, star formation and accretion might differ by a time lag of the order of a few 100 Myrs. One possible explanation is that most AGN activity and starformation in hosts of more luminous AGN is triggered by merging of galaxies.

publications

- Jahnke K., Wisotzki L. 2003, MNRAS, 346, 308
- Jahnke K., Kuhlbrodt B., Wisotzki K. 2004a, MNRAS, 352, 399
- Jahnke K., Sánchez S. F., Wisotzki L., & GEMS 2004b, ApJ, 614, 568
- Kuhlbrodt B., Örndahl E., Wisotzki L., Jahnke K., submitted to A&A
- Sánchez S. F., Jahnke K., Wisotzki L., & GEMS 2004, ApJ, 614, 586

collaborators

- GEMS: K. Jahnke, L. Wisotzki (AIP), S. F. Sanchez (CAHA/IAA), H.-W. Rix, E. Bell, M. Barden, A. Borch, B. Häußler, C. Heymans, K. Meisenheimer (MPIA), D. H. McIntosh (U Massachusetts), C. Wolf (Oxford), S. V. W. Beckwith, Peng C. Y., Somerville R. S.(STScI), J. A. R. Caldwell, S. Jogee (UT Austin)
- AO: K. Jahnke, L. Wisotzki, B. Kuhlbrodt (AIP), E. Örndahl (Tuorla)