I. Physikalisches Institut - Universität zu Köln

A low-luminosity type-1 QSO Sample

Insight from near-infrared integral-field spectroscopy of HE 1029-1831

Bonn-Cologne Graduate School of Physics and Astronomy

Gerold Busch[1*], Semir Smajić[1,2], Lydia Moser[1], Mónica Valencia-S.[1], Jens Zuther[1], Julia Scharwächter[3], Andreas Eckart[1,2]

1 I.Physikalisches Institut, Universität zu Köln, 2 Max-Planck-Institut für Radioastronomie, Bonn, 3 LERMA, Observatoire de Paris

Introduction

The properties of central supermassive black holes (SMBH) and their host galaxies have been found to follow tight correlations. This is often interpreted as indication for a coevolution-scenario. **The role of active galactic nuclei (AGN) in this context is not clear.**
In our recent study, we analyze 20 low-luminosity type-1 QSOs (LLQSOs) which are nearby AGN allowing for detailed structural analysis. **We show that LLQSOs do not follow the black hole mass (M_{BH}) - bulge luminosity ($L_{K,bulge}$) relation of inactive galaxies.** The reason for this deviation is unclear (undermassive black holes or overluminous bulges?).
To further investigate the details of star formation and AGN fueling in the centers of LLQSOs, we perform integral-field spectroscopy with SINFONI. Here, we present first results for the LLQSO HE1029-1831. The H_2 distribution suggests a big reservoir of molecular gas that is needed to fuel AGN and star formation. Although it is highly accreting (Eddington ratio of L_{bol}/L_{Edd}=0.23), the SMBH has a mass of only $\log(M_{BH})$=7.2, being offset from the relation by about 1.0 dex.

The LLQSO sample

- Representative subsample of the Hamburg/ESO survey, a wide angle survey for optically bright QSOs (Wisotzki+ 2000)
- Flux limit of $B_j \leq 17.3$
- Redshift limit of z=0.06

This results in a sample of 99 low-luminosity QSOs.

The M_{BH}-L_{bulge} relation

Tight correlations between central supermassive black holes (SMBH) and properties of the host galaxy's central spheroid have been found (M_{BH}-σ, M_{BH}-L_{bulge}, M_{BH}-M_{bulge}) and are often interpreted as an indication for a coevolution scenario.
We investigate the M_{BH}-L_{bulge} relation in the near-infrared.
NIR bulge magnitudes are the result of the 2d decomposition with BUDDA. BH masses for eleven objects have been measured by Schulze+2009 from single epoch visible spectra.

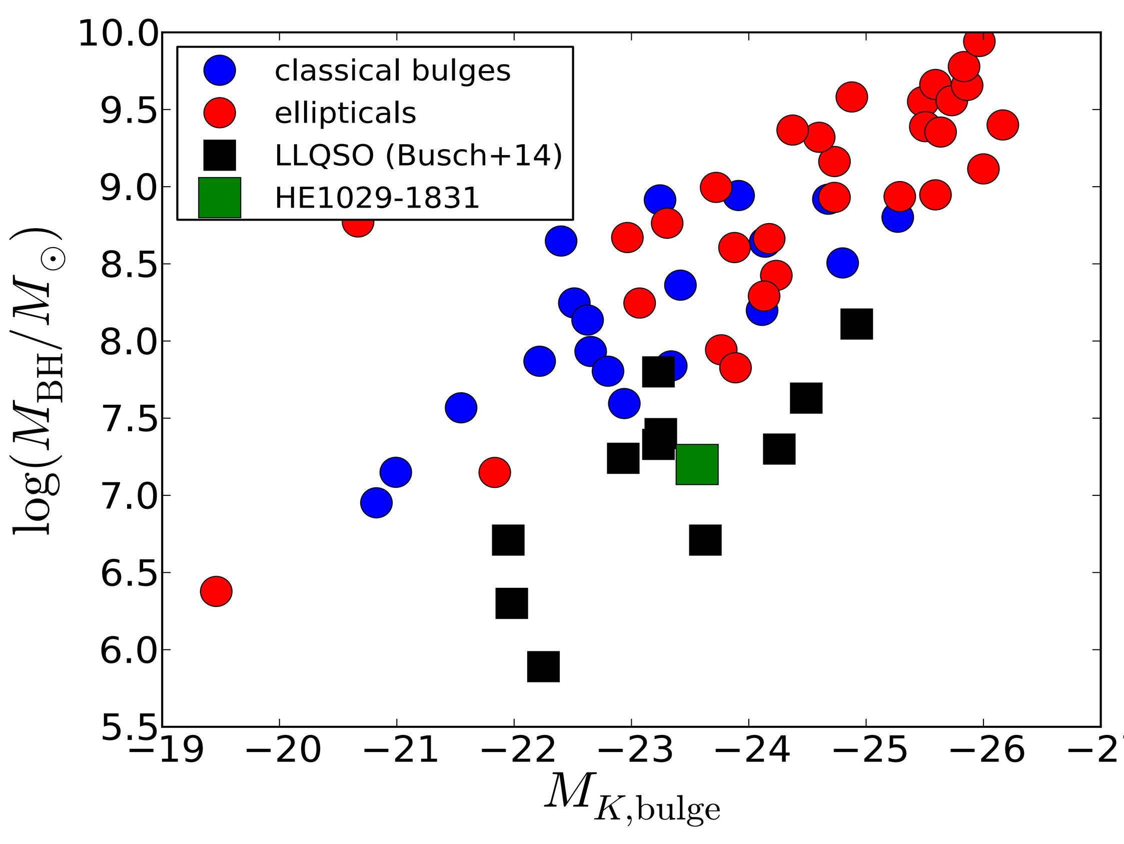

Fig. 1. *Black hole mass vs. K-band absolute magnitude. Blue and red data points (collected by Kormendy& Ho, 2013) are classical bulges and ellipticals that follow a M_{BH}-L_{bulge} correlation.*
Black and green squares are our data points for LLQSOs that do not follow the M_{BH}-L_{bulge} relation.

We compare our data with published M_{BH}-L_{bulge} relations and find that **the observed LLQSOs deviate from the relations** for inactive classical bulges and ellipticals. This could be explained by:
(a) the black holes being less massive *-or-*
(b) the bulges being more luminous than suggested by these relations.
(Busch+ 2014)

HE 1029-1831

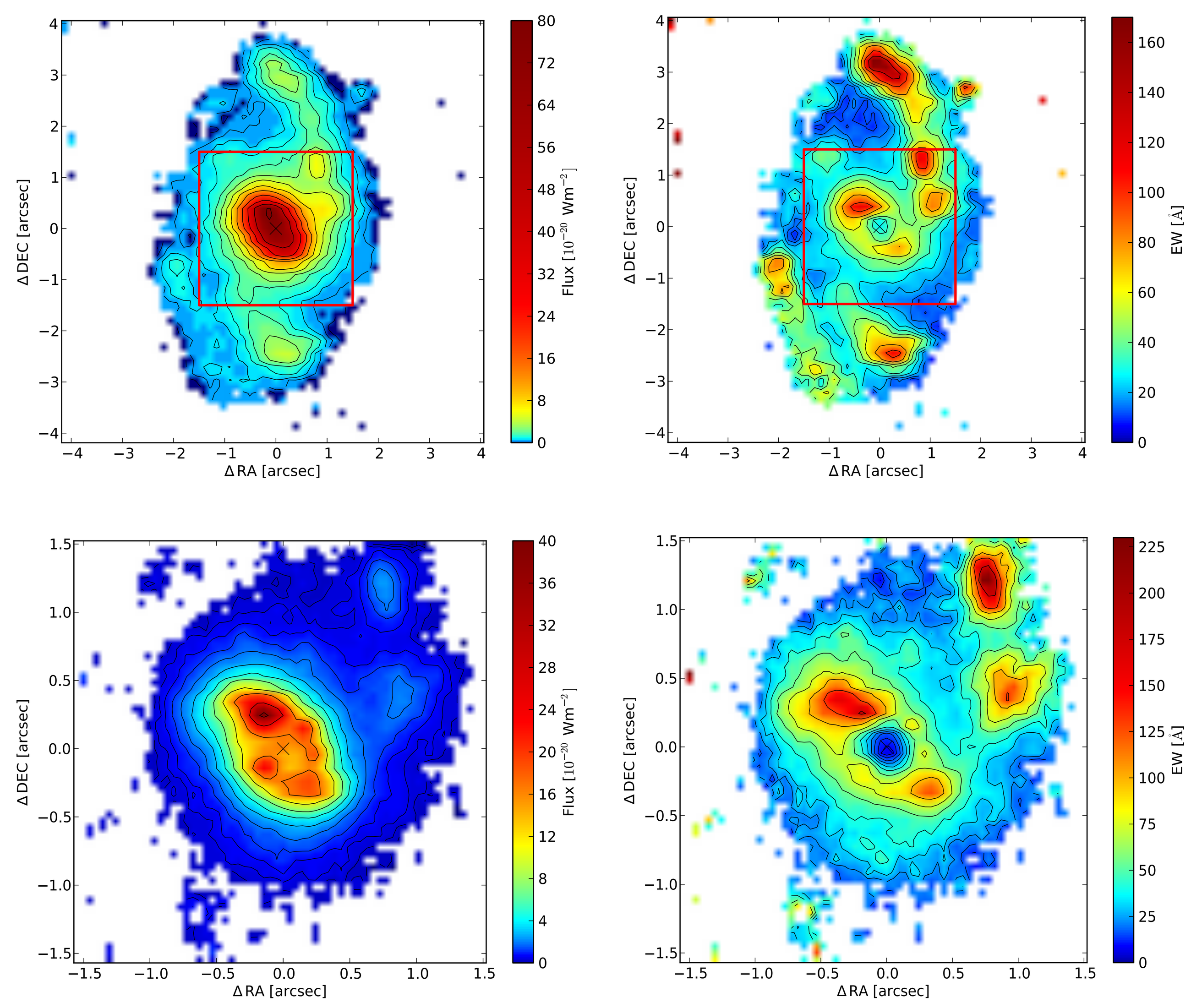

Fig. 2. *Ionized hydrogen (narrow Paα) emission of the LLQSO HE 1029-1831. Top panels: 8''x8'' FOV, lower panels: 3''x3'' FOV. Left: flux, right: equivalent width. In the upper panels, the 3x3 FOV is marked by a red box. The center of the continuum emission, i.e. the supected position of the central SMBH, is marked by a cross.*

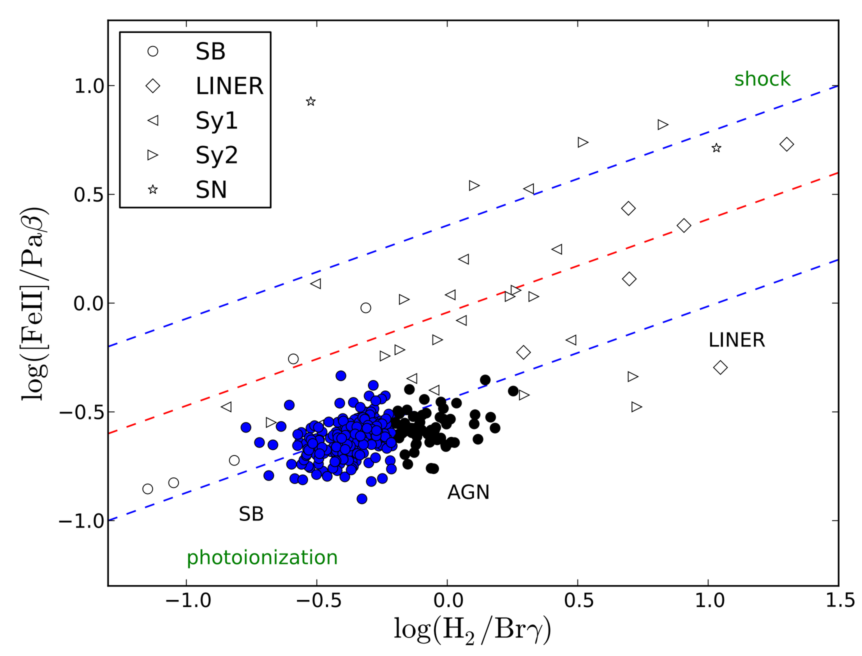

Fig. 3. *NIR diagnostic diagram (e.g. Rodríguez-Ardila+04). We calculate the line ratio log([FeII]/Paβ) using typical line ratios [FeII]λ1.644μm/λ1.257μm=0.744 (Nussbaumer & Storey 1988) and Paα/Paβ=2.05 (Osterbrock 1989).*
The line ratios observed for individual spaxels in HE 1029-1831 are marked by blue/black circles.
The observed line ratios indicate a significant contribution of star formation/photoionization to the excitation of the gas.

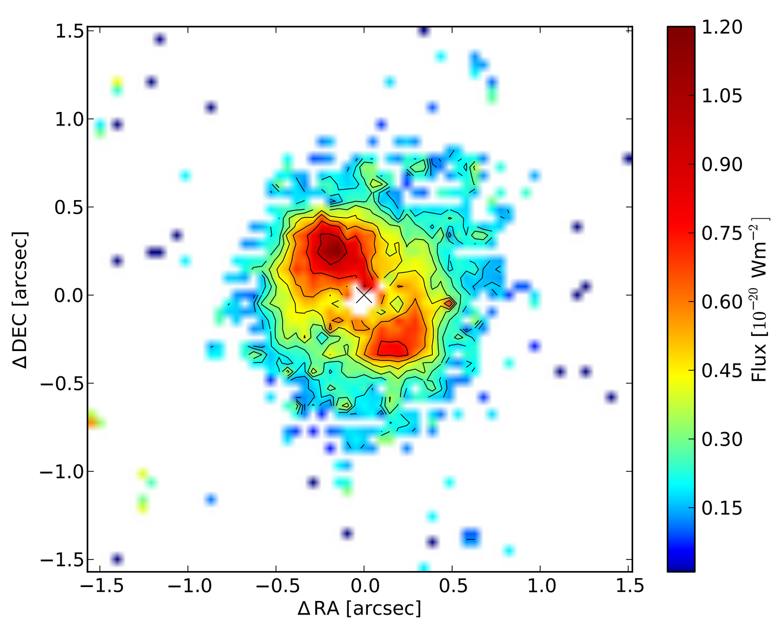

Fig. 4. *The map of the [FeII]λ1.644μm emission shows two off-nuclear peaks that trace gas excited by star formation and/or that is shocked by outflows from the nucleus.*

To further investigate the details of star formation and AGN fueling in LLQSOs, we perform 3D-spectroscopy of four LLQSOs with SINFONI. For HE 1029-1831, we obtain the following results:

- The HII line-maps show a spiral structure and a circumnuclear ring in the center of HE 1029-1831 (see Fig. 2).
- A Brγ equivalent width of ≥12Å in spots near the center is consistent with recent/ongoing massive star formation
- NIR line ratios (see Fig. 3) indicate a significant contribution of star formation/photoionization to the excitation of gas in the central region.
- From the H_2(1-0)S(1) emission in the central 3''x3'', we estimate a warm H_2 gas mass of 4500 M_{sun}, corresponding to a cold H_2 gas mass of (1-7)x10^9 M_{sun}. This is consistent with CO measurements of Krips+ 2006 and Moser+ (in prep.).
- The stellar velocity dispersion within the effective radius r_e≈500pc is σ=98km/s.
- Black hole mass estimates are $\log(M_{BH})$=7.3 from the broad Paα emission (relation of Kim+2010) and $\log(M_{BH})$=6.8 from the M-σ relation of Gültekin+2009.

The 3D-datacubes facilitate detailed observations of stellar and gas distributions in the centers of LLQSOs and enable us to analyze star formation activity and BH fueling. Comparing with NUGA-galaxies at lower redshift and quasar samples at higher redshift, the LLQSO sample can be established as a 'bridge'-sample: The nuclear activity is higher compared to NUGA. However, unlike quasar samples at higher redshift, detailed analysis is still possible with new-generation instruments and will allow for detailed insight in fueling activities of quasars.

References

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*For further information, please contact busch@ph1.uni-koeln.de