Integral field spectroscopy of low-redshift QSOs and Seyfert galaxies -

Dependence of extended emission-line regions on nuclear properties

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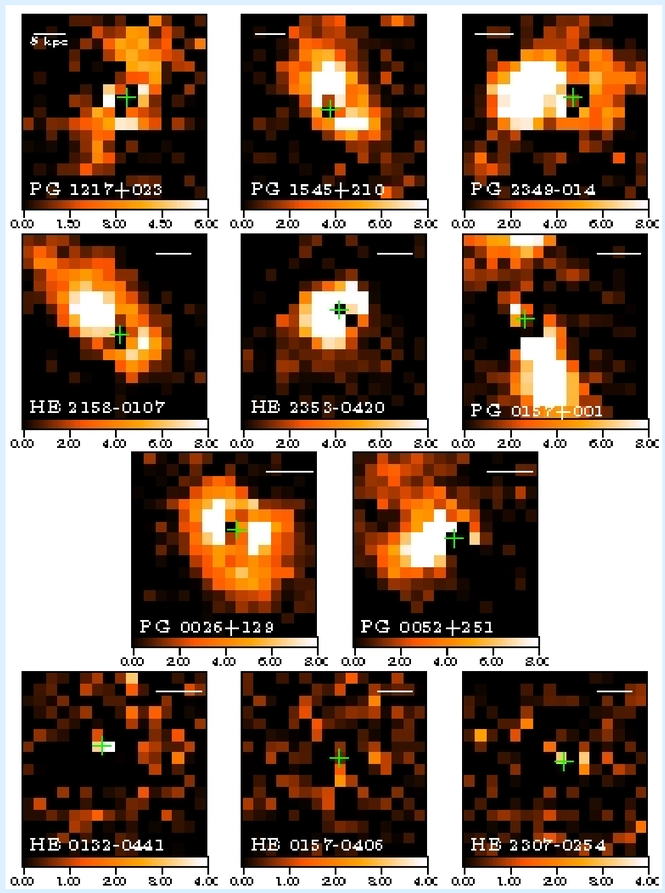
The interstellar medium (ISM) in the host galaxies of QSOs and Seyfert galaxies can be heated and ionized by the nuclear UV-radiation or by a jet-cloud interaction. So far, mainly radio-loud QSOs have been studied to investigate the effect of a jet on its gaseous surrounding. We started a programme to systematically study the ionized component of the ISM in mainly radio-quiet QSOs and Seyfert galaxies on kpc scales by means of integral field spectroscopy. Our first results show an intricate connection between the spectral properties of the nucleus and the detection of extended emission-line regions (EELRs) being the tracer for an ionized ISM. The physical driver for this connection remains unknown and needs further investigation to better understand the role of AGN feedback processes in the evolution of galaxies.

The QSO sample – EELR maps

We observed 20 low-redshift ($z < 0.3$) QSOs with the PMAS IFU (Calar Alto Observatory). 4 of the objects are radio-loud QSOs (RLQ) while the remaining 16 objects are radio-quiet QSOs (RQQ).

[OIII] λ5007 narrow-band images (8" x 8") extracted from the IFU datacube are shown *on the right*. We subtracted the nuclear emission using the technique proposed by Christensen et al. (2006, A&A, 459, 717). Some oversubtraction is still visible at the location of the QSO (green cross). The white marker shows a 5 kpc linear scale at the QSO redshift.

We found that 8/20 QSOs show an EELR with a linear size of the order of ~15kpc. Only 3 of them are RLQs and 5 are RQQs. The line ratio [OIII]/Hβ is about 10 for all EELRs implying ionization by the AGN. We show here only a subset of 3/12 undetected sources to illustrate the significance of the EELR detections.

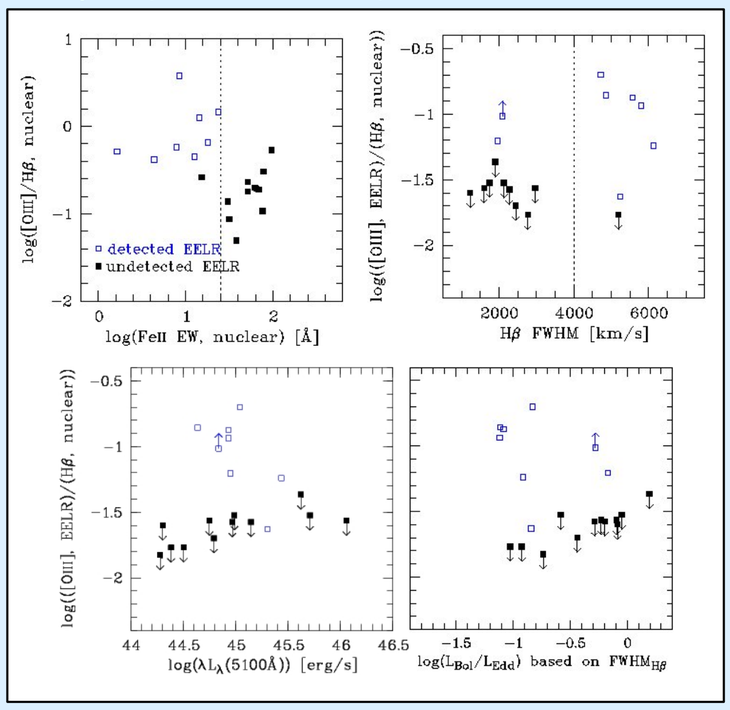


Relations between EELR and QSO properties

In essentially all QSOs where we detected an EELR in [OIII], we measured FeII emission to be very weak in their *nuclear spectra*. Thus, QSOs with and without an EELR populate two distinct groups (*upper left plot*) with a cut at log(Fe II EW)=1.4.

Comparing the EELR [OIII] flux normalized by the nuclear Hβ flux with the FWHM of broad Hβ emission line, we found again a clear separation of the two groups at a FWHM of 4000 km/s (*upper right panel*), albeit with a slightly larger number of interlopers.

By exploring more fundamental quantities of the AGN we found that our QSOs have similar distribution of continuum luminosities (*lower left panel*) and Eddington ratios (*lower right panel*). Thus, neither the luminosity nor the Eddington ratio of the QSO seems to be primarily responsible for the presence of an EELR.

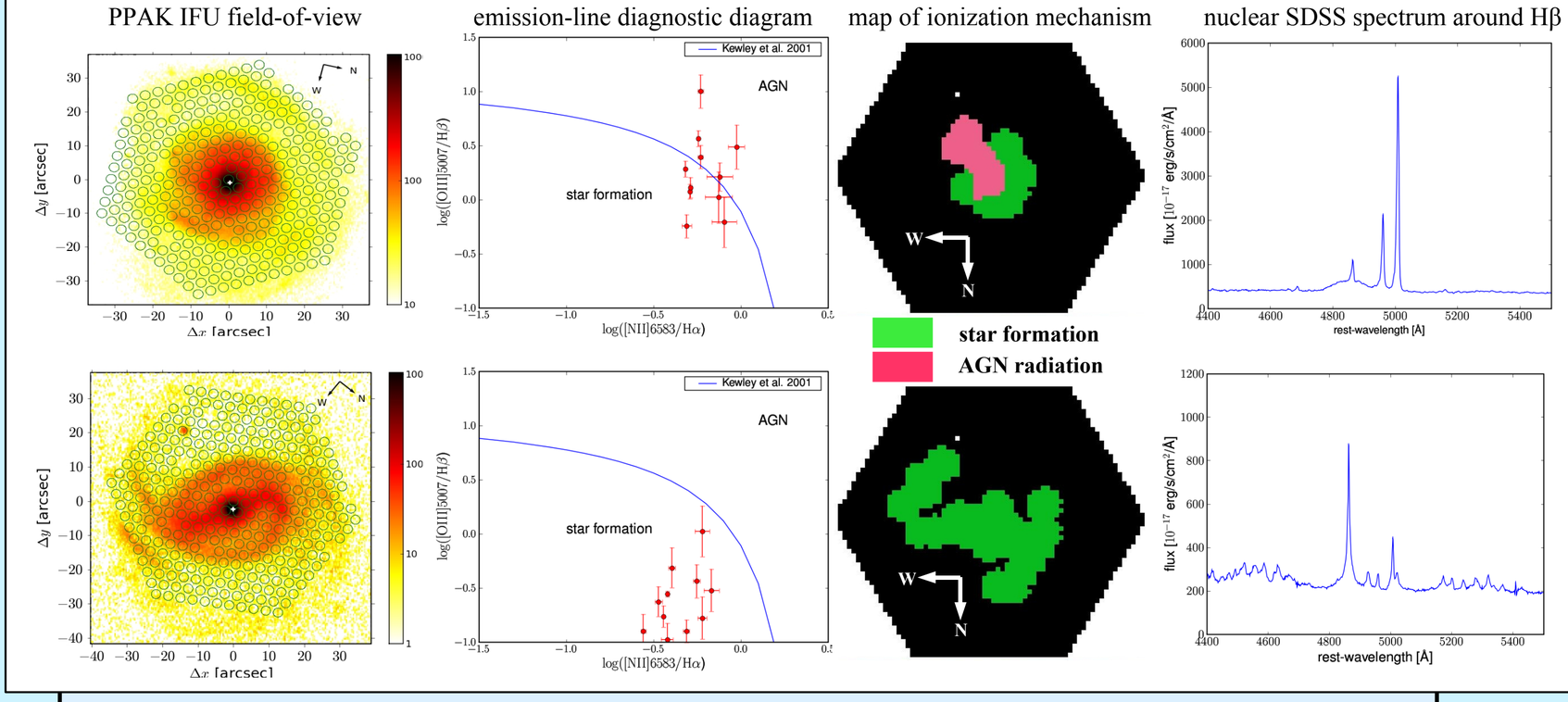


An X-ray selected sample of Seyfert galaxies – Preliminary results

To extend the range in AGN luminosities, we analysed an X-ray selected sample of Seyfert galaxies observed with the PMAS/PPAK IFU. Due to the X-ray selection the sample contains not only Seyfert 1 galaxies (8 objects), but also Seyfert 2 galaxies (4 objects). The results for the Seyfert 1 galaxies are in agreement with what we found for the QSOs. We show these preliminary results qualitatively by comparing the properties of the ISM and the nuclear spectra for the two Seyfert 1 galaxies RBS 1367 and RBS 1545:

The *first panel* shows the fibre positions of the IFU overplotted on the g'-band SDSS images. The emission-line fluxes of Hβ, [OIII] λ5007, Hα, [NII] λ6583 are measured after subtraction of the stellar continuum and plotted in a diagnostic diagram (*second panel*) to discriminate between ionization by AGN and star formation. The corresponding interpolated map of the ionization mechanisms is shown *in the third panel*. This can be compared with the nuclear spectrum (*fourth panel*). Only Seyfert 1 galaxies with weak nuclear FeII emission and a broad Hβ component have an ISM which is at least partly ionized by the AGN.

The ionization state of the ISM in two Seyfert 1 galaxies: RBS 1367 and RBS 1545



Conclusions

EELRs can be found around high and low luminosity AGN irrespective of their radio activity. We found, however, that the detection of an EELR can be linked to the nuclear spectral properties of the AGN itself. It appears that we can predict the presence and properties of an EELR already from the nuclear spectrum.

This is a very important result as it gives a relation between the properties of the sub-pc scale nucleus and the properties of the super-kpc scale ISM in the host galaxy. Since we can basically rule out the QSO luminosity as a driver for this connection, there remain probably only two possibilities:

1. Differences in the structure of the nuclear region (e.g. inclination)

2. The properties of the host galaxies of the two QSO classes are intrinsically different.