

OzSSy1: The Australian Southern Seyfert-1 Spectroscopic Atlas and Catalogue at $z < 0.1$

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ABSTRACT

We present a spectroscopic atlas of 887 broad-line active galactic nuclei (AGNs) in the Southern sky, spanning redshifts $z < 0.1$, declinations $\delta < 0^\circ$ and Galactic latitudes $|b| > 10^\circ$. **The sample aims at being a largely complete census of nearby broad-line AGN.** The atlas is constructed from observations with $R \sim 3000$ using the integral-field Wide Field Spectrograph at the Australian National University 2.3 m telescope. Spectra are extracted in a 6.7 arcsec aperture and have a median signal-to-noise ratio of 13 and 23 per Å in the blue and red arms, respectively. Each spectrum is accompanied by a spectral decomposition that models the AGN continuum and host galaxy, along with fits to the emission lines H γ , H β , H α , He II, He I, [O III], [O I], [N II] and [S II], including broad Balmer and Helium components. The data products are publicly available and designed to support studies of population demographics and AGN variability in conjunction with future time-domain surveys.

Key words: methods: observational – atlases – catalogues – galaxies: active – galaxies: Seyfert

1 INTRODUCTION

The spectral energy distribution of active galactic nuclei (AGNs) spans the entire electromagnetic spectrum (Brown et al. 2019). In the optical, emission from the viscous accretion disc and surrounding gas produces diagnostic emission lines whose luminosities, widths, ratios, and profiles encode the physical conditions of the broad- and narrow-line emitting regions (BLR and NLR). These features enable redshift measurements and single-epoch estimates of supermassive black hole (SMBH) masses, making large spectroscopic samples particularly valuable for AGN population studies.

Optical AGN samples are often incomplete at low luminosities and low redshifts, where host-galaxy starlight can dominate the observed emission and cause AGNs to be missed by photometric selection (Ho et al. 1997; Ho 2008; Barquín-González et al. 2024). Spectroscopy is therefore necessary to unambiguously confirm the presence of an active nucleus in such systems, with sensitivity limited by the contrast between the point-source AGN and the extended host galaxy. This paper presents a spectroscopic atlas and catalogue of type 1 Seyfert galaxies in the Southern hemisphere at $z < 0.1$, designed to provide a highly complete community resource.

Seyfert galaxies (Seyfert 1943) are most readily identified at low redshifts, due to their intrinsically lower luminosity relative to quasars, enabling access to the longest rest-frame temporal baselines for characterising AGN variability. Accretion disc emission is

intrinsically variable across timescales from days to decades, reflecting stochastic accretion processes and structural instabilities (Kelly et al. 2009; Cackett et al. 2021; Arévalo et al. 2024; Blaes et al. 2025). Crucially, low-luminosity AGNs exhibit more rapid and higher-amplitude UV-optical variability than their more luminous quasar counterparts (Vanden Berk et al. 2004; Tang et al. 2023; Tan et al. 2026), making nearby Seyferts preferred targets for reverberation mapping (RM; Blandford & McKee 1982; Peterson et al. 2004) of the BLR (Wang & Woo 2024) and other variability studies.

An increasing availability of wide-field time-domain photometry opens new windows on AGN variability. Current large photometric surveys include the Asteroid Terrestrial-impact Last Alert System (ATLAS; Tonry et al. 2018) and the Zwicky Transient Facility (ZTF; Bellm et al. 2019). These all-sky or wide-area surveys have operated for nearly a decade and will be complemented and extended by the Legacy Survey of Space and Time (LSST; Ivezić et al. 2019), which will deliver unprecedented photometric cadence and depth over a ten-year baseline. Among the most striking phenomena uncovered are changing-look AGNs (CLAGNs; see review by Ricci & Trakhtenbrot 2023), in which broad emission lines appear or disappear on timescales of months to years (Tohline & Osterbrock 1976; MacLeod et al. 2016, 2019; Amrutha et al. 2024). Further varieties of nuclear transients are being discovered, including tidal disruption events (TDEs; Gezari 2021) and slow blue nuclear hypervariables (Lawrence et al. 2016).

Interpreting these events requires comparison against a well-characterised archival reference spectrum (López-Navas et al. 2022, 2023; Sánchez-Sáez et al. 2024; Fries et al. 2024), but spectroscopic

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variability studies are limited by the expense of repeat observations. Large-scale programmes, such as the Sloan Digital Sky Survey Reverberation Mapping (SDSS-RM; [Shen et al. 2019](#)) project, have monitored AGNs over multi-year baselines, but are restricted to small sky areas (e.g. a single 7 deg^2 field) and modest sample sizes. Longer-baseline spectroscopic monitoring exists for only a handful of nearby AGN, including well-studied systems such as NGC 5548 and NGC 4151 ([Bon et al. 2016](#); [Chen et al. 2023](#)), which have been observed for 43 years and 28 years respectively in observed frame. While these intensive campaigns have provided critical insights into AGN structure and variability, they are necessarily limited in their ability to generalise variability across the broader AGN population. The SDSS-V Black Hole Mapper ([Kollmeier et al. 2026](#)) currently represents the most ambitious ongoing effort, but the SDSS efforts have been concentrated in the Northern hemisphere, with the first large data release in the Southern hemisphere still imminent.

In the Southern hemisphere, the 6-degree Field Galaxy Survey (6dFGS; [Jones et al. 2004, 2009](#)) provides the most complete flux-limited spectroscopic catalogue of galaxies at $z < 0.1$. Several studies have already exploited 6dFGS subsets as reference epochs for variability studies ([Malyali et al. 2024](#); [Amrutha et al. 2024](#); [Saha et al. 2025](#); [Wang et al. 2025](#); [Tan et al. 2026](#)). However, the 6dFGS observations were obtained approximately two decades ago, a timescale comparable to the characteristic BLR orbital period in low-luminosity AGN ([Amrutha et al. 2026](#)). Furthermore, the spectra are not flux-calibrated and were obtained using a wide-field Schmidt telescope with a small plate scale and a fibre diameter of 6.7 arcsec , encompassing a substantial fraction of host-galaxy light for nearby AGN. While AGNs within 6dFGS have since been identified and their emission lines measured ([Chen et al. 2022](#); [Hon et al. 2025](#); [Suresh et al. 2025](#)), the original observations are not ideally suited as reference epochs for contemporary variability studies.

Re-observing the low-redshift 6dFGS AGN population therefore offers an opportunity to establish a modern, homogeneous spectroscopic reference sample with a multi-decade temporal baseline. Such a dataset enables population-level constraints on long-term spectroscopic variability, provides a benchmark for identifying anomalous behaviour and nuclear flaring events discovered in photometric surveys, serves as a pre-LSST spectroscopic reference ahead of future surveys such as the 4MOST Hemisphere Survey ([Taylor et al. 2023](#)), and complements the SDSS-V Black Hole Mapper spectra.

In this work, we present a spectral atlas of a sample of 887 AGN at $z < 0.1$ observed with the Wide Field Spectrograph (WiFeS) on the ANU 2.3-m telescope at Siding Spring Observatory. The data release comprises reduced integral field data cubes, extracted AGN spectra, along with AGN–host decomposition, and a catalogue of continuum and emission-line measurements, allowing a broad range of AGN population studies while providing a spectroscopic reference for variability studies. The sample is predominantly drawn from the 6dFGS broad emission line AGN sample by [Hon et al. \(2025\)](#) but complemented with other selections of broad line AGNs.

This paper is structured as follows: Section 2 describes the target selection. Sections 3 and 4 explain observations, data reduction, spectrum extraction and decomposition. Section 5 discusses the quality of the spectra and Section 6 the overall sample properties. Section 7 presents example science cases, and Section 8 summarises the paper. The data product structure is listed in Appendix A. Throughout the paper, we use AB magnitudes, with the exception of 2MASS-XSC magnitudes which are presented in Vega magnitudes, and adopt a flat Λ CDM cosmology with $\Omega_\Lambda = 0.7$ and $H_0 = 70 \text{ km s}^{-1} \text{ Mpc}^{-1}$.

2 SAMPLE DEFINITION

This atlas aims to be as complete as possible for Southern broad-line AGNs at $z < 0.1$, encompassing both previously catalogued objects and newly identified systems, subject to sufficient AGN-to-host contrast. The sample consists of 887 unique AGNs, whose sky distribution is presented in Figure 1. In the following, we explain the construction and completeness of the sample.

2.1 Parent sample and target selection

The majority of sources in our sample are drawn from the 6-degree Field Galaxy Survey (6dFGS; [Jones et al. 2004, 2009](#)), a redshift survey with a primary target selection based on near-infrared (NIR) K -band magnitudes from the Two Micron All Sky Survey Extended Source Catalogue (2MASS XSC; [Jarrett et al. 2000](#)). The 6dFGS contains 125,071 galaxies complete to $K < 12.65 \text{ mag}$, with a median redshift of $z \sim 0.053$, and covers the Southern sky at Galactic latitude $|b| \geq 10^\circ$.

From this parent galaxy sample, [Hon et al. \(2025\)](#) identified a large sample of broad emission-line AGN, which is the first pillar of our target selection. We restrict this to $z < 0.1$, beyond which the $\text{H}\beta$ – $[\text{O III}]$ complex approaches the strong $\lambda 5577 \text{ \AA}$ sky emission line, making accurate sky subtraction difficult. This redshift cut yields 784 broad-line AGN. We include all objects in this parent sample regardless of close foreground neighbours ($< 3 \text{ arcsec}$), bad 6dFGS spectra, or high Galactic extinction, since we independently re-observe the sample with a different instrument.

As a small supplement, we include low-redshift AGNs from the Siding Spring Southern Seyfert Spectroscopic Snapshot Survey (S7; [Thomas et al. 2017](#)). These galaxies were originally selected to map ionisation cones in nearby ($z < 0.023$) AGNs with high spatial resolution. While these observations were obtained with the same instrument (see Section 3), type 1 AGNs can be strongly variable, and we re-observe them to provide an updated spectroscopic dataset. Only the eleven type 1–1.9 Seyferts were included, as type 2 objects are beyond the scope of this atlas.

Since 6dFGS is selected from the 2MASS XSC, it excludes point sources and is therefore incomplete for more luminous AGN, where emission dominates that of the host galaxy and produces a quasar-like appearance, such as 3C 273 ([Schmidt 1963](#)) and PDS 456 ([Torres et al. 1997](#)). To address this, we include AGN found by a sister project, the All-Sky Bright Complete Quasar Survey (AllBRICQS; [Onken et al. 2023](#)). AllBRICQS is constructed from *Gaia* (DR3; [Gaia Collaboration et al. 2023](#)) and mid-infrared *WISE* data (CatWISE2020; [Marocco et al. 2021](#)) to identify bright quasars. The infrared selection begins with *Gaia* sources of $R_p \leq 18$, Galactic latitude $|b| > 10^\circ$, that are consistent with negligible parallax and proper motion. The AllBRICQS spectral atlas for quasars at $0.1 < z < 5$ will soon be published, while $z < 0.1$ objects are presented here. AllBRICQS has provided 40 type 1 AGNs to this atlas, 3 from [Onken et al. \(2023\)](#), and the 37 new discoveries yet to be published.

6dFGS was designed as a redshift survey, where ~ 12 per cent of targets with existing archival spectroscopy were excluded from 6dFGS observations. Consequently, the 6dFGS AGN sample is not fully complete. We therefore extend the sample using the Milli-quas catalogue ([Flesch 2023](#)), selecting sources with $z < 0.1$, declination $\delta < 0^\circ$, and Galactic latitude $|b| \geq 10^\circ$, matching the sky coverage of the 6dFGS selection. To avoid the large number of host-dominated systems at low redshift where broad-line signatures may fall below our sensitivity limit, we apply a redshift-dependent magnitude limit of $K < 13 + 3 \log(z/0.1) \text{ mag}$ (Fig-

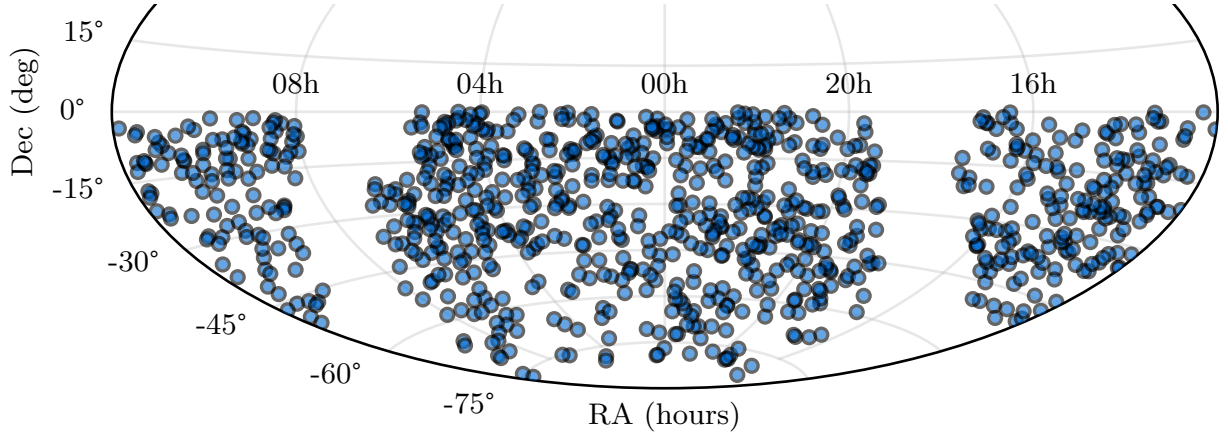


Figure 1. Distribution of the 887 AGNs in the atlas on the sky: The sample covers the Southern hemisphere at Galactic latitudes $|b| \geq 10^\circ$.

ure 2; using K_{m_ext} from 2MASS XSC), and require Milliquas objects to additionally satisfy selection criteria similar to AILBRICQS. In particular, we require: $Gaia R_p \leq 18$, $parallax_over_error < 5$, $(pmra/pmra_error)^2 + (pmdec/pmdec_error)^2 < 25$ or $pmra^2 + pmdec^2 < 0.04$, BP/RP excess factor < 4 , and the *WISE* colour criterion $W1 - W2 > -0.25(R_p - W1 - 3.3)$.

After removing duplicate sources across all input catalogues, the final sample consists of 887 unique AGNs. This combined dataset forms the basis of the IFU atlas presented in this work. The heterogeneous origin of the sample naturally introduces selection effects, particularly at the lowest AGN luminosities. These are discussed in the following section.

2.2 Sample completeness

The parent 6dFGS sample is complete to $K < 12.65$ mag, brighter than the completeness limit of the 2MASS XSC ($K \sim 14$ mag; Jones et al. 2009). Since 6dFGS is a galaxy survey rather than an AGN-targeted survey, the spectroscopic identification of type 1 AGNs by Hon et al. (2025) ensures that the completeness of the 6dFGS AGN sample inherits the completeness of the underlying galaxy population at this magnitude limit, with the exception of the 12 per cent of the galaxies in the 6dFGS catalogue without 6dFGS spectra. The Milliquas supplement and its additional AILBRICQS cuts together recover AGNs missed within the 6dFGS footprint and extend coverage to point-source-like quasars absent from the 2MASS XSC, while the redshift-dependent magnitude limit excludes host-dominated systems at $z \lesssim 0.03$ where broad-line identification becomes increasingly incomplete owing to reduced AGN-to-host contrast. The combined sample is therefore expected to be effectively complete for luminous type 1 AGNs across $z < 0.1$, with the dominant residual incompleteness arising from host-galaxy dilution at the lowest redshifts. The S7 and AILBRICQS samples supplement the 6dFGS and Milliquas selections by recovering broad-line AGNs missed due to lack of 6dFGS spectra or incompleteness in the literature samples compiled in Milliquas.

A further limitation arises from AGN variability. The 2MASS photometry, obtained more than two decades prior to the WiFeS observations, may not reflect the AGN luminosity at the epoch of spectroscopic follow-up. AGN luminosities can vary by factors of ~ 2 over such timescales (Amrutha et al. 2026; Tan et al. 2026), causing sources to scatter across the adopted magnitude boundary in either direction. All type-2 AGNs in the 6dFGS catalogue (Suresh

et al. 2025) exhibiting photometric variability have been followed up spectroscopically to identify the emergence of broad emission lines (i.e., turn-on CLAGN; Hon et al. 2022; Amrutha et al. 2024). Turn-off CLAGN are already included through their earlier broad-line classifications in 6dFGS.

Other compilations of CLAGN (see list in Camus & Panda 2026, and references therein) are largely drawn from Northern-hemisphere surveys, extend beyond $z \sim 0.1$, or are constructed from previously known type-1 AGN samples, favouring the identification of turn-off events. Furthermore, most CLAGN classifications are based on changes in the broad $H\beta$ line, whereas broad $H\alpha$ is often present in both spectral states and would therefore already satisfy our selection criteria. These considerations indicate that the present sample captures the vast majority of CLAGN within the defined selection boundary, with the primary remaining incompleteness arising from short-lived double-transitions in type-2 AGNs not observed spectroscopically during their active phase.

Therefore, the sample is effectively complete for luminous type 1 AGN with $K < 12.65$ mag and $z < 0.1$, with the dominant sources of residual incompleteness being host-galaxy dilution at $z \lesssim 0.03$, and variability-driven flux changes across the magnitude boundary.

3 DATA

3.1 Observations

Observations were carried out at the Australian National University (ANU) 2.3-m telescope (Mathewson et al. 2013) at Siding Spring Observatory. We used the Wide Field Spectrograph (WiFeS; Dopita et al. 2007, 2010), an integral field unit (IFU) with a field of view of 38×25 arcsec² sampled by 1 arcsec² spaxels, corresponding to spatial scales of 200 pc at $z = 0.01$ and 1.9 kpc at $z = 0.1$. We adopt the B3000 and R3000 gratings, providing a combined wavelength coverage of 3200–9800 Å with a mean resolution of $R \approx 3000$, corresponding to a velocity resolution of ~ 100 km s⁻¹.

The observations for this sample were obtained between 2020 and 2026 (MJD 59015–61147), with approximately half of the spectra acquired during the 2023 calendar year. The observing campaign expanded significantly following the transition of the ANU 2.3-m telescope to robotic operations in March 2023 (Price et al. 2024). Spectra obtained prior to this date were drawn from archival observations conducted for other programmes, including those presented

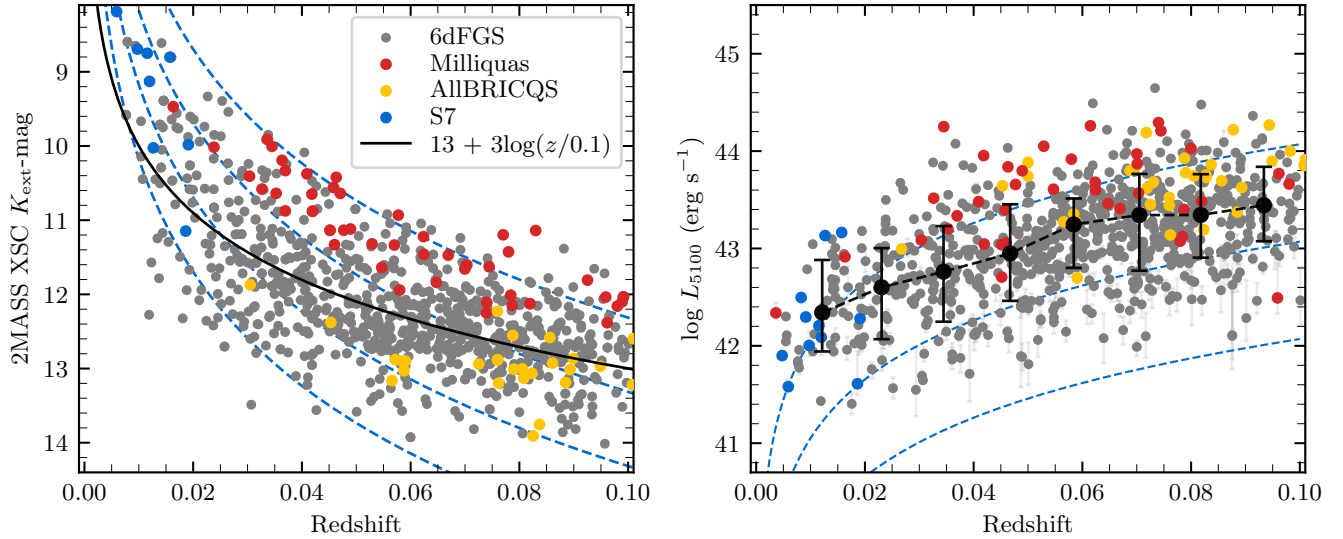


Figure 2. AGN sample. **Left:** K magnitudes (K_{ext} column from 2MASS XSC) vs redshift. Dashed lines denote constant absolute magnitudes of M_K : $\{-23, -24, -25, -26\}$. The solid line marks the heuristic $K < 13 + 3 \log(z/0.1)$ limit we use for the Milliquas selection. The source surveys of the AGNs are marked separately. **Right:** The AGN monochromatic luminosity of the continuum, L_{5100} (λL_λ at $\lambda 5100\text{\AA}$), as a function of redshift. The running median is shown, with error bars indicating the 16th–84th percentile range. Objects with large errors indicate degeneracy with the host continuum. Dashed lines denote constant apparent flux (erg s⁻¹ cm⁻² Å⁻¹): $\{10^{-15}, 10^{-16}, 10^{-17}\}$.

in Hon et al. (2022) and Amrutha et al. (2024) for the identification of Changing-Look AGN. Several further of the archival spectra were obtained for student theses but not yet published in refereed journals.

Individual targets were typically observed in a single exposure with integration times ranging from 350 to 1800 s. Exposure times were selected based on the r -band magnitudes from the SkyMapper Southern Sky survey (SMSS DR4; Wolf et al. 2018; Onken et al. 2024). Observations were conducted during dark or grey time (< 50 per cent lunar illumination), with the brightest targets observed under grey conditions, as scattered moonlight can affect measurements of the $\text{H}\beta$ –[O III] emission-line complex in the blue arm. In some cases, observations were made at higher lunar illuminations, with large angular separation from the Moon. The average seeing conditions at the observatory is 2 arcsec, and observations were conducted with a median airmass of 1.08 with near-polar objects observed at a naturally higher airmass (> 1.3 for $\delta < -75^\circ$).

While preparing robotic observation blocks, the instrument field of view was occasionally shifted by a few arcseconds or rotated to avoid bright neighbouring sources entering the IFU field. For extended targets, we positioned the field such that a region free of host-galaxy emission was available for sky estimation. In cases where the host galaxy extended across the entire field of view, we instead used the nod-and-shuffle observing mode. In this configuration the telescope alternates between the target and a nearby blank sky position, allowing the sky background to be measured separately. Although this approach effectively doubles the required observing time, these objects are typically the brightest and nod-and-shuffle mode provides significantly improved sky subtraction compared to the standard observing mode.

3.2 Data cube generation

The integral field data cubes were reduced using an updated version (Onken et al., in prep) of the PyWiFeS¹ pipeline described by Childress et al. (2014). We briefly summarise the reduction procedure here. The PyWiFeS pipeline performs standard CCD reduction and cube reconstruction procedures. Raw frames are first bias-subtracted and corrected using dome flat-field exposures to remove pixel-to-pixel sensitivity variations. Wavelength calibration is performed using arc-lamp exposures, producing a wavelength solution for each slitlet. The data are then rectified and assembled into a three-dimensional data cube with two spatial dimensions and one spectral dimension. The cubes are corrected for atmospheric differential refraction, which causes an excess deflection of light of bluer wavelengths. Flux calibration is implemented using observations of spectrophotometric standard stars with identical instrument settings and extracting their instrumental spectra in a circular aperture with 12 arcsec diameter. Telluric absorption features are corrected using the same standard star observations for just the red arm. For observations conducted in nod-and-shuffle mode, sky subtraction is performed directly within the pipeline using the interleaved sky exposures, while for standard observations the sky subtraction is handled during the spectral extraction stage as described in Section 4. The final products of the pipeline are wavelength-calibrated and flux-calibrated integral field data cubes for both the blue and red spectrograph arms. The two arms are independently reduced, and the cubes are re-binned in the wavelength axis, with even bin widths of $0.77\text{\AA}$ for the blue arm and $1.25\text{\AA}$ for the red arm.

¹ <https://github.com/PyWiFeS/pywifes>

3.3 Spectrum extraction

From the reduced IFU data cubes we extract integrated spectra of the AGN. This first requires subtraction of the sky emission from the cube. For objects observed in nod-and-shuffle mode this step is unnecessary, as sky subtraction is already performed during cube generation. However, since the majority of objects were observed in the standard observing mode, we estimate the sky spectrum directly from the cube. A circular sky region with a diameter of 5 arcsec was selected and the median spectrum within this region was subtracted from the entire cube. This region is sufficiently large to obtain a robust median sky spectrum, while remaining small enough that spatial variations in the background are negligible. For WiFeS in particular, each vertical detector strip shares a consistent wavelength calibration. Therefore, where possible, the sky region was chosen to lie along the same detector column as the AGN centroid, otherwise the sky subtraction would leave large residuals on prominent sky emission lines.

Given the low redshifts of the sample and the 1 arcsec² spatial resolution of WiFeS, the host galaxies of most AGN are spatially resolved in the IFU data. An annular sky subtraction was therefore not appropriate, as the host galaxies exhibit a wide range of spatial extents and morphologies, making it difficult to define a uniform background region surrounding the nucleus. Instead, both the AGN centroid and the sky region were manually selected using the visual extraction tool *PySpecExtract* (Amrutha 2026). This allowed reliable identification of the nuclear source in crowded fields and ensured that sky regions were placed in areas free from host galaxy contamination.

We extract all spectra using a fixed circular aperture with a diameter of 6.7 arcsec. This aperture is large enough so that FWHM of the point spread function (PSF) trends with wavelength become less significant, and the actual precise choice matches the fibre diameter of the UK Schmidt Telescope spectrograph used for the 6dFGS observations, which exist for the majority of the objects. The relatively large aperture ensures that the majority of the nuclear flux is captured even under poor seeing conditions, providing a consistent measure of the total AGN luminosity. The trade-off is that the host galaxy contribution within the aperture varies between objects, both due to intrinsic host galaxy size and redshift dependent apparent size. Host galaxy properties derived from these spectra therefore represent only the fraction in the fixed aperture and not the galaxy as a whole, which may have stellar population gradients. In this work we prioritise accurate nuclear luminosities, and therefore do not attempt to interpret host galaxy measurements from the extracted spectra.

In principle, a wavelength-dependent PSF model could be used to separate the nuclear and host-galaxy contributions and define an adaptive extraction aperture. However, the seeing conditions at Siding Spring Observatory cause the nuclear point-source emission and extended host-galaxy light to blend according to the PSF, making such modelling challenging for extended sources. The field-of-view of WiFeS is also typically too small to contain a star as an independent PSF reference. We attempted to characterise the PSF across the wavelength range by dividing the cube into eight spectral bins and fitting a two-dimensional Moffat profile to the collapsed image in each bin. The resulting PSF parameters were then interpolated smoothly along the wavelength axis using a univariate spline.

This approach proved unreliable for two main reasons: First, at the blue end of the spectrum, where instrumental sensitivity is low, and at the red end, where strong sky lines dominate, the derived PSF parameters deviated significantly from the median profile. These effects are further exacerbated by wavelength-dependent defocus in WiFeS,

which causes additional changes in the PSF shape near the edges of the spectral range. Second, the fraction of host galaxy light contributing to the binned images varies with wavelength. In spectral regions where the host contribution is significant, the extended emission artificially broadens the fitted PSF, producing an overestimated PSF width. While the first issue can be mitigated by excluding the end points of the wavelength range during interpolation, the second introduces a wavelength-dependent host fraction that is not physically meaningful. This is particularly problematic because host galaxy light is removed during spectral decomposition using simple stellar population templates (see Section 4.1). A wavelength-dependent extraction aperture would therefore cause an unphysical host extraction and compromise the reliability of the host subtraction.

For these reasons we choose the fixed circular aperture. However, the centroid of the extraction aperture is determined from the PSF fitting procedure, using the manually identified centroid as the initial estimate. The extracted spectrum is the sum of the pixels that fall within the circular approximation over the spatial plane after sky subtraction. Example images of the extraction are provided in Figure 3.

The spectra extracted for this atlas span the wavelength range 3800–9000 Å in observed frame. Instrumental sensitivity decreases blueward of ~ 4100 Å, while imperfect sky subtraction affects wavelengths redder than ~ 7800 Å. Nevertheless, this spectral range comfortably includes the Balmer emission lines from H α to H γ ; the latter may be difficult to detect in some cases due to the increased noise at the blue end and its own intrinsic weakness. Bluer features, including H δ and the [O II] doublet, are retained in the extracted spectra but are not included in the emission-line fitting or catalogue measurements. The sample has mean signal-to-noise ratios (SNRs) of 13 and 23 per Å in the blue and red arms, respectively (Figure 4), where the SNR is defined as the median flux-to-error ratio across the extracted wavelength range.

Since the WiFeS blue and red arms are reduced independently, with an overlap region between approximately 5300 Å and 5900 Å, the final spectrum is constructed by combining the two arms with a transition at 5650 Å. In some cases small discontinuities are present at this boundary, primarily due to wavelength-dependent residuals from sky subtraction. Comparison with standard star observations and reduced calibration spectra indicates that the blue arm is reliably flux calibrated, with the discontinuity arising from the red arm. We therefore correct for this offset by normalising the red arm to match the blue arm, using the median flux measured in a 100 Å region centred at transition wavelength, which is part of the overlap region with moderate noise in both arms. The scaling factor on the red arm is 0.96 on average with a standard deviation of 0.12, i.e., the red arm tends to have overestimated flux on average. The origin of this systematic offset is not currently understood.

In Figure 5, we assess the flux calibration of the extracted WiFeS spectra by comparing synthetic photometry to measurements from SMSS DR4. We compute *g*-, *r*-, and *i*-band magnitudes from the WiFeS spectra using the corresponding filter transmission curves within the 6.7 arcsec extraction aperture. These are compared to SMSS aperture magnitudes measured within 6.0 and 8.0 arcsec apertures. For consistency with the WiFeS extraction, we use SMSS fluxes from `dr4.photometry.flux_ap06` and `flux_ap08`, which are not corrected for seeing-dependent aperture losses, and average over multiple SMSS epochs. Figure 5 shows the distribution of magnitude differences between WiFeS and SMSS measurements for the 6.0 arcsec apertures, along with the median offsets for the 8.0 arcsec apertures. The medians of the differences are consistent with zero within ~0.04 mag, assuming a linear interpolation between 6.0

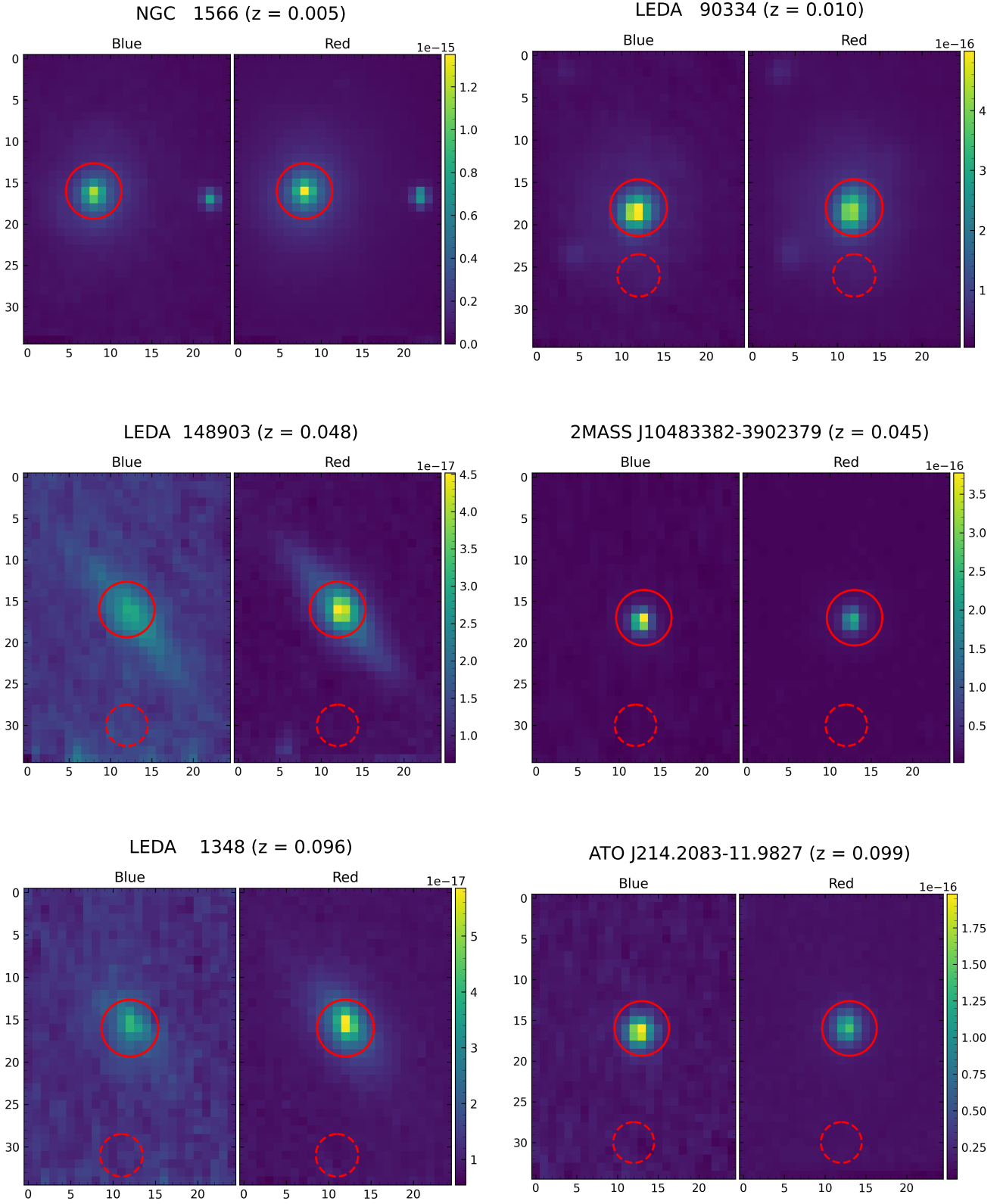


Figure 3. Example spatial extraction images for six objects, ordered by redshift from top to bottom. The left column shows sources with high host-galaxy contribution, while the right column shows AGN-dominated systems. For each object, the WiFeS data cube is collapsed into median images in the blue and red arms, with flux units of $\text{erg s}^{-1} \text{cm}^{-2} \text{\AA}^{-1}$. The solid circle indicates the 6.7 arcsec extraction aperture, and the dashed circle marks the 5 arcsec sky region used for background subtraction. NGC 1566 was observed in nod-and-shuffle mode and therefore does not include a sky region.

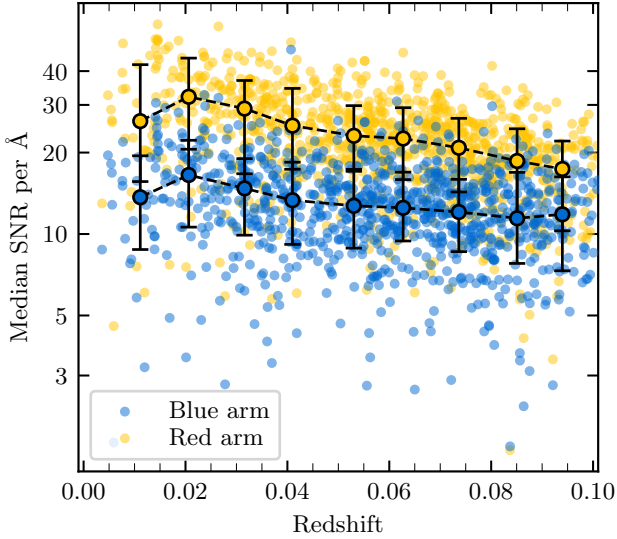


Figure 4. Distribution of the signal-to-noise ratio of the spectra, computed by taking the median signal to noise ratio of the extracted spectrum in the wavelength axis, as a function of redshift. The running medians for the red and blue arms are shown separately, with error bars indicating the 16th–84th percentile range.

arcsec and 8.0 arcsec to the 6.7 arcsec WiFeS aperture, indicating good overall flux calibration. The observed standard deviation of the distributions ranges between 0.32–0.37 mag across the three bands, agreeing with intrinsic AGN variability amplitudes of this sample over the ~6 year time difference between the SMSS and WiFeS observations, based on photometric variability analysis conducted by Tan et al. (2026). Consistent with expectations, the scatter is larger in g -band than in i -band, reflecting the stronger variability of AGN emission at shorter wavelengths as well as the smaller average host fraction at shorter wavelengths.

4 SPECTRAL ANALYSIS

4.1 Spectrum decomposition

The extracted spectra are decomposed with the Bayesian AGN Decomposition Analysis for SDSS Spectra code (BADASS3²; Sexton et al. 2021). This framework models the full optical spectrum simultaneously, with the continuum, host galaxy contribution, and emission-line components fitted in a self-consistent manner. Unlike traditional approaches that require predefined continuum windows or manual masking of emission lines, BADASS3 fits the continuum and emission-line components jointly, reducing user intervention and enabling efficient modelling of large spectroscopic samples.

Each spectrum is fitted over the rest-frame wavelength range 4200–7100 Å, after correcting for Galactic extinction (Schlegel et al. 1998). The continuum model consists of three primary components: (i) a power-law representing the AGN continuum emission, (ii) an Fe II pseudo-continuum based on the empirical template of Véron-Cetty et al. (2004), and (iii) a host galaxy component. Host-galaxy contamination is expected to be significant for this low-redshift sample, and

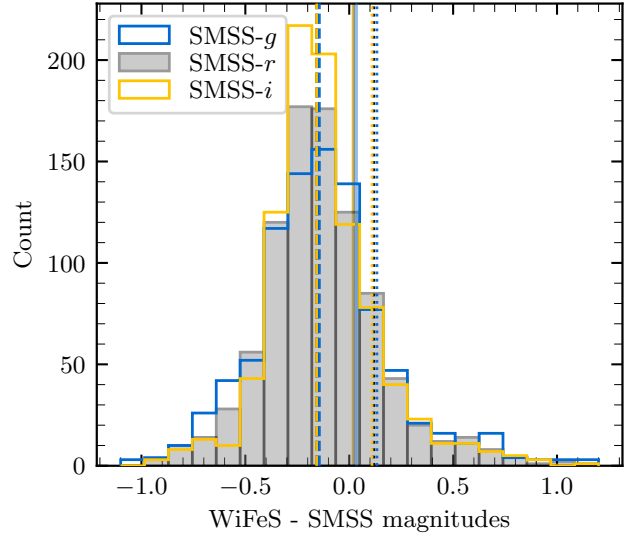


Figure 5. Distribution of differences in magnitudes extracted from the 6.7 arcsec aperture WiFeS spectra, with 6.0 arcsec magnitudes from SMSS DR4 in g , r and i bands. The dashed lines indicate medians of the differences. The dotted lines indicate the medians of the differences for 8.0 arcsec SMSS photometry. The solid lines indicate a linear interpolation to 6.7 arcsec aperture magnitudes.

is therefore modelled using a combination of single stellar population templates from the EMILES library (Vazdekis et al. 2016). The template basis is extended with a reddening parameter to account for intrinsic host-galaxy extinction (see Section 6.3). This flexibility is required for strongly reddened systems, such as highly inclined galaxies where part of the bulge is observed through dust lanes. All components are fitted simultaneously along with emission lines within a Bayesian framework, with parameter uncertainties derived from the posterior distributions.

Emission lines are represented using Gaussian components. Narrow emission lines are modelled with two Gaussian components in order to account for potential asymmetries or extended wings commonly observed in AGN narrow-line regions. Broad-line emission is modelled with two additional Gaussian components where present. The set of emission lines included in the fits, together with the adopted number of components for each line, is listed in Table 1. Vacuum wavelengths are used for line centroids, based on WiFeS wavelength calibration, but the difference between vacuum and air wavelengths are negligible, considering the width and allowed velocity offsets of emission-line components.

Physically motivated constraints are imposed on the velocity dispersions of the Gaussian components. The velocity dispersion of individual narrow components is restricted to $\sigma < 500 \text{ km s}^{-1}$, while broad components are required to satisfy $\sigma > 500 \text{ km s}^{-1}$, with an upper limit of 5500 km s^{-1} for broad components and a lower limit of 40 km s^{-1} for narrow components. Broad line components therefore have a FWHM range of $\sim 1200 \text{ km s}^{-1}$ to 14000 km s^{-1} , and narrow lines have a lower FWHM limit of $\sim 100 \text{ km s}^{-1}$, which corresponds to the resolution limit of WiFeS. In about 10 per cent of the objects, the broad line dispersion/FWHM were increased to $7500 \text{ km s}^{-1}/19000 \text{ km s}^{-1}$ to account for some special cases, although the limits were not reached for majority of the fits.

To reduce degeneracy between the narrow and broad H β components, the widths of the narrow Gaussians and the amplitude ratio be-

² <https://github.com/remingtonsextton/BADASS3>

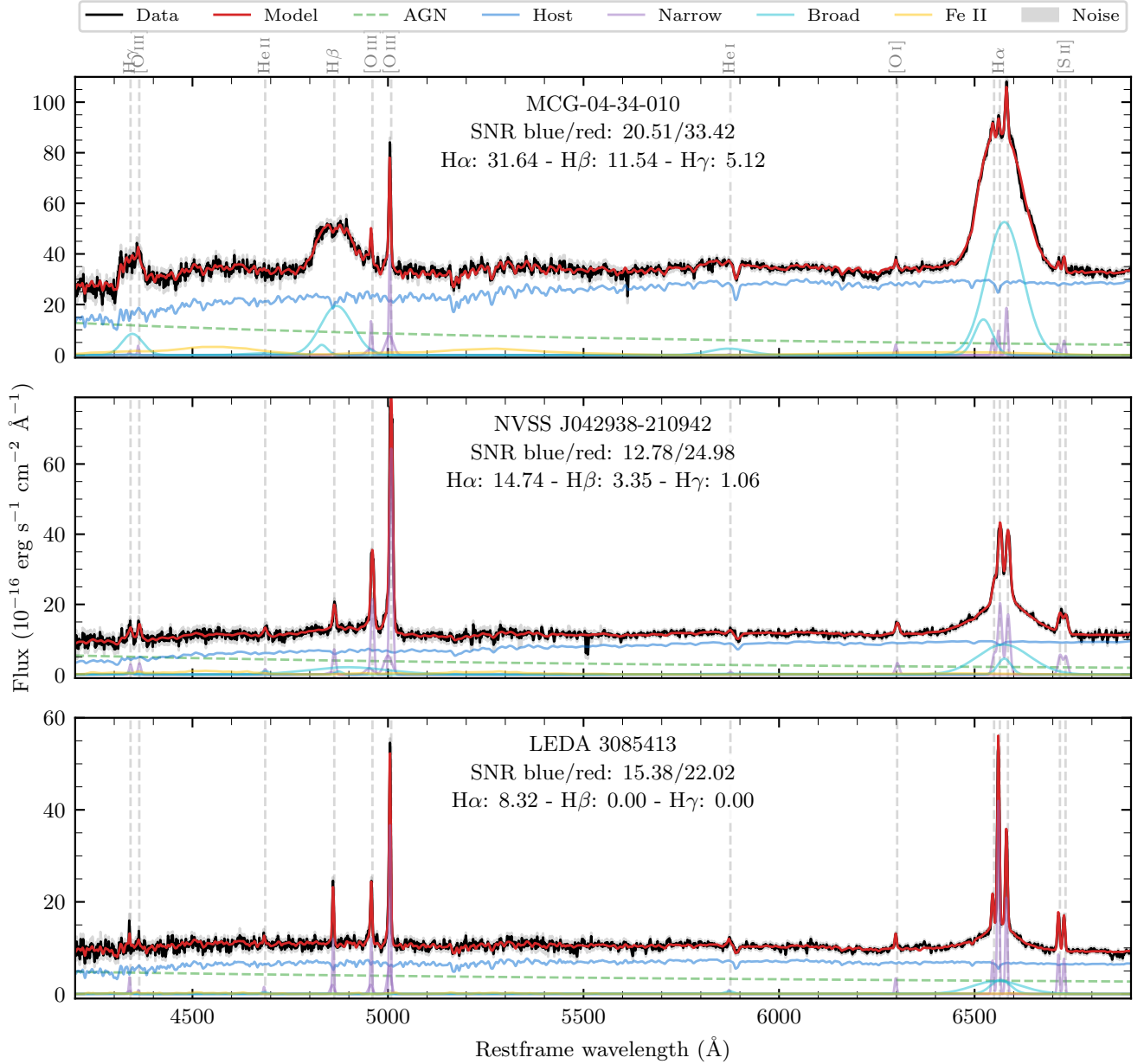


Figure 6. Spectrum decomposition: Examples with diverse $H\beta_{Br}/[O\text{ III}]$ ratios and Balmer line SNRs, representative of average AGNs in the sample. Vertical dashed lines denote centroids of emission lines based on Table 1. The median SNR per Å of the two arms and the Balmer emission line SNRs are provided.

tween their secondary and primary components are tied between the narrow $H\beta$ and $[O\text{ III}]$ emission lines, while the total amplitude of the narrow $H\beta$ component remains free. A similar approach is adopted for the $H\alpha$ and $[N\text{ II}]$ emission-line complex, where the narrow-line kinematic parameters are tied between the corresponding transitions. Examples decompositions are shown in Figure 6.

4.2 Spectral measurements in the catalogue

From the spectral decomposition we derive a set of continuum and emission-line measurements for each spectrum. The catalogue includes basic source information (object identifiers, coordinates, redshift, Galactic reddening, and observation date), together with measurements of the continuum and emission-line properties obtained

from the BADASS3 fits. Emission-line quantities include luminosities, full width at half-maximum (FWHM), velocity dispersions, and equivalent widths for both broad and narrow components of the Balmer lines, as well as forbidden and high-ionisation transitions including $[O\text{ III}]$, $[N\text{ II}]$, $[S\text{ II}]$, He I , and He II . For each parameter we report the median from the posterior distribution together with the corresponding 16th and 84th percentile uncertainties.

Continuum properties derived from the spectral fits include the AGN power-law slope ($\alpha_\nu = -2 - \alpha_\lambda$), the monochromatic continuum luminosity at 5100 Å, and the relative contributions of the AGN and host galaxy components at 5100 Å. In addition, we provide several diagnostic quantities commonly used in AGN studies, including the $H\beta_{Br}/[O\text{ III}]$ flux ratio, Fe II strength parameters, and signal-to-noise estimates for the principal broad emission lines.

Table 1. Emission line components used in the spectral fitting. Narrow components are tied to the kinematics of [O III] where indicated, while broad components are fitted independently. Vacuum wavelengths are used for line centroids, based on WiFeS wavelength calibration.

Line	λ_0 (Å)	N_{narrow}	N_{broad}	Notes / Constraints
H γ	4341.68	2	2	Narrow components tied to [O III] kinematics; second component scaled to [O III] wing. Broad components free.
[O III]	4364.44	1	0	Narrow component tied to [O III] $\lambda 5007$ dispersion and velocity offset.
He II	4686.00	1	1	Narrow component tied to [O III] dispersion and velocity offset. Broad component shares velocity offset with [O III] but otherwise free.
H β	4862.69	2	2	Narrow components tied to [O III] core and wing kinematics; core-to-wing amplitude ratio tied to [O III]. Broad components free.
[O III]	4960.30	2	0	Flux fixed to 1/2.98 of [O III] $\lambda 5007$; kinematics tied to corresponding [O III] components.
[O III]	5008.24	2	0	Core and wing components fitted freely; defines reference kinematics for narrow-line region. Second narrow component weaker and broader than first component.
He I	5875.61	1	1	Narrow component tied to [O III] kinematics. Broad component shares velocity offset with [O III].
[O I]	6300.30	1	0	Narrow component tied to [O III] dispersion and [N II] velocity offset.
[N II]	6549.86	1	0	Flux fixed to 1/2.93 of [N II] $\lambda 6585$; kinematics tied to [O III] dispersion and [N II] velocity offset.
H α	6564.63	1	2	Narrow component tied to [O III] dispersion and [N II] velocity offset. Broad components free.
[N II]	6585.28	1	0	Narrow component fitted with free amplitude and velocity offset; dispersion tied to [O III].
[S II]	6718.29	1	0	Narrow component tied to [O III] dispersion and [N II] velocity offset.
[S II]	6732.67	1	0	Narrow component tied to [O III] dispersion and [N II] velocity offset.

While BADASS3 directly extracts line parameters from the fits, we separately extract the line dispersion of the summed components such that it is calculated within a window defined by $\pm 2.5 \times$ the median absolute deviation (MAD) around the half-flux wavelength, following Wang et al. (2019). We also report equivalent widths computed using the AGN power law slope component as the sole continuum, rather than a total continuum that includes the host galaxy and Fe II features.

We provide two sets of single-epoch black hole mass estimates in the catalogue. The first set is based on commonly used virial mass prescriptions, using the relations from Feng et al. (2014), Vestergaard & Peterson (2006), and Greene et al. (2010) for L_{5100} , $L_{H\beta}$, and $L_{[OIII]}$, respectively. In all cases, the virial velocity is estimated from the broad FWHM $_{H\beta}$. The second set is based on the radius–luminosity relations from Wang & Woo (2024), adopting the corresponding mass calibrations from Amrutha et al. (2026). In addition, black hole masses derived from the broad H α luminosity and FWHM are computed using the relation from Cho et al. (2023). Since all relevant luminosity and line-width measurements are included in the catalogue, users may readily re-compute masses using alternative calibrations.

Goodness-of-fit metrics from the Bayesian modelling, including reduced χ^2 of the model relative to the data in each wavelength channel, are also reported. The redshifts of the objects are updated using the central component of the [O III] $\lambda 5007$ Å velocity offset, with typical corrections of ~ 50 km s $^{-1}$ capped at ~ 450 km s $^{-1}$. The full list of catalogue columns is provided in Table 2, and the complete catalogue is released in machine-readable format alongside the data products described in Appendix A.

5 QUALITY CONTROL AND VALIDATION

To quantify the reliability of the released spectra and catalogue products, we perform a series of quality-control and validation tests. These include checks of the emission-line fitting, error-spectrum calibration, source blending, and the assignment of catalogue quality flags. In this section, we go through each of these steps.

5.1 Broad Balmer emission line fits

We assess the reliability of the emission-line decomposition using signal-to-noise ratio (SNR) measurements for the broad Balmer components. We define the SNR as the ratio between the peak amplitude of the fitted broad Gaussian components and the mean noise level in the surrounding continuum region. The distributions of the broad-line SNRs are shown in Figure 7. Throughout this work, we consider a broad emission line to be undetected when $\text{SNR} < 1$, while robust measurements typically require $\text{SNR} > 3$. In the intermediate regime ($1 < \text{SNR} < 3$), the fits become increasingly uncertain.

As expected, the higher-order Balmer lines are progressively less well detected. Broad H β is particularly susceptible to degeneracies with the Fe II pseudo-continuum, the AGN continuum, and broad He II emission. In some cases, these degeneracies cause one of the broad H β components to become extremely broad and low in amplitude, effectively mimicking a continuum-like feature and driving the fitted FWHM to the imposed upper limit. We identify such cases by selecting fits in which one of the broad H β components reaches the maximum allowed width. The affected component is then excluded from the broad H β measurement, which is instead computed using the remaining broad component. To account for the removed flux, the luminosity of the excluded component is added in quadrature to the upper uncertainty of the retained broad H β luminosity. These objects are flagged using the `spurious_hbb_flag` parameter (see list of flags in Section 5.4).

In Figure 8 we compare the luminosities of the broad Balmer lines for objects with $\text{SNR} > 3$ for all lines, and separately mark sources with $2 < \text{SNR} < 3$ for at least one line. The majority of the sample follows the expected trends, with the broad H β –H α relation scattering around Case B recombination (broad H α /H β = 2.86; Dopita & Sutherland 2003) and extending to larger ratios as previously observed in AGN BLRs (Gaskell 2017). A similar distribution is seen in the broad H γ –H β relation, with most objects lying below the Case B expectation (broad H β /H γ = 2.12).

In Figure 9 we compare the measured broad-line FWHM values. For the objects with reliable measurements, we find the median ratio $\text{FWHM}_{H\beta}/\text{FWHM}_{H\alpha} \sim 1.24$. This is consistent with reverberation-mapping results showing that the broad H β -emitting region lies closer to the ionising source than the broad H α -emitting region (Bentz et al. 2010). Assuming virial motion ($V^2 \propto 1/R$), the

Table 2. Summary of extracted spectral fitting parameters, descriptions, and units. Lower and upper errors, when subtracted/added to the scalar, provide the 16th to 84th percentile range of the posterior distribution of the MCMC sampling. Emission line properties are provided for the summed components where more than one component is used.

Parameter	Units	Type	Description
Basic Properties			
spectrum_id	–	ID	Spectrum identifier
name, alt_name	–	ID	Object names
z	–	scalar	Redshift
ra, dec	deg	scalar	Right ascension, Declination
mjd	day	scalar	Modified Julian Date
airmass	–	scalar	Airmass at the time of observation
ebv	mag	scalar	$E(B - V)$ reddening value from Schlegel et al. (1998)
type	–	–	Seyfert classification described in Section 5.5
smss_id	–	ID	Crossmatched SMSS DR4 ID of the object
smss_dist	arcsec	scalar	On-sky separation of the source to crossmatched object
closest_smss_id, closest_gaia_id	–	ID	Closest SMSS and <i>Gaia</i> objects (<15 arcsec)
closest_smss_dist, closest_gaia_dist	arcsec	scalar	On-sky separation of the source to closest SMSS and <i>Gaia</i> objects
Magnitudes			
r_psf, e_r_psf	mag	scalar	SMSS <i>r</i> -band magnitudes used for exposure time calculation
spec_{g,r,i}_mag, spec_{g,r,i}_err	mag	scalar	6.7 arcsec aperture magnitudes from WiFeS based on SMSS filters
smss_{g,r,i}_magc06, smss_{g,r,i}_errc06	mag	scalar	Mean seeing corrected 6.0 arcsec aperture magnitudes from SMSS DR4
{j,h,k}_mag_ext, {j,h,k}_mag_err	mag	scalar	2MASS XSC magnitudes
Emission Line Properties			
*_lum, *_lum_low / upp	log erg s ⁻¹	scalar	Emission line luminosity, lower / upper uncertainty on luminosity
*_fwhm, *_fwhm_low / upp	log km s ⁻¹	scalar	Full width at half maximum, lower / upper uncertainty on FWHM
*_disp, *_disp_low / upp	log km s ⁻¹	scalar	Velocity dispersion, lower / upper uncertainty on dispersion
*_ew, *_ew_low / upp	Å	scalar	Equivalent width, lower / upper uncertainty on EW
Emission Lines			
ha_br_*, ha_nr_*	–	group	Broad/narrow H α
hb_br_*, hb_nr_*	–	group	Broad/narrow H β
hg_br_*, hg_nr_*	–	group	Broad/narrow H γ
o_iii_4364/5007_*, o_i_6300_*	–	group	[O III] λ 4364, [O III] λ 5007 and [O I] λ 6300 lines
n_ii_6549/6585_*	–	group	[N II] doublet
s_ii_6718/6732_*	–	group	[S II] doublet
he_i_br*, he_i_nr*	–	group	Broad/narrow He I λ 5875 line
he_ii_br*, he_ii_nr*	–	group	Broad/narrow He II λ 4686 line
Ratios and Diagnostics			
hb_oiii_ratio	–	scalar	log H β _{Br} /[O III] flux ratio (broad H β flux only)
hb_oiii_ratio_low / upp	–	error	Uncertainty on the ratio
agn_frac	–	scalar	AGN power-law to total flux ratio at λ 5100 Å
host_frac	–	scalar	Host galaxy to total flux ratio at λ 5100 Å
fe_ii_r_hb	–	scalar	Fe II to H β ratio; Fe II integrated over λ 4340 Å – λ 4680 Å
fe_ii_r_oiii	–	scalar	Fe II to [O III] ratio; Fe II integrated over λ 4340 Å – λ 4680 Å
fe_ii_r_*_low / upp	–	error	Symmetric uncertainty in Fe II ratios; estimated from error spectrum
Continuum Properties			
pl_s, pl_s_low / upp	–	scalar	AGN power-law spectral index (α_ν) and uncertainty
l5100, l5100_low / upp	log erg s ⁻¹	scalar	AGN luminosity at λ 5100 Å and uncertainty
h5100, h5100_low / upp	log erg s ⁻¹	scalar	Host contribution at λ 5100 Å and uncertainty
t5100, t5100_low / upp	log erg s ⁻¹	scalar	Total luminosity at λ 5100 Å and uncertainty
Black Hole Mass Estimates			
lc_m	log $M_\odot$	scalar	L_{5100} -based mass estimate (Feng et al. 2014)
hb_m	log $M_\odot$	scalar	$L_{H\beta}$ -based mass estimate (Vestergaard & Peterson 2006)
oiii_m	log $M_\odot$	scalar	$L_{[OIII]}$ -based mass estimate (Greene et al. 2010)
ha_m	log $M_\odot$	scalar	$L_{H\alpha}$ -based mass estimate (Cho et al. 2023)
ww_*	log $M_\odot$	scalar	Mass estimates from Amrutha et al. (2026) using <i>R-L</i> relations in Wang & Woo (2024)
*_m_low / upp	log $M_\odot$	error	Uncertainty on mass estimates
Data Quality and Fit			
hab_snr, hbb_snr, hgb_snr	–	scalar	SNR of broad Balmer lines: H α , H β , H γ
r_chi, r_sq	–	scalar	Reduced χ^2 of the fitted model and R^2 statistic
median_snr, blue_snr, red_snr	–	scalar	Median spectrum SNR per Å for full spectrum, blue arm and red arm
*_flag	–	group	Flags described in Section 5.4
bel_src, cite_link, cite_name	–	group	Reference literature AGN classification

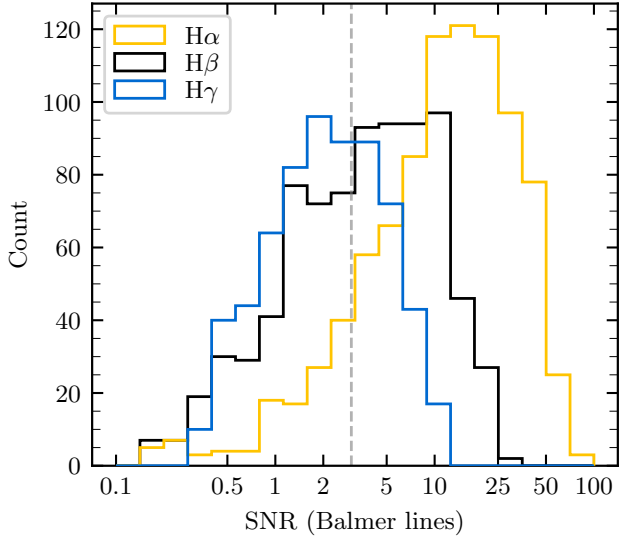


Figure 7. SNR distribution of the fitted broad Balmer lines. The SNRs are computed by dividing the peak of the summed Gaussian components by the mean noise level in the fitted region.

measured lag ratio $\tau_{H\alpha}/\tau_{H\beta} = 1.54$ implies an expected line-width ratio of $\text{FWHM}_{H\beta}/\text{FWHM}_{H\alpha} \sim 1.24$, in excellent agreement with our observations.

A similar comparison between broad $H\gamma$ and $H\beta$ is less robust. We measure a median $\text{FWHM}_{H\gamma}/\text{FWHM}_{H\beta} \sim 0.83$, whereas the reverberation-mapping lag ratio reported by [Bentz et al. \(2010\)](#) predicts a value of ~ 1.28 under the same virial assumption. This discrepancy is likely driven by measurement uncertainties in $H\gamma$, which is an intrinsically weak line, overlaps with host-galaxy absorption features, and is blended with the [O III] $\lambda 4343$ emission line. Consequently, separating the narrow and broad $H\gamma$ components is considerably more challenging than for $H\alpha$ or $H\beta$. This tendency for the broad $H\gamma$ component to be fitted with a narrower width than expected may contribute, at a sub-dominant level, to the slightly lower $H\gamma/H\beta$ luminosity ratios observed in Figure 8. However, the deviation from the expected Case B values is small, and the $H\gamma/H\beta$ ratios remain broadly consistent within the overall scatter. Relative to $H\beta/H\alpha$, the effect is marginal, suggesting that any bias in the broad $H\gamma$ flux is likely minor.

5.2 Error spectra

The propagated error spectra are not always reliable due to the presence of bad pixels in the data cubes. In particular, individual spaxels in regions dominated by sky emission can contain pixels with artificially large uncertainties, occasionally reaching values of order $\sim 10^8$ times the median error. These extreme values are typically associated with flags created during PyWiFeS reduction due to detector artefacts. When constructing the median sky spectrum and propagating uncertainties through the sky-subtraction process, such outliers can disproportionately inflate the resulting error spectrum, even when the underlying flux measurements are otherwise well behaved. To mitigate this effect, we impose a conservative cap on the error spectrum. Specifically, any pixel in the error spectrum with a value exceeding 20 times the median of the error spectrum is reset to the median error value. This approach preserves the global

noise characteristics of the data while preventing a small number of pathological pixels from dominating the overall uncertainty estimates. Hence, we quote medians rather than mean errors and SNRs for spectra as a whole. In turn, this stabilises subsequent spectral decomposition, where inflated errors can otherwise bias the weighting of spectral regions and degrade the quality of the fits.

5.3 Source blending

We cross-match each source with the nearest objects in the SMSS DR4 and Gaia DR3 catalogues to identify potential counterparts and blended sources. For each source, we report the closest match within a search radius of 15 arcsec, along with its angular separation. Given the 6.7 arcsec diameter extraction aperture used to construct the spectra, sources separated by less than 3.35 arcsec are expected to be centred within the aperture, and along with the PSF, a larger separation is required to ensure blending does not affect the extracted spectrum. In such cases, flux from neighbouring objects contributes to the observed spectrum. Given a seeing range from 1 arcsec to 3 arcsec in the observations, we expect noticeable contamination of the spectra from point sources separated as far away as 6 arcsec and potentially from extended sources that are even further away.

This blending predominantly affects the continuum emission, as emission lines, particularly broad lines, are less susceptible to contamination unless the secondary source is comparably bright. However, when the contaminating source contributes significantly to the continuum, the model fails to explain the observed spectrum, potentially leading to unreliable continuum parameters or decompositions. Neighbouring galaxies at nearly identical redshifts primarily alter the mix of stellar populations contributing to the host-galaxy spectrum. In contrast, projected neighbours at substantially different redshifts can introduce a second set of spectral features, potentially complicating line identification and measurements. Contamination from foreground stars is generally easier to identify, as stellar absorption features at $z = 0$ typically stand out against the AGN spectrum.

5.4 Catalogue flags

To assist in assessing the reliability of the derived spectral measurements, we provide a set of diagnostic flags. These flags are designed to capture common failure modes and edge cases in a simple, uniform manner, allowing the construction of clean subsamples for scientific analyses without requiring detailed inspection of individual spectra. In the following, we list all quality flags used in the catalogue:

- **15100_flag**: quantifies the reliability of the AGN continuum luminosity at 5100 Å. This flag combines constraints on the spectral slope, luminosity, and fractional AGN contribution. A value of 0 corresponds to high-confidence measurements, requiring a physically plausible spectral index ($-2 < \alpha_\nu \leq 0.5$; [Xie et al. 2016](#); [Rakshit et al. 2020](#)), sufficient luminosity ($\log L_{5100} > 41.5$), and a dominant AGN contribution ($\text{agn_frac} \geq 0.5$). A value of 1 indicates moderate reliability, where the spectral shape and luminosity appear acceptable but the AGN contribution is lower ($0.2 < \text{agn_frac} < 0.5$), increasing the potential impact of host-galaxy contamination. A value of 2 flags the remaining cases, typically associated with unphysical slopes, low luminosities, or strong degeneracies in the continuum decomposition. The flag values are roughly split into thirds for this criterion.

- **balmer_flag**: assesses the physical consistency of the broad Balmer line luminosities. Under standard conditions, the broad $H\beta$ luminosity is expected to be lower than that of $H\alpha$, although we note that we are not including the Case-B cut of $H\alpha > 2.86 \times H\beta$.

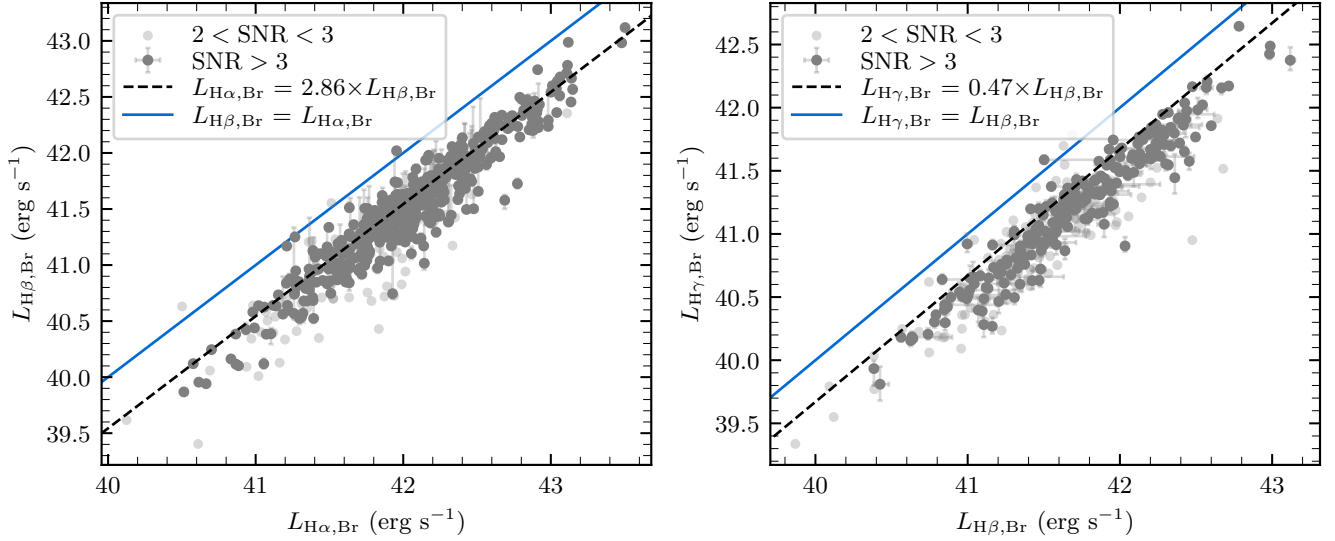


Figure 8. Comparison of the Balmer line luminosity for $H\alpha$, $H\beta$ and $H\gamma$. The solid and dashed lines show the 1:1 relation and Case-B scenario respectively. Different SNR regimes are marked separately. For $\text{SNR} > 3$, both lines need to fulfil the condition, but for $2 < \text{SNR} < 3$, one of the lines may have $\text{SNR} > 3$.

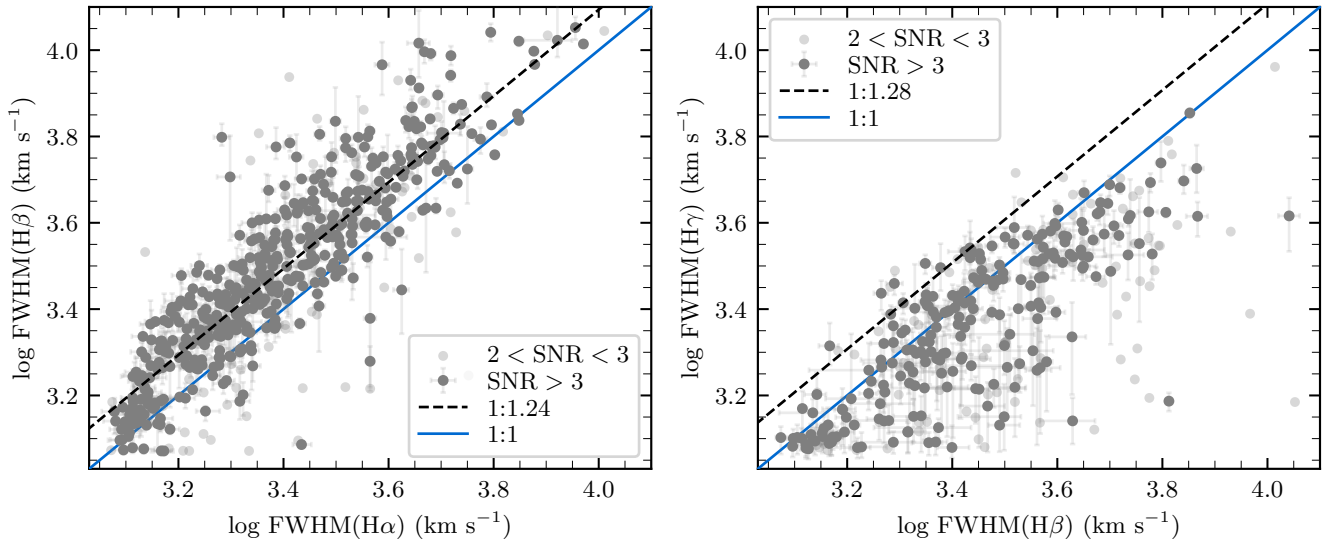


Figure 9. Comparison of the Balmer line FWHM for $H\alpha$, $H\beta$ and $H\gamma$ (see Figure 8 for SNR regimes). The solid line marks the 1:1 relation and the dashed line indicates the expected width relations based on the reverberation-mapping lag ratios of [Bentz et al. \(2010\)](#), assuming Keplerian motion ($V^2 \propto 1/R$). These predict $\text{FWHM}_{H\beta} = 1.24 \times \text{FWHM}_{H\alpha}$ and $\text{FWHM}_{H\gamma} = 1.28 \times \text{FWHM}_{H\beta}$. The observed median ratios are $\text{FWHM}_{H\beta}/\text{FWHM}_{H\alpha} \sim 1.24$, in agreement with the prediction, and $\text{FWHM}_{H\gamma}/\text{FWHM}_{H\beta} \sim 0.83$, substantially below the expected value.

A value of 0 corresponds to the physically consistent regime with a robust detection ($\text{SNR}_{H\beta} > 3$). A value of 1 indicates marginal detections, where $1 < \text{SNR}_{H\beta} \leq 3$, and the inferred luminosity ratio is therefore less certain. A value of 2 flags cases that are either physically inconsistent ($L_{H\beta} \geq L_{H\alpha}$) or have very low SNR, both of which suggest unreliable line measurements. The flag values $\{0, 1, 2\}$ are roughly split into $\{0.50, 0.25, 0.25\}$ for this criterion.

- **balmer_snr_flag**: provides a summary measure of the overall quality of the broad Balmer-line detections. A value of 0 indicates robust detections in all three lines ($H\alpha$, $H\beta$, and $H\gamma$), with $\text{SNR} > 3$

in each case. A value of 1 corresponds to intermediate-SNR detections, requiring $\text{SNR}_{H\alpha} > 3$, $\text{SNR}_{H\beta} > 2$, and $\text{SNR}_{H\gamma} > 1$, thereby allowing for progressively lower SNR in the weaker lines. A value of 2 flags low-SNR detections where one or more of the lines fall below these thresholds. The flag values $\{0, 1, 2\}$ are roughly split into $\{0.25, 0.25, 0.50\}$ for this criterion, although we note that this flag depicts the broad Balmer emission strength more than the quality of the spectrum.

- **hb_width_flag**: evaluates the internal consistency of the broad $H\beta$ line-width measurements by comparing the logarithmic FWHM

and velocity dispersion (σ_{line}). For a well-measured line profile, these quantities are expected to follow a relatively narrow relation. A value of 0 corresponds to $0.3 < \log \text{FWHM}_{\text{H}\beta} - \log \sigma_{\text{H}\beta} \leq 0.5$, consistent with typical broad-line profiles. A value of 1 allows for a wider range ($0.15 < \log \text{FWHM}_{\text{H}\beta} - \log \sigma_{\text{H}\beta} \leq 0.6$), capturing moderately uncertain fits. A value of 2 flags strongly discrepant measurements, which often indicate low SNR or continuum model degeneracies. The flag values {0, 1, 2} are roughly split into {0.65, 0.15, 0.20} for this criterion.

- **balmer_width_flag**: compares the broad-line widths of $\text{H}\alpha$ and $\text{H}\beta$ to assess cross-line consistency. A value of 0 corresponds to ($0 \leq \log \text{FWHM}_{\text{H}\beta} - \log \text{FWHM}_{\text{H}\alpha} < 0.25$), which is commonly observed in well-constrained fits. A value of 1 allows for small deviations ($-0.05 \leq \log \text{FWHM}_{\text{H}\beta} - \log \text{FWHM}_{\text{H}\alpha} < 0$). A value of 2 flags significant discrepancies between the two lines. These conditions are chosen based on the distribution in Figure 9 and observed reverberation lag ratio for $\text{H}\alpha$ and $\text{H}\beta$ in Bentz et al. (2010). Large deviations, particularly in spectra with otherwise adequate SNR, are empirically associated with poorer-quality $\text{H}\beta$ fits and potential continuum-fitting degeneracies. The flag values {0, 1, 2} are roughly split into {0.50, 0.15, 0.35} for this criterion.

- **super_flag**: is the sum of the above five flags, with lower values meaning better spectrum decomposition and strong broad Balmer lines.

- **spec_flag**: indicates the basic quality of the spectrum based on visual inspection. The majority of spectra (~95 per cent) are labelled **good**, corresponding to cases where the data are reasonably well described by the fitted model. We emphasise that this flag reflects only the agreement between the data and the model, and does not guarantee that the decomposed components are physically meaningful; the additional flags described above should be used to identify reliable measurements. Spectra labelled **bad_all** or **bad_blue** indicate that the entire spectrum, or the blue arm respectively, is of insufficient quality for reliable decomposition. In many such cases, alternative observations of the same target are available and yield acceptable results. The **bad_fit** label denotes spectra with adequate data quality for which the fitting procedure failed to converge, due to unusual spectrum features, and only three such cases exist. All figures in this work that rely on spectral decomposition include a selection of **spec_flag == good**.

- **spurious_hab_flag**: identifies cases where the broad $\text{H}\alpha$ component is likely non-physical. Because the narrow $\text{H}\alpha$ and $[\text{N II}]$ lines are modelled with a single Gaussian component each, the broad $\text{H}\alpha$ component can occasionally absorb residual flux from the wings of the narrow-line complex. Such cases are flagged when the broad component is both relatively narrow and weak compared to the narrow $\text{H}\alpha$ line: $\text{FWHM}_{\text{Br,H}\alpha} < 10 \times \text{FWHM}_{\text{Nr,H}\alpha}$, $L_{\text{Br,H}\alpha} < 1.12 \times L_{\text{Nr,H}\alpha}$, and $\text{hab_snr} > 1$. For flagged objects, the broad $\text{H}\alpha$ flux is redistributed among the narrow $\text{H}\alpha$ and $[\text{N II}]$ components according to their fitted flux fractions. Approximately 4 per cent of the sample satisfies these criteria and is assigned **spurious_hab_flag = 1**; all other objects have a value of 0.

- **spurious_hbb_flag**: identifies cases where one of the broad $\text{H}\beta$ components reaches the maximum allowed line width during fitting. In these objects, the broad $\text{H}\beta$, Fe II , and He II components can become highly degenerate with the AGN and host-galaxy continua, producing an artificial broad feature extending across much of the $\text{H}\beta$ spectral region and leading to overestimated line luminosities. The flag takes three values: 0 indicates no issue; 1 indicates that the second broad $\text{H}\beta$ component reached the maximum allowed width and was removed; and 2 indicates that the primary broad $\text{H}\beta$ component was removed, following the approach of Amrutha et al. (2026).

The luminosity of the removed component is added to the upper uncertainty of the retained broad $\text{H}\beta$ measurement. For all objects with **spurious_hbb_flag** > 0, Fe II and He II measurements are considered unreliable and are therefore excluded from the catalogue. 20 per cent of the sample have **spurious_hbb_flag** > 0.

These flags are derived directly from the catalogued spectral properties and are intended to offer a reproducible framework for quality assessment. While bespoke selections can be tailored to specific use cases from the catalogue data provided, for general use we recommend restricting samples to sources with individual flag values of 0 or 1 to ensure a balance between sample size and measurement reliability.

5.5 Seyfert classification

The catalogue includes a **type** column that provides a spectroscopic classification for each object. 41 objects with bad spectrum quality are labelled **Bad** and are not assigned a classification. Classification follows a decision tree (see Figure 10) based on the detection of narrow and broad emission lines. We first identify emission-line galaxies (ELGs) using the narrow $\text{H}\alpha$, $[\text{O III}]$, $[\text{N II}]$, and $[\text{S II}]$ lines. Objects with no significant detection of any of these features are classified as **Non-ELG**, following visual inspection of cases where the individual narrow-line SNRs are below unity. For ELGs without a significant broad $\text{H}\alpha$ component, we apply standard Baldwin–Phillips–Terlevich (BPT; Baldwin et al. 1981) diagnostics to separate Seyfert 2 (Sy 2) galaxies from star-forming (SF) systems following the demarcation of Kauffmann et al. (2003).

ELGs with a broad $\text{H}\alpha$ detection ($\text{hab_snr} \geq 1$) are classified as broad-line AGN. These objects are further subdivided using the broad $\text{H}\beta$ emission. Where a reliable broad $\text{H}\beta$ measurement is available ($\text{hbb_snr} \geq 1$), we assign Seyfert subtypes (Sy 1.0, Sy 1.2, Sy 1.5, and Sy 1.8) following the line-ratio scheme of Winkler (1992), based on the $\text{H}\beta_{\text{Br}}/[\text{O III}]$ ratio. When broad $\text{H}\beta$ is not reliably detected ($\text{hbb_snr} < 1$ with $\text{hab_snr} > 1$), we do not assume its absence. Instead, we compute an upper limit on the broad $\text{H}\beta$ flux by adopting a Gaussian profile with peak amplitude set to the local noise level and a width tied to the broad $\text{H}\alpha$ component via the expected virial scaling ($\text{FWHM}_{\text{H}\beta}/\text{FWHM}_{\text{H}\alpha} \sim 1.24$). These objects are assigned extended Seyfert classes (Sy 1.0+ to Sy 1.8+) that replace the traditional Seyfert 1.9 category but explicitly reflect the possibility that broad $\text{H}\beta$ may be present below the detection threshold rather than physically absent (Barquín-González et al. 2024). The upper limits of the broad $\text{H}\beta$ luminosity and $\text{H}\beta_{\text{Br}}/[\text{O III}]$ ratio are provided in upper error columns of the catalogue (**hb_br_lum_upp** and **hb_oiii_ratio_upp** respectively). We note that the quality flags from Section 5.4 that require $\text{hbb_snr} > 1$ will always have a value of 2 by design for these objects.

6 SAMPLE PROPERTIES

In this section, we present an overview of the key properties of the sample and assess the physical consistency of the measurements. We examine emission-line diagnostics using the Baldwin–Phillips–Terlevich diagram, investigate dust attenuation through the Balmer decrement, and explore continuum scaling relations relevant to AGN luminosity. Together, these properties provide a global view of the ionisation conditions, line-emitting regions, and continuum properties of the sample, while also serving as a validation of the spectral decomposition. We conclude with a brief discussion of a few individual objects in this sample.

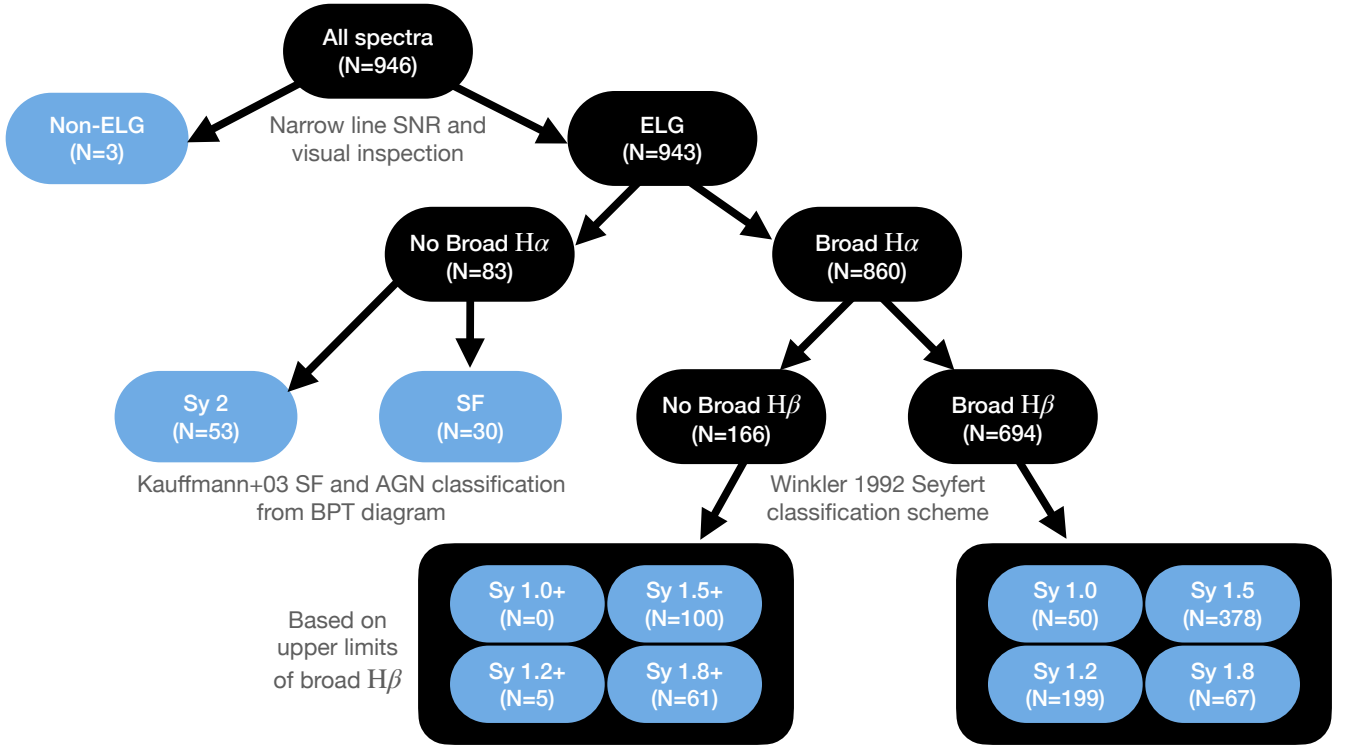


Figure 10. AGN classification decision tree. The full procedure is described in Section 5.5. The end nodes of the tree denote classification labels presented in the type column of the catalogue. 41 objects with bad spectrum quality are labelled "Bad" and are not assigned a type.

6.1 Ionisation diagnostics

We present the standard BPT diagnostic diagrams in Figure 11, showing the narrow-line ratios $[\text{O III}] \lambda 5008/\text{H}\beta$ as a function of $[\text{N II}] \lambda 6585/\text{H}\alpha$, $[\text{S II}] \lambda 6732, 6718/\text{H}\alpha$, and $[\text{O III}] \lambda 6300/\text{H}\alpha$ for the sample. We also indicate the theoretical and empirical boundaries separating AGN, composite, and star-forming regions from Kewley et al. (2001) and Kauffmann et al. (2003). The majority of sources lie within the AGN-dominated region, as expected from the selection of the parent sample. A smaller fraction extends towards the composite region, which may reflect residual host-galaxy contamination or intrinsically weak AGN activity.

The overall distribution is consistent with previous low-redshift AGN samples, indicating that the emission-line measurements and spectral decomposition recover meaningful line ratios across the sample. In particular, the separation of broad and narrow components is verified with the BPT diagram.

6.2 Balmer decrement

In Figure 12 we compare the broad Balmer decrement, $L_{\text{H}\beta}/L_{\text{H}\alpha}$, against the $\text{H}\beta_{\text{Br}}/[\text{O III}]$ flux ratio. The Balmer decrement is sensitive to dust attenuation along the line of sight, and also BLR optical depth and ionisation conditions (Gaskell 2017), while the $\text{H}\beta_{\text{Br}}/[\text{O III}]$ ratio traces the relative strength of BLR and narrow-line region (NLR) emission. The latter is sensitive to viewing angle, anisotropic emission, variability on timescales shorter than $[\text{O III}]$ reverberation, and dust obscuration. The distribution shows a broad correlation with significant scatter. Objects with lower broad Balmer decrement ratios (indicative of increased reddening) tend to exhibit lower $\text{H}\beta_{\text{Br}}/[\text{O III}]$ values, consistent with preferential attenuation of the BLR emission

relative to the more extended NLR. In Figure 12, reddening vectors are shown for $A_V = 1$ mag for $R_V = \{2, 3, 5\}$ under the assumption that the dust reddens only the broad Balmer lines and leaves the $[\text{O III}]$ emission from the extended narrow-line region unaffected. However, the observed scatter likely reflects a combination of dust geometry, intrinsic variability of the broad-line emission, and differences in the relative contributions of the BLR and NLR. Disentangling these effects requires multi-epoch or multi-wavelength observations; the catalogue presented here provides a starting point for identifying suitable targets for such studies.

6.3 Continuum scaling relations

We investigate the relation between emission-line equivalent width and continuum luminosity in Figure 13. The Baldwin effect (Baldwin 1977) predicts an anti-correlation between line equivalent width and continuum luminosity, such that more luminous AGN exhibit weaker emission lines. However, the strength of this relation is expected to differ between emission lines due to their distinct physical origins. The $[\text{O III}]$ emission arises in the spatially extended narrow-line region and traces the time-averaged ionising luminosity of the AGN, whereas the broad $\text{H}\beta$ emission originates in the compact broad-line region and responds to continuum variations on much shorter timescales. As a result, single-epoch measurements of broad $\text{H}\beta$ are more strongly affected by intrinsic variability, and are therefore expected to exhibit a weaker Baldwin relation compared to $[\text{O III}]$. Consistent with this expectation, we observe a clear anti-correlation for the $[\text{O III}]$ emission, in agreement with previous studies of AGN narrow lines (Zhang et al. 2013), while the broad $\text{H}\beta$ emission shows only a weak dependence on continuum luminosity. This discrepancy

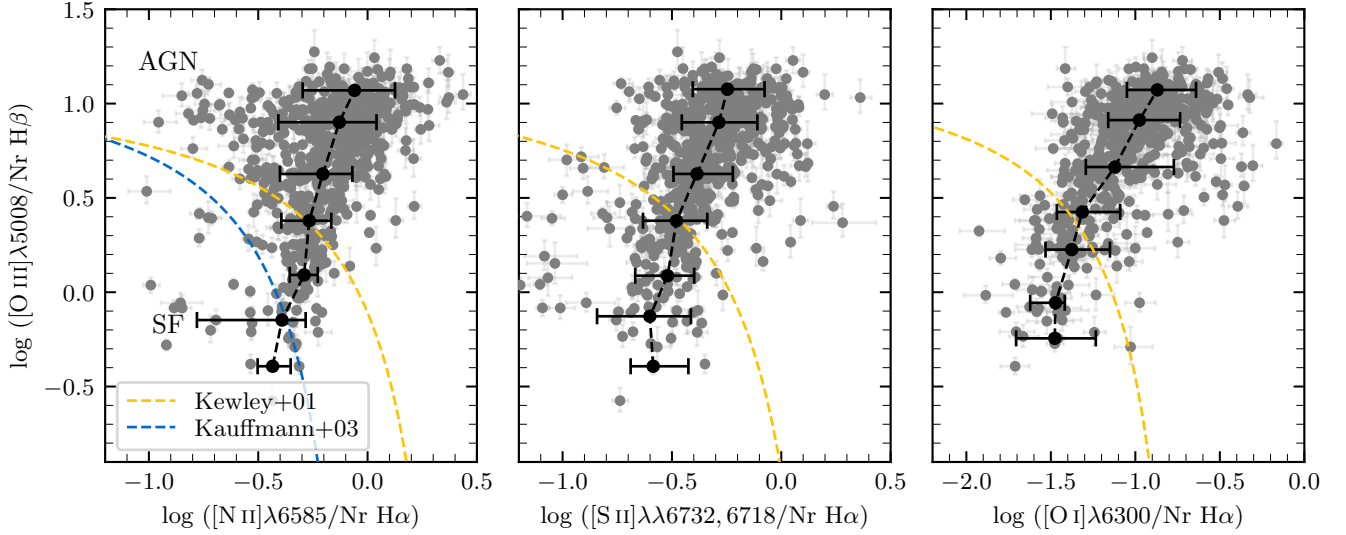


Figure 11. BPT diagram showing narrow line ratios $\log [O \text{ III}] \lambda 5008/H\beta$ versus $\log [N \text{ II}] \lambda 6585/H\alpha$, $\log [S \text{ II}] \lambda \lambda 6732, 6718/H\alpha$, and $\log [O \text{ III}] \lambda 6300/H\alpha$. The dashed curves in the $[N \text{ II}]$ panel indicate the demarcation lines from Kewley et al. (2001) and Kauffmann et al. (2003) separating star forming and AGN regions. The regions between the curves are typically classified as composite galaxies. The remaining panels only include the Kewley et al. (2001) line. In each panel, a running median relation is shown, with error bars indicating the 16th–84th percentile range. For visual clarity, only 70 per cent of the sample with the least measurement errors are presented here. The remaining sample follows the same distribution but have larger errors. The Kauffmann et al. (2003) line is used to classify Seyfert 2 and star forming galaxies as described in Section 5.5.

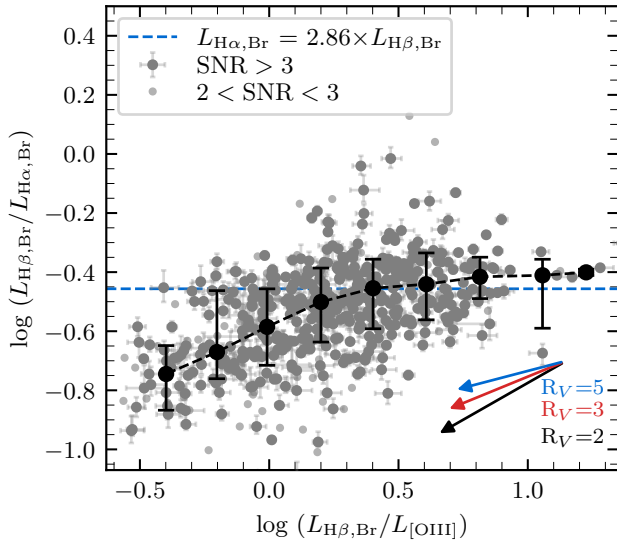


Figure 12. Balmer decrement $L_{H\beta}/L_{H\alpha}$ as a function of the $H\beta_{Br}/[O \text{ III}]$ ratio. The running median is shown, with error bars indicating the 16th–84th percentile range. The horizontal line marks the Case B recombination value. The SNR regimes are marked separately, following from Figure 8. The arrows mark reddening vectors from Calzetti et al. (2000) for $A_V = 1$ mag.

in the strength of the Baldwin effect between broad $H\beta$ and narrow $[O \text{ III}]$ has important implications for single-epoch black hole mass estimates, as discussed in Amrutha et al. (2026).

In Figure 14, we present the fitted AGN power-law spectral index as a function of the AGN luminosity, L_{5100} , and the AGN fraction of the total continuum. To focus on reliable measurements, we exclude

values that lie outside the plausible range and those clustered at the imposed boundary, restricting the sample to $-1.95 < \alpha_v < 0.35$ and a minimum AGN fraction of 0.2. This selection retains approximately 60 per cent of the sample. We compare our results to the SDSS quasar sample analysed by Rakshit et al. (2020), who also perform host–AGN spectral decomposition. We limit the SDSS sample to $z < 0.5$. Although the SDSS $z < 0.1$ sample overlaps with the higher luminosity end of our sample, a correlation is observed between spectral slope and luminosity in the SDSS sample, whereas only a weak trend is present in our sample. Especially, our atlas contains many lower-luminosity objects with clearly blue continua.

The discrepancy can be understood in terms of the treatment of the host galaxy component. Typical host galaxy fitting procedures do not fully account for the additional reddening of host galaxies due to dust, effectively limiting the range of allowed host spectral shapes. This introduces a degeneracy in which intrinsically red host galaxies are instead absorbed into the AGN component, leading to artificially redder inferred AGN slopes at lower luminosities. When we restrict our own modelling to exclude this additional degree of freedom, we recover a similar slope–luminosity correlation observed in the SDSS sample, confirming that the effect is driven by modelling assumptions rather than intrinsic AGN physics. In the extreme case where no host component is included, the typically red host contribution naturally biases lower-luminosity AGN towards redder inferred continua.

This interpretation is further supported by the right panel of Figure 14. For sources with significant host contributions, the SDSS sample occupies only the red half of the plausible spectral index range, whereas our decomposition allowing for dust-reddened hosts, recovers the full range of spectral slopes. Conversely, the SDSS sample does not identify host components for many objects with bluer spectral indices. We note, however, that differences in extraction aperture between this work (6.7 arcsec) and the SDSS analysis (3 arcsec) may also contribute to these trends. These results highlight

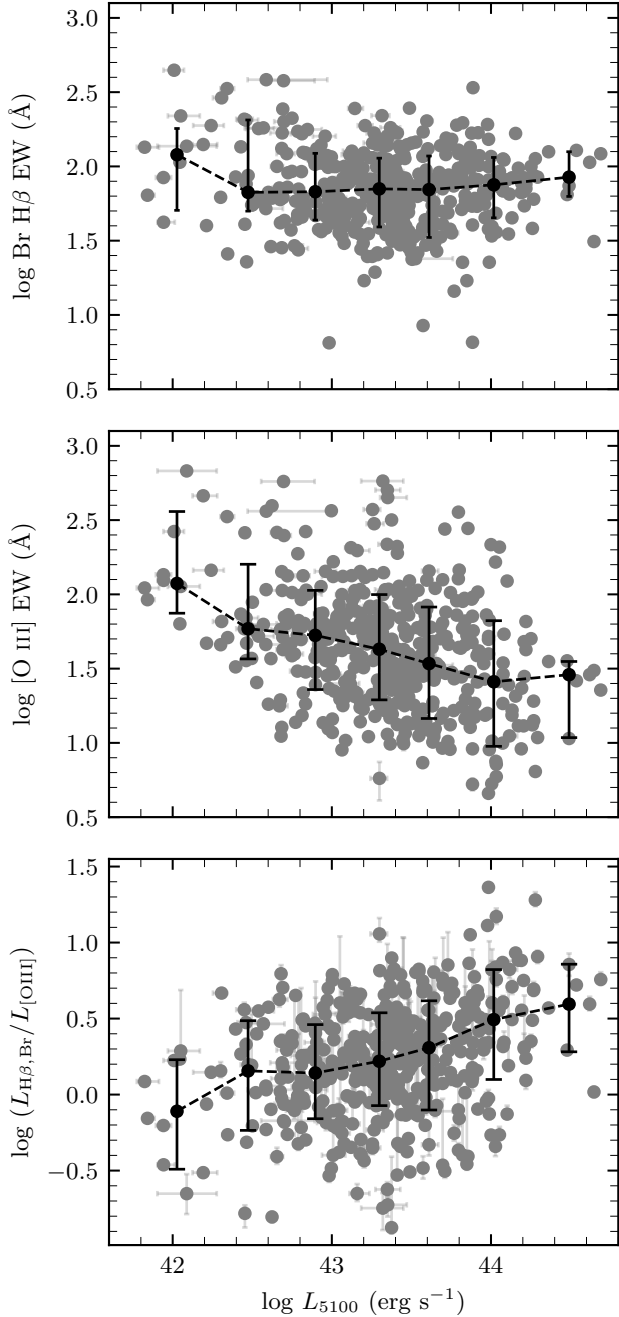


Figure 13. Equivalent width of broad $H\beta$ and narrow $[O\text{ III}]$, along with the $H\beta_{\text{Br}}/[O\text{ III}]$ luminosity ratio as a function of AGN continuum luminosity, L_{5100} . Running medians are shown, with error bars indicating the 16th–84th percentile range. A Baldwin effect is evident for narrow $[O\text{ III}]$, while the trend is absent for broad $H\beta$.

the challenges in reliably separating AGN and host galaxy continua. Care must therefore be taken when interpreting spectral slope measurements from single-epoch optical spectra, particularly in samples where host contamination is significant.

6.4 Notes on special objects

6.4.1 Non-emission-line galaxies

We identify three objects with spectra lacking significant emission-line signatures: *LEDA 131166*, *ICRF J112824.6–112218*, and *PKS J2231–0824*. All three sources are classified as type 1 AGNs in the Milliquas catalogue, with spectroscopic references traced to [Paturel et al. \(2003\)](#). However, the WiFeS spectra presented here do not exhibit the broad or narrow emission lines typically associated with AGN activity. Weak narrow $[N\text{ II}]$ and $[O\text{ III}]$ emission is detected in *PKS J2231–0824*, but the source remains dominated by stellar continuum features. For the purposes of this atlas, these objects are classified as non-emission-line galaxies (Non-ELG).

6.4.2 Double-peaked emitters

Four objects exhibit clear double-peaked broad-line profiles: *Z 395–23*, *6dFGS gJ100202.9–302117*, *ESO 359–19*, and *ESO 116–10*. These sources were modelled with three broad Gaussian components. The fitting procedure was initialised such that one component was centred on the systemic velocity, while the remaining two components were offset by $\pm 1000\text{ km s}^{-1}$, to allow convergence on the observed double-peaked profiles. A further 25 objects display possible double-peaked features, although these are less pronounced and were adequately modelled using the standard two-component broad-line prescription.

Two additional sources, *LEDA 88835* and *MCG–02–58–022*, were also fitted with three broad Gaussian components. However, these objects do not exhibit clear double-peaked profiles. The additional component was introduced because the BADASS fitting routine failed to converge using the standard two-component model.

6.4.3 Changing-look AGN

The atlas includes changing-look AGN (CLAGN) identified by [Wolf et al. \(2020\)](#), [Hon et al. \(2022\)](#), and [Amrutha et al. \(2024\)](#). These represent all systematically identified CLAGN currently known within the selection limits of the atlas.

Most CLAGN are recognised through the appearance or disappearance of broad $H\beta$ emission, corresponding to transitions between Seyfert subtypes. Because our sample includes AGN exhibiting broad $H\alpha$ emission, it is expected to contain the majority of CLAGN transitioning from type 1.9 to type 1.0, 1.2, 1.5, or 1.8. In contrast, transitions from type 2 AGN into broad-line states appear to be intrinsically rare; only one such object was identified among more than 1000 type 2 AGN examined by [Amrutha et al. \(2024\)](#), particularly because most of these type 2 AGNs have their broad line regions obscured by the dusty torus rather than being “true” type 2s with an intrinsic absence of broad emission.

We note that the objects classified as Seyfert 2 or star-forming galaxies in the present catalogue were previously classified as type 1 AGN in either 6dFGS or Milliquas. In some cases these sources may represent unrecognised CLAGN that have transitioned into a low-accretion state since the earlier observations. Alternatively, the higher spectral resolution and signal-to-noise ratio of the WiFeS observations may allow features previously interpreted as broad emission to be more accurately decomposed into narrow-line components. We therefore retain these objects in the atlas, even when no significant broad-line emission is detected in the WiFeS epoch, as they may provide valuable targets for future variability and CLAGN studies.

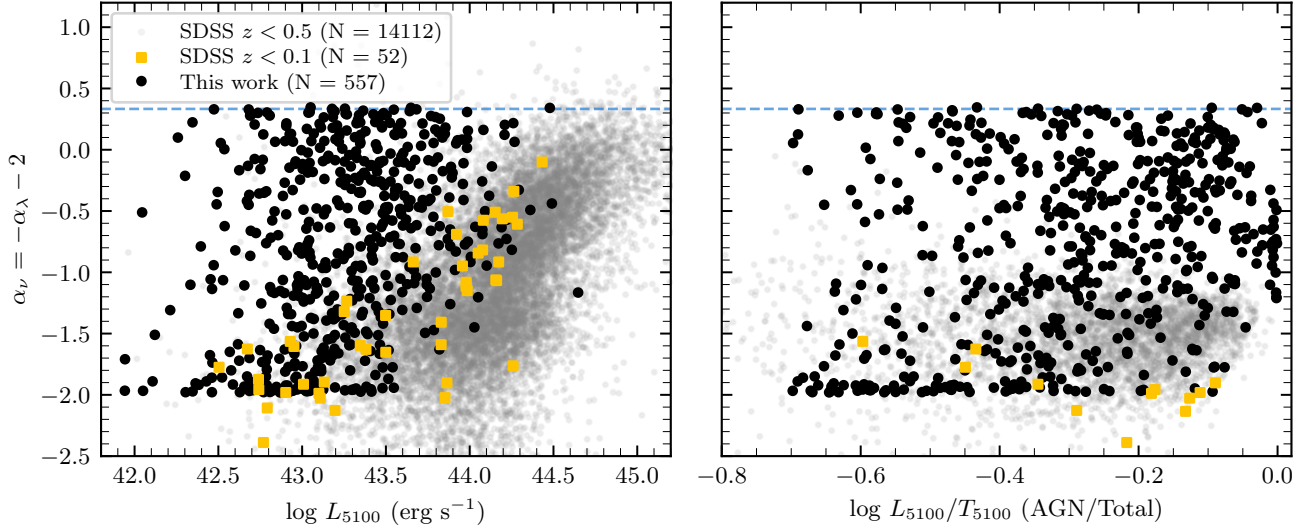


Figure 14. AGN power-law spectral index (in frequency space) as a function of **(left)** continuum luminosity, L_{5100} , and **(right)** the AGN fraction of the total continuum. The horizontal line marks the theoretical expectation for a standard thin accretion disc ($\alpha_\nu = 1/3$). A comparison with the SDSS quasar sample from Rakshit et al. (2020) is also presented. Objects with only AGN contribution no detected host components from the SDSS data set are omitted from the right panel, as the SDSS data provide null values for the host fractions.

7 EXAMPLE SCIENCE CASES

The primary goal of this atlas is to provide a contemporary spectroscopic reference for broad line AGN in the Southern sky at $z < 0.1$, enabling both variability studies and population-level analyses. In this section, we mention population studies that have been conducted or are underway, and an example transient follow-up scenario using a serendipitous observation of a flare.

7.1 Population studies

The first motivation for constructing the atlas was quantifying long-term variability of the broad $H\beta$ emission line over a ~ 20 -year baseline relative to earlier 6dFGS observations. This is used in both the $H\beta_{Br}/[O\text{III}]$ ratio underpinning Seyfert sub-types (Winkler 1992) and in estimating black-hole masses. The analysis by Amrutha et al. (2026) found evidence for long-term mean-reverting behaviour in the $H\beta_{Br}/[O\text{III}]$ ratio, where individual objects typically change by up to a factor of ~ 2 , while the sample as a whole remains bounded. These changes are accompanied by corresponding variations in luminosity and inferred single-epoch black hole masses, while broad-line widths remain largely unchanged. Such behaviour is not consistent with simple broad-line region “breathing” expectations and suggests that the effective BLR size does not respond strongly to luminosity variations on decadal timescales. Consequently, virial mass estimates based on instantaneous luminosities may be systematically biased by variability, whereas estimates based on longer-timescale luminosity tracers, such as $[O\text{III}]\lambda 5007$, appear to be more stable.

A photometric variability study of this sample has been carried out by Tan et al. (2026), who analysed the ensemble variability through structure functions derived from NASA/ATLAS light curves. Contrary to earlier work over shorter time spans, they found that variability amplitudes rose over the time span probed instead of converging to a decorrelation limit as predicted. Splitting the variability diagnostics by $H\beta_{Br}/[O\text{III}]$ ratio also suggested that the variety of Seyfert subtypes cannot be explained by an obscuration sequence.

Disentangling the roles of accretion variations and changes in ob-

scuration for producing the observed diversity of AGN sub-types, multi-wavelength data are very useful. The eROSITA mission includes X-ray observations for two thirds of the AGN in this atlas, and column densities inferred from X-ray spectra will further help obscuration studies. Together, these multi-wavelength datasets will provide new insights into the physical drivers of AGN spectral diversity.

7.2 Transient follow-up

In addition to population studies, the spectra presented in this atlas provide a reference set for future spectroscopic follow-up of transient phenomena in AGN. While individual observations may occasionally coincide with unusual activity, such as tidal disruption events (TDEs) or episodes of enhanced accretion, the sample as a whole is expected to represent the typical spectroscopic properties of the local AGN population. Consequently, when variability surveys such as ATLAS, ZTF or LSST identify anomalous behaviour, follow-up spectra can be directly compared to the archival spectra presented here.

An illustrative example is the type 1.5 Seyfert MCG-06-30-015 shown in Figure 15. This object represents a serendipitous transient discovery within our atlas. Three spectroscopic epochs are available: a first spectrum obtained at MJD 59434, a spectrum exhibiting transient spectral features at MJD 60770, and a subsequent spectrum obtained 27 days later at MJD 60797, that had largely returned to its original state. Figure 15 shows the ATLAS o -band difference-flux light curve for the source. The anomalous spectroscopic epoch coincides with an optical flare, occurring approximately 100 days after the photometric peak. The broad spectral feature at $\lambda 4650\text{\AA}$ is consistent with Bowen fluorescence, with strong $N\text{III}\lambda 4641$ emission characteristic of such flares (Trakhtenbrot et al. 2019; Makrygianni et al. 2023). The origin of the highly redshifted broad $H\beta$ without a correspondingly redshifted broad $H\alpha$ remains unknown. A comparably large velocity offset between these two lines has been reported in a nuclear flare by Li et al. (2022), though in that case the broad $H\alpha$ was strongly blueshifted rather than stationary, attributed to a newly formed broad-line region in the aftermath of a flare.

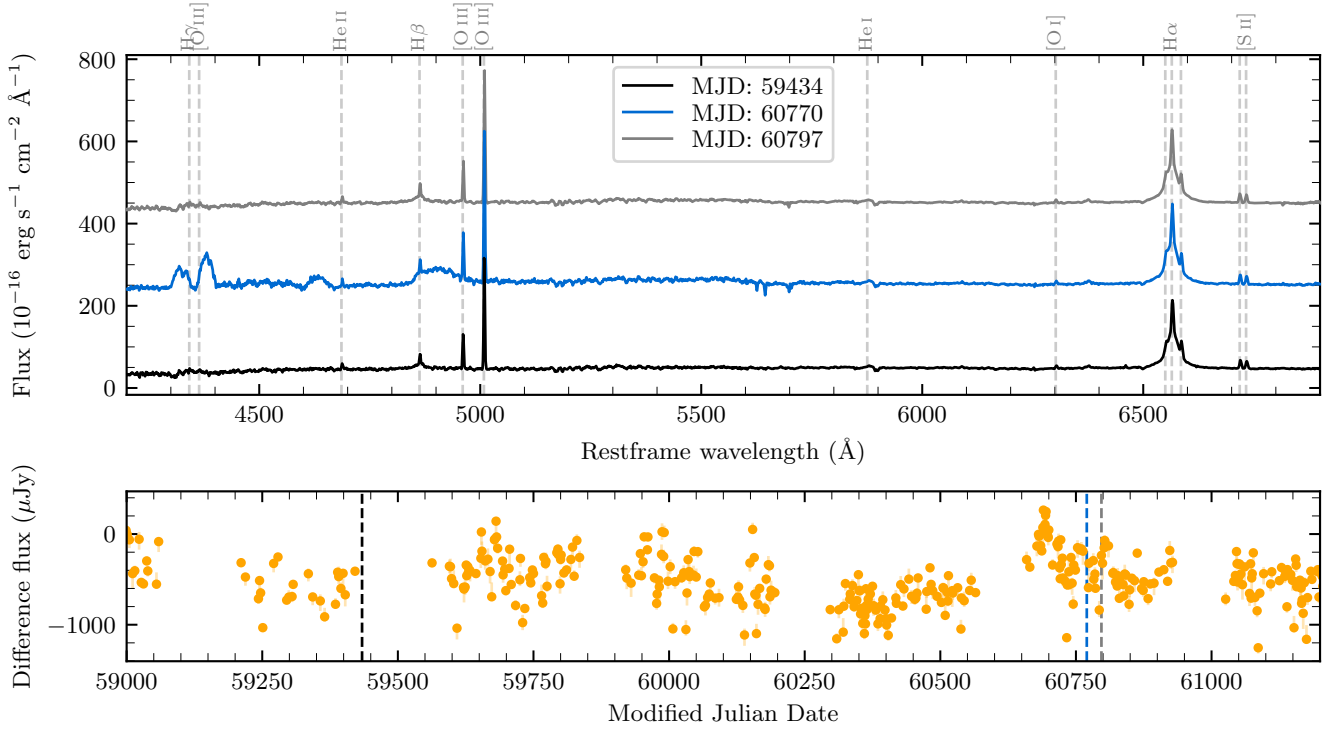


Figure 15. Example transient follow-up use case for MCG-06-30-015. **Top:** WiFeS spectra obtained before, during, and after the event. The spectra are offset by 200 flux units for visual clarity. The spectrum obtained at MJD 60770 exhibits transient spectral features associated with the flare, while the spectrum obtained four weeks later has largely returned to the pre-flare state. **Bottom:** ATLAS *o*-band difference-flux light curve showing a significant optical flare. The dashed vertical lines indicate epochs of the WiFeS observations.

Although this object is unique within the present sample, it shows the scientific value of maintaining a library of AGN reference spectra. In a typical future scenario, a transient may be identified photometrically and trigger spectroscopic follow-up. The resulting spectra could then be compared directly with the archival observations in this atlas, allowing rapid identification and characterisation of transient phenomena superimposed on the underlying AGN spectrum.

8 SUMMARY

We present a spectroscopic atlas and catalogue of 887 broad-line AGNs in the Southern sky at $z < 0.1$, declination $\delta < 0^\circ$, and Galactic latitude $|b| > 10^\circ$, observed with the WiFeS integral field spectrograph on the ANU 2.3 m telescope. The sample is drawn from 6dFGS (Hon et al. 2025), S7 (Thomas et al. 2017), AllBRICQS (Onken et al. 2023, Onken et al., in prep), and Milliquas (Flesch 2023), and is designed to be as complete as possible for luminous type 1 AGNs in this parameter space, with residual incompleteness driven by host galaxy dilution at $z \lesssim 0.03$. The final dataset comprises of 987 spectra of the 887 unique objects, with a median signal-to-noise ratio of 13 and 23 per Å in the blue and red arms respectively. For each source, we provide reduced IFU data cubes, extracted AGN spectra, AGN–host decomposition, and a uniform catalogue of emission-line properties, kinematics, and continuum luminosities.

This atlas is designed as a reference dataset for studies of AGN population demographics and variability in the local Universe. The sample overlaps extensively with the footprint of already ongoing large photometric time-domain surveys such as Asteroid Terrestrial-

impact Last Alert System and Zwicky Transient Facility. The Legacy Survey of Space and Time (LSST) carried out at the Vera C. Rubin Observatory will monitor these AGNs photometrically over the coming decade. Beyond characterising stochastic variability, these surveys will enable the identification of transient phenomena such as TDEs and changing-look behaviour in these sources with the spectra presented here providing a reference, allowing comparisons between spectroscopic states before and after photometric triggers. Complementary spectroscopic epochs will be provided by SDSS-V and the 4MOST Hemisphere Survey, both of which are expected to observe a substantial fraction of the sample. Together, these datasets will support systematic studies of long-term spectroscopic variability and AGN demographics across the full Southern broad-line population.

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stands, the Gamilaraay people, and pay our respects to elders past and present. We thank the WiFeS observers Katie Auchettl, Patrick Tisserand and Harrison Abbot for efforts in acquiring the spectra for this paper. The national facility capability for SkyMapper has been funded through ARC LIEF grant LE130100104 from the Australian Research Council, awarded to the University of Sydney, the Australian National University, Swinburne University of Technology, the University of Queensland, the University of Western Australia, the University of Melbourne, Curtin University of Technology, Monash University, and the Australian Astronomical Observatory. SkyMapper is owned and operated by The Australian National University's Research School of Astronomy and Astrophysics. The survey data were processed and provided by the SkyMapper Team at ANU. The SkyMapper node of the All-Sky Virtual Observatory (ASVO) is hosted at the National Computational Infrastructure (NCI). Development and support of the SkyMapper node of the ASVO has been funded in part by Astronomy Australia Limited (AAL) and the Australian Government through the Commonwealth's Education Investment Fund (EIF) and National Collaborative Research Infrastructure Strategy (NCRIS), particularly the National eResearch Collaboration Tools and Resources (NeCTAR) and the Australian National Data Service Projects (ANDS).

DATA AVAILABILITY

The final data products are publicly available, and can be accessed at https://www.mso.anu.edu.au/stromlo_agn/atlas/. The data products include the extracted spectra from WiFeS cubes, the decomposition outputs directly from the BADASS3 routine, catalogue of extracted parameters, summary PDF and HTML pages for each object, and a merged summary of all the PDF pages as a single document. The SMSS data underlying this paper are available at the SkyMapper node of the All-Sky Virtual Observatory (ASVO), hosted at the National Computational Infrastructure (NCI) at <https://skymapper.anu.edu.au>. The 6dFGS data are available at <http://www-wfau.roe.ac.uk/6dFGS/> and the Final Data Release is available for public access.

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APPENDIX A: DATA STRUCTURE

The data can be accessed via the provided web link³. The data is presented as follows:

- `catalogue.csv` (file): The main catalogue of derived parameters for all sources. Column definitions are provided in Table 2.
- `raw_spectra/` (directory): FITS files containing the extracted 1D spectra.
- `decomp_spectra/` (directory): Spectral decomposition output from BADASS3, provided in tabular format. Fluxes are reported in units of $10^{-16} \text{ erg s}^{-1} \text{ cm}^{-2} \text{ Å}^{-1}$.
- `pdf_pages/` (directory): Per-object summary pages in PDF format, including the spatial extraction image, the decomposed spectrum, and derived parameters. An example is shown in Figure A1.
- `object_pages/` (directory): HTML summary pages for each object, containing the same information as `pdf_pages` together with an interactive spectrum viewer.
- `merged_summaries.pdf` (file): A compiled PDF containing all individual pages from the `pdf_pages/` directory (~ 0.5 GB).

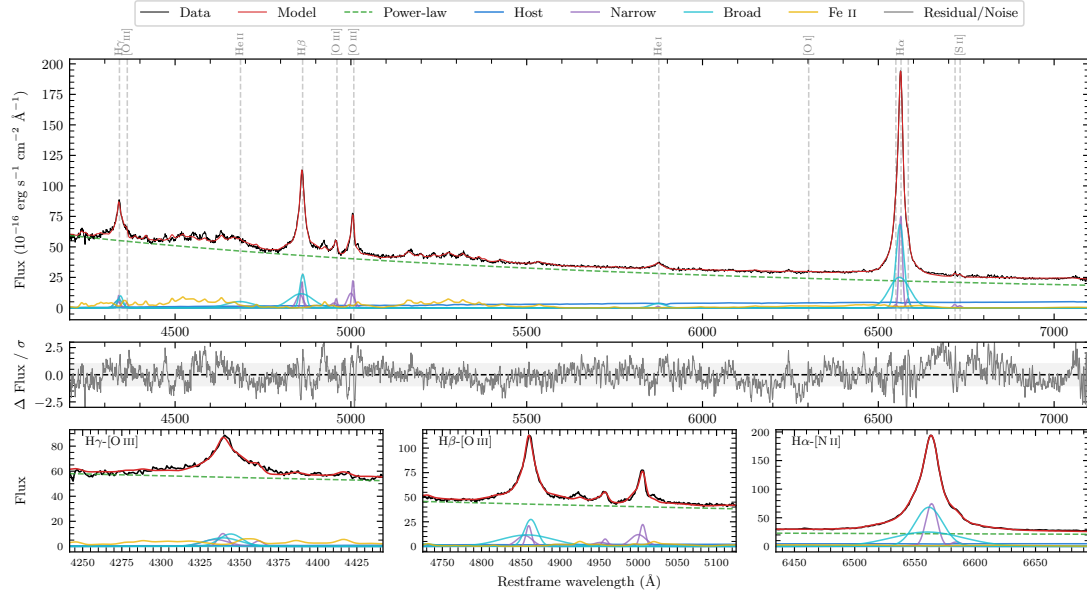
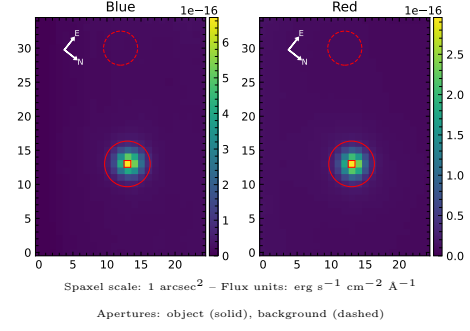
Files are named using the corresponding `spectrum_id` in `catalogue.csv` in the directories. The base web page includes a table for quick access of the individual objects.

This paper has been typeset from a $\text{\TeX}/\text{\LaTeX}$ file prepared by the author.

³ Data access: https://www.mso.anu.edu.au/stromlo_agn/atlas/

Ton S 180

Spectrum ID	12274614.sp1	Spectrum type	Sy 1.2
Alt name	TON S180	Quality flag	good
z	0.0615	AGN reference	B+1994
RA, Dec	14.3342, -22.3824	MW $E(B - V)$	0.012
MJD	59438.81	Power law α_ν	0.22 ± 0.03
SNR/Å B/R	30.9/38.4	$\log L_{5100, \text{AGN}}$	44.26 ± 0.01
Obs airmass	1.11	$\log H\beta_{\text{Br}}/[\text{O III}]$	0.49 ± 0.02
SMSS ID	12274614	$\log M_{L5100}/M_\odot$	7.40 ± 0.03
Neighbour	3.3", 2021684939	$\log M_{H\alpha}/M_\odot$	7.20 ± 0.05
SMSS $r_{6''\text{ap}}$	14.62 ± 0.05	$\log M_{H\beta}/M_\odot$	7.29 ± 0.03
2MASS K_{ext}	nan $\pm$ nan	$\log M_{[\text{O III}]} / M_\odot$	7.23 ± 0.03



Emission Line Measurements

Line	$\log L$ (erg s ⁻¹)	FWHM (km s ⁻¹)	σ (km s ⁻¹)	EW (Å)
H γ Narrow	41.29 ± 0.08	680 ± 65	509 ± 26	3.83 ± 0.17
Hγ Broad	41.60 ± 0.06	1469 ± 102	567 ± 79	7.10 ± 0.19
[O III] 4364	40.53 ± 0.15	513 ± 63	217 ± 25	0.67 ± 0.10
He II Narrow	40.03 ± 0.27	513 ± 63	217 ± 25	0.25 ± 0.10
He II Broad	41.69 ± 0.03	5651 ± 210	2400 ± 89	11.13 ± 0.36
H β Narrow	41.65 ± 0.04	680 ± 65	509 ± 26	11.36 ± 0.19
Hβ Broad	42.18 ± 0.01	1553 ± 49	1176 ± 33	38.25 ± 0.35
[O III] 5007	41.69 ± 0.01	680 ± 65	509 ± 26	13.22 ± 0.20
He I Narrow	40.14 ± 0.15	513 ± 63	217 ± 25	0.53 ± 0.09
He I Broad	41.26 ± 0.02	2462 ± 92	1046 ± 38	7.06 ± 0.20
[O I] 6300	39.38 ± 0.39	513 ± 63	217 ± 25	0.11 ± 0.09
H α Narrow	41.94 ± 0.02	513 ± 63	217 ± 25	42.93 ± 0.18
Hα Broad	42.58 ± 0.01	1485 ± 67	728 ± 25	184.62 ± 0.34
[N II] 6585	40.95 ± 0.03	513 ± 63	217 ± 25	4.42 ± 0.15
[S II] 6718	40.53 ± 0.04	513 ± 63	217 ± 25	1.75 ± 0.12
[S II] 6732	40.35 ± 0.07	513 ± 63	217 ± 25	1.15 ± 0.12

Emission Summary

H α broad SNR	62.47
H β broad SNR	26.04
H γ broad SNR	11.11
AGN frac	0.95
Host frac	0.05
$\log L_{5100, \text{Host}}$	42.99
Fe II/H β	1.07
Fe II/[O III]	3.30

Quality Flags

spurious_hab/hbb	0/0
15100	0
balmer	0
balmer_snr	0
hb_width	2
balmer_width	0

Figure A1. Example summary page for a spectrum.