Multi-component analysis of SDSS-V galaxy/AGN spectra using the Nbursts technique

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I am happy to answer the questions and discuss our results
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Our goals: check, how does a galaxy's BPT diagram position depend on the X-ray/Hα flux ratio for eROSITA X-ray galaxies, observed with SDSS-V

Methods: we used NBursts technique to fit SDSS-V galaxies` spectra

Objects: we used the sample of eROSITA X-ray selected sources from IPL3 (DL1-SDSSV-IPL3-eROSITA data). It contains 26,962 spectra of SDSS-V observed objects with eROSITA X-ray counterparts.

Results: On the example of [OIII] line we found that the fluxes for optical emission lines, obtained with NBursts code are in agreement with previously obtained with SDSS-IV DR17 (Fig. 3a, b) .

For SDSS-V eROSITA galaxies fitted with NBursts code:
lg(L_X)=0.77*lg(L_[OIII])+11.36
lg(L_X)=0.75*lg(M_BH)+36.43

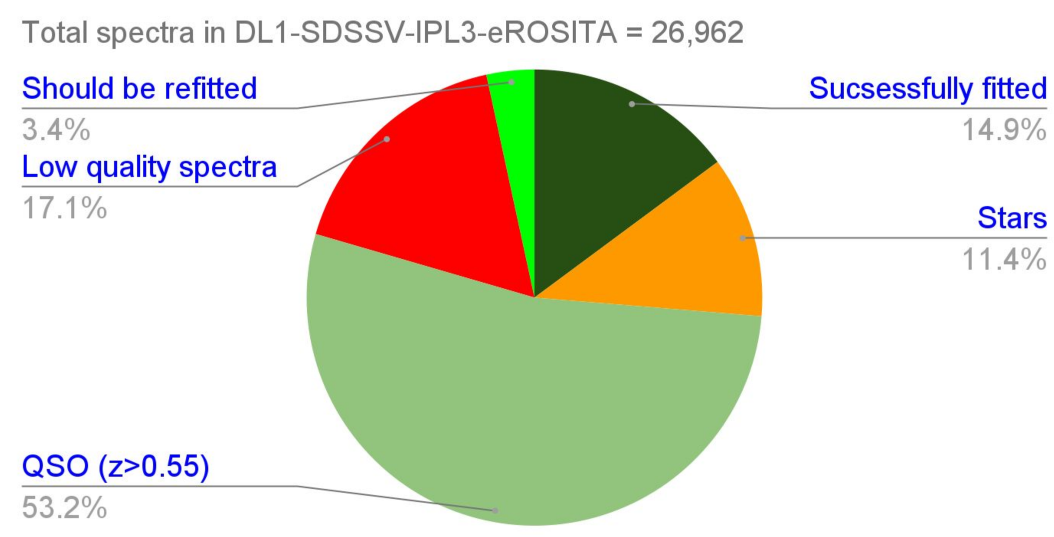
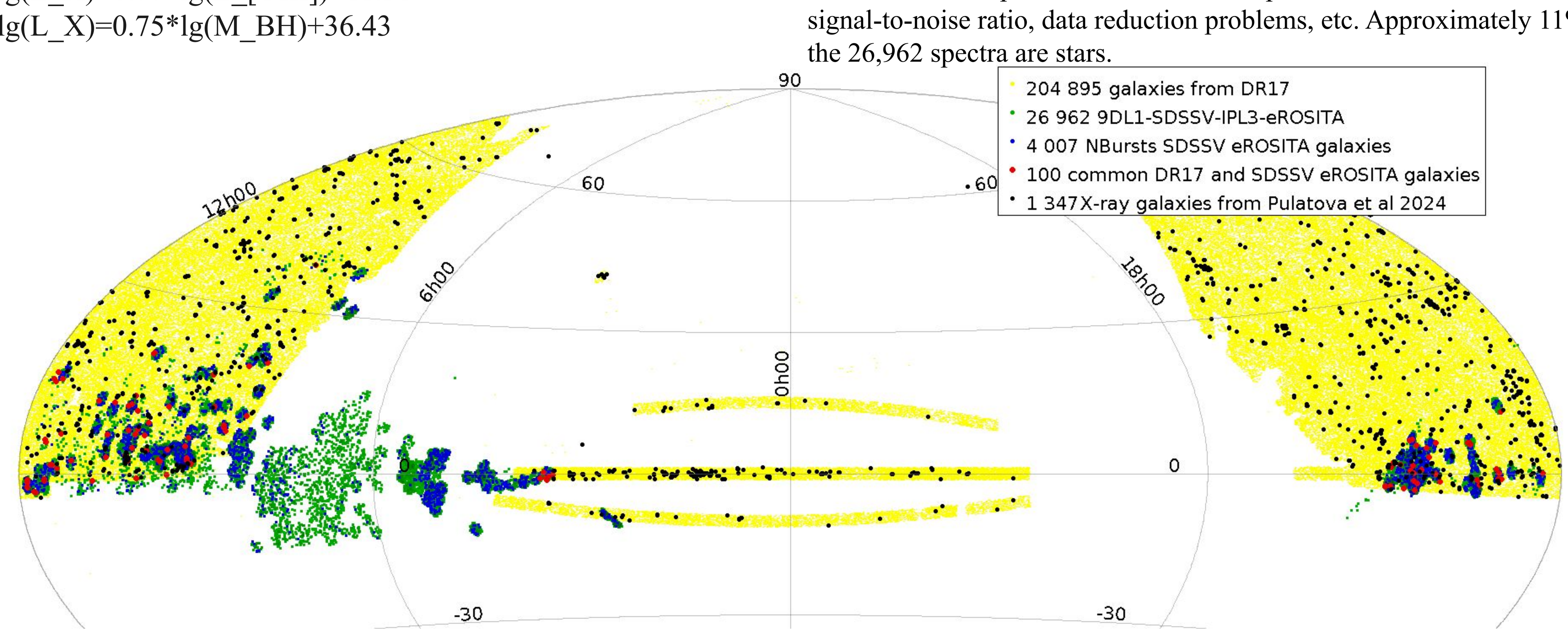


Fig. 1 shows the content of the DL1-SDSSV-IPL3-eROSITA 26,962 spectra. The majority are QSO spectra (53.2%). These spectra cannot yet be automatically fitted with the NBursts code, as emission line templates need to be developed. About 17% of the spectra cannot be used due to low signal-to-noise ratio, data reduction problems, etc. Approximately 11% of the 26,962 spectra are stars.

Nbursts technique (Chilingarian et al. 2007)

NBursts has been successfully applied to more than 5,000,000 optical spectra (including previous SDSS versions,http://rcsed-dev.sai.msu.ru/about/, https://dev-rcsed2.voxastro.org/about). Compared to the existing pipeline analysis, NBursts' most important advantages are: -automatic correction and consideration of typical errors in initial spectra, -lists of emission lines that can be defined individually for each galaxy, -modelling of multiple multi-component emission line scenarios. We will use a parametric fitting for AGN spectra, which includes omponents for a stellar population of a host galaxy (mean age, metallicity, velocity dispersion, or a more complex parametric star-formation history), narrow emission lines, broad emission lines, AGN continuum, and an FeII template. Relative individual emission-line fluxes for both broad and narrow components are linearly constrained using considerations from atomic physics. The analysis results will include the best-fitting model (total + individual components: stellar population, narrow and broad line models, AGN continuum, an FeII model), parameters of the stellar population of an AGN host galaxy, emission line fluxes and widths for narrow and broad emission lines (optionally, with h3/h4 auss-Hermite moments), the AGN continuum luminosity at a desired wavelength (e.g. 5100A), a normalization factor for the FeII template (see Fig. 2).



For more information about NBursts code contact to:
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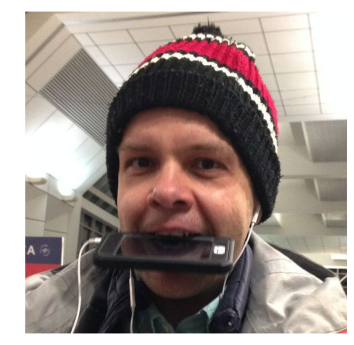


Fig. 2 Position on the celestial sphere of 4,007 SDSS-V eROSITA spectra of selected galaxies with z<0.55 that were automatically successfully fitted with the NBursts code (blue dots). For comparison, 204,895 galaxies from DR17 with S/N>3 are plotted as a yellow background. Green dots represent the total sample of 26,962 eROSITA X-ray sources with SDSS-V optical spectra. The red dots show 100 common galaxies with available fluxes from SDSS-IV, DR17 and fluxes obtained by applying the NBursts code to 26,962 eROSITA X-ray sources with SDSS-V optical spectra. Using the [OIII] line as an example, we found that the optical emission line fluxes obtained with the NBursts code agree with those previously obtained with SDSS-IV DR17 (see Fig. 4a, b). The positions of 1,347 XMM-Newton X-ray selected galaxies with fluxes in optical emission lines from SDSS DR 17 are shown as black dots (Pulatova et al 2024).

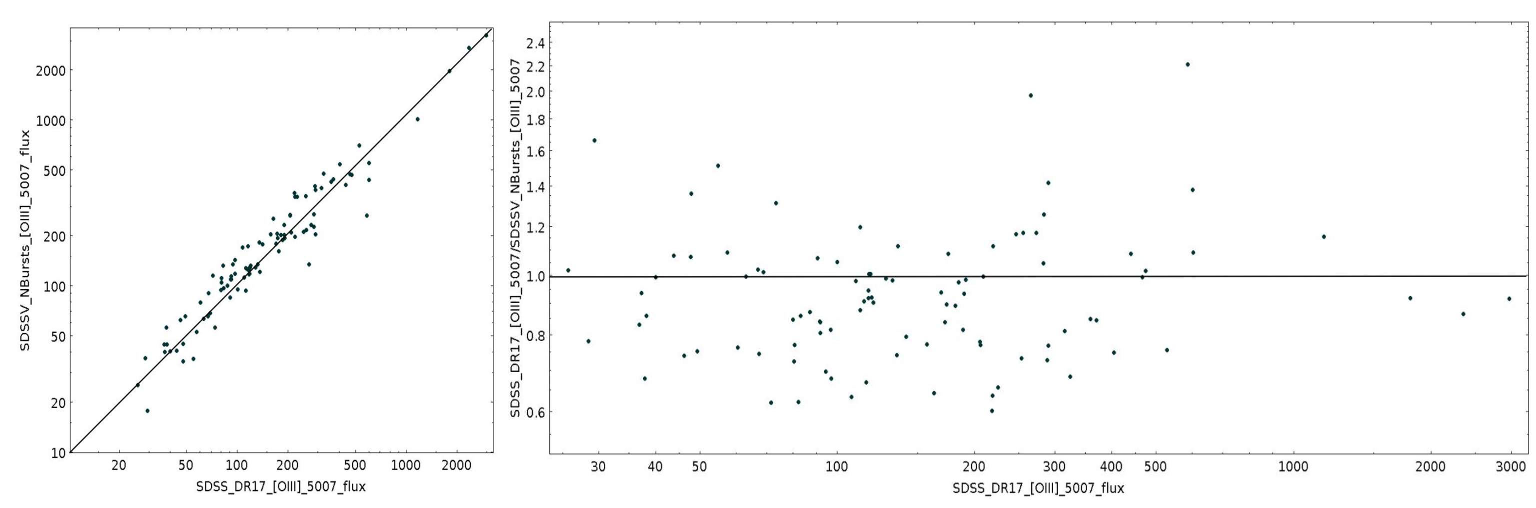
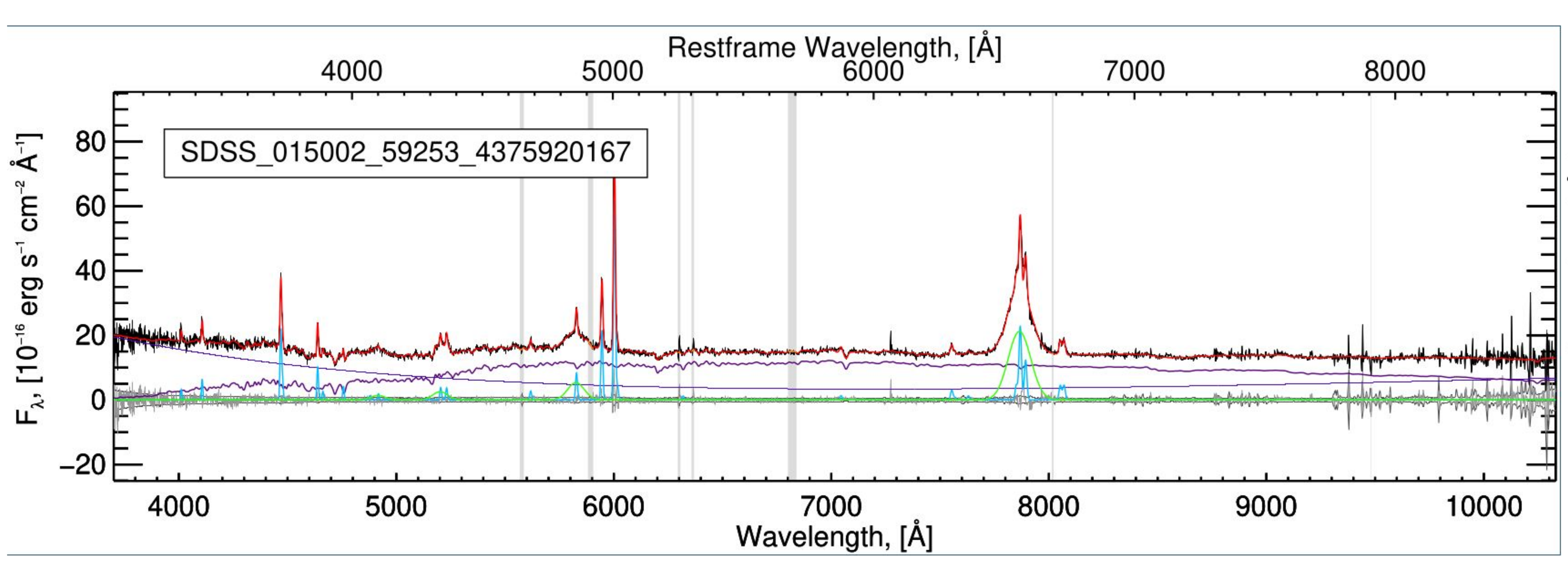
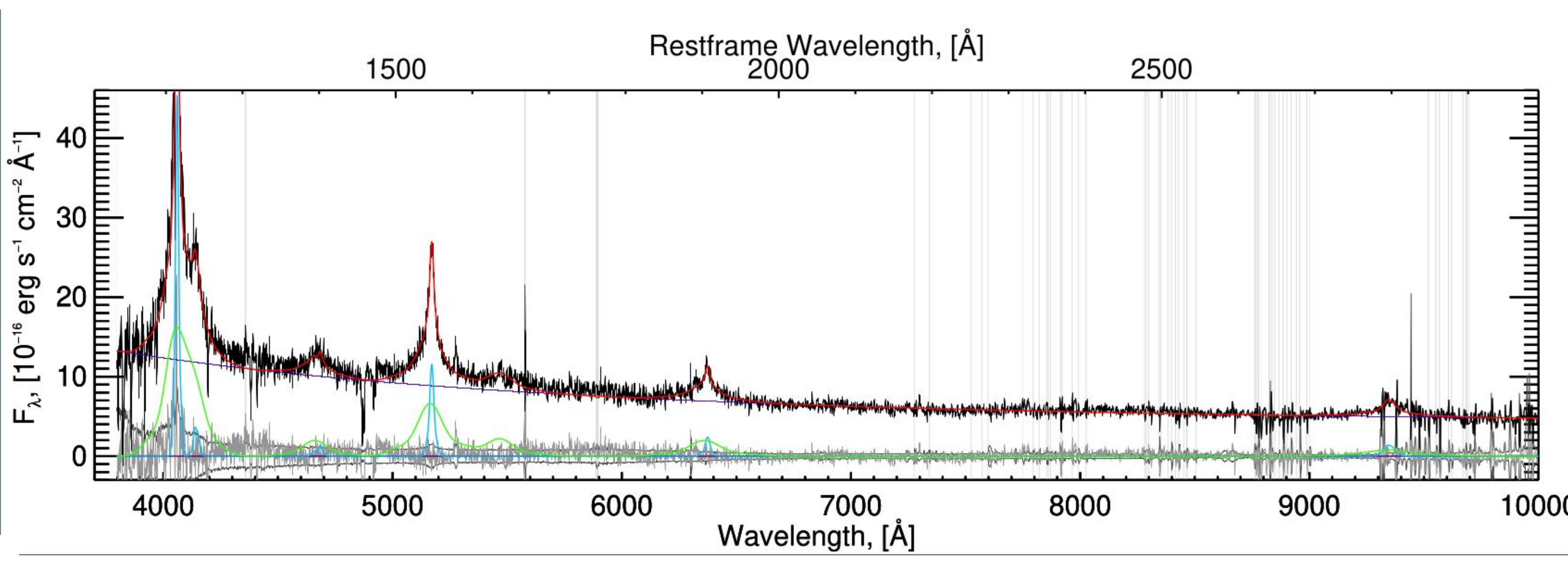


Fig. 4a, b shows the comparison of the fluxes in the [OIII] optical emission line for the SDSS-IV DR17 data and the results obtained with the NBursts code applied to the SDSS-V data. The comparison was made for 100 common galaxies, that were observed with SDSS-IV and SDSS-V phases (see Fig. 2). Fig. 4a (right) shows a correlation between the flux in the [OIII] line obtained with the NBursts code (y-axis) and that calculated in SDSS-IV, DR17 (x-axis). Both fluxes are in 10-17 erg*cm-2*s-1. The solid black line is x=y. The ratio of the fluxes in the [OIII] line calculated in SDSS DR17 and obtained from the NBursts code for the same sample of 100 common galaxies as in Fig. 4a is shown in Fig. 4b. The solid line is at y=1. From Fig 4a,b we can conclude, that fluxes in [OIII] line from NBursts code and DR17 are in agreement. The difference between two fluxes (NBursts and SDSS DR17) can come from data reduction and observation conditions, as we comparing different spectra made in different time for the same objects.





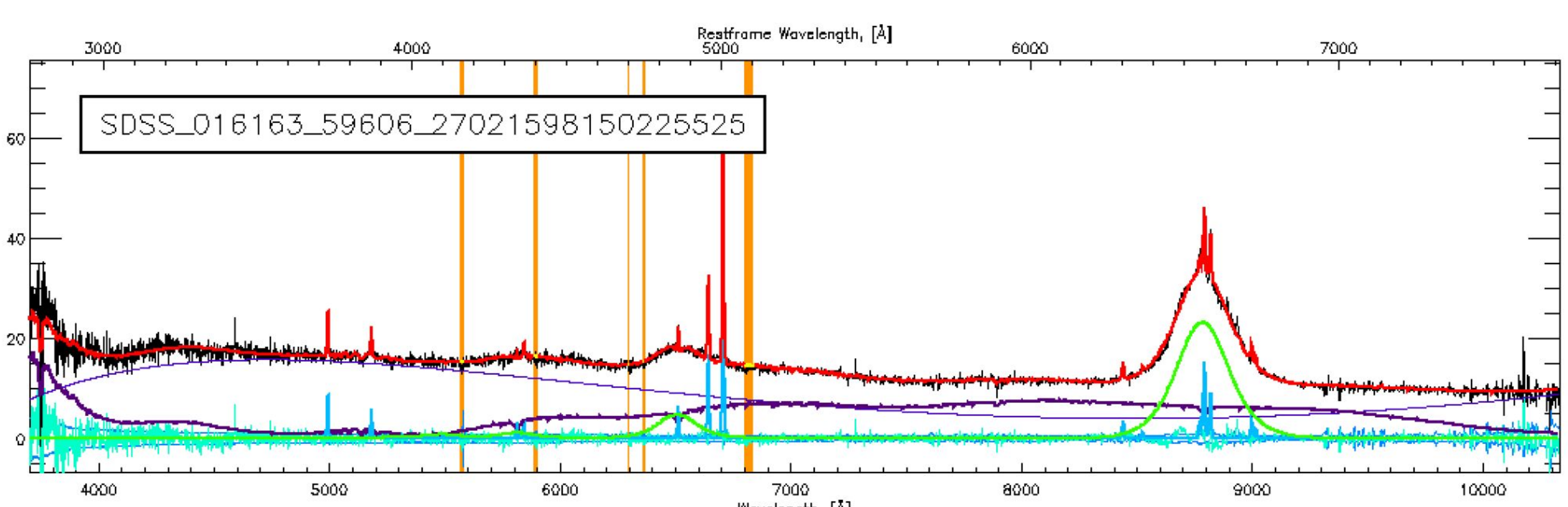
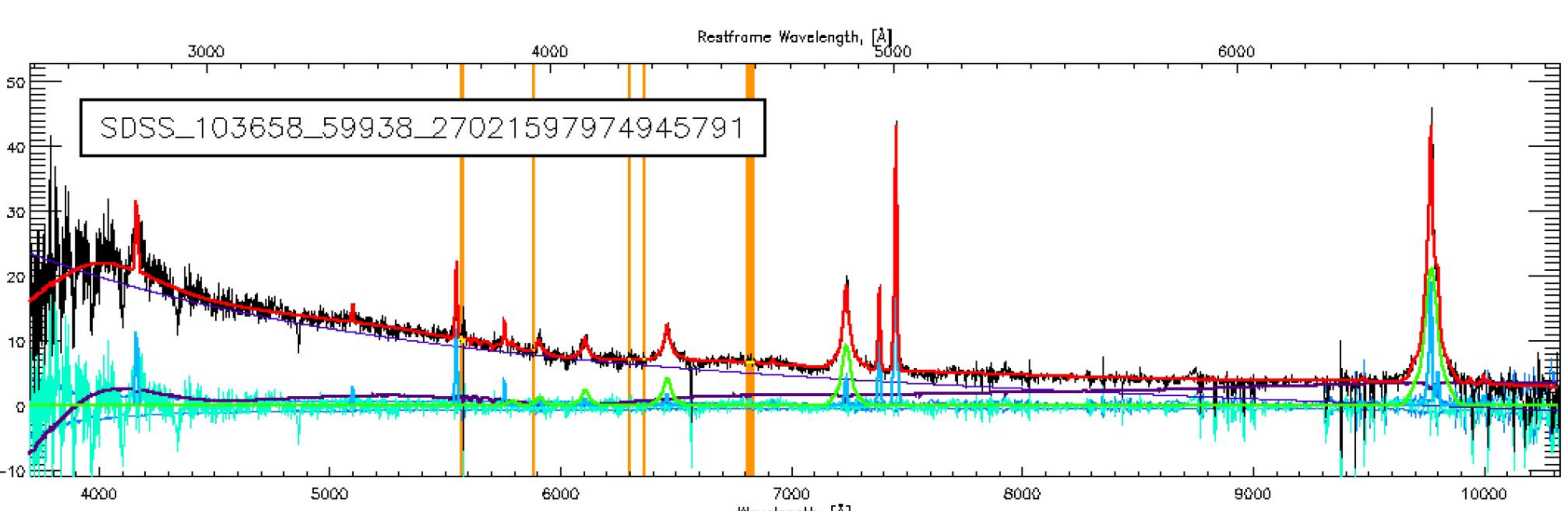
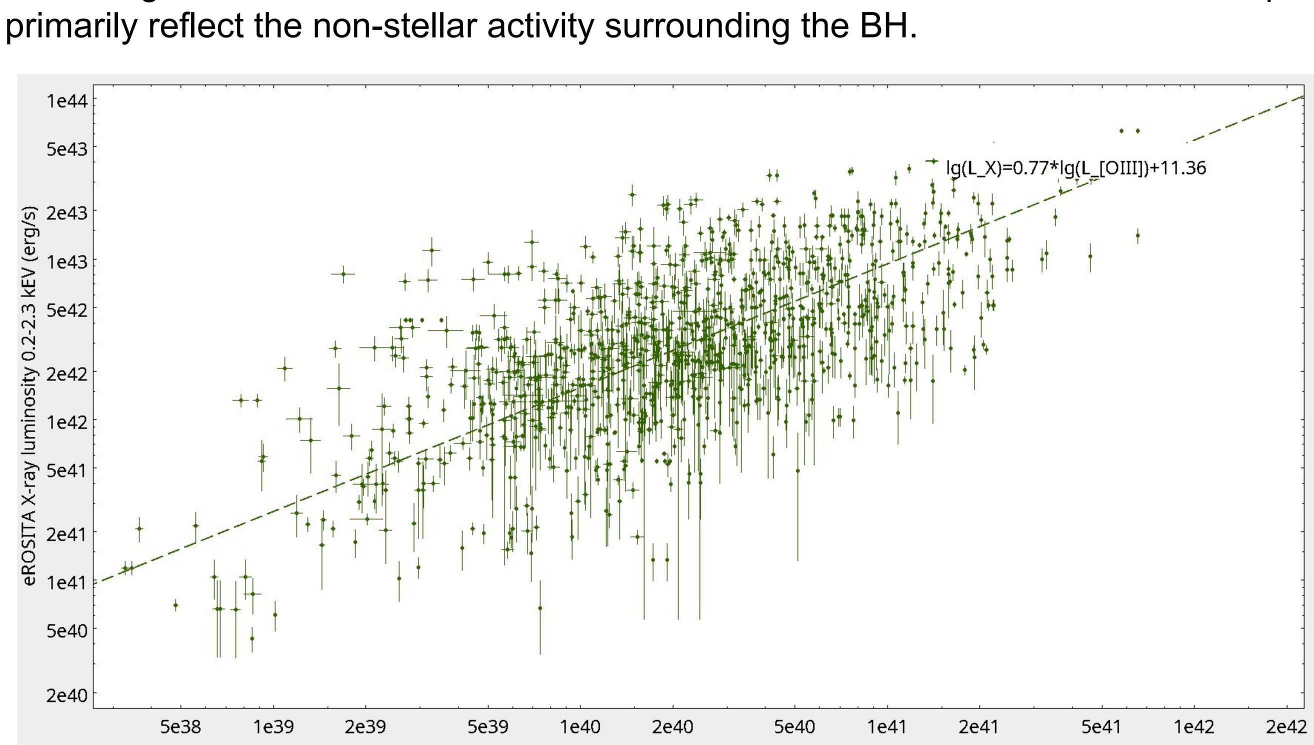
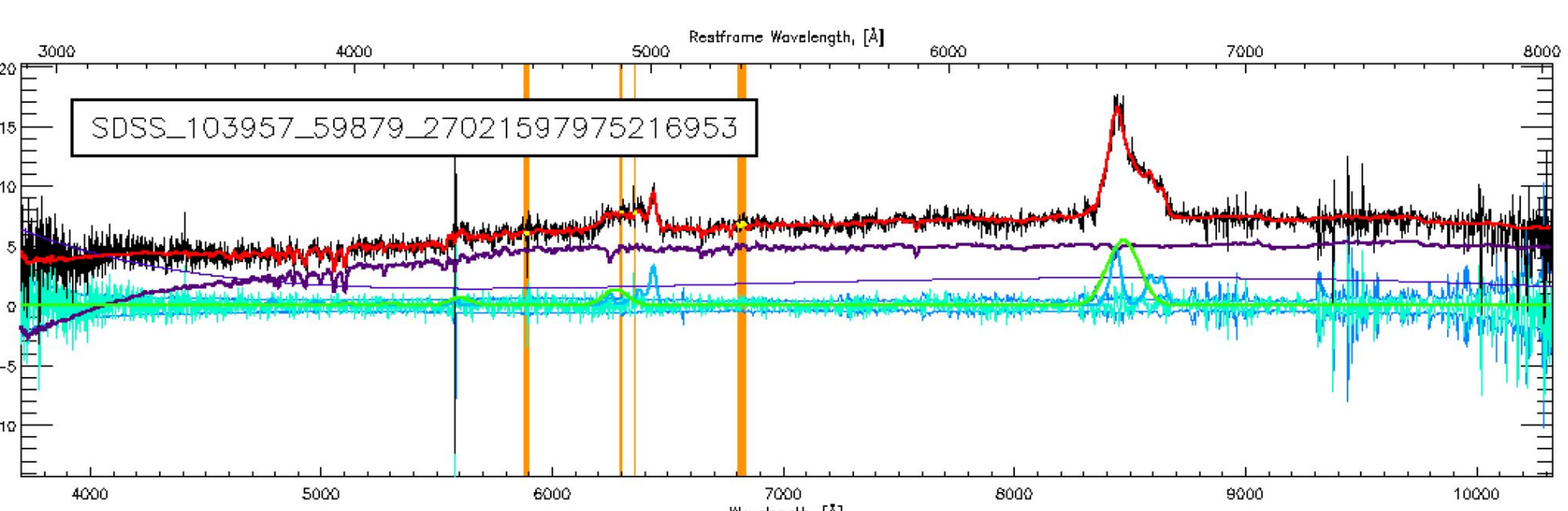


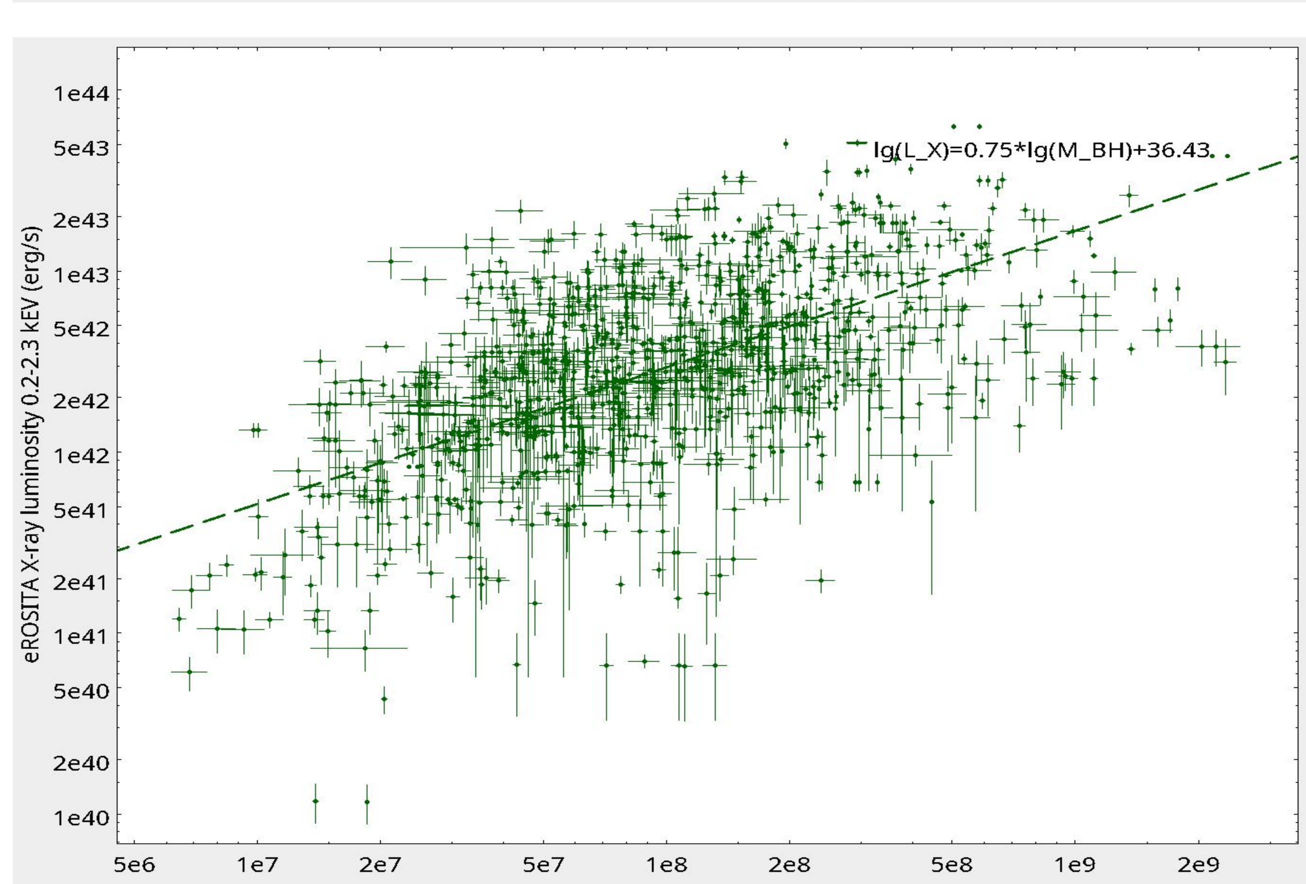
Fig 3 a-f. The examples of SDSS-V spectra, fitted with NBursts code. Fig. 3a-e (left) the example of AGN and Fig. 3f (above) QSO spectra respectively. The **solid black line** in all figures is the original SDSS-V spectrum. The total NBursts fit is shown by the **solid red line**. The total NBursts fit consists of 3 main components:

1. Emission lines (broad - light green, narrow - sky blue). An emission line model with 1 broad and 1 narrow component was used for the plotted fits.
2. Additive continuum (from the accretion disk) - solid purple line.
3. Stellar component (present only for AGN spectrum, Fig. 3a above) - purple solid line with absorption features. The optical spectra of QSOs generally lack a stellar component, because the emission is dominated by the intense radiation from the accretion disk surrounding the SMBH at the QSO's centre. In addition, quasars are often located at great distances, making the stellar light even harder to detect compared to the much brighter central AGN. As a result, the emission lines and continuum of the quasar primarily reflect the non-stellar activity surrounding the BH.









Total DL1-SDSSV-IPL3-eROSITA (26,962)

Successfully fitted with NBursts code 4,007 spectra

QSO with z>0.55
Stars z<0.03,
low quality, with peculiarities
Total: 22,955 spectra

X-ray luminosity vs BH mass: 1,298 spectra

- The signal-to-noise ratio (SNR) in the 5 narrow lines in the BPT diagram > 3.
- The SNR in the broad components of Hα and Hβ was > 3.
- The velocity dispersion of the narrow-line region (NLR) was < 500 km/s.
- The velocity dispersion of the broad-line region (BLR) was > NLR + 500 km/s (but no more than 5000 km/s).
- The radial velocities of the components differed by less than 2000 km/s.