Open-source web tools for spectroscopic and imaging data visualization for the VOXAstro initiative

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Abstract.
VOXAstro stands for Virtual Observatory tools for eXtragalactic Astrophysics. This initiative includes several projects such as Reference Catalog of Spectral Energy Distribution (RCSED;http://rcsed.sai.msu.ru/) Chilingarian et al. (2017) and Las-Campanas Stellar Library. Here we present a set of flexible open-source tools for visualization of spectral and imaging data. Using web-visualisation libraries FlotJS and Dash we developed interactive viewers for displaying low- and high-resolution spectra of stars and galaxies, which allow one to view spectra having resolution up to R=80000 without putting a significant load on server and client sides, which is achieved by choosing the adaptive spectral binning window and dynamically preloading the datasets. We implemented a number of additional features like multiple spectra display, output of header info (e.g. stellar atmospheric parameters or stellar population properties of galaxies), display of emission lines decomposition parameters (fluxes, widths etc.) The spectral viewers can be easily embedded into any archive or database web-site. We also present a cutout service that extracts data on the fly from the UKIDSS near-infrared imaging survey and generates colour composite RGB stamps, which we use, e.g. in the RCSED web-site as an embedded service. The service is built using Astropy python library and uses IVOA SIAP to access images, which it then cutouts on the fly. In the coming years we plan to expand the capabilities of our spectroscopic and imaging visualization services and use them in future projects within VOXAstro.

1. Introduction

VOXAstro stands for Virtual Observatory tools for eXtragalactic Astrophysics. This initiative includes several projects such as Reference Catalog of Spectral Energy Distribution (RCSED; http://rcsed.sai.msu.ru/) and several stellar spectral libraries. Here we present a set of flexible open-source tools for visualization of spectral and imaging data. For all applications, we tried to reach the maximal flexibility and convenience in embedding them into html pages which makes possible re-using them in other projects.

2. RCSED spectra viewer

For RCSED (Reference Catalog of Galaxy SEDs, rcsed.sai.msu.ru, Chilingarian et al 2017) we developed a viewer of galaxy spectra. This application is based on the Flot javascript library (`https://www.flotcharts.org/`) which implements draggable plots. The viewer displays a calibrated spectrum and its best-fitting model (including models of emission lines with non-parametric or gaussian profile and starlight). One can also get the information about fluxes in emission lines by clicking on them, the positions of lines are marked by vertical bars. Besides the spectrum plot, a clickable table is provided which contains emission line fluxes, flux errors, signal-noise-ratios.

3. UKIDSS RGB YHK images in RCSED

Near-infrared RGB composite images are often useful for eyeball assessment of stellar populations and morphology in galaxies. The 2MASS survey gives access to all-sky JHK data, however its data is very shallow, therefore we use a much deeper UKIDSS survey data in RCSED. Unlike 2MASS, UKIDSS does not have an RGB MOC map in Aladin, that is why it is non trivial to embed UKIDSS RGB image to an arbitrary web page. We use the python library APLpy (`https://aplpy.github.io/`) to generate RGB images on the fly in on the RCSED web-site. The Lupton et al. (2004) algorithm is used for the RGB composite generation from YHK images.

4. Interactive visualization for spectra of different types

Many astrophysical studies deal with spectral data of different flavors: from one-dimensional (like SDSS) to three-dimensional (e.g. MANGA). The diversity of data one has to work with makes essential the development of a versatile spectral visualization tool. We developed a flexible interactive Web-based tool for spectral display. It is based on Dash and Plotly libraries (`https://plot.ly/products/dash/`). These libraries allow us to efficiently display even high-resolution spectra (R=80000, 500k data points) without heavy load on both server and client. For users it could be also important to display some values from FITS file in tabular form, e.g. parameters of the best-fiting model. There is also an option to plot some arbitrary data as a supplementary dataset (e.g. a correcting polynomial for the stellar continuum). Supplementary datasets and the output parameter table are controlled via URL parameters. One can also adjust the parameters of main datasets (flux, error, etc), which default to the IVOA Spectrum Data Model. This makes possible to use our web application to visualization nearly all existing types of spectra.

5. Interactive visualization for libraries of stellar spectra

Some projects require simultaneous visualization of several spectra in order to compare them against each other. This is particularly important for libraries of stellar spectra, which provide uniformly processed data collections typically from the same instrument. For this purpose, we extended the simple spectrum viewer. This tool is also based on Dash and Plotly and includes all advantages from the ordinary single spectra visualizator, but it also has additional feature for the interactive selection of spectra from a

dataset. For stellar libraries, we use the stellar atmospheric parameter space (Teff, logg, [Fe/H]). The selection can be done using a 2D or 3D plot or a an ordinary table with parameters.

References

Chilingarian, I. V., Zolotukhin, I. Y., Katkov, I. Y., Melchior, A.-L., Rubtsov, E. V., & Grishin, K. A. 2017, ApJS, 228, 14. 1612.02047