Astronomical Data Analysis Software and Systems XX
ASP Conference Series, Vol. 442
Ian N. Evans, Alberto Accomazzi, Douglas J. Mink, and Arnold H. Rots, eds.

Visualization and Logical Binding of Hyperspectral Data Using QuickViz and SAADA

Matthieu Petremand,[1] Laurent Michel,[2] and Mireille Louys[1]

[1]*LSIIT, UMR CNRS 7005, Bd Sébastien Brant, BP 10413, 67412 Illkirch CEDEX, FRANCE*

[2]*Observatoire de Strasbourg, UMR CNRS 7550, 11 rue de l'université, 67000 Strasbourg, FRANCE*

Abstract. Next generation integral-field spectrographs (IFS) such as MUSE will record large hyperspectral cubes and thus generate a huge amount of observational and interpretable data. Their visualization remains a problematic and crucial task before any processing. In addition, observation parameters such as variance values may also be associated to each cube and be involved in the scientific interpretation of the data. In this paper, we propose a new software named QuickViz that provides a set of basic and advanced features enabling the exploration of such hyperspectral images with their related observation parameters. This new software is designed in Java as an Aladin plug-in and thus extends its hyperspectral functionalities while managing all the interactions between cubes and extracted spectra. Moreover, the specifications of the SAADA application allowing to automatically generate astronomical relational databases give the ability to easily explore such large data sets with respect to their complex relationships.

1. Introduction

Future deep-field surveys carried out by next generation integral-field spectrographs will produce a high number of heterogeneous astronomical data sets: hyperspectral cubes, observation parameters (e.g., variance values, PSF widths, data quality flags) and metadata. For instance, the size of a reconstructed MUSE (Laurent et al. 2006) observation with its associated variance cube is about 2.4 GB. Since the amount of data to be analyzed grows, the development of dedicated exploration and visualization tools becomes a mandatory goal. Indeed, new developed software must be designed to ease the joint analysis of such large data sets or the benefit of hyperspectral imagery will be lost. Moreover, additional parameters associated with an observation should no longer be ignored throughout the analysis process as they can give relevant clues for further investigations. For example, variance values and PSF reflect the data quality and can thus be taken into account to check local data quality and select regions of interest. We then propose a new software tool, QuickViz (Petremand et al. 2010), especially dedicated to the visualization of large hyperspectral images together with their associated parameters (see § 2). This innovative tool can be jointly used with a SAADA repository (Michel et al. 2005), automatically designing and populating an astronomical relational database with a set of FITS or VOTable files containing either tables or images. Queries can thus be sent from a web interface to the database so as to select data sets on specified constraints. SAADA's facilities are illustrated in § 3 with a repository housing simulated hyperspectral MUSE data sets. The conclusion and perspectives for further development are given in § 4.

2. Hyperspectral Visualization with QuickViz

Currently existing software such as Aladin (Bonnarel et al. 2000) or GAIA3D[1] offer well-designed hyperspectral visualization features but don't totally provide a framework for IFS data exploration. For instance, GAIA3D cannot handle more than one cube at the same time whereas Aladin is mainly dedicated to 2D visualization and thus lacks spectral functionalities. Instead of starting the development of a new tool from scratch, we have rather chosen to extend Aladin as it already provides plug-in capabilities, a cross-platform architecture (written in Java) and optimized memory management (up to 3 cubes of 1.2 GB each can be loaded with 1.2 GB of memory). Figure 1 presents the main features of the Aladin/QuickViz duo[2] (circled numbers on Fig. 1 are refered to those in italic font in the following paragraph).

Data extraction from loaded hyperspectral cubes (*1*) can be carried out at each spatial position (*2*) or by computing an averaged spectrum over a circle shaped area (*3*). All newly extracted spectra are stacked in QuickViz (*4*) and available for display, superposition and comparison on spectrum panels (*5*). Users can easily interact with these panels to: browse selected cube's frames thanks to a calibrated cursor (*6*), define selections over spectral ranges (*7*) and use intuitive zoom features (*8*). Several customizable visualization modes can be enabled for data display (*9*) and spectra can be shared between panels thanks to multiview (synchronized or not) capability (*10*). Variance values can be displayed together with data along the spectral axis with the help of two visualization modes: error covering and error bars (*11*). Simple visualization algorithms can also be executed either on frames or spectra and produced outputs such as mean, weighted mean or RGB colored composition (*12*) be used to refine the data analysis or to act as guide images. New algorithms or visualization modes can be easily developed (in Java) and added to QuickViz to fit users' needs. Mainly focused on quick view and advanced visualization, QuickViz can pass selected data on to dedicated IVOA tools (such as VOSpec or SPLAT) for further data analysis via the IVOA SAMP protocol (still in progress).

3. Logical Binding with SAADA

To illustrate the ability of SAADA[3] to deal with heterogeneous astronomical collections, an online example database has been created (Fig. 2) and filled with 9 simulated MUSE data sets each composed of: a raw image Y, PSF related to each pixel p of Y, a pixtable mapping sensor locations to sky positions and also containing data quality flags and noise variances for each p, a hyperspectral data cube reconstructed from Y with its associated variance cube. A web interface[4] allows a user to send queries on the

---

[1] `http://star-www.dur.ac.uk/~pdraper/gaia/gaia3d/index.html`

[2] `http://lsiit-miv.u-strasbg.fr/paseo/cubevisualization.php`

[3] `http://saada.u-strasbg.fr`

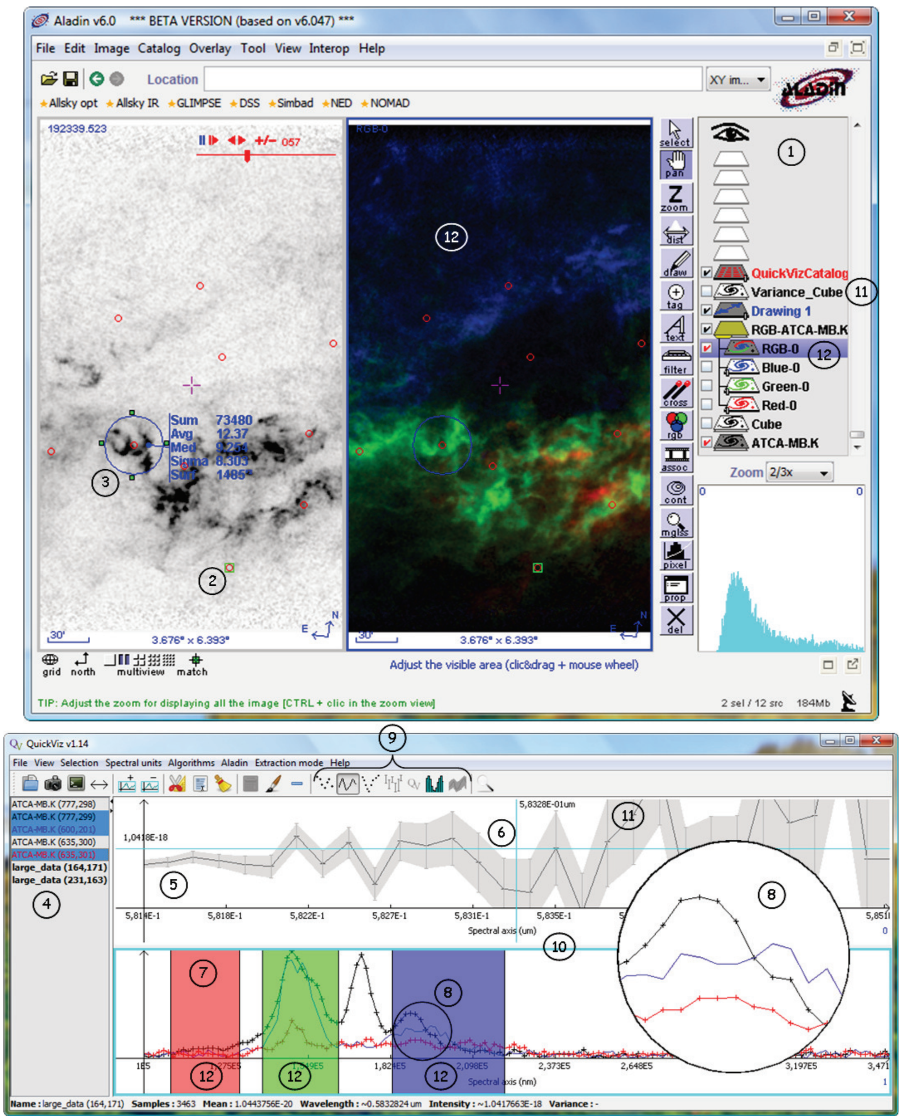

Figure 1. Aladin/QuickViz duo in action (both in multiview mode). QuickViz (bottom window) takes care both of spectral side and interactions with the spatial domain (e.g., 2D visualization, catalogs, database queries, calibrations) whose management is totally delegated to Aladin (top window). QuickViz, developed in Java, can be easily installed on different operating systems (32-bit or 64-bit architectures) and used to visualize any kind of hyperspectral images if they follow the standard FITS format.

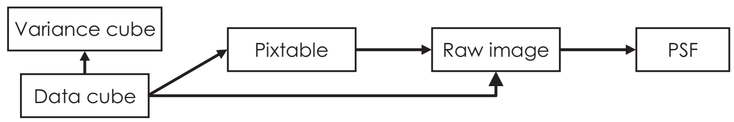

Figure 2. Database with qualified links generated by SAADA from simulated MUSE data sets. The data cube is notably linked to its pixtable and the raw image from which it has been computed through a reconstruction (resampling) step.

database so as to highlight relevant information. For instance, data cubes can be constrained with data quality flags (*e.g.* number of dead or hot pixels) as well as variance values and output results can be exported to Aladin and QuickViz for visualization. The use of such a SAADA database can greatly improve data exploration and selection, especially in the case of large deep-field surveys where GB of data are nightly recorded.

4. Conclusion and Perspectives

The size and the complexity of hyperspectral images has greatly increased during the last few years and new analysis tools must be designed to address the management of such a large amount of data. Besides a new hyperspectral visualization tool, we proposed, in this paper, an application of the SAADA software to simulated MUSE data sets. The visualization of observation parameters has been partially solved and current work concern displaying PSF and variance values across the field of view. The latter is performed through a video where the intensity of pixels varies with corresponding variance values, *i.e.* higher variance values induce higher and quicker intensity variations (Petremand et al. 2010). Advanced interactions between Aladin and SAADA repositories are also under discussion so as to directly interrogate SAADA databases from Aladin by providing server definitions in additional GLU mark files.

Acknowledgments. This work was partially funded by the French Research Agency (ANR) as part of the DAHLIA project (*grant #ANR-08-BLAN-0253*). We thank Roland Bacon and the MUSE project team at CRAL in LYON, for providing the simulated data sets used to develop and train the tools.

References

Bonnarel, F., et al. 2000, A&AS, 143, 33

Laurent, F., Henault, F., Renault, E., Bacon, R., & Dubois, J. P. 2006, PASP, 118, 1564

Michel, L., Nguyen, H. N., & Motch, C. 2005, in Astronomical Data Analysis Software and Systems XIV, edited by P. Shopbell, M. Britton, & R. Ebert (San Francisco, CA: ASP), vol. 347 of ASP Conf. Ser., 71

Petremand, M., Louys, M., Collet, C., Mazet, V., Jalobeanu, A., & Salzenstein, F. 2010, in Proceedings of Astronomical Data Analysis VI, to appear (Monastir, Tunisia)

[4] `http://saada.u-strasbg.fr/MUSE`