

## THE JAVA-APPLET FOR RADIO SPECTRA ANALYSIS

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### 1. INTRODUCTION

The Web-server of the Astronomical Institute of the St. Petersburg University had opened extended services on galaxy cluster data since 1995. The description of Clusters of Galaxies Database and its content are available at <http://www.astro.spbu.ru/CLUSTERS/>.

The information contained in the database can be used for the solution of specific astronomical problems. Two big projects – “Identifications of Radio Sources in Clusters of Galaxies” and “The Study of Radio Emission Spectra of Cluster Radio Sources”, those being carried out in Astronomical Institute at present time – use the Clusters of Galaxies Database actively. The second one can help in the solution of the problems of origin and evolution of extragalactic radio sources.

This report presents the client-application for the database that allows to work with radio spectra of extragalactic sources. It has been released as a Java-applet and thus provides a Web-based interface that is supported on many operating systems. The facilities of the applet such as approximations of spectra measurement points and the calculation of spectral parameters are illustrated in the report. Also we demonstrate the last version of the Java2 realized application that gives additional functions such as printing.

### 2. CLUSTERS OF GALAXIES DATABASE

#### *2.1. Content of the database*

The “Clusters of Galaxies” database contains information about objects from the ACO catalogue (Abell et. al. 1989). For all 4076 rich

clusters the database includes information about the main optical and radio characteristics.

There are many services on the server for the presentation of information contained in this database, for example the visualization of the cluster galaxies fields, the generation of requests to different astronomical data centers, the calculation of some parameters of the cluster objects.

The "Clusters of Galaxies" database has free access to these services and data by Internet. One of the given services is a Java-applet for the analysis of radio spectrum data.

### *2.2. Spectra applet access*

The user obtains access to Clusters of Galaxies Database by Internet-browser <http://www.astro.spbu.ru/CLUSTERS/> and requests necessary data by the name of the cluster.

The server processes the request and prepares the data that the user needs. The client receives a hypertext document containing links to the various services and data and, in particular the link [radio spectra 1.2 or 1.1] to a document with a Java-applet call. Following this link the client browser requests the Java-applet from the server and runs it.

At first the applet loads data from the Database. After receiving them, the user can work with a graph of a radio source spectrum, calculate its spectral characteristics and change data on the graph and their graphical presentation. At the beginning, he can select more comfortable sizes of the user-interface widgets by menu options.

## 3. MAIN APPLET FUNCTIONS

The client gets the following functions to work with radio spectra.

### *3.1. The diagram functions*

Spectral data are displayed as a diagram of the dependence of measurement flux densities with their errors on frequency of the observations. The axes of the diagram have logarithmic scale as usual. Users can change ranges of the axes and put a coordinate grid. They have a fundamental possibility to add new spectral points on the graph if necessary and to delete/restore superfluous or non-exact measurements. In this case the approximation uses new points and automatically leaves out of account the deleted points automatically.

Also users can save diagrams as jpg-files on their computers.

### 3.2. The approximation of spectral data

The radio spectrum measurement points are approximated by a curve for the calculation of spectral parameters (radio emission power, spectral index and others). The curve type is defined by some general functional dependencies. The least squared method is used for the approximation of the spectral data. Users themselves can choose one of the curve types. Also the applet has an automatic option for choosing the approximation that has minimum deviation from the measurements. The line with spectral index  $\alpha = 0.8$  is used as default approximation for a single measurement point. The curve values of frequency, of flux density and of spectral index are displayed when the mouse is moved along a curve in the special *GraphInfo* window.

### 3.3. The calculation of the radio emission parameters

Users can calculate the radio luminosity for the selected radio source at any frequency range and the spectral power of the emission at any frequency. As is well known, the calculation of these values for extragalactic radio sources depends on the choice of the cosmological model. Thus we used the most common formulas containing the necessary cosmological parameters, as the Hubble constant, deceleration parameter  $q_0$ , redshift and the comoving frames calculations. The *RadioEmission* window allows users to choose these parameters. In principle the applet permits to calculate the spectral parameters for any distant radio source (even for radio sources out of the database).

### 3.4. The printing

The capability of Java2 enables to realize the printing function. The applet allows users to print the graph of the radio spectrum. There is a special *PrintView* window containing the options to prepare the graph to print. Users can choose the parameters of paper (its format, orientation and position of graph) and change the name of graph and axes titles, their colors, fonts and positions. After the diagram preparation, it is possible to print the diagram or to save as a jpg-file.

### 3.5. The help

All functions are described in detail. The help contains a set of hypertext documents, related one other. They are available from the applet and from the Cluster Database user interface.

#### 4. APPLET STRUCTURE

Java as an object-oriented language requires a deep analysis of the application domain, flexible organization of the Graphical User Interface (GUI) and their clear interaction with each other under applet construction. During working and maintenance of the applet the authors designed the main required functions and three basic versions of the radio spectral applet were realized. The final version of the applet is based on all past experience.

Spectra applet consists of five packages. The main package *spectra* responds to the initialization of all modules of the applet, its life cycle and stops it. The package *spectra.clusterData* contains classes to storage parameters of cluster and its objects and to request database information. The module *spectra.graphics* gives a tool to work interactive with a graph of a spectrum. The *spectra.emission* consists of classes used for the calculation the radio emission parameters. The package *spectra.print* provides the functions for preparing and printing a graph of a spectrum. A standard *java.awt* package is used for building the GUI of the applet.

In general there are about 50 classes in the applet. Classes of the applet may be used as a class library to support other astronomical information systems.

At present there are two versions of the applet on the server of the Astronomical Institute; those are realized on JDK1.1 and Java2 correspondingly. It was done for useful access to the applet because most of Internet-browsers have built-in JDK1.1 support still, but some require to install the plug-ins for Java2.

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#### REFERENCES

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