# MIGALE: Milestones and Roadmap

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## Introduction.

MIGALE (The Multiparametric Virtual Instrument to Study Galaxy Evolution) is a collaboration between French (GEPI Observatoire de Paris, CRAL Observatoire de Lyon), Russian (Sternberg Astronomical Institute) and Bulgarian (Sofia Observatory) laboratories. The scientific goal feeding the project is to study the evolution of galaxies during the last 9 Gigayears.

The goals and main activities of MIGALE were already described [1,2].

Presently, MIGALE is in charge of the following database projects:

•HyperLEDA (http://leda.univ-lyon1.fr): the database, containing homogenized data for 3 million galaxies

•GIRAFFE archive (http://giraffe-archive.obspm.fr) distributing reduced data obtained with Giraffe integral field spectrograph on VLT

•HiGi (http://klun.obs-nancay.fr/) the database distributing radio spectral data for spiral galaxies obtained with Nancay radiotelescope

•ASPID (http://alcor.sao.ru/db/aspid/) distributing the raw data obtained using selected instruments on the Russian 6-m telescope since 1992 (including all the 3D spectroscopic data)

These projects are powered by the PLEINPOT package, distributed by the team.

## Virtual Instrumentation

MIGALE built the prototypes of the tools that would constitute the virtual instrumentation: a set of online-tools for data reduction, processing and analysis using VO protocols for data access and exchange.

• DisGal3D - the tool to make deconvolution of 3D spectral data using high-resolution direct images (for instance HST) as references [4]. The technique allows to determine the velocity profiles of distant galaxies using very small velocity fields obtained by the means of integral field spectroscopy. The example in Fig.1 shows a reconstruction of the velocity field of a distant galaxy obtained with the FLAMES-Giraffe spectrograph at VLT.
• PEGASE.HR - a new generation facility to build high-resolution (R=10000) synthetic spectra of galaxies using the ELODIE.3 library [5].
• SPIKeR (Stellar Population and Internal Kinematics Reconstruction tool). Using PEGASE.HR models with the penalized pixel fitting algorithm [6] it is possible to extract internal kinematics and put the constrains on the properties of stellar populations [7], Fig.2.

The online versions of the tools will have significant advantages compared to the standalone versions.

Though the software is available, it is quite complex and its installation takes time. Online version allows to avoid this procedure.

The data may be either taken from the archive or provided by user. In the first case the data reduction will be done on the fly (if necessary) and this will save time for downloading and processing raw data.

The proposed techniques require rather complex computation, so the big amount of computer time is necessary. Online versions will propose the power of PC cluster.

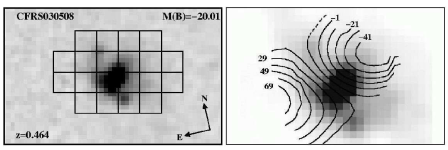
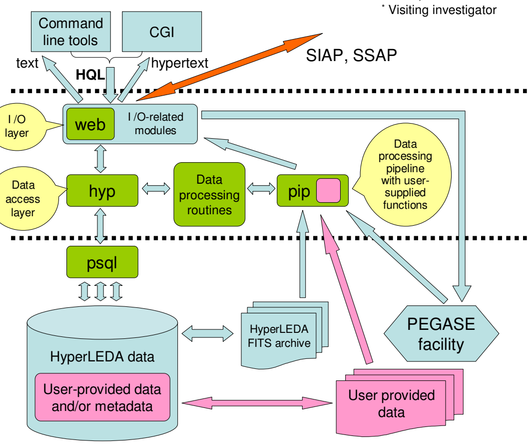



Figure 1. The reconstruction of the velocity field of distant galaxy observed with FLAMES using the HST imagery as a reference. Credits of the figure: H. Flores




## PLEINPOT

PLEINPOT is an open source software package, developed and maintained by MIGALE. It provides a ready-to-use DBMS system based on PostgreSQL, filled with the HyperLEDA data, and name resolving mechanism fed by it. The package is portable: it works on Linux, Sun Solaris, Compaq Tru64 UNIX and MacOS X platforms.

PLEINPOT has a modular structure containing the following major parts:
•astronomical and statistical functions and procedures
•database access layer
•data processing pipeline
•output formatting routines

PLEINPOT is a platform to build astronomy related database projects. General structure of a project powered by PLEINPOT is presented on the diagram. The user provided data and methods to deal with them are indicated by a pink colour. The diagram represents three layers: client applications on top, data storage and data generation tools on bottom and all the data processing mechanisms provided by PLEINPOT in between. The example of data generation tool is PEGASE, a facility to compute synthetic spectra of galaxies on the fly, that is included into PLEINPOT distribution.

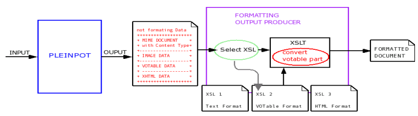
During the installation the user can choose whether he/she wants to have HyperLEDA data and/or HFA (HyperLEDA FITS archive) locally or have a remote transparent access to them.

The data processing pipeline ("pip" module) provides a set of tools for online processing of images and spectra: normalization, convolution, unsharp masking, continuum fitting etc. It is easily extensible with user-written dynamically loadable procedures.

The following APIs are provided: C/C++, Fortran, Java (optional), PHP (optional), Perl (optional), Python (optional)

All routines in the library are natively written C or Fortran, the wrappers for other languages are provided via SWIG (Simplified Wrapper and Interface Generator).

All the queries from client applications (presently command-line tools or CGIs) are passed to the "web" module, where the HQL (HyperLEDA Query Language) query is parsed and forwarded to the data access layer or data processing routines. We also plan to implement VO protocols (SIAP and SSAP). The output of the system is processed by different formatting routines depending on the requested output type. PLEINPOT supports or will support the following output formats:
•Hypertext document
•Plain text
•VOTable
•SIAP and SSAP (not implemented yet)




The individual output formatting routines shall be replaced by the unified solution. The general idea is to generate multipart mime documents and pass them to an output producer which will extract various parts of the document and present the VOTable sections according to XSLs.

Building the astronomical database using PLEINPOT allows to save a lot of time and manpower. For instance, Giraffe archive had been built in 3 weeks by one engineer working full time.

A very nice example of a stand-alone project powered by PLEINPOT and not connected directly to MIGALE is the ELODIE archive [3] in the Observatoire de Haute Provence (http://atlas.obs-hp.fr/elodie/). It is a telescope archive containing homogeneous data: more than 4000 reduced flux-calibrated high-resolution spectra collected with the ELODIE spectrograph at the 1.93m telescope at OHP.

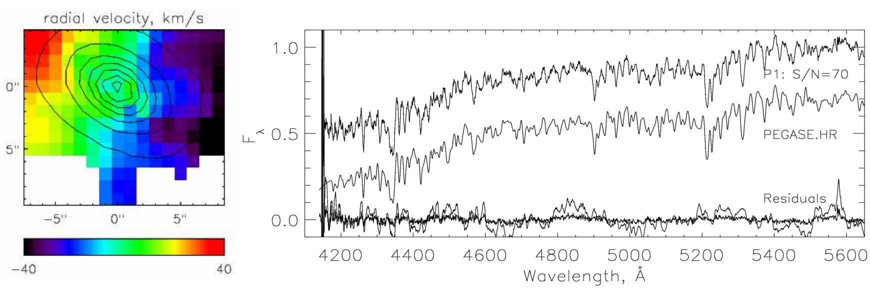



Figure 2. Examples of the fitting procedure and extracted velocity field. Upper plot on the right graph is a spectrum of the compact interacting elliptical galaxy NGC770 obtained with MPFS integral field spectrograph at the Russian 6-m telescope. Middle plot is the best fit composed of several PEGASE.HR SSPs (single-age single-metallicity model). The bottom lines show the residuals: unmodified and magnified by a factor of 5. The velocity field reveals kinematically decoupled core seen as a counter-rotation in the central region of the galaxy.

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