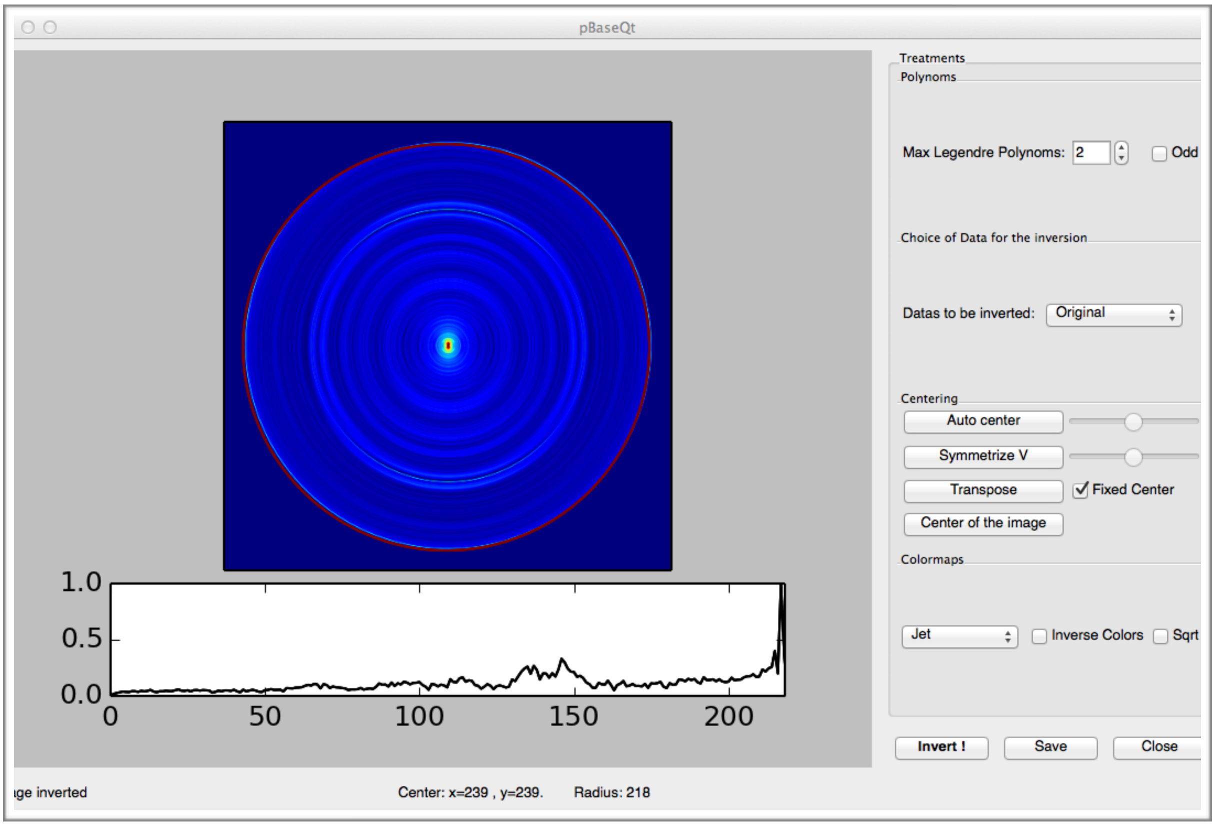
pBasexQt 2014



Max Legendre Polynoms: 2 □ Odd

Datas to be inverted: Original

☑ Fixed Center

Jet □ Inverse Colors □ Sqrt

ıge inverted

Center: x=239 , y=239. Radius: 218

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Introduction

The pBasex program performs an inversion of the input image by fitting basis functions with a known inverse Abel transform. The program is also able, through a Graphical User Interface (GUI), of doing simple operations to prepare the image for inversion, like centre-finding, symmetrising or transposing. This program is based on previous work from G. Garcia.

Requirements

This program is written in Python language. It is using standard scientific libraries and a Qt GUI. The software requirements are currently:

- Python 2.7
- Numpy (>=1.8) and Scipy (>=0.13.3) libraries
- matplotlib (>=1.3.1) as plotting library
- PySide (>=1.2.1) for the GUI
- PyFITS (>=3.0.6) for managing input and output files

Python is a multiplatform (Windows, Linux, OS X) and open source language. For the sake of simplicity some users might be interested into distribution such as Canopy which contains the required libraries already build in (and free for academics).

The second requirement concerns the hardware on which the program will run: it needs an amount of memory (RAM) suited for loading in memory the basis functions. Each functions depend on two spacial coordinates (a grid of size NRxNTh) and each Legendre polynom has a full set of function (which correspond to a total number of function NLxNK). With the current settings (2 polynoms and 220 functions) it represents 700MB. In addition extra memory is needed during the calculations (inversion, calculation of the inverted image, …). Should your amount of memory be less than 128 Mb, the computer would use the virtual memory slowing considerably the process. 2GB of free memory would insure decent calculation speed.

Files

The source code contains several source files:

- pBase.py: Main program. It displays the GUI.
- pBaseCore.py: Subroutine file containing all the computation function: image centring, symmetry, transposition, inversion, I/O, …
- pBaseQt.py: GUI Subroutine with mapping to pBaseCore.py

The program has been designed for being used either with the GUI or alone in command line style.

The source contains as well a separate program to generate the basis

- core_basis.cpp: C++ program which compute the basis set
- plot_basisG.py: Python script for plotting the basis function

Basis Set

The basis set that is fitted to the image consists of basis functions with a known inverse Abel transform. The known inverse functions are of two types, one for the radial part and the other for the angular part. The number of radial functions is currently 220 and they have a Gaussian shape that extends over 2 pixels. The angular functions are Legendre polynomials and their number depends on the physics of the process that created the image.

The Basis set is stored in a *.dat file. For example, if we have chosen NL=2 using the NL counter and ODD=1 (true) then the program will look for the three files: UP0P1P2.dat.

It can be generated by compiling and executing the *core_basis.cpp* program. The main function can be edited to generate various basis set by using the instruction **write_forward(lmax,odd);** where lmax represent the maximum degree of Legendre polynoms computed and odd is a boolean switching on and off the calculation of odd Legendre polynoms. The radial and angular binning **NR** and **NTH**, the number of radial basis functions **NK**, the width of the basis functions **BWIDTH** and the radial spacing between the functions **BSPACE** can be adjusted in the header of the program.

NOTE: the GSL library need to be installed on the computer used for generating the basis set, altogether with a C++ compiler.

Installation

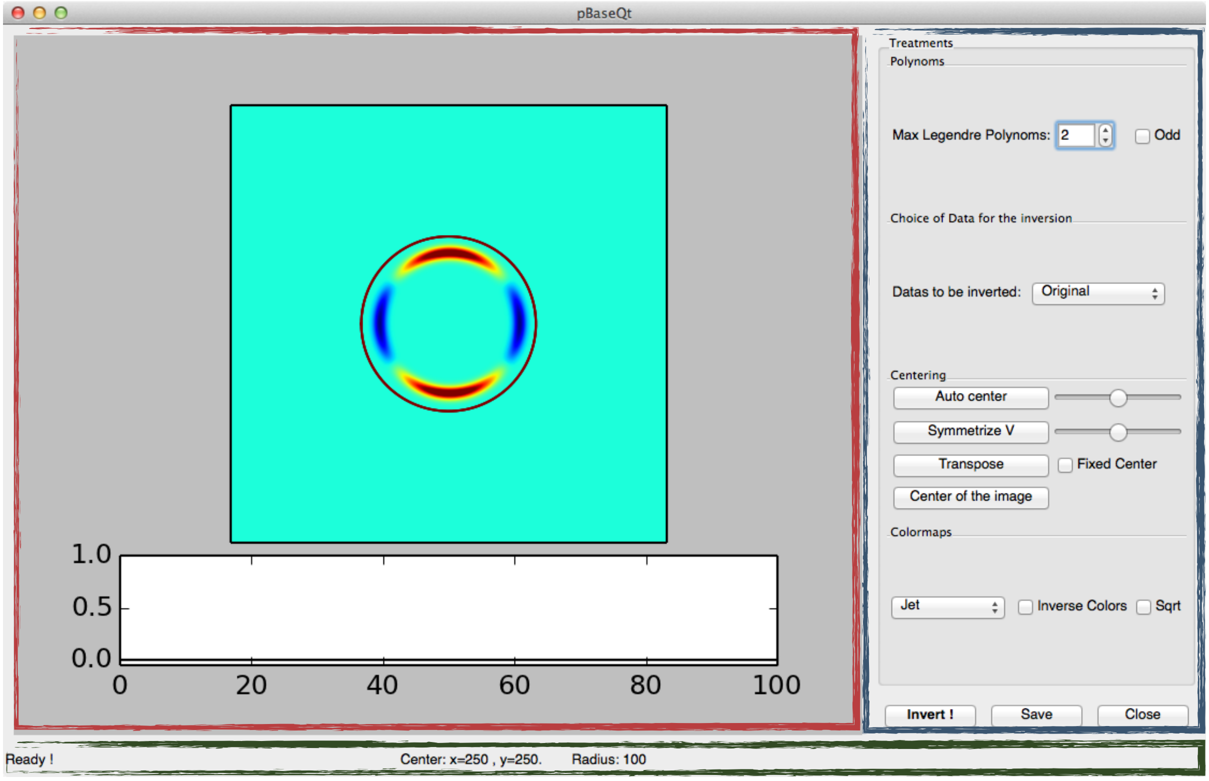
Apart form a python distribution (mentioned in the requirements) and the basis set precompiled nothing is required apart from having the three python script in the same directory.

Starting the program

The program can be started from the command line by typing **python pBase.py** (need to be in the same directory as the scripts. That can be achieved by using the *cd* command).

Windows user having *python.exe* command available in the *%PATH%* environment variable can simply double click on *pBase.py* script to launch it.

The following figure represent the window displayed by the program when launched:



Max Legendre Polynoms: 2 □ Odd

Datas to be inverted: Original

□ Fixed Center

Jet □ Inverse Colors □ Sqrt

Ready !

Center: x=250 , y=250. Radius: 100

The window consist in three areas:

- The image panel where the image and the normalised spectrum are displayed.
- The options for treating the image.
- The status bar for displaying some useful informations.

There is as well a file menu allowing to open an image (FITS (.fit), Picture (.jpg,.bmp), Text (.dat) formats) or to save the computation. Those menu have keyboard shortcuts CTRL+O for opening a file and CTRL+S for saving.

Image Interaction

Red box on above figure.

Few can be done in the image panel. Only the **red circle** can be modified. The inner part of the circle correspond to the region of interest that will be used for centring and inverting the image. If the box *Fixed Center* is not ticked a new circle can be defined by ONE click: when pressing the button, the center of the new selected area is chosen; while releasing the button define the radius of the area. So to select and area: *click and drag*.

Status bar informations

Green box on above figure.

It contains three fields. The left one contains infirmation on the current operation. The middle one display the *coordinates of the center* of the current region of interest and the *radius* of this area.

Treatment panel

Blue box on above figure.

The first box deals with basis set characteristics. The maximum degree of used Legendre polynoms can be chosen. Odd degree can be included by checking the *Odd* box.

The second box concern the image that will be inverted. It could be the original one or the displayed one after eventual modification.

The third box allow fine tuning of the center of the region of interest.

- **Center of the image** button will compute the center of mass of the image and center the region of interest on it.
- **Auto center** button It finds the centre of the selected region by maximising the multiplication of symmetric pixels along a diagonal. For more information see C. Bordas, F. Paulig, H. Helm, and D. L. Huestis, *Rev. Sci. Instrum.* **67**, 2257 (1996). By successive iteration it finds the center of the image. NOTE: the bigger the circle, the longer are the calculations.
- **Fixed center** button: if pressed the center of the selected area is fixed and can not be moved until the button is unchecked. A click in the image area define then the radius of the selected area.
- **X and Y sliders**: move the center of the selection along each axis. While selected keyboard arrows can be used for moving the center pixel by pixel. TAB key can be used to navigate within the interface.
- **Transpose:** Exchanges the rows and columns of the image. Please note that the orientation of the electric vector of the light is parallel to the South-North direction of the image displayed. Use this button to align the electric vector (or the direction of propagation of the light in the case of circularly polarized light) with the rows of the image.
- **Symmetrize V:** It symmetrises the image along the central row (makes North=South). There is no need to symmetrise the Est-West since the Legendre polynomials are symmetric with respect to the electric vector of the light or the propagation of the light in the circularly polarized case.

The colormap box can be used for changing the display of the image.

The **Invert!** button is triggering the inversion process. Please be patient. Here are some of the steps: Loading the basis, Converting image into polar, Inverting the image, and Computing the inverted image.

The **Save** button allow to save the result of the inversion. The file will be at FITS format and will contain the following features:

- Inverted image
- Normalized spectrum (pixel, spectrum, error)
- Angular distribution
- Error on angular distribution
- A table with the following parameters: Center, Radius of the selected area, Maximum degree of Legendre polynom used and the Odd boolean.

The **Close** button is closing the program.

Further informations

For further information please read G. A. Garcia, L. Nahon and I. Powis, *Rev. Sci. Instrum.* **75**(11), 4989 (2004)