User Manual

`QDeblend`$^{\mathrm{3D}}$

Version 0.1.2

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1 Introduction

1.1 Aim of the Program

`QDeblend`^{3D} is designed to provide a user-friendly Graphical User Interface (GUI) to perform a deblending of a point source with specific spectral features and an underlying spatially resolved component for 3D datacubes obtained with integral field spectrographs. So far, we have only considered the specific case of deblending Quasi-Stellar Objects (QSOs) or unobscured Active Galactic Nuclei (AGN) from their underlying host galaxies, but other applications may be possible. Please read the description of the algorithm, especially the section about advantages and limitation, in order to use the program most efficiently.

1.2 Requirements

The software is based on `Python` and several Add-On packages as well as `Qt` for the cross-platfrom User Interface framework with its `PyQt` bindings.
`QDeblend`^{3D} requires the following packages to be installed on the system

- `Python 2.5.4` or later (no support for `Python 3` yet)
  Download from `www.python.org`
- `scipy 0.7.1` and `numpy 1.3.0` or later
  Download from `www.scipy.org`, but we strongly recommend to install those packages with the installation packages provided for your current Linux/Unix distribution.
- `pyfits 2.2.2` or later
  Download from `http://www.stsci.edu/resources/software_hardware/pyfits`
- `matplotlib 0.99.0` or later
  Download from `http://matplotlib.sourceforge.net/`
- `Qt 4.5.3` or later
  Download from `http://qt.nokia.com/`
- `PyQt 4.7.3` and `SIP 4.11.2` or later
  Download from `http://www.riverbankcomputing.co.uk/software/pyqt/intro`

NOTE: `QDeblend`^{3D} was successfully tested with the packages above, but *earlier* versions of individual packages might work with `QDeblend`^{3D} as well.

1.3 Installation

`QDeblend`^{3D} is designed for scientific use in the astronomy community. Thus, we assume that the target operating system will be a Linux/Unix system. Please follow the steps outlined below to install `QDeblend`^{3D} on your system.

1. Download the compressed archive from `http://sourceforge.net/projects/qdeblend/` and unpack the tar-ball in a directory of your choice (`DIR`)

2. Add `DIR` to your `PYTHONPATH` environment variable of your login shell:

   `setenv PYTHONPATH DIR:${PYTHONPATH}`
   for the `(t)csh` shell or

   `export PYTHONPATH=DIR:$PYTHONPATH`
   for the `bash` shell

3. Copy the file `QDeblend3D` into a directory of your `PATH` environment variable (`/home/user/bin/` for example) and add the execute access to the file permissions:

   ```
   cp DIR/QDeblend3D /home/user/bin/
   cd /home/user/bin/
   chmod ugo+x QDeblend3D
   ```

4. Now, you can run `QDeblend`^{3D} from any directory with the command
   `QDeblend3D`

`Python` and `Qt` are cross-platform compatible, so that the installation guide above may be modified by experienced users for their own operating system, e.g. MacOS or MS Windows. Please report your adopted scheme, so that the manual can be updated in the future.

2 License

3 The Deblending Algorithm

3.1 Background

For the study of QSO host galaxies, 2D analytic modelling of broad-band photometric observations with dedicated software packages, such as `GALFIT` (Peng et al. 2002, 2010) or `GIM2D` (Simard et al. 2002), has enabled us to properly deblend the QSO and host galaxy emission to infer their properties independently. However, spectroscopic observation are required to gain further insight into the properties and distribution of the ISM, dust content, kinematics, element abundances, etc. Techniques to deblend the QSO and host galaxy contribution in longslit spectra have already been developed (Jahnke et al. 2007; Letawe et al. 2007), but longslit spectroscopy can only cover a certain part of the host galaxy. In order to get a more complete picture, integral field units (IFUs) offer exciting new perspectives but also require the development of new techniques to cope with the data.

3.2 Basics of the algorithm

At the core of the `QDeblend`^{3D} software tool, we used an improved iterative algorithm that was initiated by Christensen et al. (2006). The basic concept is to treat the spaxels (x, y) of the IFU datacube as a set of independent spectra $f(x, y, \lambda)$. The spectral shape of a point source is the same in each spaxel (in the absence of atmospheric dispersion), whereas the brightness is a function of position with scale factors $s(x, y)$ according to the Point Spread Function (PSF) of the observations. In the following we assume that the scale factors are normalised to one at the QSO position $(x, y) = (x_{\mathrm{cent}}, y_{\mathrm{cent}})$.

While broad-band imaging studies typically use stars simultaneously observed within the field of the target to obtain an empirical PSF, current IFUs usually do not capture stars with the target due to their relatively small FOV of a few arcseconds. In the case of a broad-line AGN, scale factors for each spaxel can fortunately be estimated from the strength of the broad emission lines with respect to the adjacent continuum as presented by Jahnke et al. (2004) to reconstruct the scale factors $s(x, y)$ at the wavelength of the chosen broad emission line (see Fig. 1 for illustration).

On the other hand, the underlying continuum and line emission of the host may be spatially resolved and follow different distributions, $h(x, y)$ and $l(x, y)$, which contribute both to the spectra of the IFU datacube:

$$f(x, y, \lambda) = s(x, y) f_{\mathrm{QSO}}(\lambda) + h(x, y) f_{\mathrm{cont}}(\lambda) + l(x, y) f_{\mathrm{lines}}(\lambda) \tag{1}$$

For simplicity we assume for the time being that the spectral shapes of the host spectrum and the emission line spectrum does not change in a datacube. We will relax and discuss this assumption later on.

Since we can easily construct the scale factors $s(x, y)$ from the data itself, only the QSO spectrum $f_{\mathrm{QSO}}(\lambda)$ needs to be determined to separate $f(x, y, \lambda)$ in a QSO and host galaxy term for each spaxel (x,y). But how can we obtain a pure QSO spectrum without any contamination from resolved host emission? The spectrum at the QSO position, e.g. the brightest spaxel, should contain an almost pure S/N QSO spectrum

$$f(x_{\mathrm{cent}}, y_{\mathrm{cent}}, \lambda) \approx s(x_{\mathrm{cent}}, y_{\mathrm{cent}}) f_{\mathrm{QSO}}(\lambda) \ . \tag{2}$$

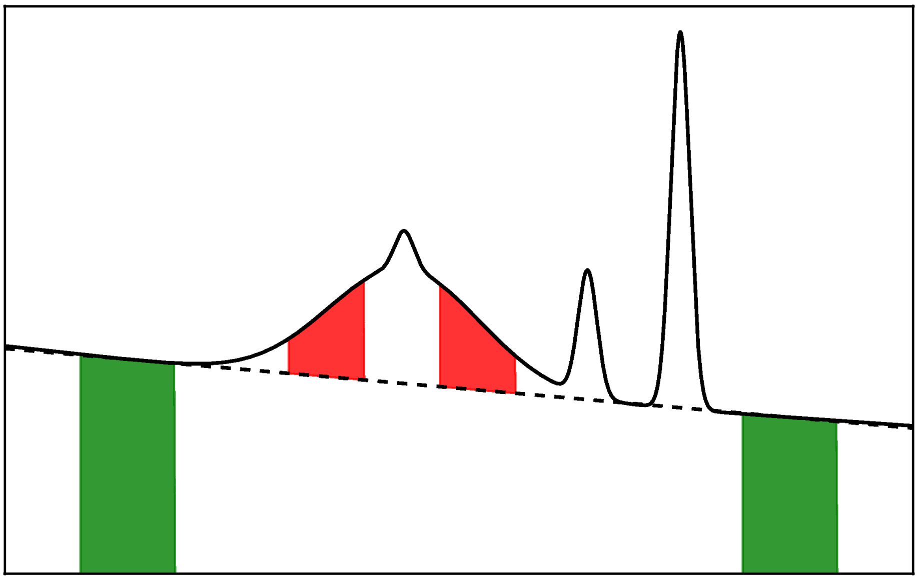

Fig. 1. Sketch of the broad line measurement in the case of Hβ spectral region. Two adjacent continuum windows (green shaded areas) are defined to estimate a linear approximation of the local continuum (dashed line). To avoid contamination by a narrow Hβ component one or two spectral windows at the Hβ wings are selected and the flux is measured within these regions above the local continuum (red shaded areas).

under the condition that

$$s(x_{\rm cent}, y_{\rm cent}) f_{\rm QSO}(\lambda) \gg h(x_{\rm cent}, y_{\rm cent}) f_{\rm cont}(\lambda) + l(x_{\rm cent}, y_{\rm cent}) f_{\rm lines}(\lambda) \quad . \tag{3}$$

This condition is certainly not fullfilled for low or intermediate luminosity QSOs so that the measured template QSO spectrum $f_{\rm QSO,temp}(\lambda) \equiv f(x_{\rm cent}, y_{\rm cent}, \lambda)$ will be inevitably contaminated by a significant fraction of host galaxy emission. Thus, the residual datacube

$$f_{\rm residual}(x, y, \lambda) = f(x, y, \lambda) - s(x, y) f_{\rm QSO,temp}(\lambda) \tag{4}$$

will be subject to an oversubtraction of the QSO component around the QSO position.

3.3 The Iterative Scheme

Our solution is an iterative scheme to reduce the host contamination of the QSO spectrum in an empirical way as good as possible. When we subtract the scaled QSO spectrum $s(x, y) f_{\rm QSO,temp}(\lambda)$ from each spaxel in the datacube during the initial iteration. The signal in the central spaxel of the residual datacube will then be $f(x_{\rm cent}, y_{\rm cent}, \lambda) = 0$ by design. Since the host galaxy emission is spatially extended, their normalised scale factors will be higher than that of the QSO $h(x, y) > s(x, y)$ and $l(x, y) > s(x, y)$ for all spaxels around the centre. Some level of host galaxy emission will therefore remain in the residual datacube around the QSO position. We define a certain region around the one used to construct the QSO spectrum, i.e. 8 spaxels around the central one or any other selection of spaxels that appears best suited, to extract a host galaxy spectrum ($f_{\rm host}$) from the residual datacube.

The idea is now to decontaminate the QSO spectrum $f_{\mathrm{QSO,temp}}(\lambda)$ iteratively by subtracting the extracted host spectrum from the QSO spectrum

$$f_{\mathrm{host}}(\lambda) = \frac{h(x_{\mathrm{cent}}, y_{\mathrm{cent}})}{\sum_{(x,y)\in(X,Y)} h(x,y)} \sum_{(x,y)\in(X,Y)} f_{\mathrm{residual}}(x,y,\lambda) \ . \tag{5}$$

Here, we have made the implicit assumption that host continuum and line emission follow the same light distribution $h(x, y) = l(x, y)$, which is not necessarily true, but in most cases only $h(x, y)$ can be constrained externally from broad-band images with an analytic profile. If no external information is available at all, the flux of the host galaxy spectrum needs to be extrapolated based on other assumption as discussed in the next paragraph.

In each of the subsequent iterations a cleaned QSO spectrum is created via $f_{\mathrm{QSO,iter}}(\lambda) = f_{\mathrm{QSO,temp}}(\lambda) - f_{\mathrm{host}}(\lambda)$ and subtracted from the initial datacube. After a few iterations (3-4) the QSO spectrum usually converges to a stable solution. We provide an illustration of the iterative process in Fig. 2, which also outlines the basic steps that can be summarised as follows:

1. Extraction of $f_{\mathrm{QSO,temp}}(\lambda)$ from the IFU datacube (e.g. the spectrum of the brightest spaxel or a co-added spectrum over a few central spaxels).
2. Determination of $s(x, y)$ based on the broad emission lines above the continuum.
3. Subtraction of $s(x, y)f_{\mathrm{QSO,temp}}(\lambda)$ from the initial datacube.
4. Reconstruction of $f_{\mathrm{host}}(\lambda)$ by co-adding several spaxel from $f_{\mathrm{residual}}(x, y, \lambda)$ and assuming some analytic distribution for $h(x, y)$ and/or $l(x, y)$.
5. Decontamination of $f_{\mathrm{QSO,temp}}(\lambda)$ with $f_{\mathrm{host}}(\lambda)$.
6. Iterate steps 2-5 until the QSO spectrum converges.

3.4 Limitation and Advantages

In the previous section we assumed, mainly for mathematical clarity, that the spectral shape of $f_{\mathrm{cont}}(\lambda)$ and $f_{\mathrm{lines}}(\lambda)$ do not change in the entire datacube. This is certainly not true, but the algorithm actually does not use this very strict assumption. An identical spectral shape is only assumed around a small region around the QSO nucleus corresponding to the galaxy centre. The physical size of that region, however, strongly depends on the spatial resolution of the observations and the redshift of the galaxy.

On the other hand, this is already much better compared to the 3D Deblending technique (Sánchez et al. 2004), which performs a 2D analytic modelling of each monochromatic IFU image to deblend the QSO and host spectrum. By design this method assumes implicitly that the shape of $f_{\mathrm{host}}(\lambda)$ is constant over the entire field of view, which certainly affects the deblended spectra.

In the case of low S/N data the spatial regions to extract $f_{\mathrm{QSO,temp}}(\lambda)$ and $f_{\mathrm{host}}(\lambda)$ can be enlarged compared to the best solution outlined above. This has the disadvantage of limiting the ability to decontaminate the QSO spectrum leading to

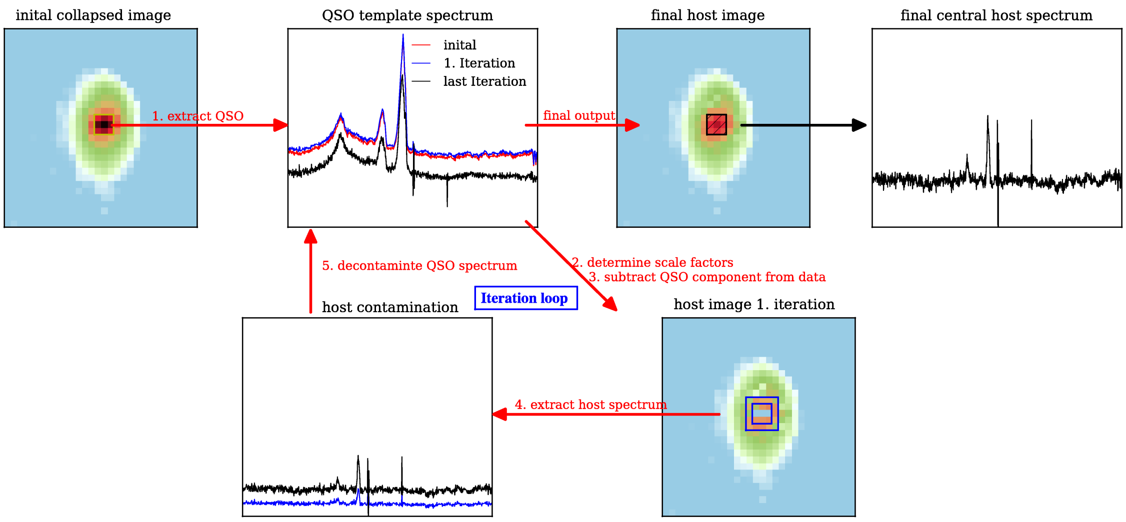

Fig. 2. Illustration of the iterative deblending process used by `QDeblend`^{3D}.

oversubtraction effects. The user must find a compromise depending on the specific situation.

The deblending results will certainly depend on the assumed surface brightness distribution $h(x, y)$ of the host. Unfortunately, this cannot be self-consistently determined within the algorithm and needs to be determined externally, e.g. using high resolution broad-band images or via reasonable assumptions. Several options can be considered to set $h(x, y)$:

- An analytic surface brightness model based on broad-band imaging or other (probably the best option)
- A constant surface brightness $h(x, y) = 1$ in the central galaxy region of concern (reduces oversubtraction)
- $\frac{h(x_{\mathrm{cent}}, y_{\mathrm{cent}})}{\sum_{(x,y)\in(X,Y)} h(x,y)}$ is manually set to a certain value, i.e, so that no stellar absorption line remain in the deblended QSO spectrum.

The adopted scheme will depend on the AGN sample and the science, but it should be chosen to be consistent for the whole sample even though it might not be the optimal solution in all cases.

Another limitation of the algorithm is that the atmospheric dispersion, in particular the wavelength dependence of seeing, is not taken into account, because the PSF $s(x, y)$ can only be determined self-consistently from the data at the wavelength of broad lines. Several broad lines might be covered in the wavelength range of the spectrum, but the S/N may not be high enough to reconstruct the PSF with a sufficient accuracy for all of them. It is therefore recommended to restrict the deblending to a certain wavelength range centred on the broad line or to split up the data into several subcubes when more than one broad line can be used for the deblending. Only when a PSF star is in the FOV of the IFU one would be able to use a proper PSF for each wavelength. This will be possible with next generation instruments such as MUSE at the Very Large Telescope.

4 The Graphical User Interface

4.1 Starting `QDeblend`^{3D}

After a succesfull installation of `QDeblend`^{3D}, the program can be started from the command line. Three options are available

1. `QDeblend3d`
   Start the plain GUI without any data
2. `QDeblend3d CUBE.fits`
   Start the GUI using the IFU datacube `CUBE.fits` as input data.
3. `QDeblend3d SESSION.q3d`
   Start the GUI loading a previously saved session `SESSION.q3d` at start-up.

The main window of `QDeblend`^{3D} GUI will then appear which allow to set all the parameters for the deblending algorithm. It is split up into three parts as shown in Fig. 3. The menu is on the top of the window, the parameters controlling the deblending process (`Deblending Control Widget`) can all be set on the left side and the data and deblending result will be visualised (`Cube Viewer Widget`) on the right side.

Although the use of this interface should be intuitive, details for each of those three components will be explained in the following three sections.

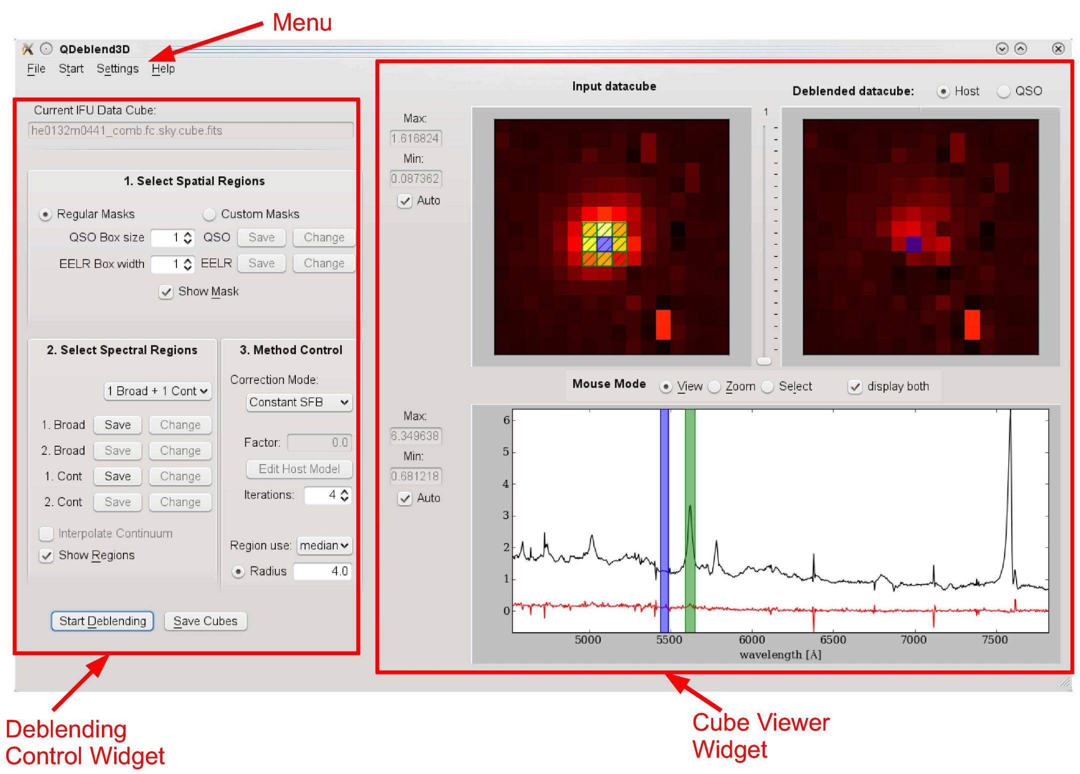

Fig. 3. The main window of `QDeblend`^{3D}.

4.2 The Menu

4.2.1 The File Menu

`Load Cube`: Load a 3D datacube in `FITS` format with spatial dimension in the x and y axis and spectral dimension in the z-axis. The data must be stored in the first extension if the file contains multiple extensions. The wavelength information must be stored in the primary `FITS` header as keywords `CRVAL3` (the wavelength of the first monochromatic image) and `CDELT3` (linear wavelength dispersion per pixel). The wavelengthes should be in units of Å.

> **Only regularly sampled `FITS` datacubes with squared spaxel can be loaded so far. It is planned to update the program to be able to load `RSS` files for arbitrary IFU geometries.**

`Save Cubes`: This item is only available after the deblending process was finished successfully. In the following dialog the user is requested to select a directory and to provide a `PREFIX` for the file names. The datacubes of the deblended QSO and host emission will then be stored in the given directory as `PREFIX_QSO.fits` and `PREFIX_host.fits`. The wavelength range for these two files can optionally be reduced to cover only a specific spectral region.

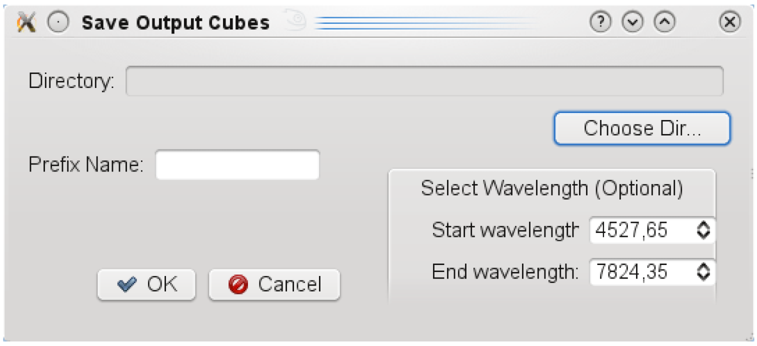

Fig. 4. Save Cubes dialog

`Save Session`: All the parameters and settings from the `Deblending Control Widget` can be stored in a special (`q3d`) binary file, so that the deblending can be repeated later or paremeters can easily be adjusted without starting from the beginning.

`Load Session`: Load a `q3d` file to recover a previous session for a specific datacube.

4.2.2 The Start Menu

`Deblending`: Starts the deblending process if all the required parameters in the `Deblending Control Widget` have been set by the user. If the process takes more than a few seconds, a progress bar will appear to inform the user about the current status. The deblended QSO or host datacubes can be viewed and compared with the initial datacube in the `Cube Viewer Widget` immediately after the deblending process was finished.

`Monte Carlo run:` In the case a variance cube is available for the data, one can perform a Monte Carlo run on the deblending process to evaluate the propagation of random errors. When all parameters in the Deblending Control Widget were set satisfactory a dialog will open, which requires the selection of the corresponding variance frame, a directory for the output files and their prefix string. The number of different cube realisations can be set which are simply produced by randomly adding Gaussian noise to the initial datacube based on the variance of each pixel. The deblending process is performed on each realisation and the resulting cubes are stored in the given output directory. Additionally, the borders of the different selected spectral regions may be randomly adjusted within a given width. Again, the user can optionally restrict the resulting cubes to a certain wavelength range.

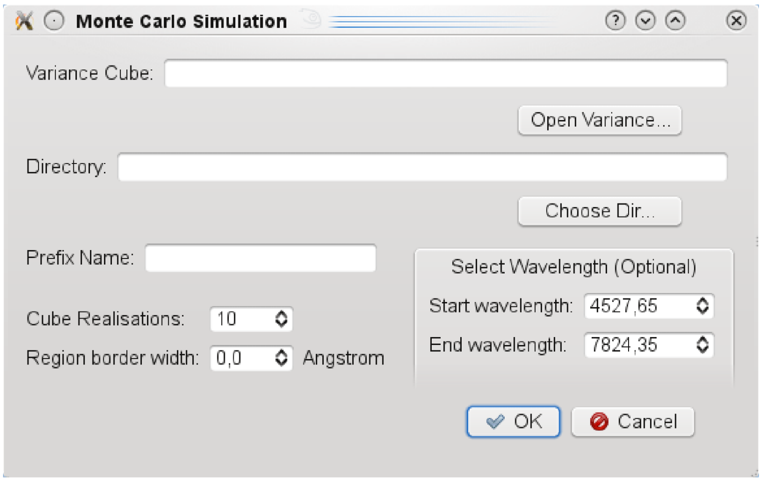

Fig. 5. Monte Carlo dialog

4.2.3 The Settings Menu

`Set QSO centre:` The QSO centre is by default set to the brightest spaxel in the spatial dimension. However, there might be cases in which this is not correct, e.g. a bright star in the field of view. To set the QSO centre manually, switch to the View Mouse Mode in the Cube Viewer Widget and select the spaxel you want to assign in the input datacube Spaxel Widget. The QSO centre will then be update after selecting this item in the menu.

`Color Settings:` Opens a dialog where all the display parameters for the Cube Viewer Widget can be changed to the users preference. These parameters settings can be saved or loaded. A default set of parameters is hard-coded in the program and can be restored at any time.

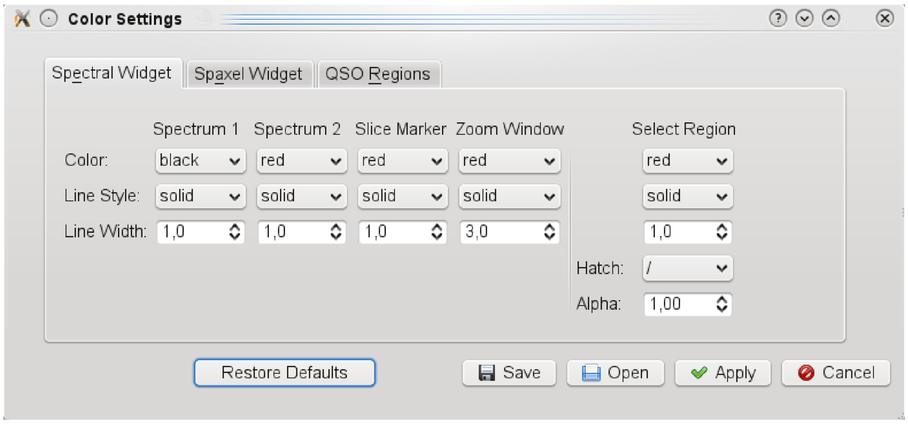

Fig. 6. Color Settings dialog

4.2.4 Help Menu

`Online Manual`: Display this Manual as a browseable page within `QDeblend`^{3D}.

`Version`: Current Version of `QDeblend`^{3D}.

`AboutQt`: Qt Version and other related information.

4.3 Cube Viewer Widget

The `Cube Viewer Widget` on the right part of the main window consists of several widgets itself as shown in Figure 8. The `Spectral Widget` on the bottom displays the spectra of individual spaxels or a sum of selected spaxels. Two different `Spaxel Widgets` visualise the light distribution at a given wavelength for the initial datacube (left) and the QSO or host datacube (right) after the deblending process was completed. One can browse through the spatial or spectral dimension or select specific feature with the mouse depending on the `Mouse Mode`.

4.3.1 Mouse Modes

`View Mode`: Only in this mode the mouse can be used to browse through the data. With a left mouse click in the `Spectrum Widget`, the corresponding monochromatic image will be displayed in the two `Spaxel Widgets`. The vertical line in the `Spectrum Widget` indicates the current wavelength of the image. To scan through the monochromatic images one can either move the slider or move the mouse within the `Spectrum Widget` while the middle mouse button is pressed.

To display a specific spectrum of a spaxel in the `Spectrum Widget` please click on the spaxel of your interest in the corresponding `Spaxel Widget`. The spaxel will be overlaid with a blue color. If the mouse is moved over the `Spaxel Widget` while the left mouse button was kept pressed, the spectrum in the `Spectrum Widget` will be updated immediately.

In order to display the spectra of both, the initial datacube and the QSO or host datacube, for a given spaxel for comparison please check the `display both` box.

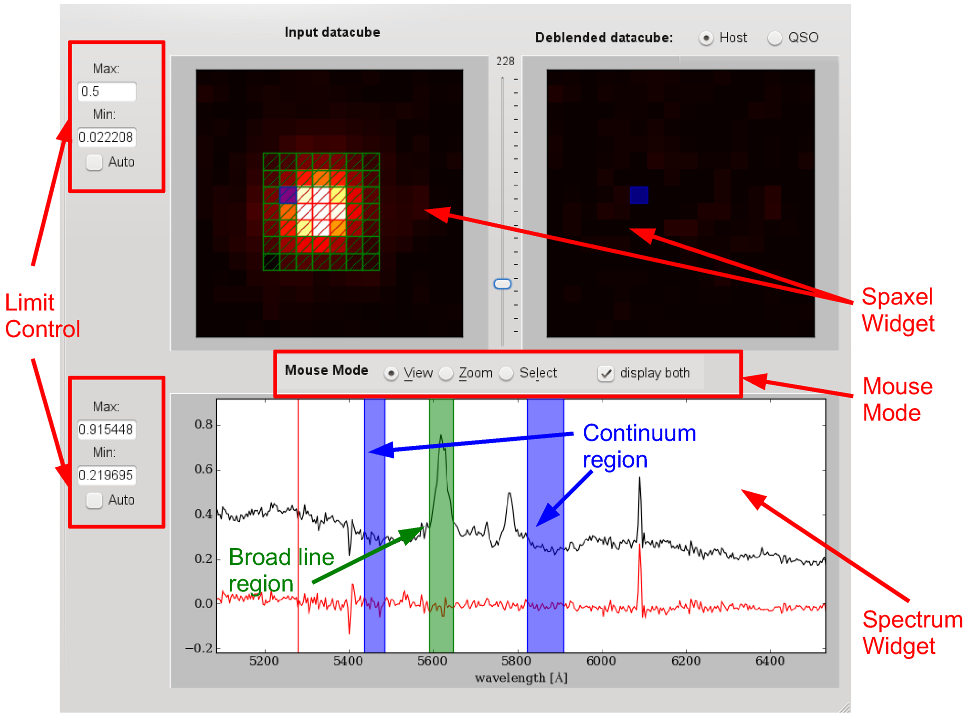

Fig. 7. The Cube Viewer Widget

`Zoom Mode:` In order to zoom either in the spectral or spatial dimension you can switch to the `Zoom Mouse Mode`. Please press the left mouse button in either the `Spectral` or `Spaxel Widget` and keep it pressed while moving the mouse. A red rectangle will show up to indicate the area which will be zoomed in after the mouse button is released. Pressing the right mouse button on either Widgets will unzoom the display to the initial area.

`Select Mode:` Several spaxels or a specific spectral range can be selected in the mode with the mouse.

In the `Spectrum Widget`, press the left mouse button and keep it pressed to select the desired wavelength range shown as the red dashed area. The wavelength range can be adjusted from the initial range by clicking on the vertical lines at the left or right border and move them to their desired wavelength whilst keeping the button pressed. The selection can be cleared by clicking on the right mouse button on the `Spectrum Widget`.

A similar selection procedure is adopted for the `Spaxel Widget`. Add individual spaxel to the selection by clicking on individual spaxel. Clicking on selected spaxels will remove them from the selection. To clear the selection of spaxel completely click the right mouse button ones in the Spaxel Widget.

In both cases the co-added image over the selected wavelength range will be shown in the `Spaxel Widget` or the co-added spectrum of the spaxel will be shown in the `Spectrum Widget` instead of individual spaxel spectra or monochromatic images.

4.3.2 Limit Control

Both the upper and lower limits for the `Spaxel` and `Spectrum Widgets` can be set individually. If Auto is checked, the upper and lower limits are determined from the maximum and minimum values in the displayed range. The current values are always shown in the `Max` and `Min` input boxes. Please uncheck the `Auto` box and change the value in the `Max` or `Min` boxes to your desired values as float numbers. The Widget will be immediately updated.

4.4 Deblending Control Widget

The `Deblending Control Widget` allows the user to set up all the parameters required to run the deblending algorithm. This means that the broad emission line feature and the adjacent continuum needs to be selected as well as QSO spaxels and host galaxy spaxels to correct the QSO spectrum for host galaxy contamination as described in Section 3. Thus, the `Deblending` Control Widget consists of the following three parts

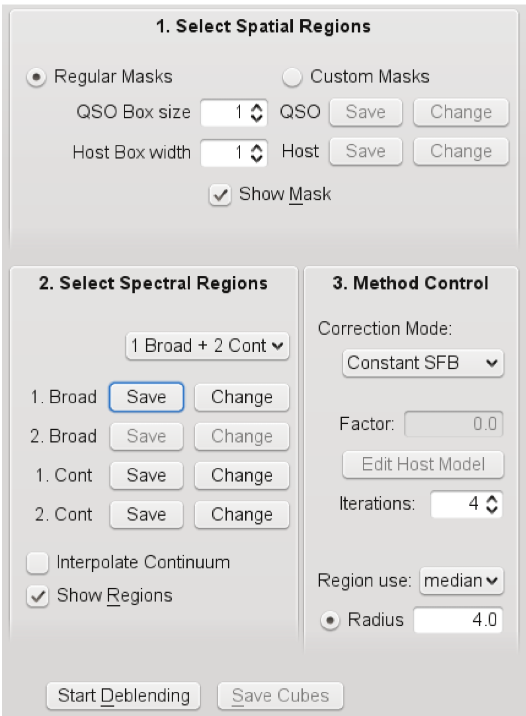

Fig. 8. The Deblending Control Widget

4.4.1 Select Spatial Regions

Two options are available to select the QSO and host spaxel, a regular mask and a custom mask.
In the regular mask, the QSO spatial region is assumed to be a square region around the QSO centre. Thus, its width can only be an odd number of spaxels, like 1,3,5, etc., which can be adjusted via the `QSO Box size`. The spatial region for the host spectrum is assumed to be a shell around the QSO region which can have a width

of 1, 2, 3, 4, etc. spaxels. If the QSO centre was not automatically set properly, please set the QSO centre manually to the appropriate spaxel as explained previously (4.2.3).
Regular regions may not optimal, for example due to bad spaxels, so that regions need to be defined specifically for the data. In this case, choose the `Custom Masks` option. In the `Cube Viewer Widget` you can select either the QSO or host region in the `Select Mouse Mode` and save them by clicking on the corresponding `Save` button. In order to change already saved regions you can click on the `Change` button which automatically switch to the `Select Mouse Mode` and the spaxel of the stored region appear selected in `Cube Viewer Widget`. These selection of spaxels can then be changed and saved again by clicking on the corresponding `Save` button.
To be aware of the selected spatial region you can check the `Show Mask` box, which will highlight the QSO region as red dashed spaxels and the host region as blue dashed spaxels.

4.4.2 Select Spectral Regions

To identify the contribution of the QSO in each spaxel one needs to measure the flux within a broad emission line for each spaxel. Thus, up to 2 spectral windows for the broad line (e.g. red and blue wing) and for the adjacent continuum can be set. First choose how many spectral windows you plan to select for the broad line and continuum in the pull down box, which activates the corresponding buttons.
In order to set those spectral windows switch to the `Select Mouse Mode` and select a specific wavelength range in the `Spectrum Widget` which can be stored in a mask (1. Broad, 2. Broad, 1. Continuum, 2. Continuum) by clicking on the corresponding `Save` button. The stored wavelength regions can be changed again by clicking on the corresponding `Change` button, which will be selected again in the `Spectrum Widget` for further adjustment.
To be aware of the selected spectral region you can check the `Show Mask` box, which will highlight the selected broad line regions as green areas and the selected continuum regions as blue areas in the default color scheme.
The `Interpolate Continuum` box is only active when two continuum regions are selected. If this feature is selected the continuum underneath the broad line is set to be a straight line going through the flux density in the two continuum regions, otherwise the mean flux density in the continuum regions is taken and subtracted internally from the spectrum to measure the flux in the broad line.

4.4.3 Method Control

The user can set a few parameters that control how the iterative deblending algorithm will correct for the host galaxy contamination of the QSO spectrum. So far four modes are available

`None`: This means that the QSO spectrum *will not be decontaminated* and taken as the co-added spectrum of the selected QSO spatial region. Thus, only one iteration will be performed.

`Constant SFB`: In this correction mode it will be assumed that the surface brightness (SFB) of the host emission in the selected spatial region is locally constant and equal to the host SFB within the area of the selected QSO spatial region. Thus, the extracted host spectrum will be scaled in each iteration to the area covered by the QSO spatial region. This mode is particularly usefull if no a-prior information on the host galaxy light distribution are available.

`Manual factor:` This mode is meant to study how different scaling factors affect the deblending process since the scale factor will in most cases not measurable from the data itself and needs to be approximated. The user can put in different scale factors manually to get a feeling of what is happening.

`Host SFB model:` The most sophisticated mode. It assumes that a-priori knowledge of the host galaxy SFB distribution is available, for example from high-resolution imaging with the Hubble Space Telescope. In that case, the user need to provide the structural components of the estimated host model.

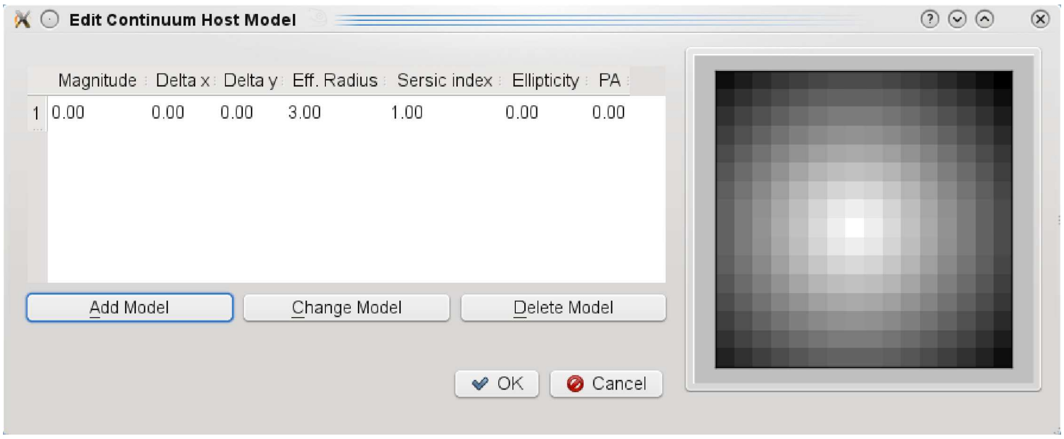

Fig. 9. The host model dialog

The corresponding dialog that opens after clicking on the `Edit Host Model` button is shown in Figure 9. The user can add, change or delete structural components which are based on the two-dimensional Sérsic SFB profile. The required parameters for the host model components are the magnitude, the distance in x and y direction to the QSO centre, the effective radius r_{e} in units of spaxels, the Sérsic index n, the ellipticity and the position angle PA in the GALFIT convention. The resulting SFB model is displayed in the widget on the right with a logarithmic SFB scaling.

During the deblending process the host model will be convolved with the recovered PSF of the observation. Afterwards the difference in SFB of the selected host spatial region and the selected QSO spatial region will be measured and host galaxy spectrum will be scaled accordingly before it is subtracted from the QSO spectrum.

Additionally, the user can set which quantity will be used to define the strength of the broad line within the selected wavelength range. Available options in `Region Use` are the **median**, the **mean** and the **sum**.
The QSO-host deblending should usually not be performed over the entire field of view, since the deblending process will decrease the S/N of individual spaxel spectra.

Thus, it might be desirable to restrict the actual deblending to an area within a given radius around the QSO centre. In that case the user should select the `Radius` box and enter the desired radius in units of spaxels.
If all required parameters in the `Deblending Control Widget` have been set satisfactory the user can start the deblending process with the `Start Deblending` button in the Widget or from the `Start Menu` item.

Please check, that the QSO centre has been set correctly!

5 Conditions of use

`QDeblend`^{3D} is free to use on under GNU GPL licence. No co-authorship in papers is required if you used this program for the data anaylsis. However, we would like to ask you to cite the following two papers (to be submitted) where initial results using `QDeblend`^{3D} are presented.

Husemann, B., Wisotzki, L., Sánchez, S.F., & Janke, K., "The properties of extended emission-line regions around low-redshift QSOs and the lack of high-velocity AGN outflows", 2011, A&A, to be submitted

Husemann, B., Nugroho, D., Jahnke, K., Wisotzki, L., Sánchez, S.F.,Kupko, D.,& Schramm, M., "Integral field spectroscopy of nearby QSOs: Emission-line diagnostics, resolved gas-phase metallicities & the NLR size-luminosity relation", 2011, A&A, to be submitted

Please check ADS when those papers are published at least on the preprint server.

On the other hand, we welcome any suggestions for improvements, requests for additional features or reporting bugs to be fixed. Please contact the author by eMail (bhusemann@aip.de) or use the website at sourceforge to share your comments.

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