Starter guide
How to use the GALEV web-interface
http://www.galev.org

We hope you find this guide useful in answering some of the questions you might have when (first) using the web-interface. In case you are missing some points or have further questions, comments or suggestions on any part of either this guide or the web-interface please let us know by writing an email to support@galev.org. We do our very best to make your GALEV-experience a truely good one, hoping you agree to recommend us to your colleagues and students / advisors.

The GALEV developer team
Ralf Kotulla & Peter Anders

Getting started guide to run GALEV models over the web

Intro and overview

This short presentation will guide you in several steps through the process to your own GALEV model

For this purpose we illustrate how to run models of different complexity.

1) A undisturbed Sa galaxy with default parameters

2) A galaxy with a user-defined e-folding timescale

3) The same galaxy as in 2), but this time also encountering a burst

If you are already familiar with the web-interface you can skip some of the steps and jump directly to the more advanced models

Note: all screenshots presented in the following have been obtained with FireFox under Linux, so some buttons and fields might look a bit different on your machine.

Starting the web-interface

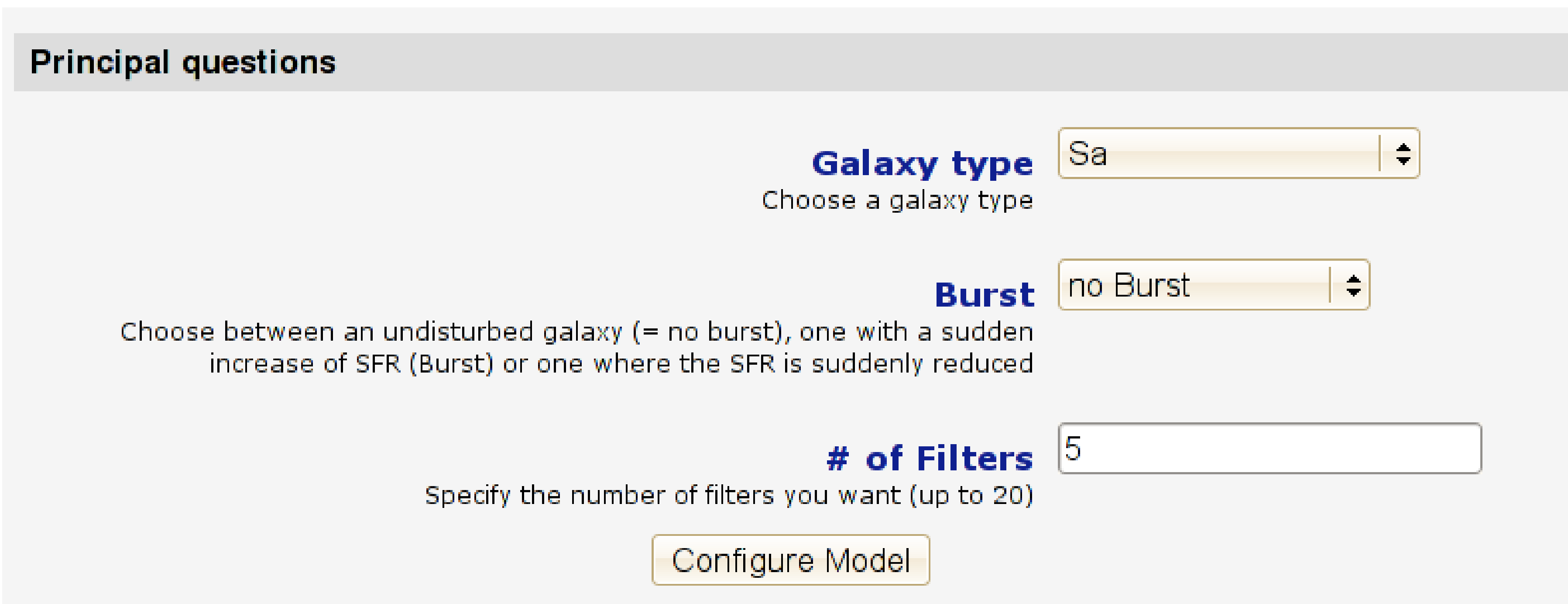
To start the web-interface, navigate your favourite browser to **http://model.galev.org**.

The resulting page gives a short overview on where to find further information (including the link to this document), which paper to cite if you use our models in your publication, and some more tools we will discuss in the further process.

At the bottom of the page you will find the following link that takes you to the first step of the modeling process:

Selecting basic parameters

In a first step you have to give some information on what kind of model you want to run, so that the web-interface can then supply the necessary fields in the next step.



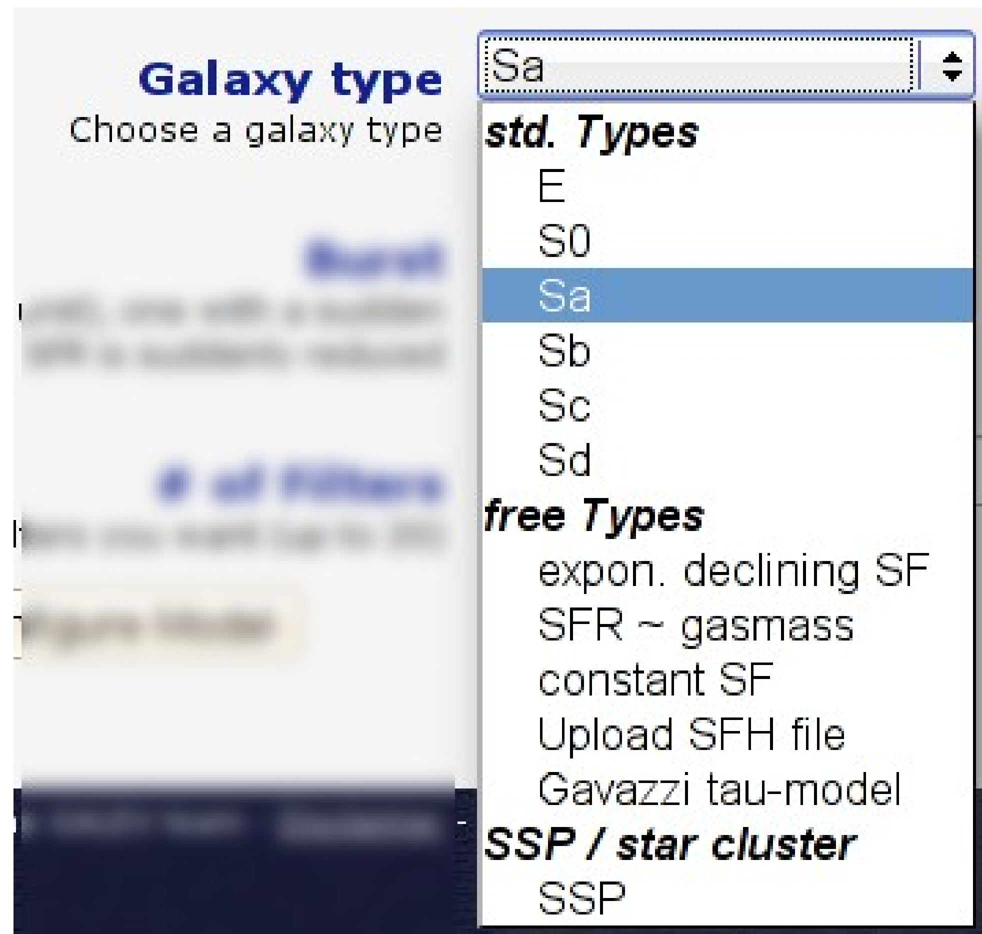
We will go through each of these fields in the following slides.

Selecting a galaxy type

Probably the most important choice to make is which galaxy type your model should be or, with other words, which star formation history.

To keep it simple let's for now choose a undisturbed Sa-type galaxy, for which GALEV already has all necessary parameters built in.

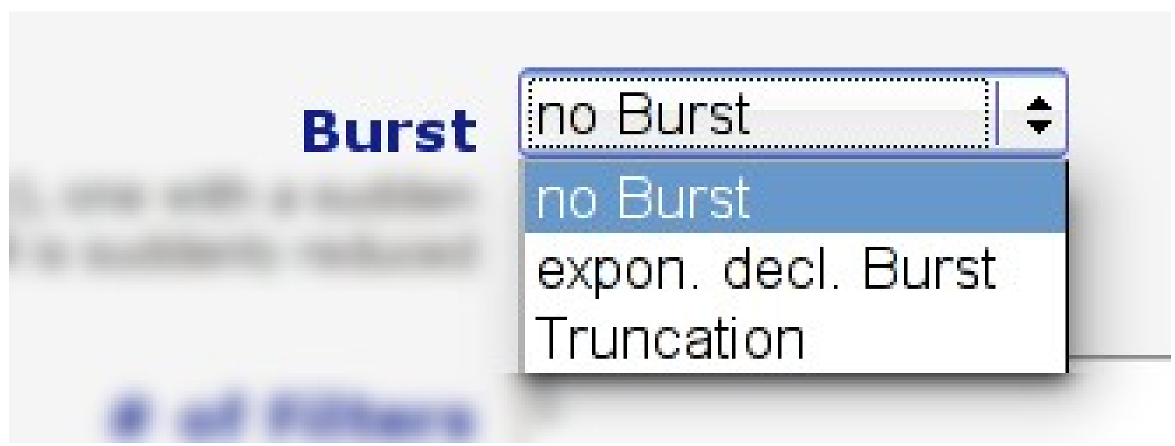
At a later stage we will describe all other types that you can choose from:



Choose a burst

The next decision you have to make is whether your model should include a starburst or a star formation truncation event.

Again, for the time being let's choose “No burst” for now, but we will come back to the other possibilities later.



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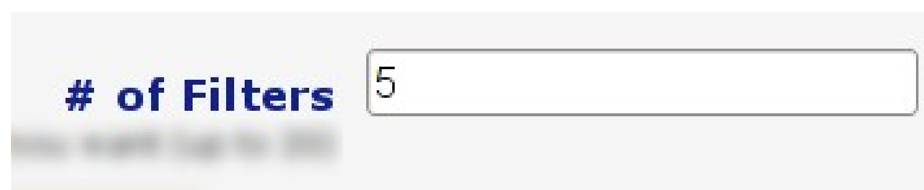
Selecting the number of filters

Although the principal output of GALEV are spectra, it nevertheless is capable of convolving these spectra with filter response curves to directly give you magnitudes that can be compared to observations.

The selection of filters will also be done in the second step, but in order to supply you with the right number of selection fields you have to specify the number of filters right now.

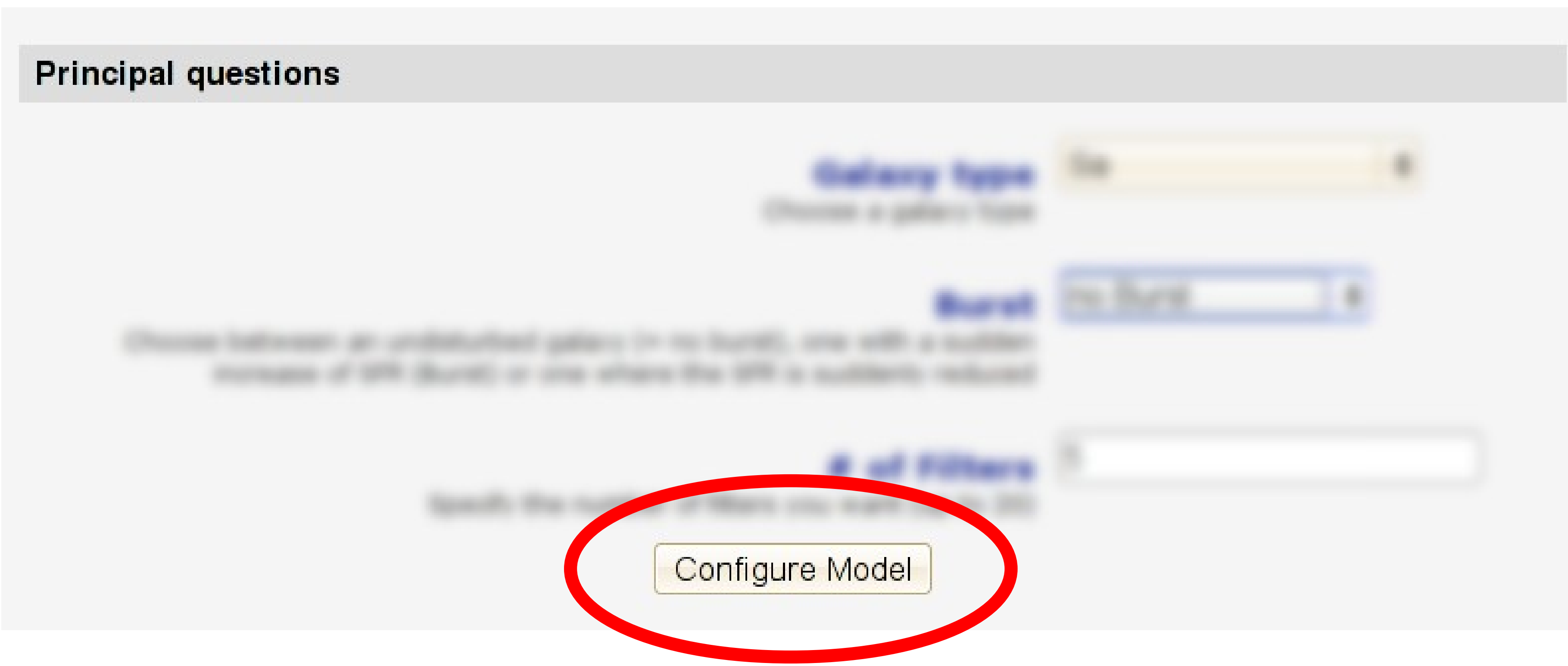
For the sake of this example let's assume you want to analyze photometry from the SDSS, so you need magnitudes in 5 filters (ugriz).



Getting ready for step 2

Once you specified all principal questions you are ready for the second step that allows you to fully specify your model.

To continue just click the “Configure model” at the bottom of the page.



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Specifying your galaxy parameters

On this second page you specify all parameters for your model. Depending on the properties you specified during the first step (e.g. burst or no burst, galaxy type) you will get a slightly different selection of parameters you can adjust.

Detailed information

Initial mass function — Salpeter IMF (0.1-100 Msun) (help)

Salpeter (1955): constant slope of -1.35, mass-range 0.1-100Msun or 0.1-120 Msun
Kroupa: M<0.5 Msun: slope -0.3, M>0.5Msun: slope -1.3
Chabrier: not yet available, coming soon

Gas emission — Full Emission lines (help)

Full Emission lines: list of supported emission lines
Continnum only: No emission lines, but continuum emission is still considered
No gas emission: Disable both continuum and line emission

Metallicity — chemically consistent (help)

Choose either chemically consistent treatment or fix the metallicity to a specific value

Galaxy type — Sa (help)

to change the galaxy type please use your browser's "Back" option.

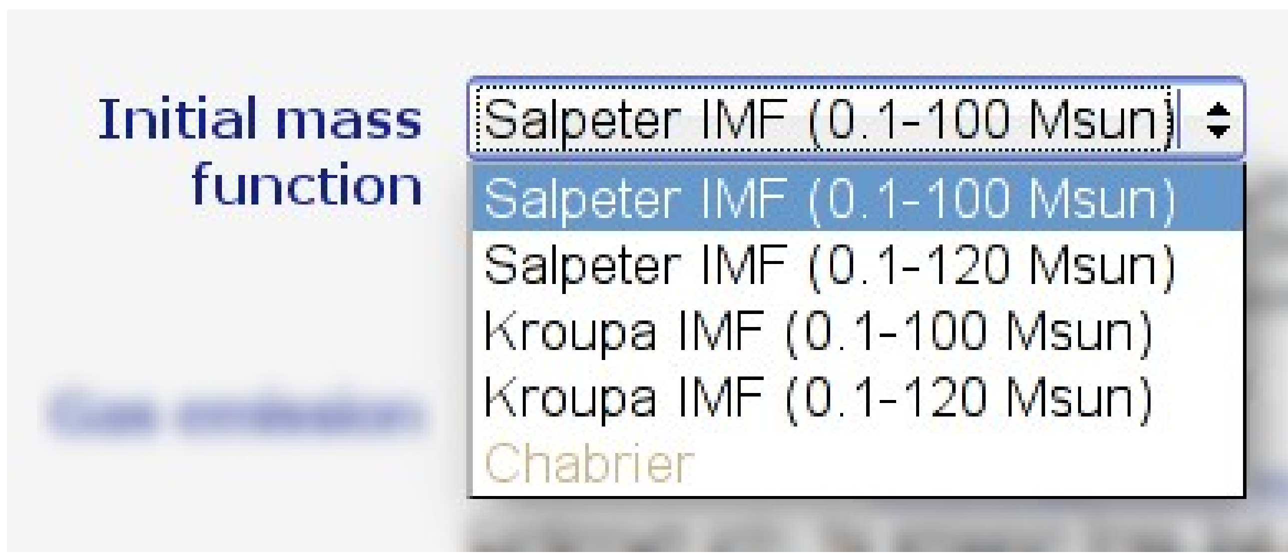
Total mass — [ ] solar masses (help)

Initial mass of the galaxy in solar masses

Initial Mass Function

One of the parameters that has a wider implication than one would originally think is the choice of the IMF. While the choice of the upper mass limit (100 or 120 solar masses) mostly affects the strengths of the emission lines, the choice of different shapes at the low-mass end affects the overall mass-to-light ratios (how mass light is emitted per unit stellar mass), but also the chemical enrichment speed by changing the ratio of high-to-low mass stars.

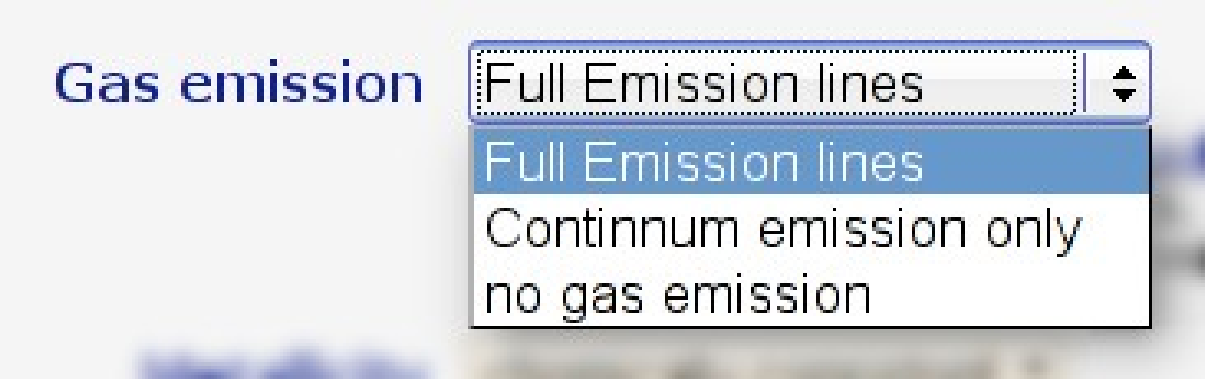
All our undisturbed models are calibrated to well reproduce observed data for a Salpeter-IMF from 0.1 - 100 solar masses, so we chose this for our example, but you are free to make a different choice for your own models.



Gaseous emission: lines & continuum

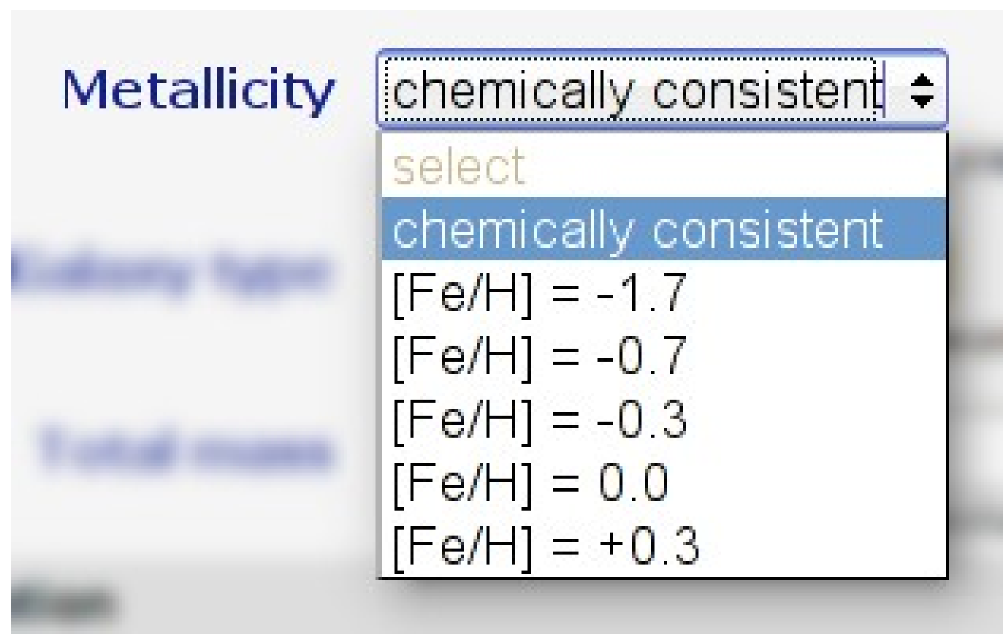
A key feature of GALEV and a crucial ingredient for studies of galaxies with ongoing star formation as well as young star clusters is light emission by ionized gas, either in the form of emission lines or as continuum emission.

Our Sa-type model has at least some star formation at all times, so we chose to include both line and continuum emission.



Metallicity and chemical consistency

Metallicity is another important factor to think about before running your model. While it may be useful to use a fixed metallicity for certain types of models (e.g. in the case of strong starbursts), for most applications our chemically consistent treatment is the better choice. If enabled, GALEV fully accounts for the increasing abundances of subsequently formed stellar populations, allowing for a realistic chemical enrichment of the galaxy over time.

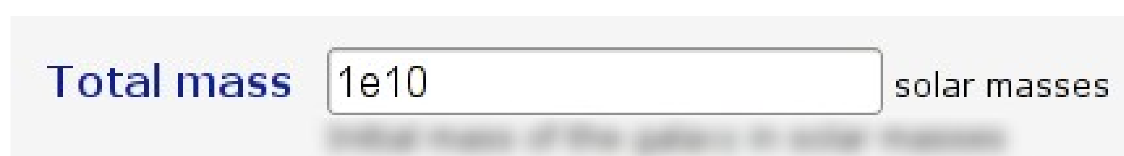


Galaxy total mass

All parameters specified until this point mostly dealt with the choice of the input physics on which the model is based, while the remaining parameters directly describe the galaxy and its parameters.

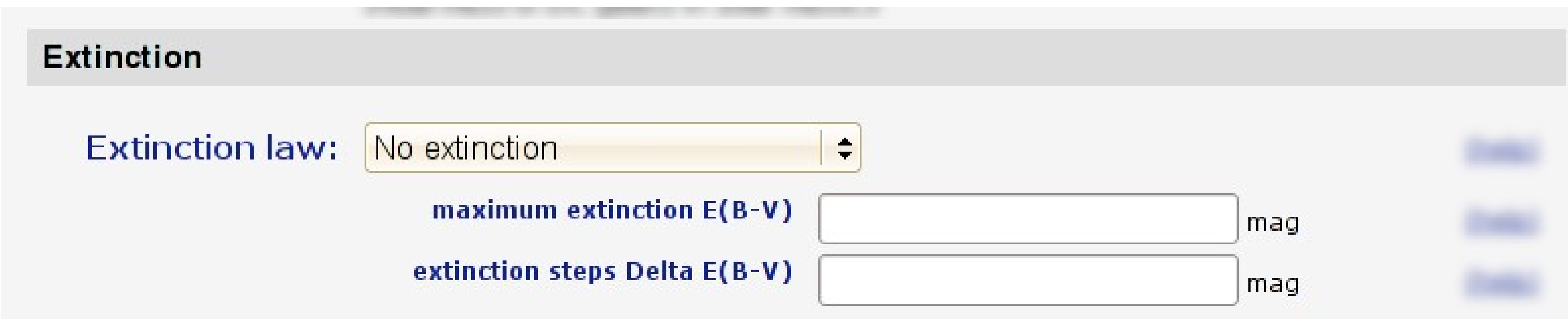
The galaxy type is given again here, but can not be changed anymore. In case you need to change your original choice you need to use your browsers “Back” button to return to the first step.

As we chose an undisturbed galaxy for out first simple model we don't have to specify any additional parameters, as these are already programmed into GALEV. The only parameter we still have to specify is the galaxy mass in solar masses. This total mass, all gaseous at the very beginning of the model, remains constant, while stellar mass changes with time as more and more gas is converted into stars by star formation.



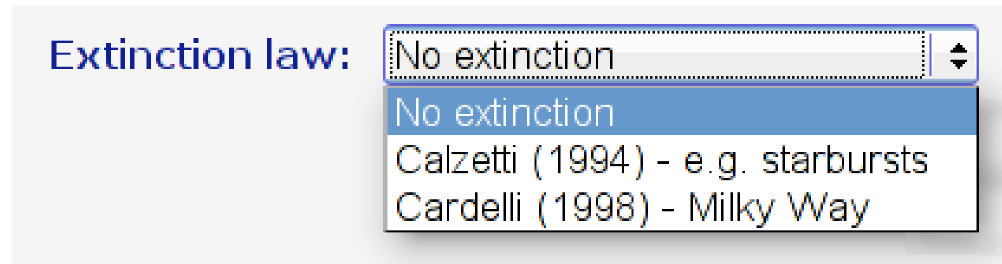
Dust reddening and extinction

Now that the stellar part of the model is specified it's time to consider other effects that contribute to the appearance of a galaxy's spectrum, most prominently reddening due to dust. For our simple model, however, let's start with a model that is not affected by any dust reddening.

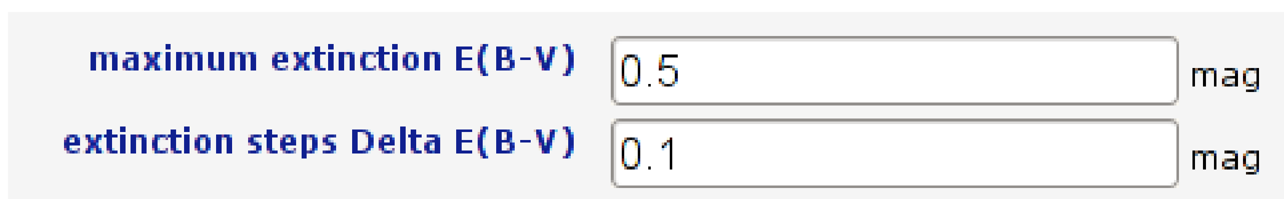


Extinction law and reddening steps

For more general models GALEV currently allows you to choose from two different extinction laws (Calzetti and Cardelli) that affect the spectrum differently, most notably in the UV.



Depending on your application you might be interested in galaxy spectra with different degrees of reddening. This can be specified by choosing a maximum reddening (say, E(B-V)max = 0.5mag) and steps of ΔE(B-V) = 0.1mag. This would result in 6 sets of spectra for each timestep, each with E(B-V) = 0.0, 0.1, 0.2, ... 0.5 mag.



Note:
Beware of the potentially large output files and prolonged computing time necessary for cases with many extinction steps.

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Cosmological parameters

The coming block of cosmological parameters can either be savely ignored (if you are interested purely in the evolution of a galaxy as function of time) or is of crucial importance (if you want to study the evolution with redshift).

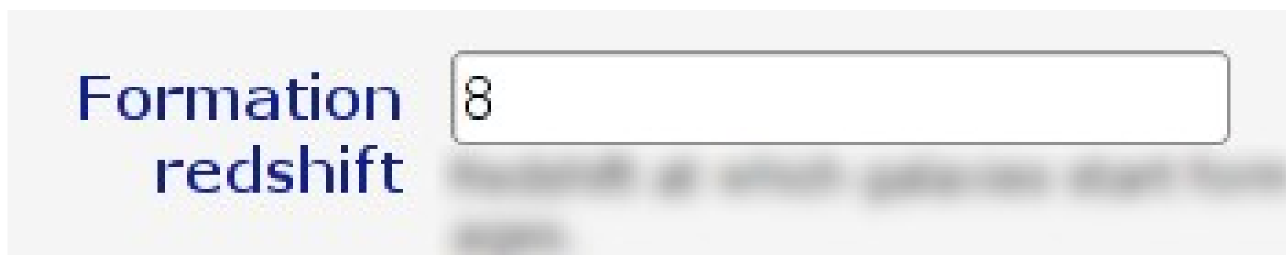
Cosmological parameters:

Parameter	Value	Description
Hubble H_0	70 km s^{-1} Mpc^{-1}	Local expansion speed of the Universe
Formation redshift	8	Redshift at which galaxies start forming stars; required to convert between redshift and galaxy ages.
Omega Matter	0.3	Matter content of the Universe
Omega Lambda	0.7	Energy density contribution of Dark Energy
Omega K	0.00	Curvature of the Universe. Internally fixed to value 0 (flat cosmology)
Z-max:	10	Truncate output to redshifts smaller than the given value

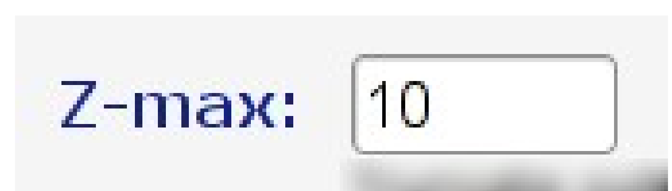
Formation redshift and z-max

Most parameters (such as Hubble constant H0, matter density Ωm and dark energy term ΩΛ) are generally well known and widely used. We therefore want to draw your attention to the two remaining parameters, zmax and the formation redshift zform.

zform describes the formation redshift of the galaxy, i.e. at which redshift the galaxy started forming stars. For this reason it is also the maximum redshift at which the galaxy exists and is required to convert between galaxy ages and redshift.



The second parameter, zmax, does not affect the evolution of the galaxy, but rather allows to limit the redshift range for which spectra and magnitudes are computed. This can be useful if, for example, you are only interested in the redshift evolution after the onset of the starburst even.



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Output options

The next block allows you to specify which kind of output you require for your application. As this is a long list we will look at the different parts individually.

Output options

time evolution

- [x] all
- [x] spectra (~20 MB)
- [x] absolute magnitudes as function of time (<1 MB pro extinction step)
- [x] statistics (stellar and gas-masses, SFRs, etc) (~350 kB)
- [x] NEW: dust attenuation, i.e. magnitude difference caused by E(B-V)=1mag (~100 kB)

cosmology

- [ ] all
- [ ] redshifted spectra with and without attenuation (Madau 1995) (~50 MB !!!)
- [ ] absolute observed frame magnitudes (<1 MB)
- [ ] apparent magnitudes without attenuation (<1 MB)
- [ ] apparent magnitudes with attenuation (Madau 1995) (<1 MB)
- [ ] e-corrections (evolutionary correction factors) (<1 MB)
- [ ] k-corrections (<1 MB)
- [ ] k-corrections including attenuation (<1 MB)
- [ ] statistics (stellar and gas masses, SFR, galaxy age, distance modulus, etc) (~ 500 kB)
- [ ] NEW: dust attenuation, i.e. magnitude difference caused by E(B-V)=1mag (~ 100 kB)

Normalization

- [x] Normalize magnitudes to fit RC3 (only for standard types) ?

Output options - time evolution

The first block allows you to retrieve the model data as a function of time.

time evolution

- [x] all
- [x] spectra (~20 MB)
- [x] absolute magnitudes as function of time (<1 MB pro extinction step)
- [x] statistics (stellar and gas-masses, SFRs, etc) (~350 kB)
- [x] NEW: dust attenuation, i.e. magnitude difference caused by E(B-V)=1mag (~100 kB)

Statistics in this respect contains a wide range of phyical parameters, e.g. stellar and gaseous masses, star formation rates, and gaseous metallicities. Also included are light- and mass-weighted galaxy ages.

Absolute magnitudes are computed for each timestep in each of the filters that are specified further down on the page and discussed in a moment.

A new feature is the dust attenuation curve. This output file contains the magnitude difference between a dust-free model and a model with a dust reddening of E(B-V)=1.0mag. Adding a scaled version of this file to the absolute magnitudes allows to compute absolute magnitudes for arbitrary dust reddenings.

Output options - redshift evolution

Unlike the block above the options in this block allow you to retrieve the model data as a function of redshift, fully including (unless noted otherwise) the effects of

- cosmological (k-)corrections (caused by changing positions of the filters relative to the restframe spectrum as consequence of the redshift),
- evolutionary (e-)corrections (more distant galaxies are also seen in earlier evolutionary states), and
- light attenuation shortwards of Lyman-alpha due to intergalactic hydrogen along the line-of-sight between the galaxy and the observer.

cosmology

- ☐ all
- ☐ redshifted spectra with and without attenuation (Madau 1995) (~50 MB !!!)
- ☐ absolute observed frame magnitudes (<1 MB)
- ☐ apparent magnitudes without attenuation (<1 MB)
- ☐ apparent magnitudes with attenuation (Madau 1995) (<1 MB)
- ☐ e-corrections (evolutionary correction factors) (<1 MB)
- ☐ k-corrections (<1 MB)
- ☐ k-corrections including attenuation (<1 MB)
- ☐ statistics (stellar and gas masses, SFR, galaxy age, distance modulus, etc) (~ 500 kB)
- ☐ NEW: dust attenuation, i.e. magnitude difference caused by E(B-V)=1mag (~ 100 kB)

Output options - Normalization

The next checkbox down the list might not be clear to everyone rightaway.

Normalization ☑ Normalize magnitudes to fit RC3 (only for standard types) ?

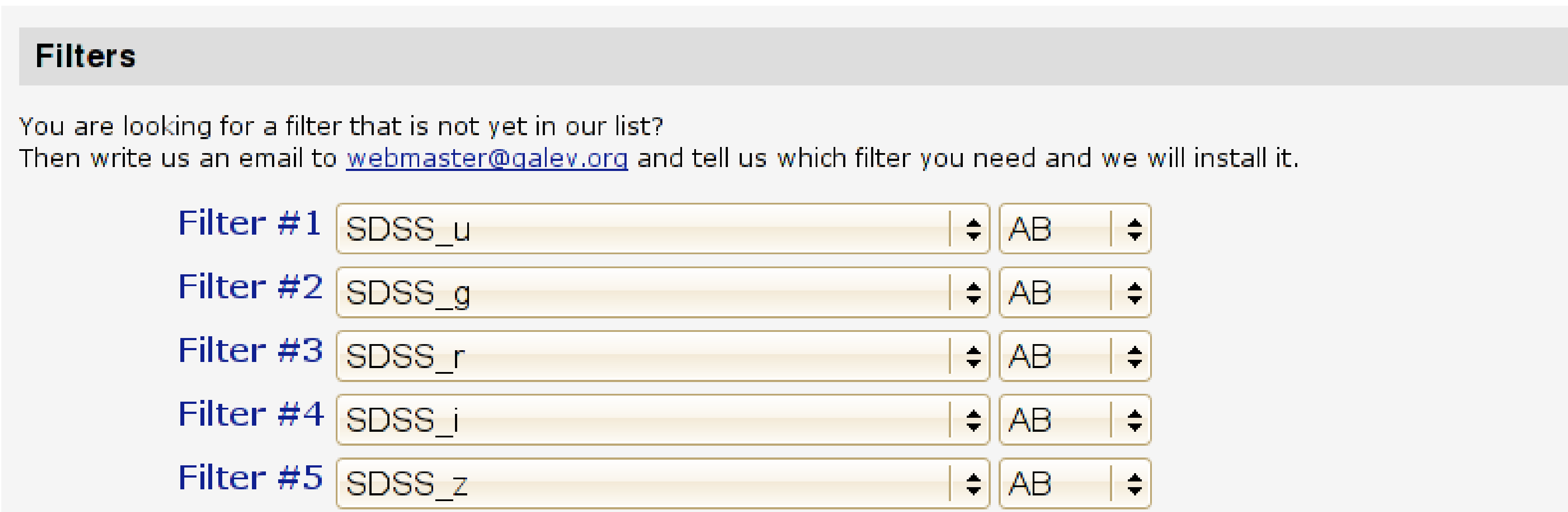
Remember, further up you could enter the total mass for your model? However, there are some cases where you are interested, e.g., how luminous your observed Sa-type galaxy is compared to a typical Sa-type galaxy found in Virgo. For these cases this option “renormalizes” the total mass and all dependent parameters (gas mass, star formation rate, absolute/apparent magnitudes) to match - at redshift z=0 - typical values as found in the Virgo cluster.

For example let's assume you ran a model for an Sd-type galaxy with a total mass of 10^{11} solar masses. This model will be significantly too bright as Sd-galaxies nearby have lower masses than 10^{11} solar masses. Enabling this option scales down the mass to roughly 10^{9} solar masses and brings masses, SFRs and magnitudes in agreement with observations.

Note: This option only affects masses, SFR and magnitudes. All other parameters (metallicities, colors, specific SFRs, etc) remain unchanged.

Output options - Filters

The next block allows you to specify which kind of output you require for your application. As this is a long list we will look at the different parts individually.



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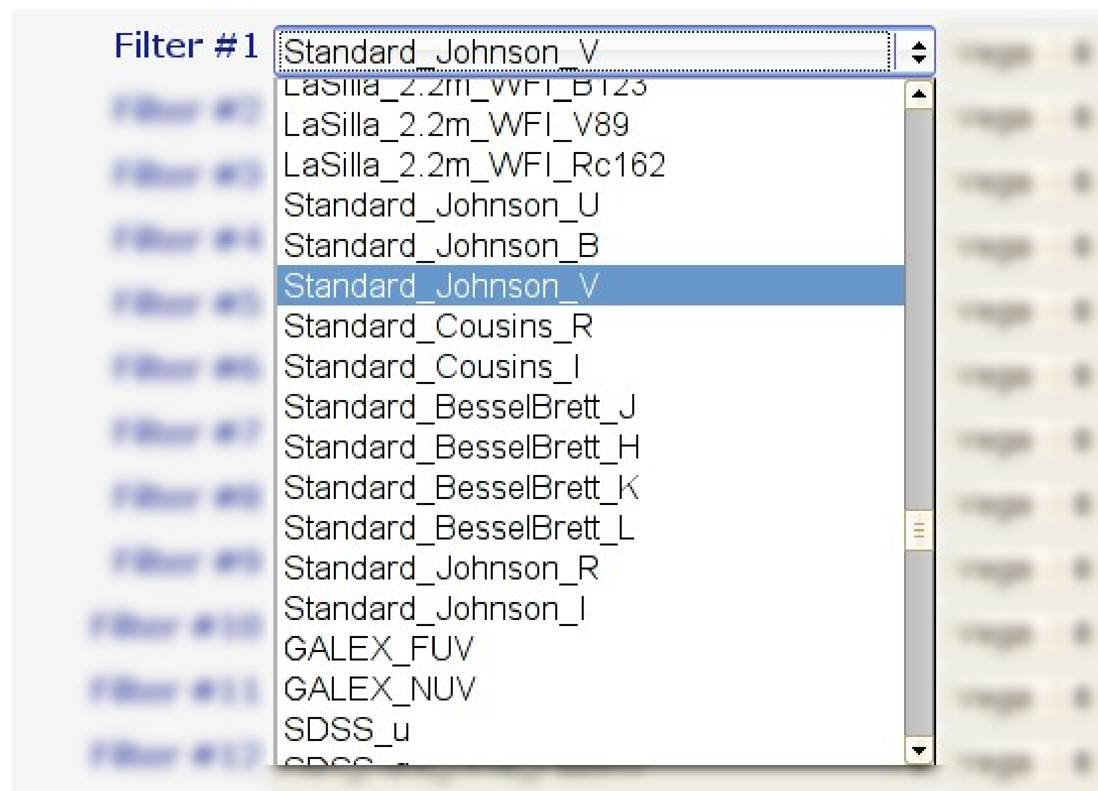
Which telescope, instrument & filter ?

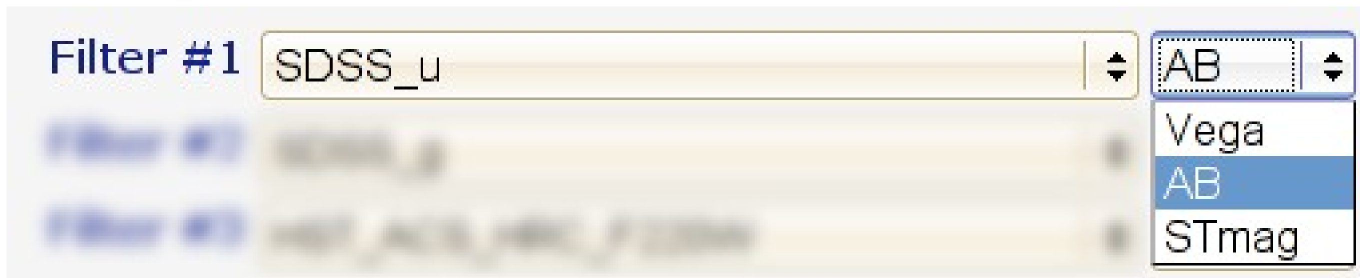
The first part is to choose the actual filter response curve for each of your observed filters. Filter names are usually a combination of telescope, instument, and filter. For large surveys such as the SDSS or telescopes with only one instrument some parts of this are omitted, so the SDSS filters are only called “SDSS_u”, while filters from the GALEX space-based UV telescope are simply called GALEX_FUV.

If you do not find the exact combination for your data just send us an email to support@galev.org and tell us which filters (incl. telescope and instrument) are missing and we will add them to the list.



Which magnitude system ?

The last choice concerning the filters is the magnitude system your photometry is based on. There are generally three common systems: Vega, AB and ST.

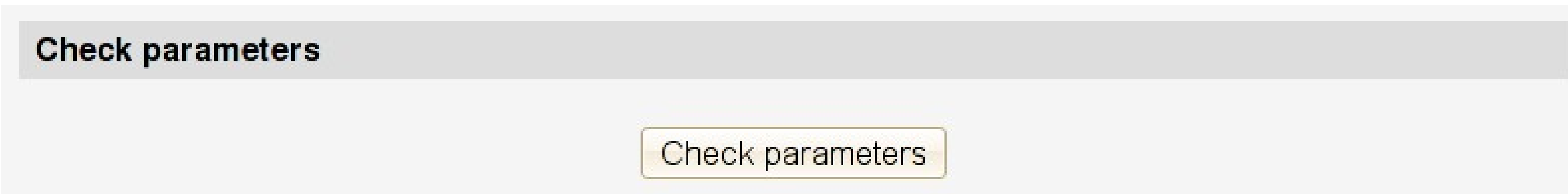


Vega and AB are the most widely used ones, with AB being used by, e.g., the SDSS. Vega magnitudes are commonly used in optical photometry in the Johnson/Cousins and related filter systems as well as in the NIR. ST (Space Telescope) magnitudes are, as the name suggests, mostly used for some HST photometry.

By choosing the right filter and magnitude system for your specific program you don't have to rely on any kind of color-transformations from one system to the other. This not only makes life a bit easier, but it also ensures you are not introducing additional uncertainties.

Check parameters

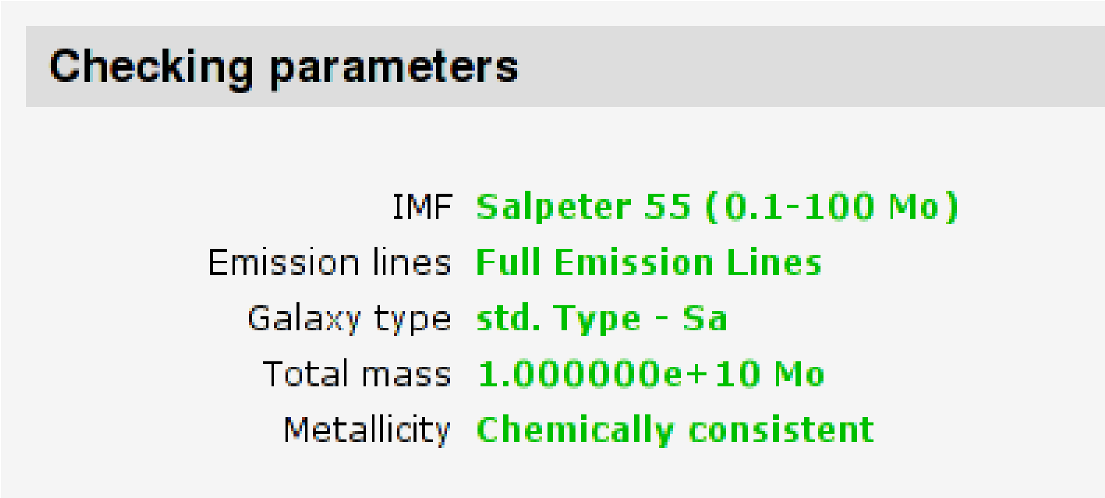
Now that you have all parameters configured you are almost done. You can now click on the “Check parameters” button at the bottom of the page.



This will open a new tab or window, so you can easily modify your parameters to solve problems or run a second model with similar parameters.

Review of parameters

The new page allows you to review all parameters you entered on the previous page.



Values are also checked in the background to make sure they allow GALEV to run correctly, i.e. that all required parameters are given and, e.g. that they have the right sign. In case you missed something or the entered value does not pass the tests, these are given in red so you can easily revise them. This check, however, does not ensure that your model makes physical sense, that still remains your very own responsibility. In case you have doubts or are not sure if your model is plausible, just send us an email to support@galev.org.

Checking dust and cosmology

We also run a quick check on your requested extinction and your choice of the cosmology.

Extinction

Extinction law: **No extinction**

Cosmology

Hubble constant: **70 km/s/Mpc**

Cosmology: Omega-Matter = **0.3**, Omega-Lambda = **0.7**, Omega-K = **0**

Formation redshift **zf = 8**

Truncate output to: **z <= 8**

Reviewing your output options

The current page also allows you to review your selections regarding the filterset and the requested output files.

Please ensure that you selected all required filters and, in particular, the correct magnitude system, since that will have a profound impact on the colors you will get.

Filters

Filter #1	(AB)	SDSS_u3
Filter #2	(AB)	SDSS_g3
Filter #3	(AB)	SDSS_r3
Filter #4	(AB)	SDSS_i3
Filter #5	(AB)	SDSS_z3

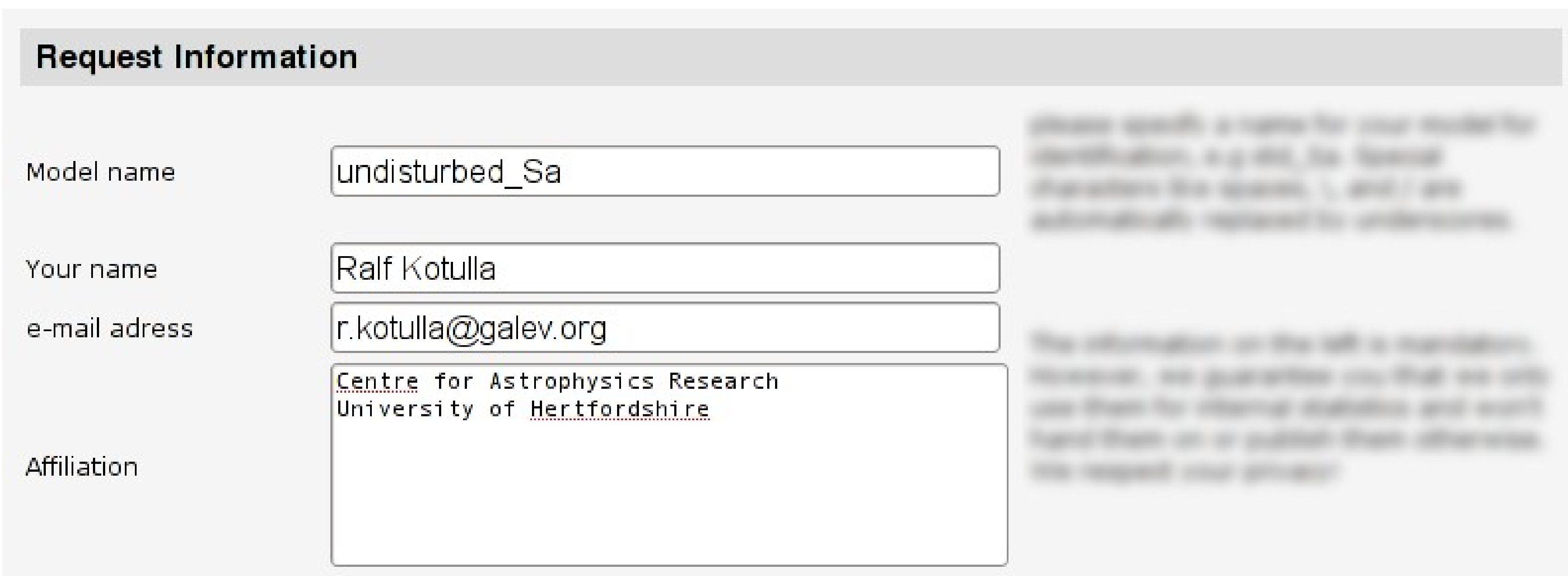
Also make sure you selected all output files that you need. But keep in mind that the more output-files you request, the longer it will take to run the model and also the longer it will take to download the data. In particular the "redshifted spectra" takes up a LOT of space.

Output parameters

time evolution	* Spectra * Absolute magnitudes * Statistics * Dust attenuation curve
cosmology	none
Normalization	YES

Model name and contact information

As a very last step in the process to your model we ask you for a name for your model, your email-address and also for some information about yourself. The modelname is mostly to help you distinguish between different models to make book-keeping easier. The email-address is crucial, as the models will be run in the background and you will recieve an email once your data is ready for download. The information about you allows us to keep track of who is using GALEV and will allow us to make GALEV and its web-interface even better in the future. Be assured that we do not hand on any of the information, your data is perfectly safe with us.



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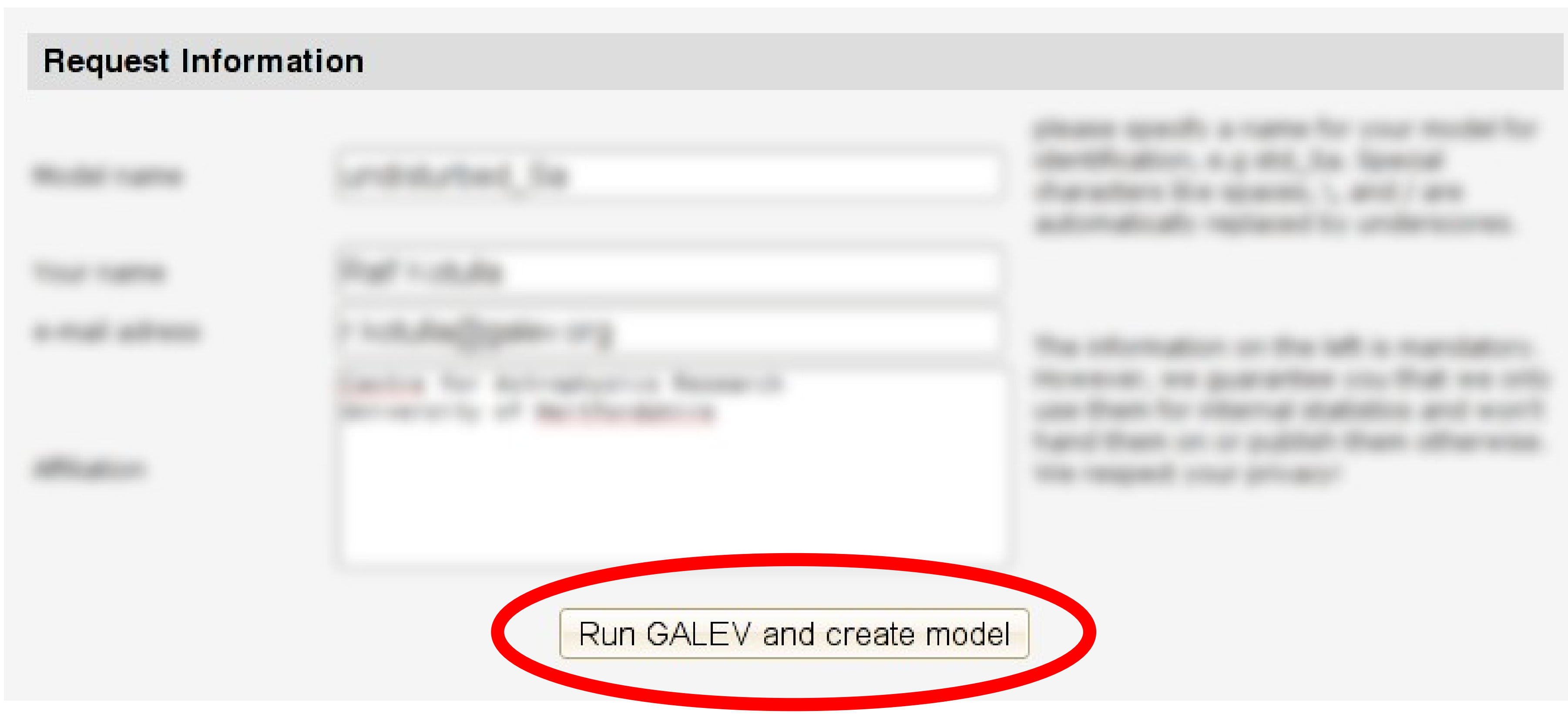
Run GALEV and create model

The only thing left to do to actually start the modeling process is to click on the “Run GALEV and create model” button at the bottom of the page.



You will also recieve a short confirmation on the following page.

The last page

The last page mostly contains information on what's going on in the background. You will see the GALEV configuration file and the definition of your filter set.

Creating configuration file for GALEV

[illegible]

Creating list of filters for magnitude computation

```
# filterlist for model
SDSS_u /galev/filter/SDSS/SDSS_u.dat 20.156914 0.0 0.0 AB
SDSS_g /galev/filter/SDSS/SDSS_g.dat 20.754539 0.0 0.0 AB
SDSS_r /galev/filter/SDSS/SDSS_r.dat 21.354792 0.0 0.0 AB
SDSS_i /galev/filter/SDSS/SDSS_i.dat 21.774947 0.0 0.0 AB
SDSS_z /galev/filter/SDSS/SDSS_z.dat 22.160017 0.0 0.0 AB
# end of file
```

Together these two files fully describe the model in case you want to review your parameters at a later stage.

Pipeline status

You will also recieve a short confirmation that your model was successfully injected into our model pipeline. This concludes your part of the modeling, the rest is done automatically in the background.

Injecting model into pipeline

We successfully added your model to our model-pipeline. Your model will now be computed in the background

As soon as your model is completed you will recieve an email sent to the address you specified. In most cases (depending on server load, etc.) this will be within the next hour or so. If you do not recieve an email within the next 24 hours please let us know and we will investigate this delay.

This email will contain all information regarding your model, which parameter you entered, and will also contain a link to the compressed archive file.

If you have any questions regarding this process please do not hesitate to contact us via email to support@galev.org

Depending on the type of model and the requested output options it will only take several minutes until your model is calculated and the files prepared for download.

Completion email

Once all your data is ready for downloading you will recieve an email with a link to your data. This email again contains the config-file as well as the filter definition, and also gives the latest reference to be used in your publication.

GALEV model completed (undisturbed_Sa) GALEV pipeline

Subject: GALEV model completed (undisturbed_Sa)
From: GALEV pipeline <pipeline@galev.org>
Reply-To: GALEV webmaster <webmaster@galev.org>
Date: 09:13 PM
To: r.kotulla@galev.org

```
Dear Ralf Kotulla

Your requested GALEV model has been finished computing
(at 20/01/2010, 03:13:55 GMT) and can now be downloaded at
http://model.galev.org/models/a20e9e1e975be8dd3408d2cd031c655e/undisturbed_Sa.tgz

If you use this model in any of your publications
please cite:
Kotulla, Fritze, Weilbacher & Anders (2009)
MNRAS 396, 462 (2009) - astro-ph/0903.0378
download here: http://model.galev.org/papers/galevweb.pdf

If you have any comments or suggestions regarding
the GALEV webpage please let us know.

Best regards
The GALEV developer team
```

End of the first example

This concludes the basic description of the web-interface. If you have any further questions about the general procedure to run a model please do not hesitate to contact us via support@galev.org.

However, the description given until here is really just the beginning as GALEV allows you to run way more complex models than the simple model presented in this first example.

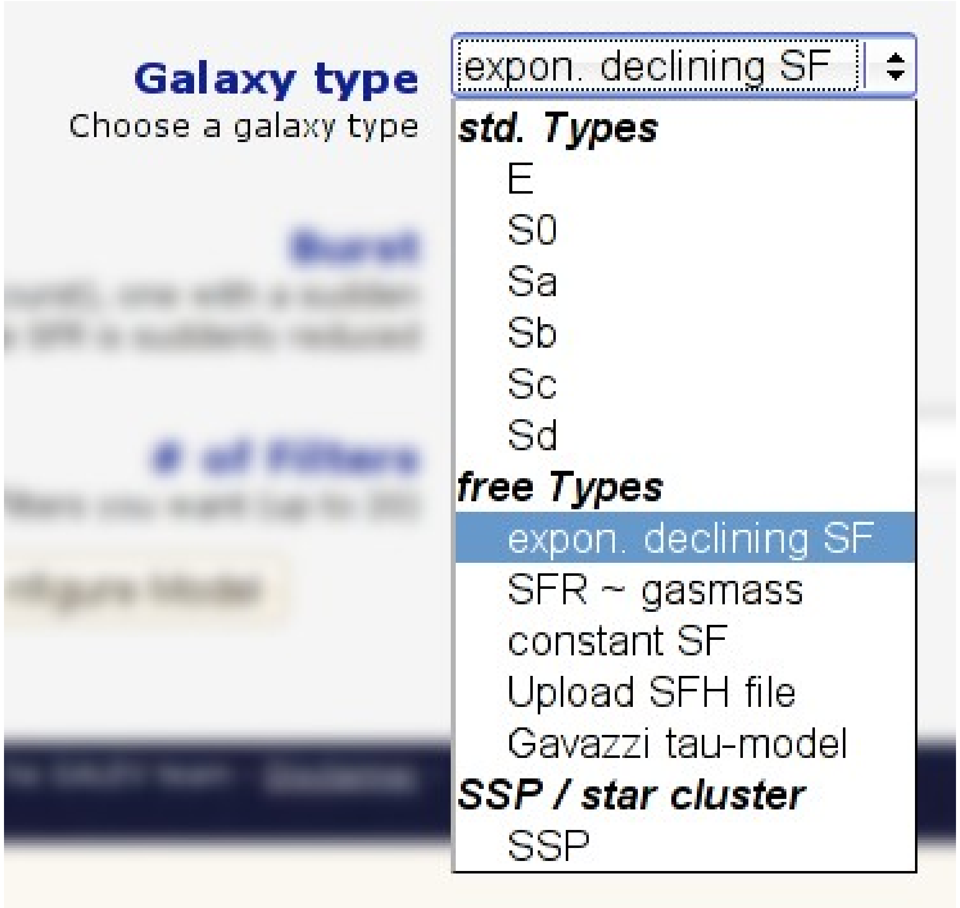
So let's continue with the second example, a undisturbed galaxy with a user-defined star formation history.

Second example

As you are now already familiar with the working of the web-interface we can go on and run a more flexible model. For this we want to run a model with a star formation rate that exponentially declines with time.

To start this model select the entry “expon. declining SFR” as galaxy type at the beginning of the modeling.

As most of the actual modeling process remains untouched by the new galaxy type and was already explained in detail we will only focus on the relevant parts.



Exponentially declining SFRs

The star formation rate for this model can be specified like this::

$$\Psi(\mathrm{t}) = \frac{\mathrm{M_{tot}}}{\alpha} \times \exp(-\mathrm{t}/\tau)$$

Eq. (4) in the GALEV paper

If you are familiar with different galaxy evolution and/or population synthesis codes you will find that this definition also includes the Mtot/alpha scaling term in addition to the exponential.

The reason for this is that GALEV does more than just model the stellar component, it also includes the chemical evolution. This chemical evolution in turn depends on the relation of stellar mass to gaseous mass, and hence required alpha as additional parameter.

As a rough rule of thumb: If the galaxy over its llifetime is to convert all its gas into stars, then alpha should be roughly the same as tau. Larger alpha values decreases the fraction of gas converted into stars. If, e.g. alpha = 2*tau then only half the gaseous mass is converted into stars. Note, however, that the gas-reservoir is partly replenished by dying high-mass stars.

SFR efficiencies and tau-timescales

The second step in the modeling process therefore offers two new fields, “star formation efficiency” and “decline factor”, to take up these two parameters in addition to the total mass. The “decline factor” means the tau from the above equation, while the alpha is labeled “SFR efficiency factor”.

$$\Psi(t) = \frac{M_{tot}}{\alpha} \times \exp(-t/\tau)$$

Note / Warning:
Small values of alpha correspond to high SFRs, that might be too large to be sustained over the lifetime of the galaxy, causing the galaxy to run out of gas”. This is recorded in the log-file that is part of the data package, so please make sure to check these files.

The remainder of the modeling process is identical with the general procedure described above, so we will not repeat it at this point.

Getting started guide to run GALEV models over the web

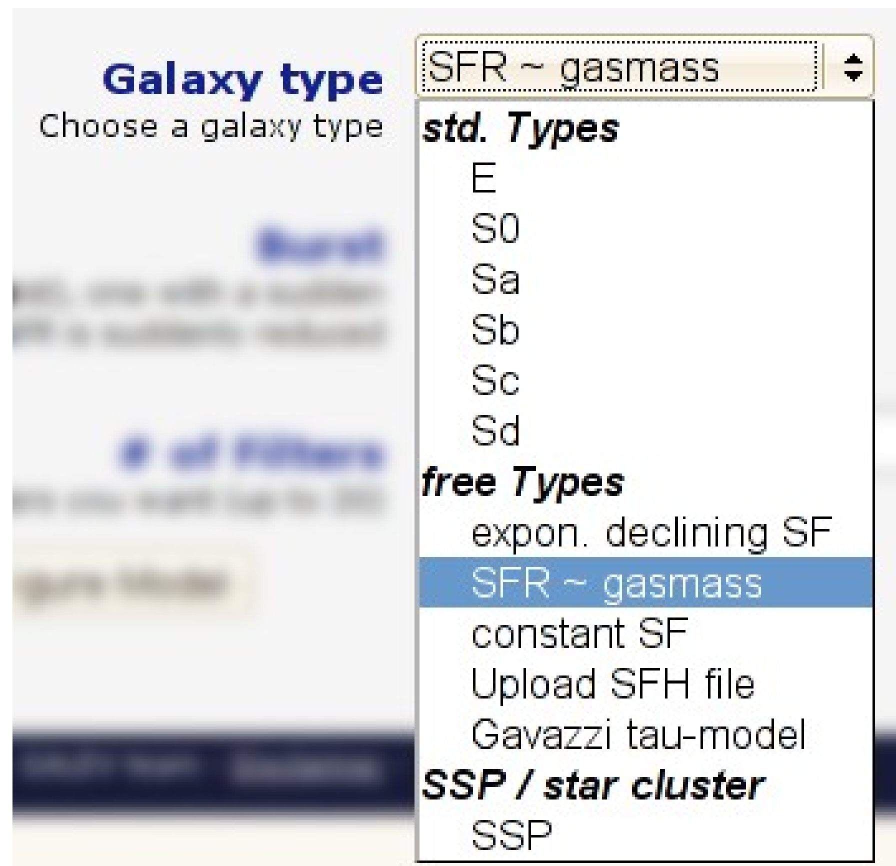
SFRs proportional to gas-mass

Now that we are at it we also would like to introduce the other SFR prescriptions, first of all the case of a star formation rate that is proportional to the available gas reservoir, similar to the Kennicutt-Schmidt law:

$$\Psi(t) = \beta \times \frac{M_{gas}(t)}{10^9}$$

This case if parametrized as shown above, via a simple scaling factor beta that links the SFR and the gas mass (eq. 5 in the GALEV paper).

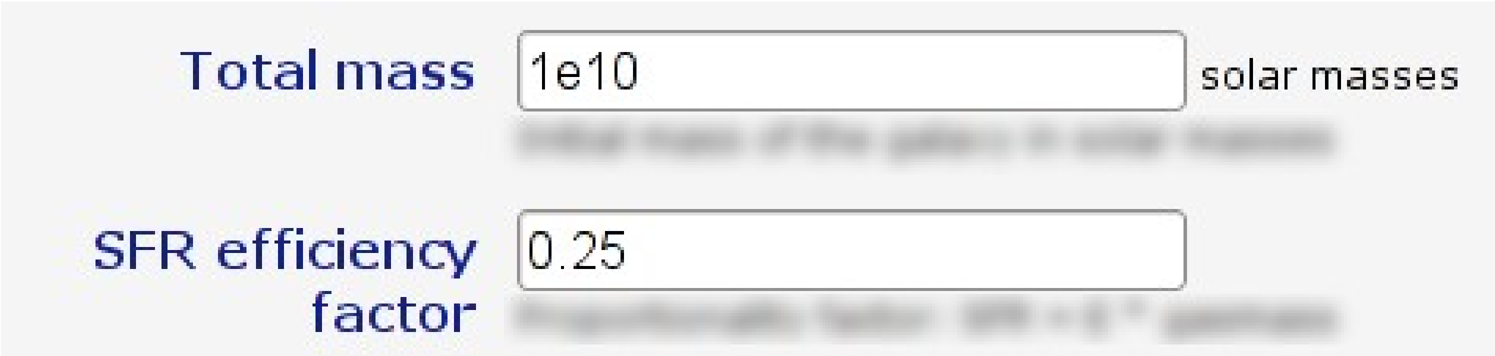
This mode can be chosen via the "SFR ~ gasmass" option in the first step.



SFRs proportional to gas-mass

Similar to the case of the exponentially declining SFR you will also find the appropriate input fields for this galaxy type on the second page. Here the beta-parameter is labeled “SFR efficiency factor”.

$$\Psi(\mathrm{t}) = \beta \times \frac{\mathrm{M_{gas}(t)}}{10^9}$$



Typical values for beta range from 0.1 for late-type spirals to 0.5 in the case of early-type spirals, corresponding to decline times of 10 and 2 Gyrs respectively.