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# A VO database for Star Formation Histories and Physical Properties of 500k SDSS galaxies

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## ABSTRACT

We present a sketch of our database in VOTable XML format. In the last year we have derived the Star Formation Histories of more than half a million galaxies from the Sloan Digital Sky Survey by perfoming detailed Angstrom by Angstrom fits to their optical spectra. Each galaxy is analysed in 3 different ways. On the whole, the resulting database of spectral fits and tables with star formation histories and physical properties (stellar masses, mean ages and metallicities, velocity dispersions, emission line fluxes, extinction, etc) occupies close to 500GB of data.

To organize this huge and highly informative database, share it with other astronomers and increase efficiency we opted to convert our tables in VOTable where the user only manipulates what she/he really needs, making selections in the list of physical and observed parameters. We also present some early results where the database was used to create graphics, tables and averages of selections using Aladin, TOPCAT, VOPlot and PLASTIC Hub.

## Starlight: our synthesis model

Our synthesis code, STARLIGHT (Cid Fernandes, MNRAS 2005) fits a linear combination of $N_\star$ SSPs of B&C 2003 models. The equation:

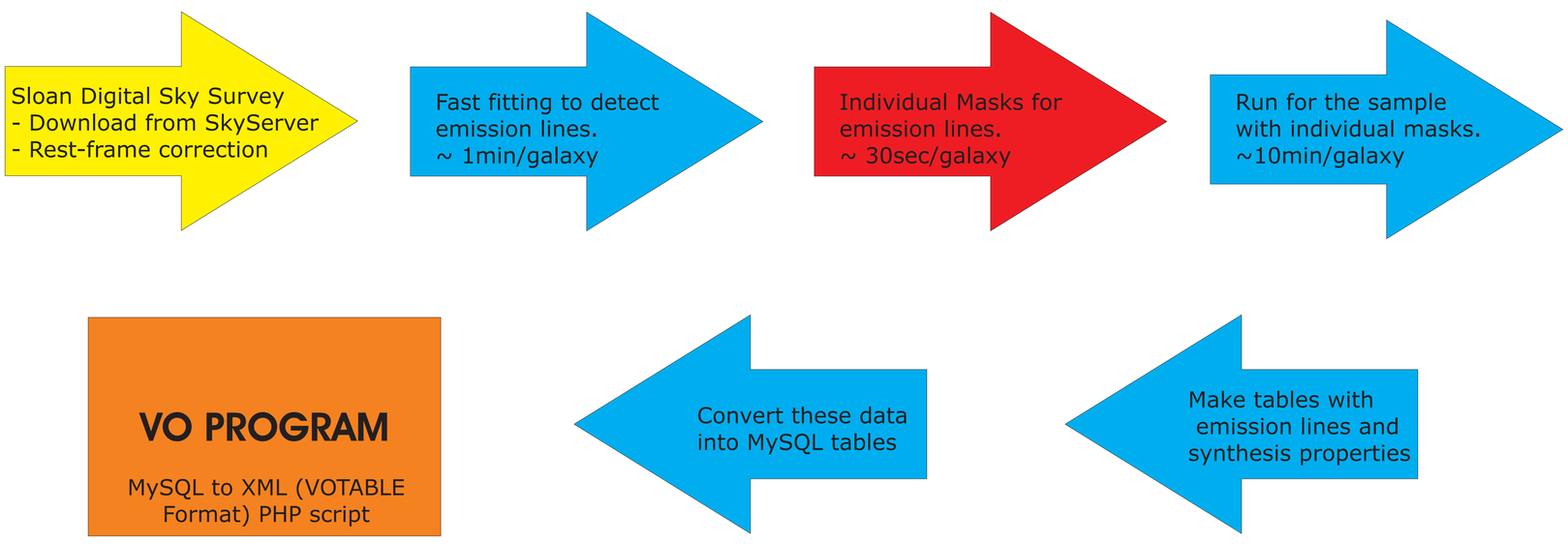
$$M_\lambda = M_{\lambda_0}\left(\sum_{j=1}^{N_\star} x_j b_{j,\lambda} r_\lambda\right) \otimes G(v_\star, \sigma_\star)$$

gives the modeled spectra $M_\lambda$, were $b_{j\lambda}$is the *jth* base component spectra (normalized in $\lambda_0$), $r_\lambda = l10^{-0,4(A\lambda - A\lambda 0)}$ is the extinction term , and **x** is the population vector which expresses how much light each base component contributes to the model. Line of sight kinematics is given by the gaussian convolution centered in $v^\star$ with $\sigma^\star$ of dispersion. The model is calculated using Markov Chains Metropolis algorithm with simulated annealing, which finds the $\chi^2$ minimum:

$$\chi^2 = \sum_\lambda [(O_\lambda - M_\lambda) w_\lambda]^2$$

where $O_\lambda$ is the observed spectrum with your corresponding error ($w^{-1}$).

## How we run Starlight!?



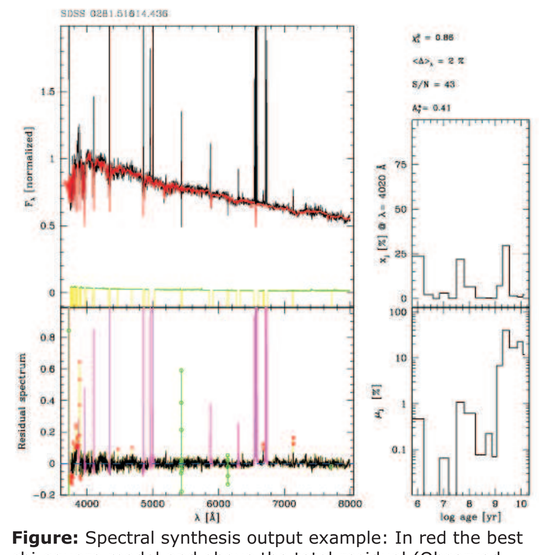
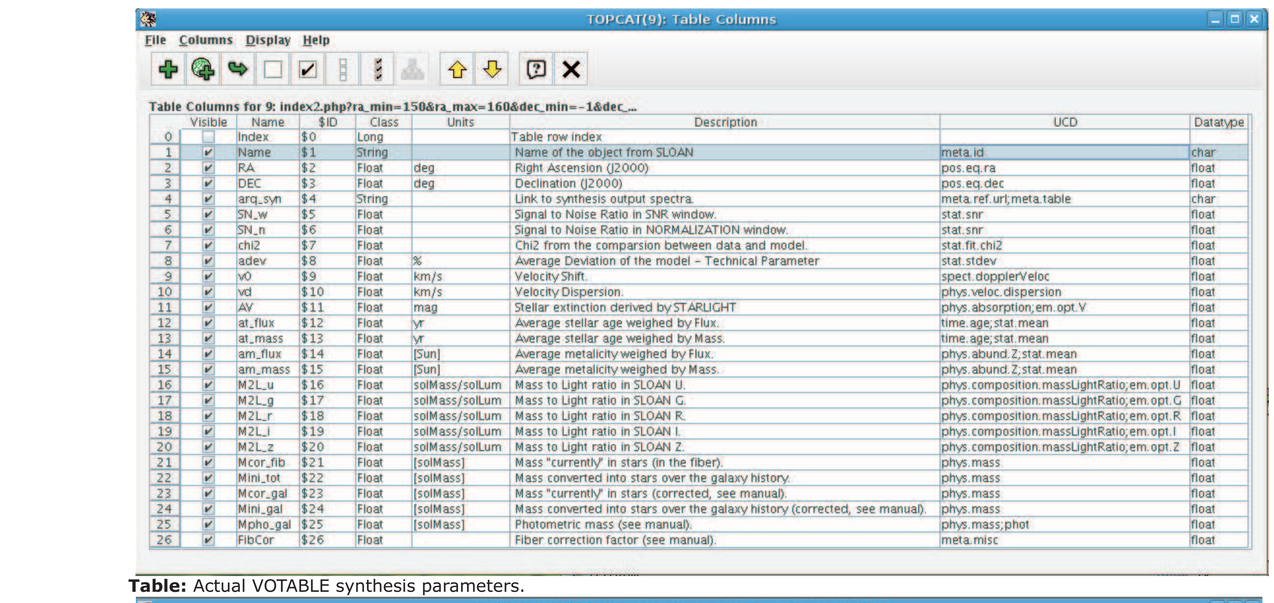




**Figure:** Spectral synthesis output example: In red the best chi-square model and above the total residual (Observed - Model). Right: Light and Mass fractions of each mass

## What we aleardy have + Some ilustrative examples




| | Visible | Name | $ID | Class | Units | Description | UCD | Datatype |
|---|---|---|---|---|---|---|---|---|
| 0 | ☐ | Index | $0 | Long | | Table row index | | |
| 1 | ☑ | Name | $1 | String | | Name of the object from SLOAN | meta.id | char |
| 2 | ☑ | RA | $2 | Float | deg | Right Ascension (J2000) | pos.eq.ra | float |
| 3 | ☑ | DEC | $3 | Float | deg | Declination (J2000) | pos.eq.dec | float |
| 4 | ☑ | arq_syn | $4 | String | | Link to synthesis output spectra. | meta.ref.url;meta.table | char |
| 5 | ☑ | SN_w | $5 | Float | | Signal to Noise Ratio in SNR window. | stat.snr | float |
| 6 | ☑ | SN_n | $6 | Float | | Signal to Noise Ratio in NORMALIZATION window. | stat.snr | float |
| 7 | ☑ | chi2 | $7 | Float | | Chi2 from the comparsion between data and model. | stat.fit.chi2 | float |
| 8 | ☑ | adev | $8 | Float | % | Average Deviation of the model - Technical Parameter | stat.stdev | float |
| 9 | ☑ | v0 | $9 | Float | km/s | Velocity Shift. | spect.dopplerVeloc | float |
| 10 | ☑ | vd | $10 | Float | km/s | Velocity Dispersion. | phys.veloc.dispersion | float |
| 11 | ☑ | AV | $11 | Float | mag | Stellar extinction derived by STARLIGHT | phys.absorption;em.opt.V | float |
| 12 | ☑ | at_flux | $12 | Float | yr | Average stellar age weighed by Flux. | time.age;stat.mean | float |
| 13 | ☑ | at_mass | $13 | Float | yr | Average stellar age weighed by Mass. | time.age;stat.mean | float |
| 14 | ☑ | am_flux | $14 | Float | [Sun] | Average metalicity weighed by Flux. | phys.abund.Z;stat.mean | float |
| 15 | ☑ | am_mass | $15 | Float | [Sun] | Average metalicity weighed by Mass. | phys.abund.Z;stat.mean | float |
| 16 | ☑ | M2L_u | $16 | Float | solMass/solLum | Mass to Light ratio in SLOAN U. | phys.composition.massLightRatio;em.opt.U | float |
| 17 | ☑ | M2L_g | $17 | Float | solMass/solLum | Mass to Light ratio in SLOAN G. | phys.composition.massLightRatio;em.opt.G | float |
| 18 | ☑ | M2L_r | $18 | Float | solMass/solLum | Mass to Light ratio in SLOAN R. | phys.composition.massLightRatio;em.opt.R | float |
| 19 | ☑ | M2L_i | $19 | Float | solMass/solLum | Mass to Light ratio in SLOAN I. | phys.composition.massLightRatio;em.opt.I | float |
| 20 | ☑ | M2L_z | $20 | Float | solMass/solLum | Mass to Light ratio in SLOAN Z. | phys.composition.massLightRatio;em.opt.Z | float |
| 21 | ☑ | Mcor_fib | $21 | Float | [solMass] | Mass "currently" in stars (in the fiber). | phys.mass | float |
| 22 | ☑ | Mini_tot | $22 | Float | [solMass] | Mass converted into stars over the galaxy history. | phys.mass | float |
| 23 | ☑ | Mcor_gal | $23 | Float | [solMass] | Mass "currently" in stars (corrected, see manual). | phys.mass | float |
| 24 | ☑ | Mini_gal | $24 | Float | [solMass] | Mass converted into stars over the galaxy history (corrected, see manual). | phys.mass | float |
| 25 | ☑ | Mpho_gal | $25 | Float | [solMass] | Photometric mass (see manual). | phys.mass;phot | float |
| 26 | ☑ | FibCor | $26 | Float | | Fiber correction factor (see manual). | meta.misc | float |

**Table:** Actual VOTABLE synthesis parameters.

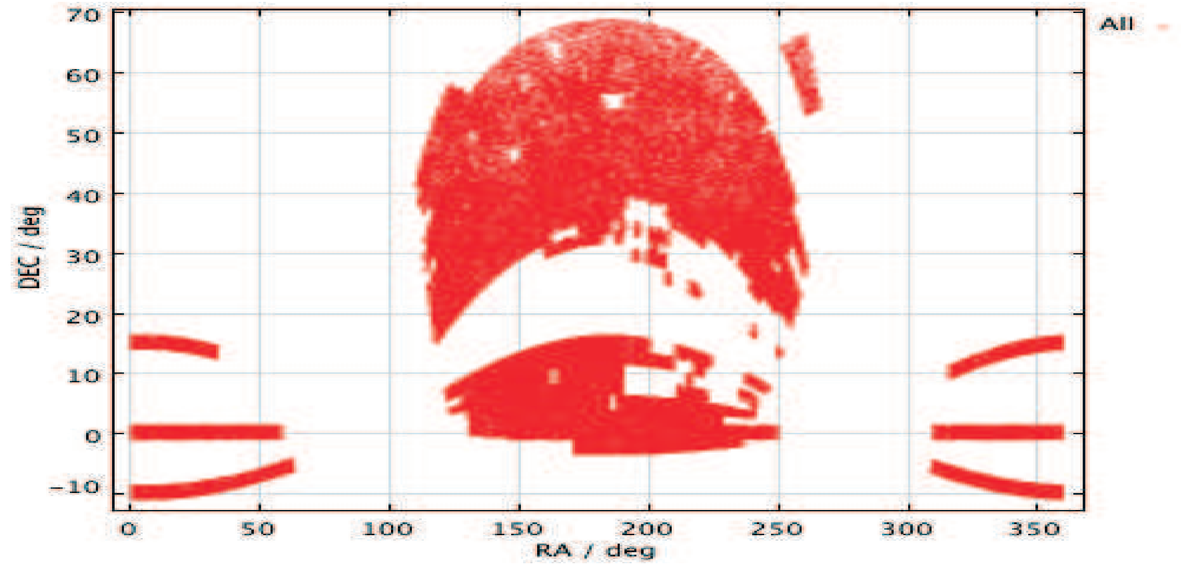



**Figure:** RA/DEC plot of 573141 galaxies of our sample database, what corresponds actually to a 600MB XML file.

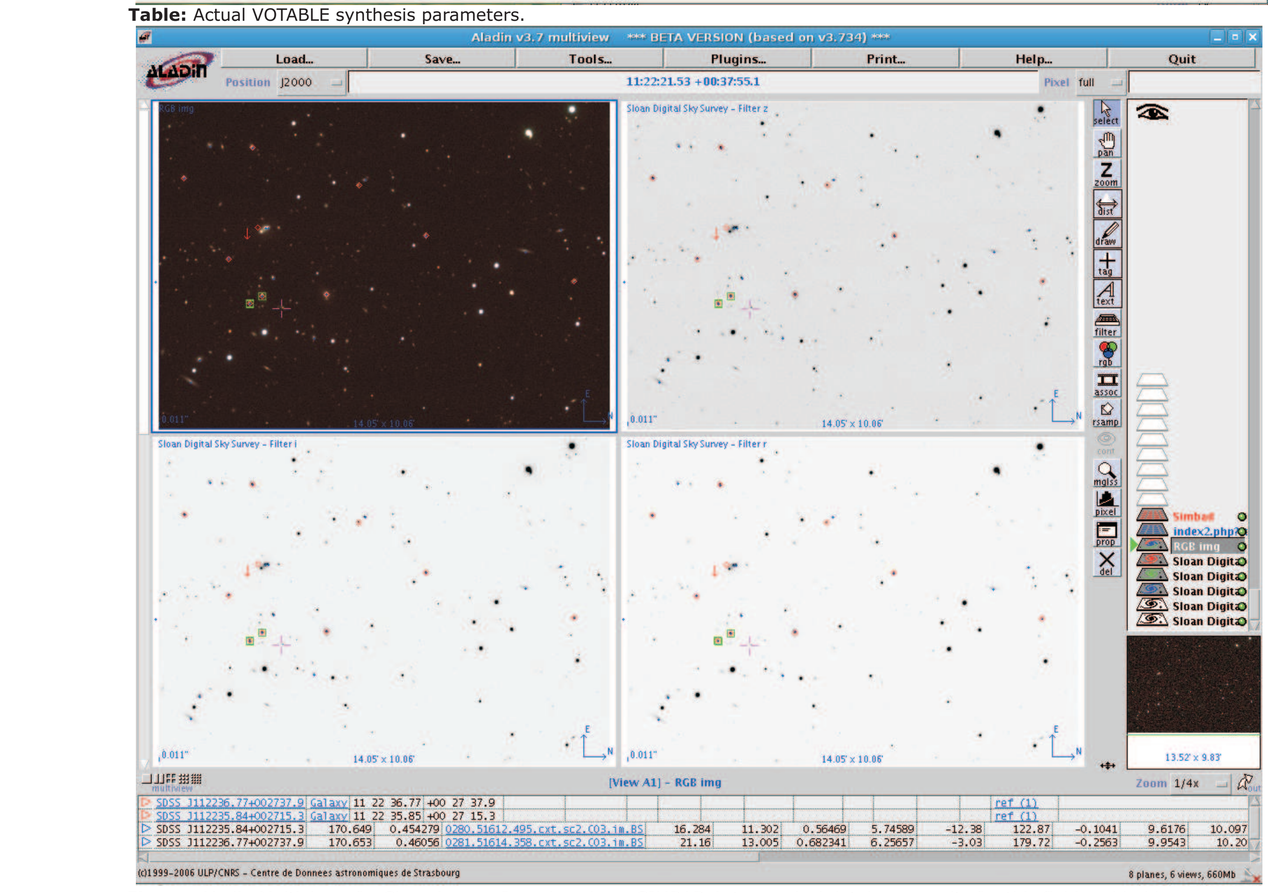



**Figure:** Aladin Multiview of a Sloan image. In red we have SIMBAD Astronomical database results for this field and in blue we have the Starlight database results.

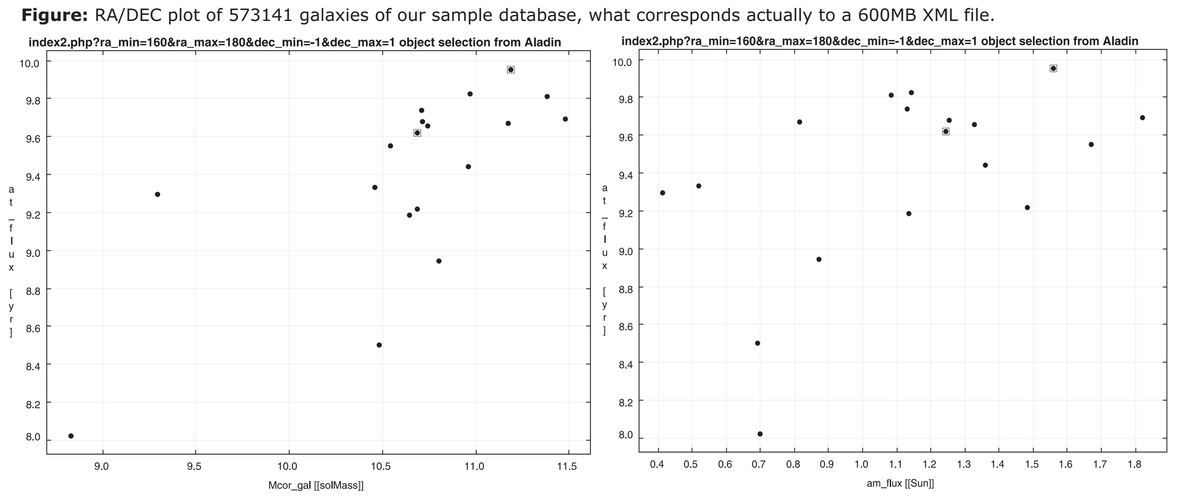



**Figure:** Mcor_gal/at_flux and am_flux/at_flux plots (see top-left table for the meaning of these parameters) using VOPLOT of a Sloan field elected in Aladin (left). Note that two selected points in Aladin are marked in these two graphs.

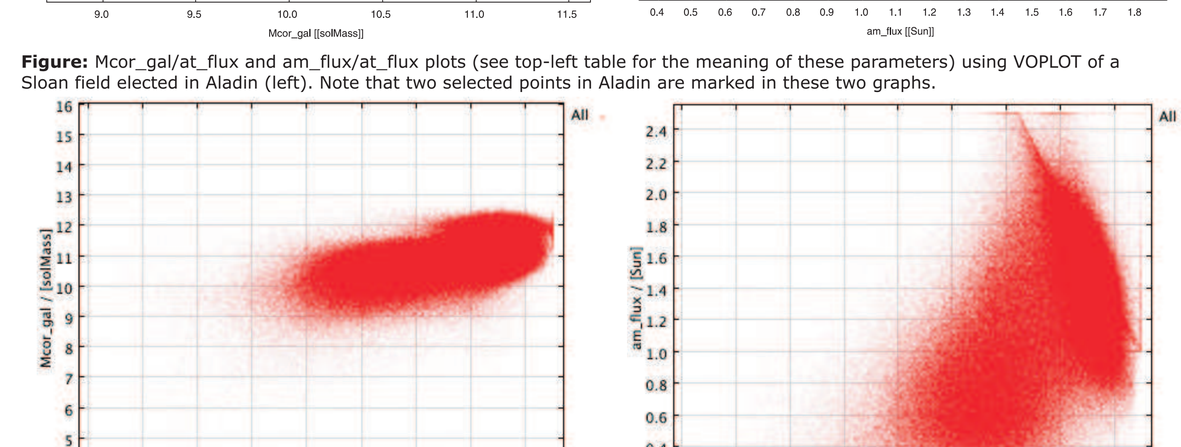



**Figure:** The same type of plots as above, but now using TOPCAT with all sample database plotted.

## Next Steps

Do this work to other bases (we already have more three with synthesis parameters)

Construct VOTables for other paramenters, e.g. FPV (Full Population Vector), Emission Lines, Star Formation Histories, Modeled Spectra, etc.

Publish these VOTables and other table formats with documentation and the source code of STARLIGHT in a web site.

SEAGal

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