NEW_HYPERZ (v12.1)

NEW_HYPERZ : AN OVERVIEW

The New_Hyperz code is un updated version of the public code « Hyperz » originaly described in Paper I (Bolzonella, Miralles & Pello, 2000, A&A 363, 476-492), distributed at http://webast.ast.obs-mip.fr/hyperz/ . The new version v12 presently under development is intended to improve several aspects of the algorithm as described below. The algorithm is written in fortran. In addition to the photometric-redshift code, the final package should include different libraries of templates (galaxies, stars and QSO), both synthetic and empirical, and a library of filter transmissions.

The New_Hyperz algorithm is based on the SED fitting procedure using a standard Xi2 minimization procedure. The observed SED of a given galaxy is compared to a set of template spectra as follows :

$$\chi^2(z) = \sum_{i=1}^{N_{\rm filters}} \left[\frac{F_{{\rm obs},i} - b \times F_{{\rm temp},i}(z)}{\sigma_i} \right]^2 ,$$

where F(obs), F(temp) and σ are the observed and template fluxes and their uncertainty in filter i, respectively, and b is a normalization constant. Figure 1 below presents the flow chart of the algorithm. The basic User's Manual can be found at http://webast.ast.obs-mip.fr/hyperz/ in html version, and an updated version is given with the distribution (hyperz_manual1.2.pdf). Only the modification introduced in versions v10 to v12 are described below.

NEW_HYPERZ v12.0 UPDATES

The differences of the released v12 with respect to the standard package are the following:

1. The new parameter's file is : new_hyperz.param

2. **Compilation update** :
   - The file *Makefile* contains the procedure for compilation. Just run :
     - make new_hyper
     - make make_catalog
     - make clean
   - The dimension of the hypercube can be modified by changing the dimension file dimension.dec as follows:

Present values:

```
PARAMETER (mxz=305,mxage=51,mxtyp=15,mxfil=15,mxred=18,
.   mxlyf=3,mxwl=4000)
```

i.e.: up to mxz=305 redshift spets (usual ranges : z=0-6, dz=0.02)
up to mxage=51 (optimum value for Bruzual & Charlot templates)
up to mxtyp=15 templates => modify if needed
up to mxfil=15 filters => modify if needed

up to mxred=18 reddening steps => modify if needed
up to mxlyf=3 lyman forest oppacities (allowed values = 1 to 3)
up to mxwl=4000 points per template => modify if needed

3. **New templates :** Version v11 and later are able to read Maraston templates, in addition to the usual Bruzual & Charlot (BC), Starburst99 (S), and ascii templates (AS) distributed in the initial version. Maraston templates should be identified as "MA" in the templates's file, e.g.:

   csp_e0.10_z02_salp.sed_agb MA
   csp_e0.25_z02_salp.sed_agb MA …

   Versions v10 and later are able to read Starburst99 models: flag "S" (same syntax as above)

4. **Filter transmissions** : The new FILTERS_FILE input file includes an additionnal (#6) column allowing the combination of filters with T(lambda) given in energy AND in photons within the same input catalog. The value of this column should be = 1 (if T(lambda) is in % of energy) or =2 (if T(lambda) is in % of photons). Default value =2 (in versions v10 and later).

5. **Absolute magnitudes** : Up to 10 output filters can be requested when computing absolute magnitudes for the best fit, instead of a single filter in the previous version. The first filter is still the "reference" for M_ABS_MIN and M_ABS_MAX. The sintax is as follows :

   FILT_M_ABS 91,224,225,226,227,228 # filter for absolute magnitude

6. **Scaling modes for absolute magnitudes** : There are 2 scaling modes for absolute magnitudes:

   MSCALE_FILT_M_ABS 1 # 1: Absolute magnitude scaled to the "reference" filter (default; compatible with previous versions)
   2 # Global scaling according to best-fit template, irrespective of the "reference" filter

7. **Galactic de-reddening :** A new option is introduced allowing to ingest an E(B-V) value for each object in the input catalogue, in addition to the usual one. This new parameter is EBV_unit should be set to a value >0 to indicate the existence of an extra column in the input catalog where this information is found. This option is useful for large catalogs covering a wide area on the sky, as for EUCLID data. The new_hyperz.param file reads as follows :

   EBV_MW 0.00897 # E(B-V) for galactic dereddening
   EBV_unit 0 # >0, read galactic E(B-V) for each object in input catalog
   # = 0: no E(B-V) column is provided

8. **Classification of extragalactic sources** is activated by the optional parameter `REF_TEMPLATES_FILE`. This parameter introduces a list of ASCII reference templates (default value, the CWW + a Kinney starburst). When this parameter is activated, in addition to the usual hyperz output, the *.z_phot file contains 1 + N(templates) additional columns with the following information:
   1- Best fit reference template (value ranging from 1 to N(templates))
   2- Reduced xi2 for the best fit with each reference template at the z_best redshift.
   These are THE LATEST COLUMNS in the .z_phot file if this option is activated. Example of use :

   ```
   REF_TEMPLATES_FILE   reference_spectra.param # "Reference" ASCII templates
   ```

9. **Robustness of the fit** (photoz quality) : `There is an additonal column in the normal output *.z_phot` file, between the absolute magnitudes and the lyman opacity, with the integrated probability P_int between z_best+/-0.1, which is an indicator of the goodness of the fit. The probability

distribution P(z) is arbitrarily normalized to 100% between z_min and z_max.

10. **PDF :** An optional parameter PDZ_FILE in the new_hyperz.param file activates the output of a PDF. The format of this file is 1 line/object, with P(z) for z=z_min to z_max , with dz=Z_STEP. The PDF is normalized as in point 9 above.

11. **Stellar-Mass scaling :** There is an additional column with a physical scaling of the normalization "b" parameter translated into physical units. This provides a direct model of the stellar masses scaling WHEN MODEL MAKES SENSE (e.g. for the Bruzual & Charlot models) as follows :

    F_lambda (intrinsic) = b_scale * F_lambda (model) (b_scale: physical scaling)
    F_lambda (intrinsic)/ [(1+z)*4*pi*d_lum^2] = b * 2x10^(-17) * F_lambda(model)
    b_scale = b * 2x10^(-17) * [(1+z) * 4 * pi * d_lum^2]

    Ex: For Bruzual & Charlot models :
Bursts & e-folding models are given in solar luminosities/ solar_Mass, with L_solar=3.90 10^(33) erg/sec => b_scale ~ solar_Masses * 3.90 10^(33) typically (b_scale ~ up to 10^(43)!). Given the typical values of this parameter, b_scale is given in log(b_scale) units.

12. **Normalization changes** : The flux output in the *.obs_sed file (if option selected is erg/s/cm2/A) is in 10^-17 units instead of 2x10^-17 in versions older than v10.

13. **Cluster mode** : The cluster mode is activated as in the previous versions by the Z_CLUSTER parameter. In addtion to the usual options in this mode, 2 additional optional parameters have been introduced as follows :

    ```
    ZP1          0.10  # z_min for integrated P_z
    ZP2          0.80  # z_max for integrated P_z
    ```

    These parameters generate an additional output file *.proba_int containing the integrated P(z) between z+/-dz, between ZP1 and ZP2, 1 column per z bin.

    In addition, when the Z_CLUSTER option is activated, 2 addionnal columns are also given in the *.z_phot file containing the P_int+/-0.05 and P_int+/-0.10, same normalization as in the point 9 above.

14. **Luminosity prior** : v12 allows the introduction of a luminosity prior when computing phtoometric redshifts. The parameters of the usual Schechter function can be specified as follows in the new_hyperz.param file :

    ```
    M_STAR       -21.0 # Schechter M* for luminosity prior on
                       # reference M_ABS
    ALPHA        -2.0  # Schechter alpha for luminosity prior
    ```