

IVOA-Theory Micro-Simulations



BaSTI: database and queries for stellar evolution models

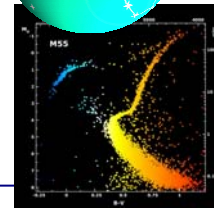


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M. Molinaro
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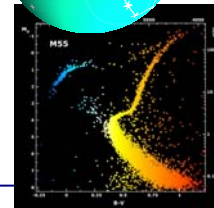


ITVO@Vobs.it

The Italian Theoretical Virtual Observatory

as a test-bed for the inclusion of theory and related tools in the VO

- ITVO project:
 - is develop under EuroVOTECH and EuroVO-DCA WP4 and WP5 and it deals with cosmological and stellar models
- Things to do:
 - Standard format (VOTable and/or FITS binary table)
 - Standard Access Protocol
 - Web services for theoretical data, also using the Grid infrastructure;

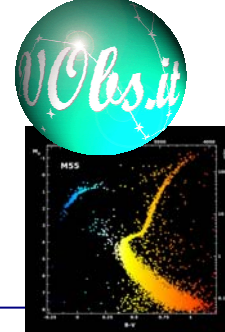


The aims

- Store the theoretical metadata inside a relational DB to allow an easy search of these data on multiple choice of parameters;
- public theoretical data so to reuse expensive data in term of CPUs time, like cosmological simulations or output of stellar evolutionary code;
- permit an easy comparison between observational and theoretical data, using the same tools and services for both kind of data (married the VO philosophy);

Information produced by stellar evolution model

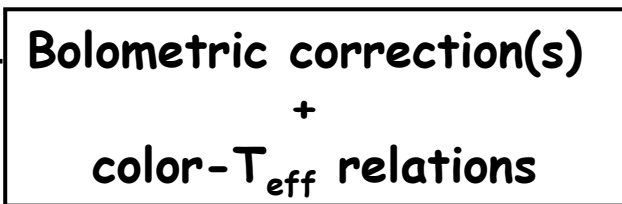
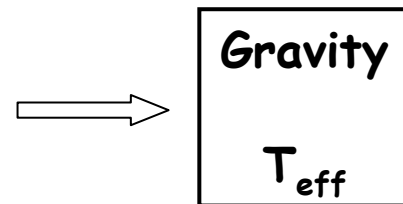
(slide by S. Cassisi)



The evolutionary stellar models provide:

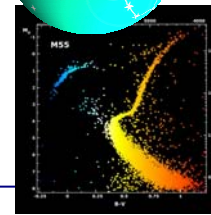
- **Evolutionary lifetimes** \Rightarrow **Star counts**

- **Bolometric luminosity**
- **Effective temperature**
- **Mass** - different than the initial one (!)

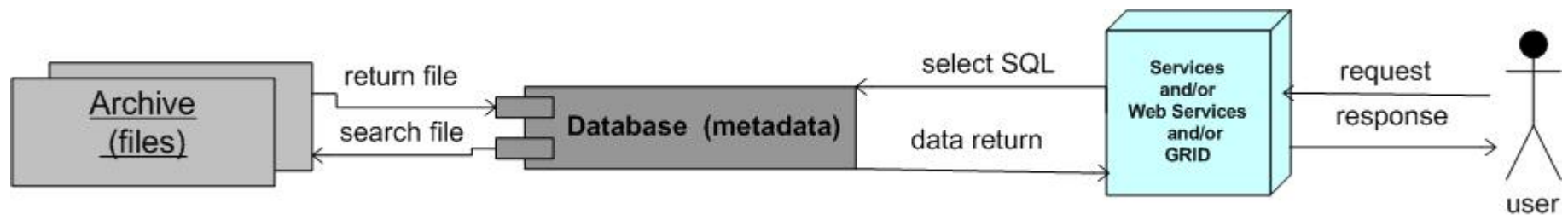


Magnitudes & Colors

- Surface chemical composition predictions \Rightarrow **spectroscopy**
- **Nuclear yields**



Archives + DBs + services



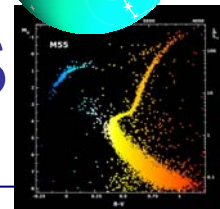
- Archives contain the output files of the simulation;
- Databases contain the metadata of the simulation that should include all the parameters to perform the running not only the physical ones;
- Data access: it could be performed via Web Portal or Web services or in future via Grid infrastructure also creating on demand new simulated data.

Stellar evolutionary computations are extremely time consuming



They are perfectly suited for running on “distributed computing facilities” (GRID)

Uses cases of stellar models

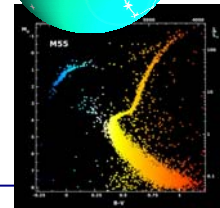


These model are important for:

- testing the “physics” in the regime of high density/low temperature;
- Investigating the IMF in various enviroments;
- Simulated evolutionary tracks and isochrones;
- Simulated the HB for sampling different evolutionary phases and study pulsating stars;
- Study M/L relation and M/R relation and confrontation with observational data;
- Optical photometric bands / near –infrared one;
- Comparison with star clusters, binary systems;
- Study fundamental ingredient for populaion syntesis;
- Analyze the integrated magnitudes, colours and spectra of composite stellar populations;

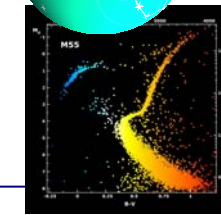
(informations taken from S. Cassisi VO-DCA WP4 talk)

The stellar theorists' wishes



- **Easy “access” to physical inputs databases;**
 - Clear explanations of HOW the physical inputs have been computed;
 - Possibility to perform online computations by using user-specified conditions;
 - standard outputs;
- **Reliable color- Teff relations**
 - As many as possible different calibrations;
 - Possibility to perform online computations for the new photometric systems;
- **Direct access to other stellar model archives**
 - Information about the adopted inputs and physical assumptions;
 - User friendly access;
- **Direct access to suitable empirical constraints**
 - For clusters stars;
 - For single stars;

(informations taken from S. Cassisi VO-DCA WP4 talk)



The stellar model users' dream

(slide by S. Cassisi)



- Updated stellar models
- Accuracy
- Homogeneity
- Completeness

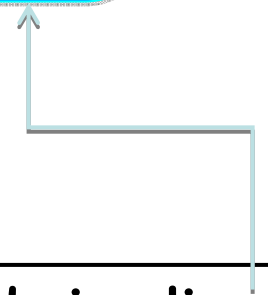
Helper Applications:

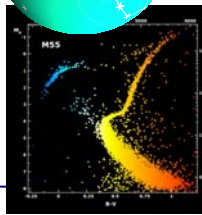
- TOPCAT: tabular data & manipulation
- VOPlot: handling with VOTable data
- Etc...

- Standardization
- "User friendly" access
- Online computational facilities



Tools to analyse and visualise
end & intermediate
data products



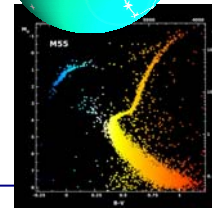


a Bag of Stellar Tracks and Isochrones



Web portal: <http://albione.oa-teramo.inaf.it/>

Stellar evolution archive



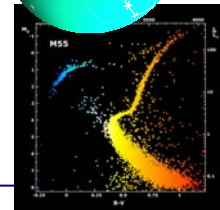
stellar evolution data computed using **FRANEC** code are stored into **BaSTI** :

- 32010 Isochrones;
- 17489 Tracks;
- 4438 HB (Horizontal Branch) –tracks;
- 121 ZAHB (Zero Age Horizontal Branch);
- 121 end-He (end Helium burning);
- 198 summary tables;

Stellar data

Stellar evolution model: the “building blocks”

(slide of S. Cassisi)



The Evolutionary Code

- Stellar structure equations
- Surface boundary conditions
- ...numerics...

physical inputs

- EOS (eq. of state)
- Opacity
- Nuclear reaction Rates
- Neutrino energy losses

(in)famous unknown...

- Mass loss
- Dredge-up efficiency (AGB)
- Impact of mixing on opacity

Mixing scheme

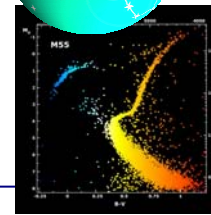
- Semiconvection
- Overshooting
- Breathing pulses
- Turbulence

Microscopic mechanisms

- Atomic diffusion
- Radiative levitation

Magnetic field
Rotation & Rotational mixing

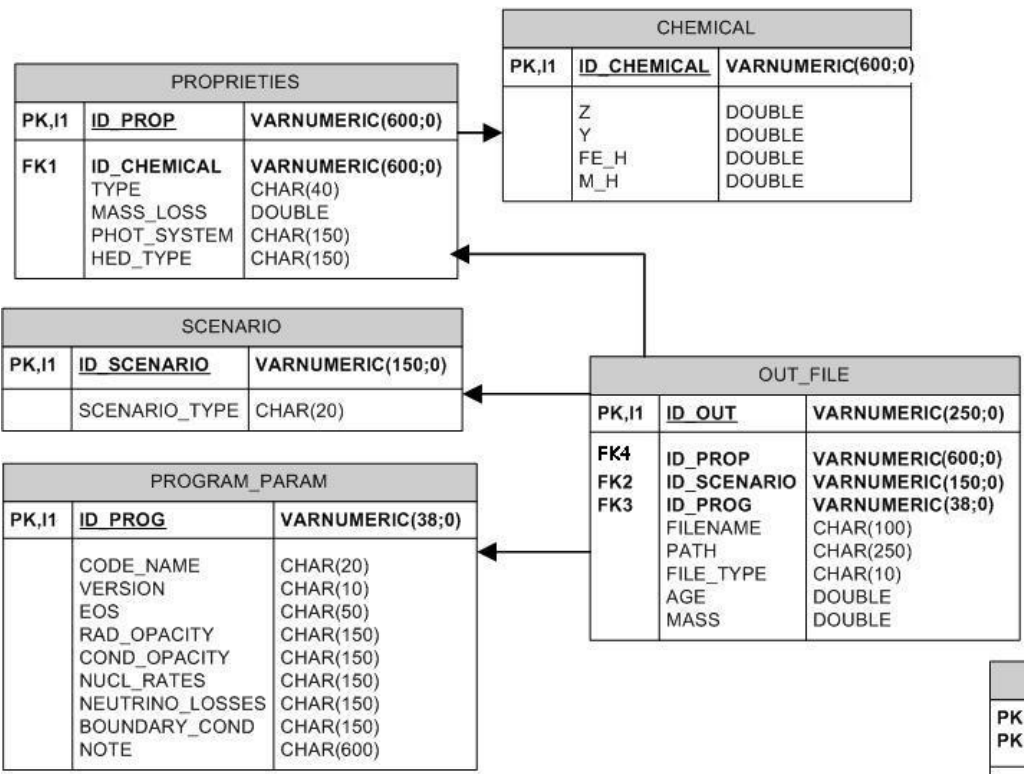
1st step: how maps these structure inside a relational DB
2nd step: ... (discussion) it fit with the theoretical DM



Stellar evolution DB structure: BaSTI (A Bag of Stellar Tracks and Isochrones)



BaSTI Database

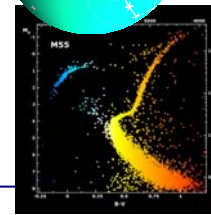


The 1st relational database for a large range of masses and initial chemical composition for stellar evolution models, obtained with **FRANEC** code.

DB contains 49939 rows in the OUT_FILE table.

UNITS		
PK,I1	TABLE NAME	CHAR(50)
PK,I1	COLUMN NAME	CHAR(50)
	UNIT	CHAR(100)

BaSTI web portal



- Query the stellar evolutionary DB;
- Personalized the SQL query;

BaSTI
A Bag of Stellar Tracks and Isochrones...

BaSTI Menu

- [Home](#)
- [Database](#)
- [Bibliography](#)
- [News](#)
- [Info](#)
- [FAQ](#)
- [Contact us](#)
- [Links](#)
- [STAFF only](#)

7,851 Visitors
Since February 2, 2004

last update:
10-01-2008

BaSTI database is maintained by: [Santi Cassisi](#), [M...](#)

Create Query on BaSTI DB

<input type="checkbox"/> Filename:	<input type="text"/>	<input checked="" type="checkbox"/> Data type:	ISOCHRON	<input checked="" type="checkbox"/> Scenario:	CANONICAL
<input checked="" type="checkbox"/> Age: (Gyr)	min: 0.02 max: 0.5	<input type="checkbox"/> Mass: (Msun)	min: <input type="text"/> max: <input type="text"/>	<input type="checkbox"/> Y:	min: <input type="text"/> max: <input type="text"/>
<input checked="" type="checkbox"/> Z:	min: <input type="text"/> max: <input type="text"/>	<input checked="" type="checkbox"/> [M/H]:	min: <input type="text"/> max: <input type="text"/>	<input checked="" type="checkbox"/> Mass loss:	0.2
<input checked="" type="checkbox"/> [Fe/H]:	min: <input type="text"/> max: <input type="text"/>	<input checked="" type="checkbox"/> Mixture:	SCALED SOLAR	<input type="checkbox"/> Code version:	FRANECPCS 2003
<input checked="" type="checkbox"/> Type:	AGB EXTENDED	<input type="checkbox"/> Rad. opacity:	Alexander & Ferguson 1994	<input type="button" value="SEARCH"/> <input type="button" value="GO"/>	
<input checked="" type="checkbox"/> Photometric system:	JOHNSON CASTELLI	<input type="button" value="RESET"/>			

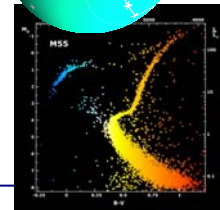
Personalize SQL:

```

TYPE, MASS_LOSS, PHOT_SYSTEM, HED_TYPE, SCENARIO_TYPE, VERSION,
RAD_OPACITY
from
ARCHA.OUT_FILE, ARCHA.PROPRIETIES, ARCHA.SCENARIO,
ARCHA.PROGRAM_PARAM, ARCHA.CHEMICAL
where
OUT_FILE.ID_PROP = PROPRIETIES.ID_PROP and OUT_FILE.ID_SCENARIO =
SCENARIO.ID_SCENARIO and OUT_FILE.ID_PROG = PROGRAM_PARAM.ID_PROG
and CHEMICAL.ID_CHEMICAL = PROPRIETIES.ID_CHEMICAL
and upper(SCENARIO_TYPE) like upper('CANONICAL*') and AGE >= 0.02
and AGE <= 0.5 and upper(FILE_TYPE) like upper('ISO*') and upper
(TYPE) like upper('AGB EXTENDED*') and MASS_LOSS = 0.2 and upper
(PHOT_SYSTEM) like upper('JOHNSON CASTELLI*') and upper(HED_TYPE)
like upper('SCALED SOLAR MODEL*')
order by FILENAME
                    
```

Powered by IA2 (INAF - Teramo Astronomical Observatory)
 For any problem please contact: [BaSTI team](#)

Queries and access protocol



A simple access protocol to search stellar evolution files

- Tracks:
 - Mass;
 - Metallicity;
 -
- Isochrones:
 - Age;
 - Metallicity;
 -

These will be matter of discussion.....

Could we use a protocol like TSAP (SSAP for theoretical spectra)? (see Carlos Rodrigo talk)

EUROVO BaSTI tools – developed by OATeramo



The tools will be transformed in web-services:

- Isochrones- tracks extractor;
- Luminosity function
- Syntetic color – Magnitude diagrams (stellar population synthesis program)

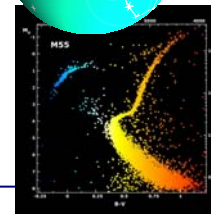
All is written in PERL.



20/05/2008

P. Manza

Tool: isochrone/track extractor



BaSTI *A Bag of Stellar Tracks and Isochrones...*

Isochrone/track Extractor

Output Type

- Isochrone (for a given age)
- Interpolated track (for a given mass)

Heavy Elements Mixture

- Scaled to solar mixture
- Alpha enhanced mixture (not yet available)

Color-temperature Transformation

- UBVRlJHKl (Scaled solar or Alpha enhanced)
- ACS (Scaled solar only)

Model Type

- Standard - $\eta=0.2$ - (without overshooting)
- Non standard - $\eta=0.4$ - (with overshooting)

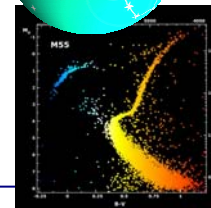
Chemical composition

<input checked="" type="radio"/> Z= 0.0001 Y= 0.245	<input type="radio"/> Z= 0.008 Y= 0.256
<input type="radio"/> Z= 0.0003 Y= 0.245	<input type="radio"/> Z= 0.01 Y= 0.259
<input type="radio"/> Z= 0.001 Y= 0.246	<input type="radio"/> Z= 0.0198 (Sun) Y= 0.273
<input type="radio"/> Z= 0.002 Y= 0.248	<input type="radio"/> Z= 0.03 Y= 0.288
<input type="radio"/> Z= 0.004 Y= 0.251	<input type="radio"/> Z= 0.04 Y= 0.303

Submit



Synthetic Colour-Magnitude diagrams



The BASTI Population Synthesis Program Web Interface - Mozilla Firefox

Getting Started Latest Headlines Google BPO Routeur Brother SFP CUPS

Stellar Population Synthesis Program

User Id:

Photometric error

- No error
- Gaussian error with the mean photometric error: (in mag)
- User Specified error law table
Number of values: (Max. 200)

Mean spectroscopic error

(in dex)

Colour excess E(B-V)

Total spatial depth of the population

Distance modulus

Fraction of unresolved binaries

(e.g. 1/10 -> 0.1)

Minimum mass ratio for binary systems

Scale factor for SFR

(Max. 8 digits integer)

Mass range

- Default mass range (0.1-120 M_{sun})
- User-specified lower mass limit: (solar masses)

Initial Mass Function

IMF type

- Single power law
- Kroupa, Tout, Gilmore (1993)

IMF exponent (in case of single power law)

Stellar Formation History

Fixed Stellar Formation Histories (SFH)

- NGC6822 (*)
- Milky Way bulge
- SMC (*)
- Sextans A
- LMC (bar field)
- LGS3
- Local disk
- (*) (global SFH)

User Specified SFH
Number of age values: (max. 200)

Search for variable stars

yes no

Selected set of isochrones

Heavy Elements Mixture

- Scaled to solar mixture
- Alpha enhanced mixture

Mass loss

- $\eta=0.2$
- $\eta=0.4$

Extra core mixing

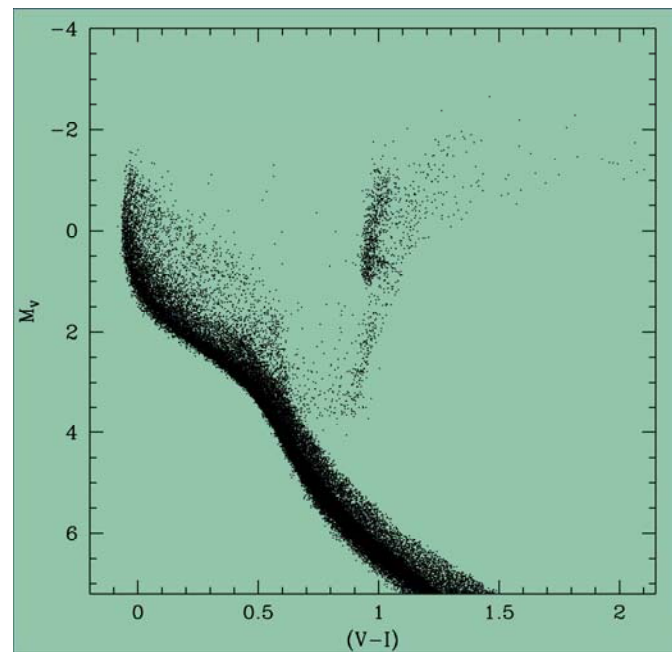
- Standard (No overshooting)
- Overshooting

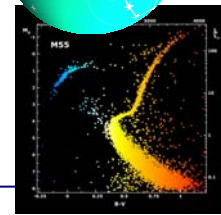
Random numbers generating

- The random number generator is automatically initialized through the Web taking a seed from <http://www.random.org> (recommended option)
- The random number generator is initialized with seeds provided by the user:

Seed 1: Seed 2:

Submit





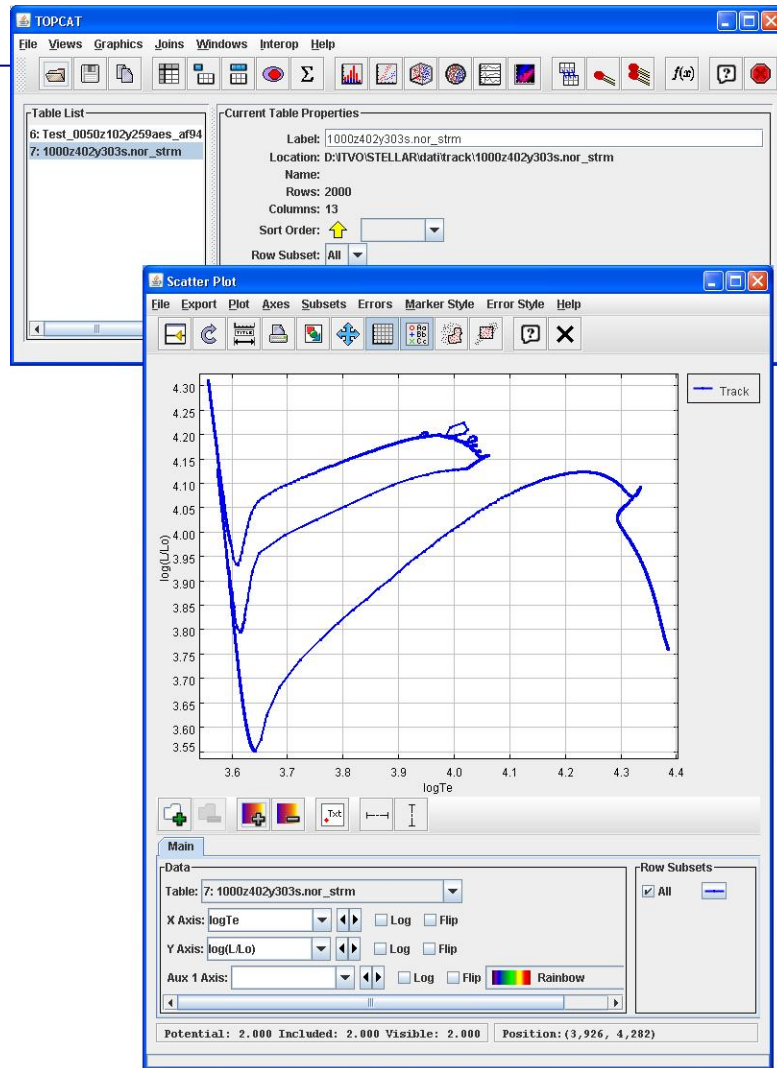
BaSTI and VVO tool



The output of BaSTI is an **ASCII file** so the natural tool to analyze these data is TOPCAT.



We transform it in a **VOTable** (or **FITS-Table**).



VOTable



Isochron ASCII file
trasform
in a VOTable

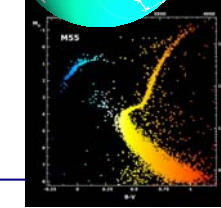
(thanks to M. Molinaro)

```

Mozilla Firefox
File Modifica Visualizza Cronologia Segnalibri Strumenti 2
file:///C:/molinaro/BA5TASCI2V0/wz102y259o.t600030_acs_hst.xml
Bookmarks Varie Virtual Observatories TUTOS - Login WebMail Tomcat - Palanir 1

-<VOTABLE version="1.1" xmlns:namespaceSchemaLocation="http://www.ivoa.net/xml/VOTable/v1.1">
-<DESCRIPTION>
  Isochrone by Pietruferri - Cassisi - Salariis - Castelli 2006 :: Non Standard Model - Scaled solar model & transformations for ACS (Castelli 2004)
</DESCRIPTION>
-<RESOURCE>
-<DESCRIPTION>
  For further information on PARAM(s) and FIELD(s) see: "http://www.oats.inaf.it/IA2/index.php?option=com_wrapper&Itemid=87"
</DESCRIPTION>
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  <OPTION>alfa-enhanced</OPTION>
</VALUES>
</PARAM>
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+<PARAM arraysize="*" datatype="char" name="CodeVersion" ucd="meta.note" unit="*" value="2007"></PARAM>
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+<PARAM datatype="int" name="Np" ucd="meta.number" unit="*" value="2000"></PARAM>
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    The mass fraction of the initial heavy elements abundance
  </DESCRIPTION>
-<VALUES>
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  <MAX>0.04</MAX>
</VALUES>
</PARAM>
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+<PARAM datatype="float" name="Age" ucd="time.age" unit="Gyr" value="0.0300"></PARAM>
+<PARAM arraysize="*" datatype="char" name="CheckDate" ucd="time.processing" unit="DD-MM-YYYY" value="16-05-2005"></PARAM>
-<TABLE>
  <DESCRIPTION>Output Data Table. Number of rows: 2000</DESCRIPTION>
+<FIELD datatype="float" name="(M/Mo)in" ucd="phys.mass.arith.ratio" unit="%"></FIELD>
+<FIELD datatype="float" name="(M/Mo)" ucd="phys.mass.arith.ratio" unit="%"></FIELD>
+<FIELD datatype="float" name="log(L/Lo)" ucd="phys.luminosity.arith.ratio" unit="%"></FIELD>
-<FIELD datatype="float" name="logTe" ucd="phys.temperature.effective" unit="K">
  <DESCRIPTION>Logarithmic value of the effective temperature</DESCRIPTION>
</FIELD>
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+<FIELD datatype="float" name="F775W" ucd="phot.mag" unit="mag"></FIELD>
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  -<TABLEDATA>
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      <TD>5000000000</TD>
      <TD>4999876494</TD>
      <TD>-1.32717</TD>
      <TD>3.60453</TD>
      <TD>10.272</TD>
      <TD>9.769</TD>
      <TD>9.059</TD>
      <TD>8.597</TD>
      <TD>8.229</TD>
      <TD>7.499</TD>
      <TD>7.392</TD>
    </TR>
  </TABLEDATA>
</DATA>
</TR>
</TABLE>

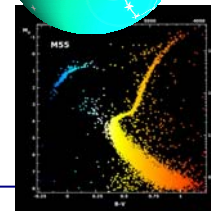
```



20/05/2008



...start the discussion



- Standard format;
- DM....
- Access protocol...
-