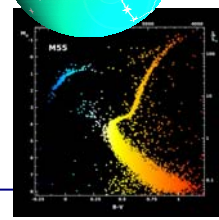
IVOA-Theory
Micro-Simulations



BaSTI:
database and queries
for stellar evolution models

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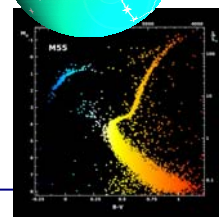
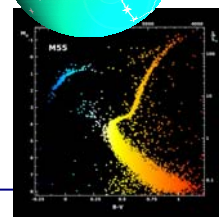


The Italian Theoretical Virtual Observatory

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



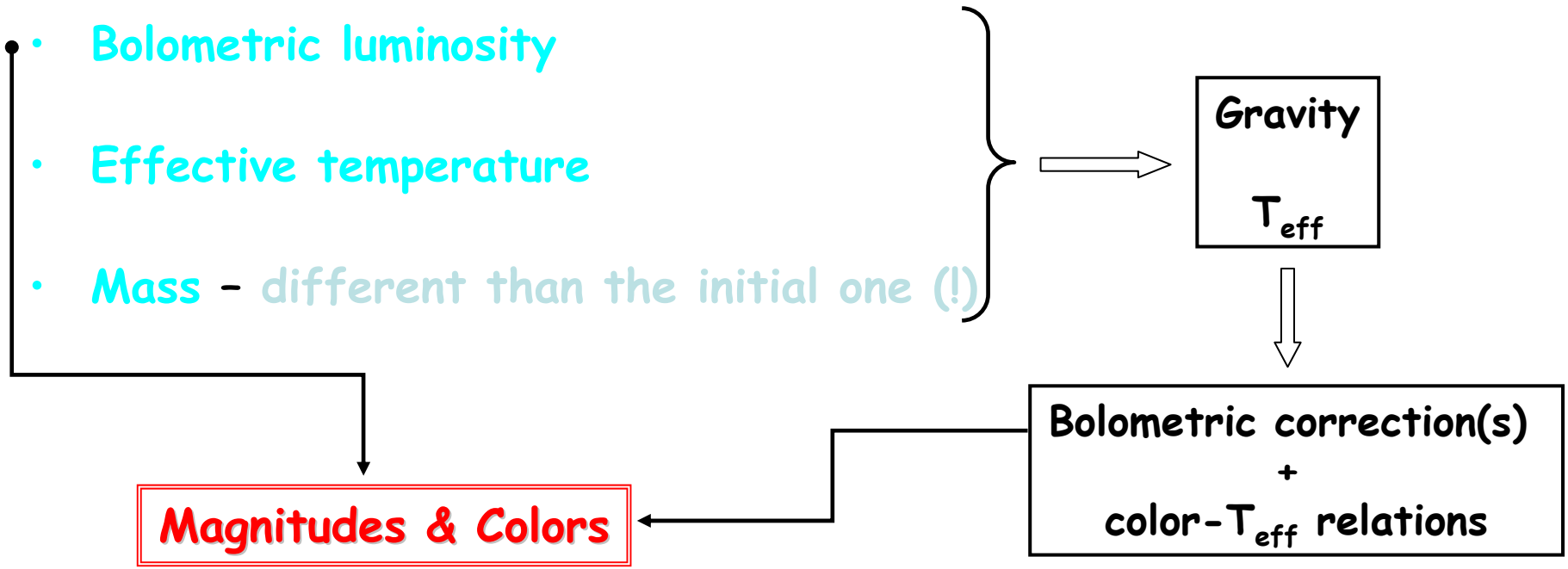
- Store the theoretical metadata inside a relational DB to allow an easy search of these data on multiple choice of parameters;
- public theoretical data so to reuse expensive data in term of CPUs time, like cosmological simulations or output of stellar evolutionary code;
- permit an easy comparison 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)

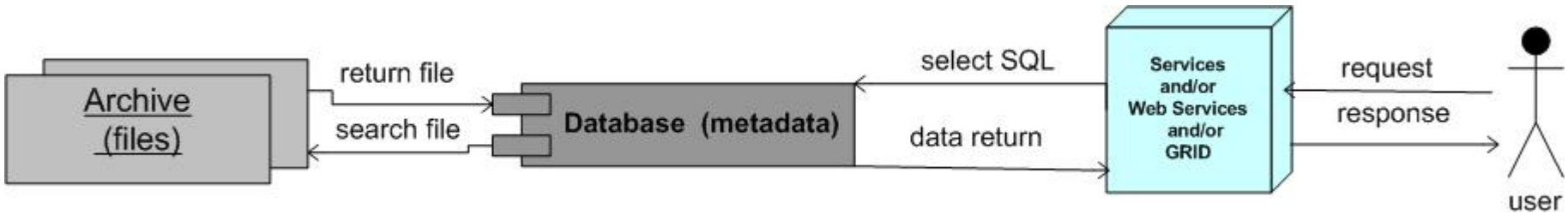
The evolutionary stellar models provide:

- Evolutionary lifetimes ⇒ **Star counts**



- Surface chemical composition predictions ⇒ spectroscopy
- Nuclear yields

Archives + DBs + services



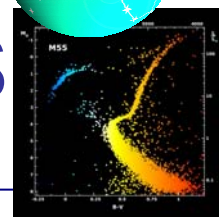
- Archives contain the output files of the simulation;
- Databases contain the metadata of the simulation that should include all the parameters to perform the running not only the physical ones;
- Data access: it could be performed via Web Portal or Web services or in future via Grid infrastructure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

Stellar evolutionary computations are extremely time consuming

⬇

They are perfecly suited for running on "distributed computing facilities" (GRID)

Uses cases of stellar models

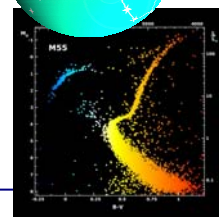


These model are important for:

- 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

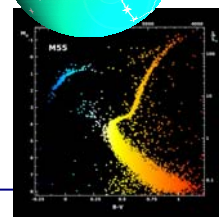


- **Easy "access" to physical inputs databases;**
  - Clear explanations of HOW the physical inputs have been computed;
  - Possibility to perform online computations by using user-specified conditions;
  - standard outputs;
- **Reliable color- Teff relations**
  - As many as possible different calibrations;
  - 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
- Standardization
- "User friendly" access
- Online computational facilities

Helper Applications:

TOPCAT: tabular data & manipulation

VOPlot: handling with VOTable data

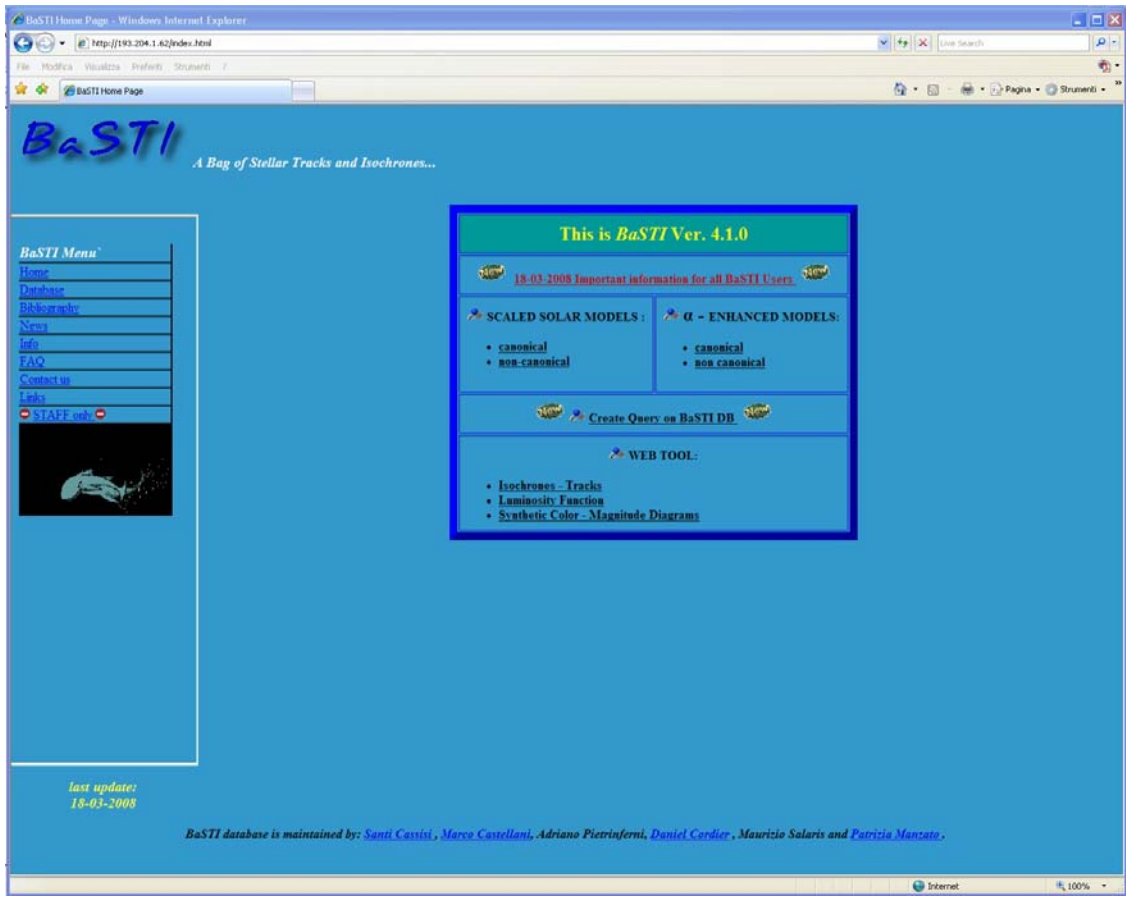
Etc…

Tools to analyse and visualise end & intermediate data products

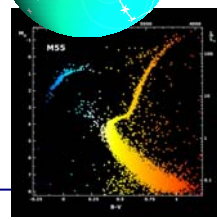
BaSTI

a Bag of Stellar Tracks and Isochrones

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



Stellar evolution archive



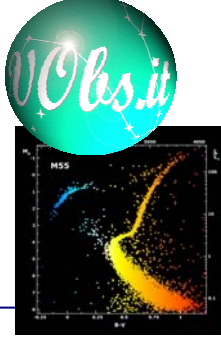
Stellar data

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 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

Microscopic mechanisms

- Atomic diffusion
- Radiative levitation

Mixing scheme

- Semiconvection
- Overshooting
- Breathing pulses
- Turbulence

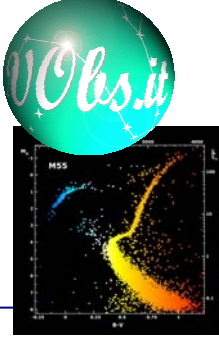
Magnetic field

Rotation & Rotational mixing

1st step: how maps these structure inside a relational DB

2nd step: …(discusson)it fit with the theoretical DM

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



BaSTI Database

CHEMICAL

PK,I1	ID_CHEMICAL	VARNUMERIC(600;0)
	Z	DOUBLE
	Y	DOUBLE
	FE_H	DOUBLE
	M_H	DOUBLE

PROPRIETIES

PK,I1	ID_PROP	VARNUMERIC(600;0)
FK1	ID_CHEMICAL	VARNUMERIC(600;0)
	TYPE	CHAR(40)
	MASS_LOSS	DOUBLE
	PHOT_SYSTEM	CHAR(150)
	HED_TYPE	CHAR(150)

SCENARIO

PK,I1	ID_SCENARIO	VARNUMERIC(150;0)
	SCENARIO_TYPE	CHAR(20)

OUT_FILE

PK,I1	ID_OUT	VARNUMERIC(250;0)
FK4	ID_PROP	VARNUMERIC(600;0)
FK2	ID_SCENARIO	VARNUMERIC(150;0)
FK3	ID_PROG	VARNUMERIC(38;0)
	FILENAME	CHAR(100)
	PATH	CHAR(250)
	FILE_TYPE	CHAR(10)
	AGE	DOUBLE
	MASS	DOUBLE

PROGRAM_PARAM

PK,I1	ID_PROG	VARNUMERIC(38;0)
	CODE_NAME	CHAR(20)
	VERSION	CHAR(10)
	EOS	CHAR(50)
	RAD_OPACITY	CHAR(150)
	COND_OPACITY	CHAR(150)
	NUCL_RATES	CHAR(150)
	NEUTRINO_LOSSES	CHAR(150)
	BOUNDARY_COND	CHAR(150)
	NOTE	CHAR(600)

UNITS

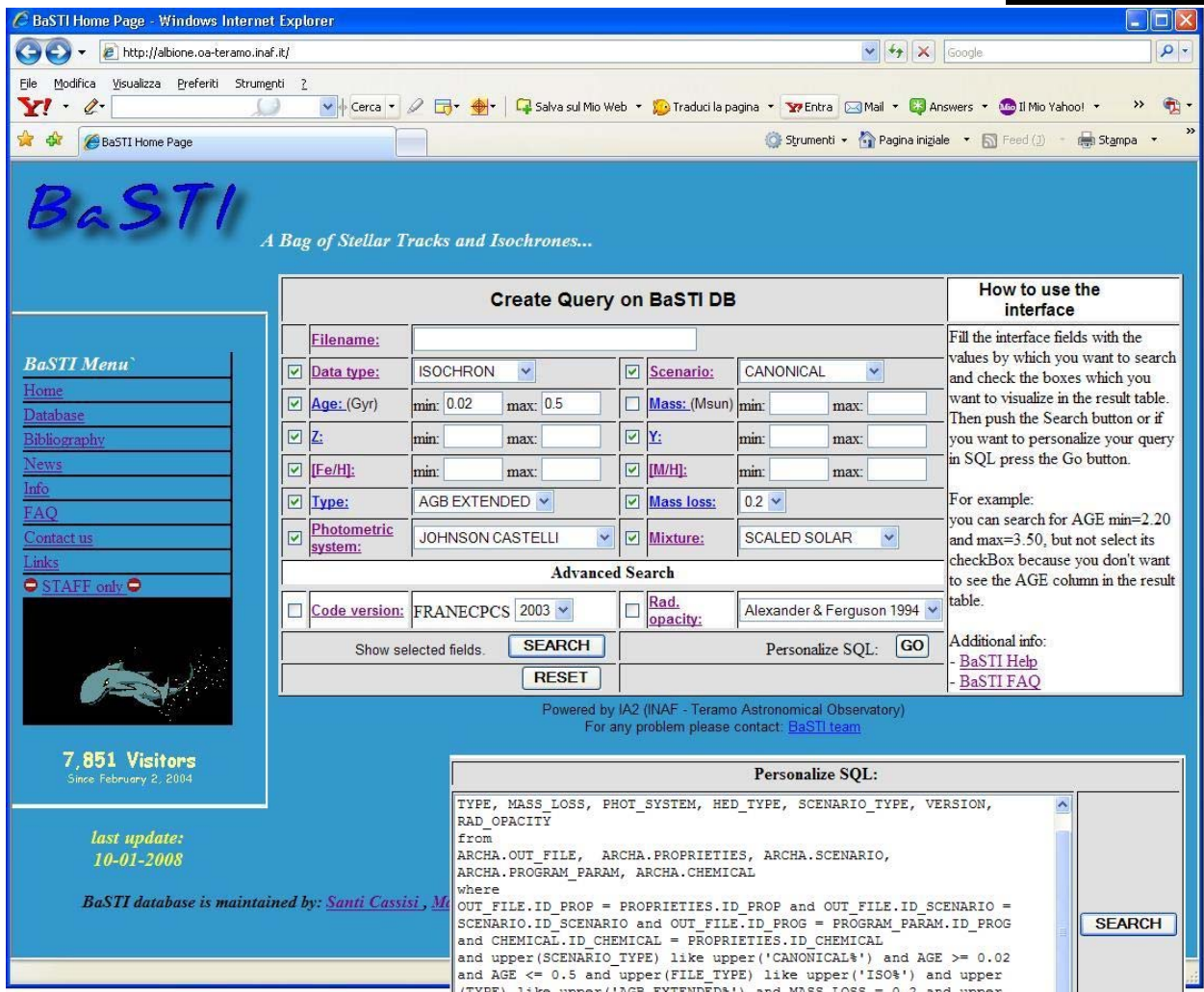
PK,I1	TABLE_NAME	CHAR(50)
PK,I1	COLUMN_NAME	CHAR(50)
	UNIT	CHAR(100)

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

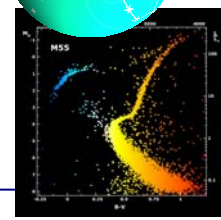
DB contains 49939 rows in the OUT_FILE table.

BaSTI web portal

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



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)

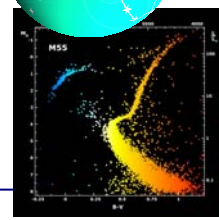
BaSTI tools – developed by OATeramo

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.

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
- (•) UBVRIJHKL (Scaled solar or Alpha enhanced)
- ( ) ACS (Scaled solar only)

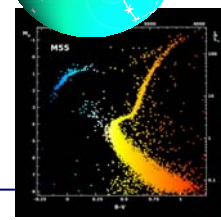
Model Type
- (•) Standard - η=0.2 - (without overshooting)
- ( ) Non standard - η=0.4 - (with overshooting)

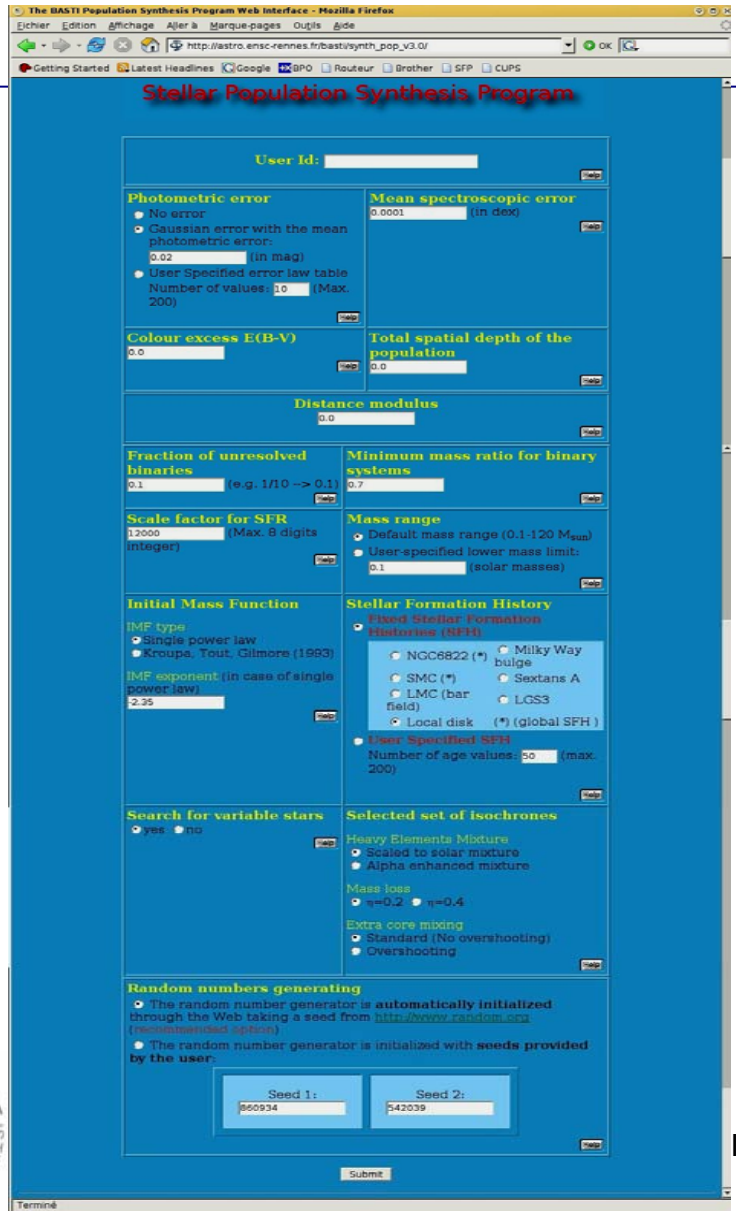
Chemical composition

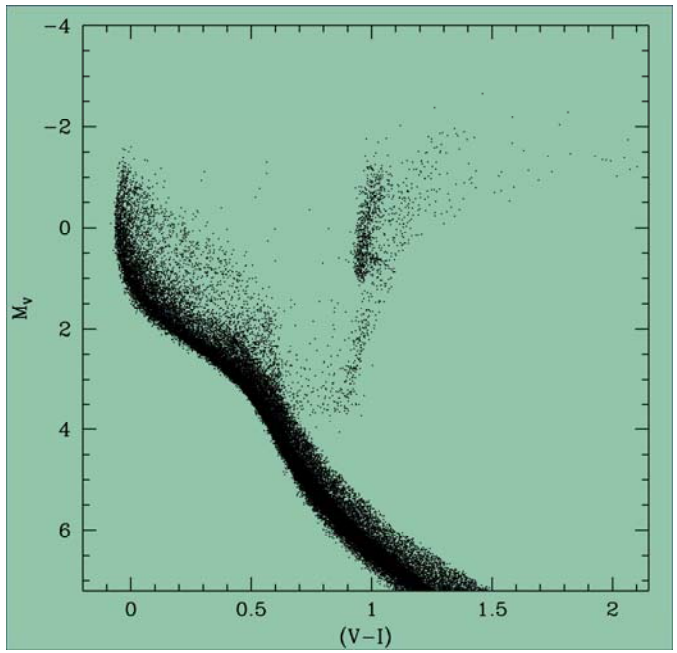
(•) Z= 0.0001 Y= 0.245	( ) Z= 0.008 Y= 0.256
( ) Z= 0.0003 Y= 0.245	( ) Z= 0.01 Y= 0.259
( ) Z= 0.001 Y= 0.246	( ) Z= 0.0198 (Sun) Y= 0.273
( ) Z= 0.002 Y= 0.248	( ) Z= 0.03 Y= 0.288
( ) Z= 0.004 Y= 0.251	( ) Z= 0.04 Y= 0.303

Submit

Synthetic Colour-Magnitude diagrams



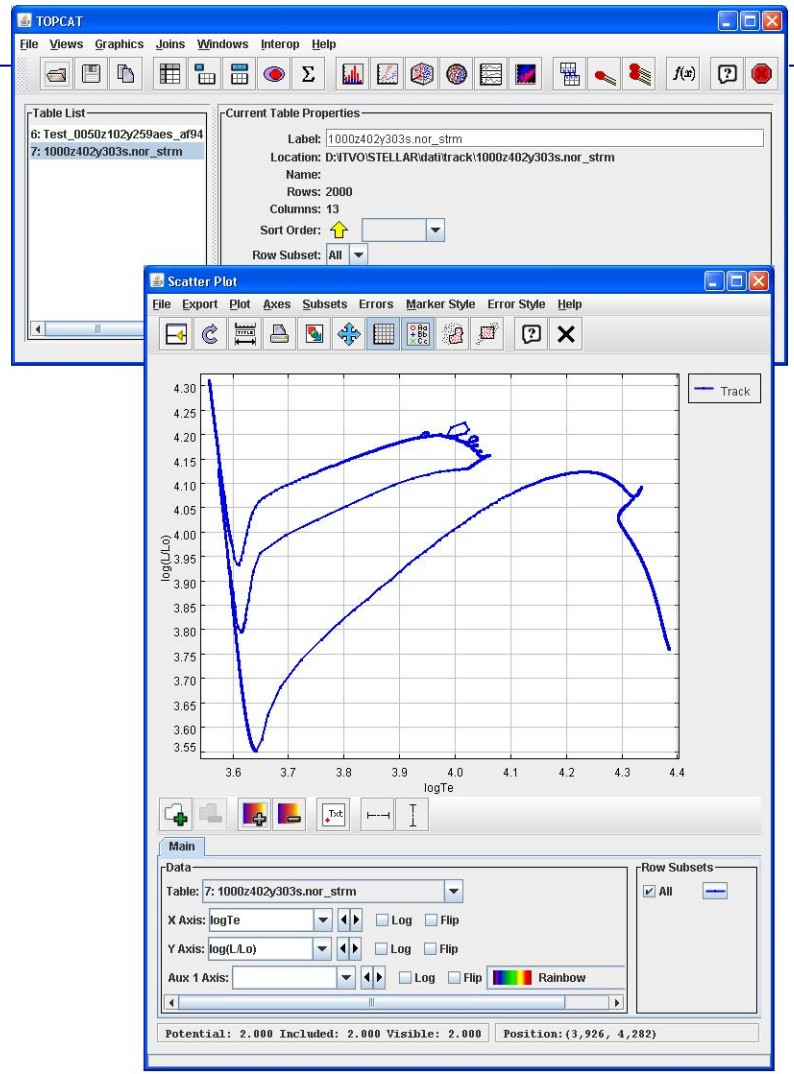




BaSTI and VO tool

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

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



VOTable

Isochron ASCII file
trasform
in a VOTable

(thanks to M. Molinaro)

20/05/2008

…start the discussion

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