Centro de Astrofísica
da Universidade do Porto

ENAA 2013

Mass and Age determination for low-mass Young Stellar Objects

Ana Rei

Advisor: Jorge Gameiro

18 July 2013

Overview

- Low-mass Young Stellar Objects;
- MESA;
- Sample;
- MESA Determinations;
- Ongoing work;
- Conclusions.

Low-mass Young Stellar Objects

- Low-mass (0.3 to 2 $M_{\odot}$) pre-main sequence (PMS) stars are also known as T Tauri Stars;

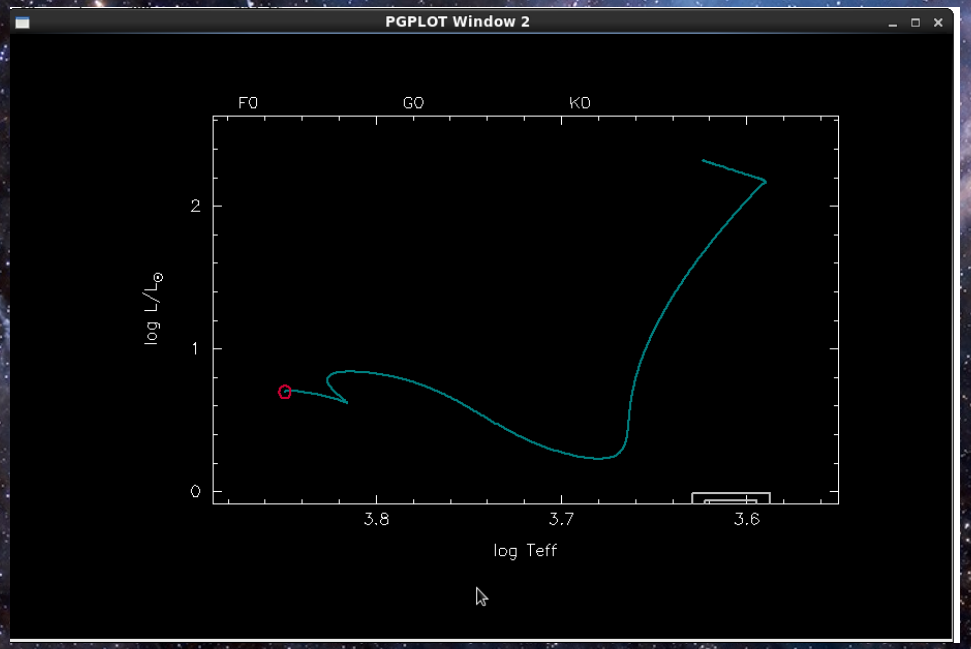
- Typical ages between 0.1 and 100 Myrs;

- T Tauri Stars can be divided into two groups:
  - Classical T Tauri Stars (CTTS): circumstellar disk/active mass accretion and mass loss processes/interaction star-disk;
  - Weak-line T Tauri Stars (WTTS): presence of a cold passive disk.

MESA

- Modules for Experiments in Stellar Astrophysics (MESA) → stellar evolutionary code: star;

- Adaptation of “example_astero” for PMS studies;



- Objective: Test MESA as a source to obtain mass and age for PMS stars (by model comparison), giving as observational constraints effective temperature (Teff), luminosity (L), surface gravity (log g) and/or metalicity.

MESA

- The code creates a PMS model and evolves it, searching for the best-fit model (varying mass).
- At the point in the H-R diagram defined by Teff and L, MESA calculates mass, age, radius, log g and other parameters;
- With this work we pretend to test MESA for the determination of mass and age for PMS stars.

2term	l0_freq	l0_corr
Teff chi2term		0.000002
Teff		6030.084914
Teff_obs		6030.000000
Teff_sigma		65.000000
logL chi2term		0.000030
logL		0.812636
logL_obs		0.812910
logL_sigma		0.050000
R/Rsun		2.338461
logL/Lsun		0.812636
Teff		6030.084914
logg		3.879739
FeH		0.000000
delta_nu		48.173667
nu_max		839.269131
a_div_r		-1.000000
correction_r		-1.000000
initial h1		0.755267
initial he3		0.000024
initial he4		0.237632
initial Y		0.237656
initial Z		0.007077
initial FeH		-0.388659
mass/Msun		1.512552
alpha		1.587500
f_ov		0.015000
age		7.9837023728817767D+06
chi^2 combined		0.000016
chi^2 seismo		2225.354848
chi^2 spectro		0.000016
model number		669

Sample

- A sample of WTTS from the Taurus Molecular Cloud (TMC);

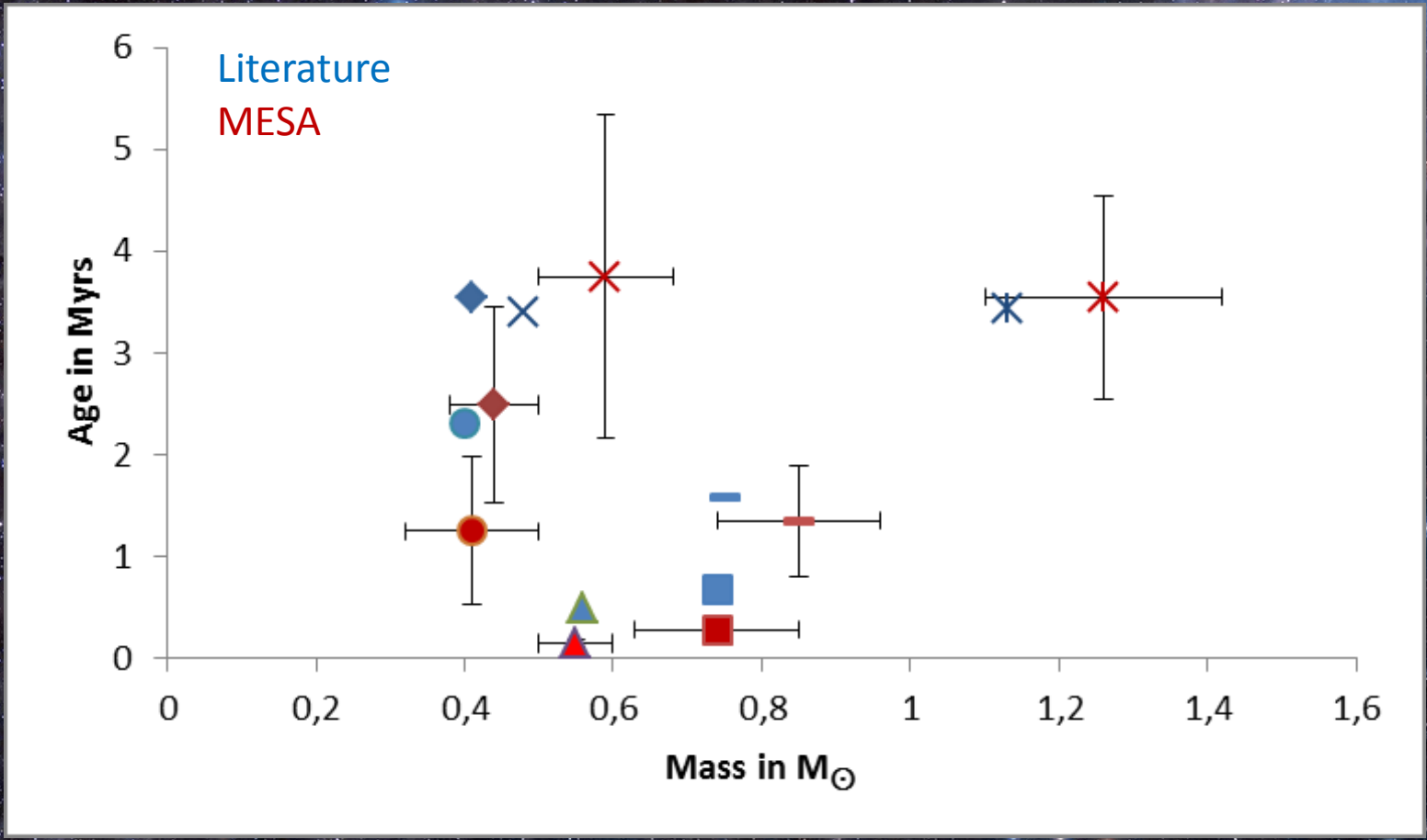
- TMC must be forming stars at the same rate for 1-3 Myrs;
- Literature data was taken from Güdel et al. 2007;
- Mass and age where calculated by model comparison with Seiss et al. 2000 PMS evolutionary tracks.

MESA determinations – Results (example)

	Literature		MESA	
Star	**Mass ($M_\odot$)**	**Age (Myrs)**	**Mass ($M_\odot$)**	**Age (Myrs)**
HBC 359	0.41	3.54	0.44±0.06	2.49±0.96
Anon 1	0.56	0.5	0.55±0.05	0.15±0.04
LK Ca 5	0.4	2.31	0.41±0.09	1.25±0.73
Hubble 4	0.74	0.68	0.74±0.11	0.28±0.11
V827 Tau	0.75	1.59	0.85±0.11	1.35±0.54
JH 108	0.48	3.4	0.59±0.09	3.75±1.58
HBC 427	1.13	3.43	1.26±0.16	3.55±1.00

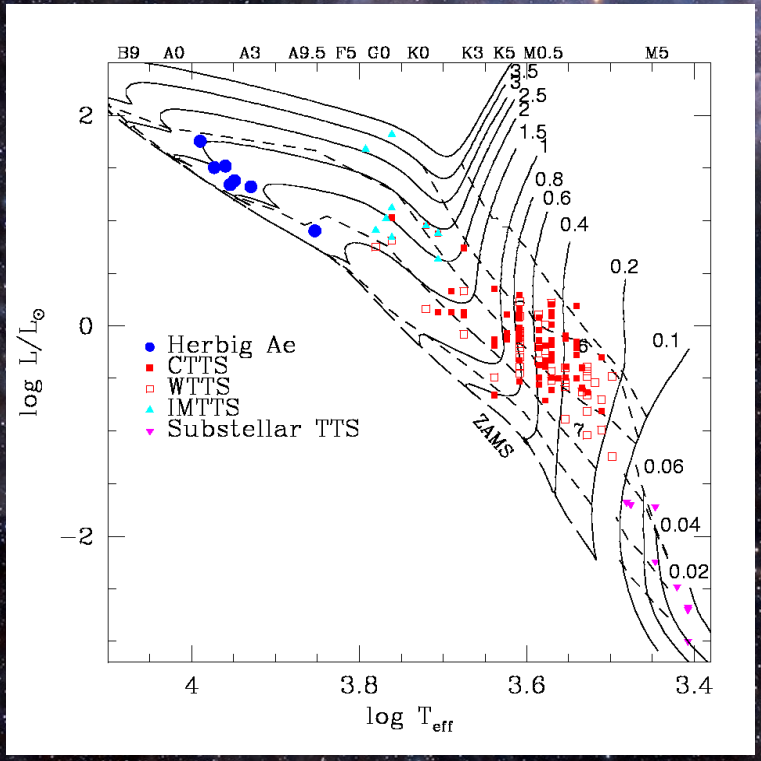
Total sample consists of 21 WTTS from the TMC.

MESA determinations – Results



Ongoing Work

- We intend to extend this work to CTTS, using Teff and log g as observational constraints and introducing mass accretion and loss processes;
- Extend our work to different metallicities;
- Use MESA to obtain mass and age for TTS from the Gaia-Eso Survey.



Conclusions

- Ages determined by MESA are, in general, lower than the literature ones and closer to the expected ages for the stars in the TMC;

- Differences might be caused by the fact that:
  - MESA values are being calculated using different initial parameters and conditions than those from literature;
  - Incorrect determinations of Teff and L can lead to inaccurate determinations of mass and age.

- MESA can be used to determine mass and age for PMS stars;