Latest updates on AIMS

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Abstract

The Asteroseismic Inference on a Massive Scale (AIMS) program is designed to estimate stellar properties and associated error bars from a set of classic and seismic constraints. It applies an MCMC algorithm while interpolating in a predetermined grid of stellar models. This poster describes some of the latest improvements of AIMS, namely the combined use of a physical age and age parameter, and the introduction of seismic indicators based on the WhoSGlAd methodology (Farnir et al. 2019).

How AIMS works

Analytical priors & Observational constraints:
- seismic: ν_i, r_{02}, r_{01}, r_{10}, $\Delta\nu$
- classical: $T_{\rm eff}$, L, [M/H], ...
- error bars and correlations

Grid of models
- n-dimensional (n ≥ 3)
- pre-computed pulsation frequencies
  - optional surface effects

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AIMS = "Asteroseismic Inference on a Massive Scale"
- unstructured linear interpolation
- MCMC approach with parallel tempering (via the python EMCEE package, Foreman-Mackey et al. 2013)

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Estimated properties
- probability distribution functions for different parameters

Representative models
- provides coefficients for interpolating acoustic structure
- allows inversions

Age Interpolation

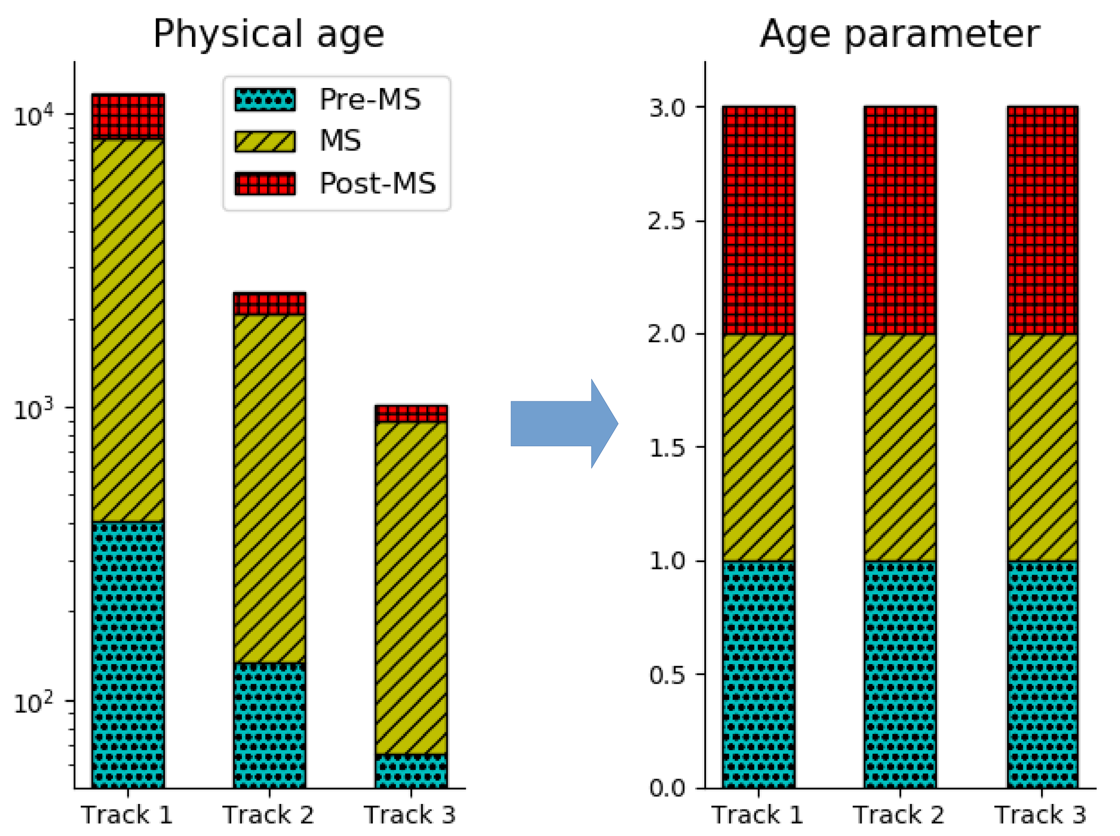

Figure 1: physical age and age parameter for three different evolutionary tracks.

- **physical age:** used for MCMC sampling
  - this avoids accidentally introducing an extra prior on the age
- **age parameter:** used for interpolating between tracks
  - this enables combining models at equivalent evolutionary stages when interpolating between tracks
  - the age parameter is supplied by the user
- hence, AIMS needs to convert physical age to age parameter and vice-versa (see Figure 2)

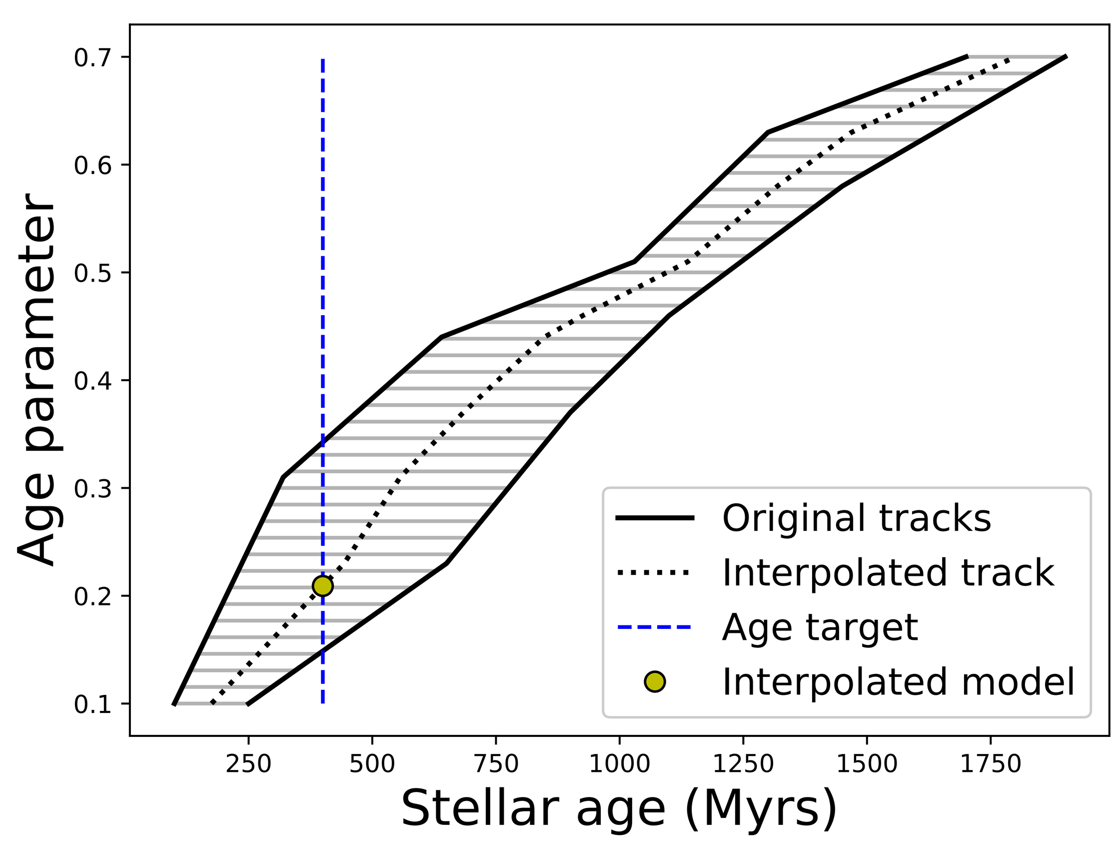

Figure 2: Schematic diagram showing the conversion from physical age to age parameter. AIMS applies a dichotomic search along the interpolated track (see Lebreton & Reese 2020).

WhoSGlAd

- implementation of WhoSGlAd seismic constraints in AIMS (Farnir et al. 2019)
  - uses Gram-Schmidt algorithm to produce orthogonal seismic indicators
  - a standalone version of the WhoSGlAd algorithm is available at: https://github.com/Yuglut/WhoSGlAd-python
- Figure 3 compares MCMC results for a Kepler LEGACY star (Silva Aguirre et al. 2017) using frequency ratios and seismic indicators based on WhoSGlAdies

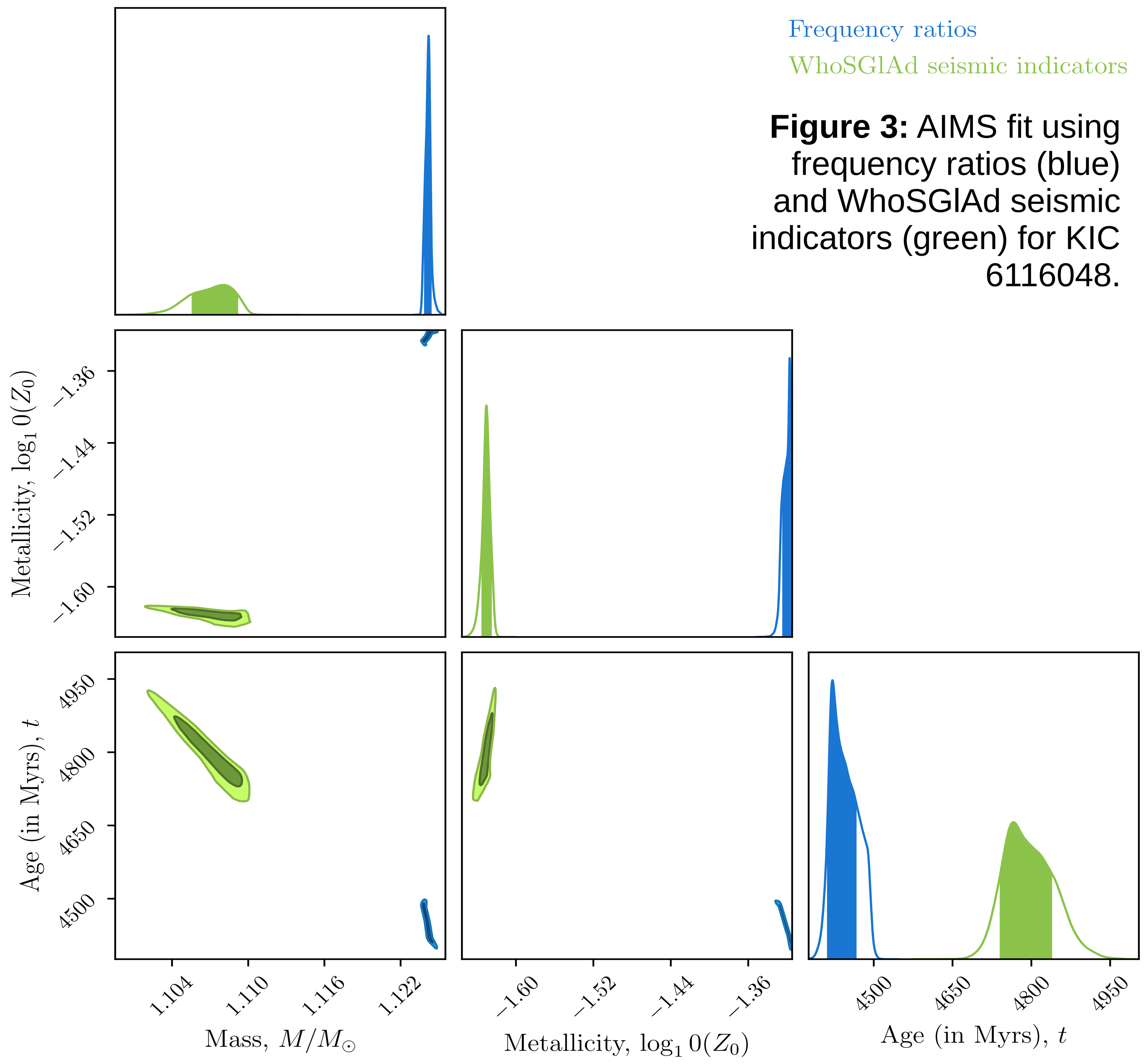

Figure 3: AIMS fit using frequency ratios (blue) and WhoSGlAd seismic indicators (green) for KIC 6116048.

- the WhoSGlAd methodology may also be used to fit seismic glitches (Fig. 4)

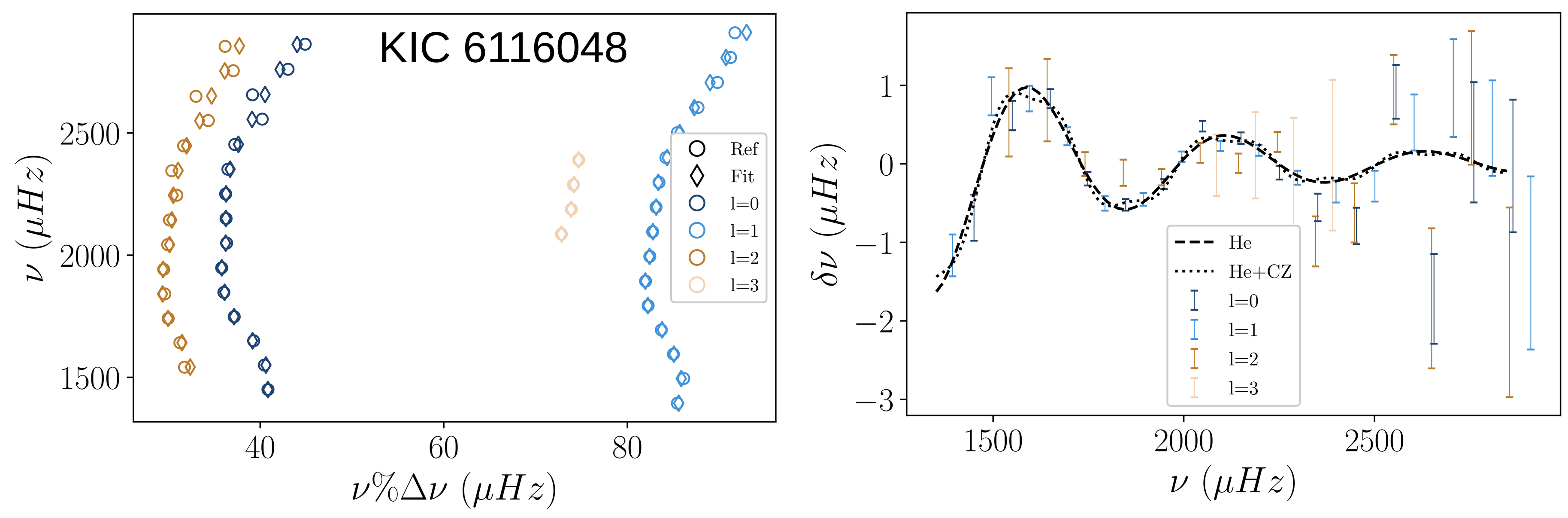

Figure 4: Echelle diagram and He + BCZ glitch pattern fitted with standalone version of WhoSGlAd.

Conclusion & prospects

- inclusion of physical age and age parameter
  - improved interpolation that may enable AIMS to work with grids including mulitple evolutionary stages
- inclusion of WhoSGlAd seismic diagnostics
  - may be used to target specific information during an MCMC run
  - allows AIMS to include He and BCZ glitch amplitudes as constraints
- other improvements:
  - use of EMCEE 3 and PTEMCEE libraries – this enables the use of dynamic temperatures in multi-tempered simulations
- prospects:
  - inclusion of automatic convergence criterion for MCMC run
  - enable AIMS to work with multiple systems (binaries, clusters) with common constraints (e.g. age, metallicity)

References

AIMS website: https://gitlab.com/sasp/aims
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