Hot Subdwarf Stars from the Hamburg surveys revisited

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sdOB7, Oxford, July 20.2015

ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Introduction

The Hamburg Objective Prism Surveys:

- Hamburg Quasar survey, Calar Alto Schmidt Telescope:
  Spectroscopic Follow-up:
  Calar Alto 3.5m Telescope, Twin: 3-5 Å resolution
  Analysis of sdB stars (Edelmann et al. 2003)

- Hamburg ESO-survey (ESO-SPY)
  Spectroscopic follow-up:
  ESO VLT & UVES: 0.2-0.4 Å resolution

Samples of hot subdwarfs
(A European View)

HQS: **sdB** (Edelmann et al., 2003): faint (av. V =16mag)

SPY: **sdB** (Lisker et al, 2005),

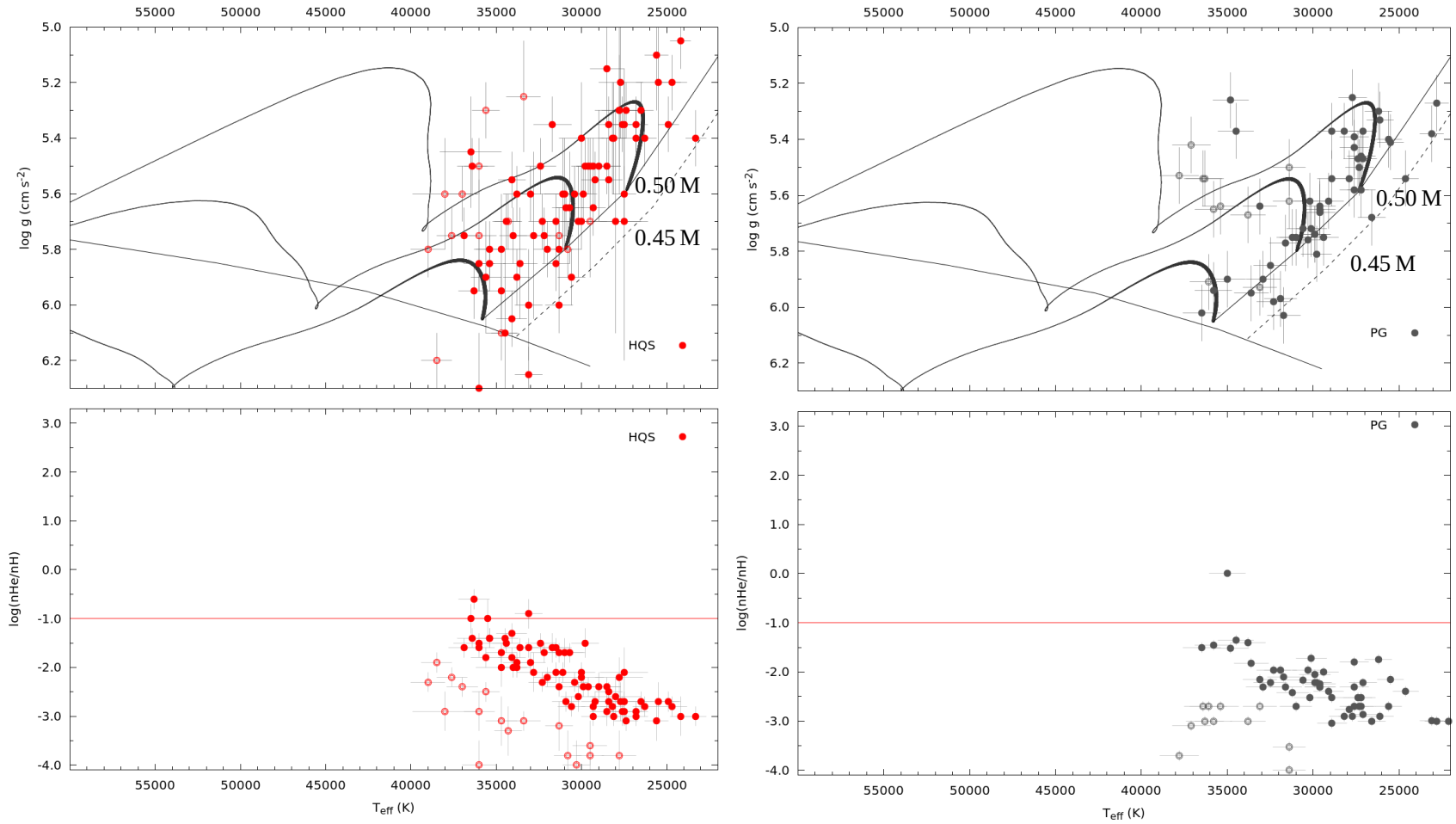
sdO (Stroeer et al. 2007, Hirsch, 2009), intermediate brightness (15mag)

PG/EC: **sdB** (Maxted et al. 2001, Morales-Rueda et al. 2003, Copperwheat et al. 2011) , Intermediate brightness

GALEX: **sdB & sdO** (Nemeth et al. 2012), bright, V=12 mag

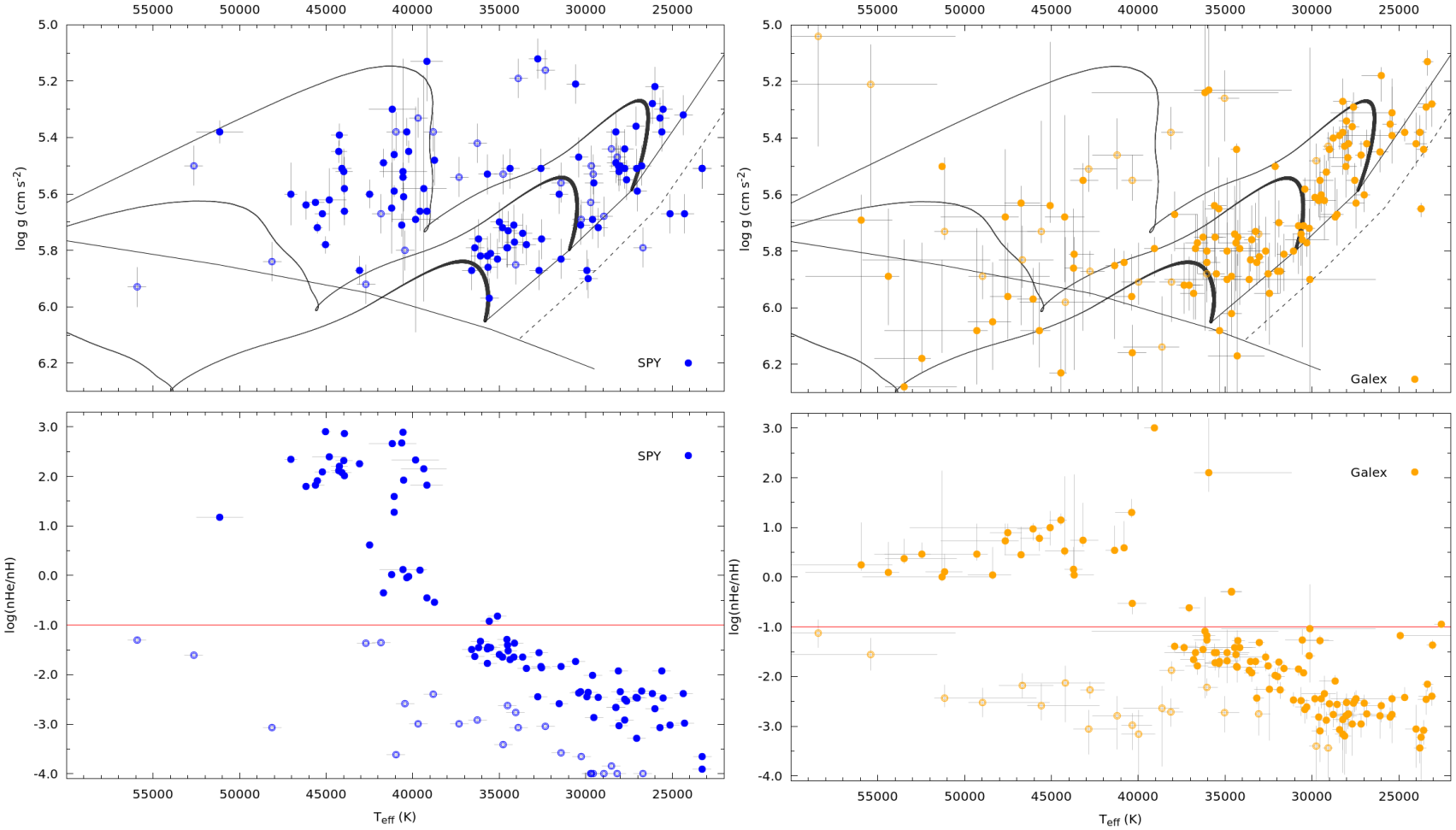
Omega Cen: (Moehler et al. 2011, Latour et al. 2014), faint, Pop. II

HQS vs PG/EC



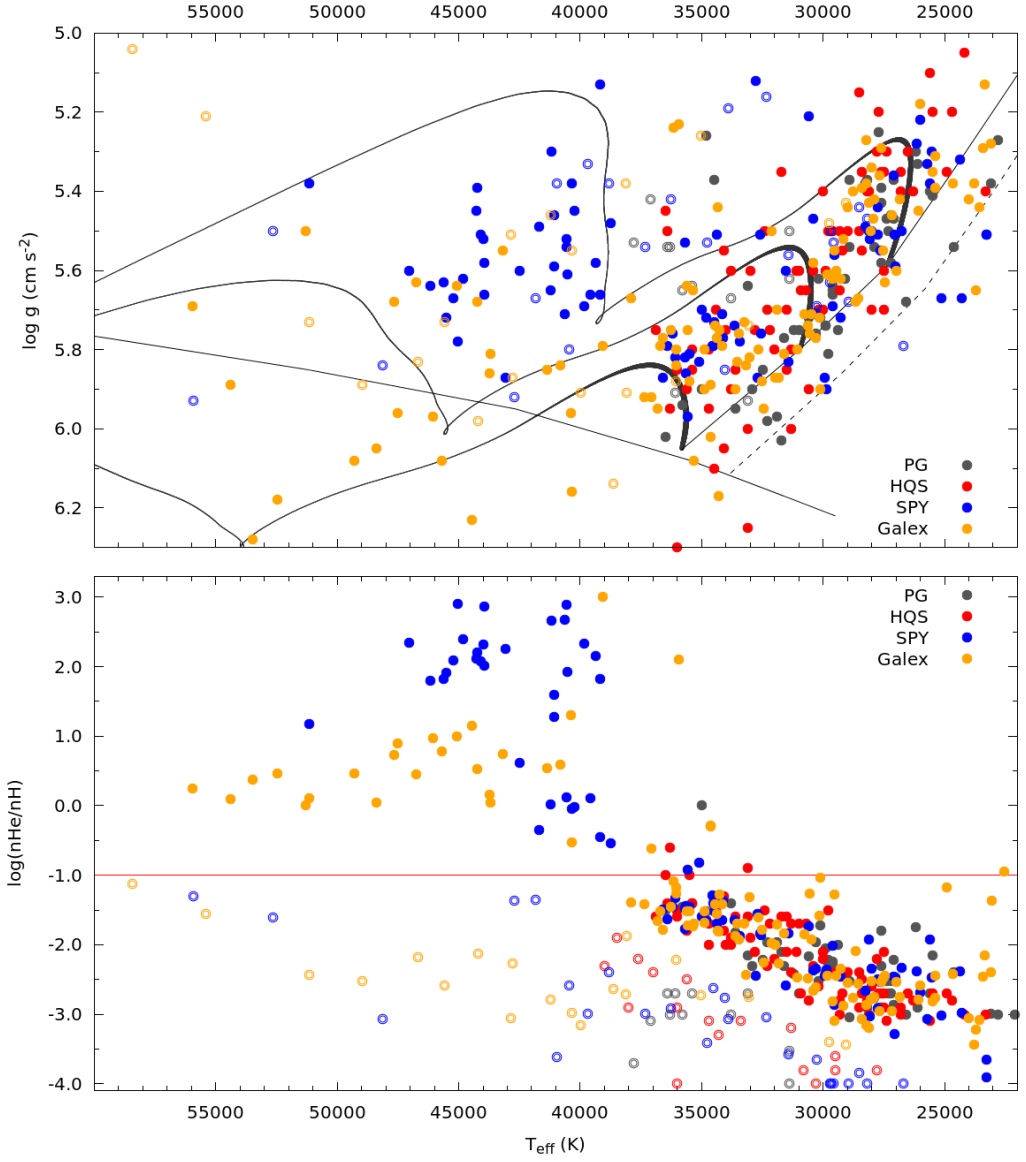
EHB models from Han et al. (2003)
depend on core mass, helium content and metallicity.

SPY vs. GALEX

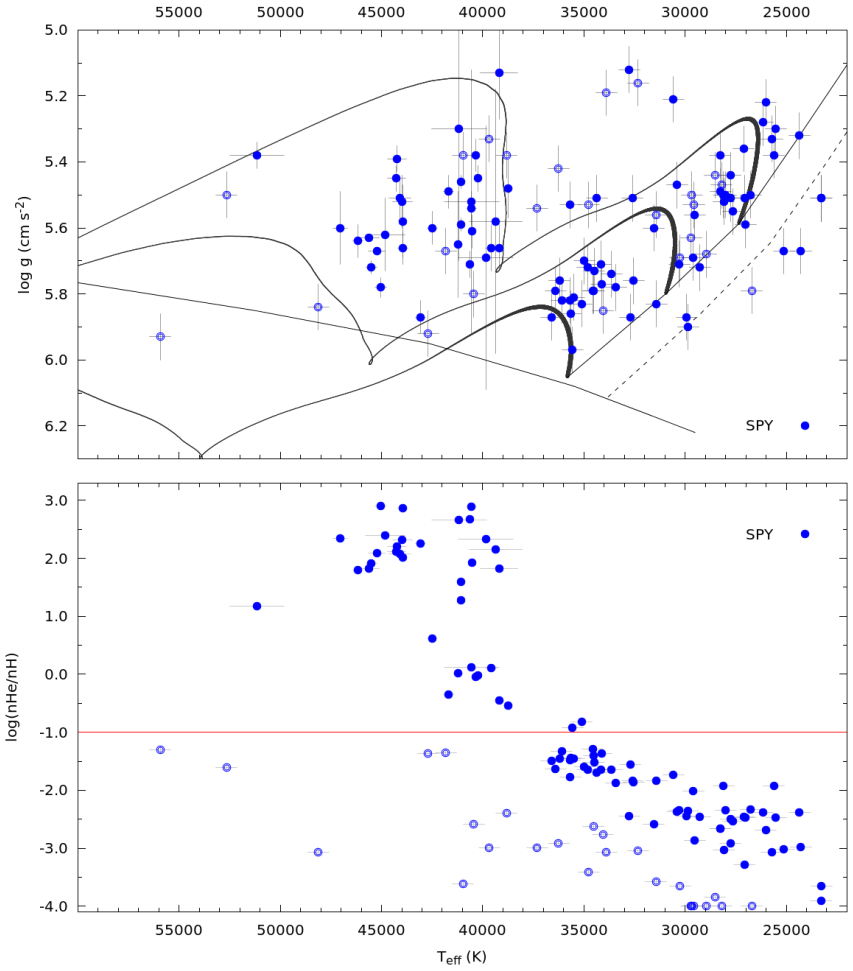


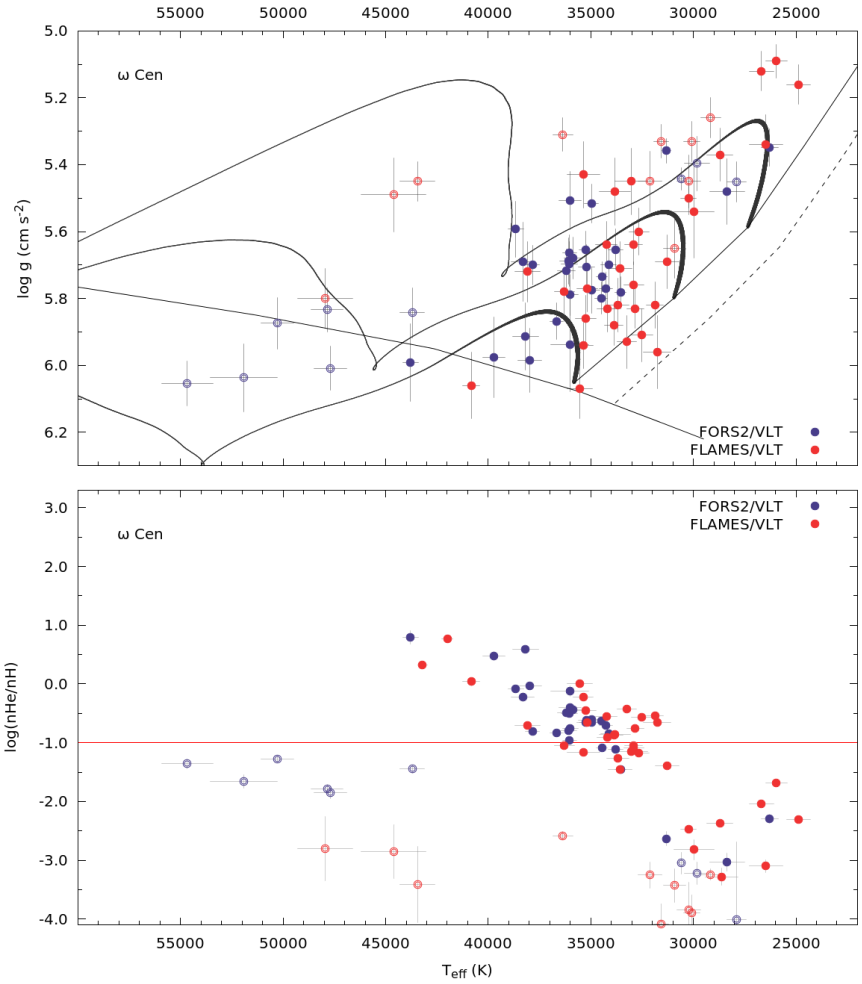
Combined surveys:

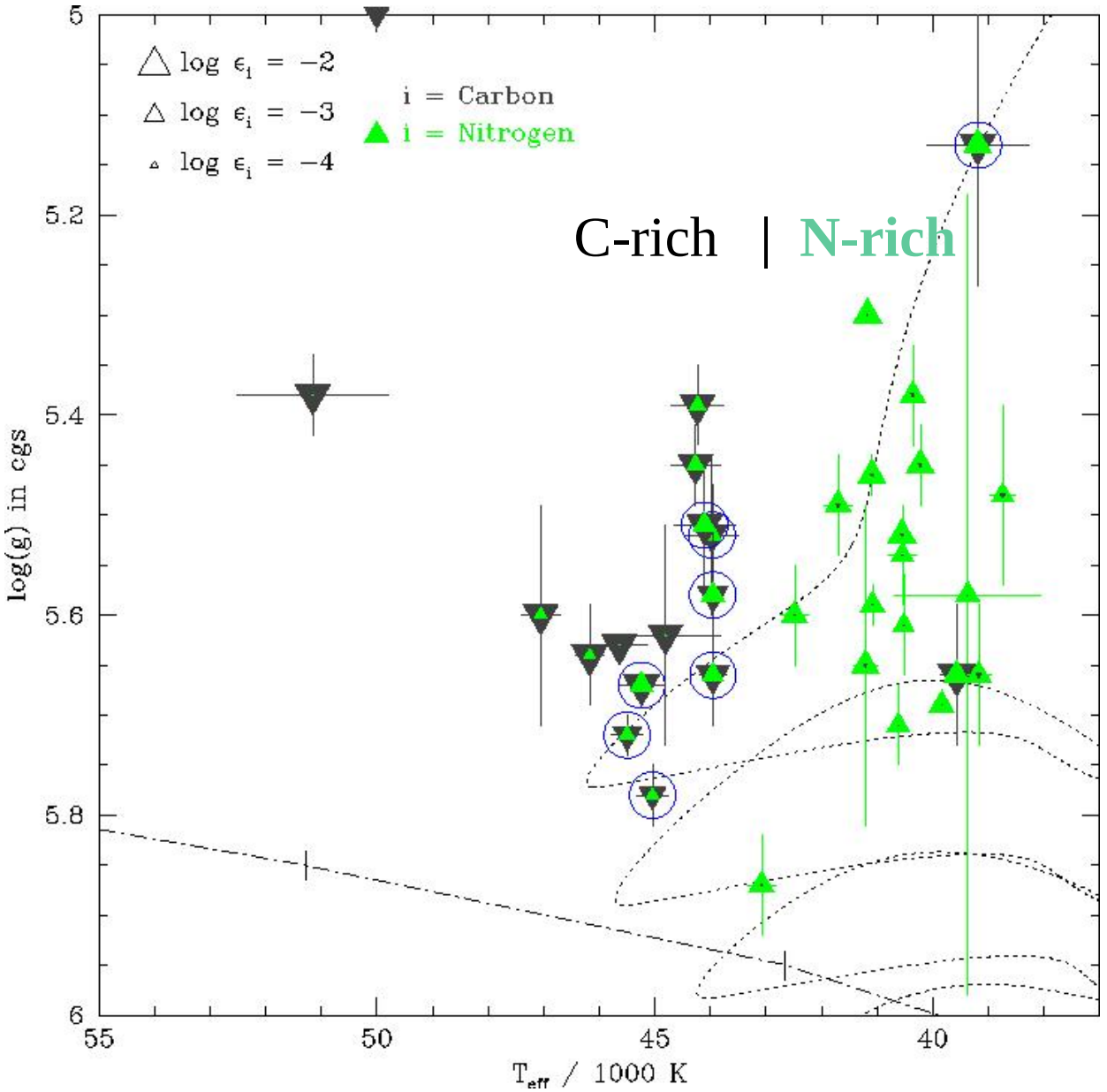
- sdB
  - **2 He sequences**:
    - low He extends to He-poor sdOs
    - high He extends to solar
- **Intermediate He-rich** sds at 40000K
- **He-sdO:** He>10:1



SPY vs Omega Cen





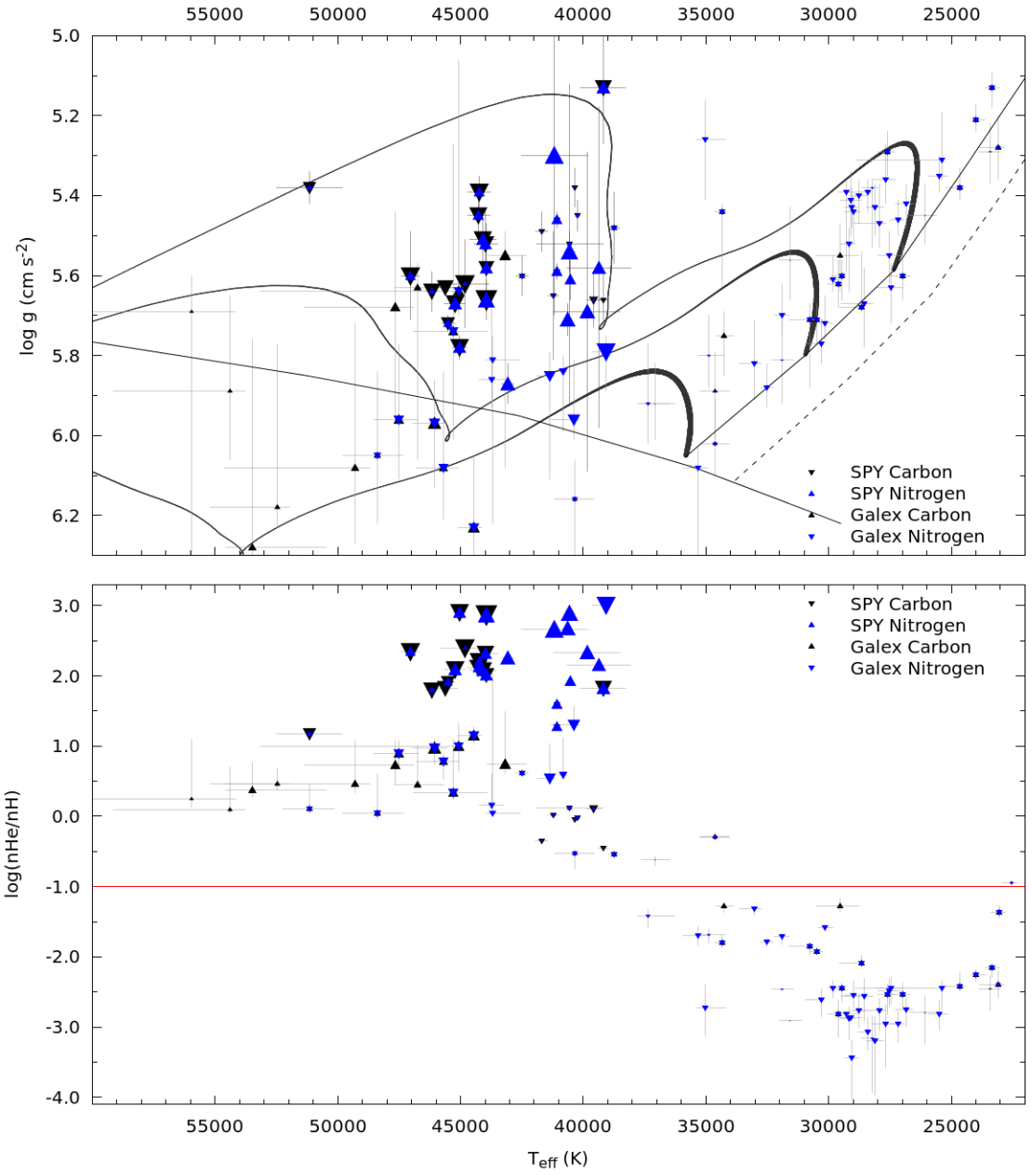


Hirsch (2009, PhD thesis)

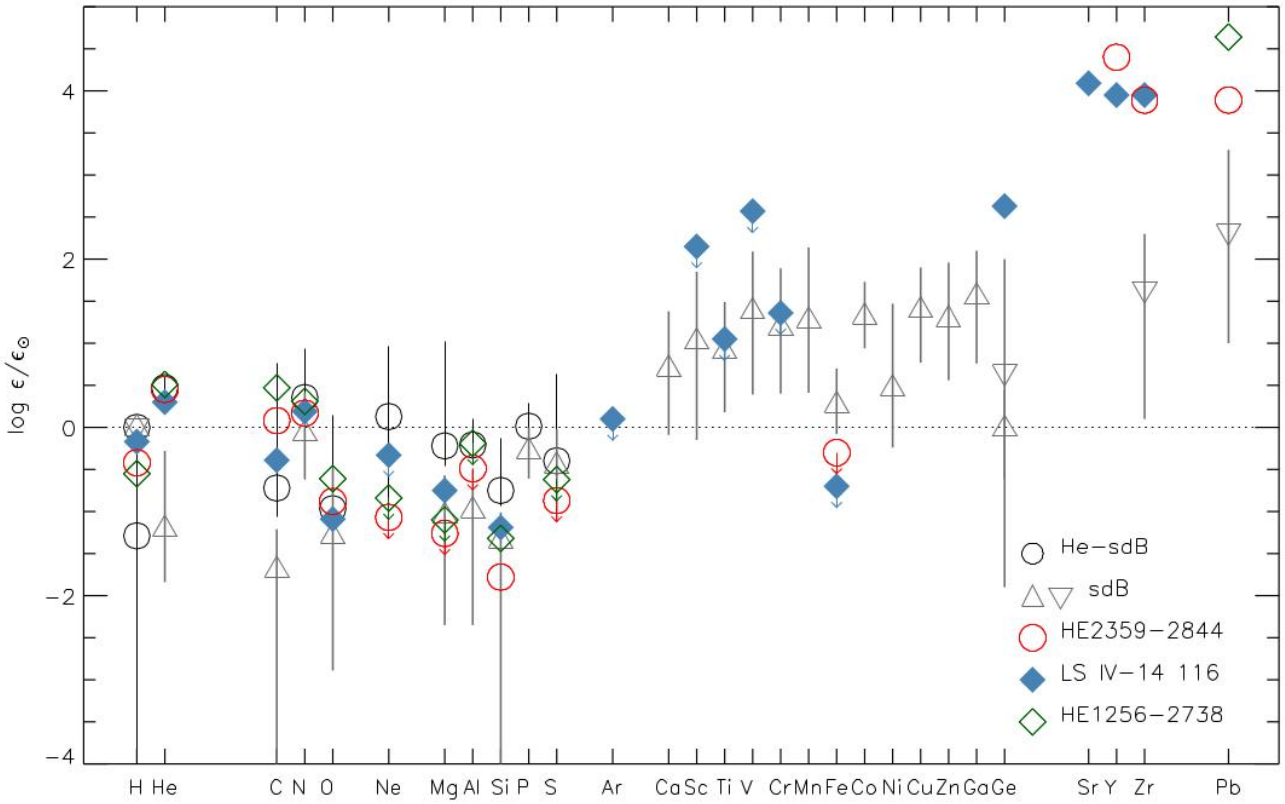
Carbon & nitrogen Abundances For the SPY sdOs

Dicotomy:
„cool“: N-rich
„hot: C-rich

SPY & Galex: C&N abundances



Intermediate He-rich subdwarfs

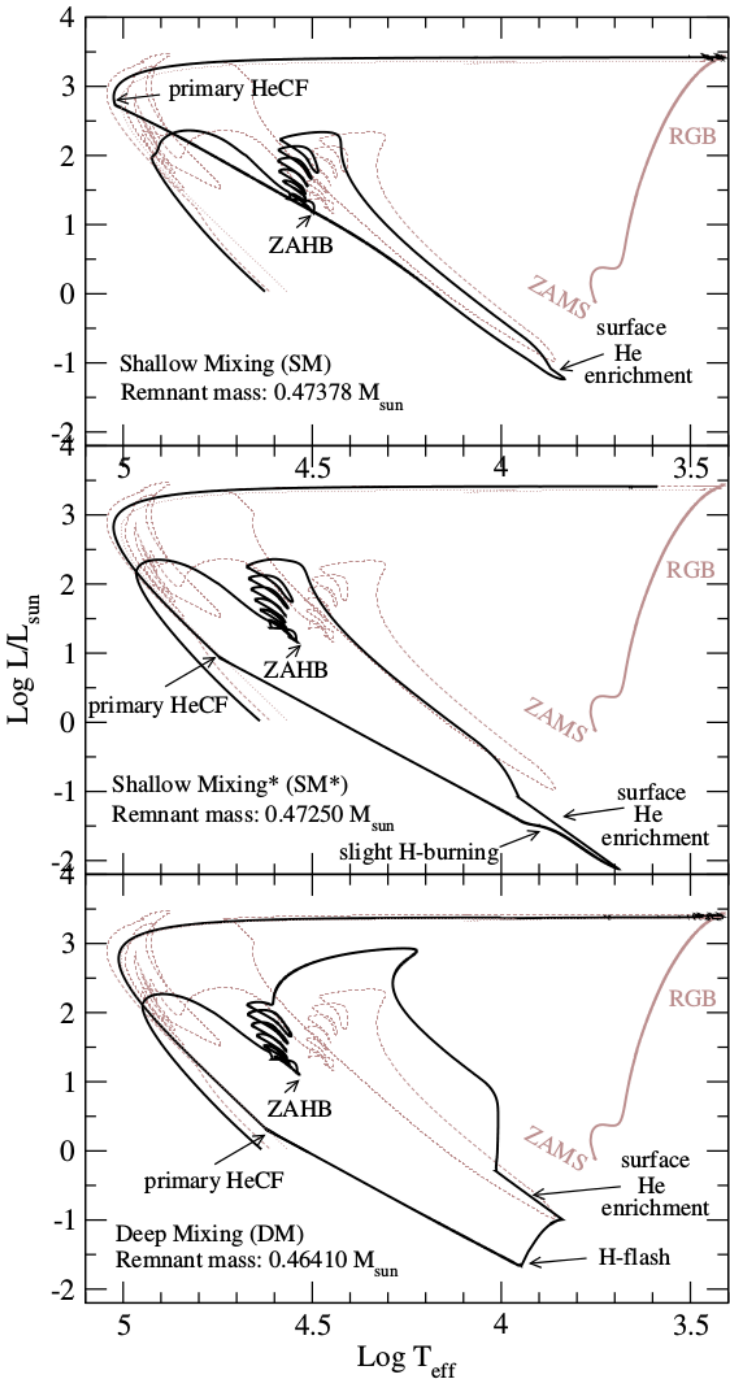


Naslim et al. 2013, MNRAS 434, 1920

HE 2359-2844& HE1256-2738: **Super lead-rich**

Dichotomies

- EHB: extra high gravities sequence
  extra low helium sequence
- sdO: o He-poor connects to low helium sdB
  o He-sdO:
  - intermediate helium-rich connect to „high“ He EHB
  - diffusion driven abundance pattern
  - extremely helium-rich sdO:
- Helium-rich sdOs in Omega Cen ON the EHB

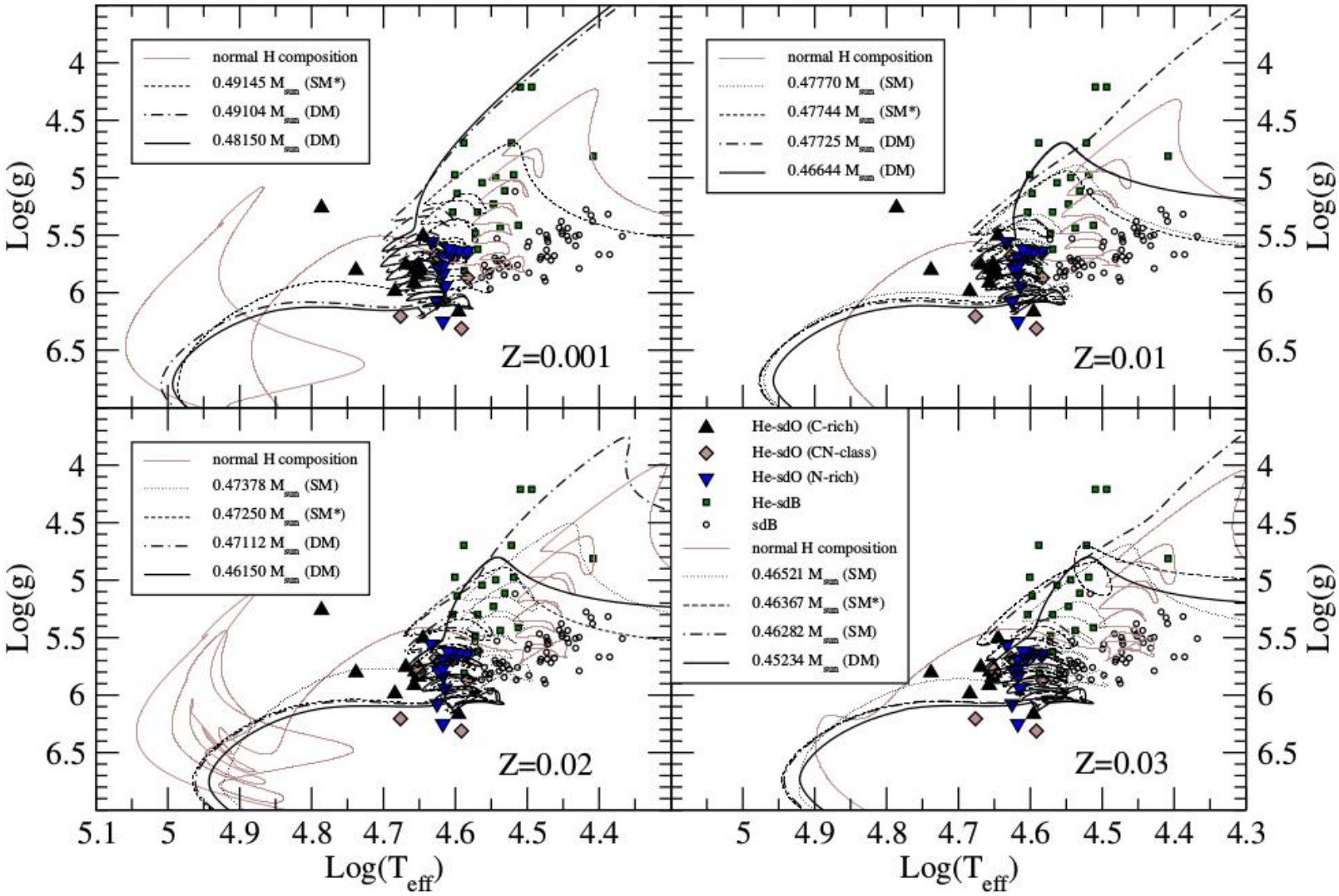


Evolution models for single Hot subdwarfs:
I. Hot flasher

Shallow vs. Deep mixing

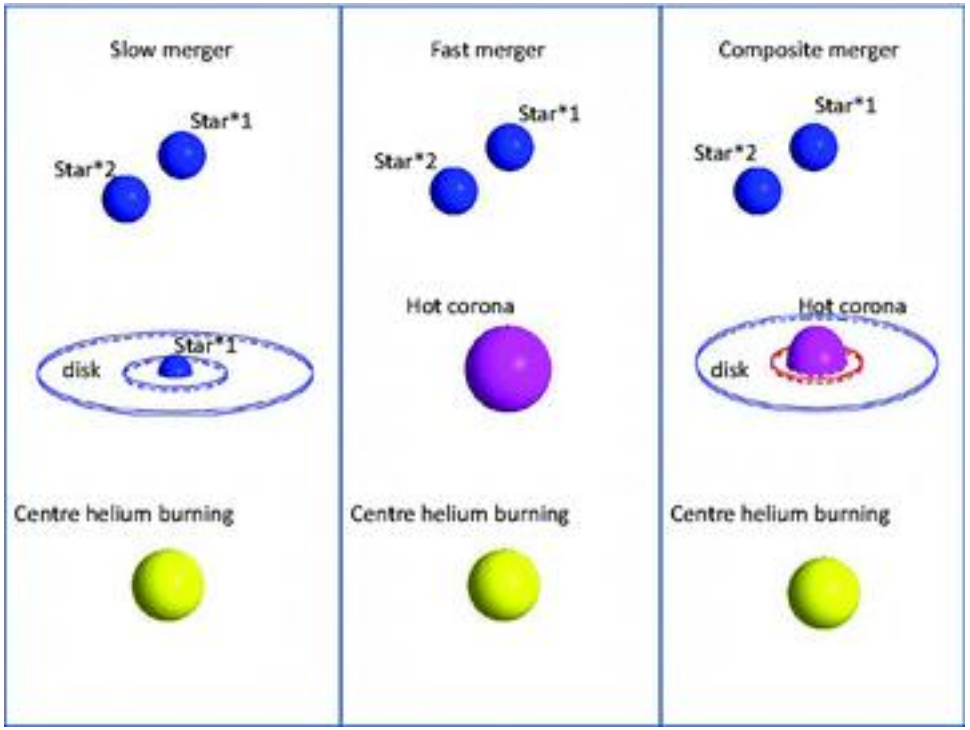
Miller Bertolami et al. (2008, A&A 491, 253)

Comparison of the SPY subdwarfs to Hot flasher models

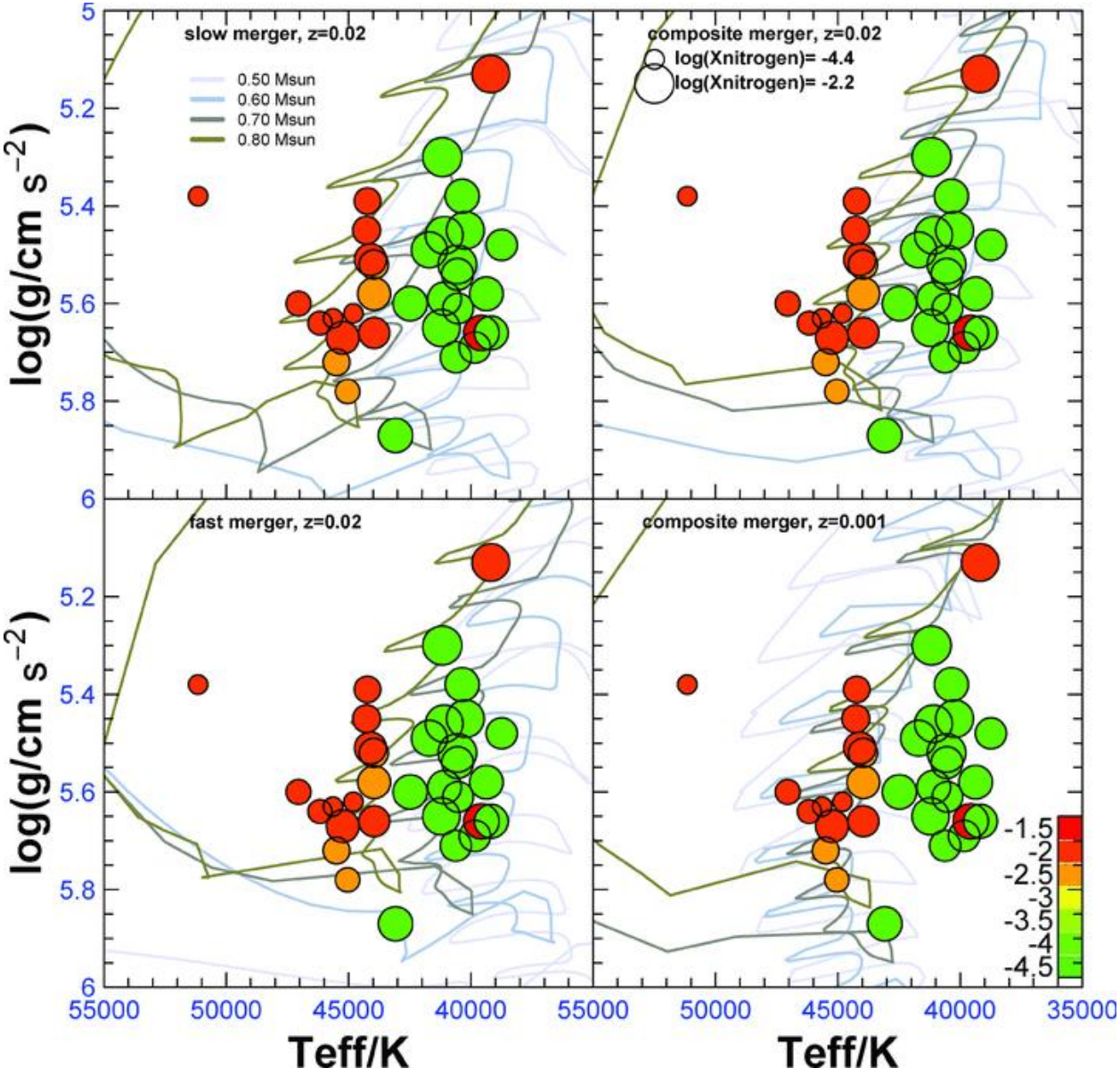


Miller Bertolami et al. 2008

Evolution models II
Helium white dwarf mergers:
Fast or slow?
Hot or cold?



Zhang & Jeffery, 2012, MNRAS 419, 452



Zhang & Jeffery, 2012, MNRAS 419, 452

Compare
the SPY sdOs
to merger models of
Zhang & Jeffery 2012

C-rich He sdOs:

Mass > 0.7 Msun

Summary

- ✓Hamburg surveys provided an important benchmark
- ✓Very good agreement with GALEX sample, although completely different selection bias
- ✓C&N dichotomy of He sdOs can be explained by either hot flasher or merger models. However, Teff/log g can not
- ✓Why is Omega Cen so different?
- ✓We lack halo stars in the field, see poster by Eichie et al.