

Work in progress



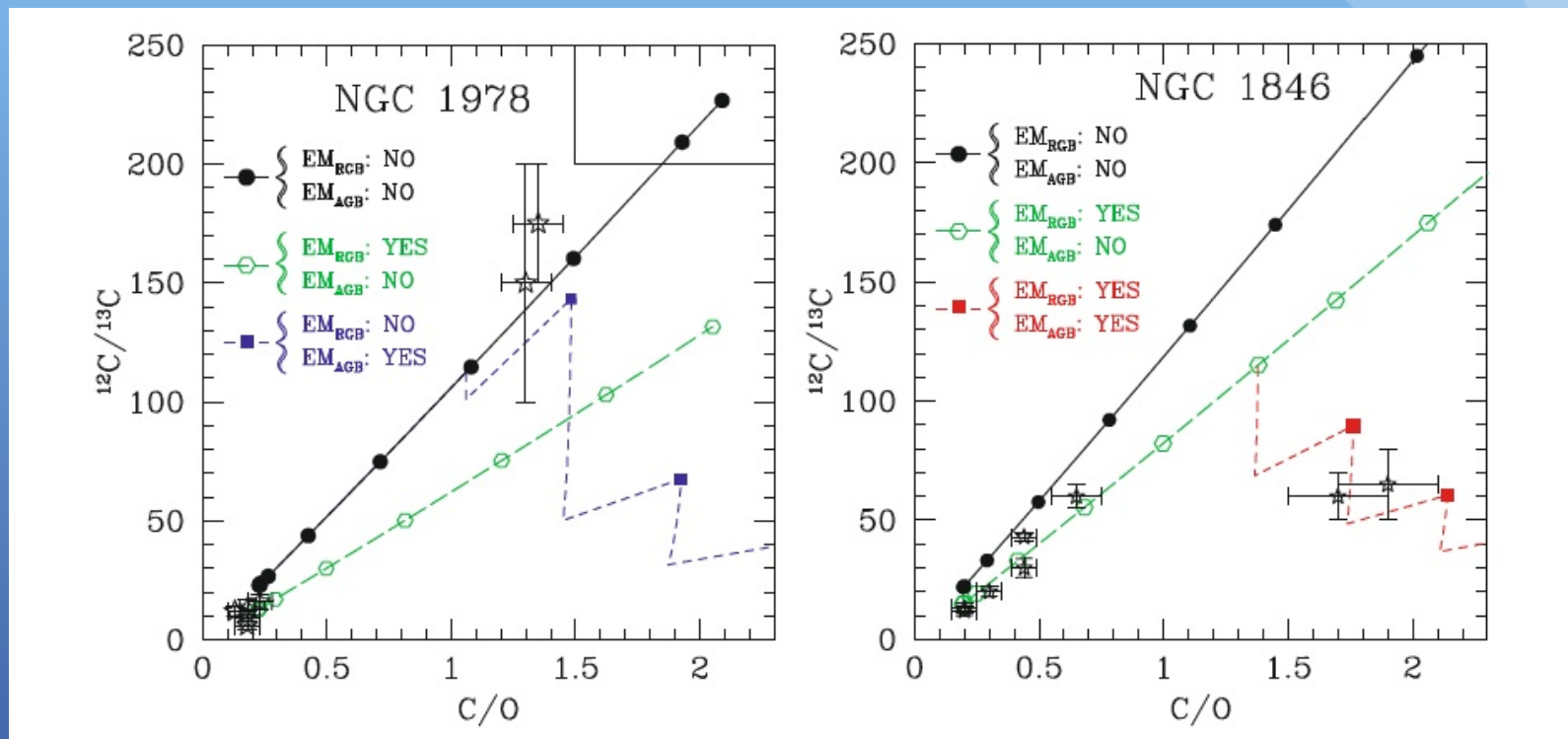
# Isotopes in AGB stars

T. Lebzelter, K.H. Hinkle,  
W. Nowotny, B. Aringer

*Thanks to Oscar Straniero and Peter Wood*

# C,O-Isotopes and Evolved stars

Introduction: see Rutger's talk on Monday morning



Lederer et al. 2009

# A literature review: O-isotopes

- Harris et al. (1985-1988): K and M giants, C-stars, early-AGB stars
- Smith & Lambert (1990): K and M giants, S stars
- Tsuji (2008): K and M giants, early-AGB stars
- Dominy & Wallerstein (1987): 2 S stars
- Abia et al. (2012): few red giants
- Garcia-Hernandez et al. (2010) & Clayton et al. (2005): RCB and HdC stars

# A literature review: O-isotopes

- Arcturus:

	$^{16}\text{O}/^{17}\text{O}$	$^{16}\text{O}/^{18}\text{O}$
Harris	1100 (400)	550 (150)
Abia	3030 (530)	1660 (400)

- Aldebaran:

Harris	600 (300)	475 (200)
Abia	1670 (550)	666 (450)

- OP Her:

Harris	850 (250)
Tsuji	329 ( 31)
Smith	360
our data	589 (150)

# Three diagrams

- The Period-Luminosity relations of AGB stars (e.g. Soszynski, Wood & Udalski 2013)
- The dependency of the  $^{16}\text{O}/^{17}\text{O}$  ratio on mass (e.g. El Eid 1994)
- The oxygen isotopic ratios measured from presolar dust grains (e.g. Nittler 2009)

# The challenges of data analysis

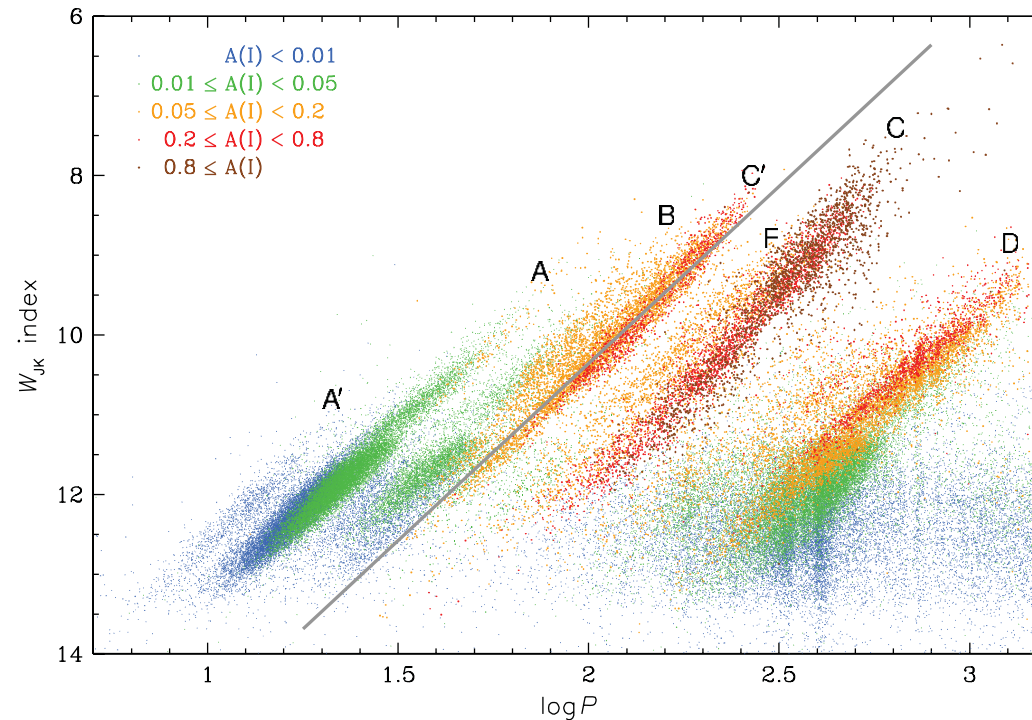
- Stellar parameters:
  - $T_{\text{eff}}$  from literature / spectral type / NIR photometry
  - [Fe/H]: literature (solar)
  - $\log g$ : literature / via period-luminosity relation
- Line blends / line lists
- Placement of the continuum
- Variability

Lebzelter et al. 2012, A&A 547, A108

Lebzelter et al. 2010, A&A 517, A6; Lebzelter et al. 2014, A&A in press

# Results 1

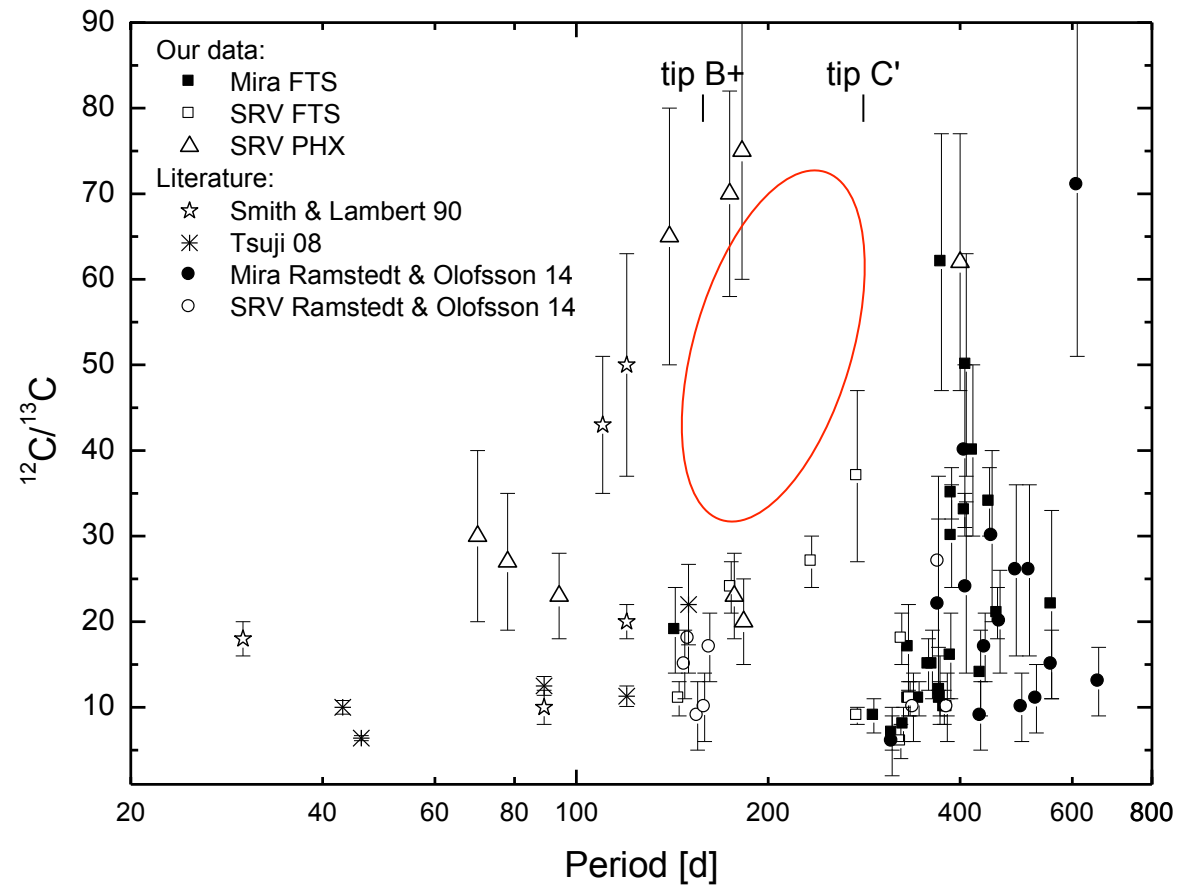
SOSZYŃSKI, WOOD, & UDALSKI



**Figure 1.** PL diagram for LPVs in the LMC. Each star is represented by one point, corresponding to the primary period. Different colors refer to different amplitudes: blue points show LPVs with  $A(I) < 0.01$  mag, green points show LPVs with  $0.01 \text{ mag} \leq A(I) < 0.05$  mag, orange points show LPVs with  $0.05 \text{ mag} \leq A(I) < 0.2$  mag, red points show LPVs with  $0.2 \text{ mag} \leq A(I) < 0.8$  mag, and brown points indicate Mira stars defined as LPVs with  $A(I) \geq 0.8$  mag. The gray solid line shows the fit to the PL sequence C'.

# Results 1

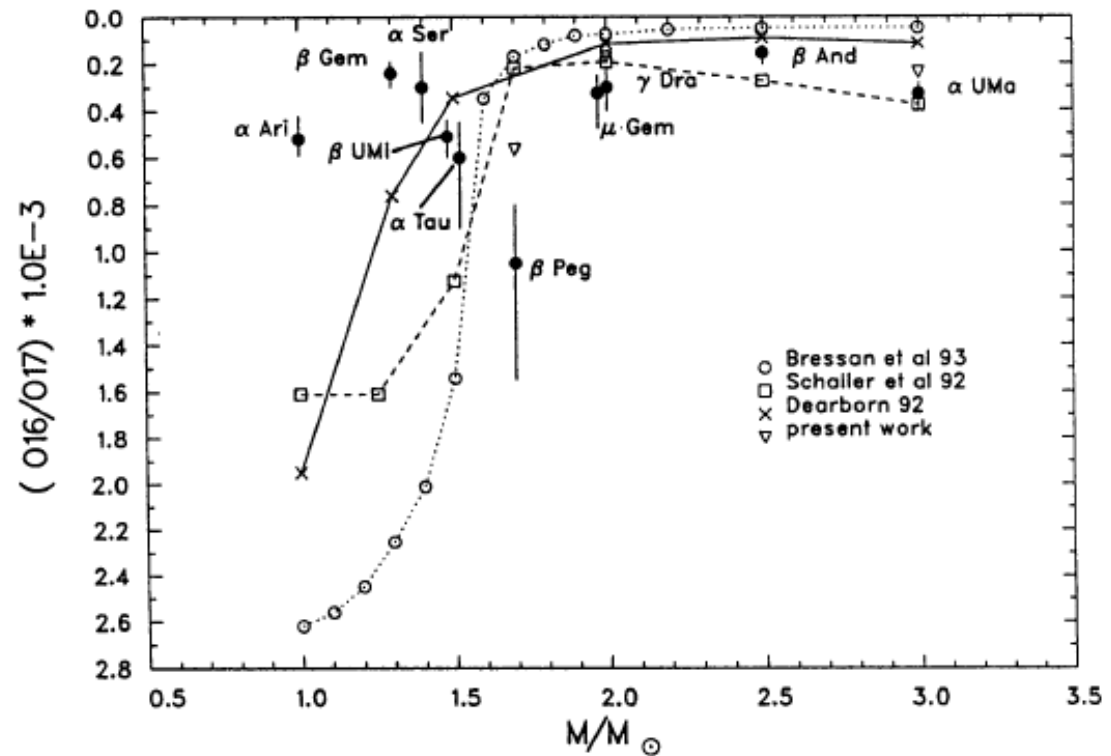
C-Stars  
Lambert et al. 1986





# Results 2

El Eid 1994



**Fig. 7d.** The same as in Fig. 7c focusing on the mass range 1.0 to 3.0  $M_{\odot}$ . A large deviation in the theoretical predictions is visible at  $M \leq 1.7 M_{\odot}$ . For details, see Sect. 4

# Results 2

## Models:

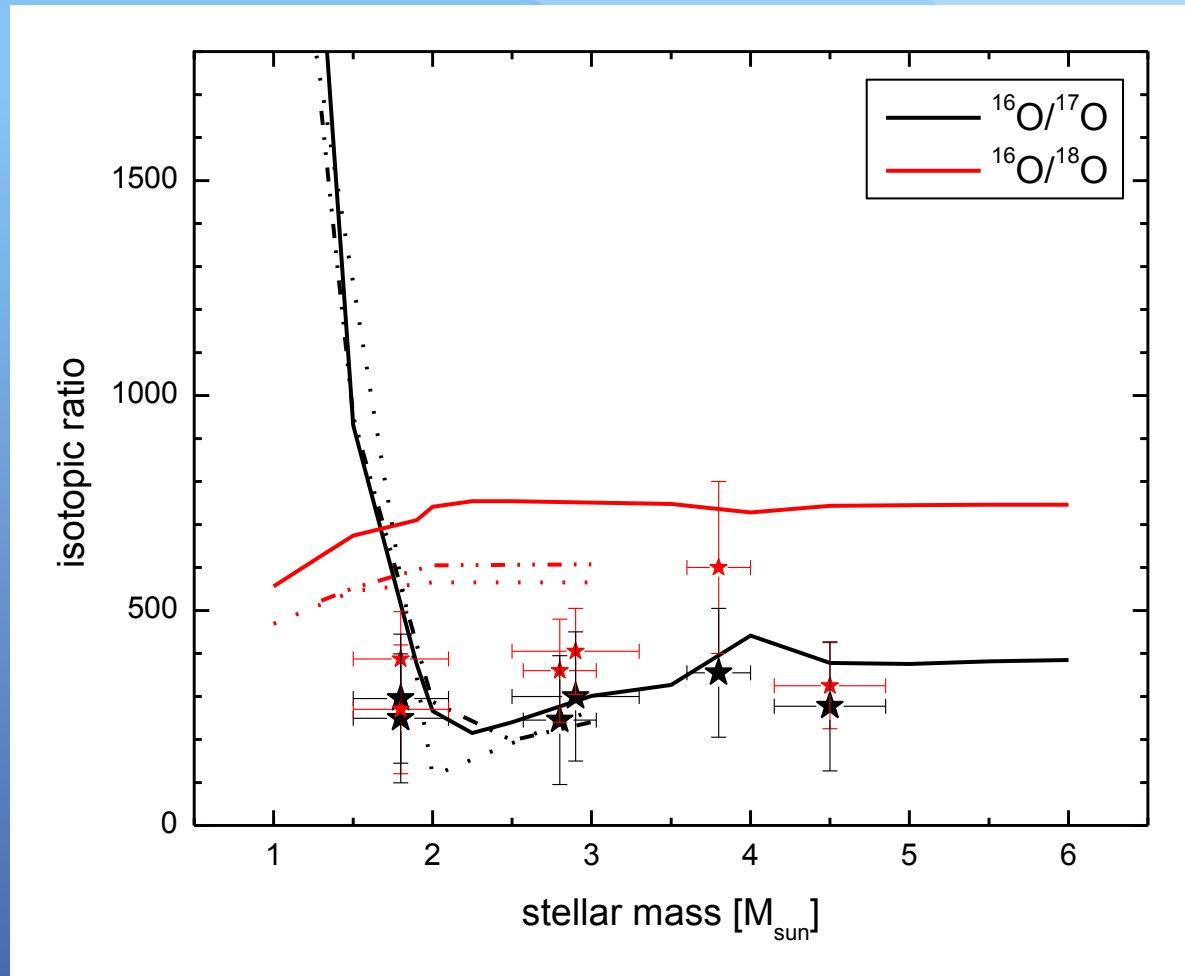
Karakas & Lattanzio 2014  
(solid)

FRUITY 2012  
(dash-dot-dot)

Stoesz & Herwig 2003  
(dot)

## Stellar parameters:

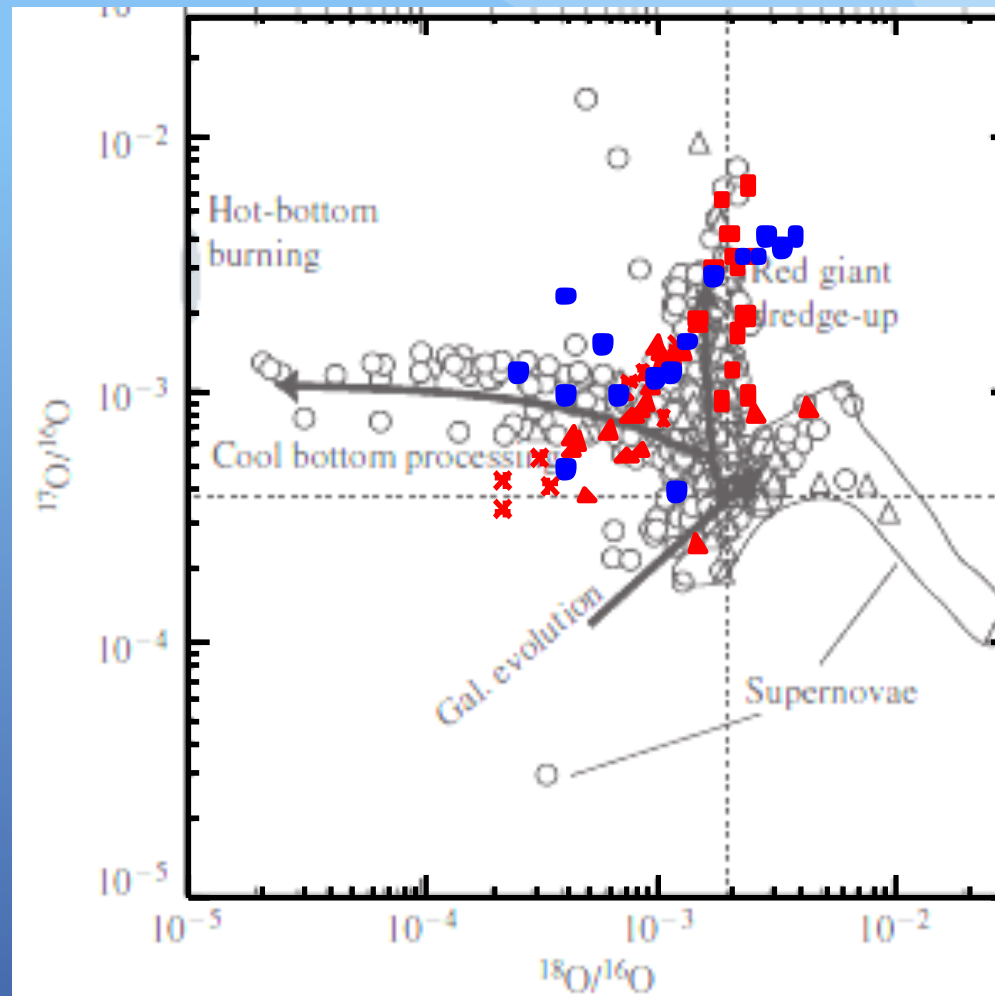
Gilroy 1989



# Results 3

Nittler 2009

Red: Harris et al.  
Boxes: RGB  
Triangles: C-AGB  
Asterisks: M/S-AGB  
Blue: our data



# Summary

- Discovery of a possible link between  $^{12}\text{C}/^{13}\text{C}$  and the P-L-relations for LPVs
- Dependency of  $^{16}\text{O}/^{17}\text{O}$  on mass supported by giants in open clusters
- O-isotopes measured in M-type AGB stars agree with group 2 presolar  $\text{Al}_2\text{O}_3$  dust grains.