Extremely iron-poor O-type stars in the Magellanic Bridge[1]

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Abstract

To study stars analogous to those in the **early Universe** (z>3), we need to probe **low metallicity environments**. Recently, a few O-type stars were identified in the nearby **Magellanic Bridge**, a unique low-density, metal-poor laboratory. With **novel HST-COS observations**, we employed **Bayesian posterior sampling** to measure their inherent **iron abundances** using NLTE atmosphere models with different iron abundances and microturbulent velocities ξ. We found that these stars have **severely sub-SMC iron abundances** reaching as low as 10.8% and 3.6% $X_{\mathrm{Fe},\odot}$, with one star showing **α-enhancement**. These stars are the nearest extremely metal-poor O-type stars discovered to date. The **iron abundances of the stars do not correlate with their oxygen abundances**, highlighting the problem of using oxygen-based metallicities. The proximity of the stars in the Bridge combined with their different abundance patterns underlines that the ISM of the Magellanic Bridge must be highly inhomogeneous and is not properly mixed.

Introduction

- Magellanic Bridge: nearest tidally interacting environment
- Distance to Bridge: 55 kpc[3]
- Average Bridge metallicity: $Z \lesssim 0.1\, Z_\odot$ – sub-SMC, can otherwise only be found in more distant dwarf galaxies (e.g. [4])

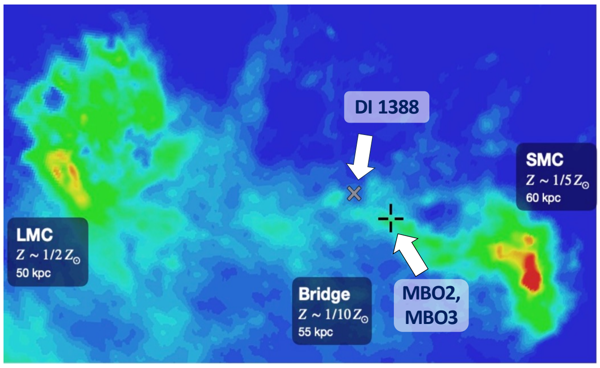

Fig. 1: HI map of the Magellanic Clouds and Bridge from the HI4PI survey

Bayesian inference of the iron abundance

- **Aim**:
  - Precisely measure Fe abundance with uncertainties in O stars
- **Method**:
  - Synthetic spectra from non-LTE atmosphere models (PoWR[5])
  - Bayesian fit to Fe IV and FeV forest lines in HST-COS UV spectra
- **Challenges**:
  - Degeneracy of Fe abundance (X_{Fe}) with microturbulence (ξ) and normalization shift of spectra

  → Fit X_{Fe} and shift simultaneously, weight result with ξ fit
- Stellar parameters were obtained from optical data[2] and fixed

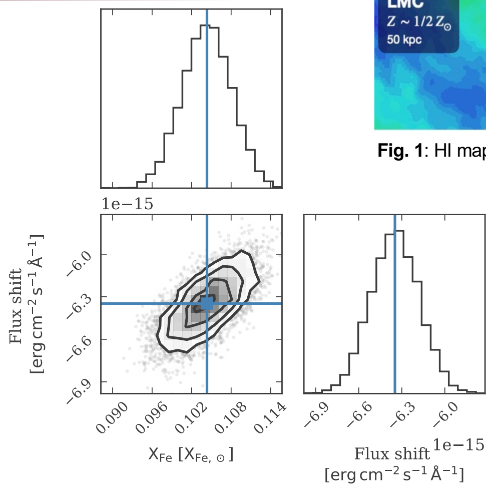

Fig. 2: Corner plot for the fit of X_{Fe} and a flux shift for MBO2 and fixed $\xi = 2\ \mathrm{km\,s^{-1}}$.

Determining microturbulence

- Fit models with different ξ to Sv line and weight posterior distribution by χ^2 of fit

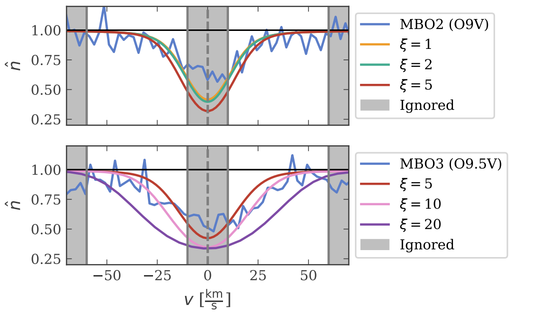

Fig. 3: Comparison of the observed and modeled Sv line for different ξ for MBO2 (top) and MBO3 (bottom) in velocity space. The defined wing region in which we evaluated χ^2 is highlighted.

Nearest most iron-poor O stars

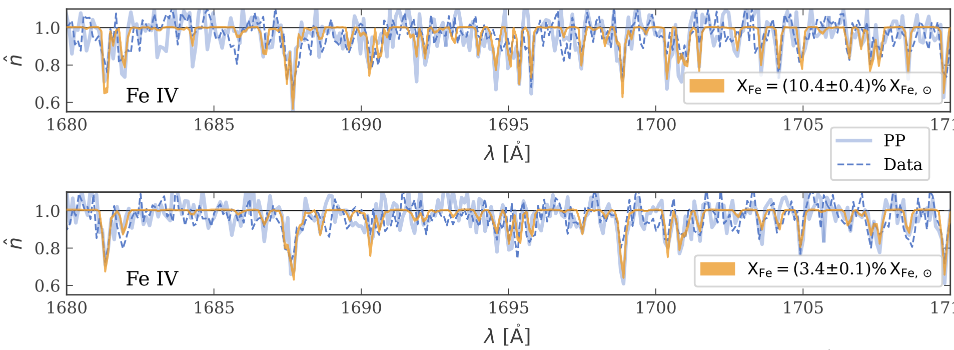

Fig. 4 Comparison of the observed and best-fit modeled Fe iv forest of lines for fixed ξ = 2 km s $^{-1}$ for MBO2 (top) and ξ = 10 km s $^{-1}$ for MBO3 (bottom).

HST Name	Sp. Type	[Fe/H]	[O/H]
MBO2	O9V	-0.97	-1.43
MBO3	O9.5V	-1.44	-0.98
DI1388	B0	-0.69	-0.50[6]

→ No simple scaling between O and Fe abundance

Tab. 1: Comparison of the abundance measurements of hot massive stars in the Magellanic Bridge.

Signs of α-enhancement

- MBO3, which has the lowest iron content, shows significant α-enhancement

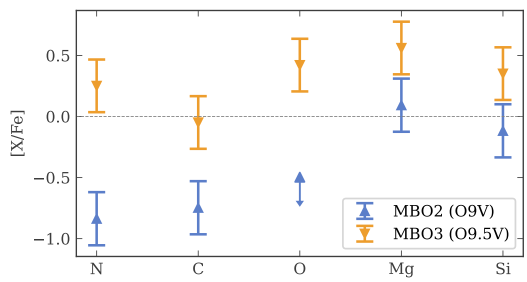

Fig. 5: Depletion of metals relative to Fe. Only an upper limit was determined for the oxygen abundance of MBO2[2] (arrow).

References

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