The recent discovery of two extremely metal-poor dwarf stars in the Galactic halo

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Tokyo 20181203
Introduction: The Early Universe

The first stars and their descendants

**First star**

Massive blue star (100 solar masses)

Blue giant

ONE OF THE FIRST STARS would have been extremely massive — 100 solar masses in this example — formed mostly from hydrogen, helium, and a tiny amount of lithium gas. After just a few million years, the star burned its fuel and ended in fantastic style: as a huge explosion. The star’s material — including heavy elements — was ejected. Either its core collapsed as the first black hole, or the explosion was powerful enough to blow up completely and scatter the star’s material throughout space.

**POPULATION III**
Introduction: The Early Universe

Metal-poor stars

4MOST collaboration
1-Methodology to find Metal-Poor Stars
1-Methodology to find Metal-Poor Stars

\~10,000,000 spectra from SDSS and LAMOST or PRISTINE and J-plus
1-Methodology to find Metal-Poor Stars

≈3,000,000 spectra

≈500 candidates to observe with ISIS at WHT or with OSIRIS at GTC

≈3,000,000 spectra from SDSS and LAMOST
1-Methodology to find Metal-Poor Stars

Aguado+ 2016
1-Methodology to find Metal-Poor Stars

- ~3,000,000 spectra from SDSS and LAMOST
- ~500 candidates to observe with ISIS at WHT or with OSIRIS at GTC
- 6 UMP stars

- ~3,000,000 spectra from SDSS and LAMOST
1-Methodology to find Metal-Poor Stars

Aguado+ 2016

![Graph showing normalized flux vs. wavelength with peaks labeled MgI, FeII, MgI, FeI and a spectrum for J0140+2344.](image)
2-Spectroscopic analysis with FERRE

- FERRE is a FORTRAN code developed by Allende Prieto (Allende+ 2014)
- FERRE is able to compare data with a grid of theoretical models
- FERRE searches for the best solution on the N space parameters
- FERRE interpolates between the nodes of the grid
2-Spectroscopic analysis with FERRE
2-Spectroscopic analysis with FERRE

Allende Prieto+ (2014)
2-Spectroscopic analysis with FERRE

Aguado+ (2017a)
2-Spectroscopic analysis with FERRE

Aguado+ (2017a)
2-Spectroscopic analysis with FERRE

SDSS J1313−0019

T=5525 K logg=3.6 [Fe/H]=−4.7 [C/Fe]=2.8

Allende Prieto+ (2015)
Frebel+ (2015)
Aguado+ (2017a)
2-Spectroscopic analysis with FERRE

Aguado+ (2017b)
3-The Discovery of J0815+4729

Aguado+ (2018a)
3-The Discovery of J0815+4729

Aguado+ (2018a)

極超金属欠乏星！
4-The Discovery of J0023+0307

Aguado+ (2018b)
4-The Discovery of J0023+0307

Aguado+ (2018b) 極超金属欠乏星 !!!
4-UVES spectrum of J0023+0307

Aguado+ (2018, submitted)
4-UVES spectrum of J0023+0307

Aguado+ (2018, submitted)
4-UVES spectrum J0023+0307

Aguado+ (2018, submitted)
4-The Discovery of J0023+0307

Aguado+ (2018, submitted)
4-The Discovery of J0023+0307

Aguado+ (2018, submitted)

Table 1: All the $T_{\text{eff}}$ derived values considered in this work and explained in Section 3

<table>
<thead>
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<th>Source</th>
<th>Ref.</th>
<th>$T_{\text{eff}}$</th>
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<td>OSIRIS spectrum</td>
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<tr>
<td>(V-I)</td>
<td>(6)</td>
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<td>130</td>
</tr>
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References: (1) Aguado et al. (2018a), (2) François et al. (2018), (3) This work, (4) González Hernández & Bonifacio (2009), (5) Casagrande et al. (2010), (6) Frebel et al. (2018)
5-Summary

![Graph showing the relationship between $\text{Teff}$ and $\text{[Fe/H]}$. A single point is marked at $1984$.](image)
5-Summary

![Graph showing Teff vs. [Fe/H] with a data point in 1984]
5-Summary
ありがとう！