Far-UV spectroscopy of white dwarfs

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Introduction

- Hot white dwarfs contain significant quantities of metals, including Fe and Ni
- The far-UV is the best (only) spectral range for their study
- High resolution, S/N HST/STIS studies of the fine structure constant
- A large FUSE survey of photospheric abundances
A typical hot H-rich white dwarf
G191-B2B (H-rich DA)

- Best-studied DA with S/N~50-100
- $T_{\text{eff}} = 52,500 \pm 900K$, $\log g = 7.53 \pm 0.09$
- Rich (for a white dwarf) in metals - C, N, O, Al, Si, P, S, Fe, Ni, Ge
- $\sim$950 lines present in FUSE & HST/STIS spectra
Fine structure constant ($\alpha$) variation

- Coupling constant characterising strength of the electromagnetic interaction
- High gravitational field of white dwarf results in very small (but potentially detectable) shift in wavelength
- Effect larger for high Z atoms (i.e. Fe, Ni!)
Challenges in UV Astronomy - 7th October 2013

White Dwarf Star
G191-B2B

Hubble Space Telescope

Spectrum if $\alpha$ depends on gravity

Spectrum if $\alpha$ doesn't depend on gravity
\[
\frac{\Delta \lambda}{\lambda_0} = z - Q_\alpha \frac{\Delta \alpha}{\alpha} (1 + z)
\]

\[
\frac{\Delta \alpha}{\alpha} \text{ Fe} = (4.2 \pm 1.6) \times 10^{-5} \quad \frac{\Delta \alpha}{\alpha} \text{ Ni} = (-6.1 \pm 5.8) \times 10^{-5}
\]

Blue Circles: Fe V  
Red Squares: Ni V
FUSE survey of composition (89 stars)

- Pure H
- Metals

Temperature Range (K):
- 20-30k
- 30-40k
- 40-50k
- 50-60k
- 60-70k

Percentage of Stars
- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%
Conclusions

• Fine structure constant
  - Need improved $\lambda\lambda$ accuracy
  - More high S/N spectra... range of gravities

• White dwarf abundances
  - Metals present in some WDs at all $T_{\text{eff}}$
  - C is depleted cf. Si... rocky material?
  - Radiative levitation is not dominant effect
  - WDs accreting from debris