SAND2010-5945C

Recreation of White Dwarf Photospheric Conditions on Z

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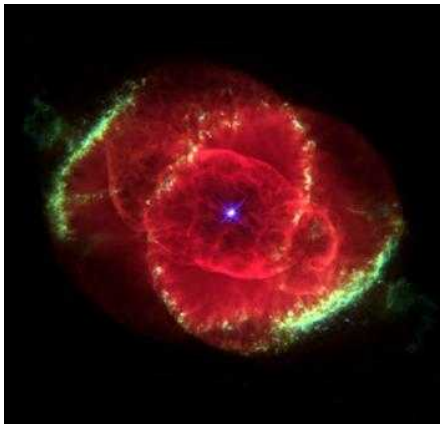
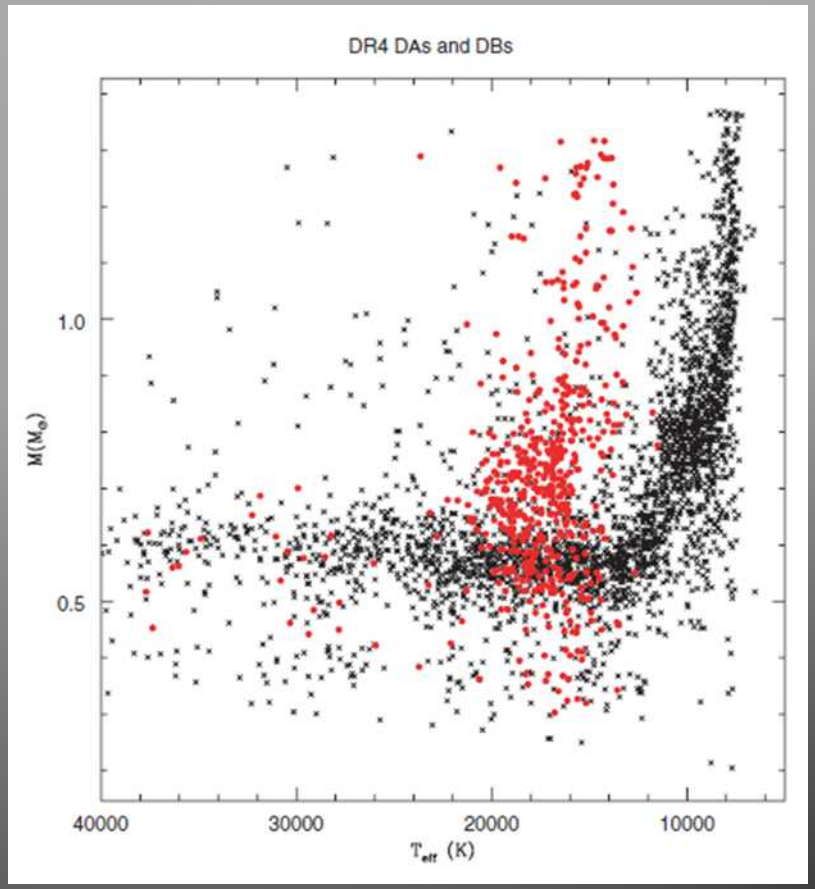
Eddington's "Impossible Star"…



- ~0.6$M_\odot$ contained in an object about the size of Earth.
  - Supported by electron degeneracy pressure.
- White Dwarfs are the end point in the evolution of ~97% of all stars.
- They are no longer fueled by fusion reactions, simply sitting and cooling off over time.
- Come in three flavors: essentially pure Hydrogen, Helium, and Carbon outer shells.

The Problem…

- "White Dwarf Upturn"
- There is an observed systematic increase in average measured white dwarf masses below temperatures of about 11500K.



Not a physical trend…

- Gravitational Redshift
  - $\Delta\lambda/\lambda = \Delta E/E = \Phi/c^2$ $\quad v_g = c*\Delta\lambda/\lambda = GM/Rc$
- With a large enough well distributed sample set radial velocity components can be averaged out, leaving only gravitational contributions.
- Falcon et al 2010 measured a mean white dwarf mass of $0.647 \pm 0.014 M_\odot$

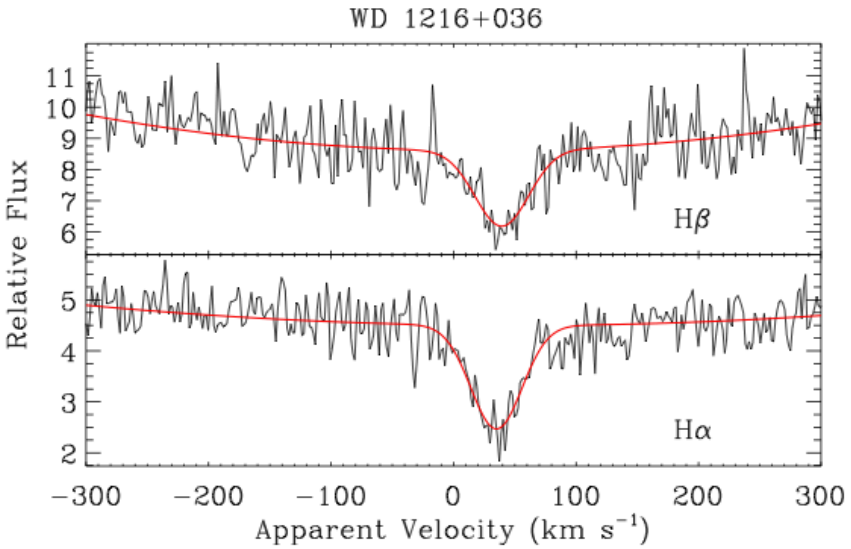
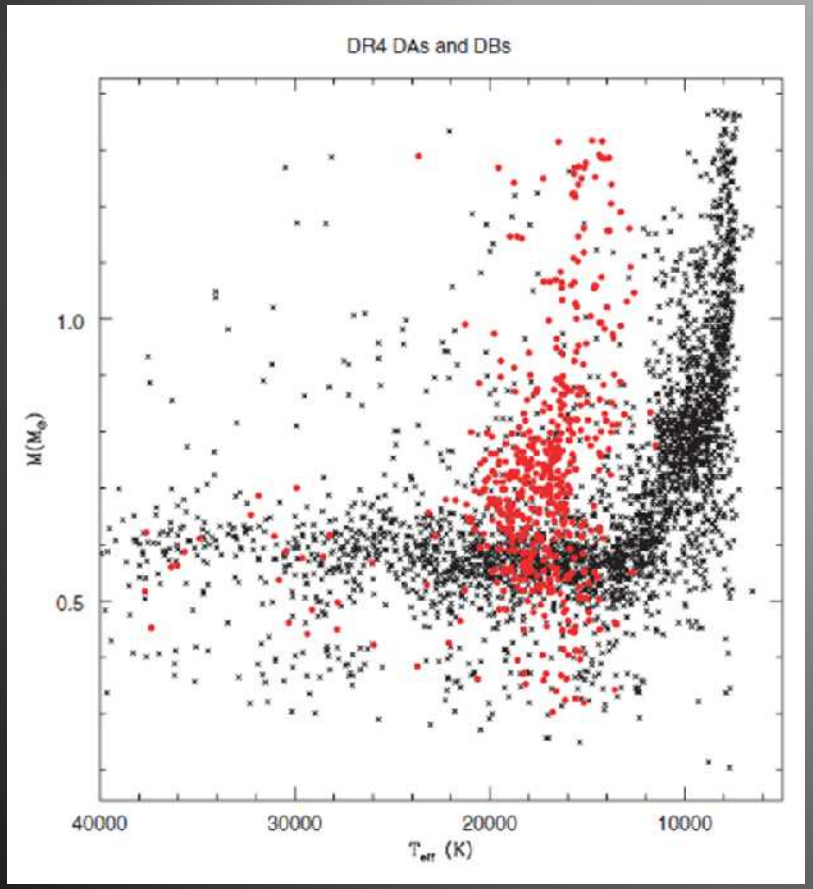
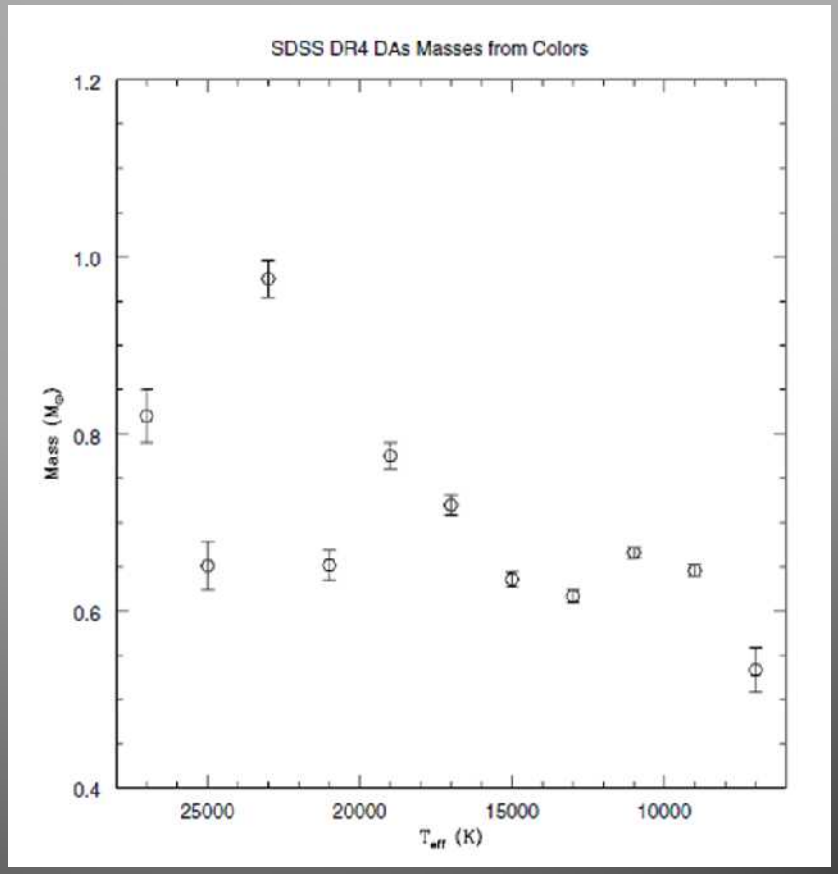


Image from Falcon et al 2010

Model Atmosphere mass determination…



- Masses determined by full spectral fits to atmospheric models.



- Masses derived by the comparison of only color bands to those predicted by atmospheric models.

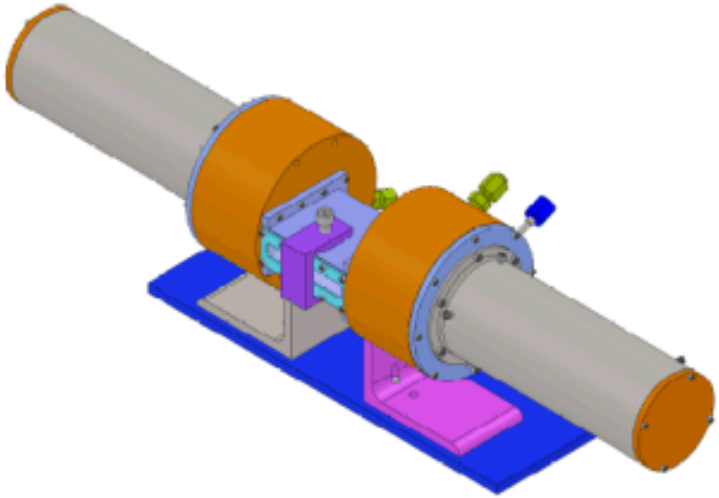
Graphs from Kepler et al, 2007

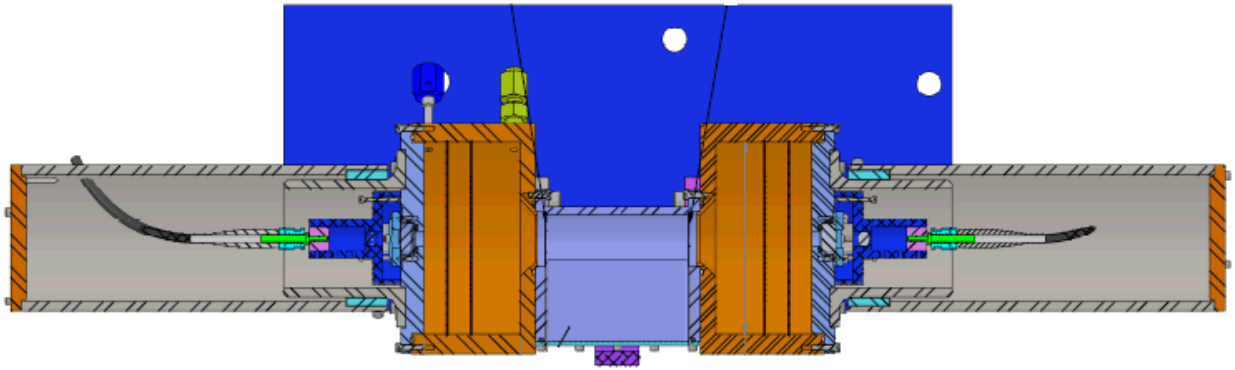
If the problem's in the lines…

- The line profiles of white dwarf spectra are characterized by heavy Stark broadening.
- Spectral lines are shifted in the presence of an external electric field – this is the Stark effect.
  - In a plasma ions and free electrons create local electric fields.
  - These varying local fields create a combined broadening of the spectral lines – Stark broadening.
- If Stark broadening isn't understood under the applicable conditions it could be the source of problems with the models.

So what are we gonna do…

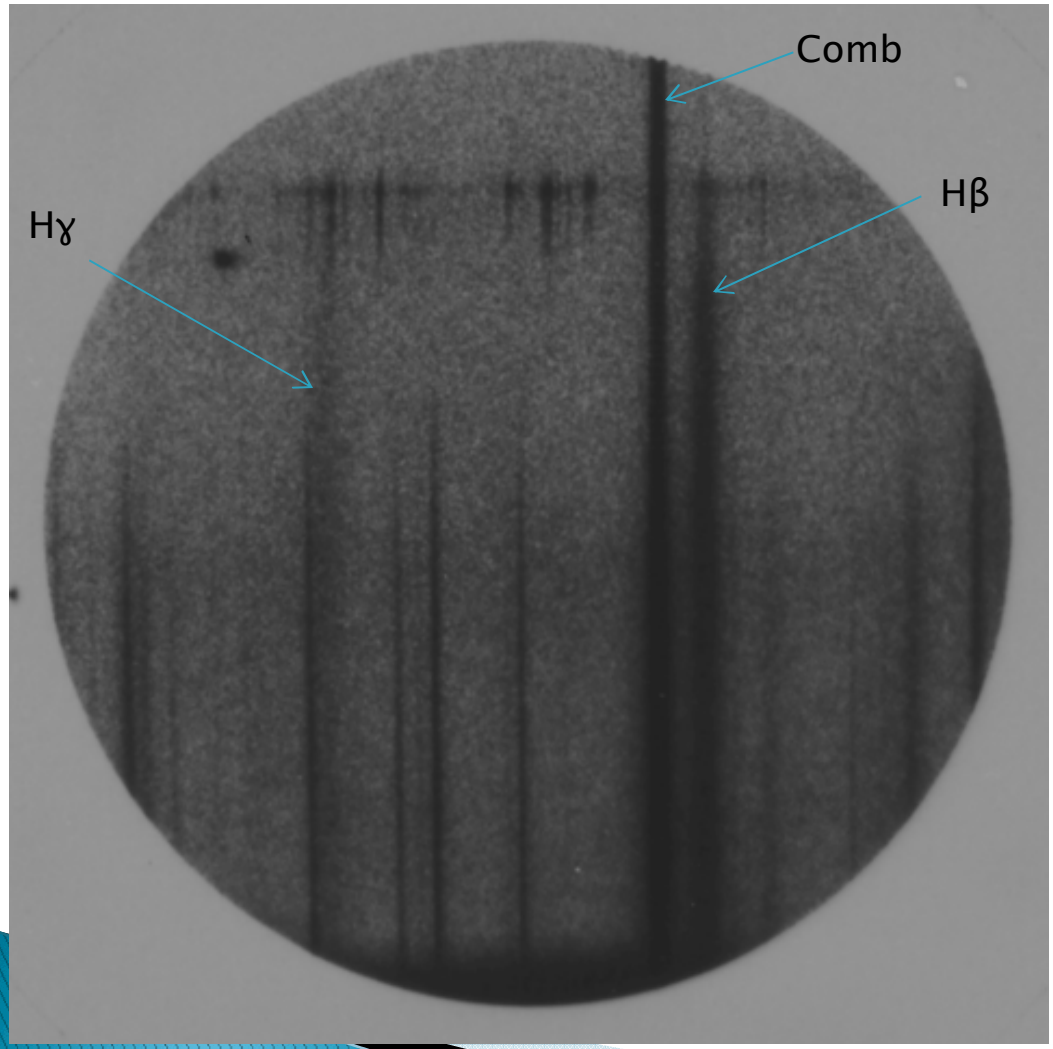
- We can utilize Z to reach the conditions of white dwarf photospheres then directly measure Stark broadening of Hydrogen.
  - ~ 1eV, $10^{17} n_e/cm^3$



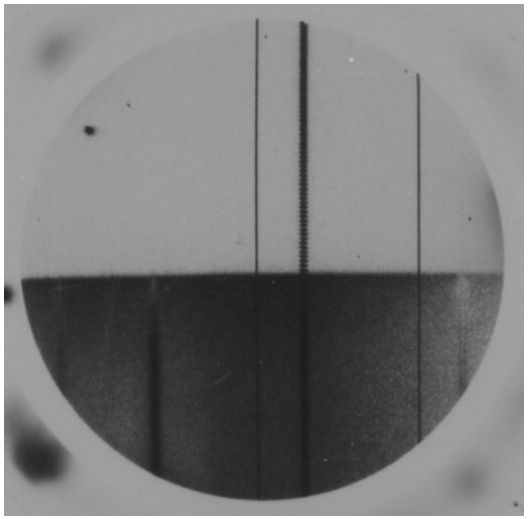


What do we see…

Z2129



Z2084



Future Plans…

Diagnostic:

- Implement a second, time integrated, spectrometer.
- Absolute calibrations.
- Spectrally independent measures of temperature and electron density.

Measurements:

- Make similar measurements with Helium, then Carbon, gas fills.
- Place gas cell in a magnetic field.

Acknowledgements…

- Ross Falcon
- Matthew Gomez
- Pat Lake and Alan Carlson
- The SEERI Program