Understanding the Fossil Magnetic Fields of Ap/Bp Stars: Conclusions From a Volume-Limited Survey

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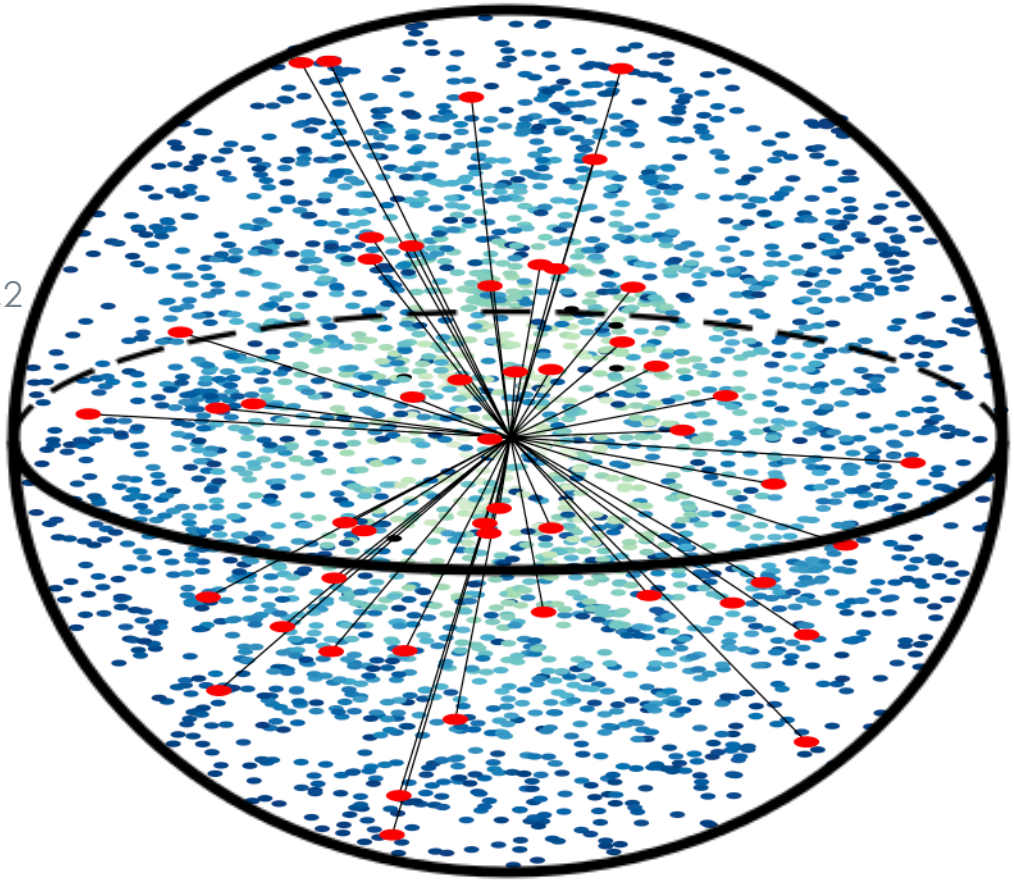


Understanding the Fossil Magnetic Fields of Ap/Bp Stars: Conclusions From a Volume-Limited Survey

Power MSc Thesis, 2007 - 2017

James Sikora

Aug. 29, 2017

Survey Goals

Obtain a complete, unbiased spectropolarimetric survey of nearby Ap/Bp stars

- Test for the existence of the "magnetic desert"
- Derive self-consistent fundamental, chemical, and magnetic properties of these Ap/Bp stars
- Compare the samples of Ap/Bp and A/B ("normal")

The Sample

Catalogue of chemically peculiar stars (Renson & Manfroid 2009)

with parallax angles ≥ 10 mas (van Leeuwen 2007)

Candidate Ap/Bp Stars

1. Known to be magnetic?

2. Exhibits photometric variability?

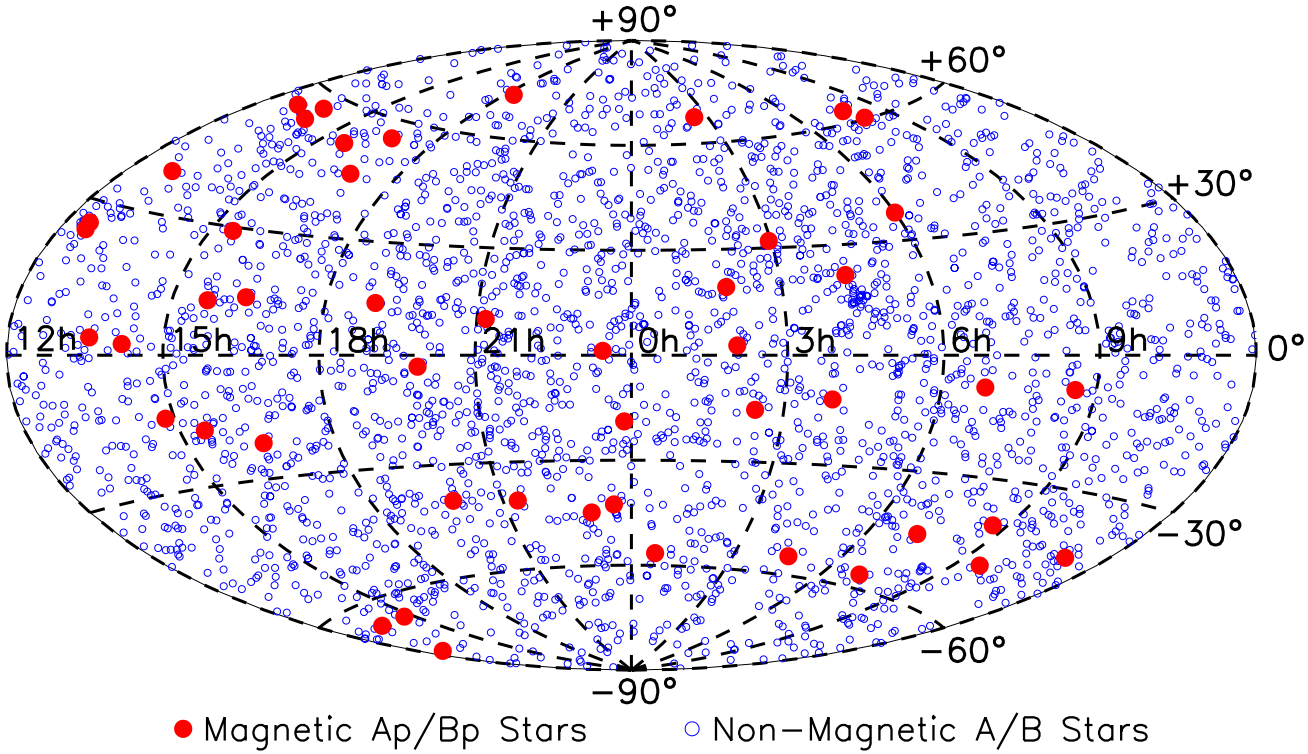
3. Satisfies photometric peculiarity relations?

(Paunzen & Maitzen 2005)

The Sample

Hipparcos catalogue within 100 pc:

- ~19,000 stars
- ~3,000 MS A/B stars within 100 pc



Fundamental Parameters

- **LLmodels** (Shulyak et al. 2004)
  - Calculate model atmospheres (and synthetic SEDs) with **chemical peculiariaties** and strong magnetic fields (Kochukhov et al. 2005)

- **Grid Search in Stellar Parameters** (GSSP) (Tkachenko 2015)

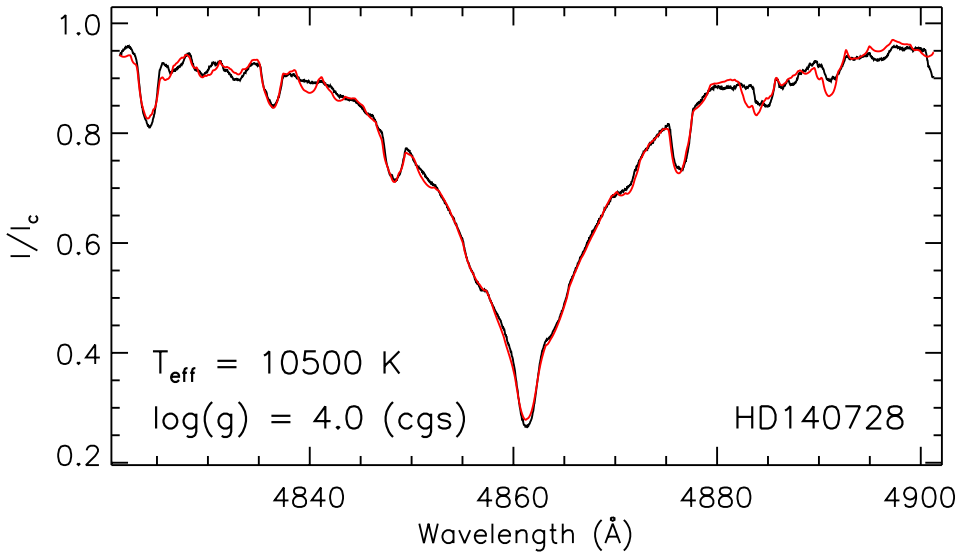
$$F = F(\log g, v \sin i, \xi_{mic}, X_i)$$

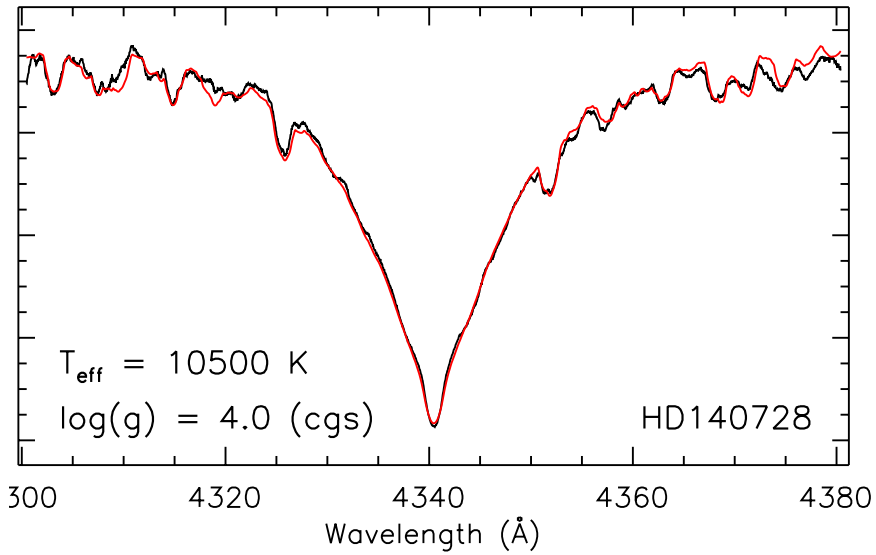
1. Fit synthetic SEDs to available photometry
2. Fit model spectra to averaged Balmer lines
3. Generate new chemically peculiar atmospheric models/SEDs

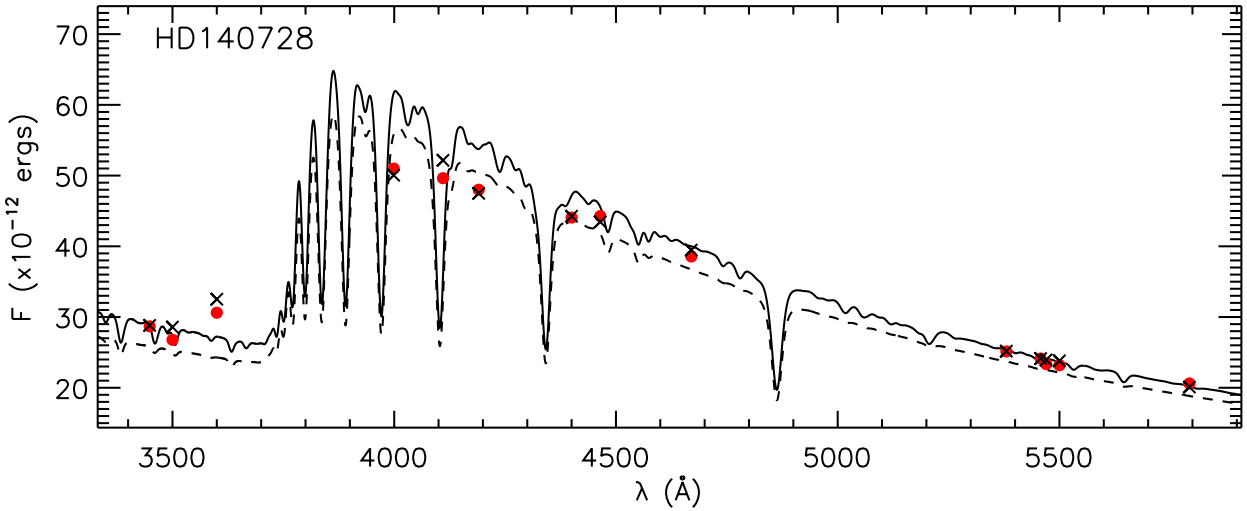
(e.g. Silvester et al. 2015)

Centre for Advanced Computing

Fundamental Parameters







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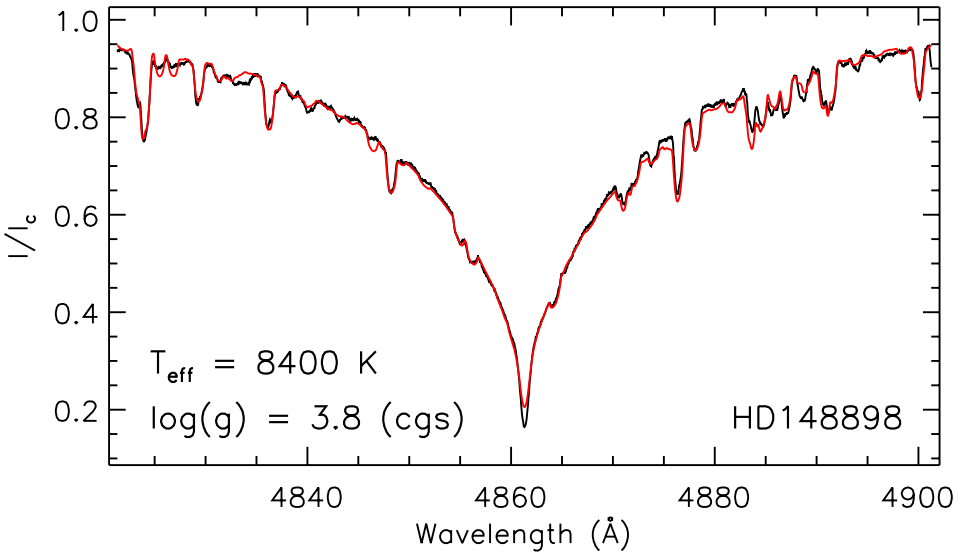

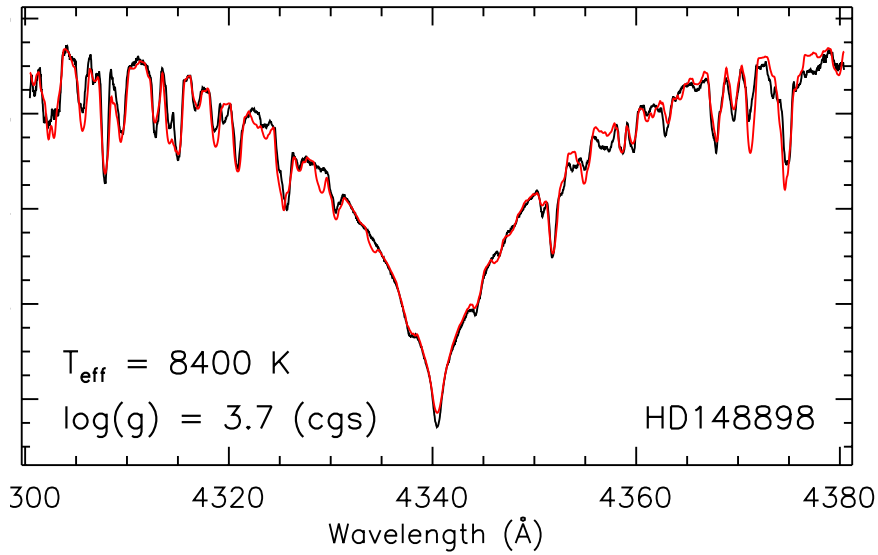

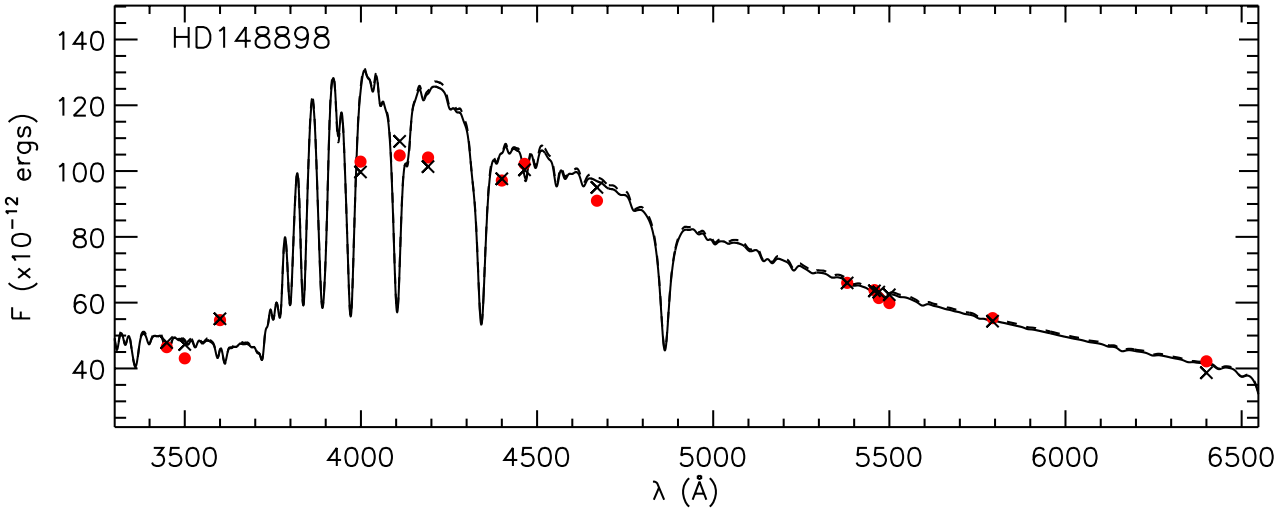

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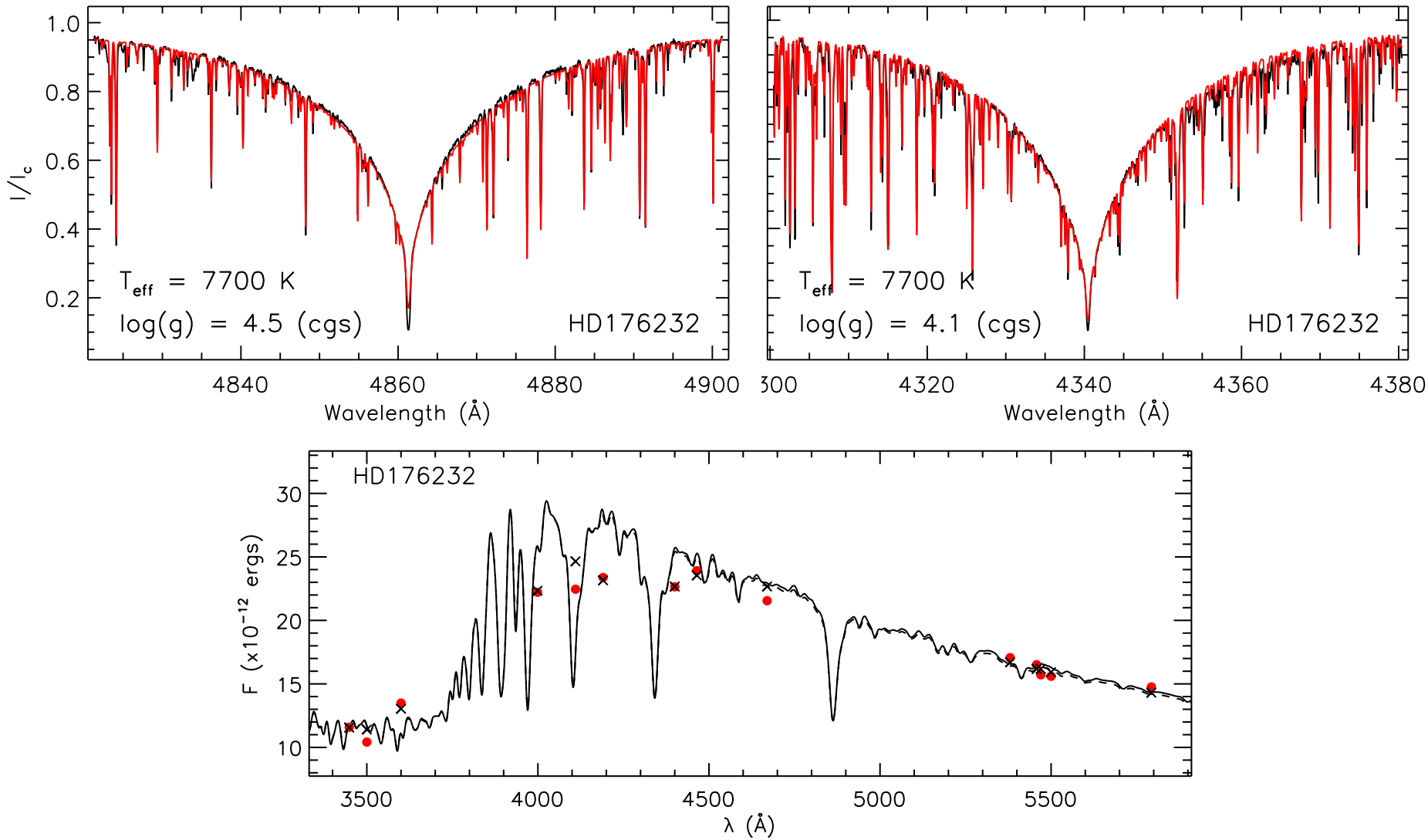

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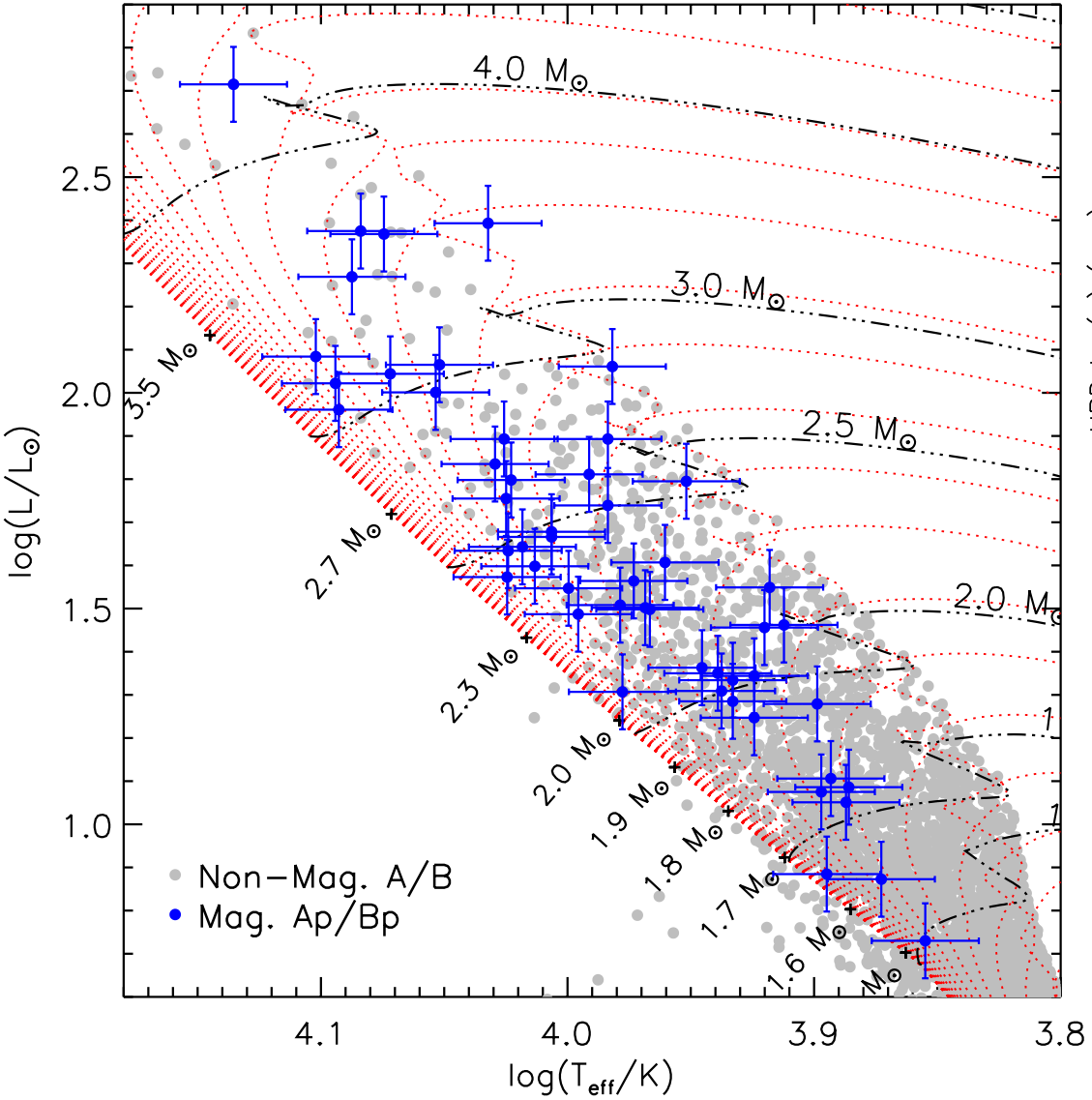
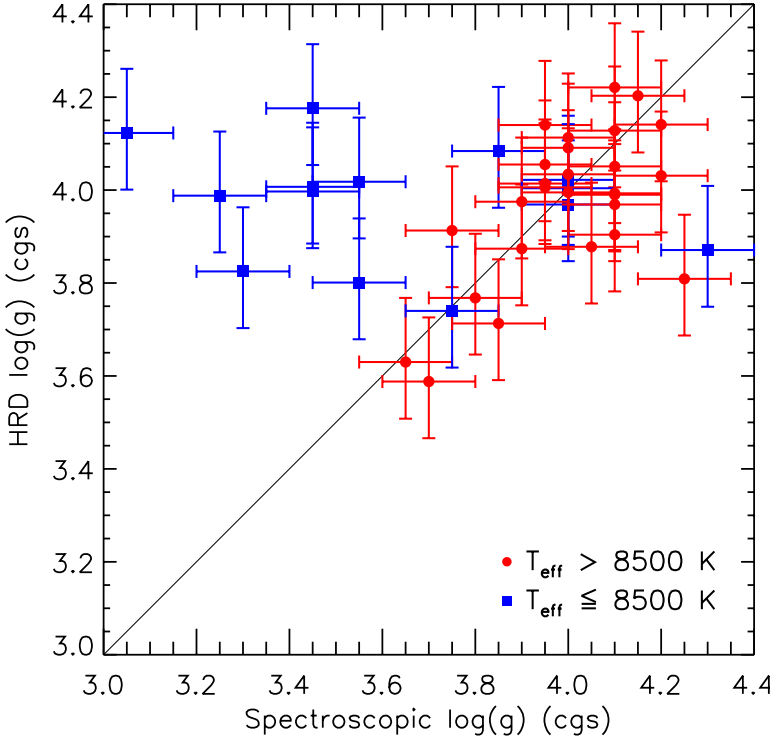
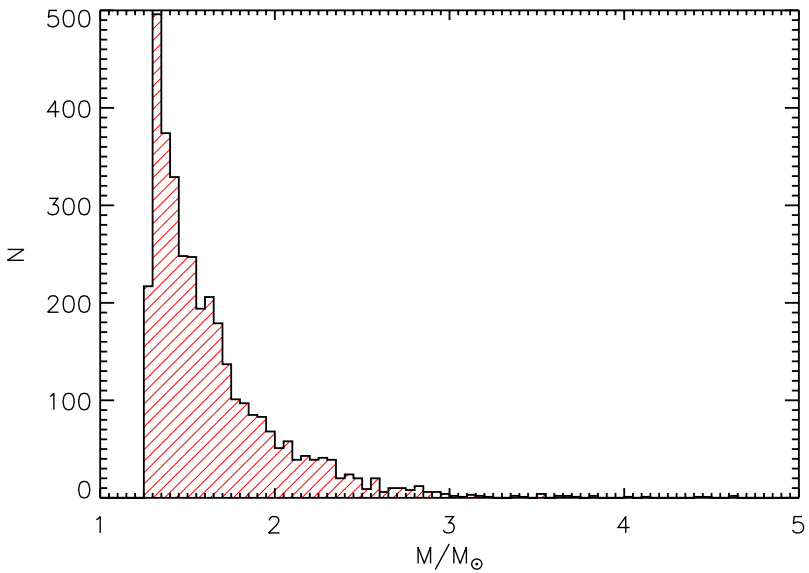


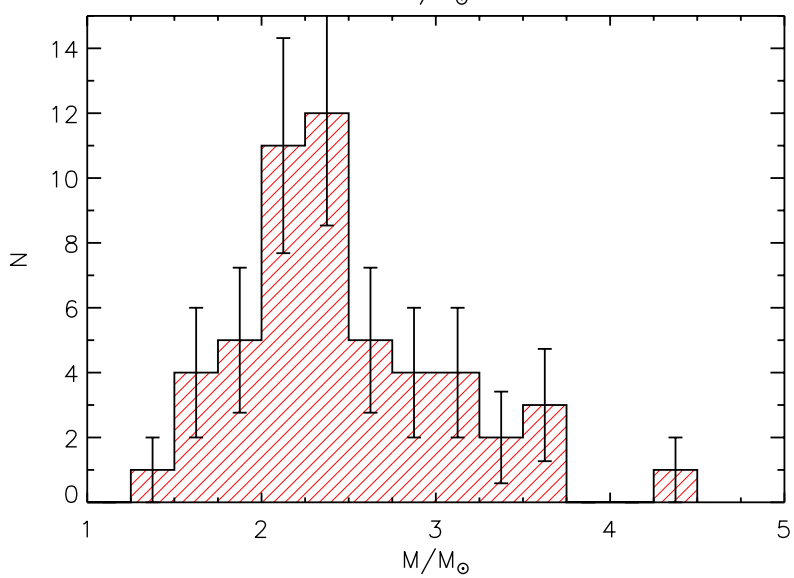


Fundamental Parameters

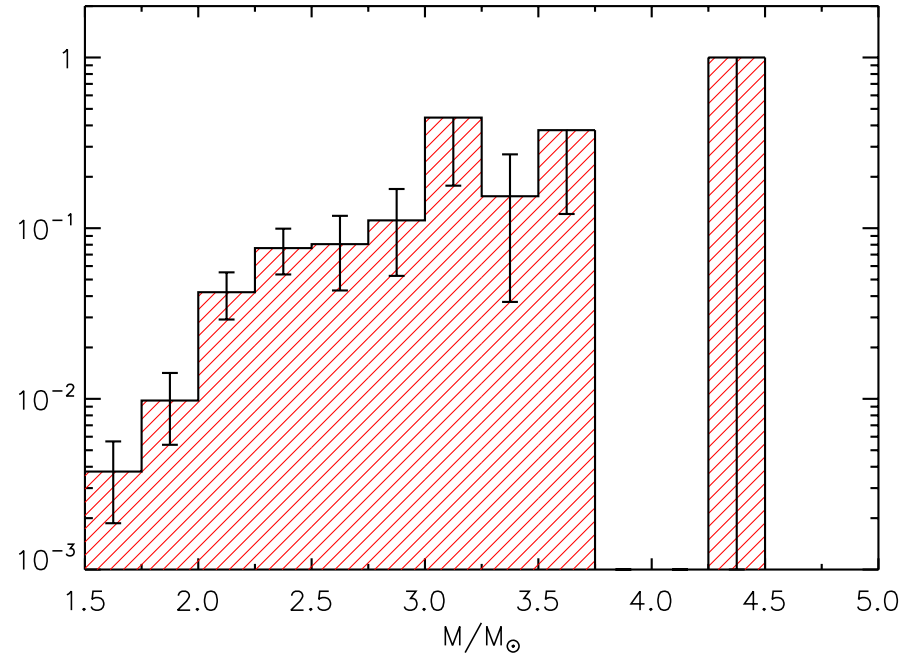
Non-Magnetic A/B



Magnetic Ap/Bp



$M/M_\odot$



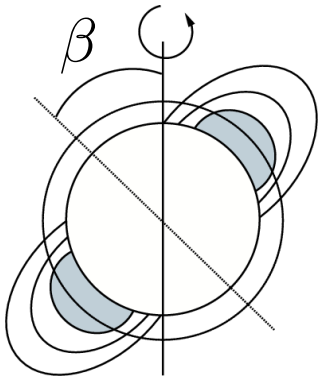
Incidence Rate

Magnetic Observations

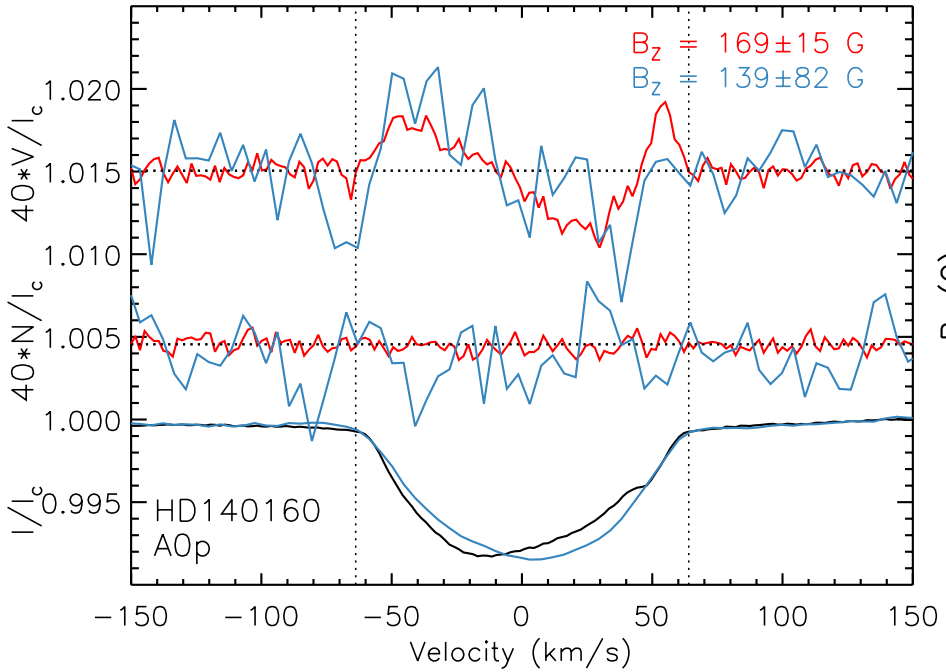
# of Known Ap/Bp Stars (d ≤ 100 pc)	**52**
# of New ESPaDOnS Spectra Obtained	**109**
# of New Narval Spectra Obtained	**17**
# of Stars Observed	**47**

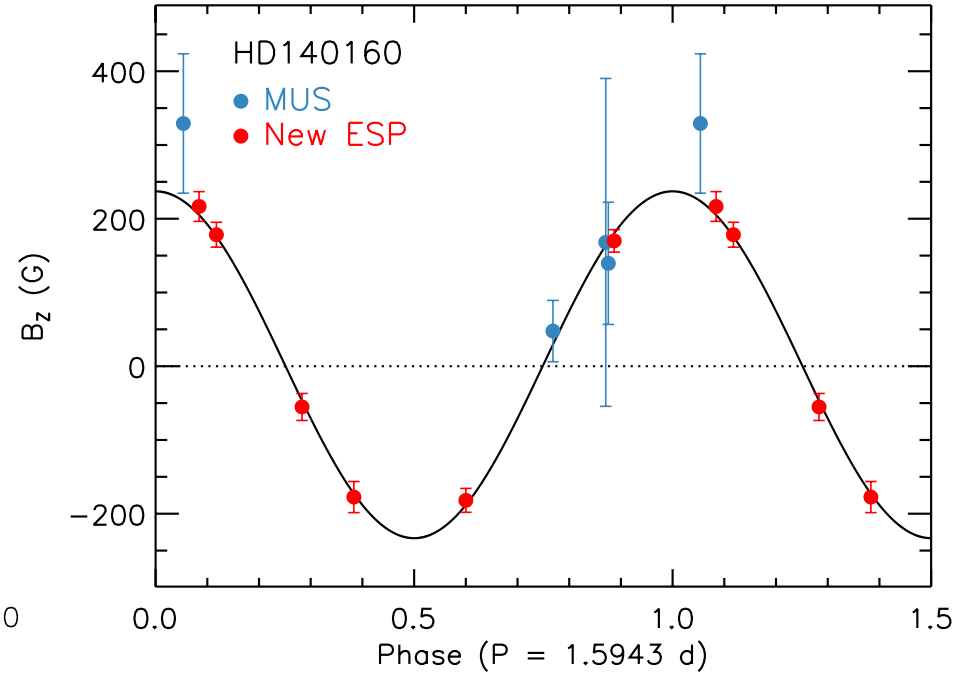
Target B_z Uncertainty: ≤ 25 G

Magnetic Observations



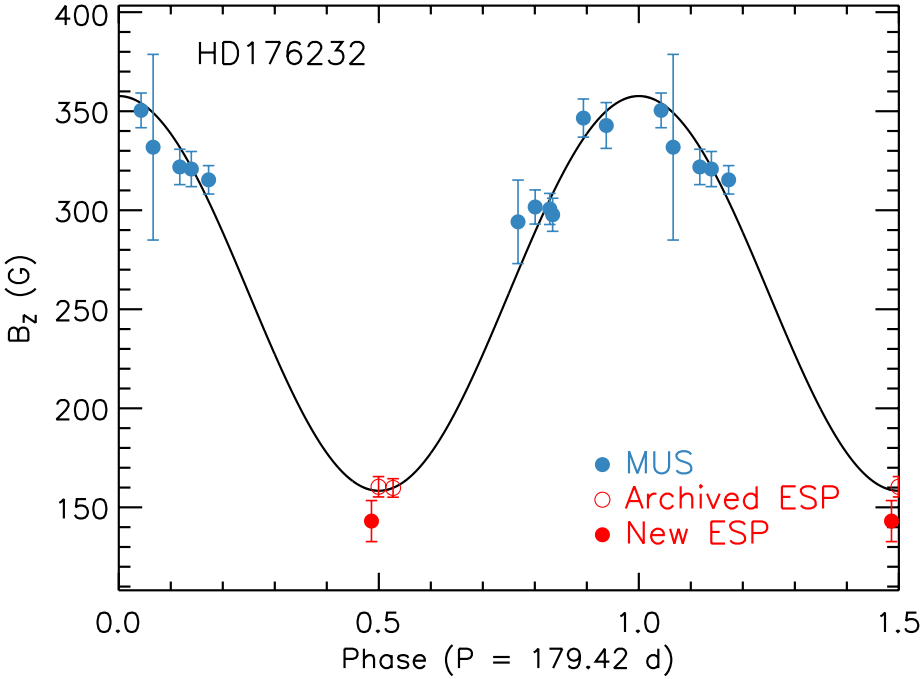
Rauw et al. (2010)

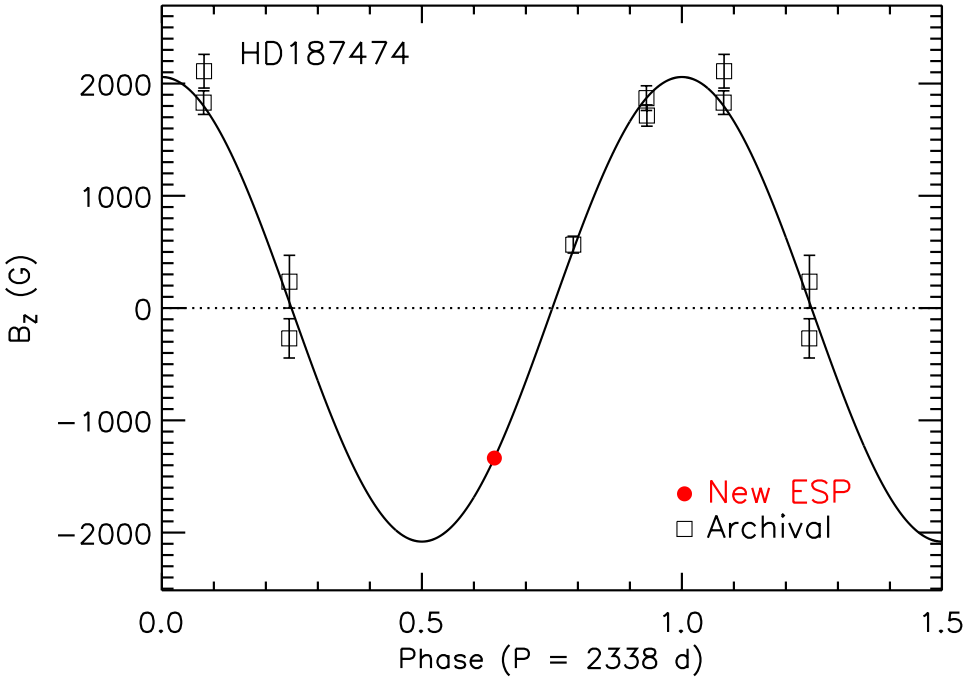




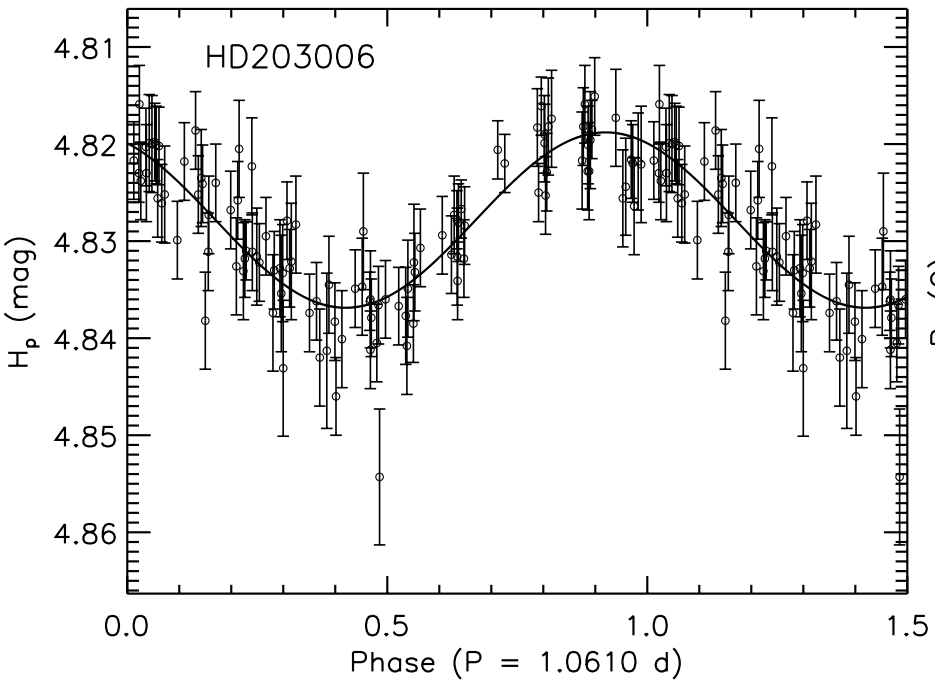
$$i = 69^{+18}_{-9}\,^{\circ} \quad \beta = 89^{+1}_{-22}\,^{\circ} \quad B_p = 840^{+90}_{-70}\ \mathrm{G}$$

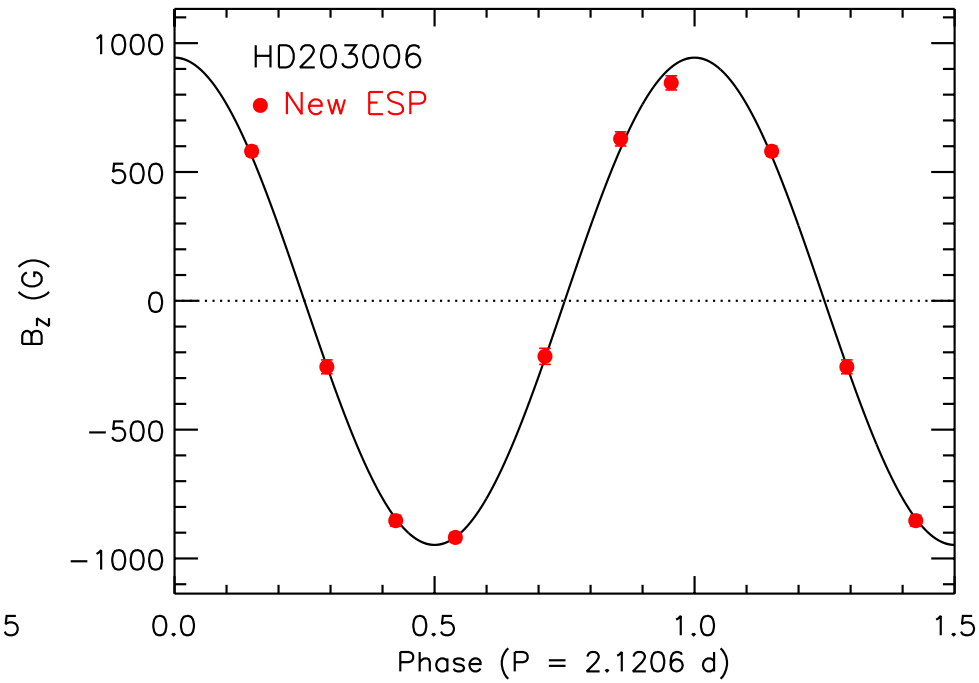
Magnetic Observations





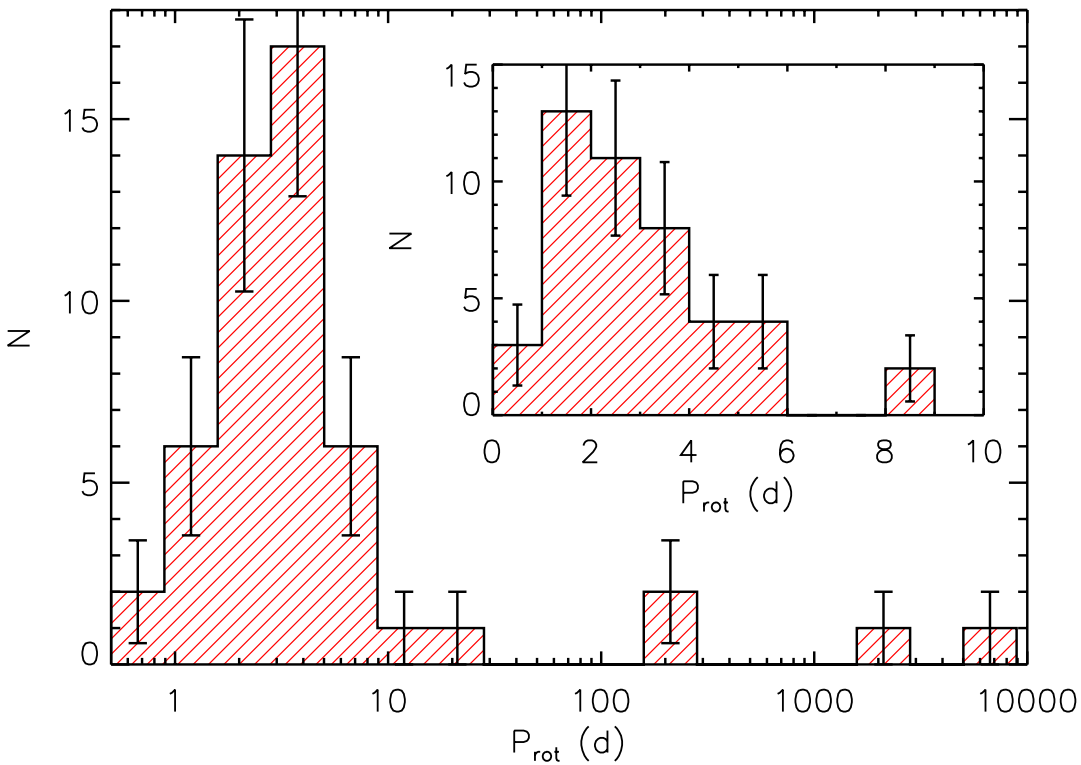
Magnetic Observations

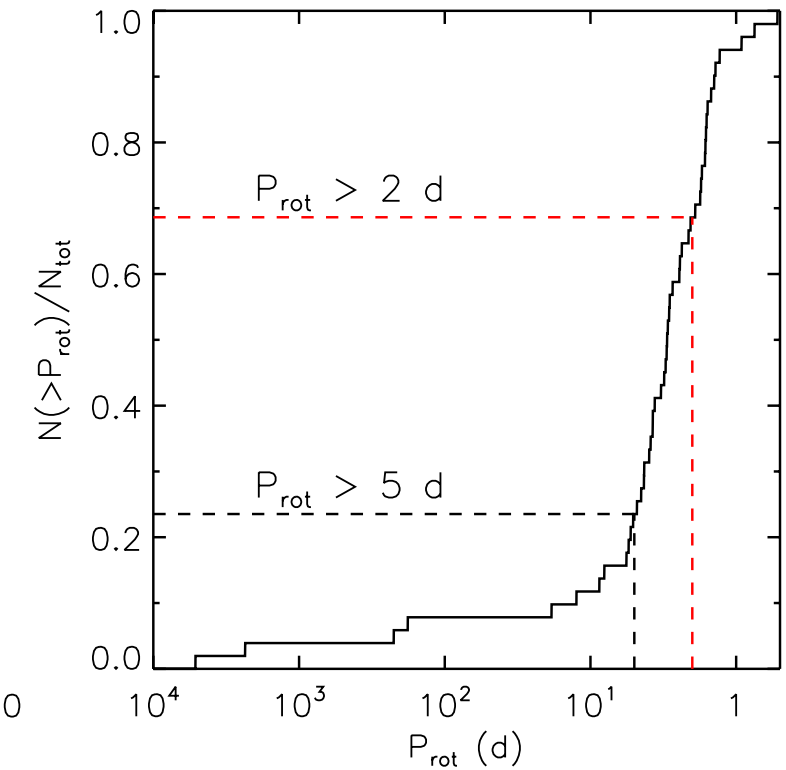




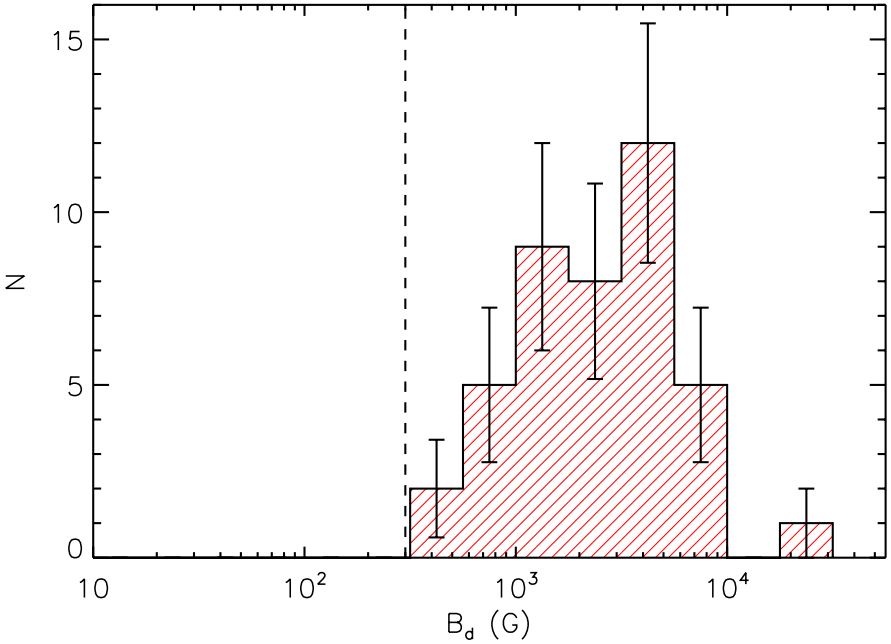
Rotational Properties

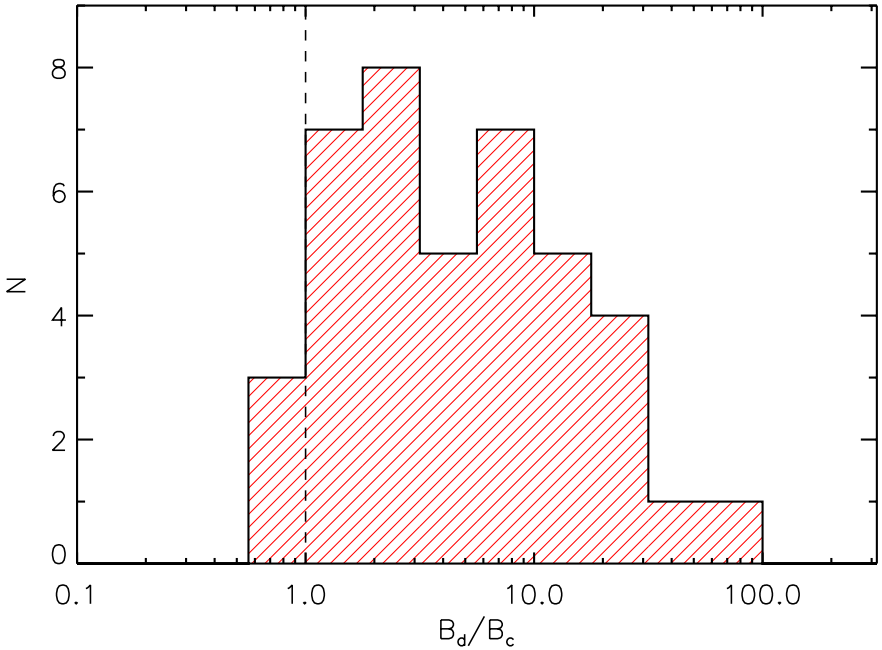
$$0.52\,\mathrm{d} \leq P_{\mathrm{rot}} \lesssim 100\,\mathrm{yrs}$$



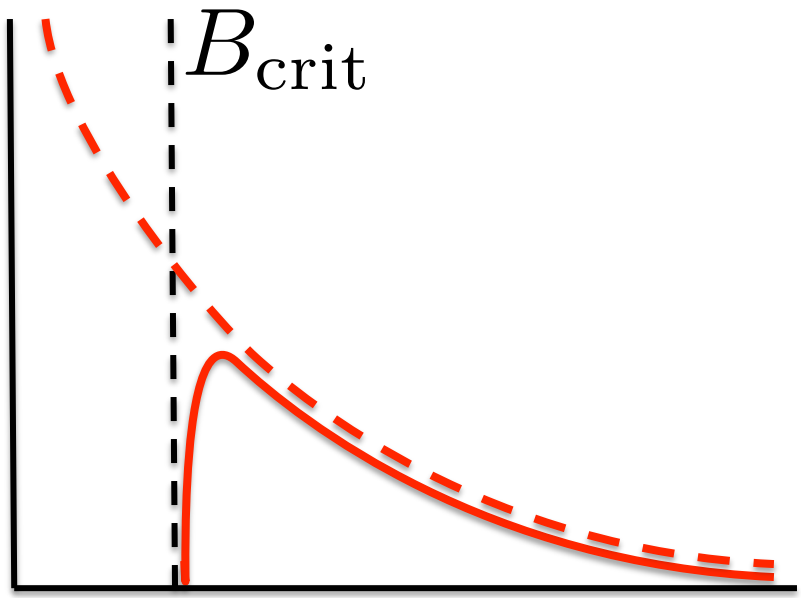


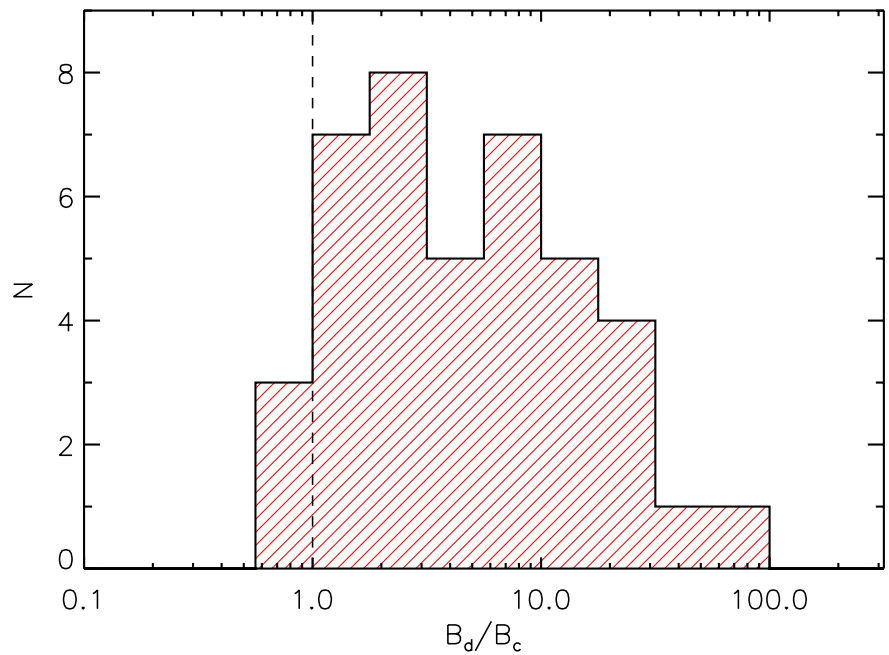
Dipole Field Strengths





Dipole Field Strengths

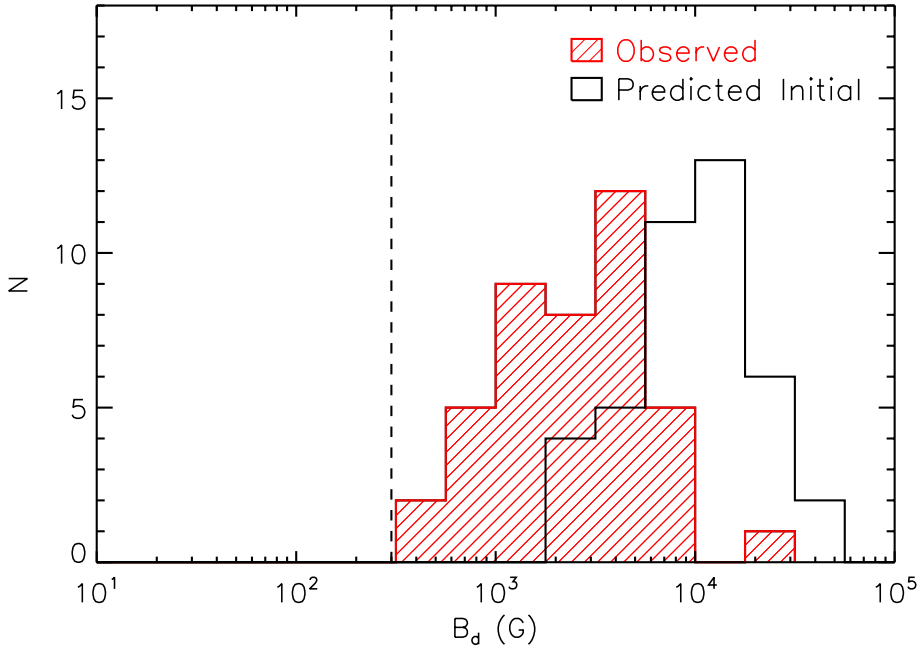


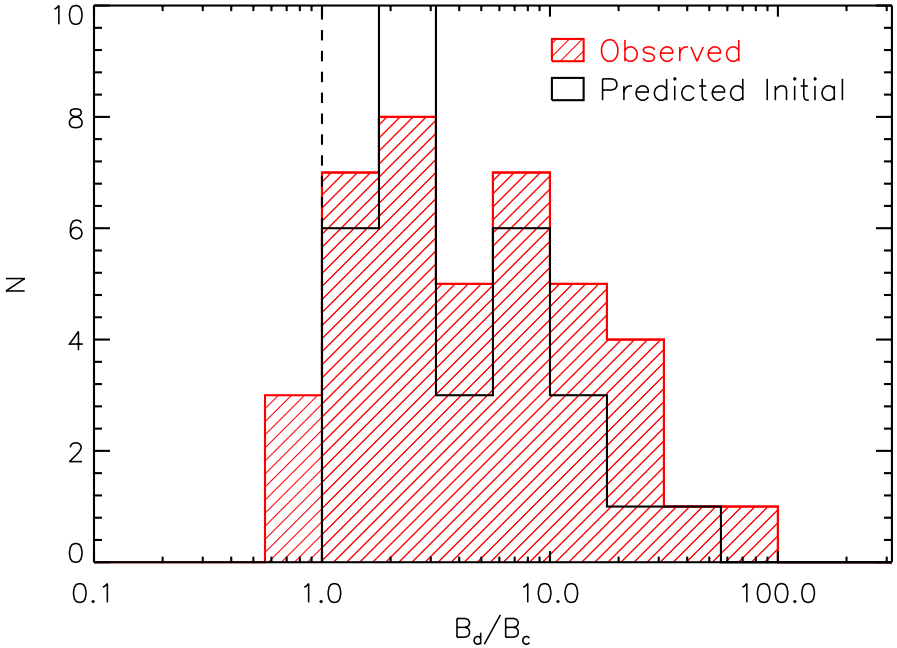


Critical field strength below which fields undergo rapid decay

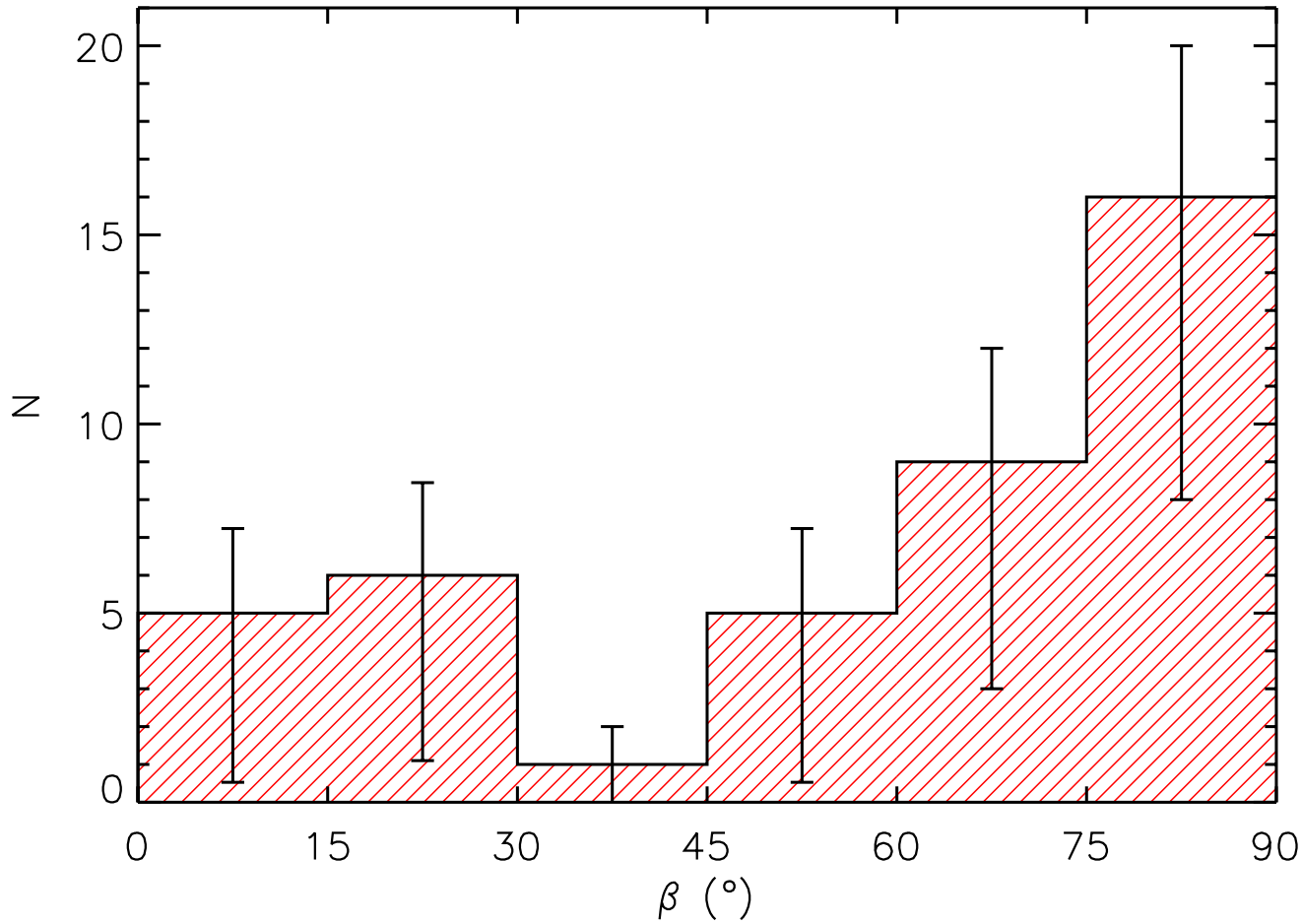
(Auriere et al. 2007)

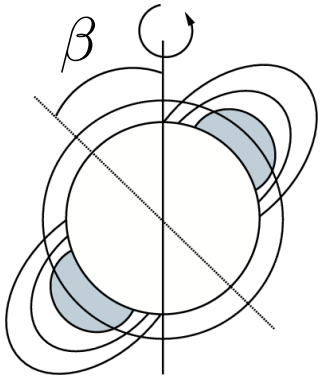
Dipole Field Strengths





Magnetic Geometry





Rauw et al. (2010)

Summary & Conclusions

- We have completed a volume-limited survey of Ap/Bp stars within 100 pc
- Important to establish **unbiased*** statistical properties of Ap/Bp stars

1. Incidence rates of large-scale fields increase with mass
2. There exists a "magnetic desert" for $B_d < 300$ G
3. Moderate increase in number of Ap/Bp stars with large obliquity angles

Summary & Conclusions