White Dwarf Stars

Kepler, UFRGS, Porto Alegre
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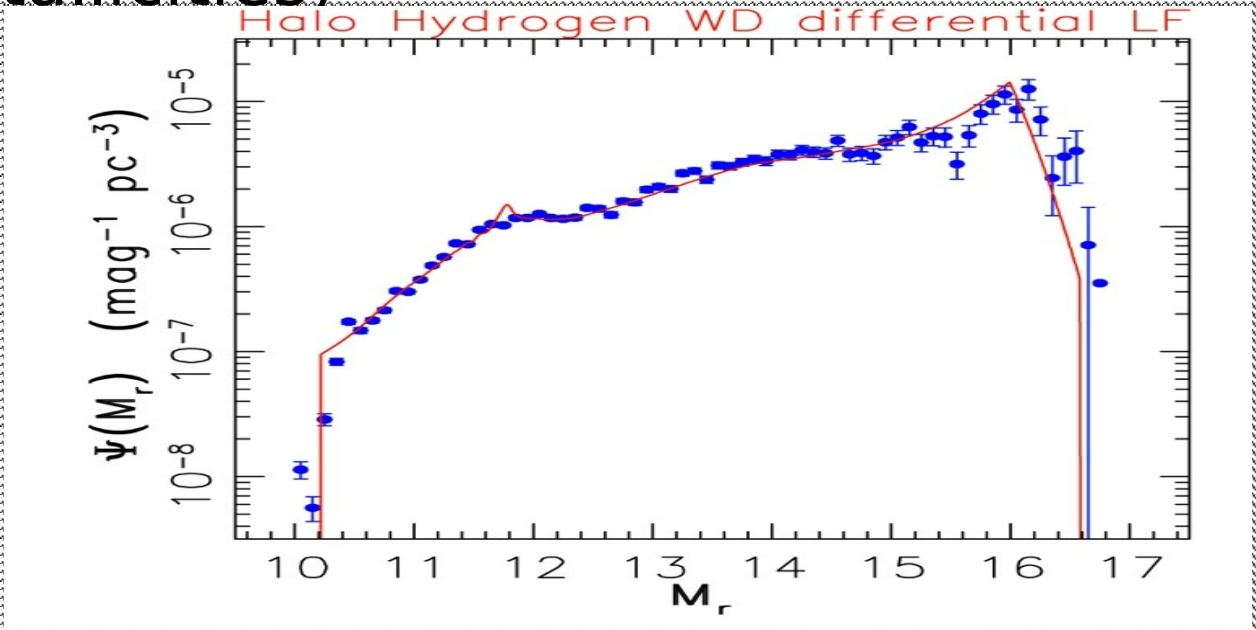
Don Winget
Bárbara Castanheira

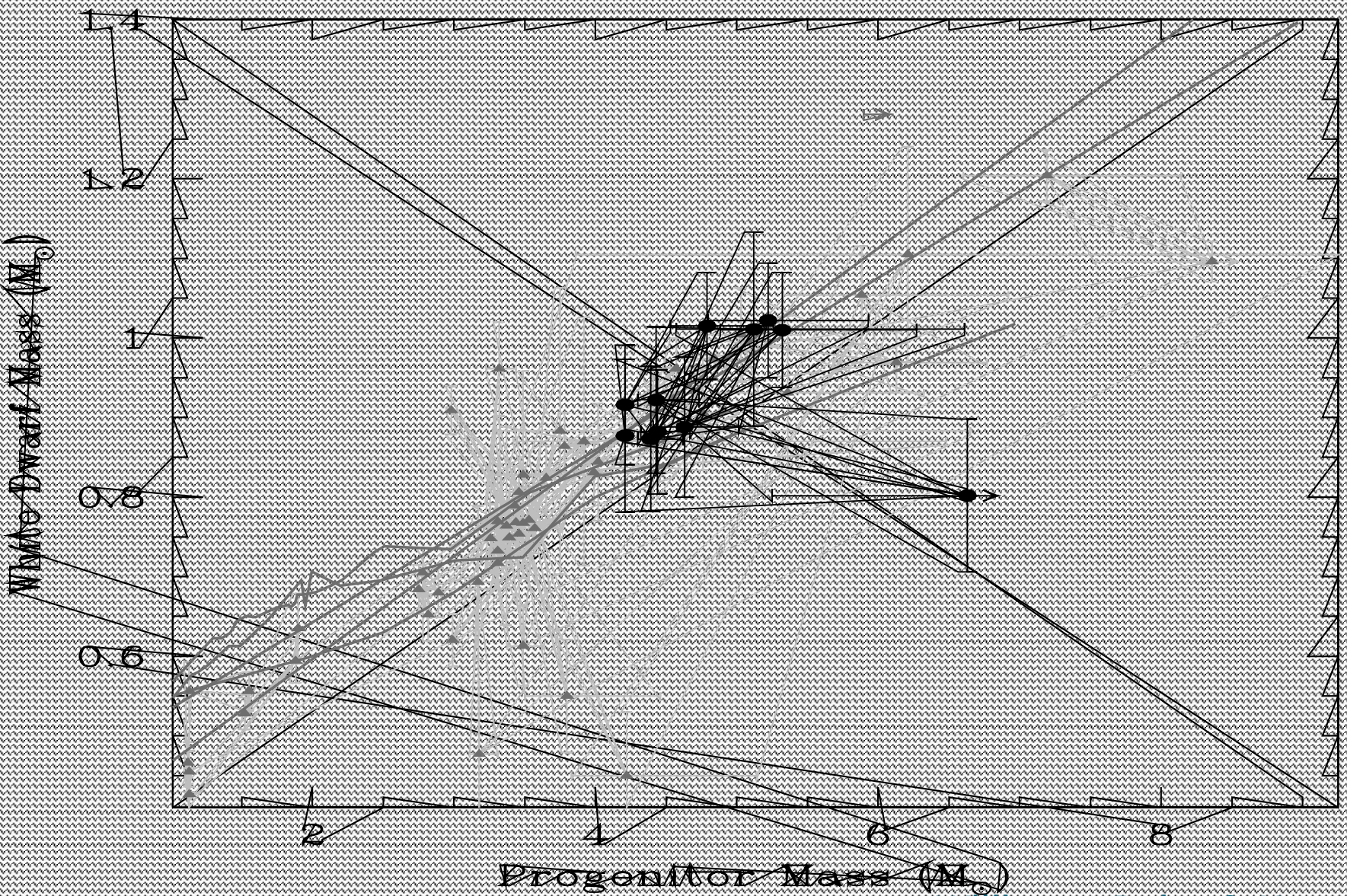
LSST

Jason Kalirai, Chuck Claver, David Monet, Zeljko Ivezic, J.B. Holberg

- 97% stars become white dwarfs
- 50 million wd
- 400 000 halo wd (ages independ of metallicities)

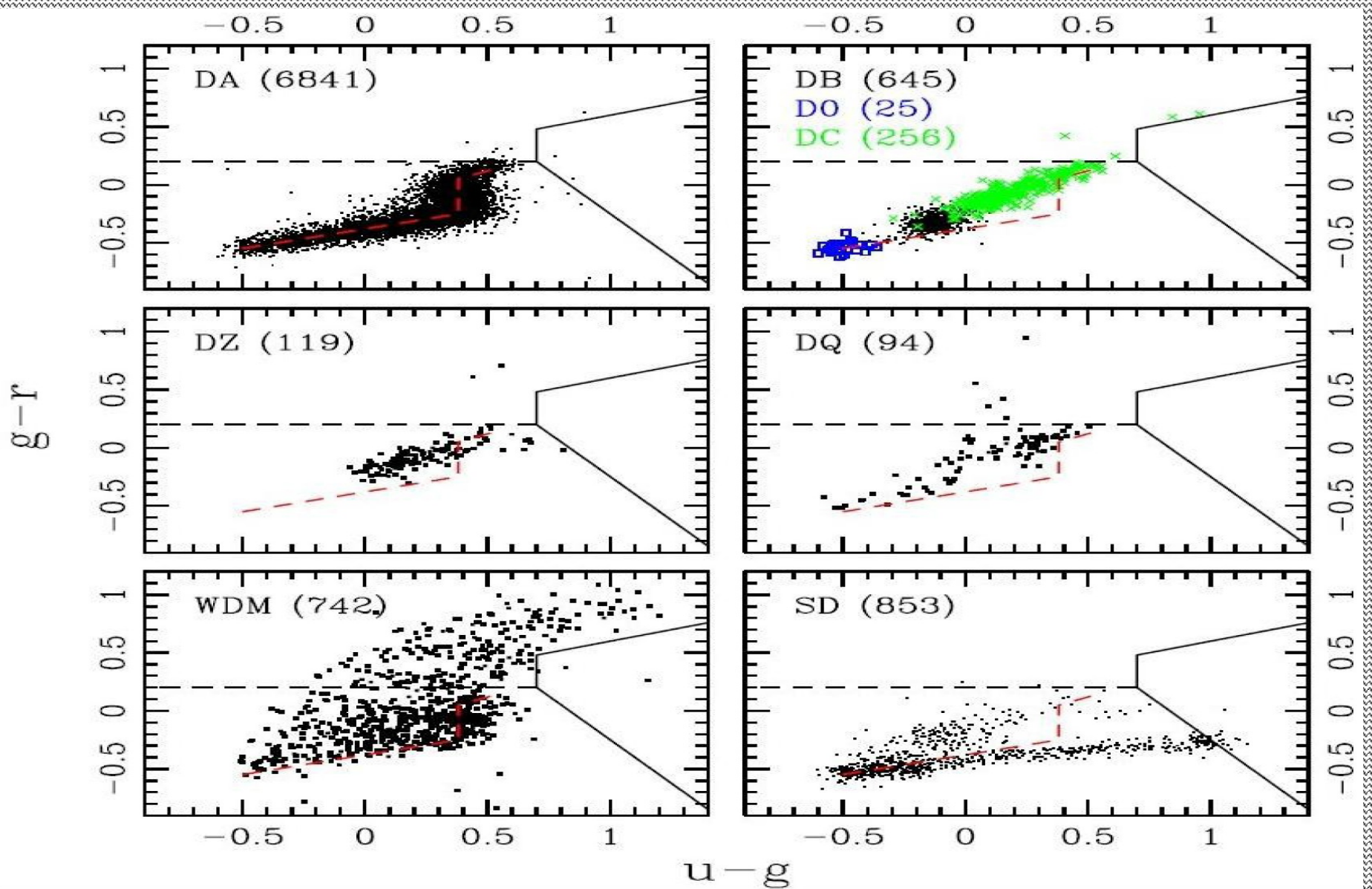


IFMR

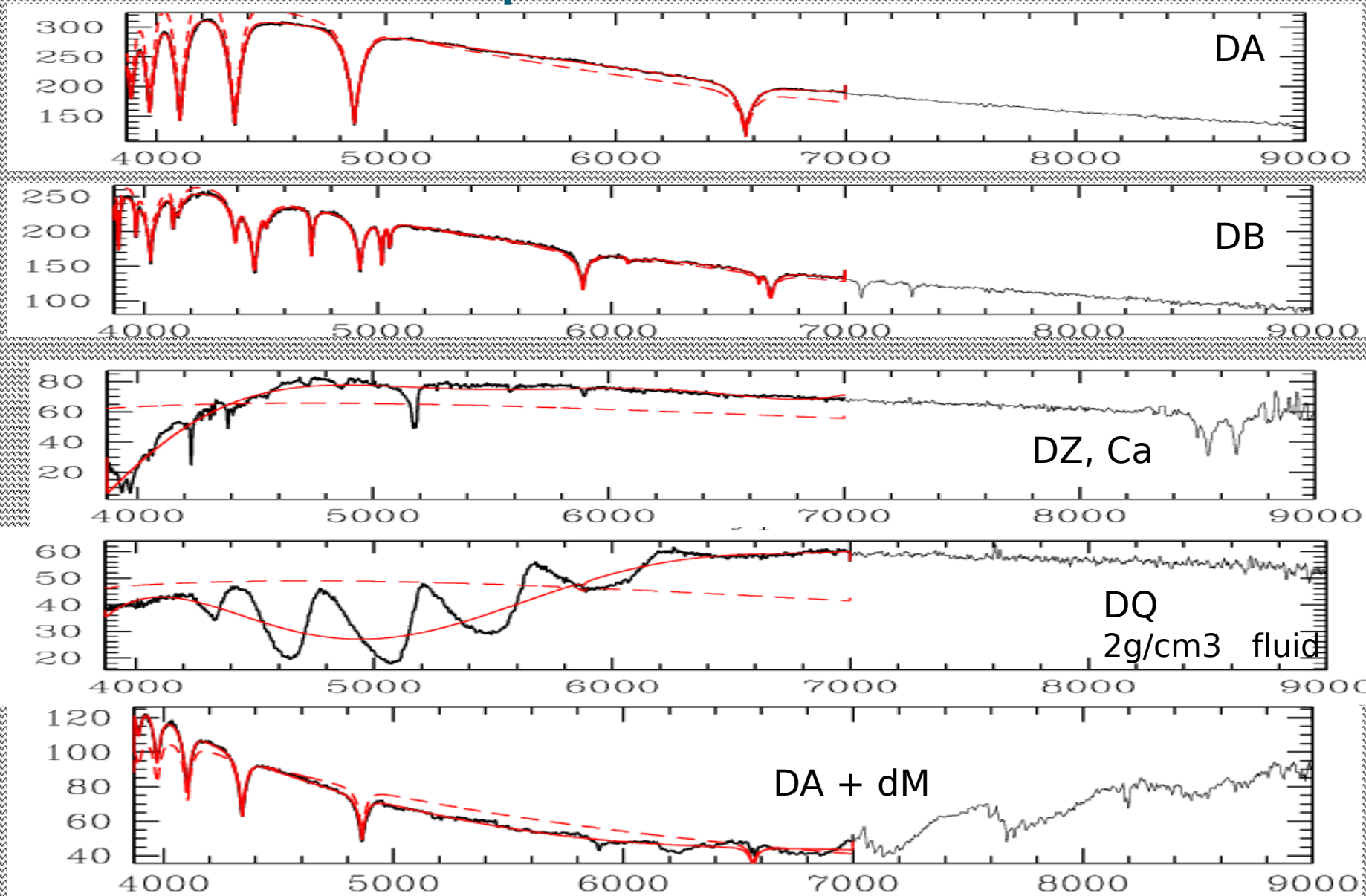


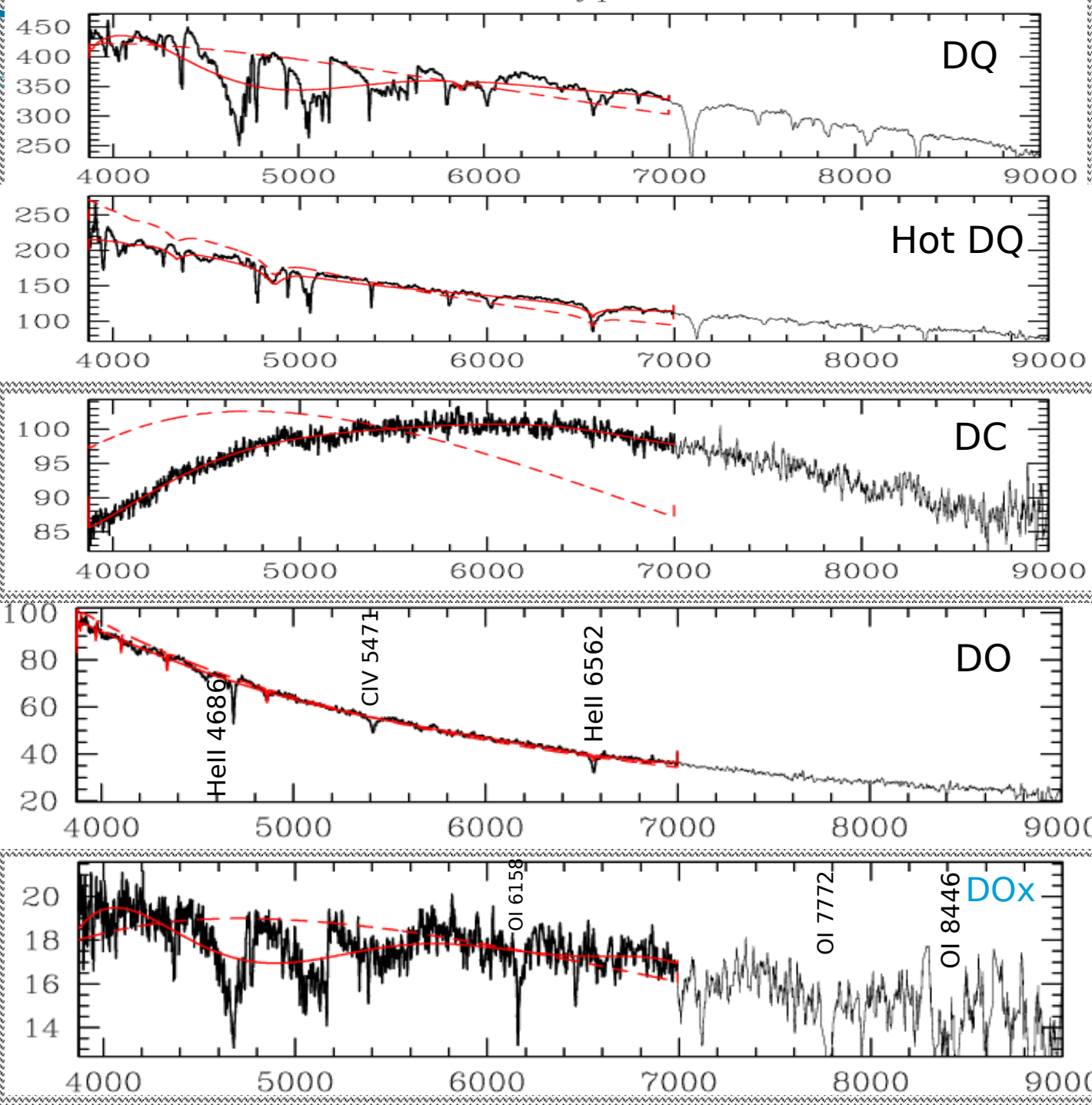
Williams, Bolte & Koester 2

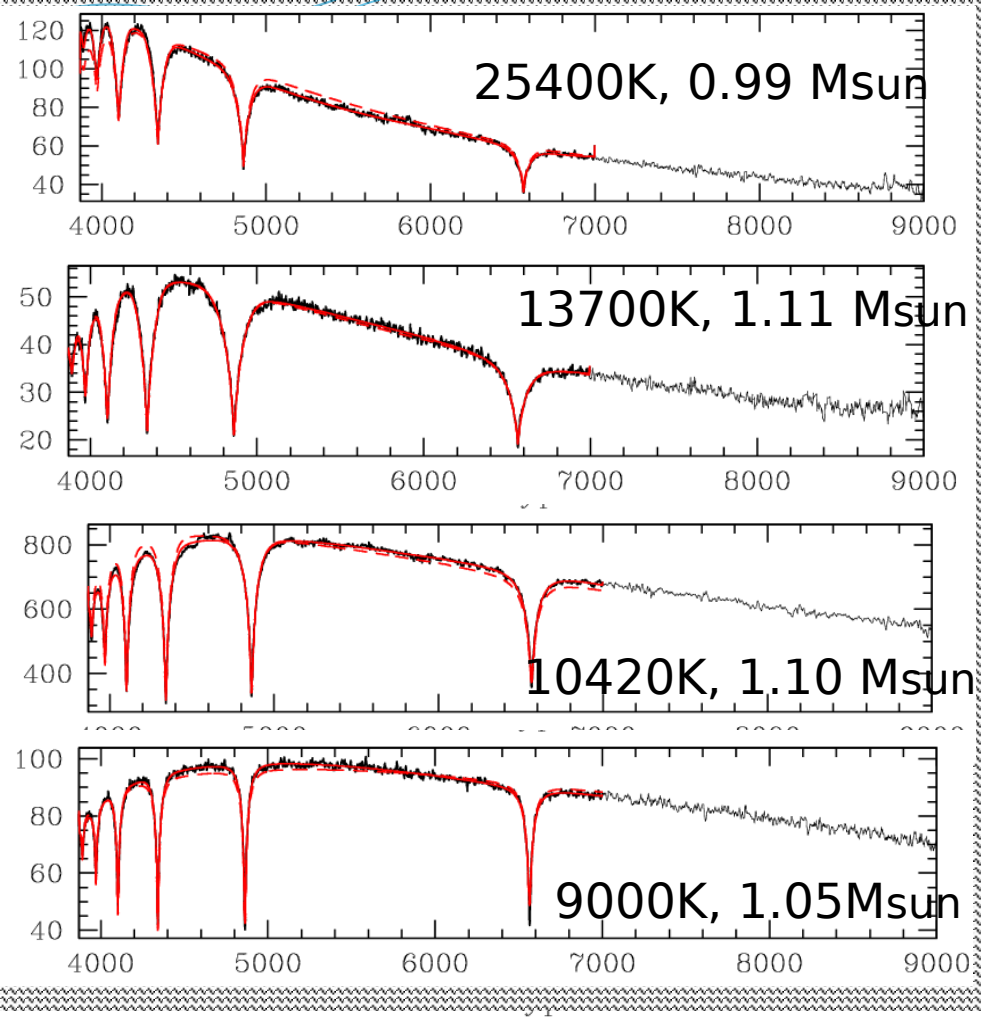
SDSS DR4


DA (6841)
DB (645)
DO (25)
DC (256)
DZ (119)
DQ (94)
WDM (742)
SD (853)
g − r
u − g
−0.5
0
0.5
1

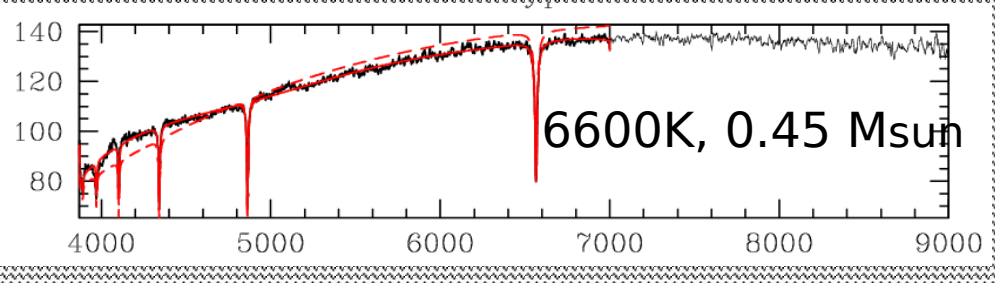
43800 spectra from colors




DQ
Hot DQ
DC
DO
DOx
HeII 4686
CIV 5471
HeII 6562
OI 6158
OI 7772
OI 8446


25400K, 0.99 Msun
13700K, 1.11 Msun
10420K, 1.10 Msun
9000K, 1.05Msun

DAs

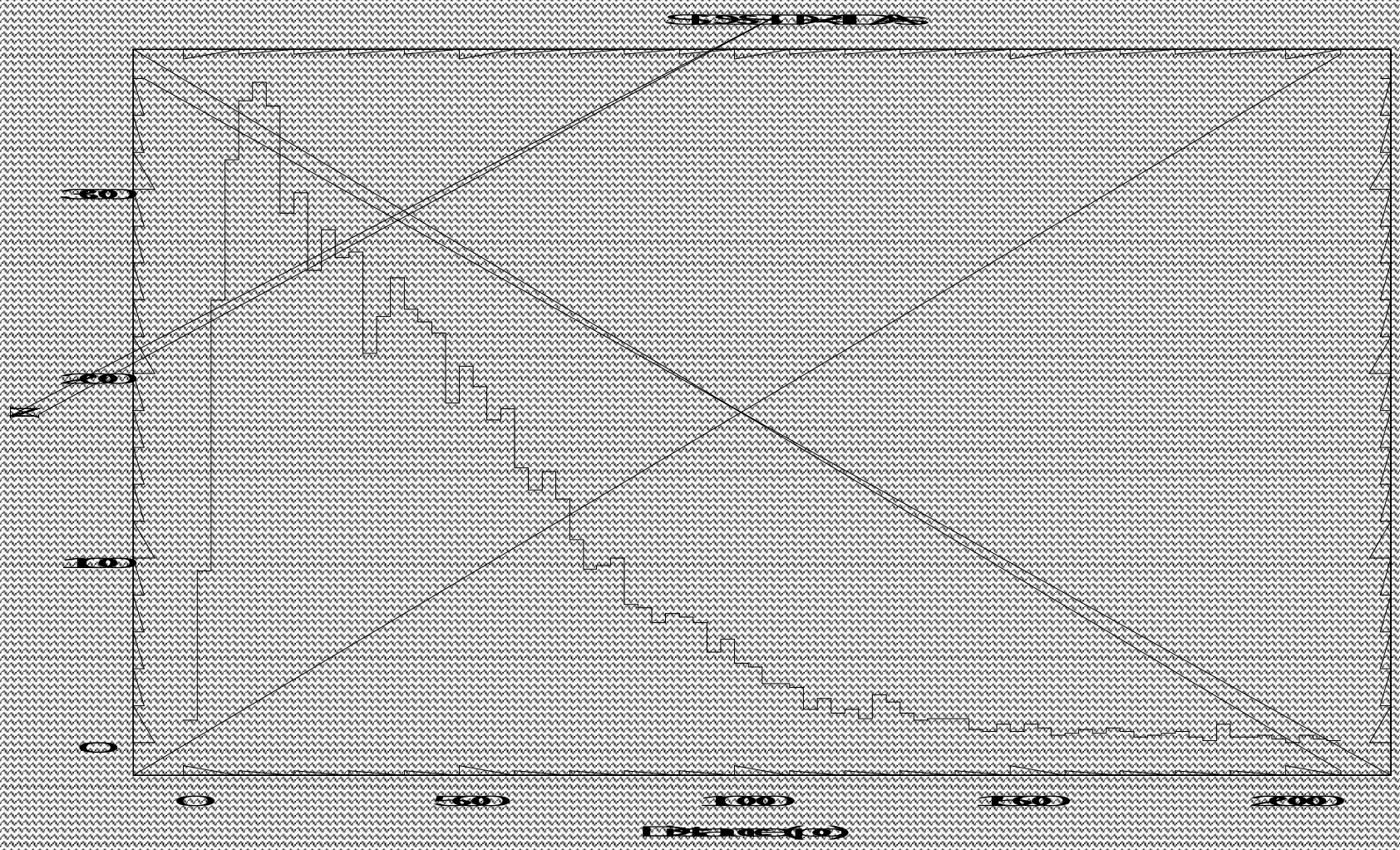

6600K, 0.45 Msun

DR7 – Kleinman, Kepler et al.

- 13724 DAs
  7.3,1.7 x DR1,DR4
- 961 DBs
  5.6,1.35 x DR1,DR4
- 968 DHs
  32.3,108 x DR1,DR4
  - 785 DAH
  - 62 DBH
- 609 DCs
  4.5, 2.1 x DR1,DR4

- 437 DZs
  7.7, 3.3 x DR1, DR4
- 218 DQs
  4.8, 2.1 x DR1, DR4
- 48 DOs
  3.7, 1.2 x DR1, DR4
- 1640 WDMs
  8.2 x DR1
- 98 Mixed WDs
- 1135 Uncertain WDs
- 1409 Subdwarfs

Distance distribution

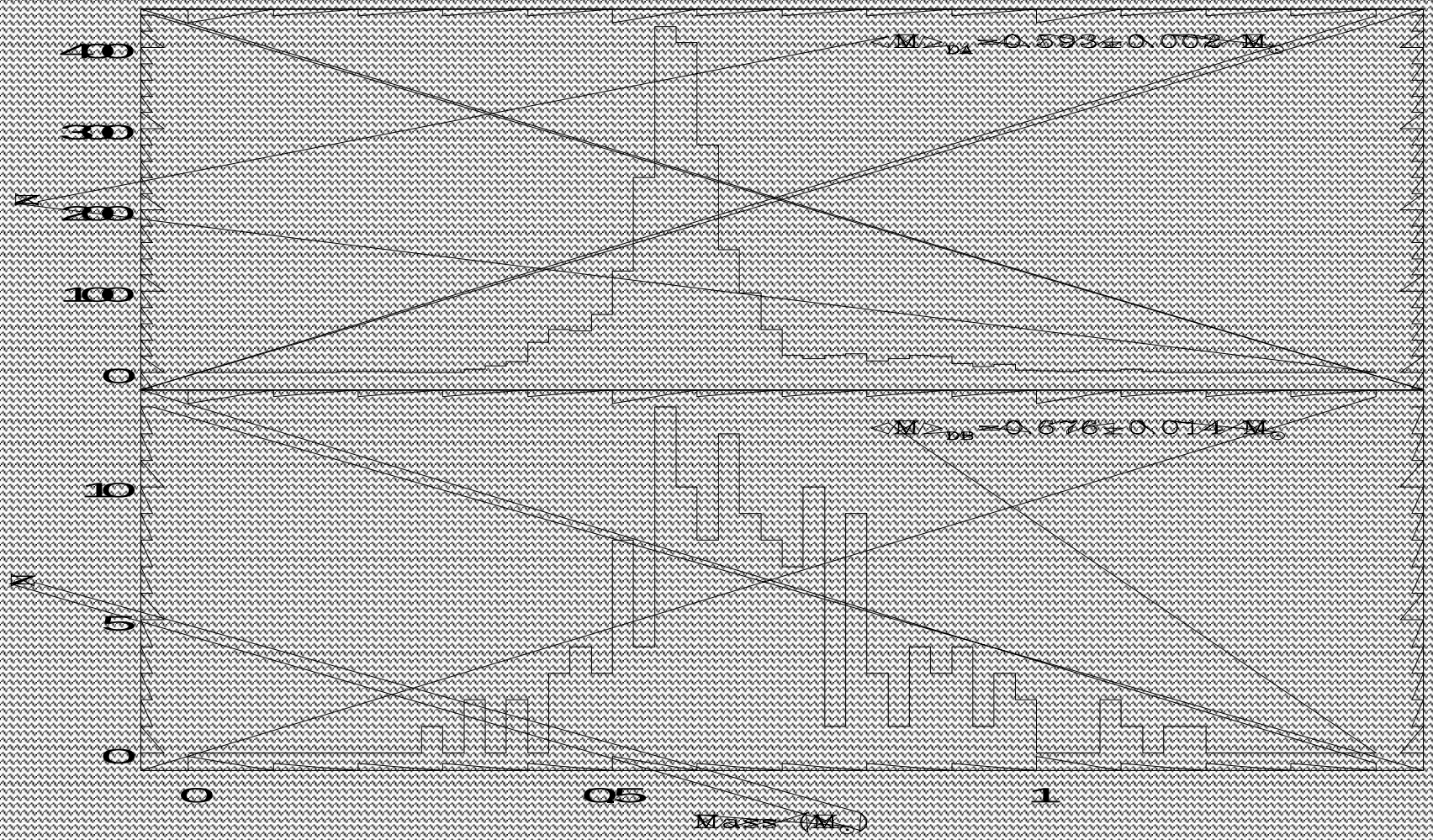


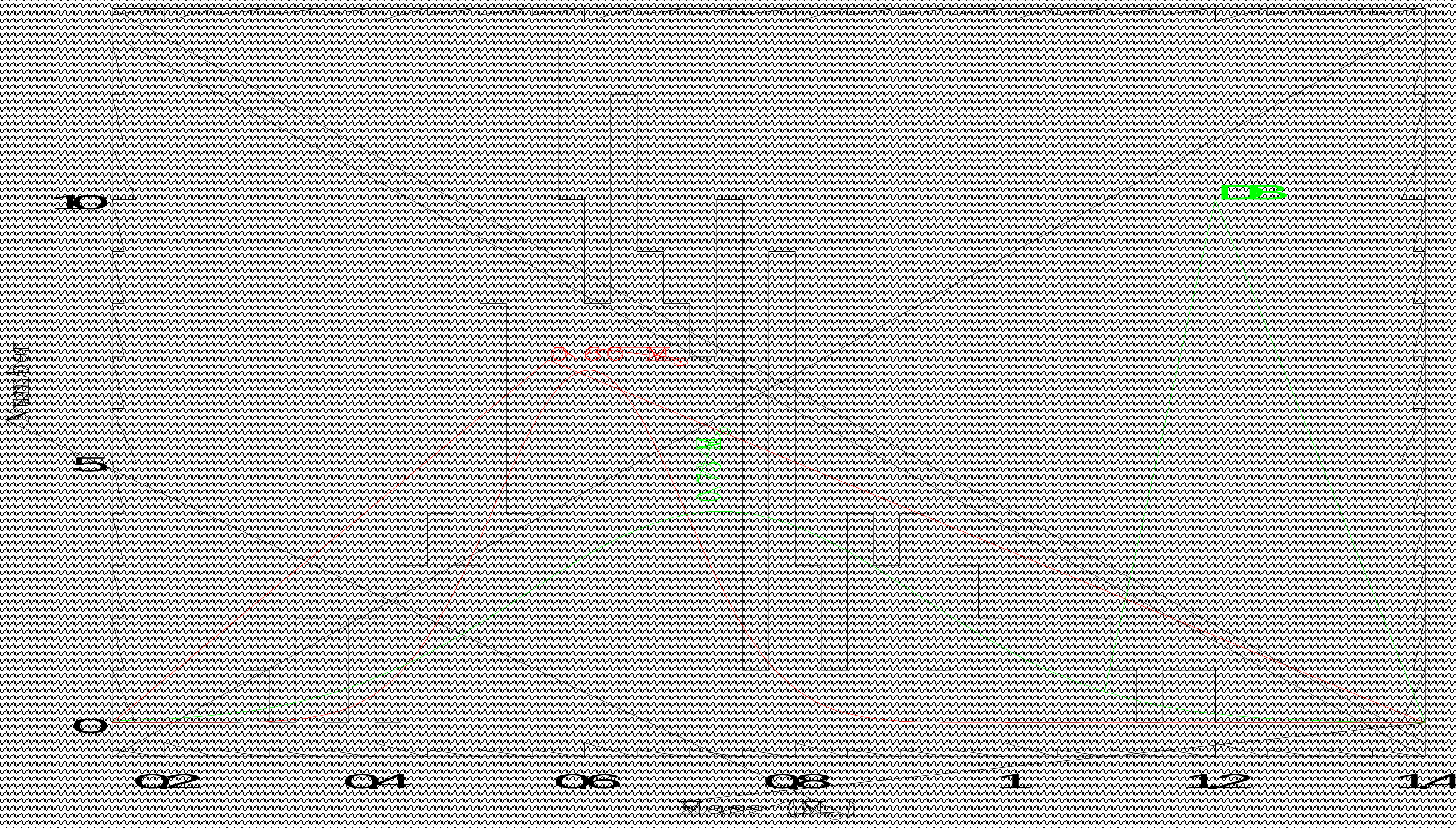
<M>=0.593±0.002 Msun, **DAs**, S/N>15, Teff>13000K, <S/N>=30, N=221
<M>=0.676±0.014 Msun, **DBs**, S/N>15, Teff>16000K, <S/N>=27, N=140

DBs, S/N>25, 1:3:18 for Teff>45000K:30000K:20000K
exactly what expected by age -> NO DB GAP!

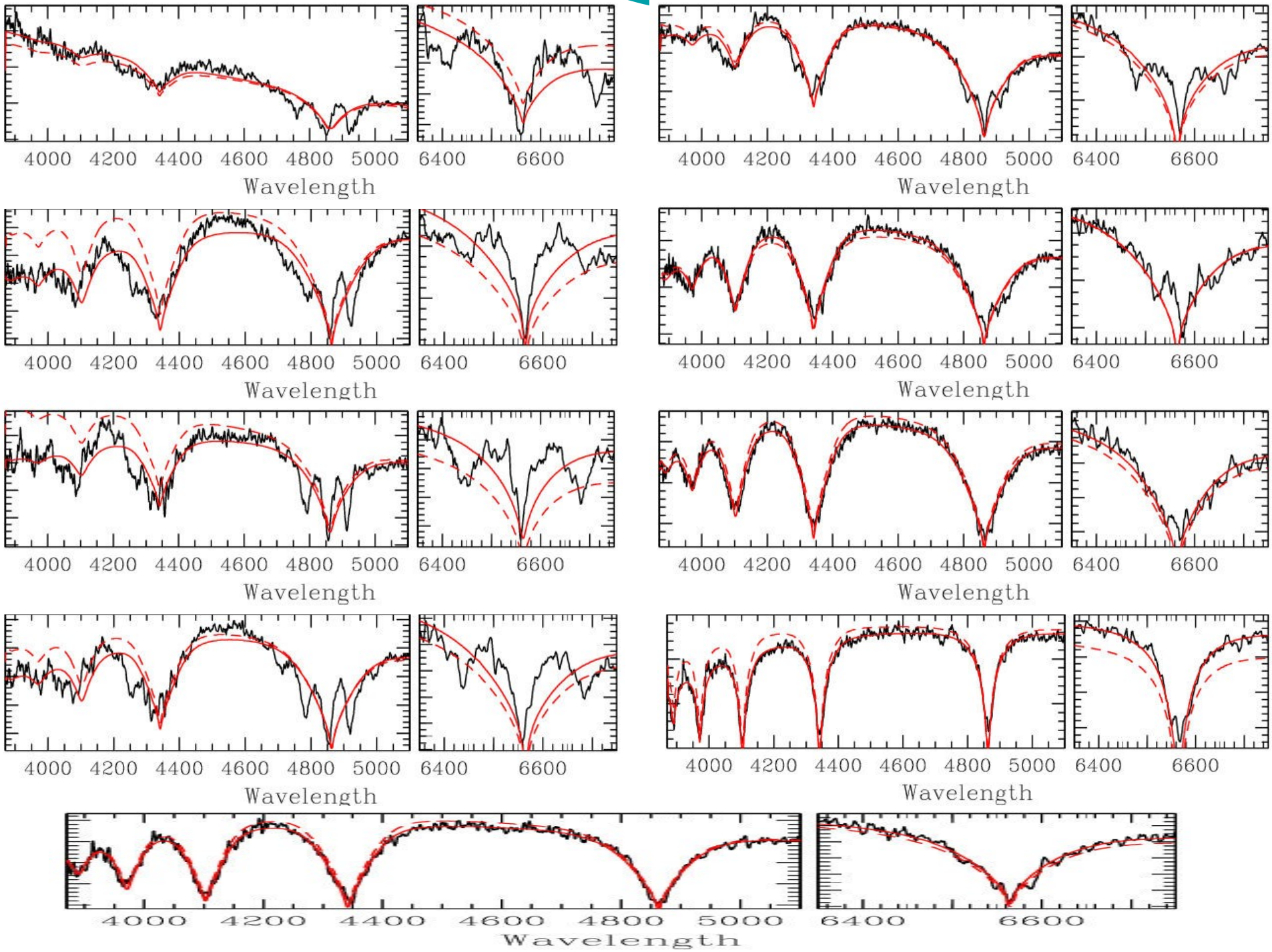
-A Spectroscopic Analysis of White Dwarfs in the Kiso Survey
M.-M. Limoges and P. Bergeron 2010
0.606 Msun and a dispersion of 0.135 for 149 DAs (but Gianninas et al. 2010 0.64MSun N=1304)
0.758 Msun and a dispersion of 0.192 for 19 DBs (but 0.696 Msun for 103 DBs from SPY)
-Spectroscopic Analysis of DA WD: Stark Broadening of H including non-ideal effects
P.-E. Tremblay and P. Bergeron 2009
0.649 Msun for 250 DAs – same value **Ross Falcon got for mean gravitational redshift** for SPY
-no He in Keck spectra of cool white dwarfs – no convection mixing

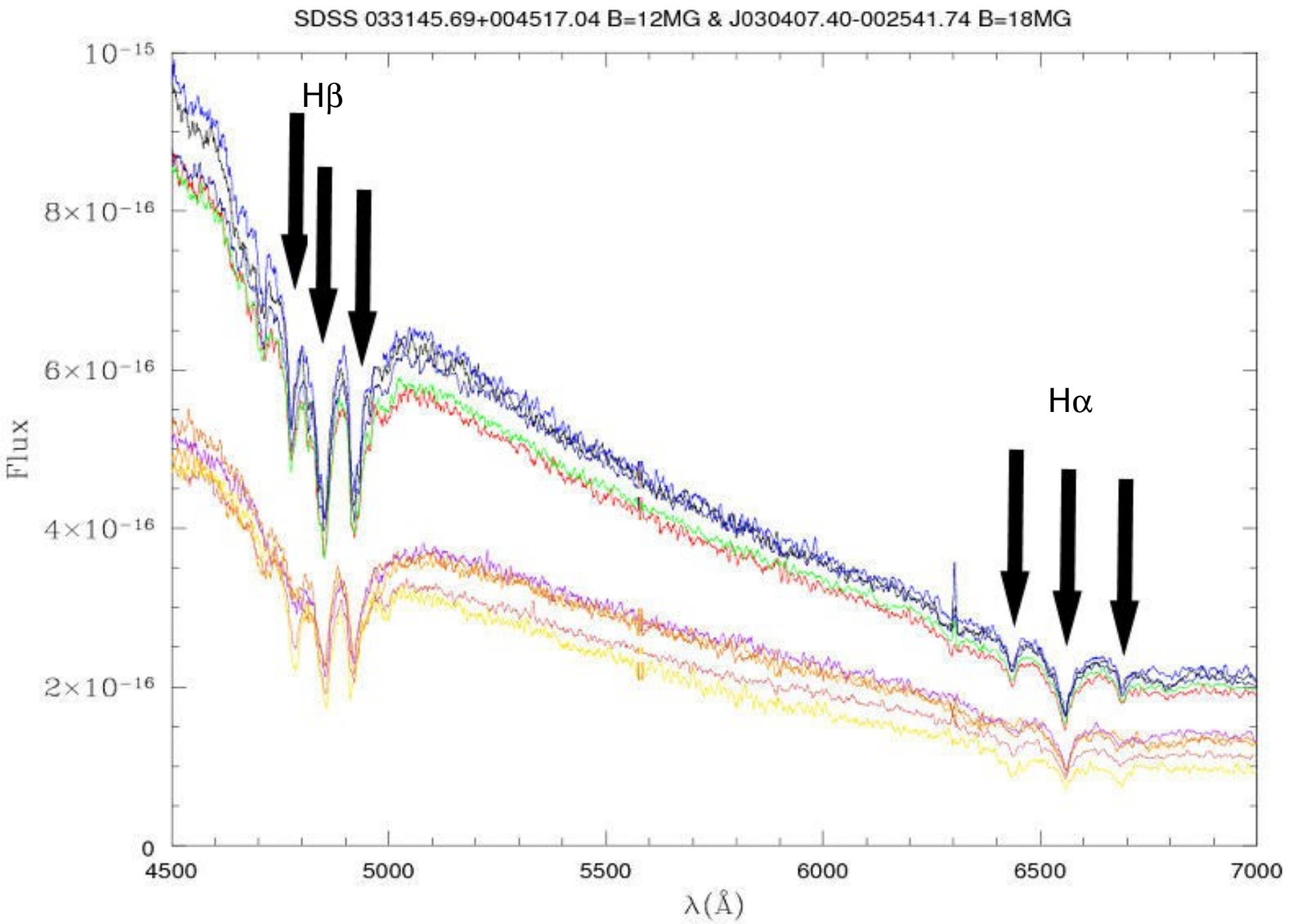
Mass distribution





10
5
0
Number
0.60 M☉
0.72 M☉
DB
02
04
06
08
1
12
14
Mass (M☉)

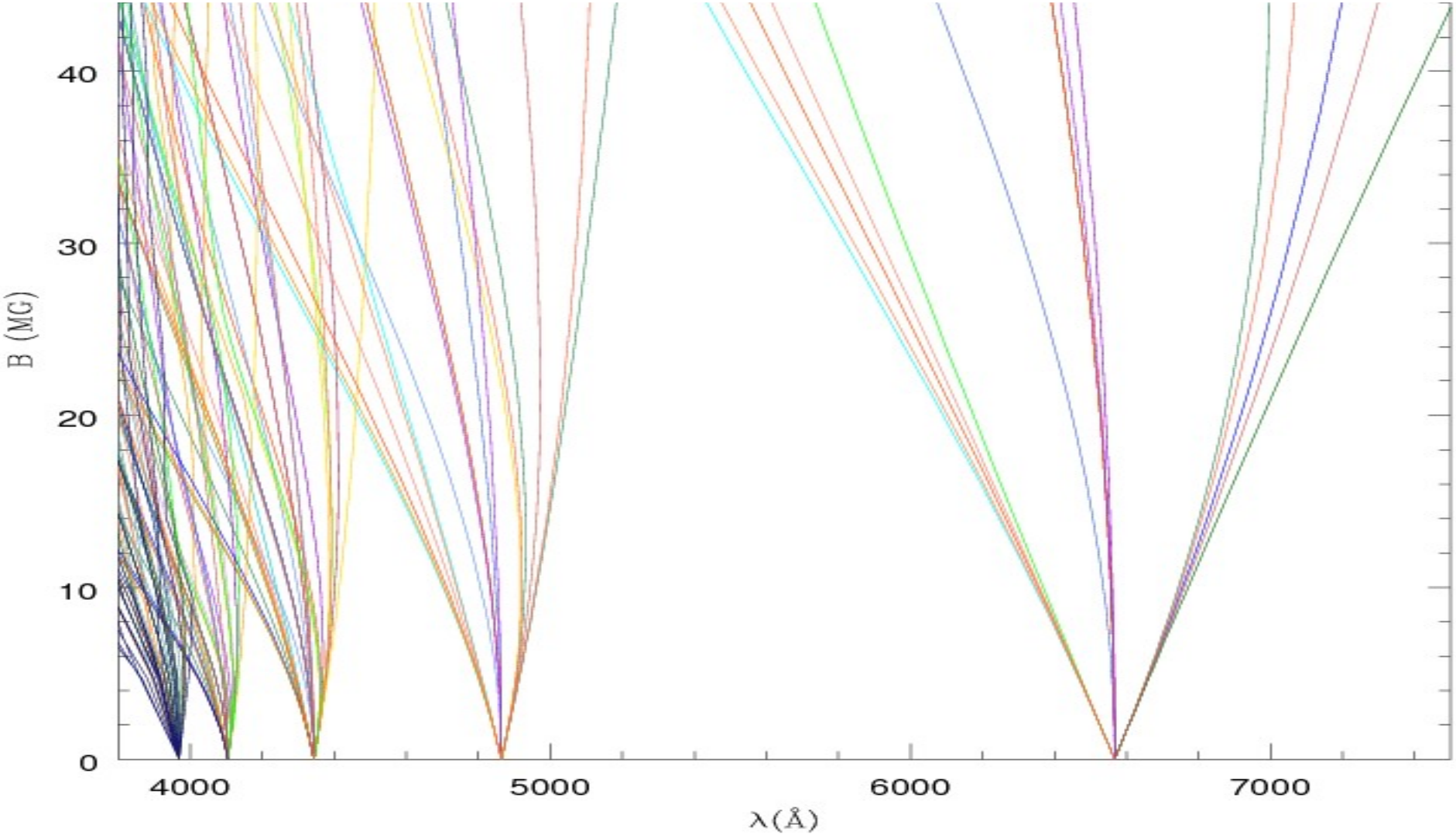

4000 4200 4400 4600 4800 5000
6400 6600
Wavelength


SDSS 033145.69+004517.04 B=12MG & J030407.40-002541.74 B=18MG
Hβ
Hα
Flux
λ(Å)
10⁻¹⁵
8×10⁻¹⁶
6×10⁻¹⁶
4×10⁻¹⁶
2×10⁻¹⁶
0
4500
5000
5500
6000
6500
7000

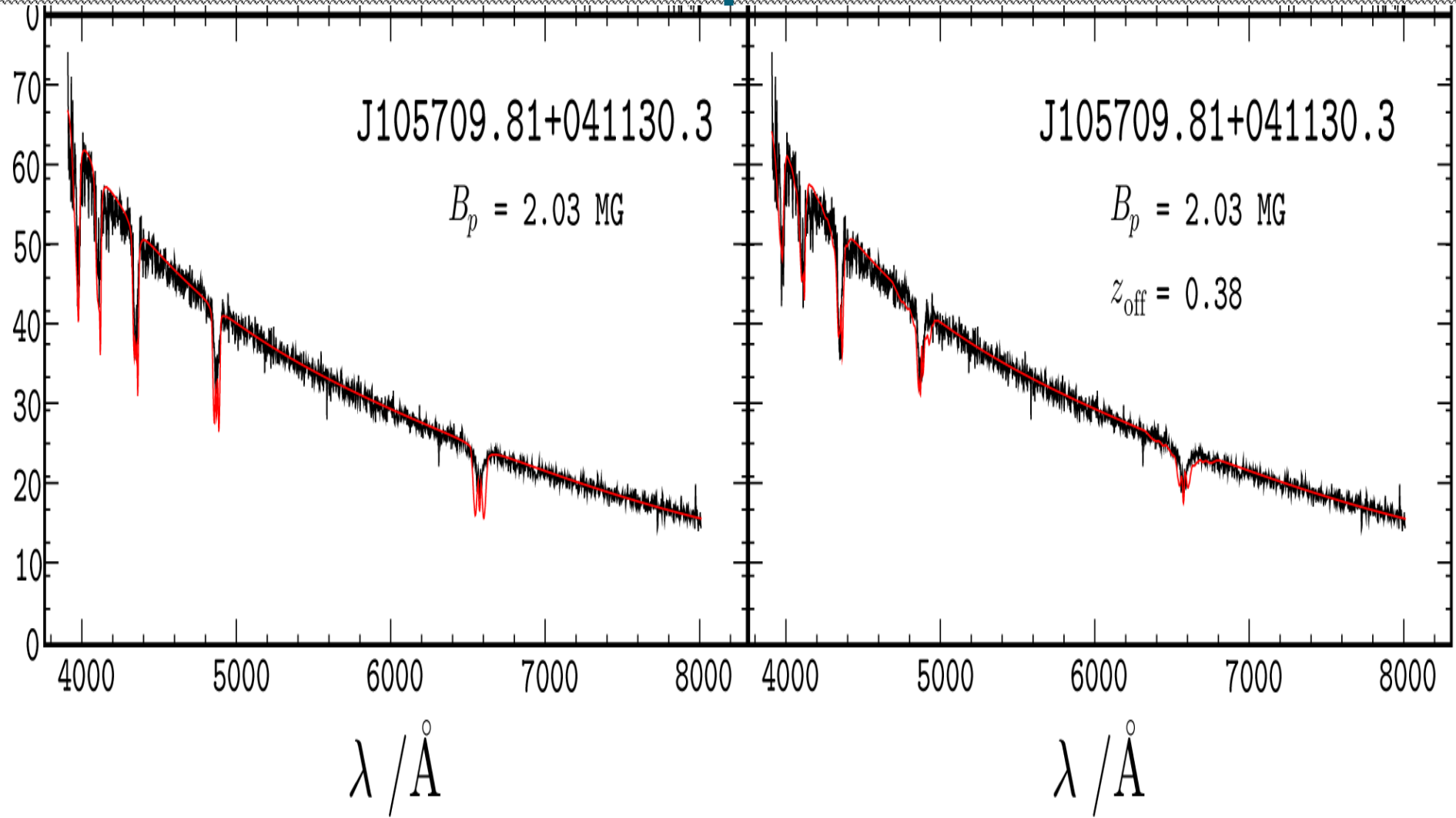
Analysis of hydrogen-rich magnetic white dwarfs detected in the Sloan Digital Sky Survey

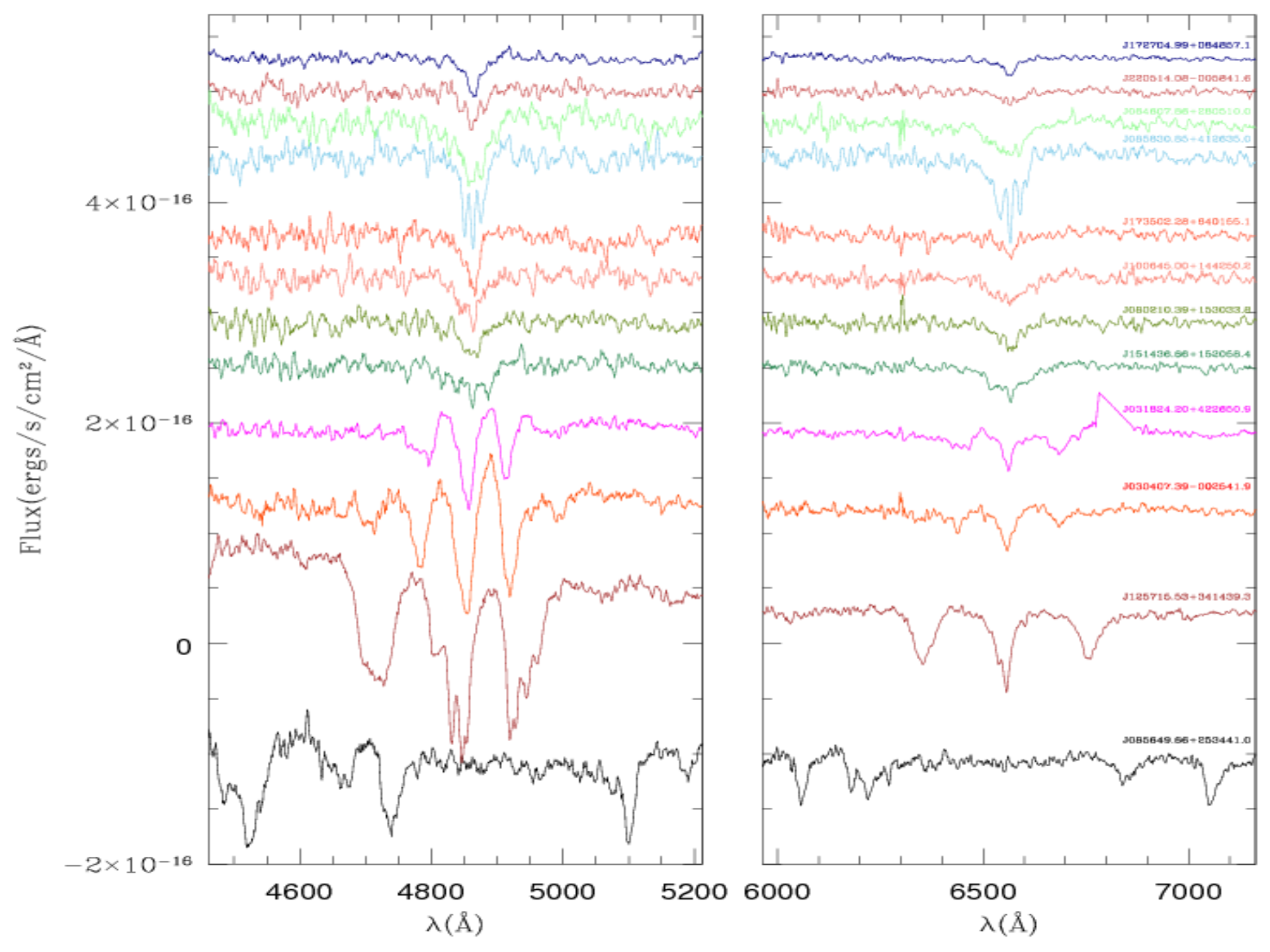
Baybars Külebi, Stefan Jordan, Fabian Euchner, Boris Gänsicke & Heiko Hirsch 2009

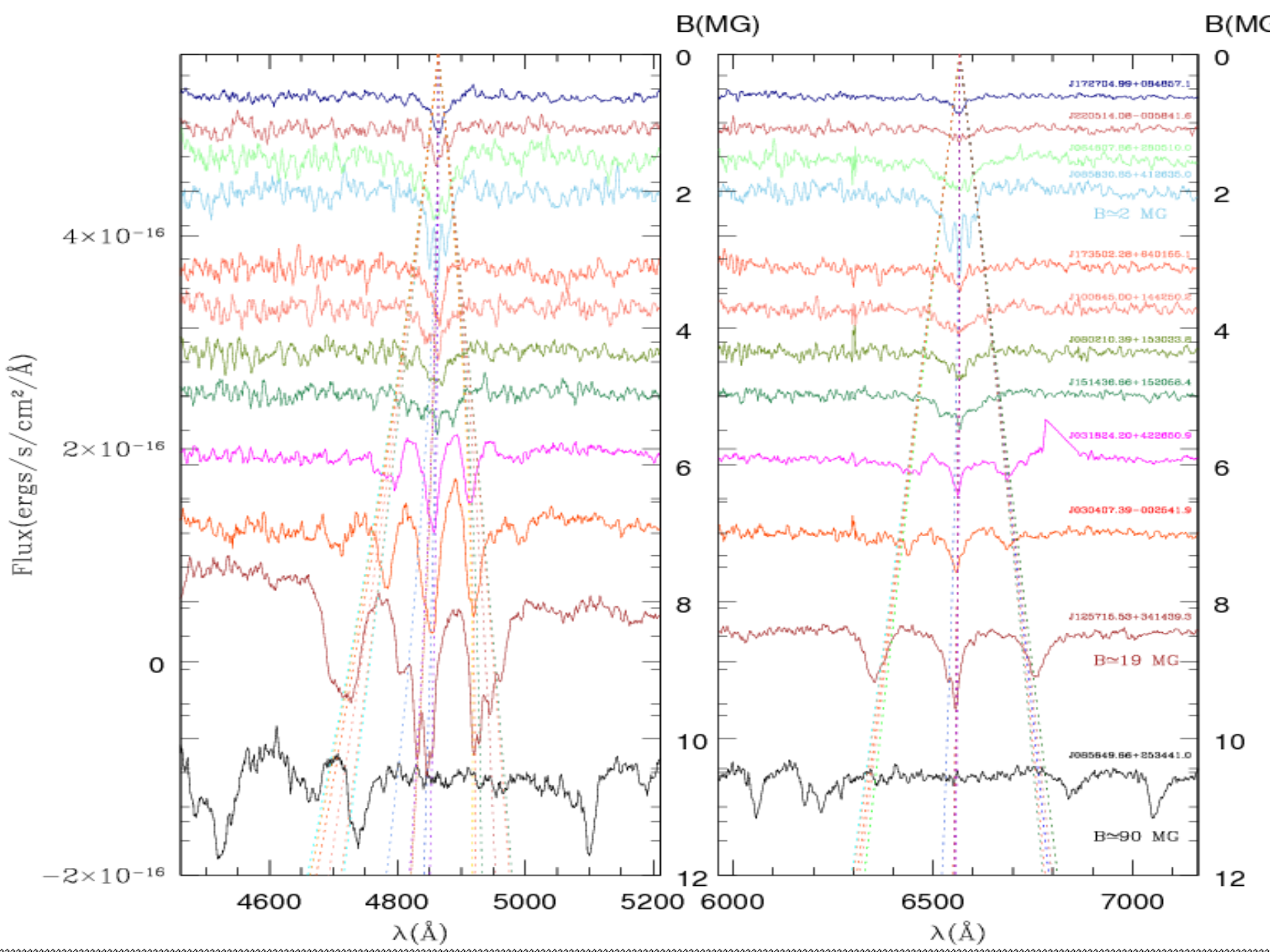
-modeled the structure of the surface magnetic fields of the hydrogen-rich white dwarfs and
-analysed the spectra of all known magnetic DAs from the SDSS : 97 previously published plus 44 newly discovered.

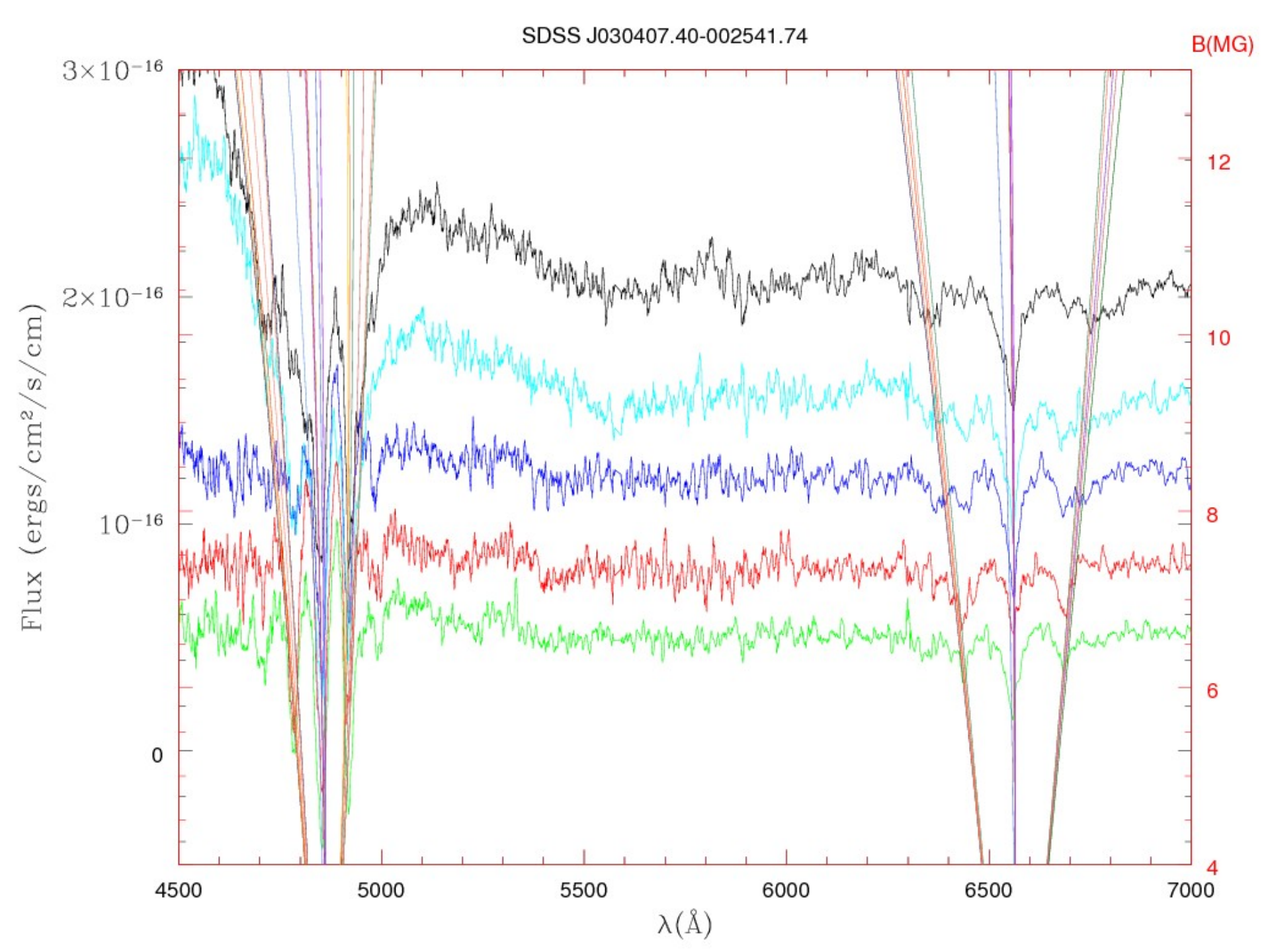


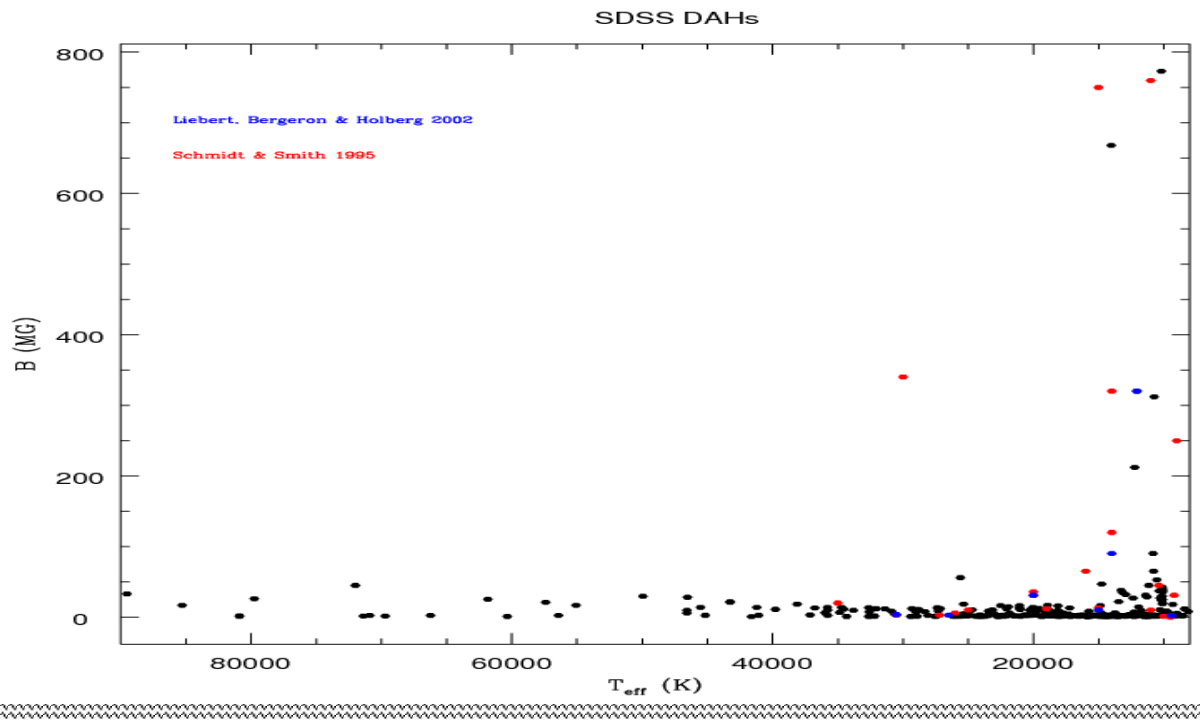
Off-center dipole

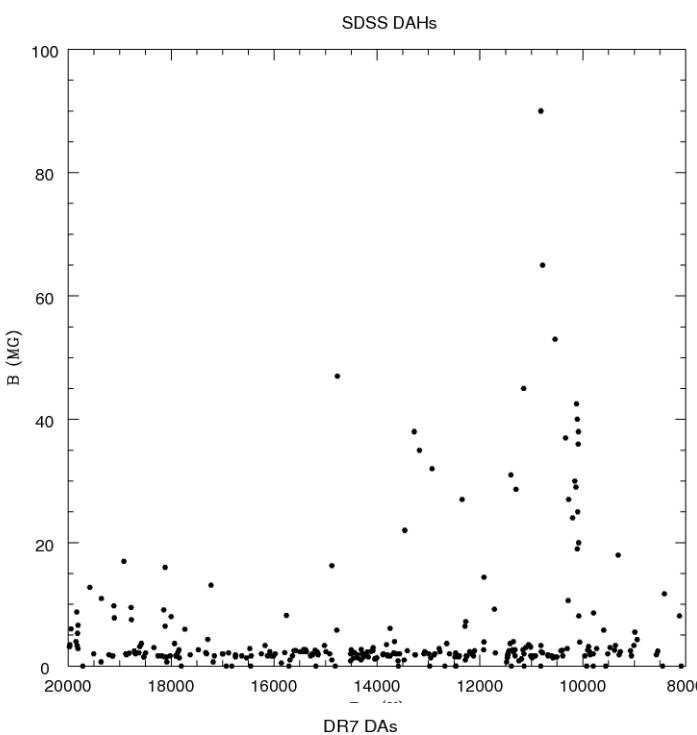


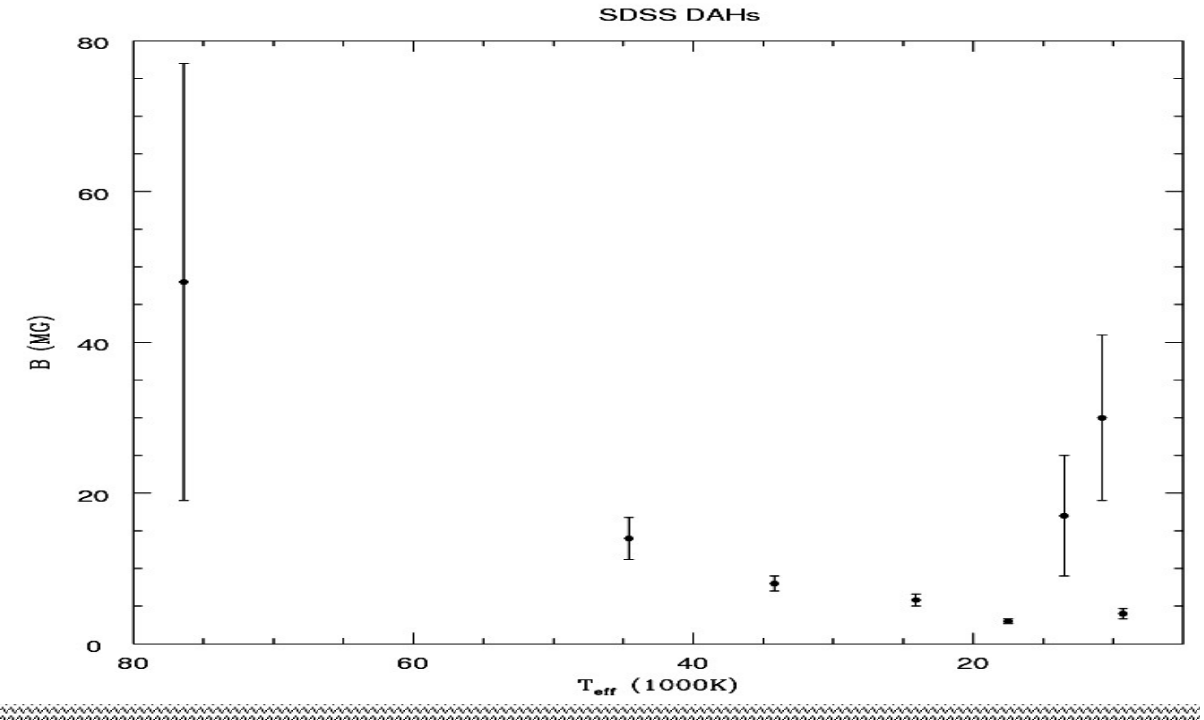

Flux(ergs/s/cm²/Å)
4×10⁻¹⁶
2×10⁻¹⁶
0
−2×10⁻¹⁶
4600
4800
5000
5200
λ(Å)
6000
6500
7000
λ(Å)
J172704.99+084657.1
J220514.08−000841.6
J084607.96+280510.0
J085830.65+412635.0
J173502.28+840155.1
J100645.00+144250.2
J080210.39+153033.8
J151436.66+152058.4
J031824.20+422650.9
J030407.39−002541.9
J125715.53+341439.3
J085649.66+253441.0

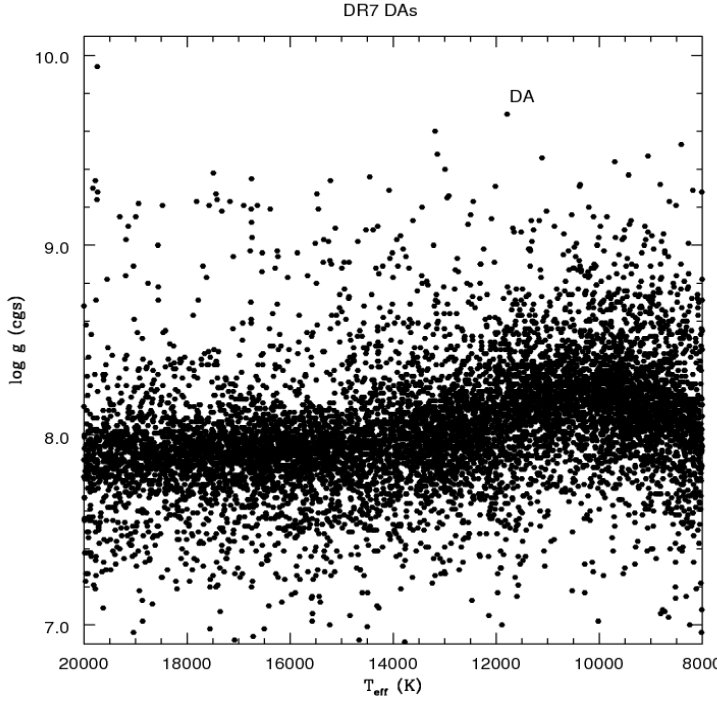

B(MG)
B(MG)
Flux(ergs/s/cm²/Å)
4×10⁻¹⁶
2×10⁻¹⁶
0
−2×10⁻¹⁶
0
2
4
6
8
10
12
4600
4800
5000
5200
6000
6500
7000
λ(Å)
λ(Å)
J172704.99+084857.1
J220514.08−005841.6
J085830.85+412635.0
B≃2 MG
J173502.28+640165.1
J100645.00+144250.2
J080210.39+153033.6
J151436.66+152066.4
J031824.20+422650.9
J030407.39−002541.9
J125715.53+341439.3
B≃19 MG
J085649.66+253441.0
B≃90 MG

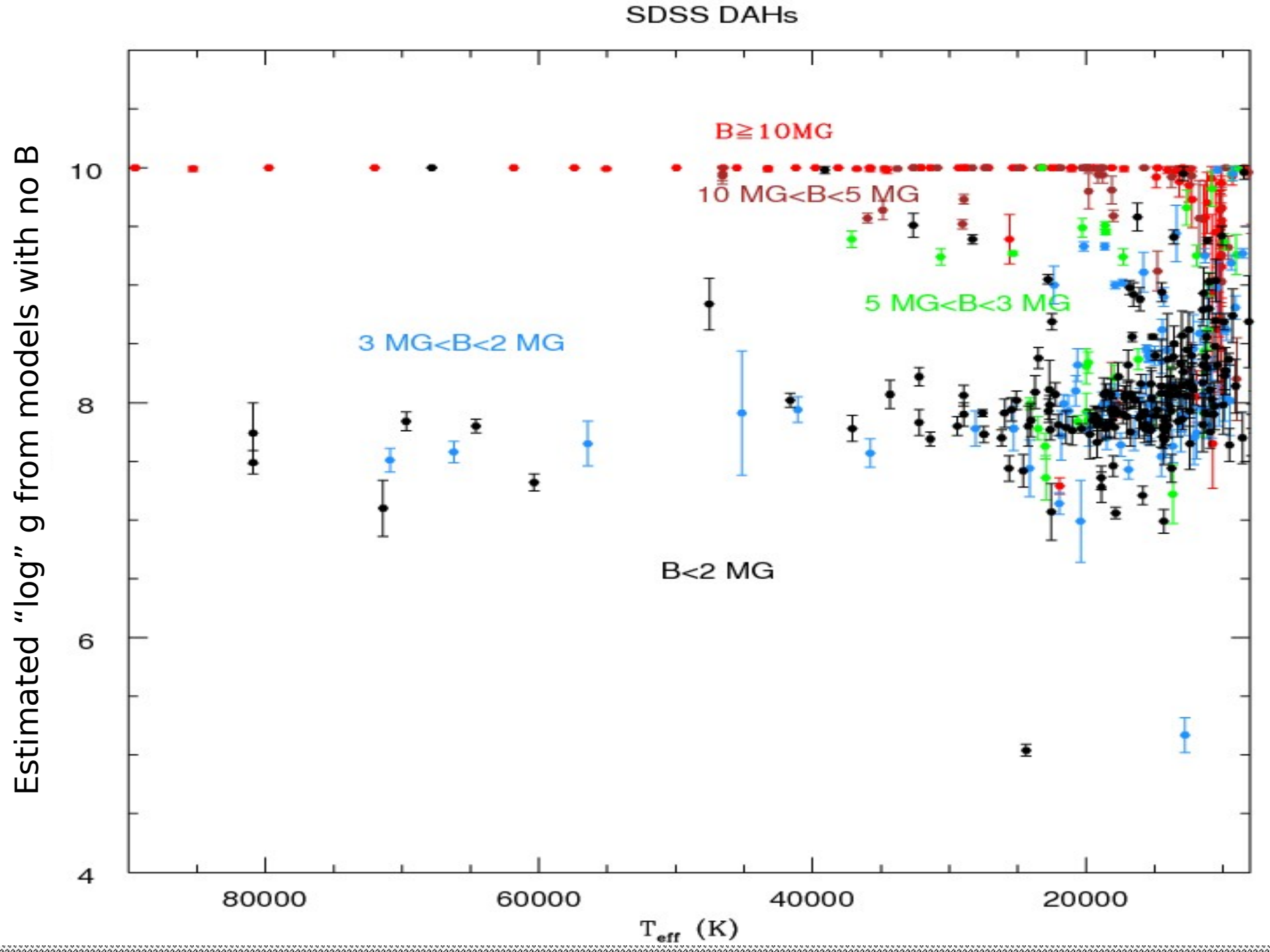

SDSS J030407.40-002541.74
B(MG)
3×10⁻¹⁶
2×10⁻¹⁶
10⁻¹⁶
0
Flux (ergs/cm²/s/cm)
12
10
8
6
4
4500
5000
5500
6000
6500
7000
λ(Å)

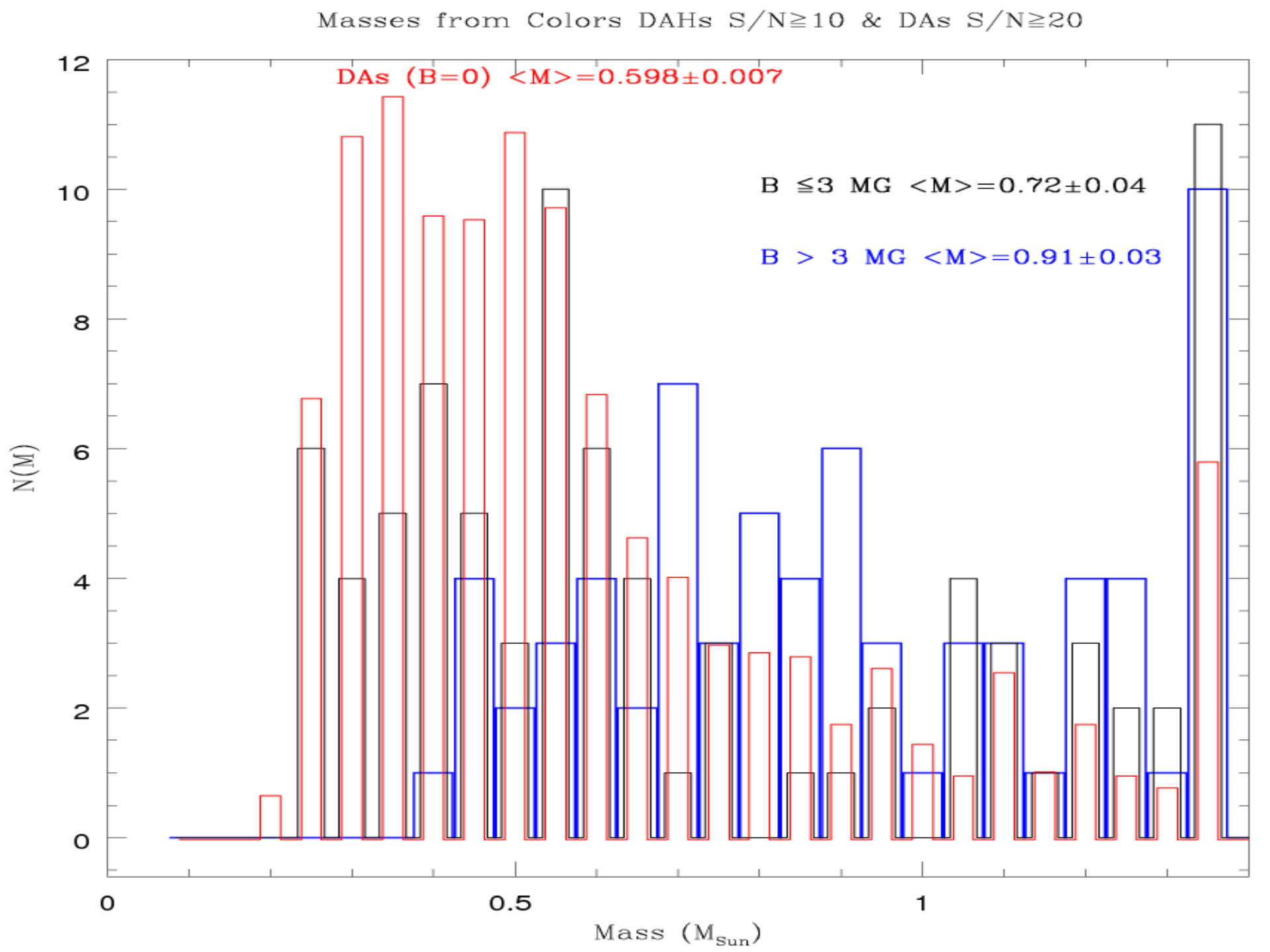

SDSS DAHs
Liebert, Bergeron & Holberg 2002
Schmidt & Smith 1995
B (MG)
T_{eff} (K)


SDSS DAHs
B (MG)


SDSS DAHs
B (MG)
T_{eff} (1000K)

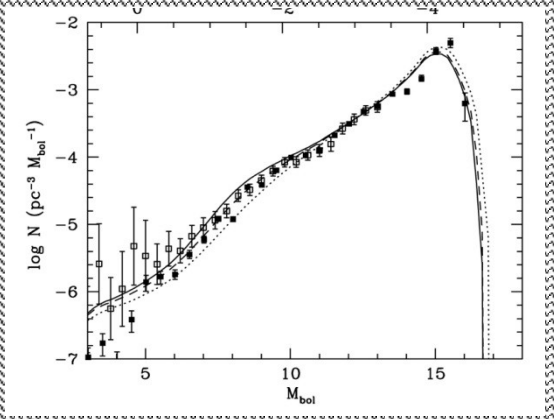

DR7 DAs
DA
log g (cgs)
T_{eff} (K)


SDSS DAHs
B≥10MG
10 MG<B<5 MG
5 MG<B<3 MG
3 MG<B<2 MG
B<2 MG
Estimated "log" g from models with no B
10
8
6
4
80000
60000
40000
20000
T_eff (K)


Masses from Colors DAHs S/N≧10 & DAs S/N≧20
DAs (B=0) <M>=0.598±0.007
B ≦3 MG <M>=0.72±0.04
B > 3 MG <M>=0.91±0.03
N(M)
Mass (M_Sun)
0
2
4
6
8
10
12
0
0.5
1

LSST

- 50 million wd: rare objects-Chandrasekhar mass, LF x mass, axions from LF



- 400 000 halo wd (ages independ of metallicities)
- Planets and asteroidal (rocky) material around wds
- CVs – variable, accreting wds
- SNIa – binary wds
- WDs as absolute flux calibrators
- Variables: 1 to 250 mma, P=100 s to 4000 s (band)