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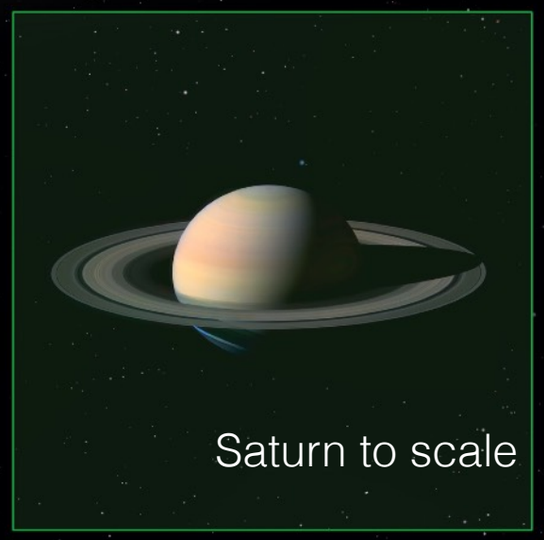
Gaseous debris discs around white dwarfs

Christopher J. Manser

Collaborators: Boris Gänsicke, Tom Marsh, Detlev Koester,
Dimitri Veras, Nicola Pietro Gentile Fusillo

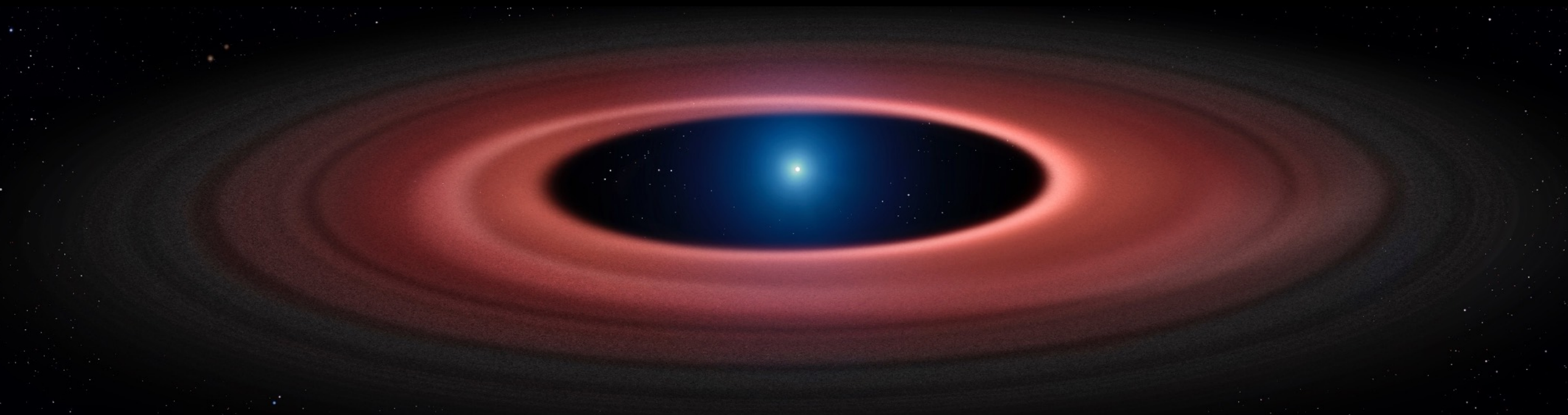


C.Manser@Warwick.ac.uk

Artists impression of SDSS J1228+1040 by Mark Garlick. Image of Saturn from NASA's Cassini mission, NASA image saturn_malmerCassini_5m.jpg

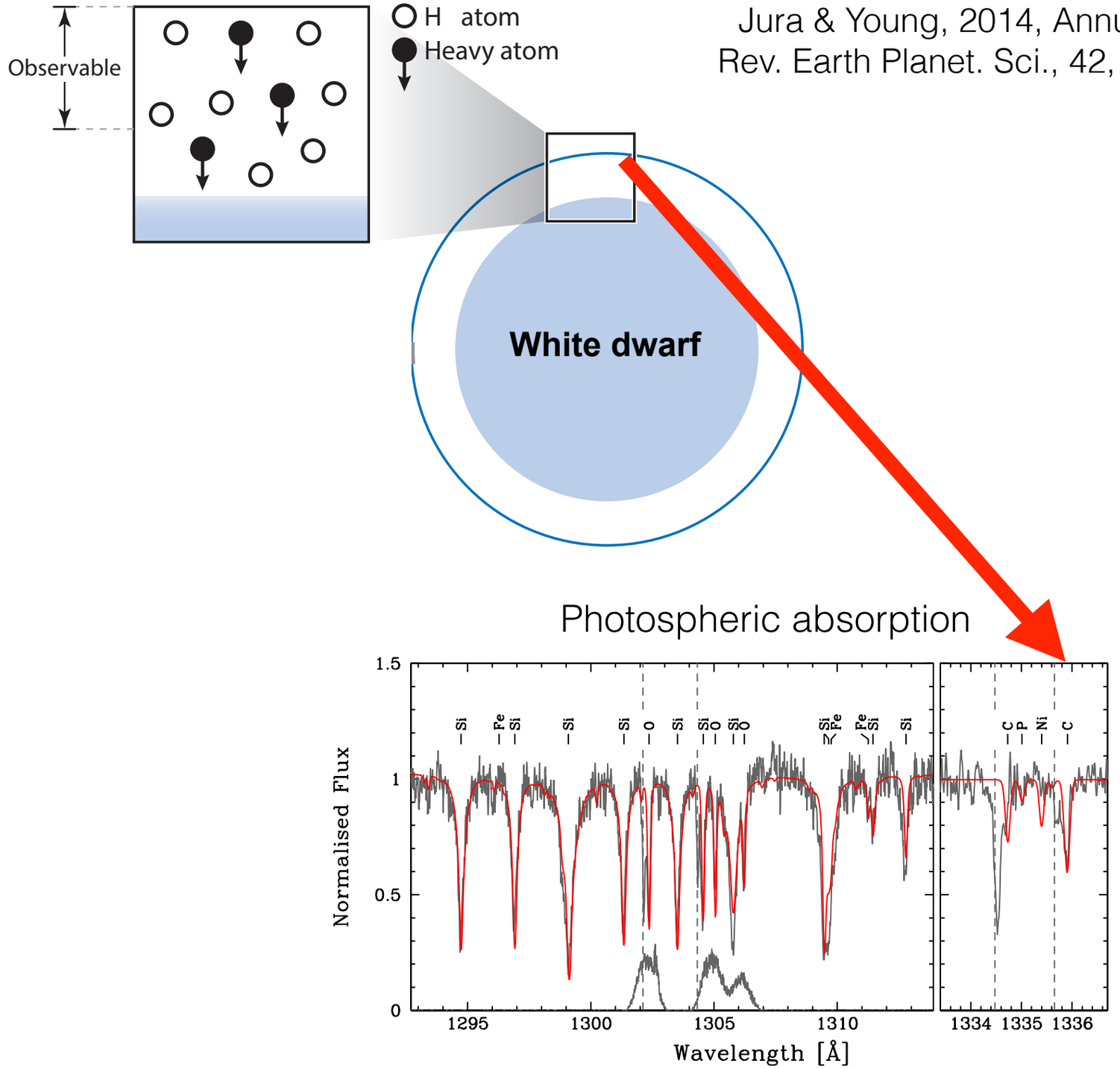
Talk Outline

- **One -** The gaseous debris disc around SDSS J1228+1040
- **Few -** Common variability of gaseous debris discs
- **Many -** Frequency of gaseous debris discs around white dwarfs



Remnant Planetary Systems

SDSS J1228+1040

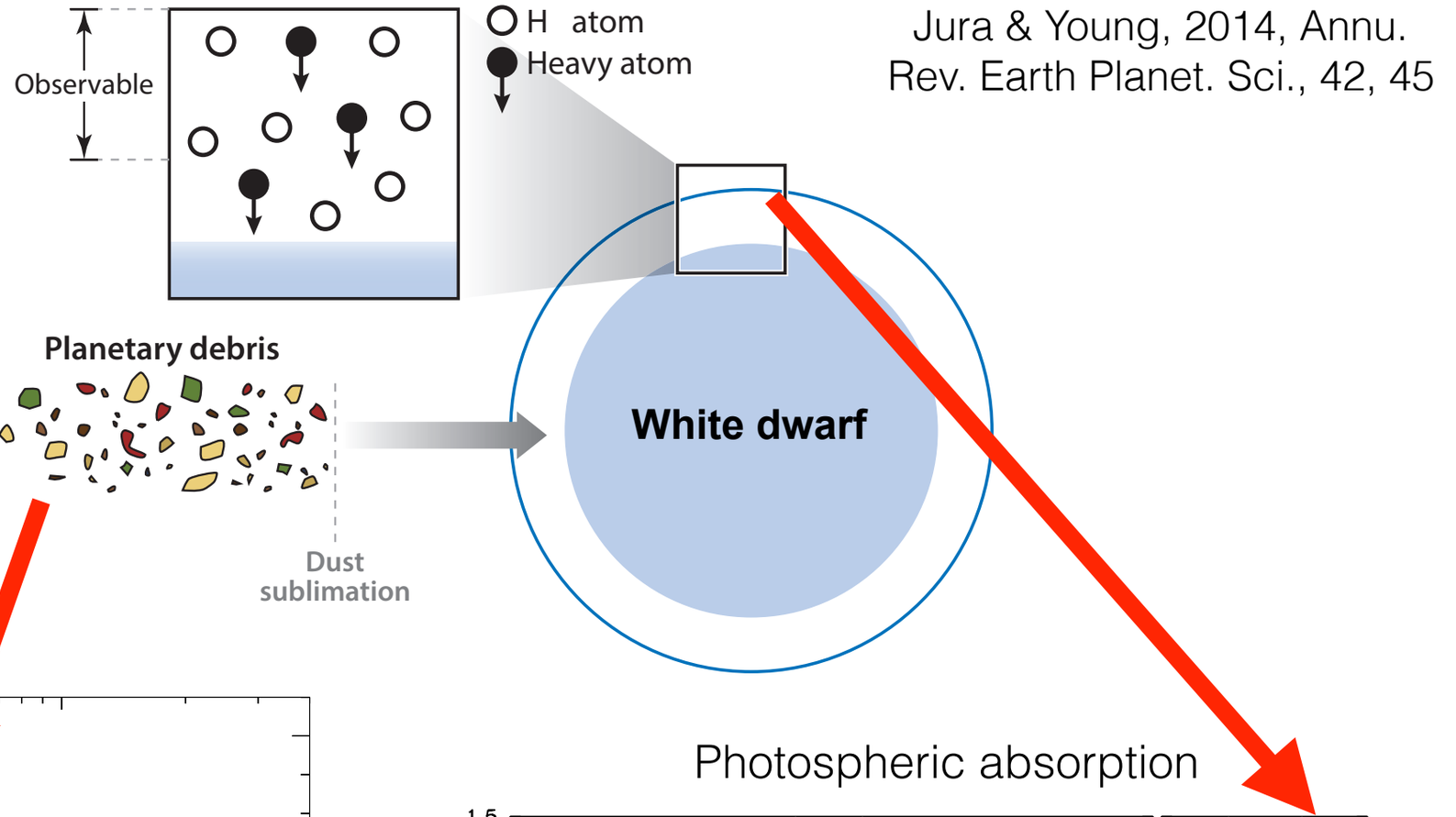


Jura & Young, 2014, Annu. Rev. Earth Planet. Sci., 42, 45

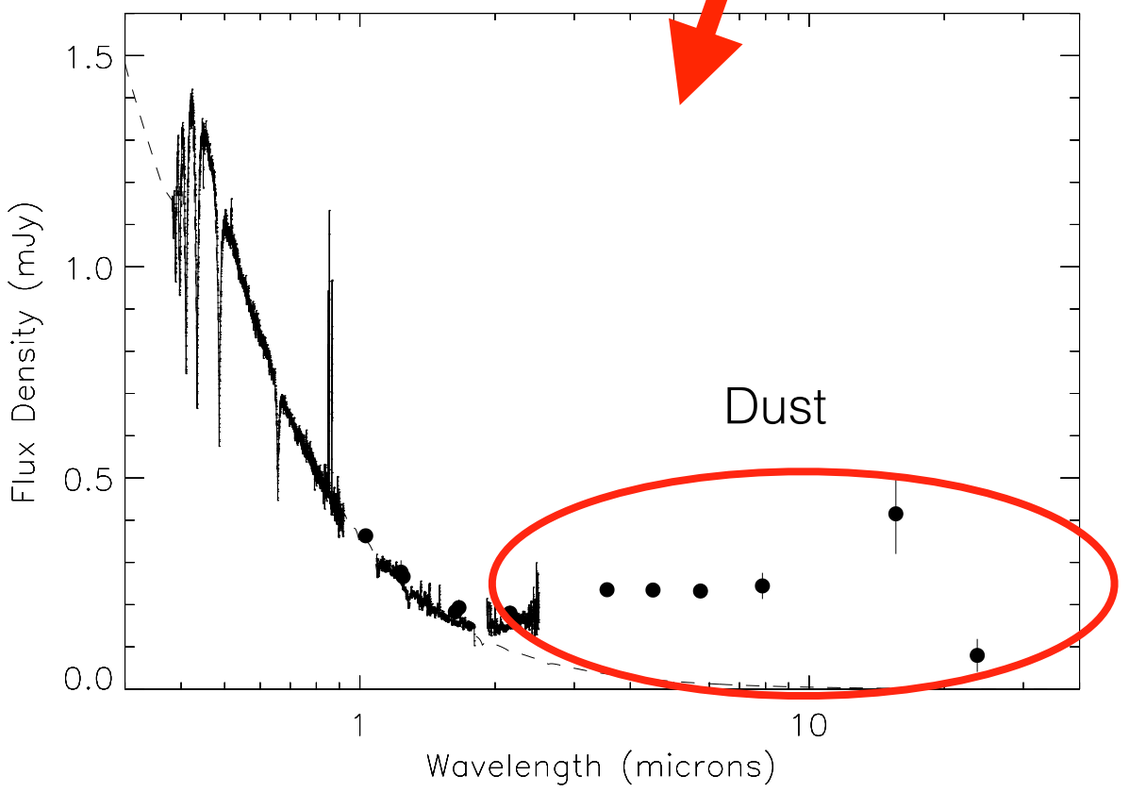
Gänsicke et. al. 2012, MNRAS, 424, 333

Remnant Planetary Systems

SDSS J1228+1040



Jura & Young, 2014, Annu. Rev. Earth Planet. Sci., 42, 45

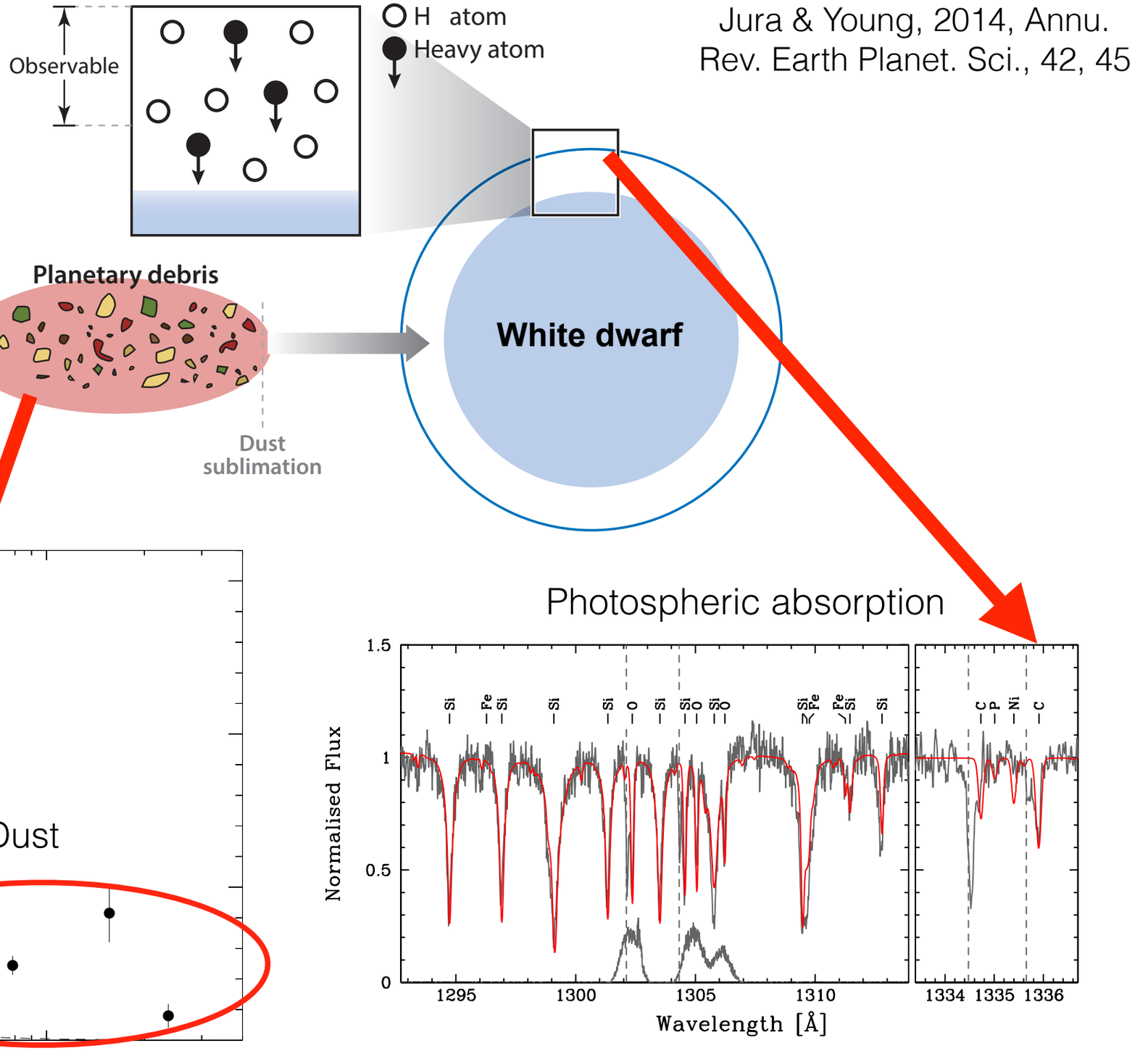


Brinkworth et. al. 2009, ApJ, 696, 1402

Gänsicke et. al. 2012, MNRAS, 424, 333

Remnant Planetary Systems

SDSS J1228+1040

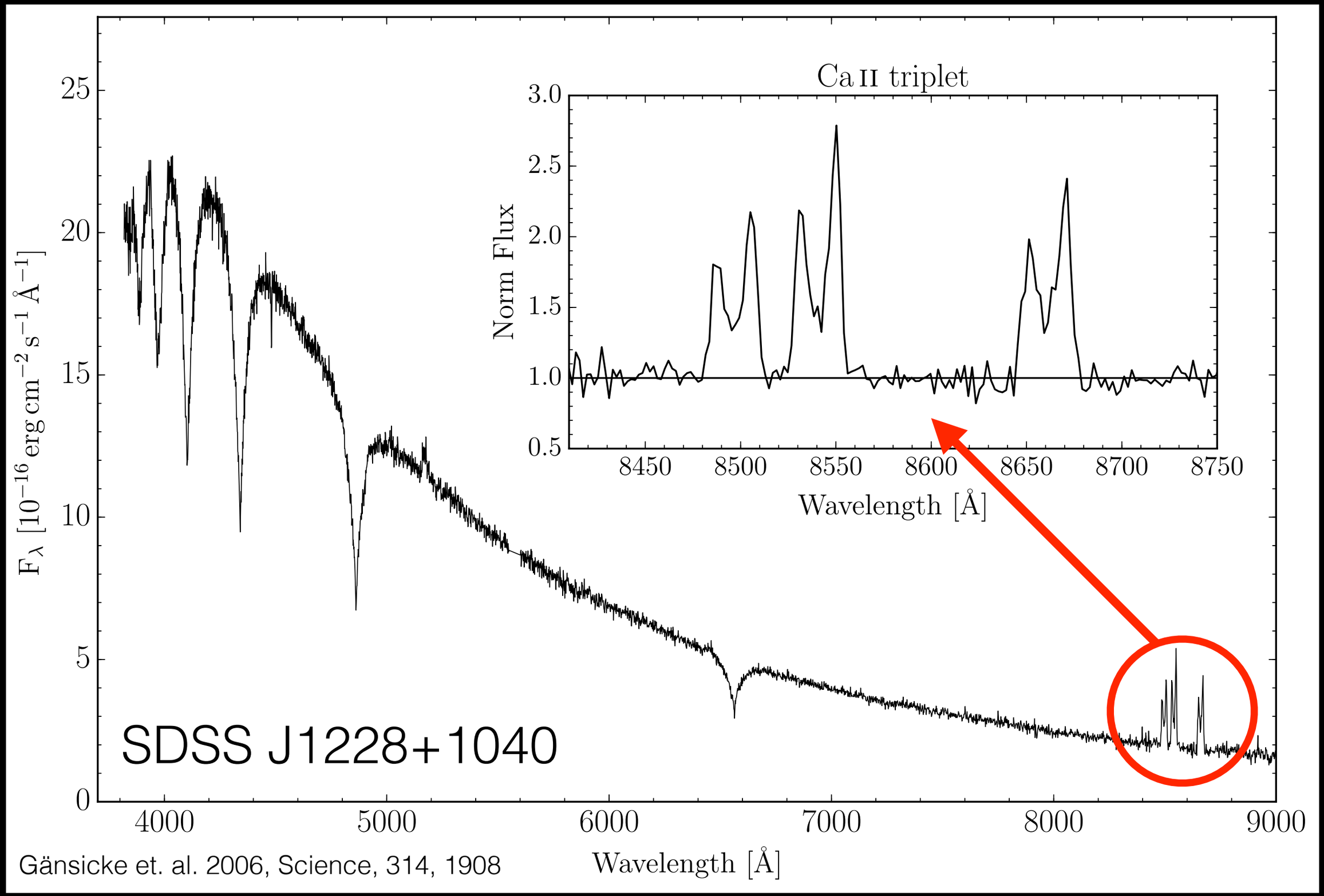


Jura & Young, 2014, Annu. Rev. Earth Planet. Sci., 42, 45

Brinkworth et. al. 2009, ApJ, 696, 1402

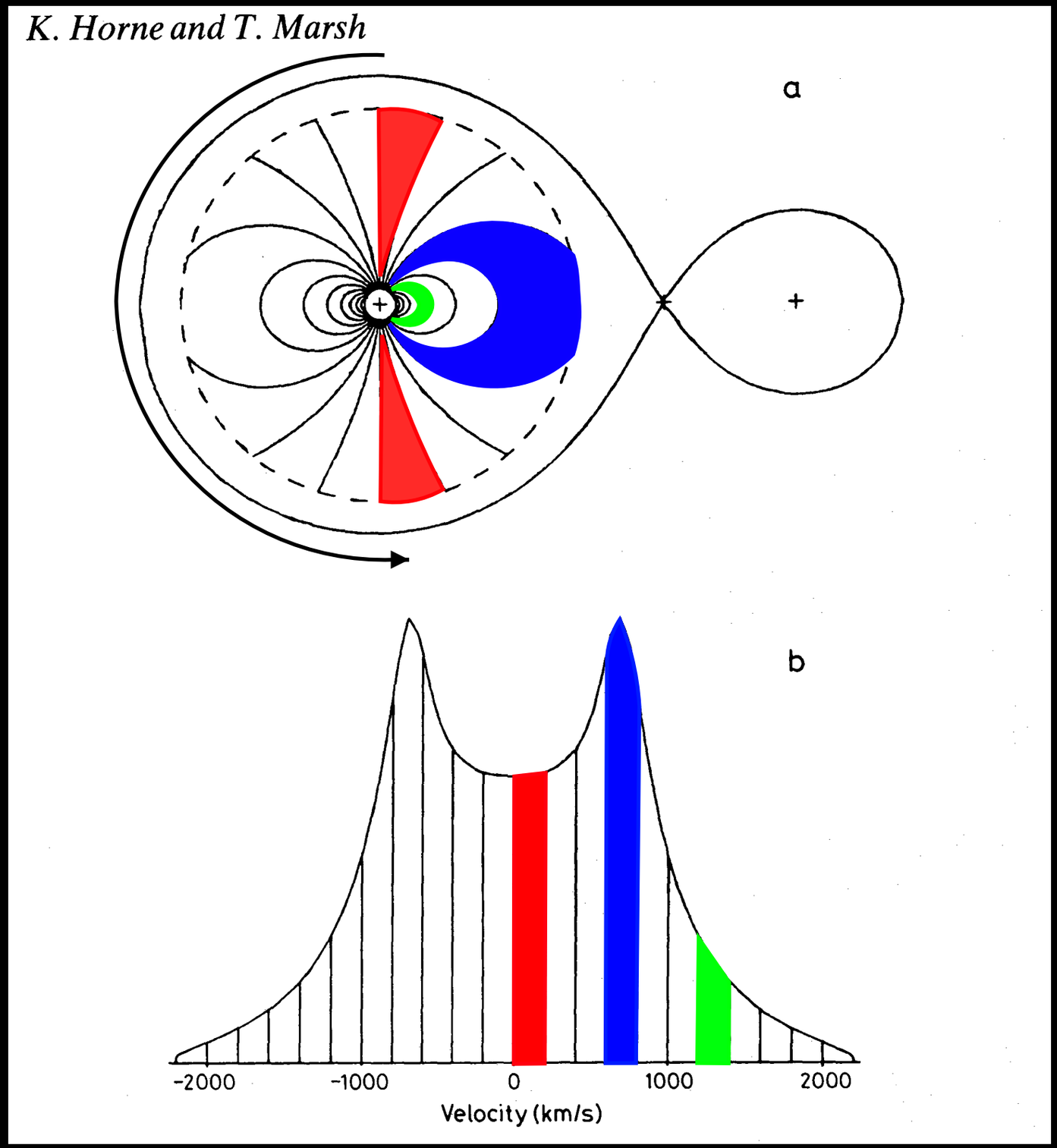
Gänsicke et. al. 2012, MNRAS, 424, 333

The gaseous component of the debris disc



Gänsicke et. al. 2006, Science, 314, 1908

Accretion disc in a binary



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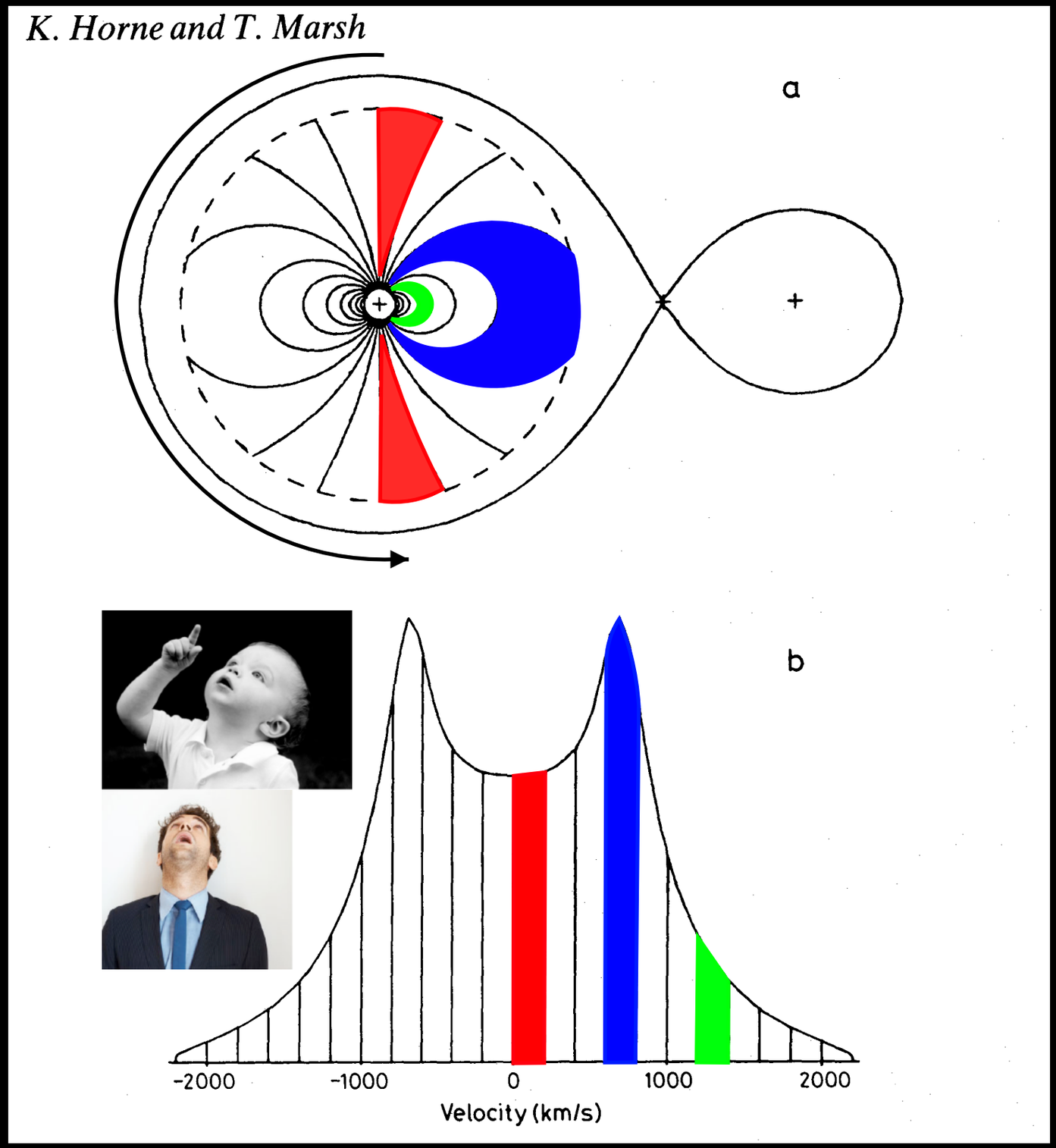
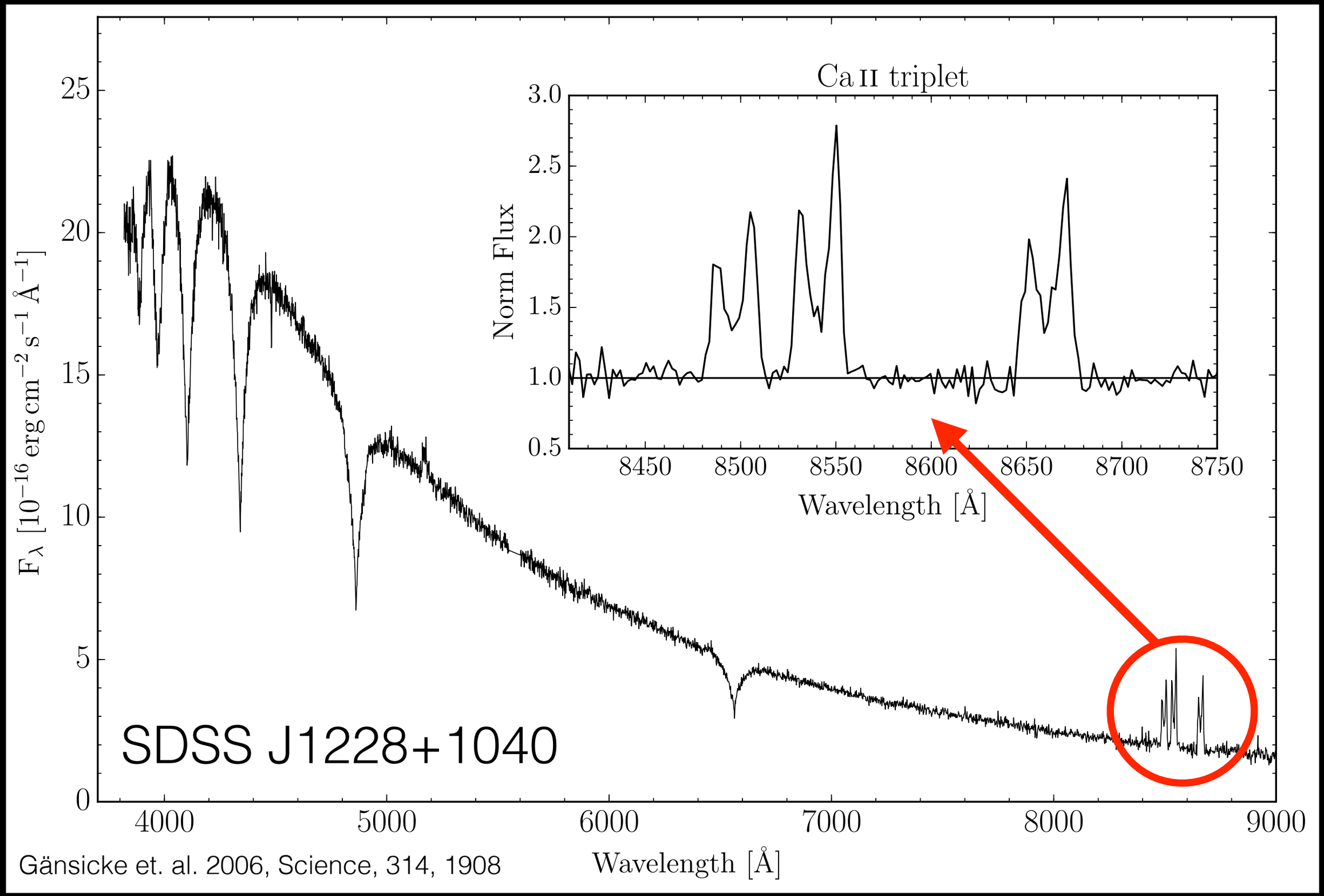
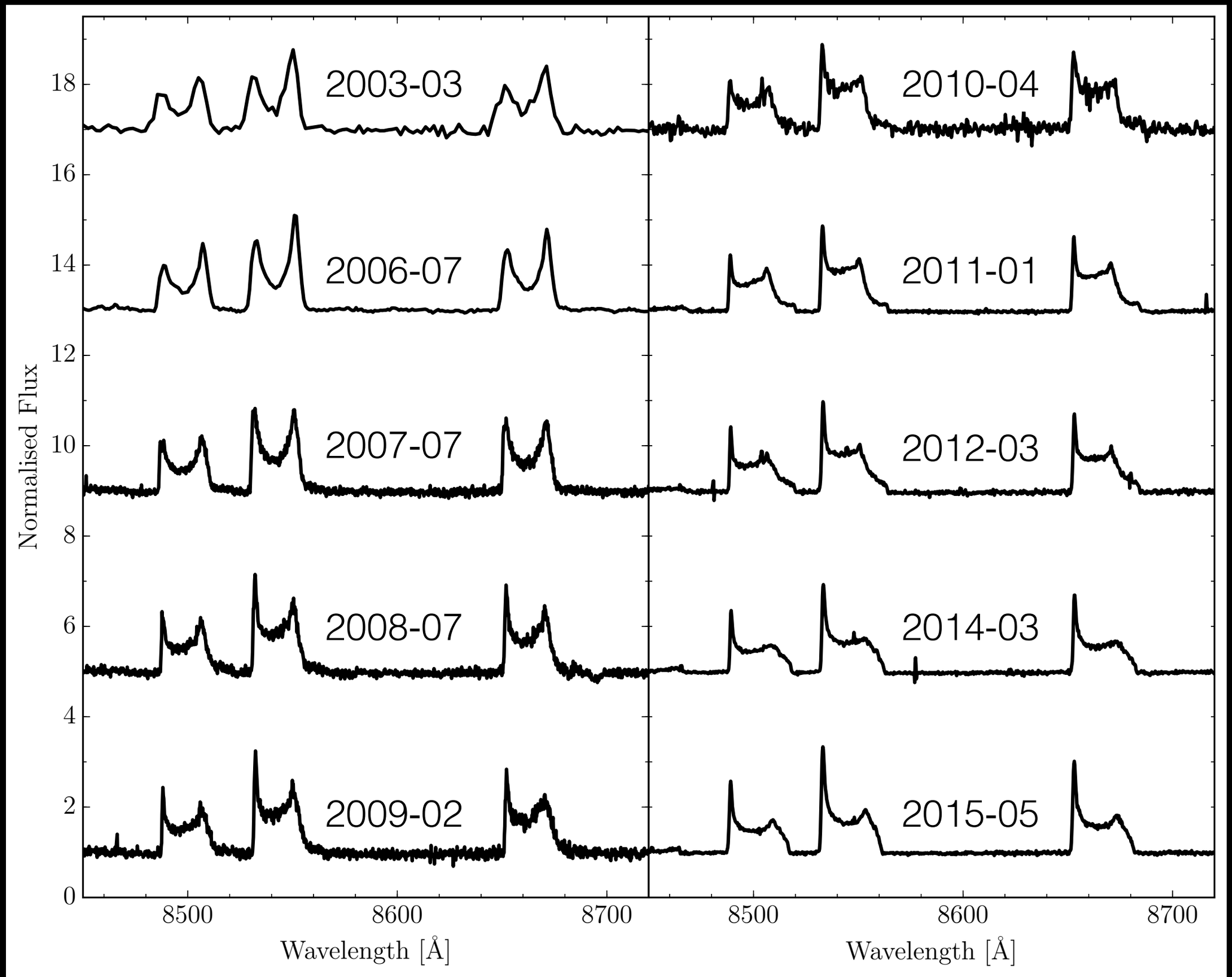


The gaseous component of the debris disc



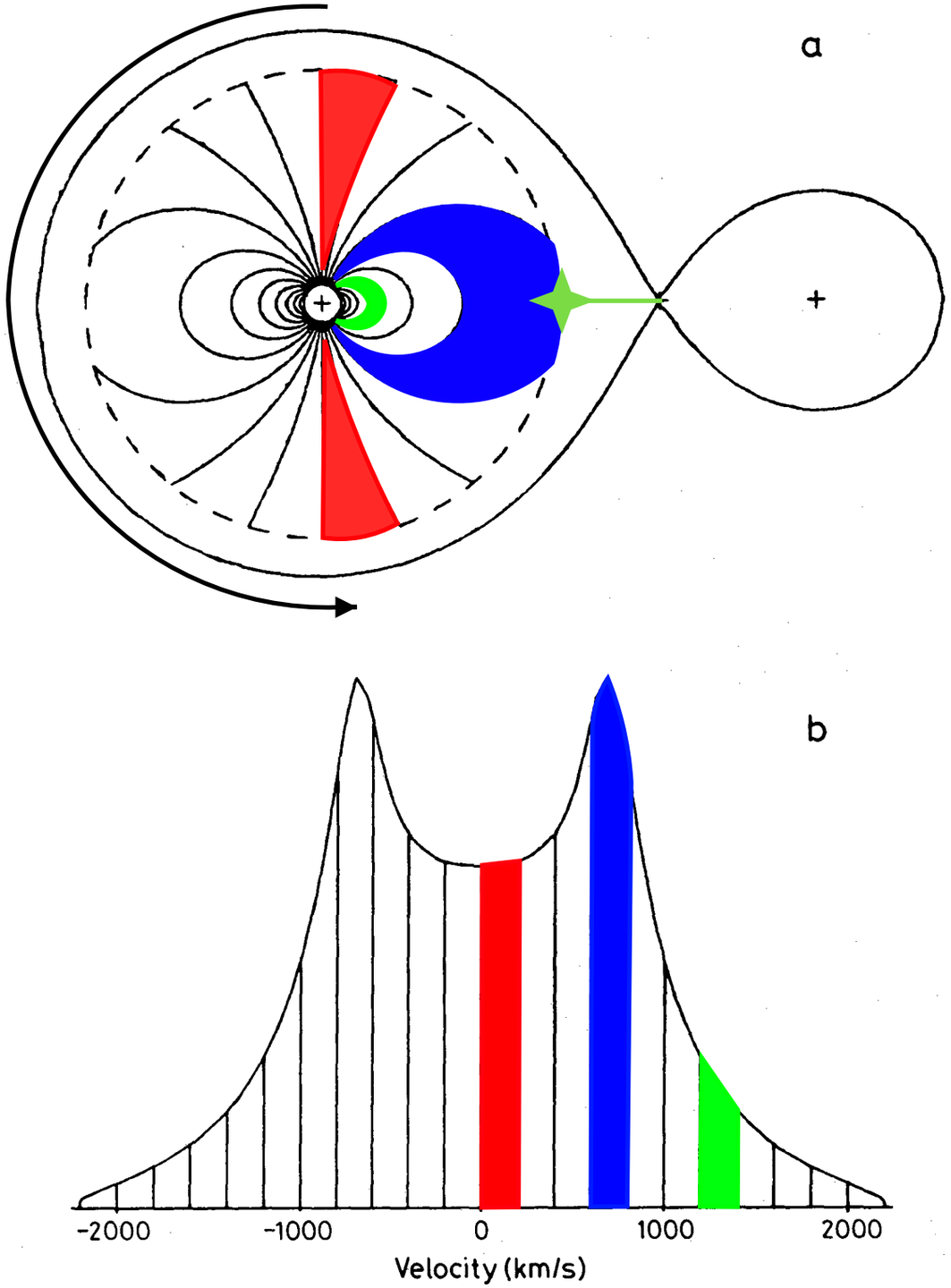
Gänsicke et. al. 2006, Science, 314, 1908

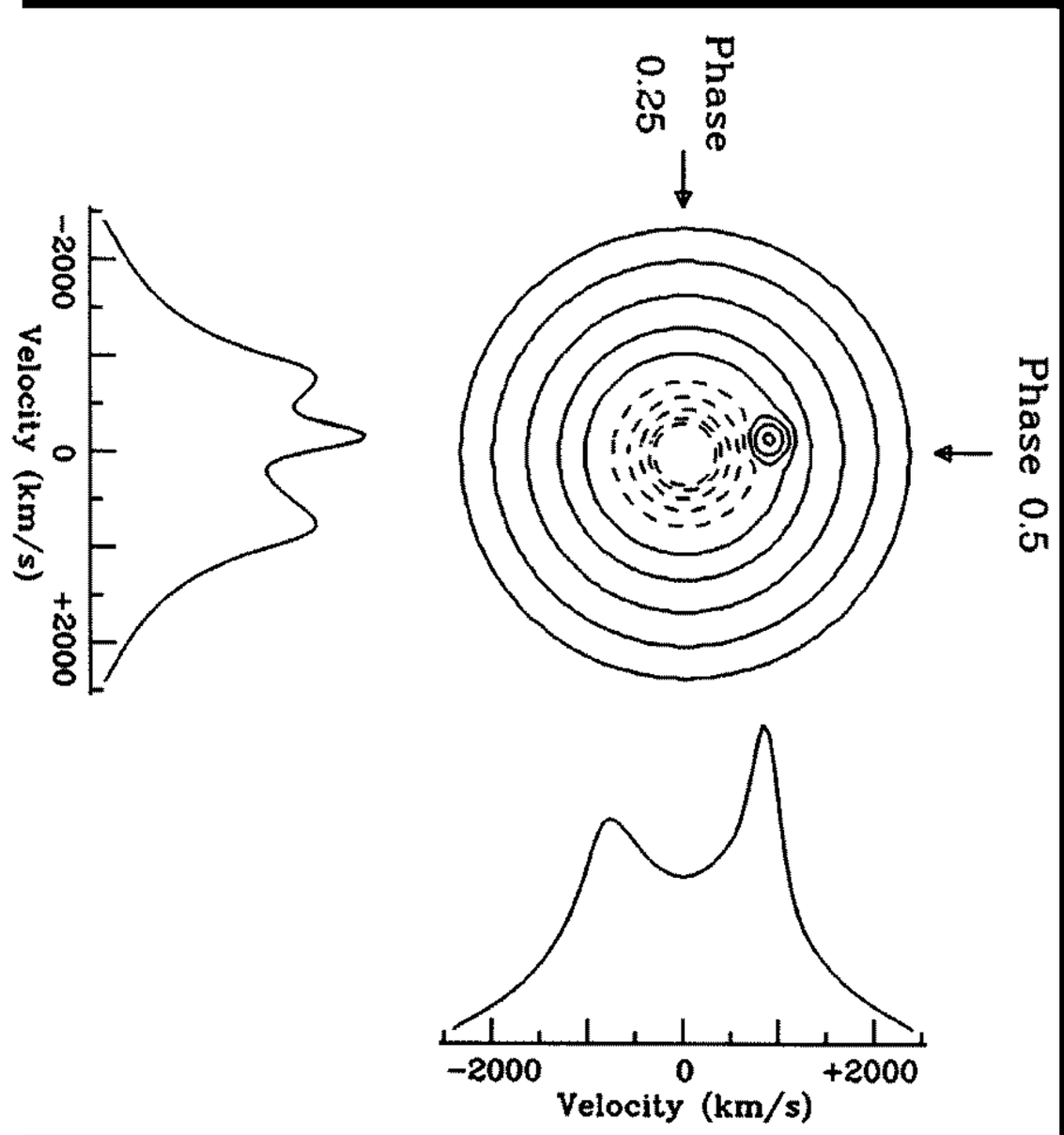
10 out of 18


2003-03
2010-04
2006-07
2011-01
2007-07
2012-03
2008-07
2014-03
2009-02
2015-05
Normalised Flux
Wavelength [Å]
Wavelength [Å]
0
2
4
6
8
10
12
14
16
18
8500
8600
8700

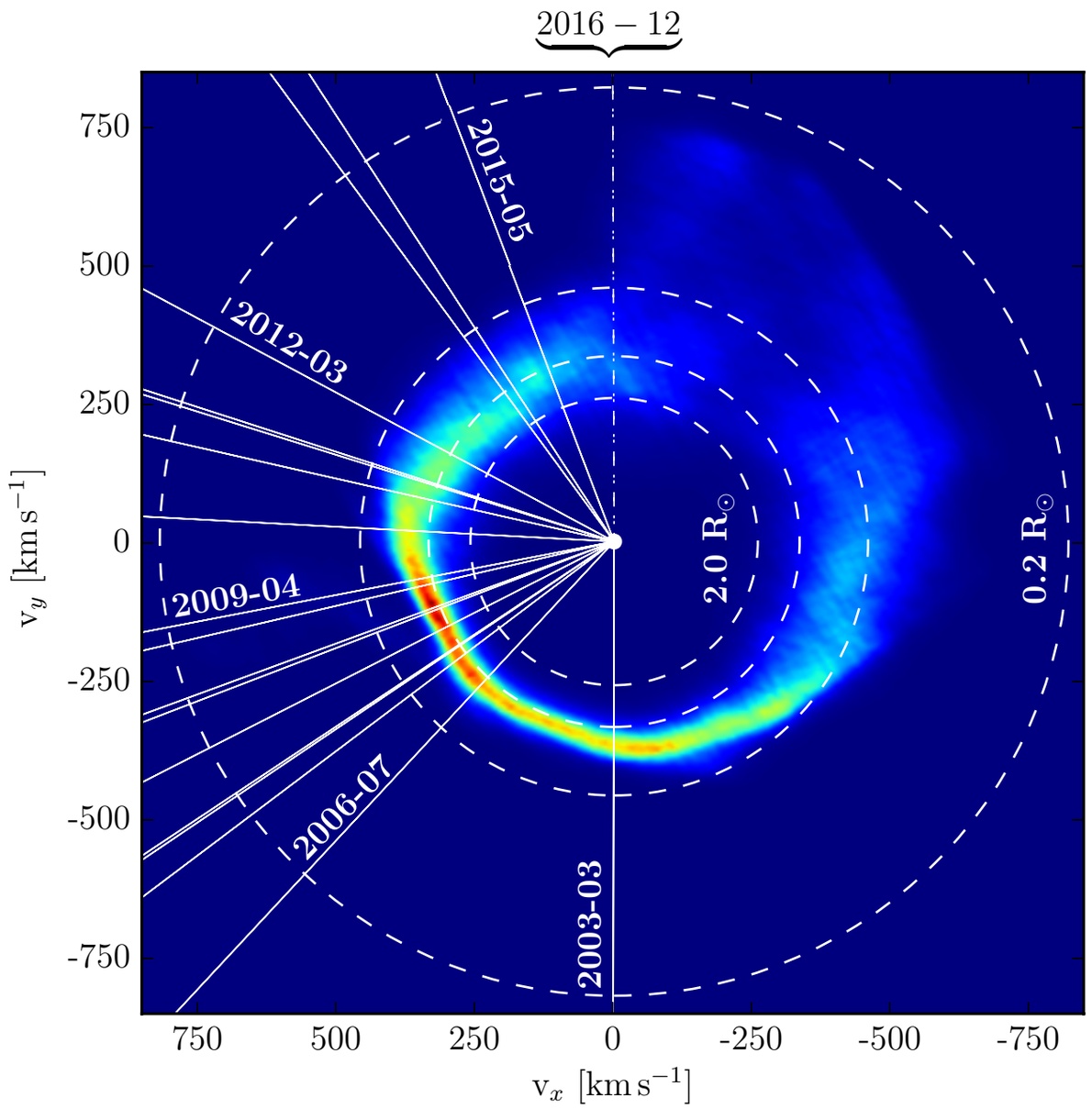
Doppler Tomography

K. Horne and T. Marsh

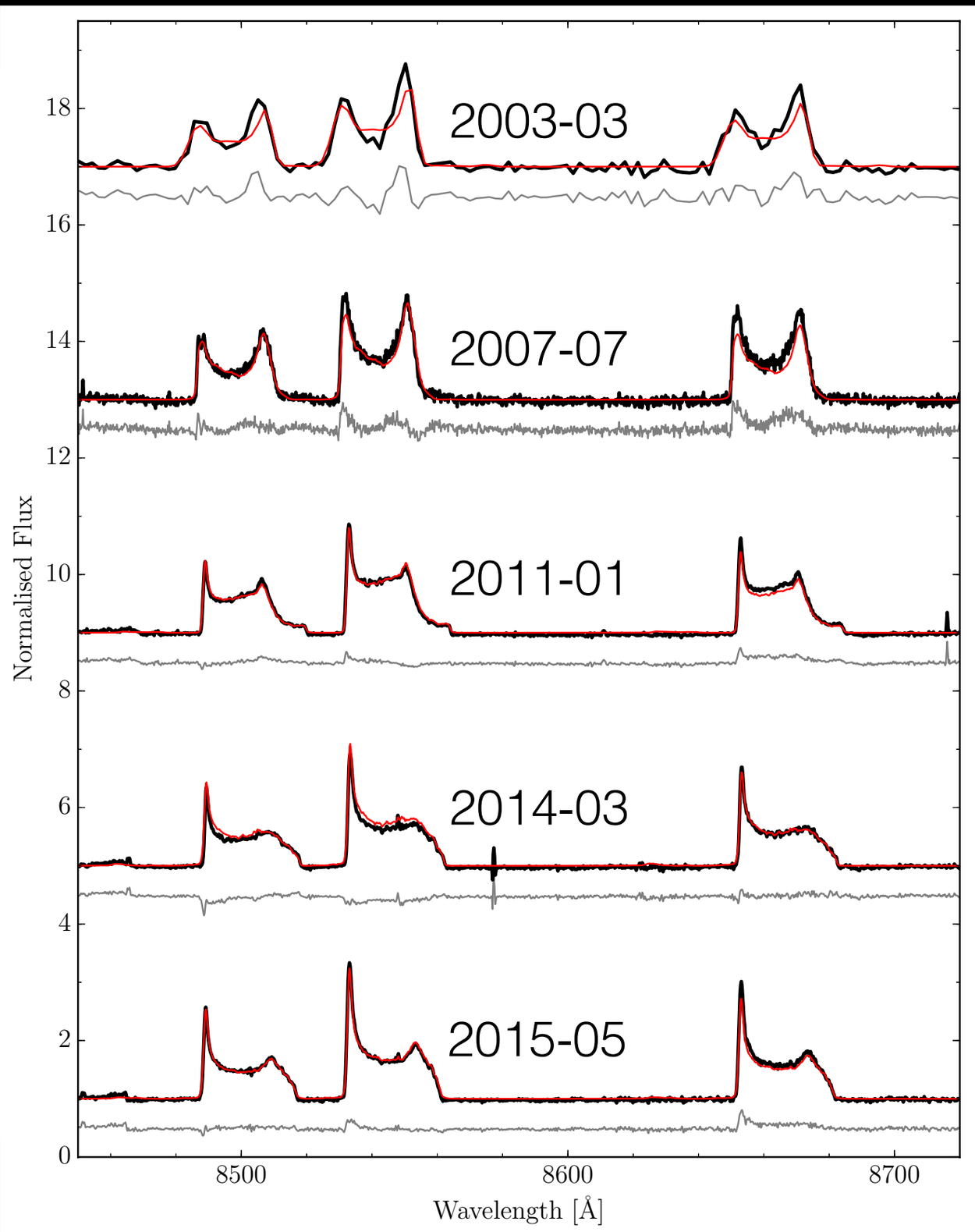




Doppler Tomography



Manser et. al. 2016, MNRAS, 455, 4467



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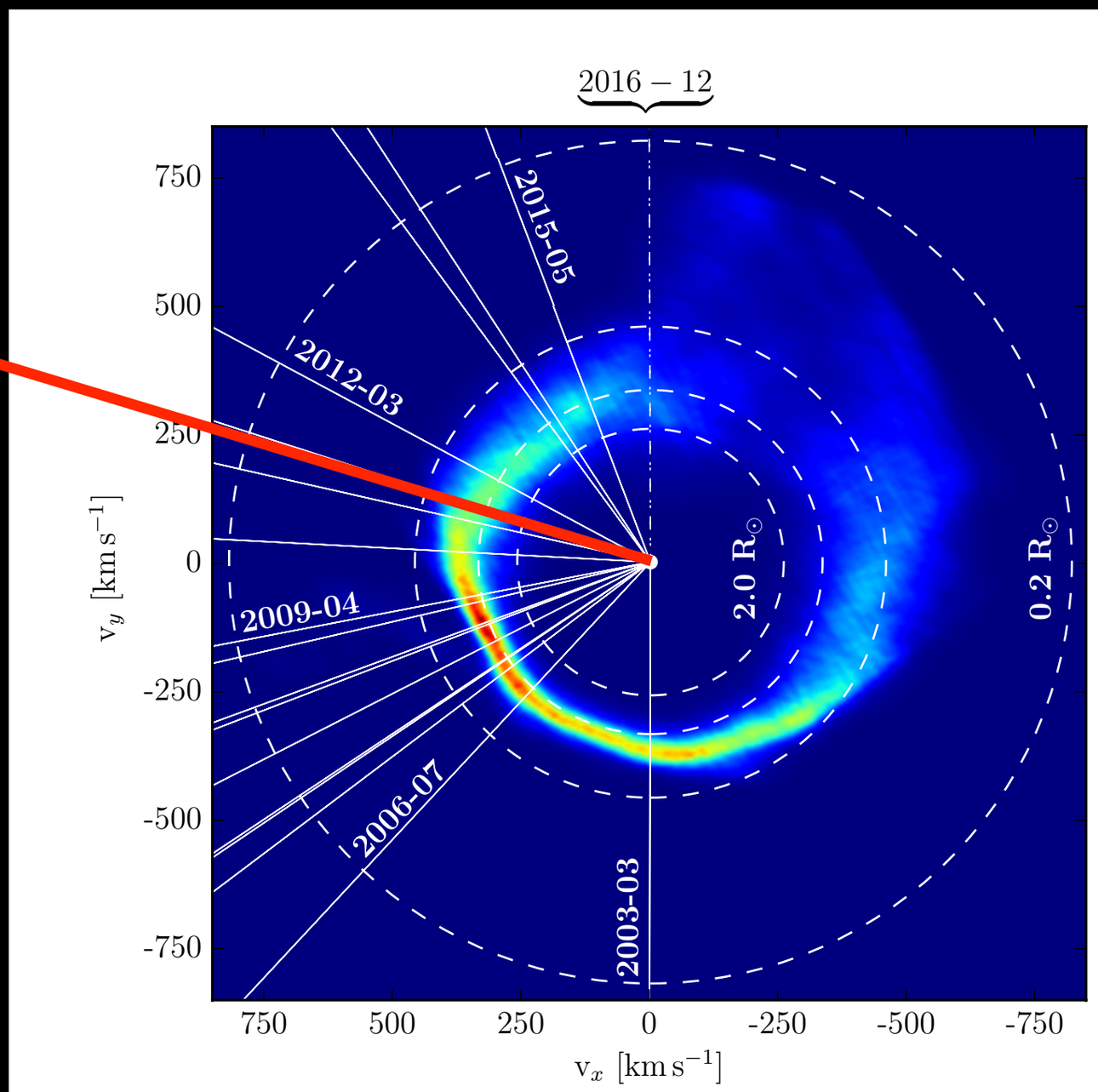
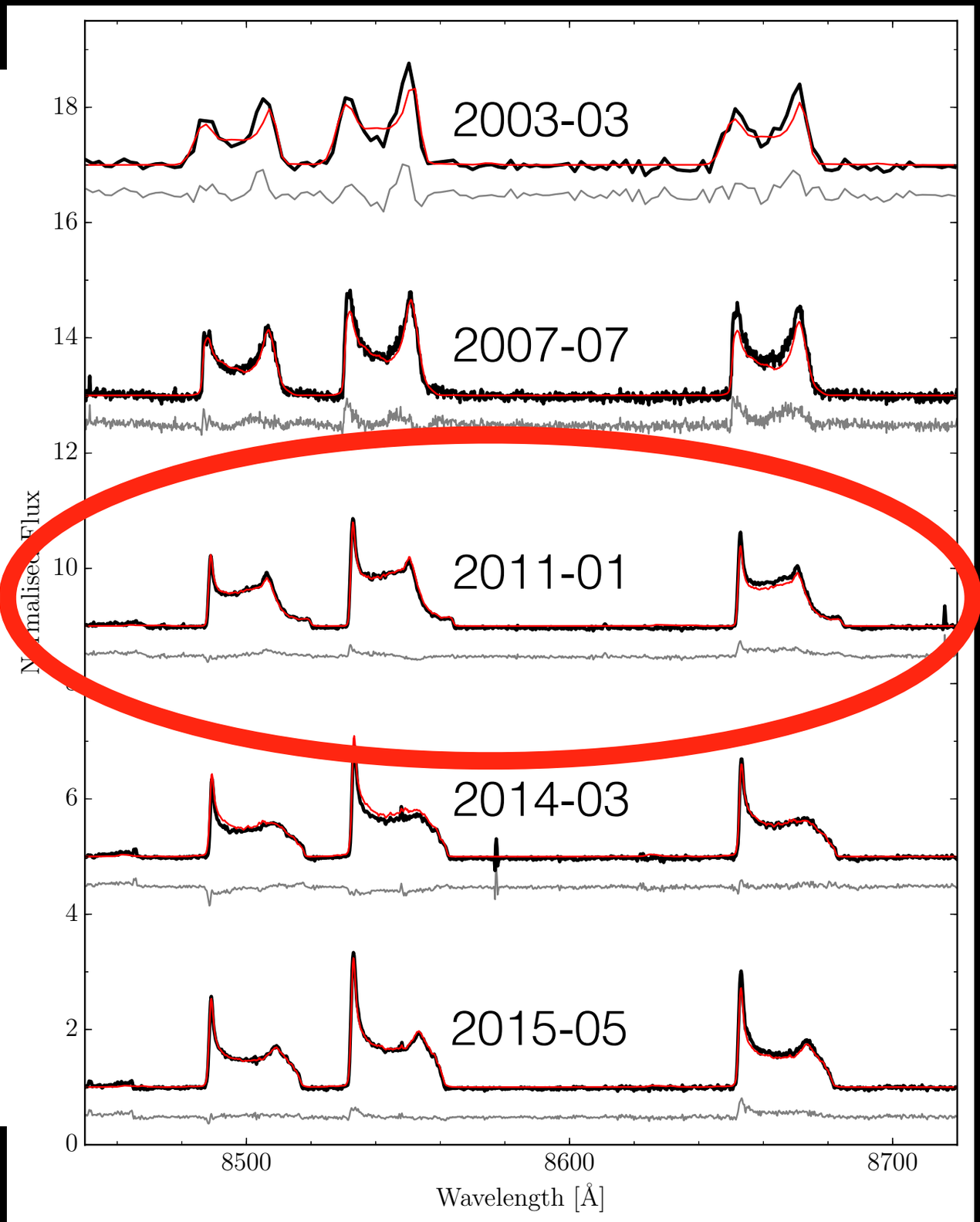
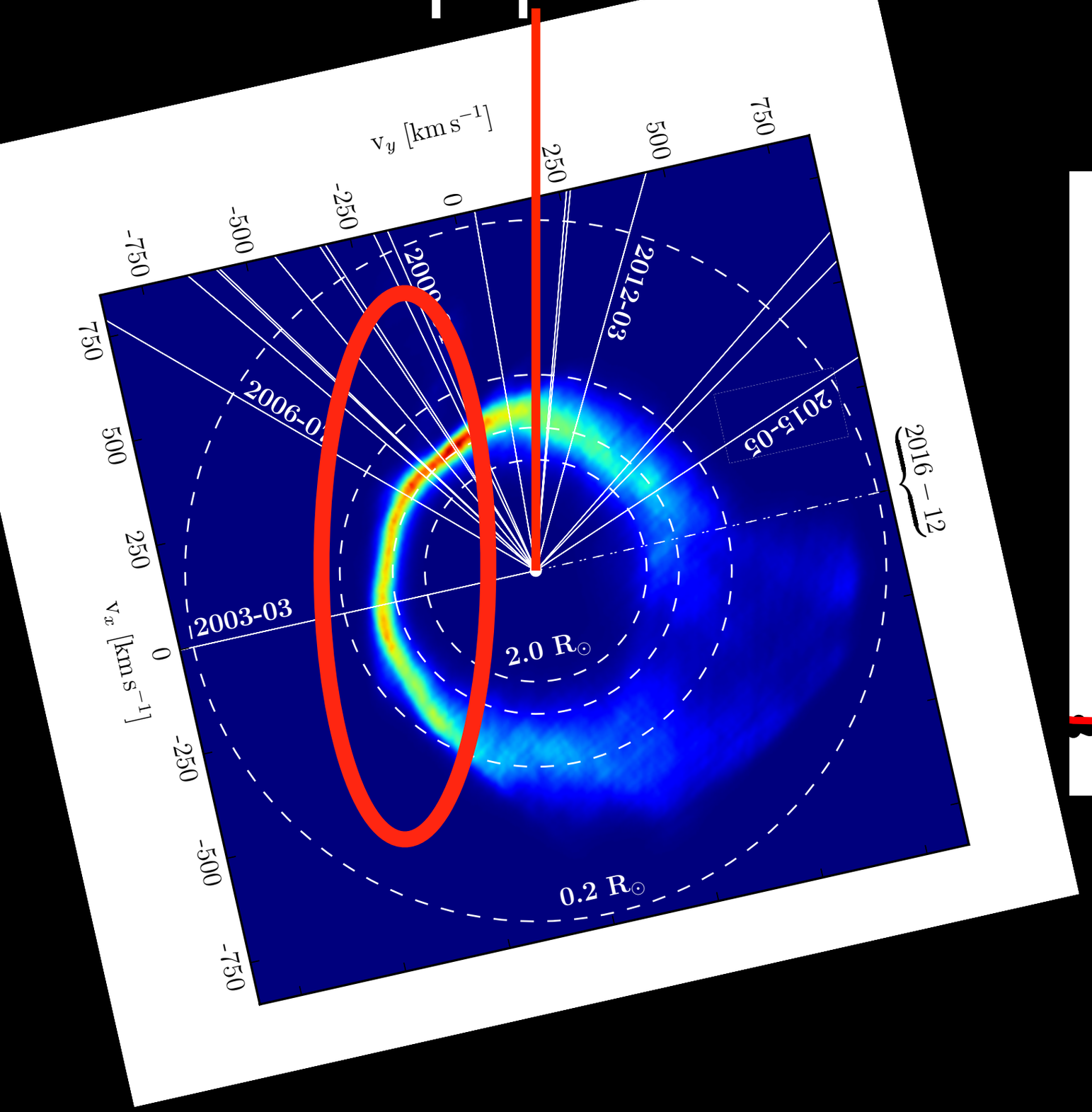
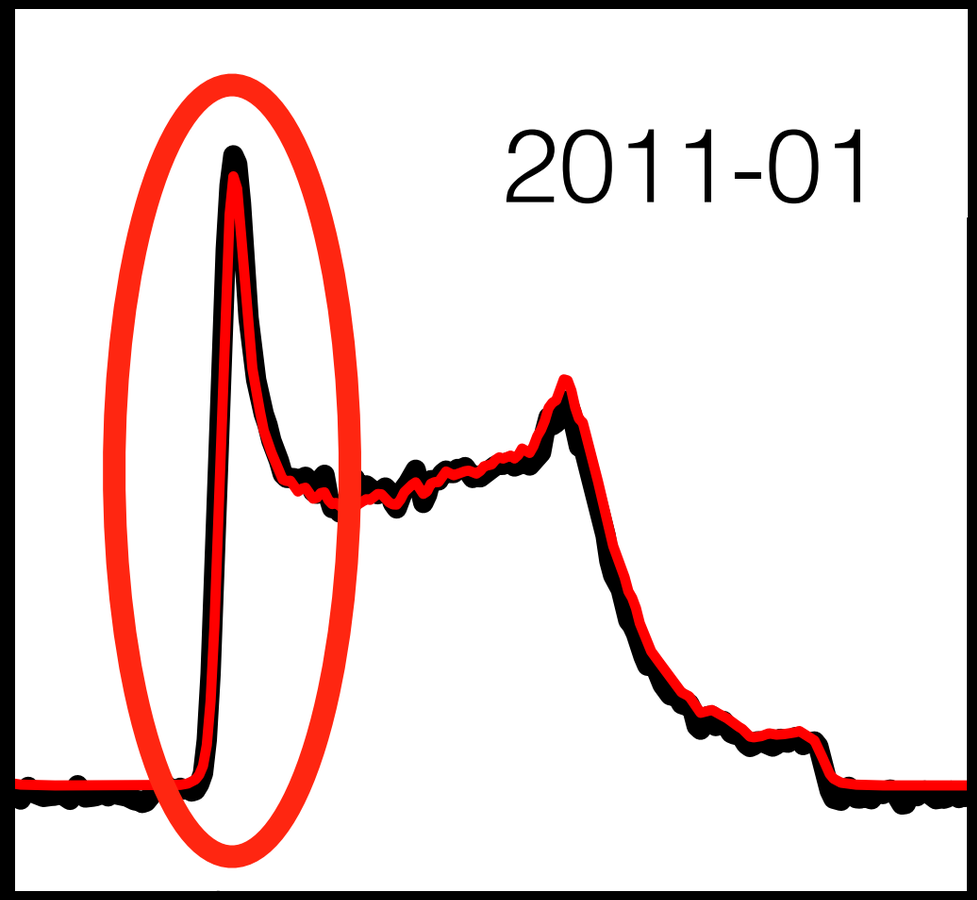


Manser et. al. 2016, MNRAS, 455, 4467



Doppler Tomography





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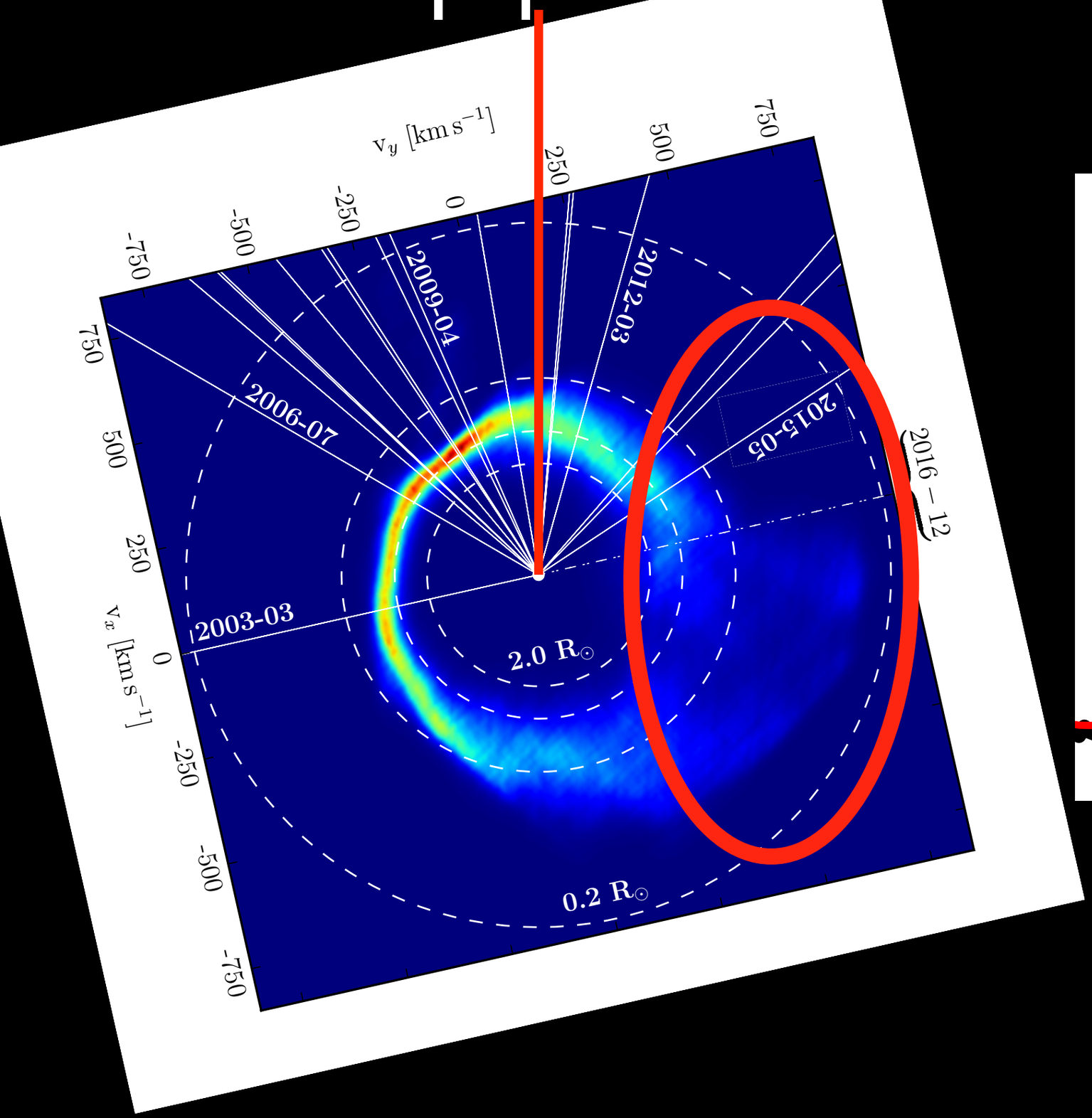

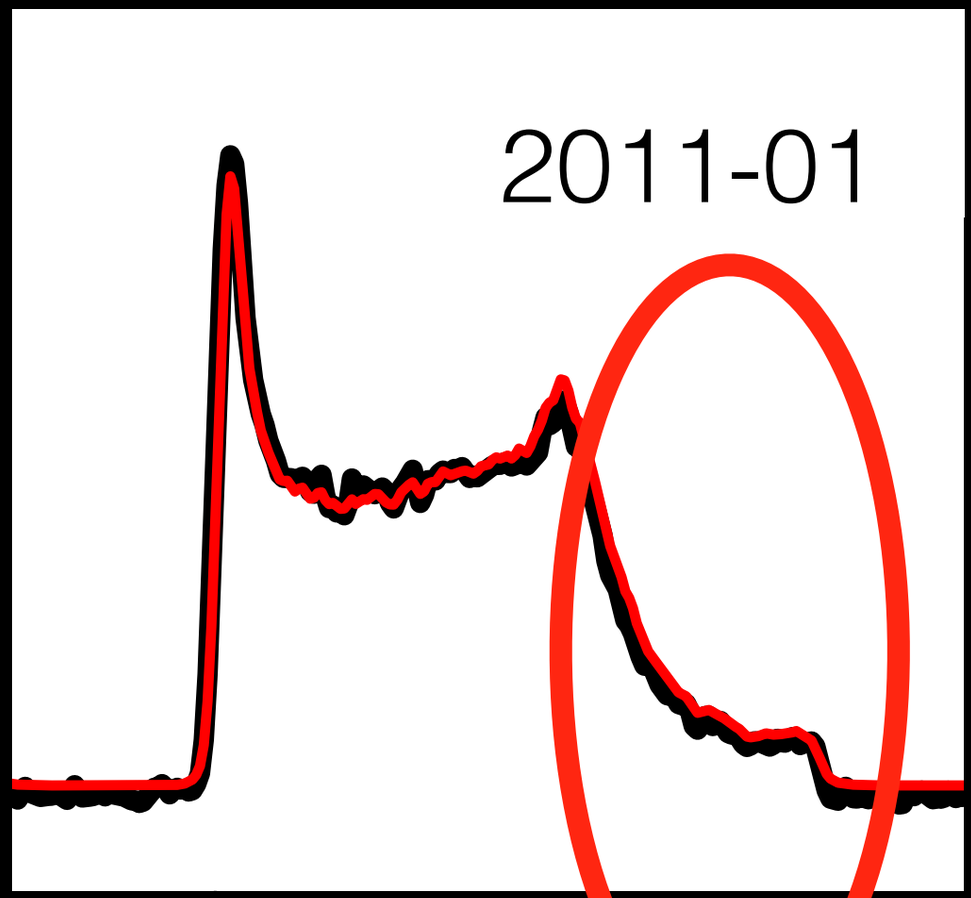

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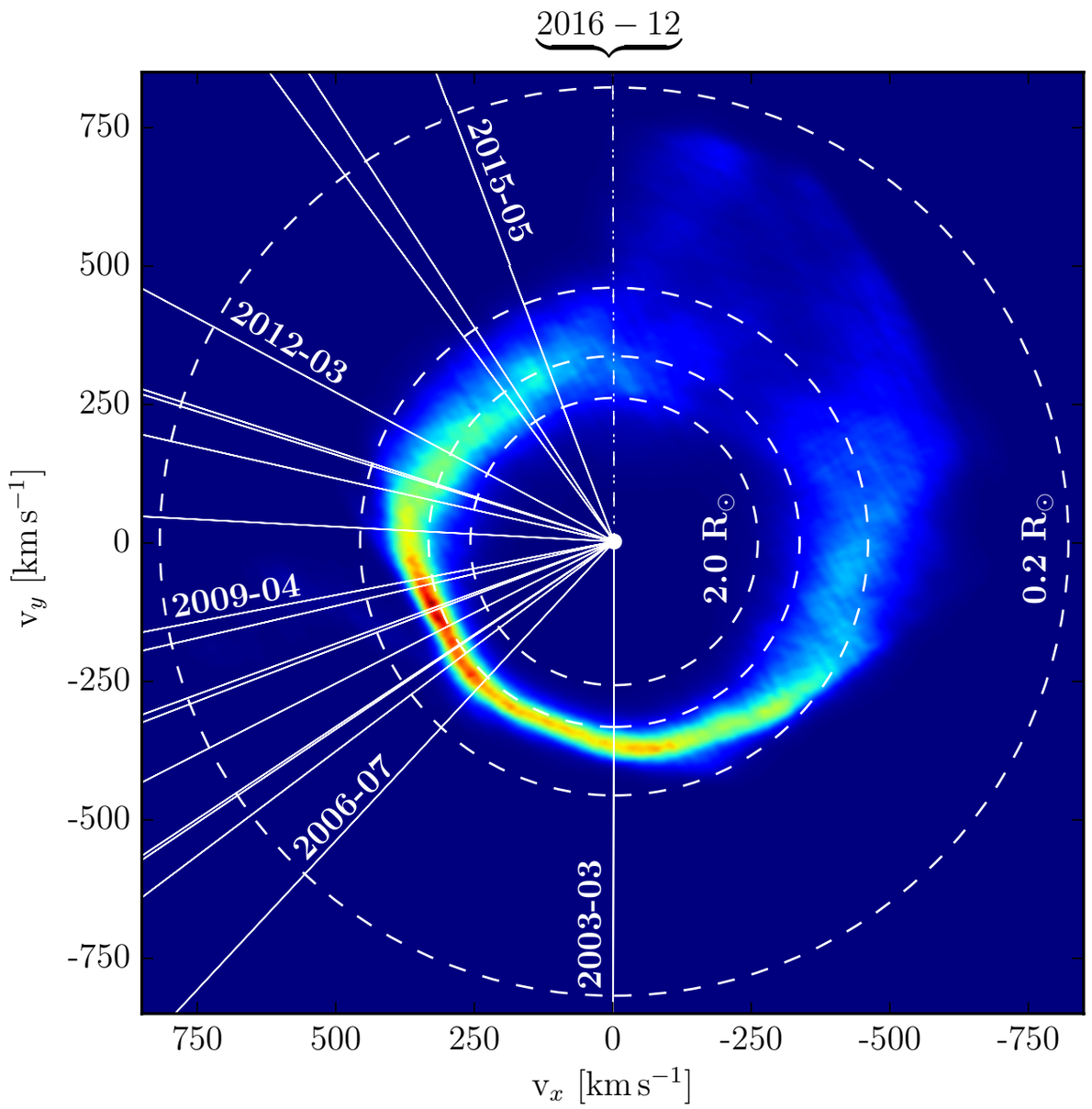
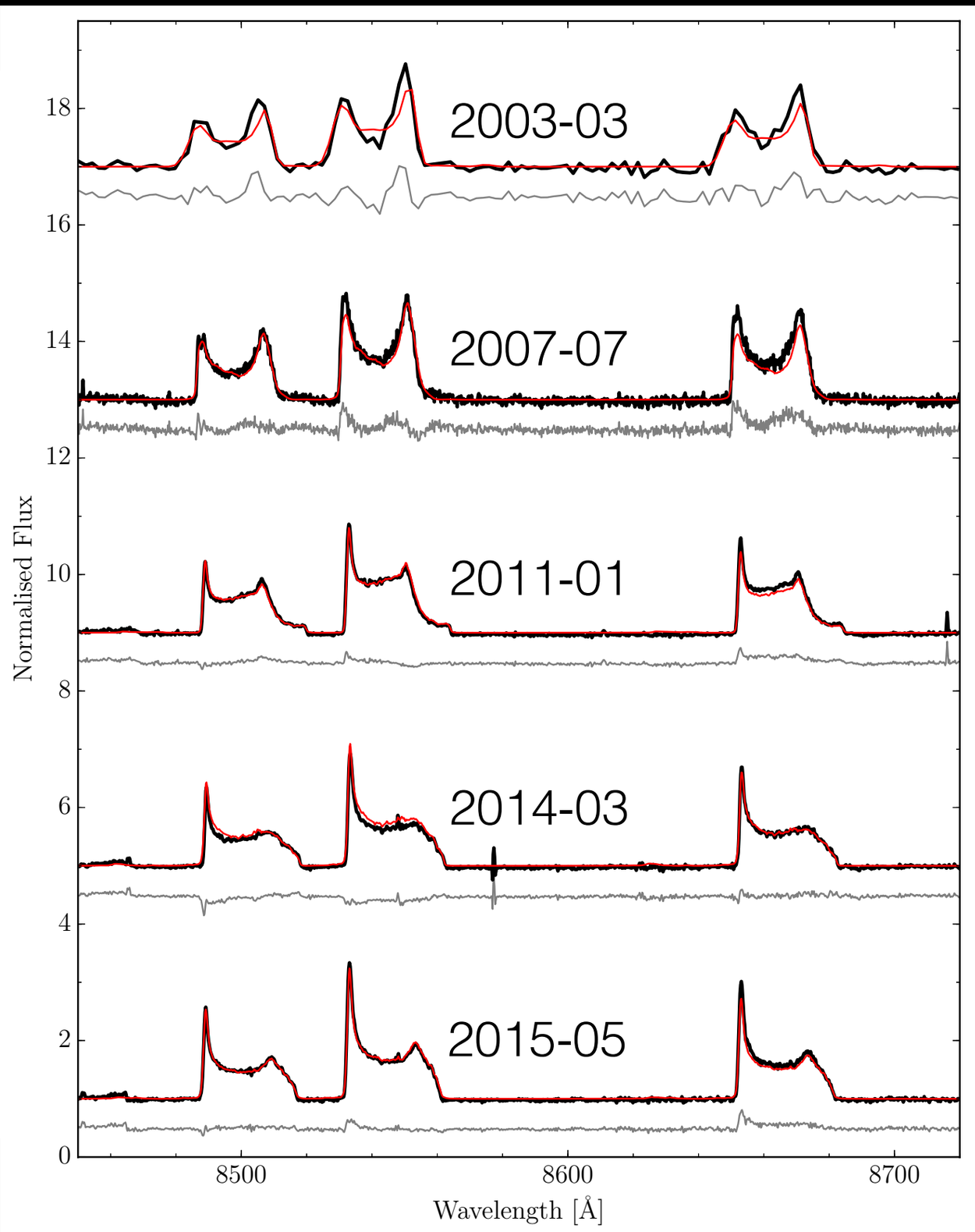
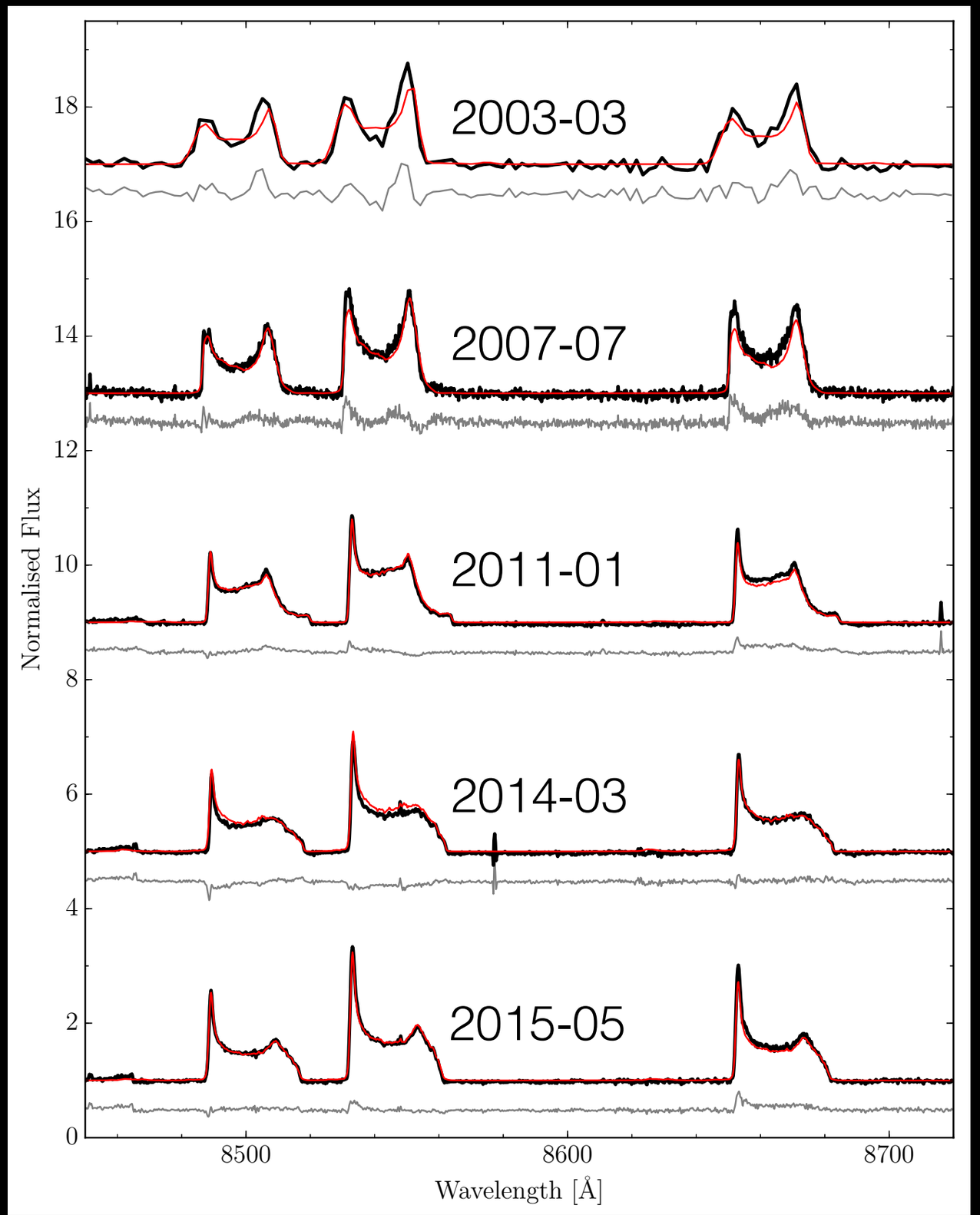
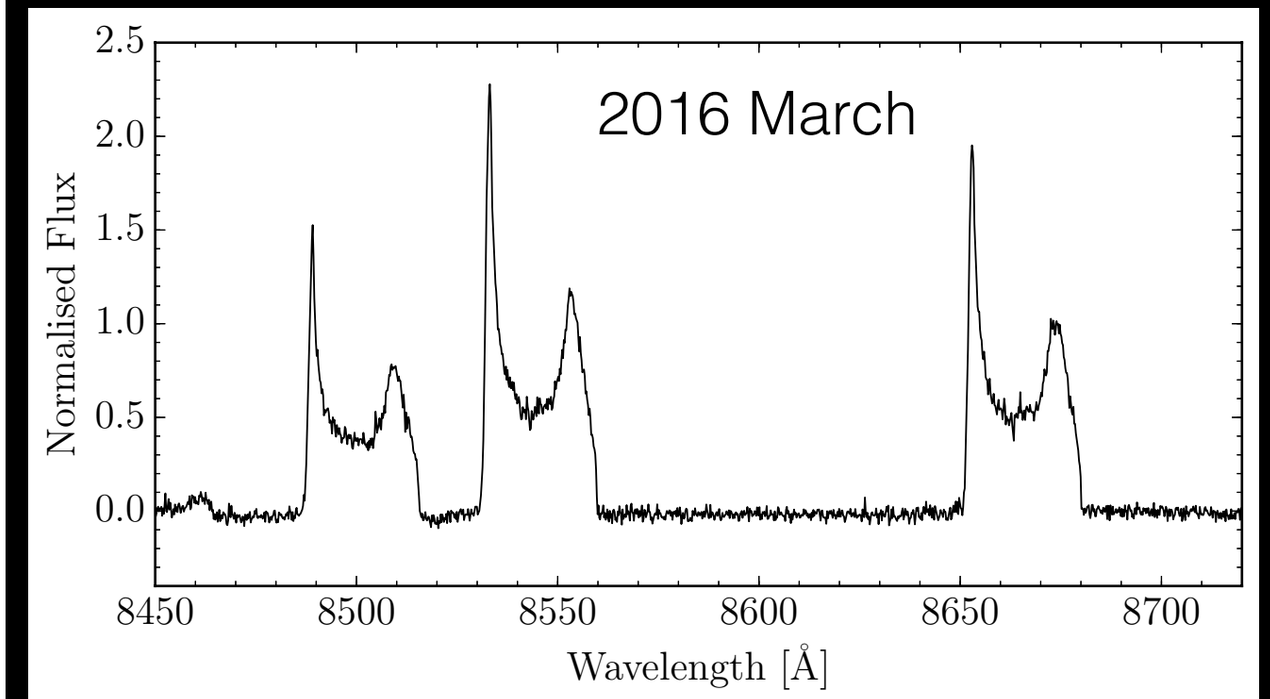


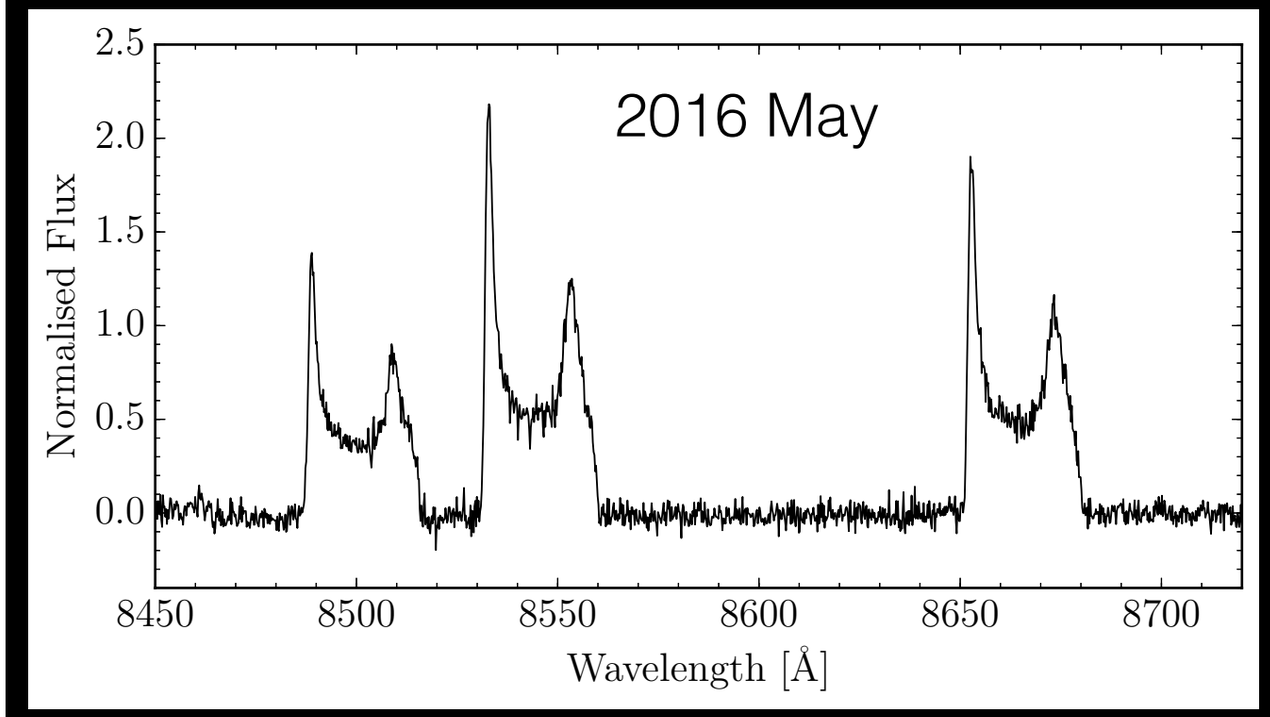
Manser et. al. 2016, MNRAS, 455, 4467



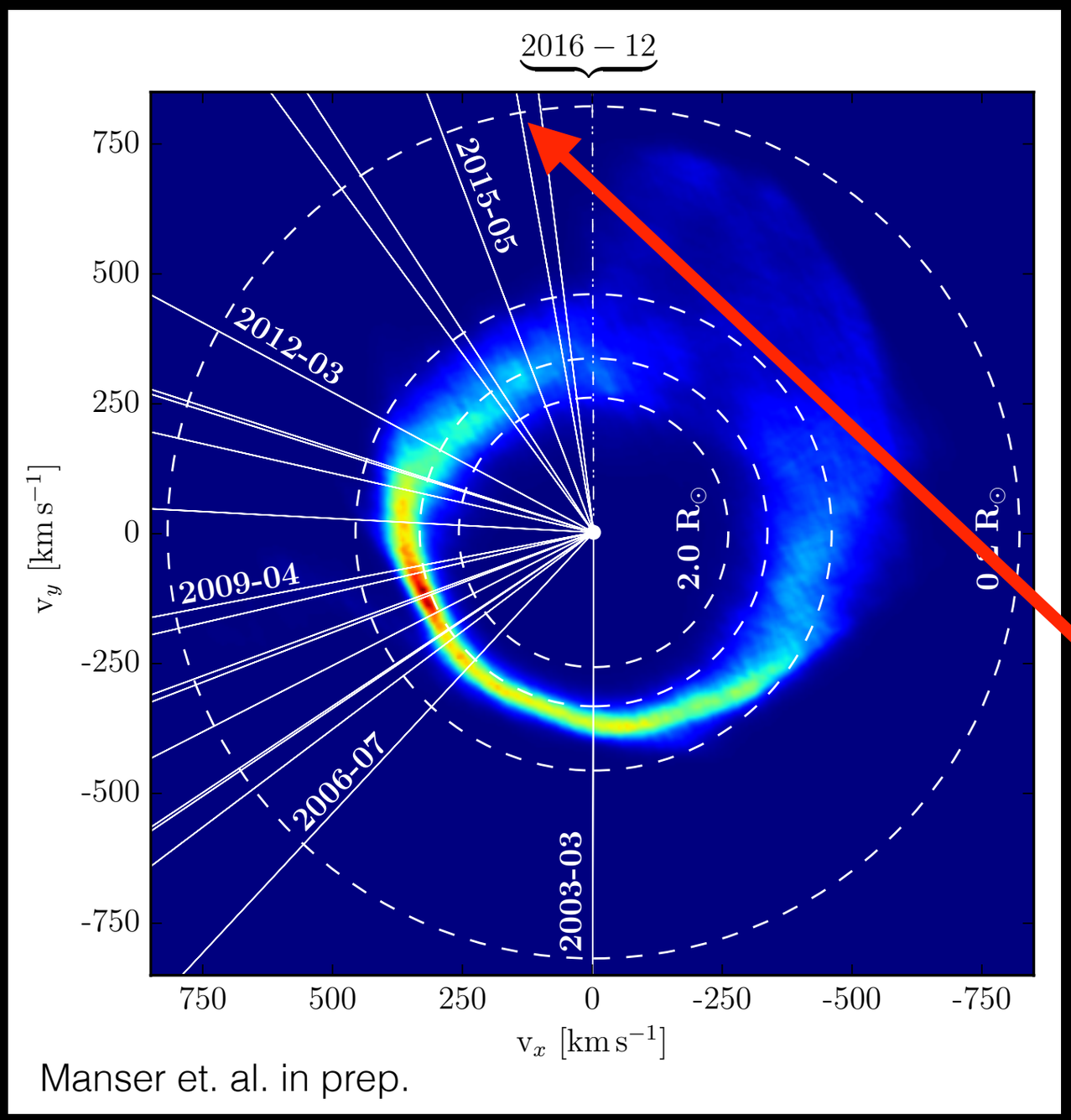
New observations in March and May



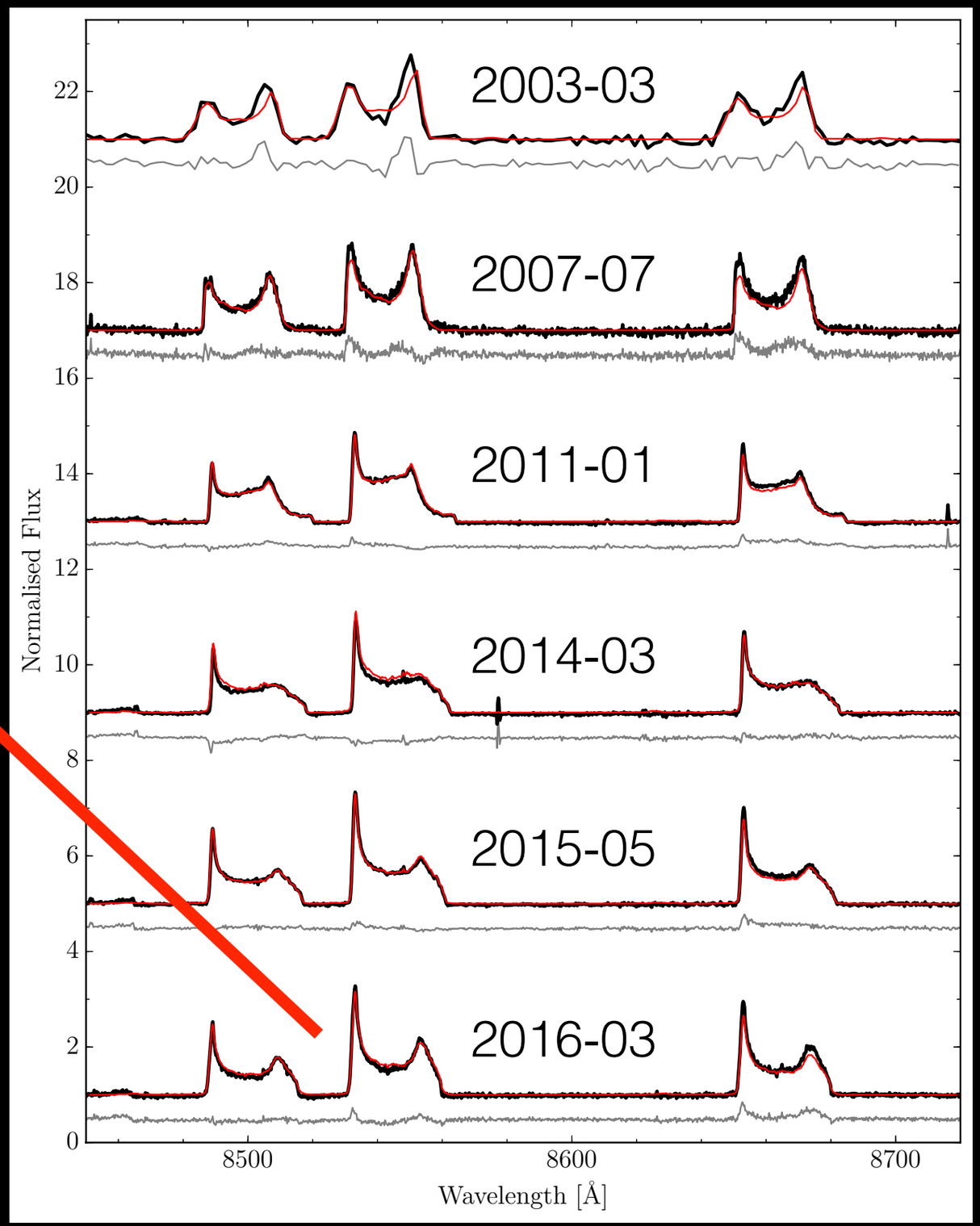




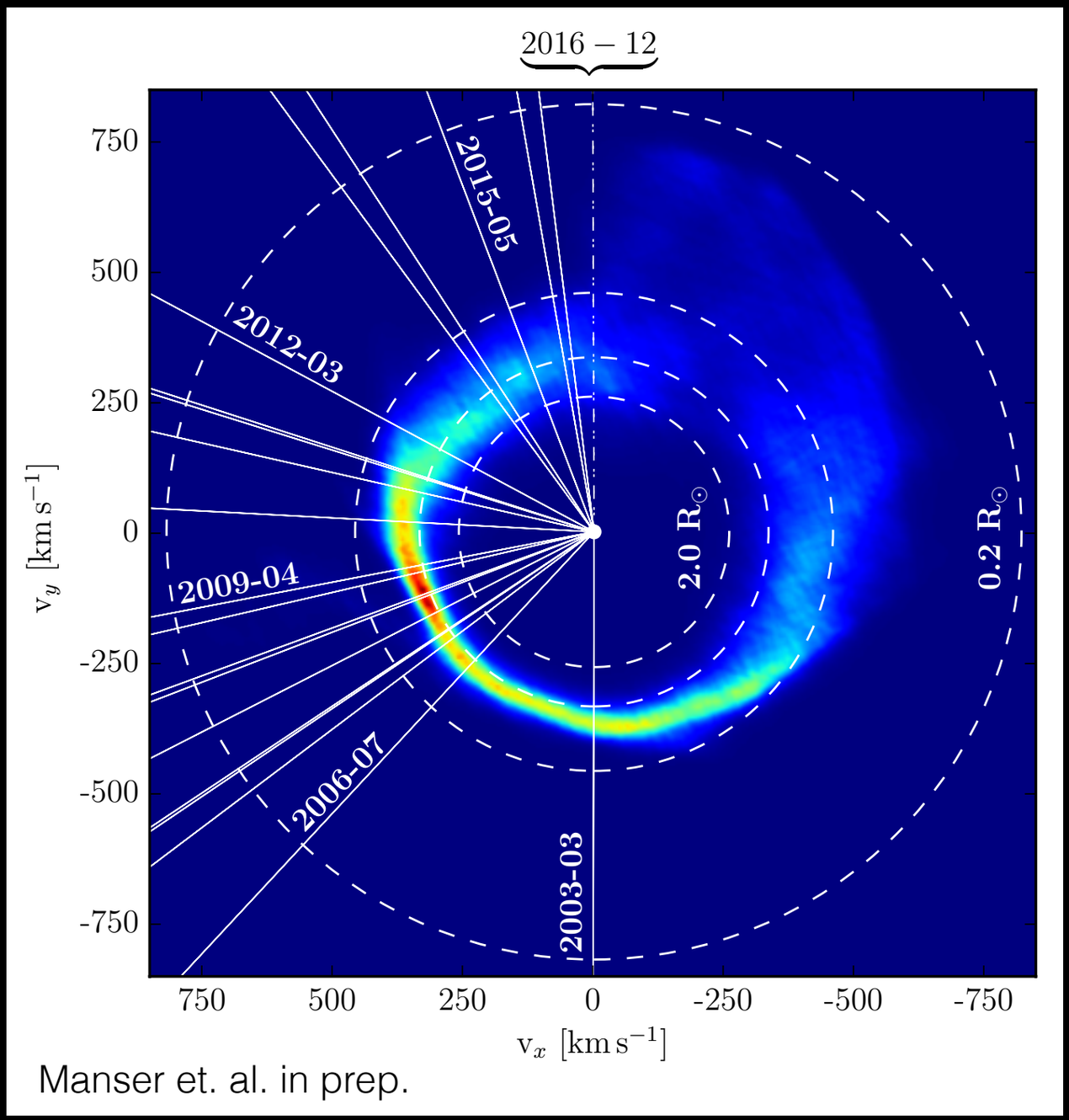
A Whole New Map



Manser et. al. in prep.

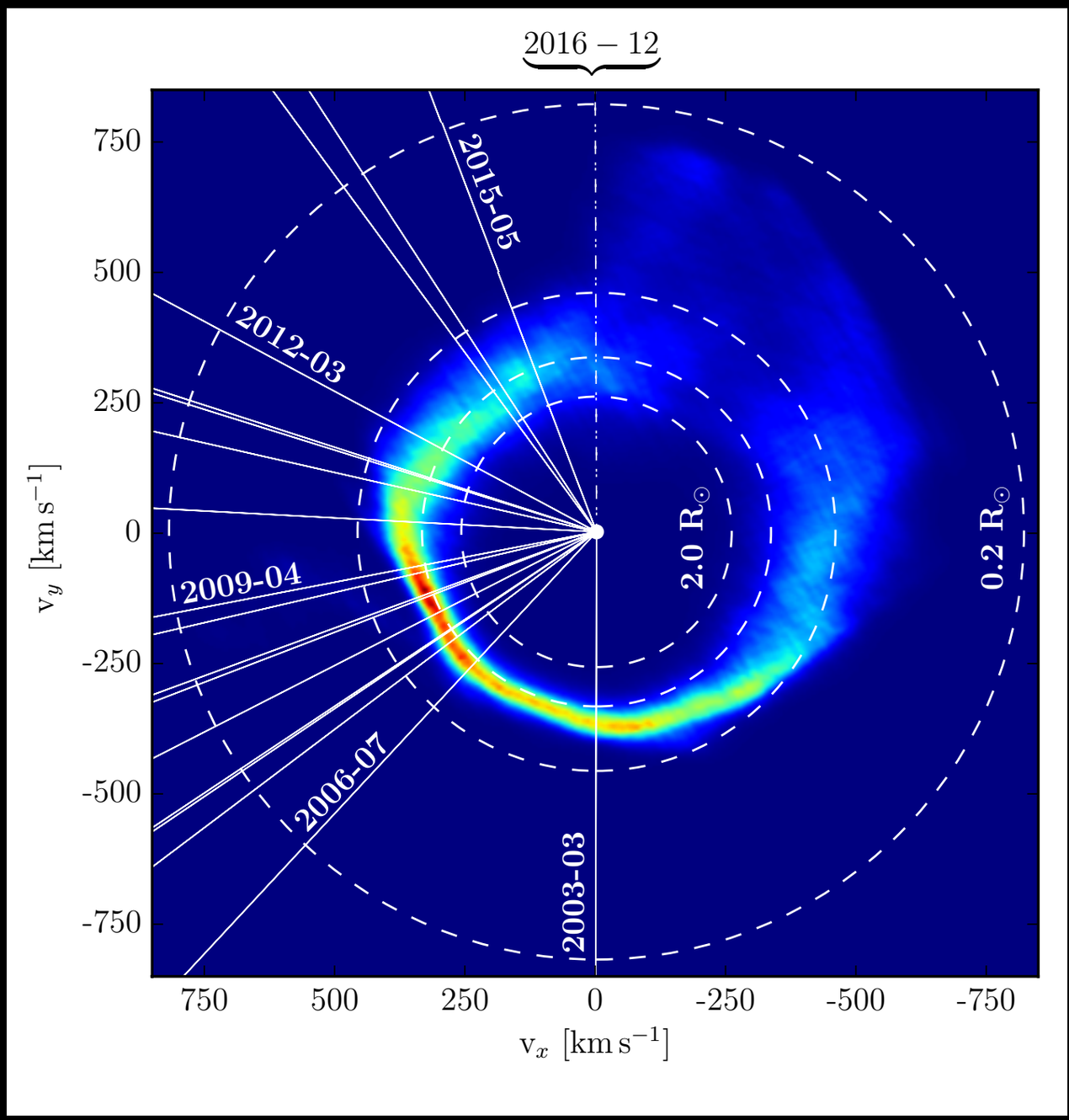


Some more comparing



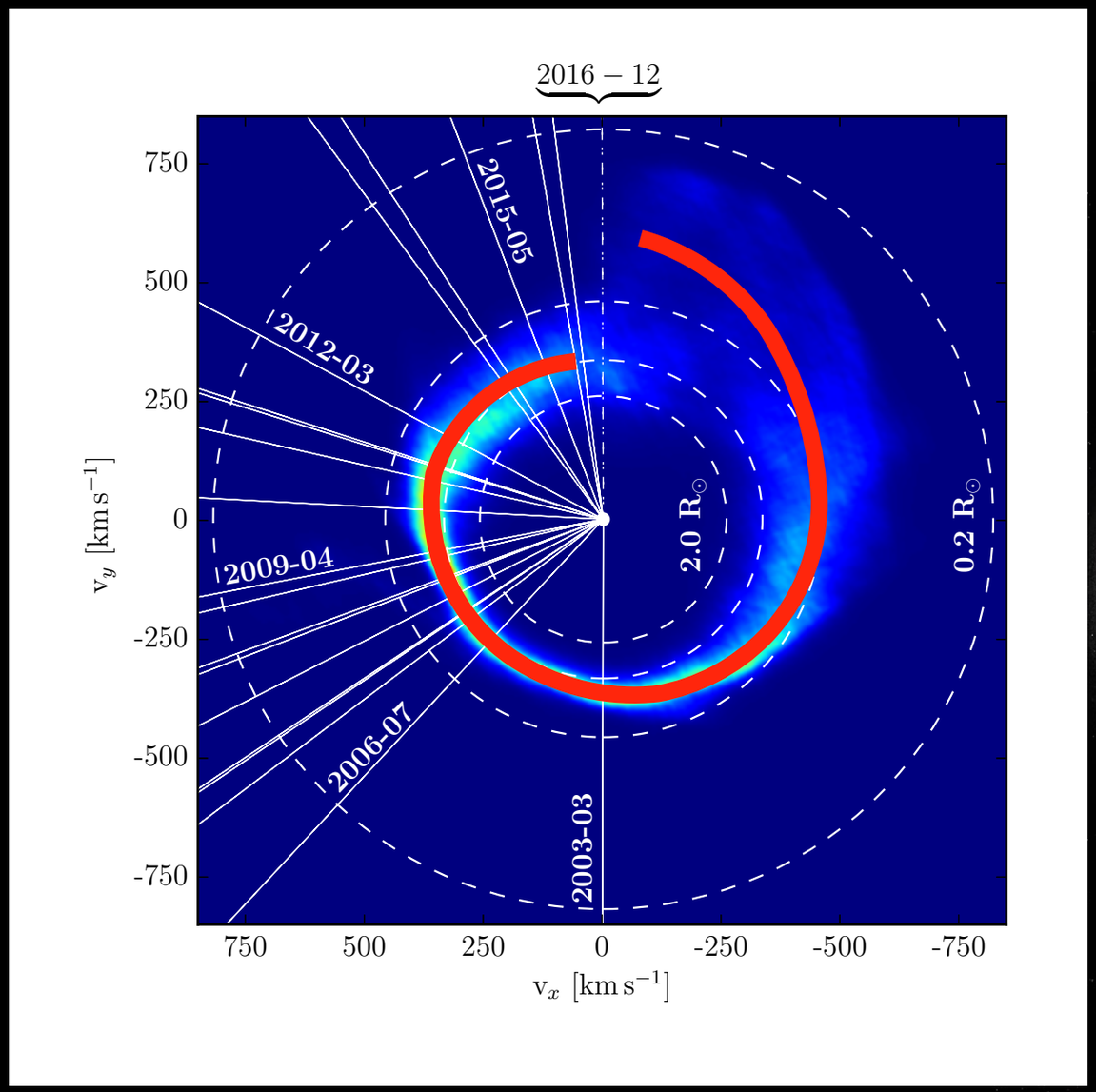
Manser et. al. in prep.

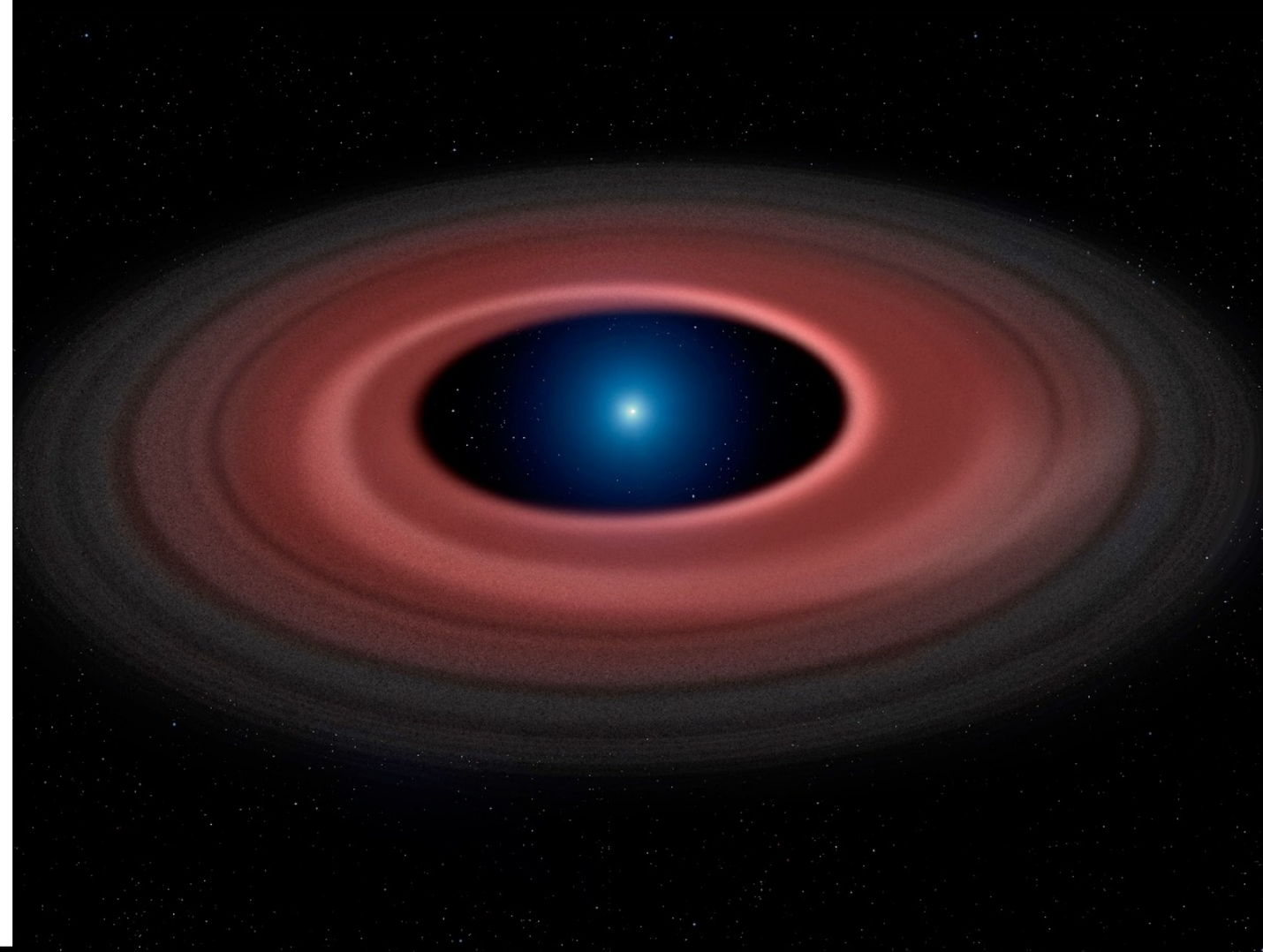
New (20 epochs)



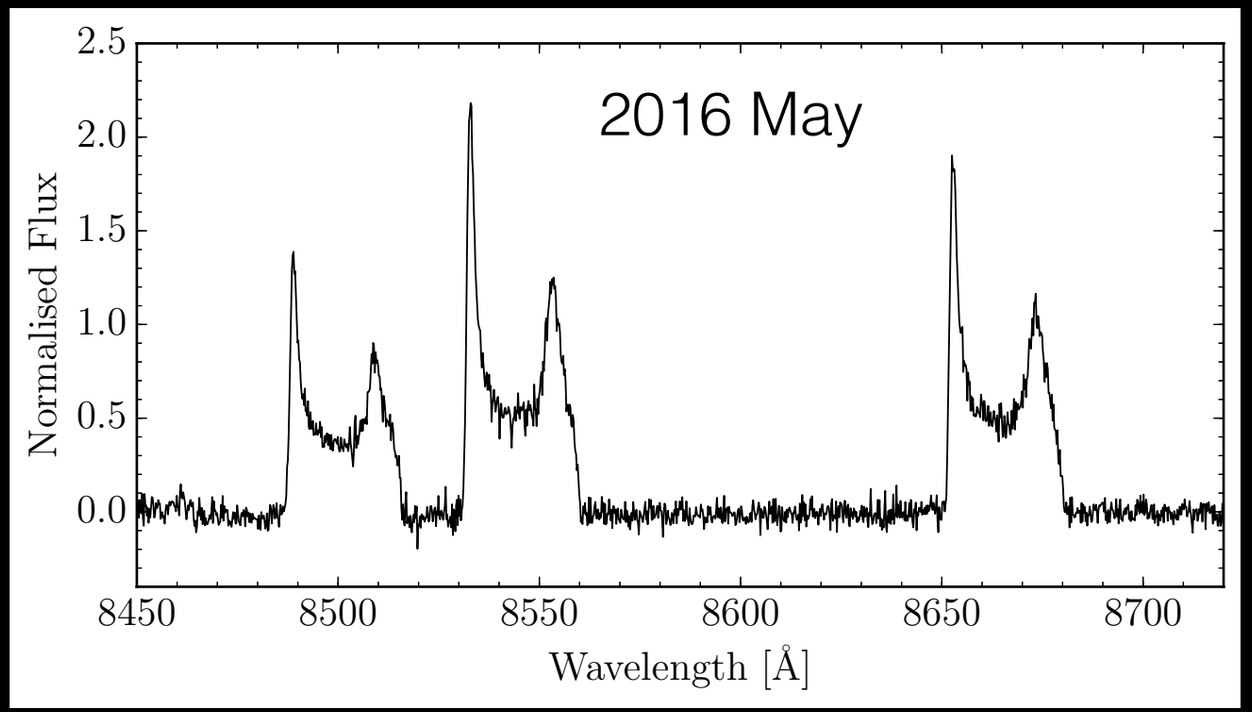
Old (18 epochs)

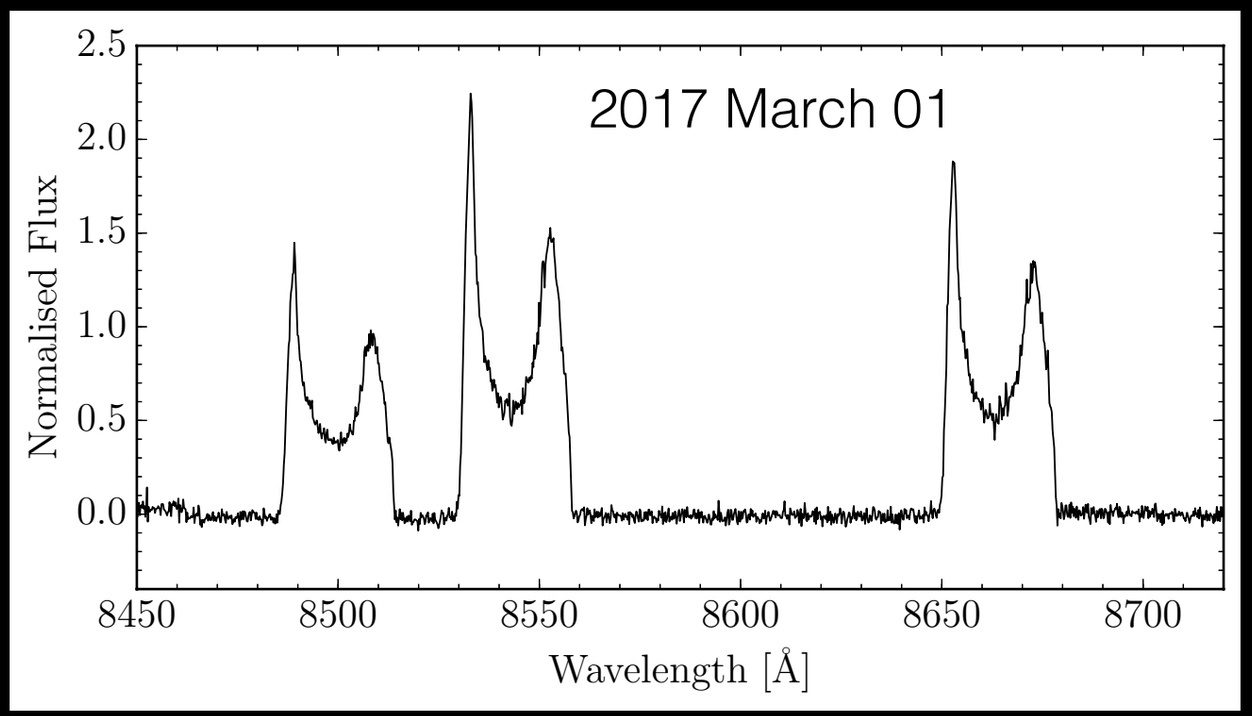
Spiral?


2016 − 12
2015-05
2012-03
2009-04
2006-07
2003-03
2.0 R⊙
0.2 R⊙
750
500
250
0
-250
-500
-750
v_y [km s^-1]
v_x [km s^-1]

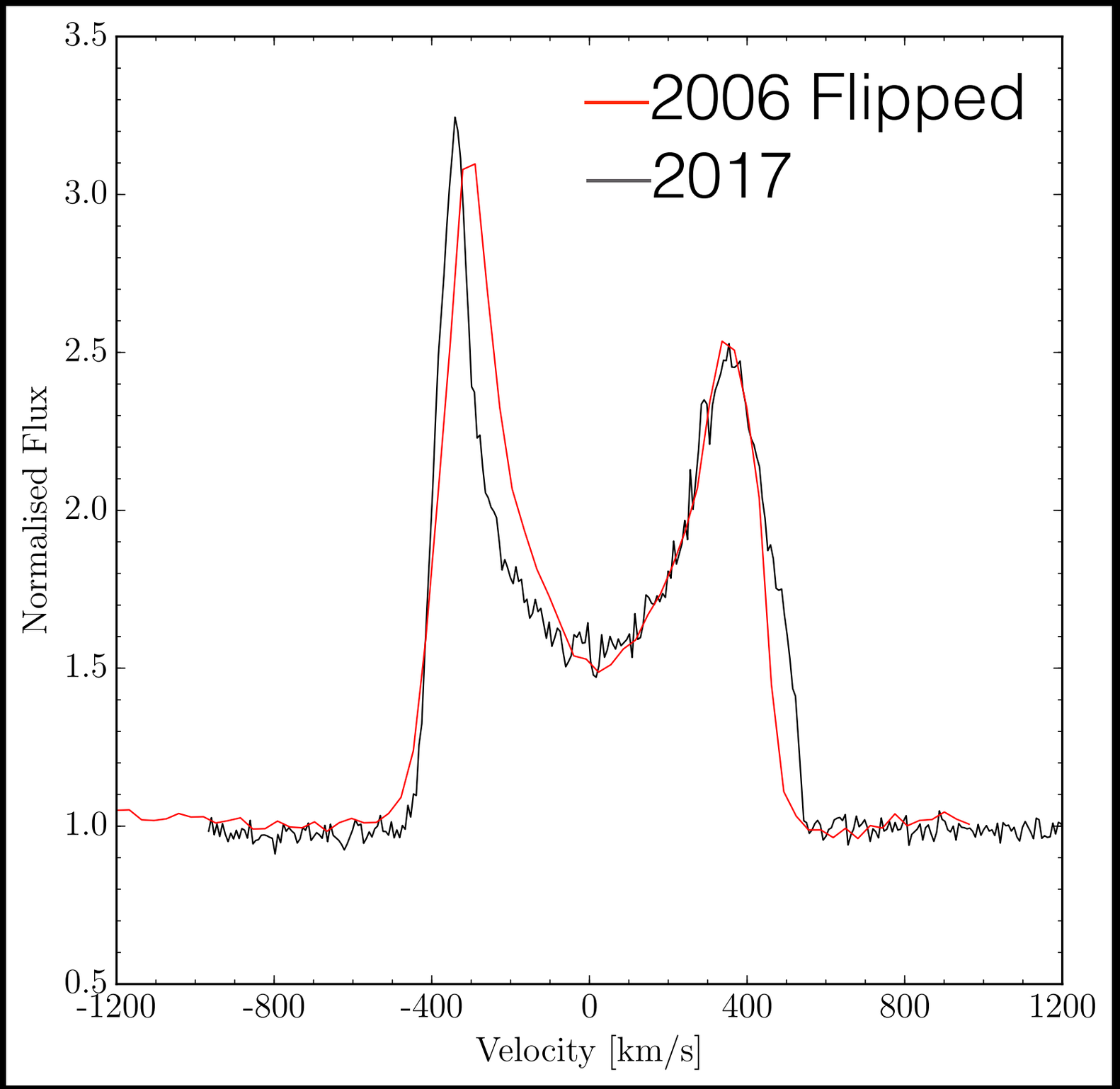


Even newer data!

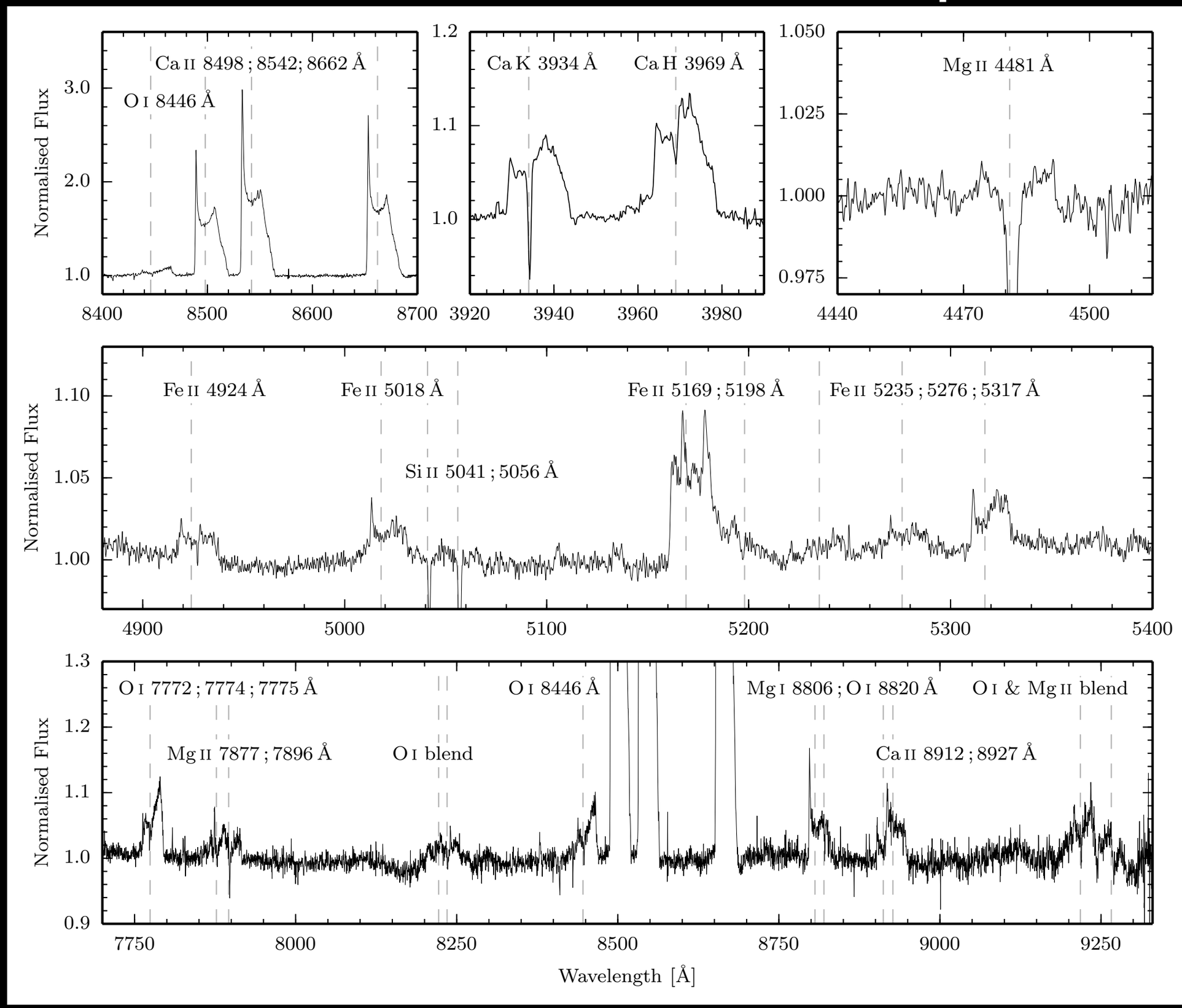




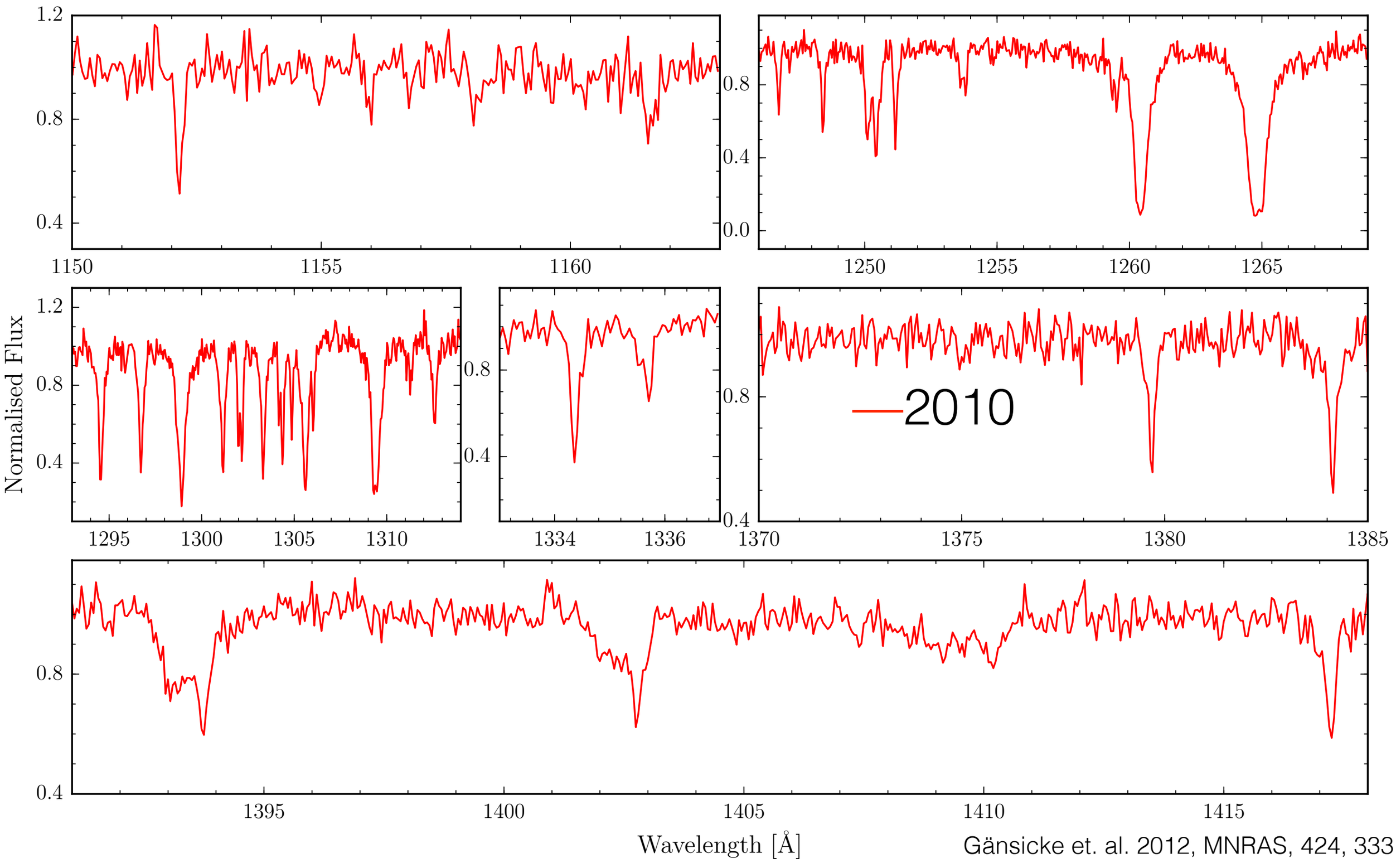
Reached half way?



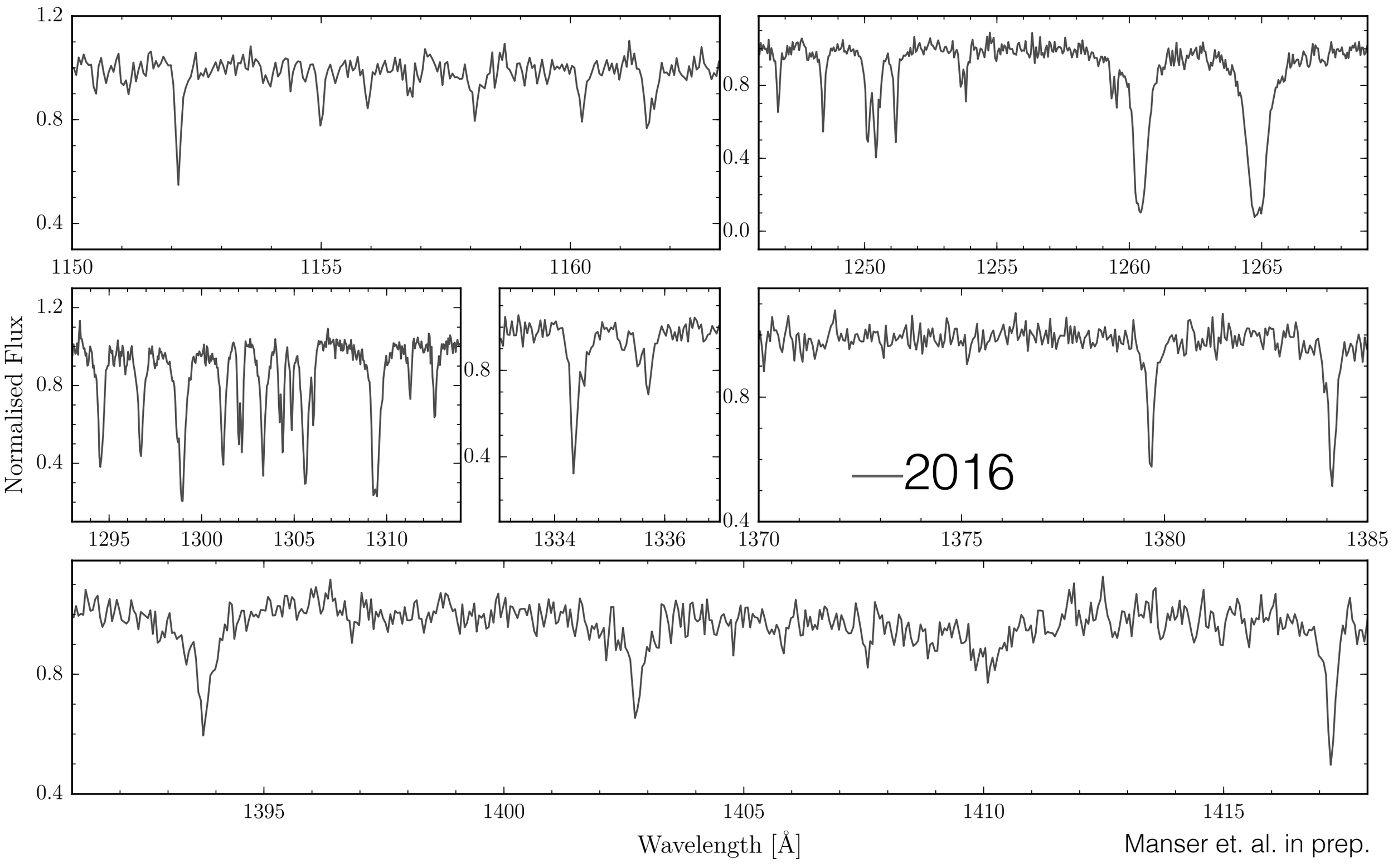
Coadded X-Shooter spectrum



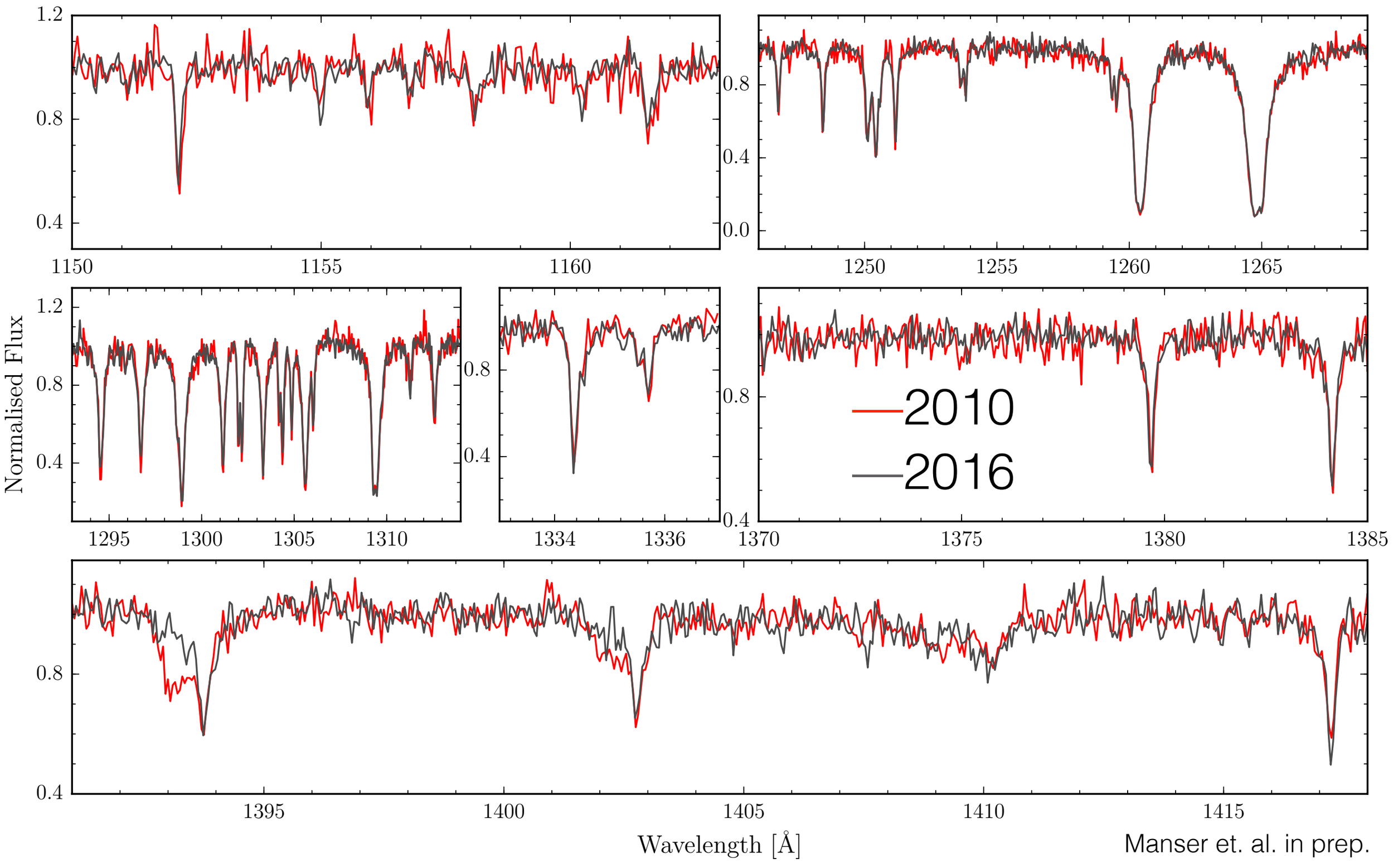
April 2010 Hubble Spectrum



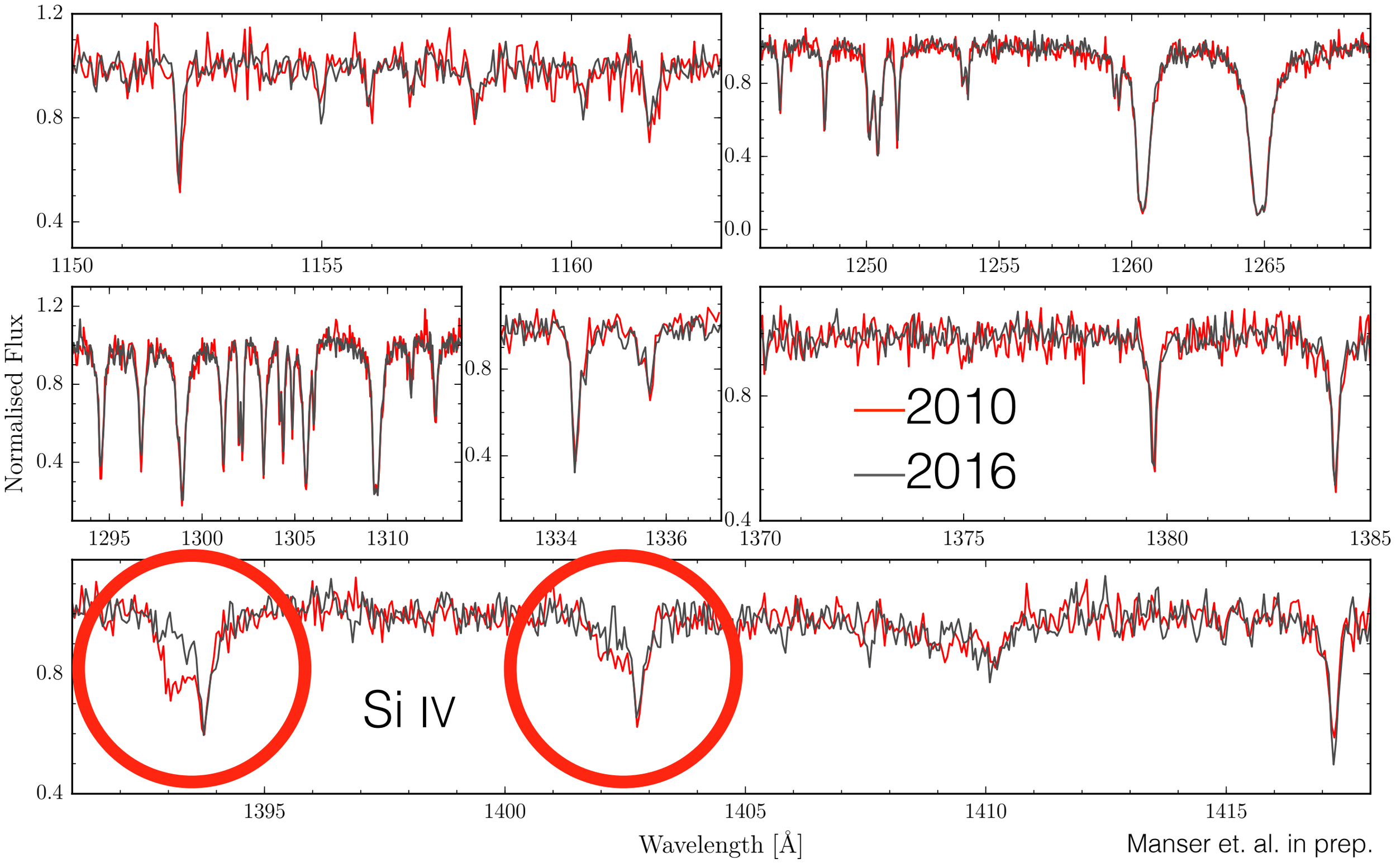
March 2016 Hubble Spectrum



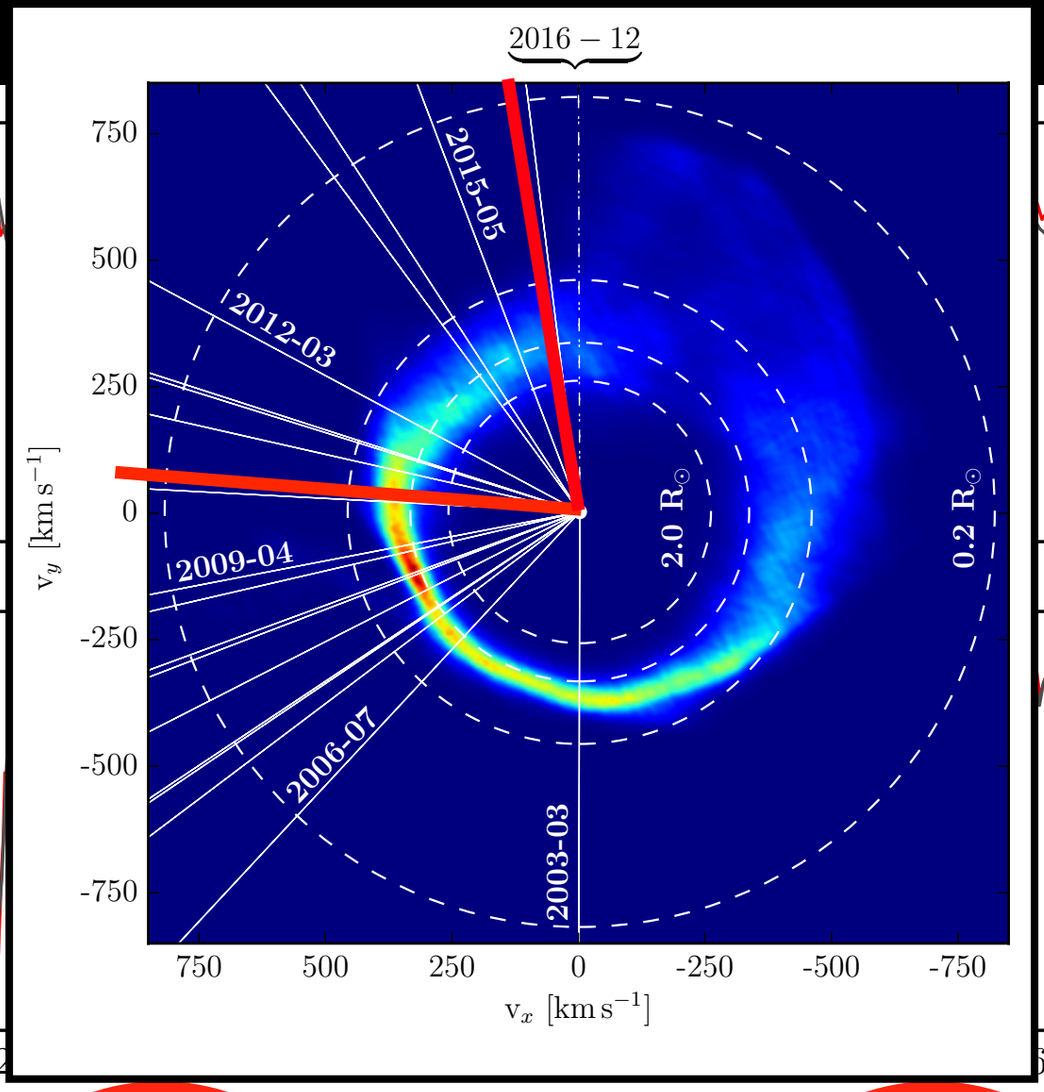
Comparing the two…



Circumstellar gas

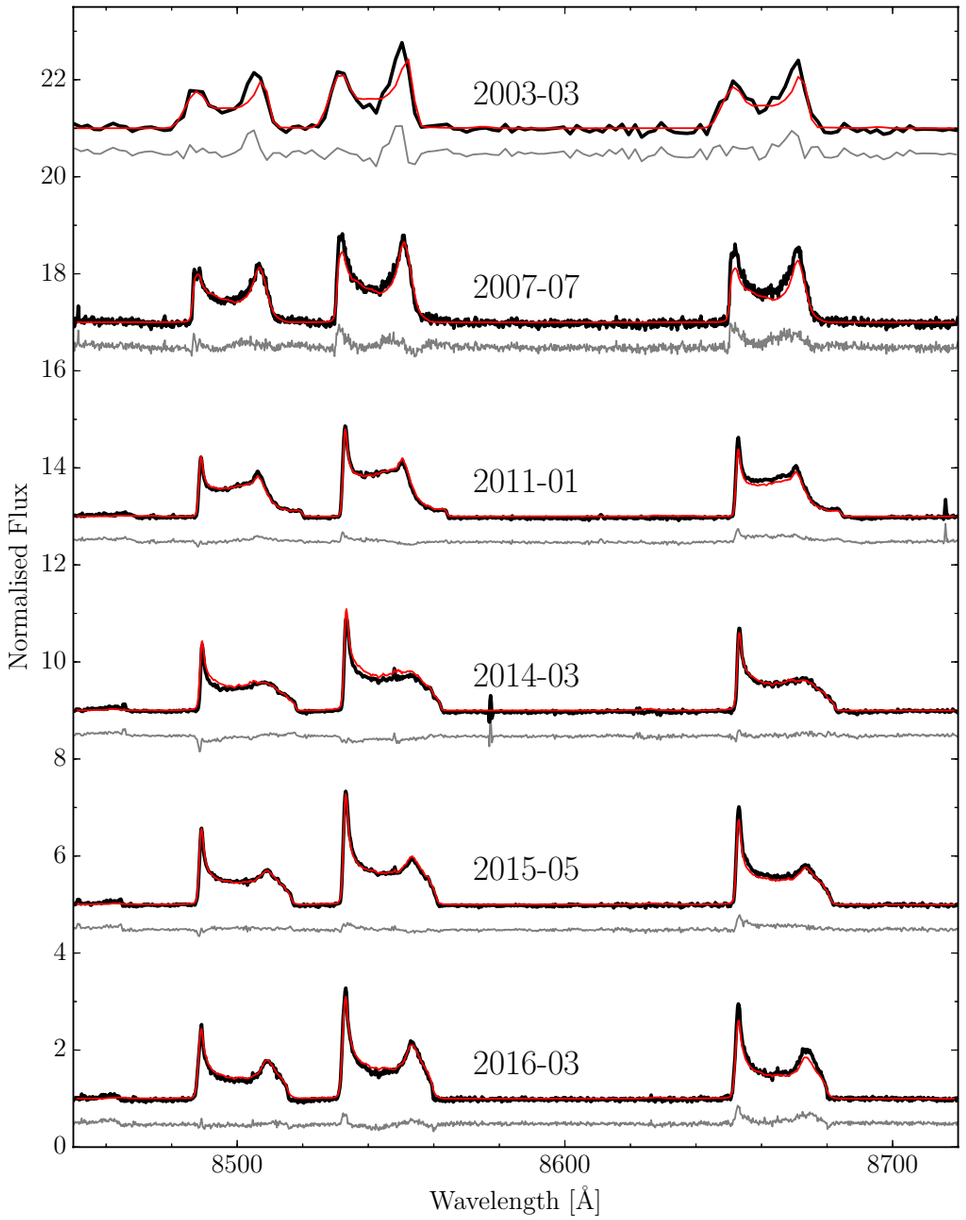


Circumstellar gas



Other variable gas discs

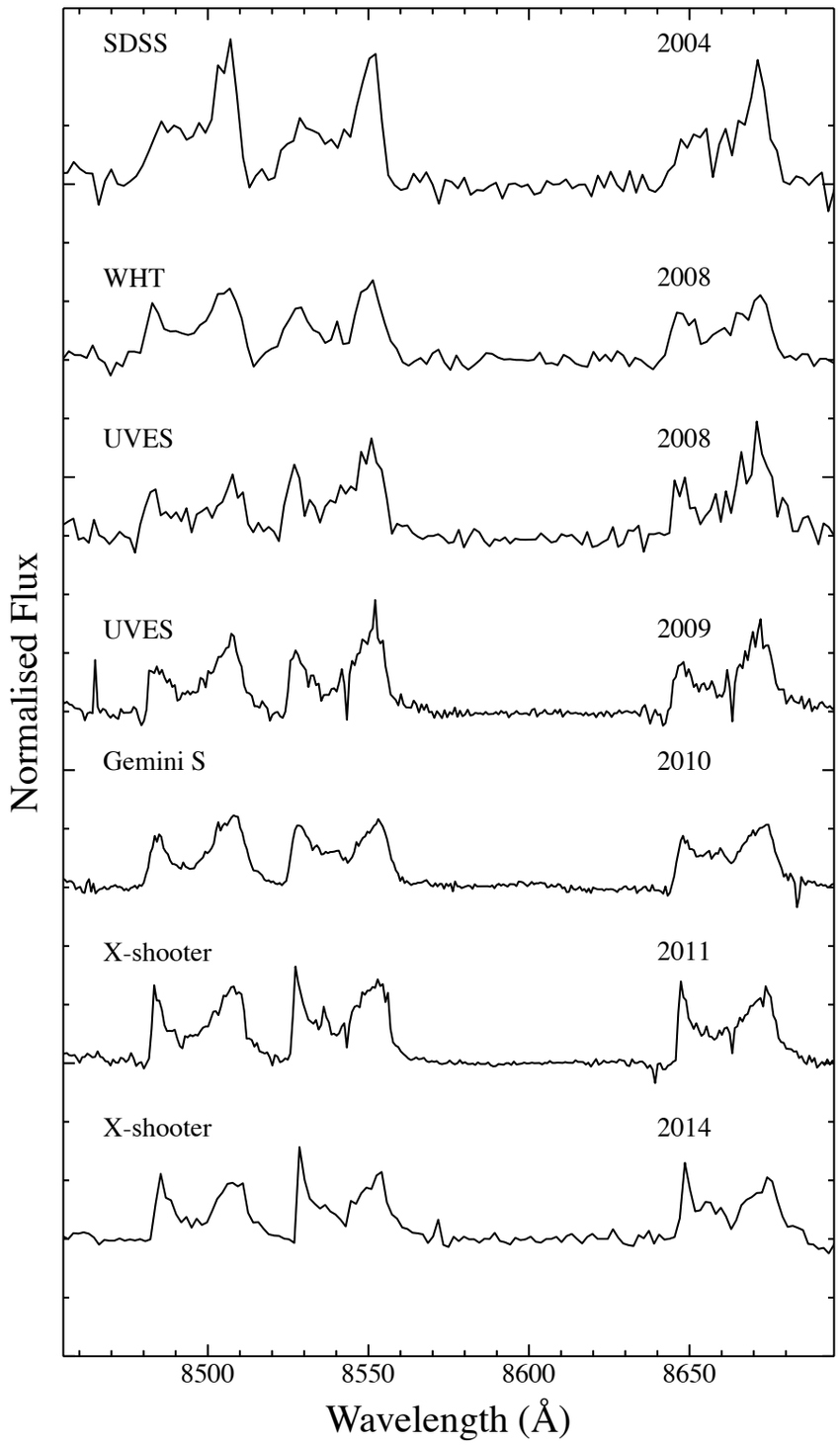
SDSS J1228+1040



Manser et. al. 2016, MNRAS, 455, 4467

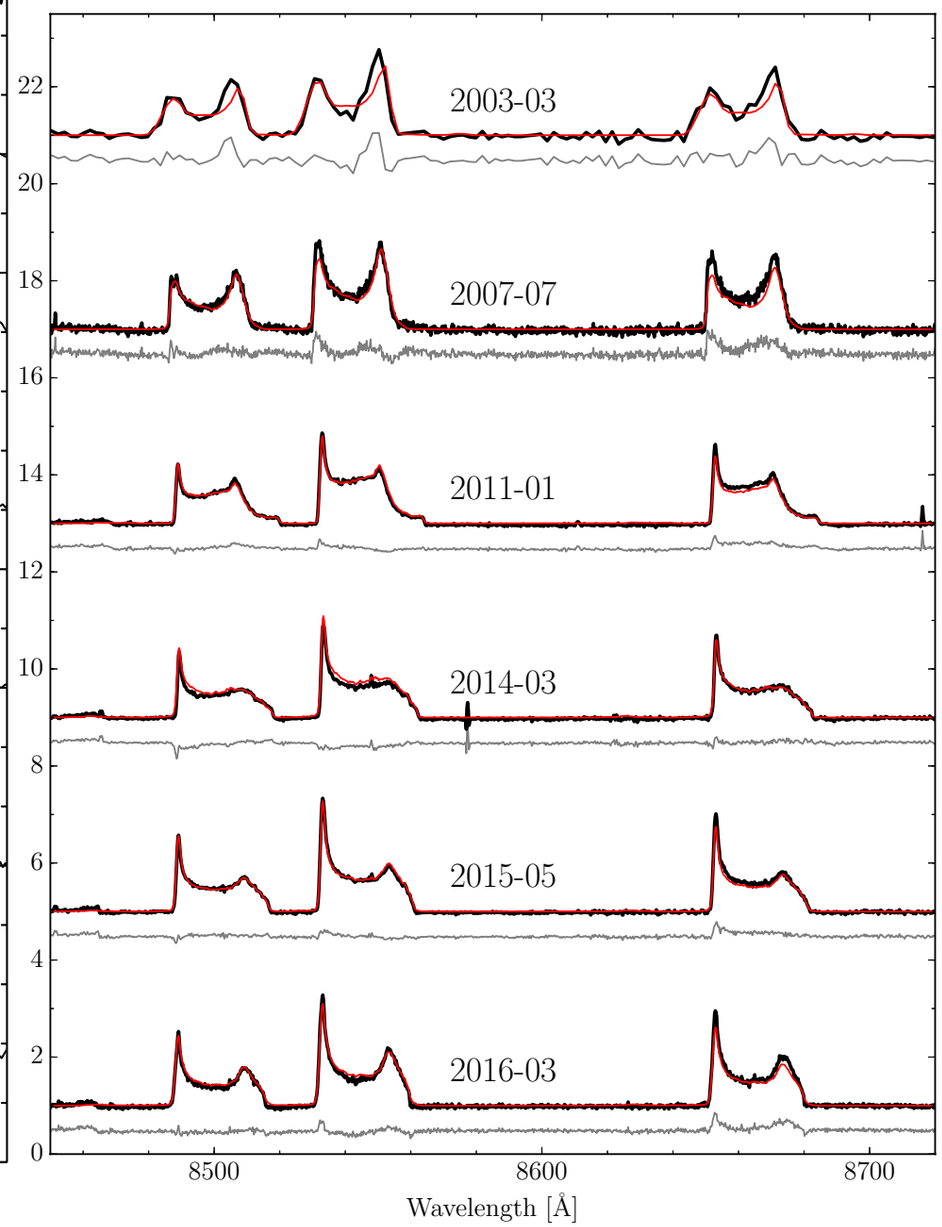
Morphologically variable

SDSS J0845+2257



Wilson et. al. 2014, MNRAS, 451, 3237

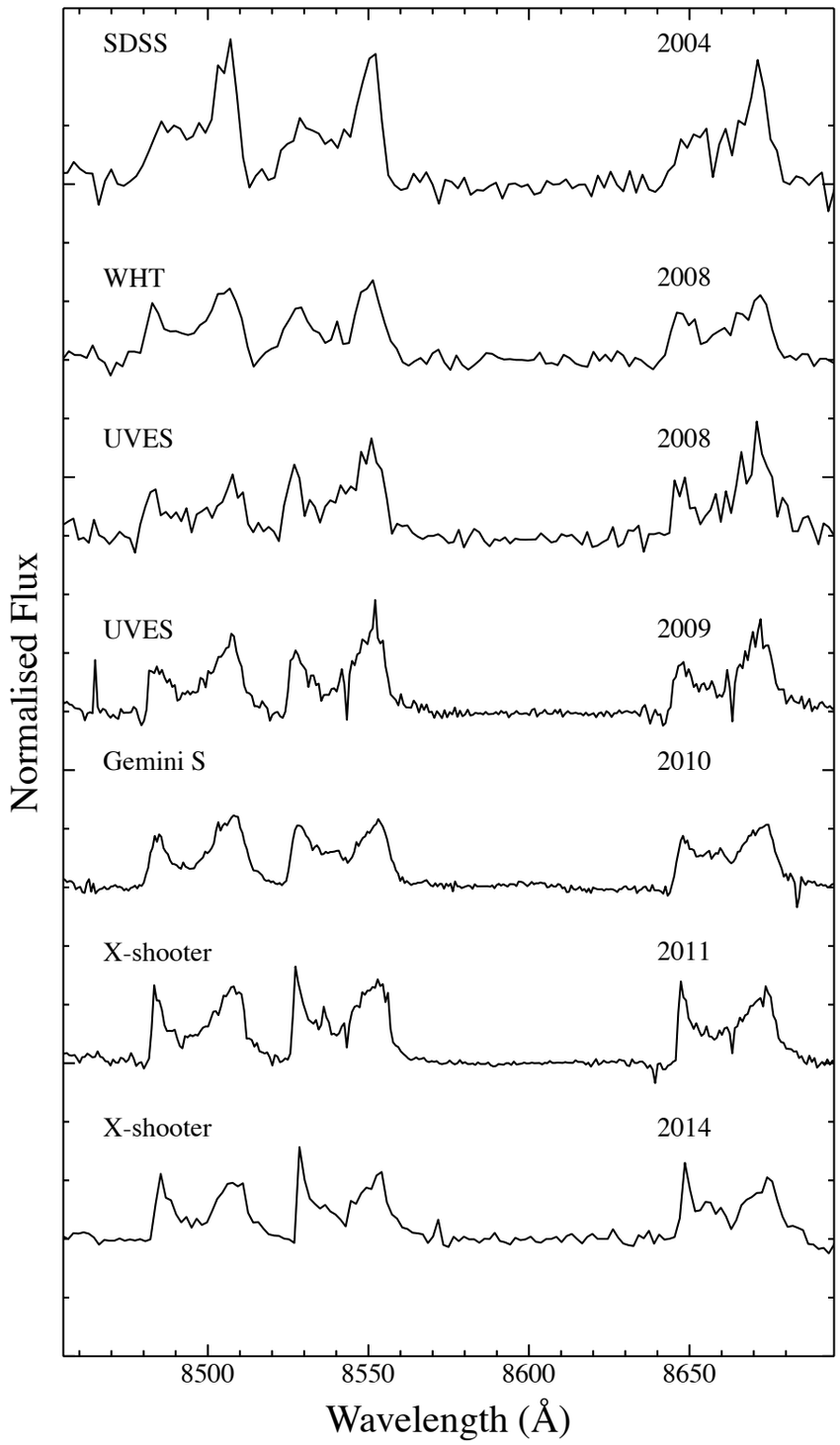
SDSS J1228+1040

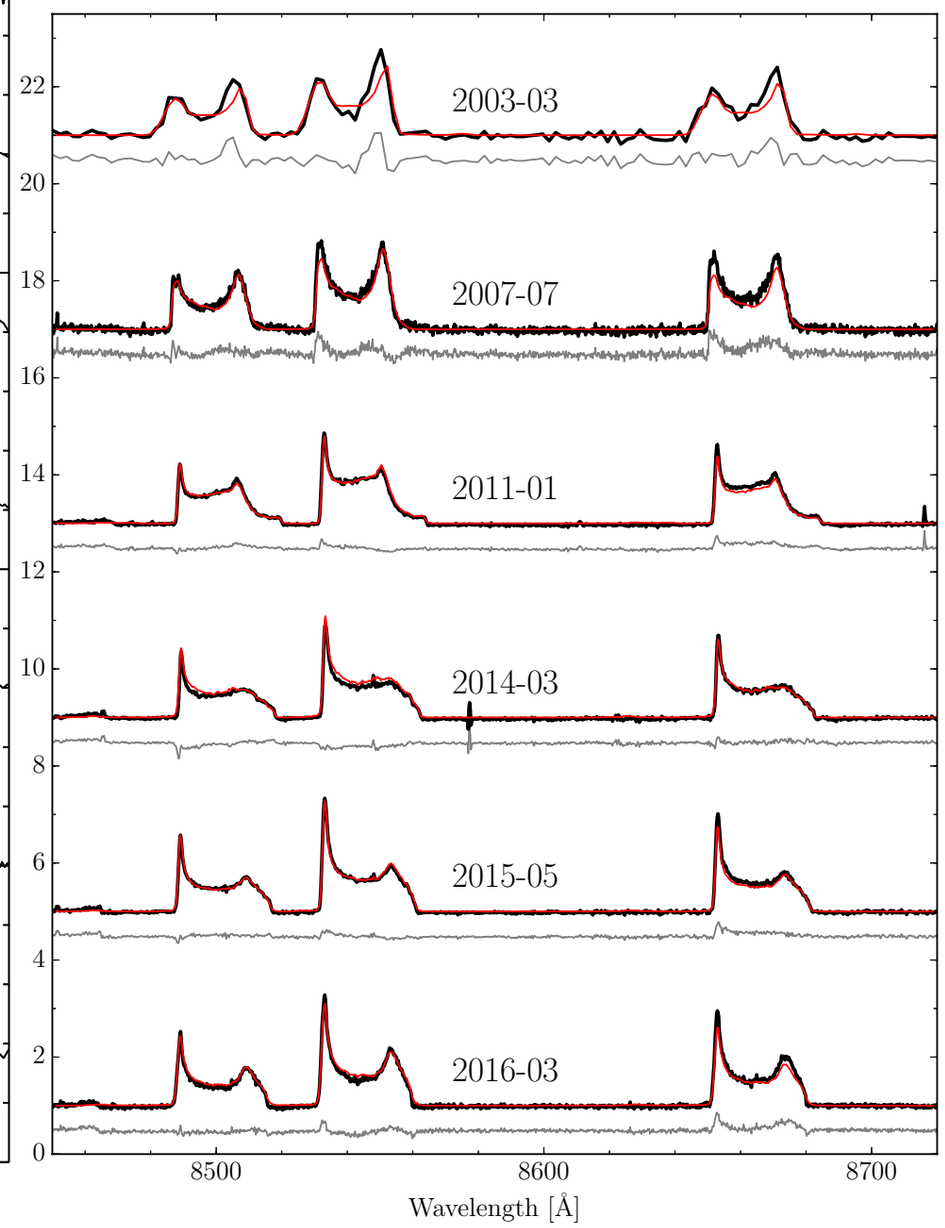


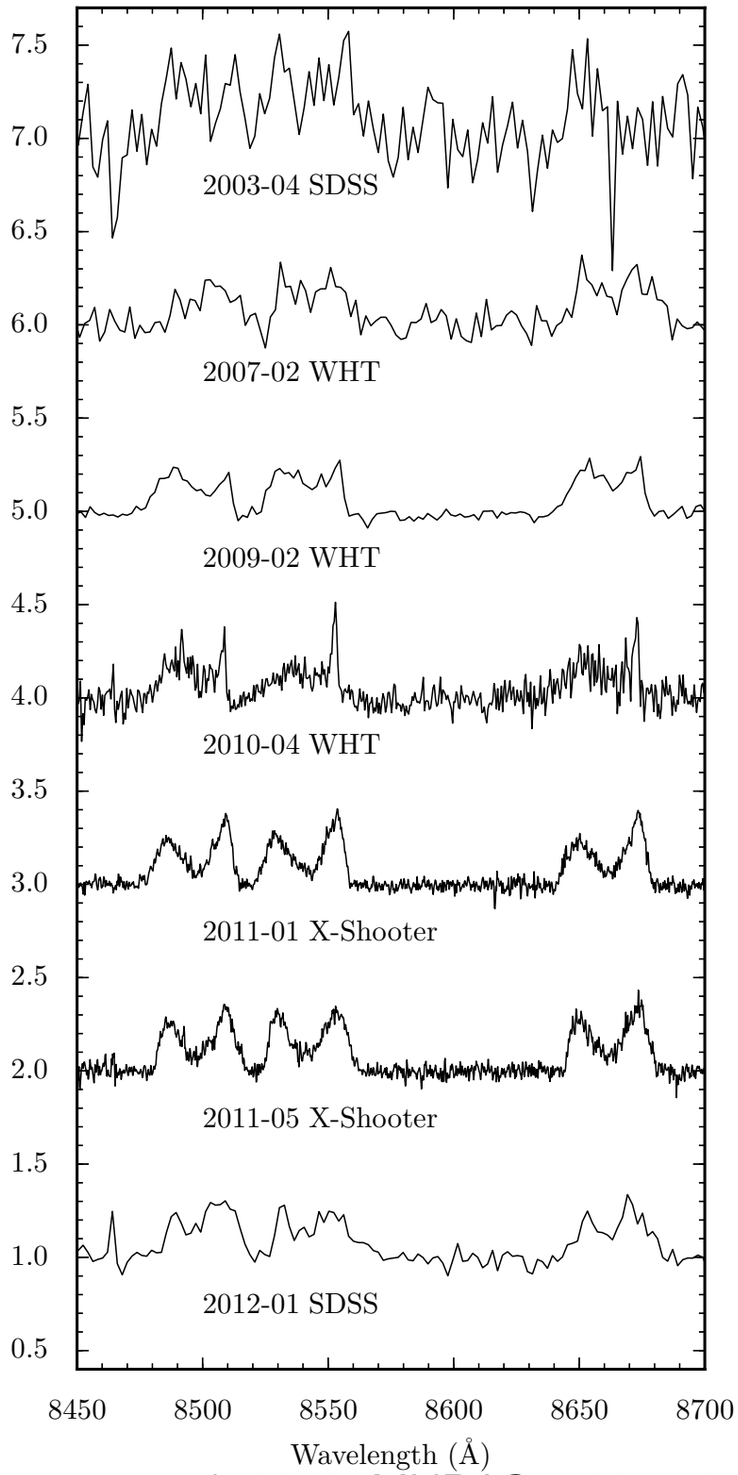
Manser et. al. 2016, MNRAS, 455, 4467

Morphologically variable

SDSS J0845+2257 SDSS J1228+1040 SDSS J1043+0855







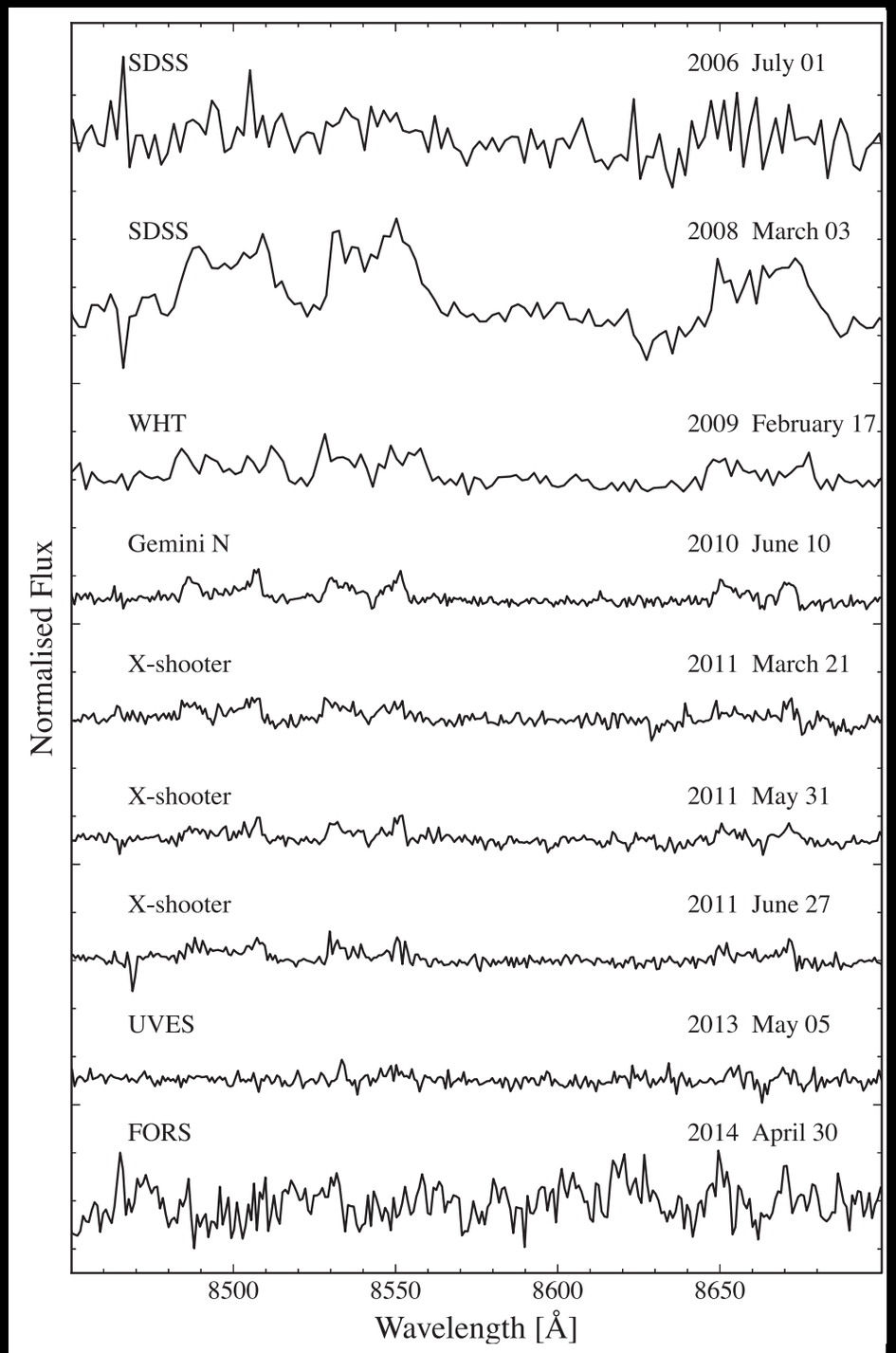
Wilson et. al. 2015, MNRAS, 451, 3237

Manser et. al. 2016, MNRAS, 455, 4467

Manser et. al. 2016, MNRAS, 462 1461

Variable strength

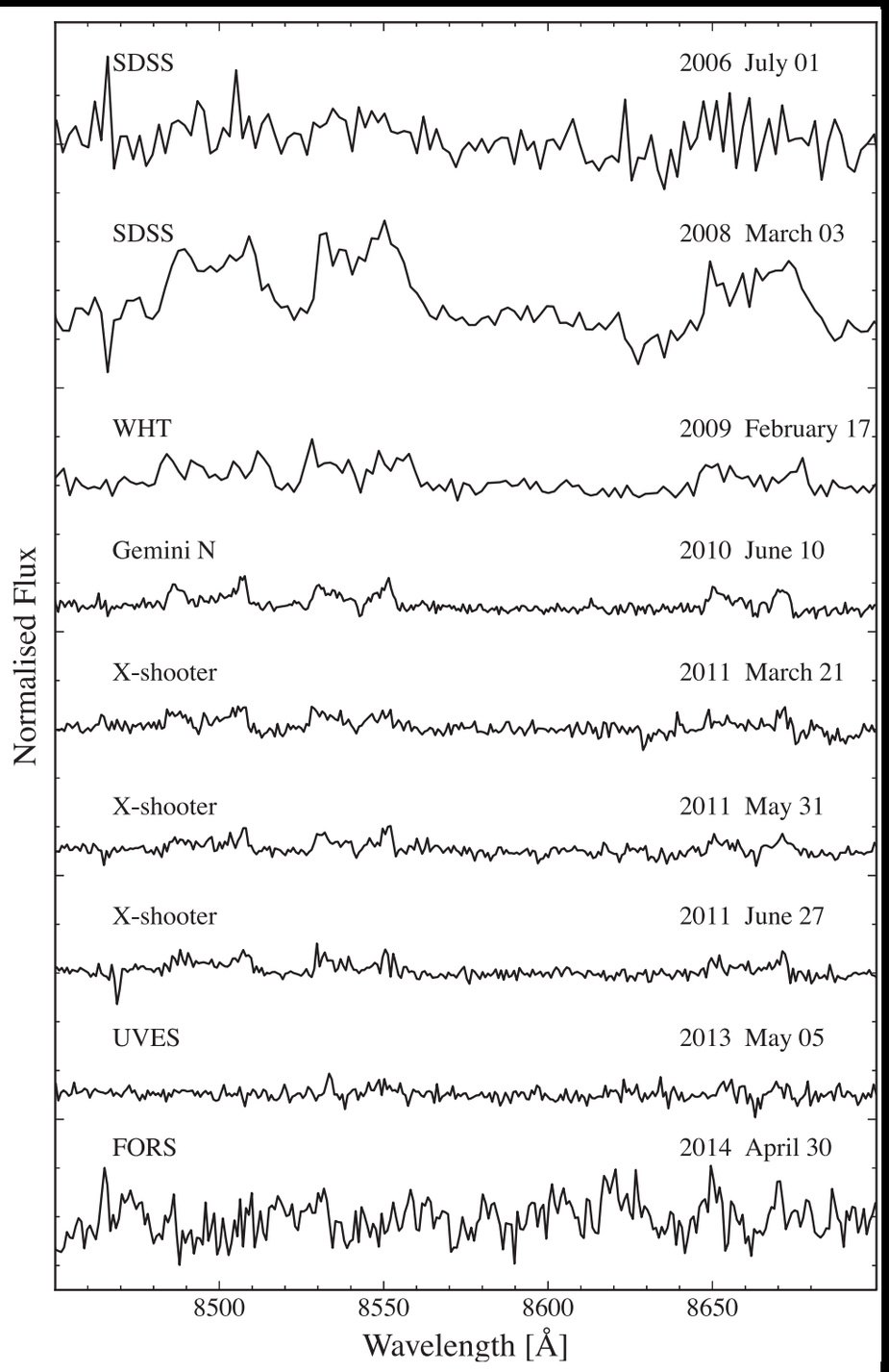
SDSS J1617+1620



Wilson et. al. 2014, MNRAS, 445, 1878

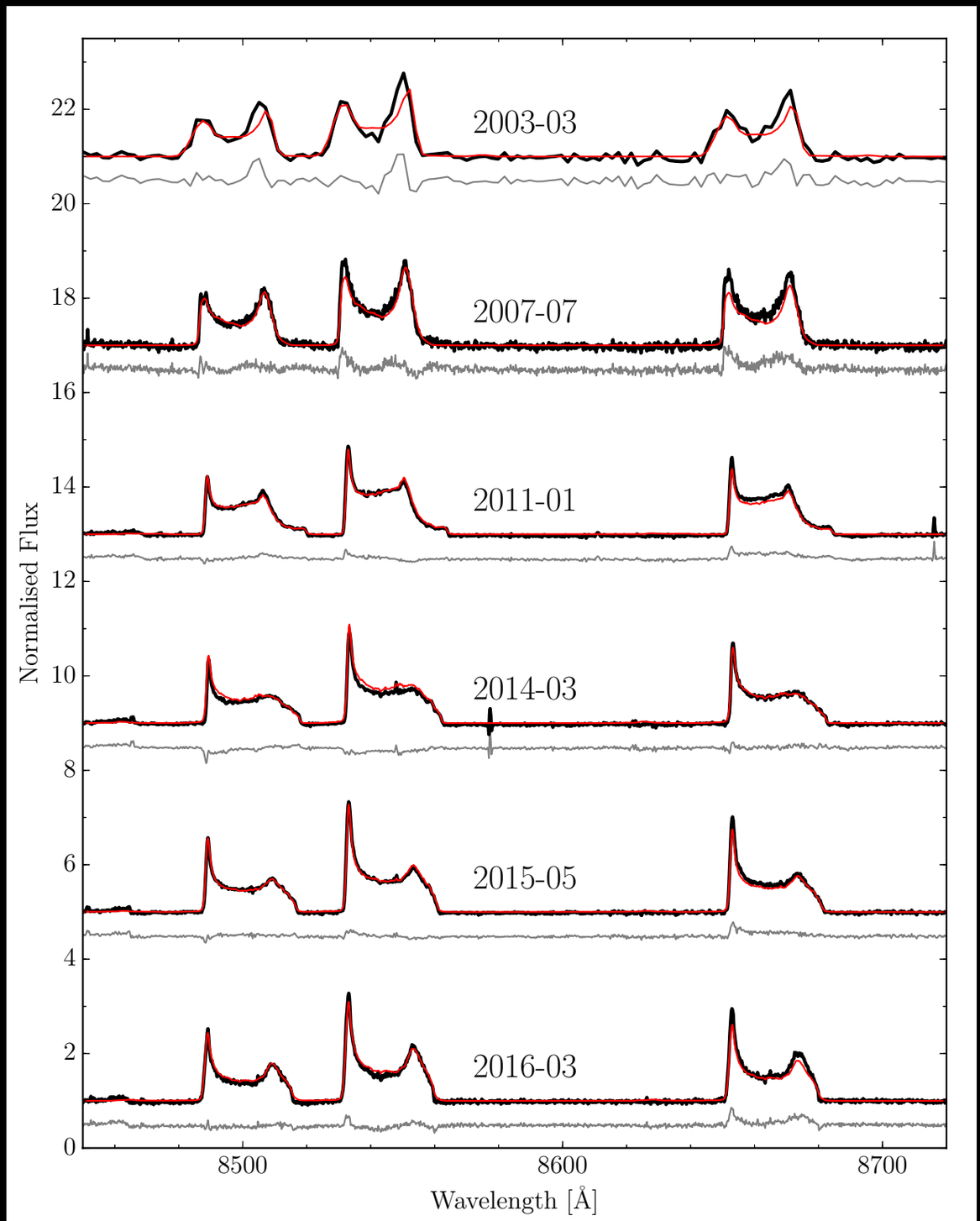
Variable strength

SDSS J1617+1620



Wilson et. al. 2014, MNRAS, 445, 1878

SDSS J1228+1040



Manser et. al. 2016, MNRAS, 455, 4467

Variability

e - Gaseous emission

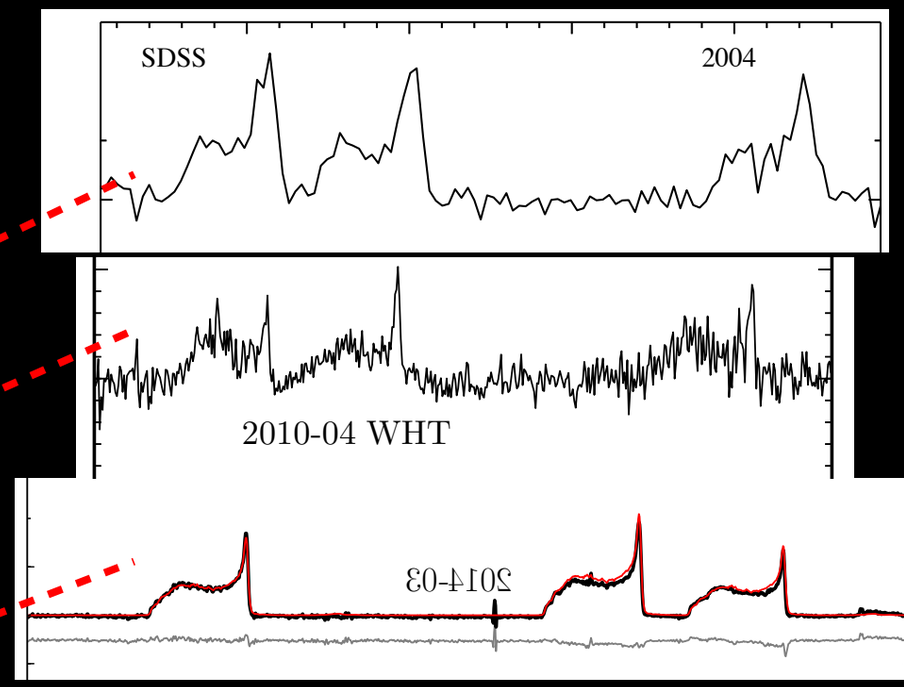
a - Gaseous absorption

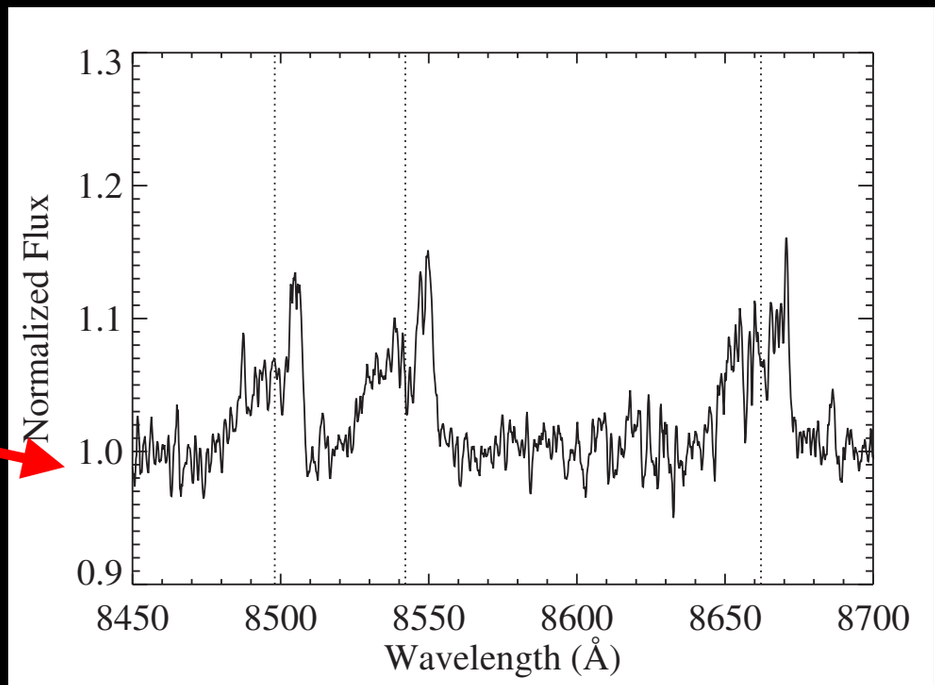
v - Spectroscopic or photometric Variability

Name	Type	Features
SDSS J0738+1835	DB	e
SDSS J0845+2257	DB	e, v
SDSS J0959–0200	DA	e, v
SDSS J1043+0855	DA	e, v
WD 1144+0529	DA	e
SDSS J1228+1040	DA	e, a, v
HE 1349–2305	DBA	e
SDSS J1617+1620	DA	e, v

Variability

Name	Type	Features
SDSS J0738+1835	DB	e
SDSS J0845+2257	DB	e, v
SDSS J0959–0200	DA	e, v
SDSS J1043+0855	DA	e, v
WD 1144+0529	DA	e
SDSS J1228+1040	DA	e, a, v
HE 1349–2305	DBA	e
SDSS J1617+1620	DA	e, v

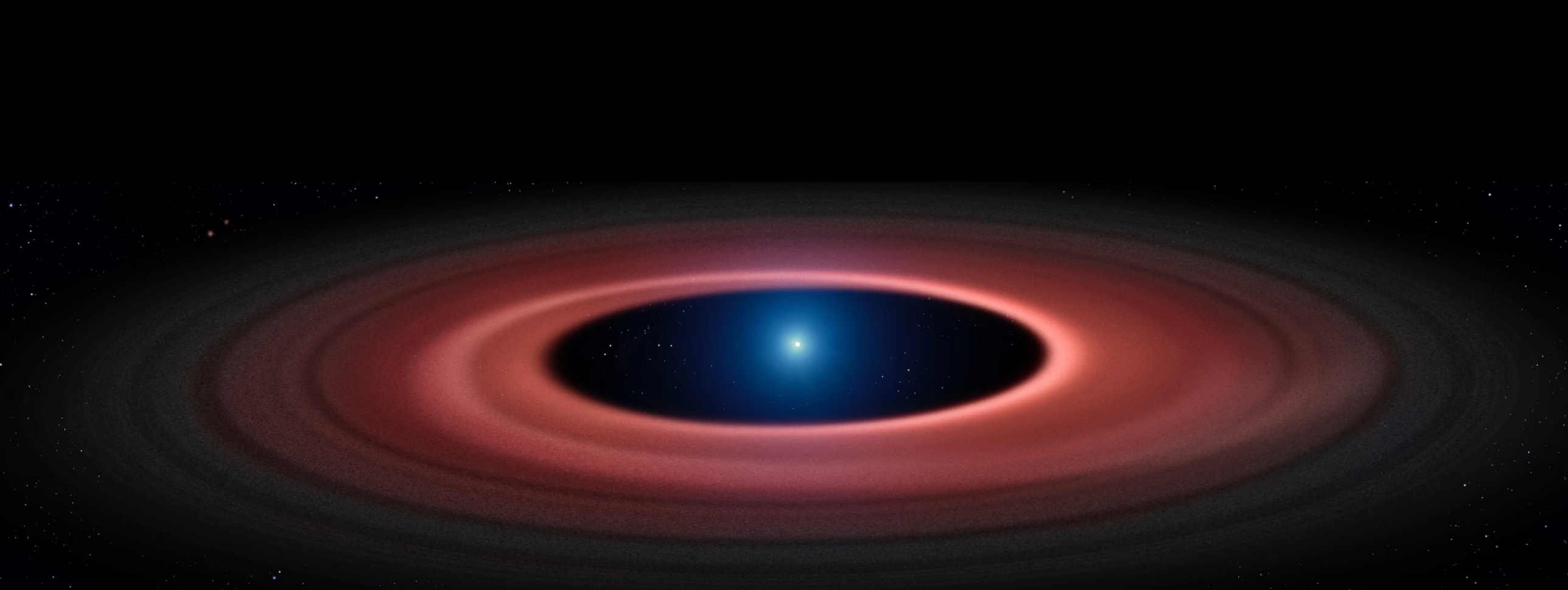




Melis et. al. 2012, ApJL, 715, L4

Detected Remnant Planetary System statistics

Metal pollution Koester et. al. 2014 25 - 50 %



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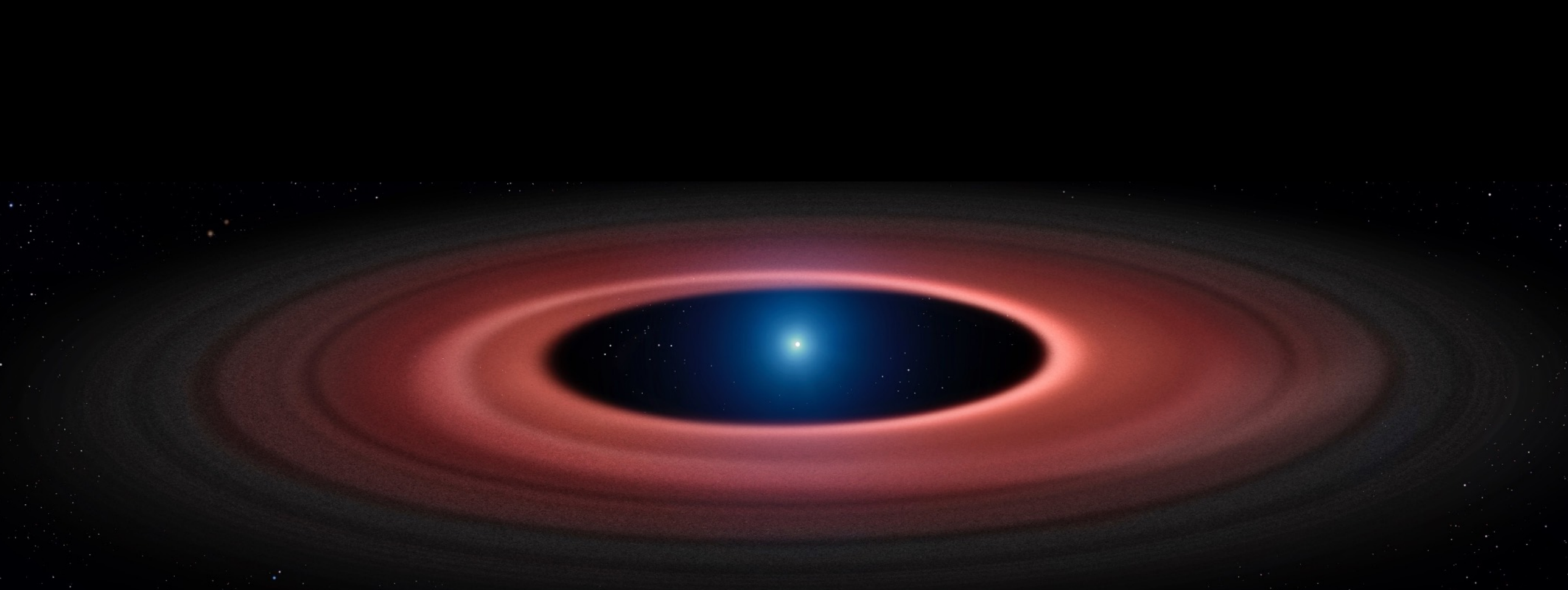

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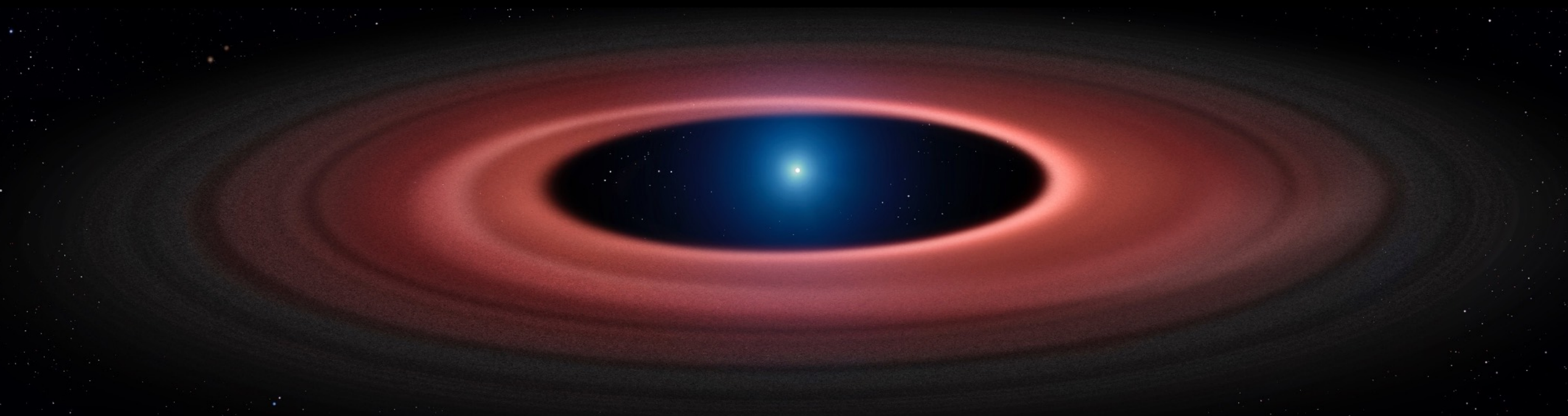
Gaseous component ??? %



The sample

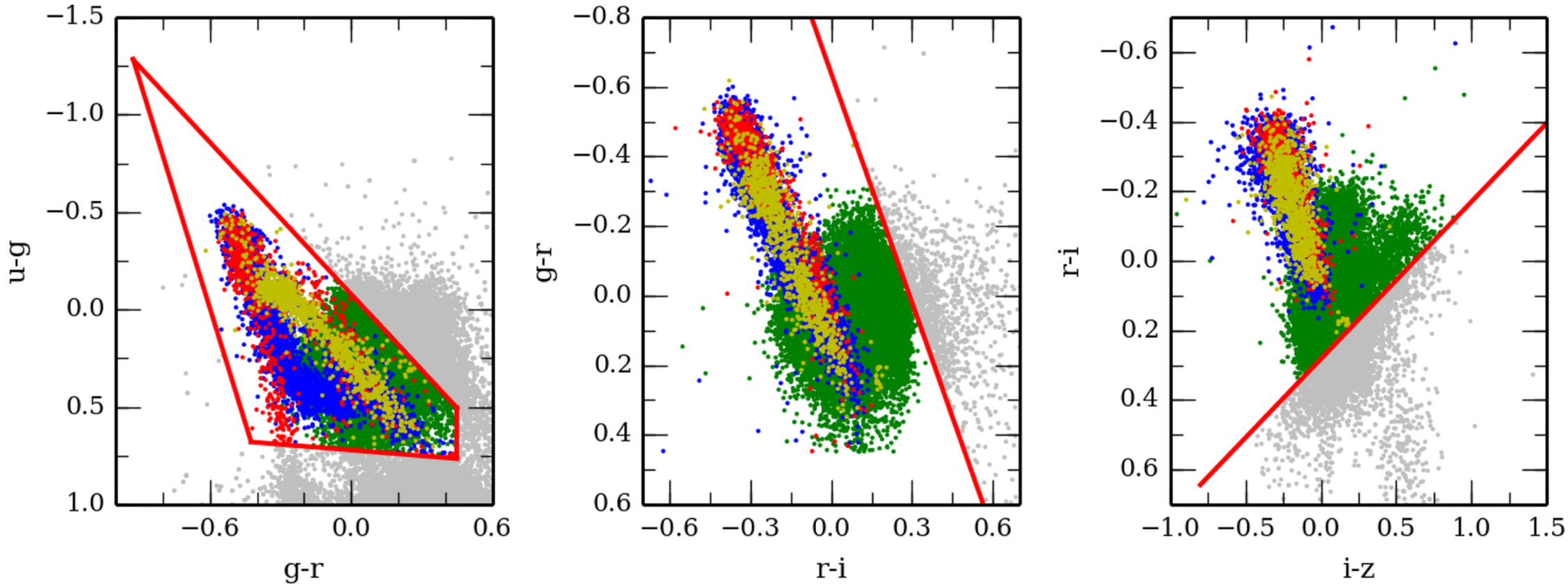
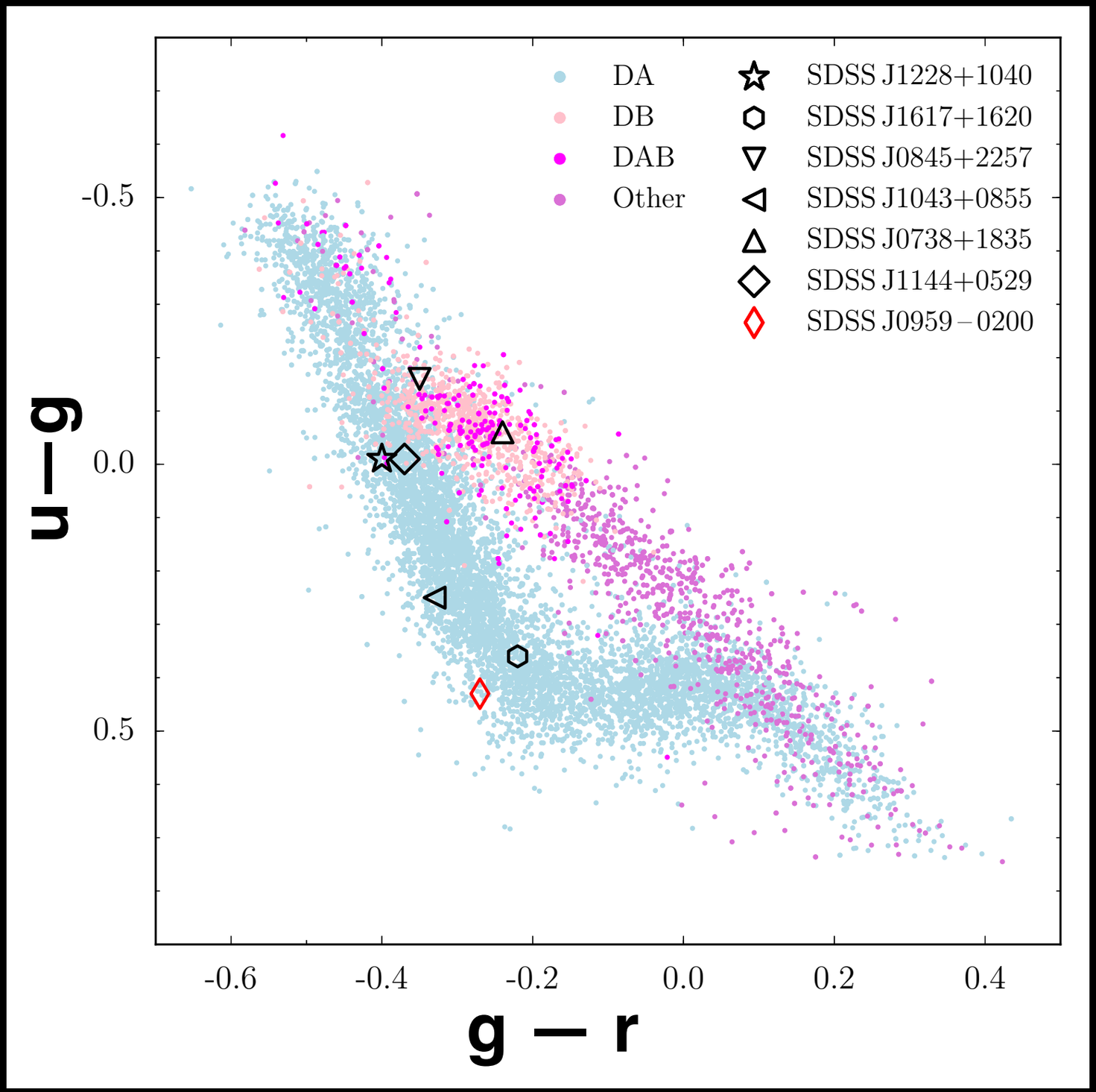


Figure 2. Colour–colour diagrams illustrating the location of the 27 639 DR7 spectroscopic objects that we used as training sample for our selection method. DA white dwarfs, non-DA white dwarfs, NLHS and quasars are shown as blue, yellow, red and green dots, respectively. The colour cuts that define our initial broad selection from Table 2 are overlaid as red lines. Objects outside this selection were not classified and are therefore plotted as grey dots.

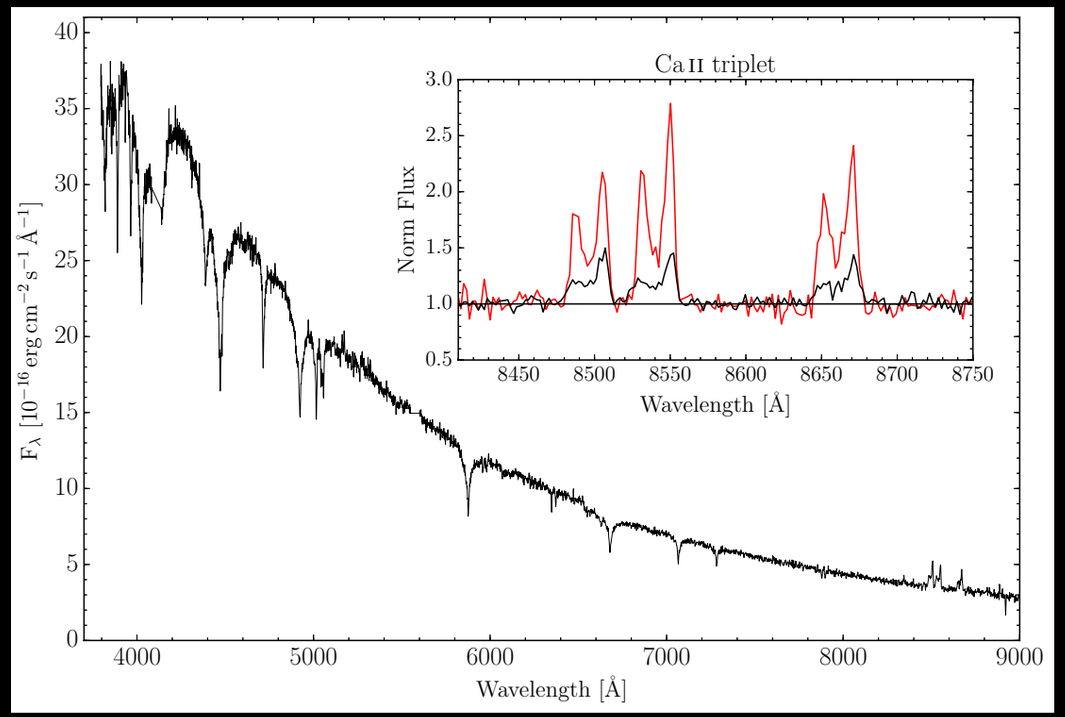
Gentile Fusillo et. al. 2015, MNRAS, 448, 2260

The sample


DA
DB
DAB
Other
SDSS J1228+1040
SDSS J1617+1620
SDSS J0845+2257
SDSS J1043+0855
SDSS J0738+1835
SDSS J1144+0529
SDSS J0959−0200
-0.5
0.0
0.5
u − g
-0.6
-0.4
-0.2
0.0
0.2
0.4
g — r

The frequency of gaseous discs

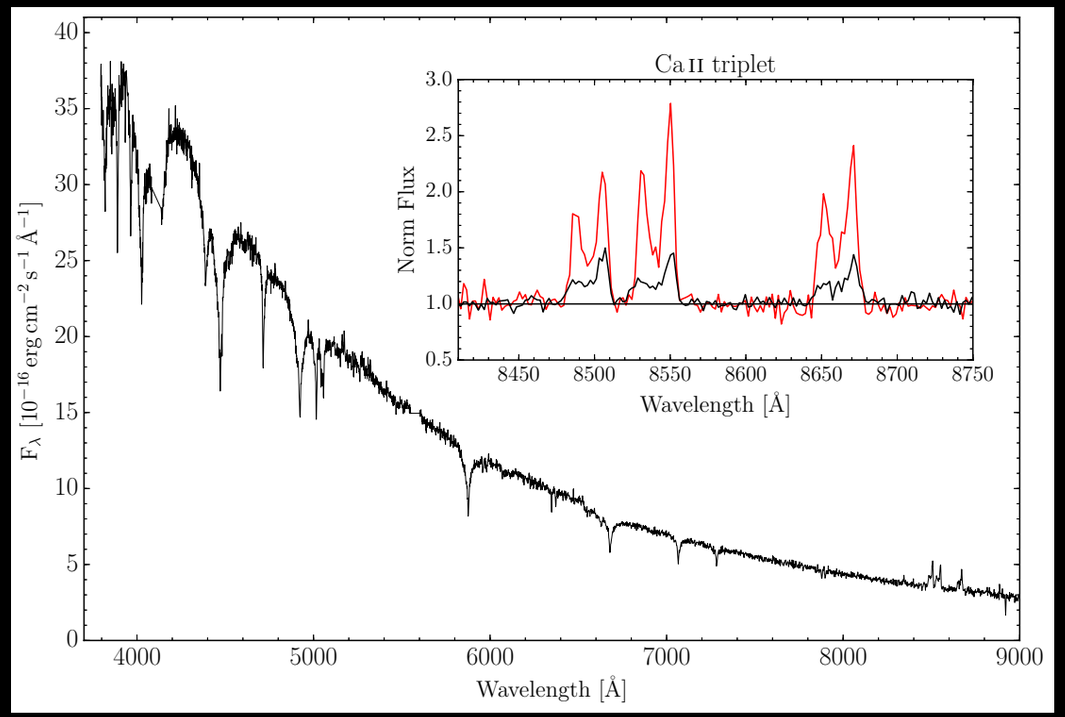
9079 single white dwarfs



The frequency of gaseous discs

9079 single white dwarfs

6 Gasesous components



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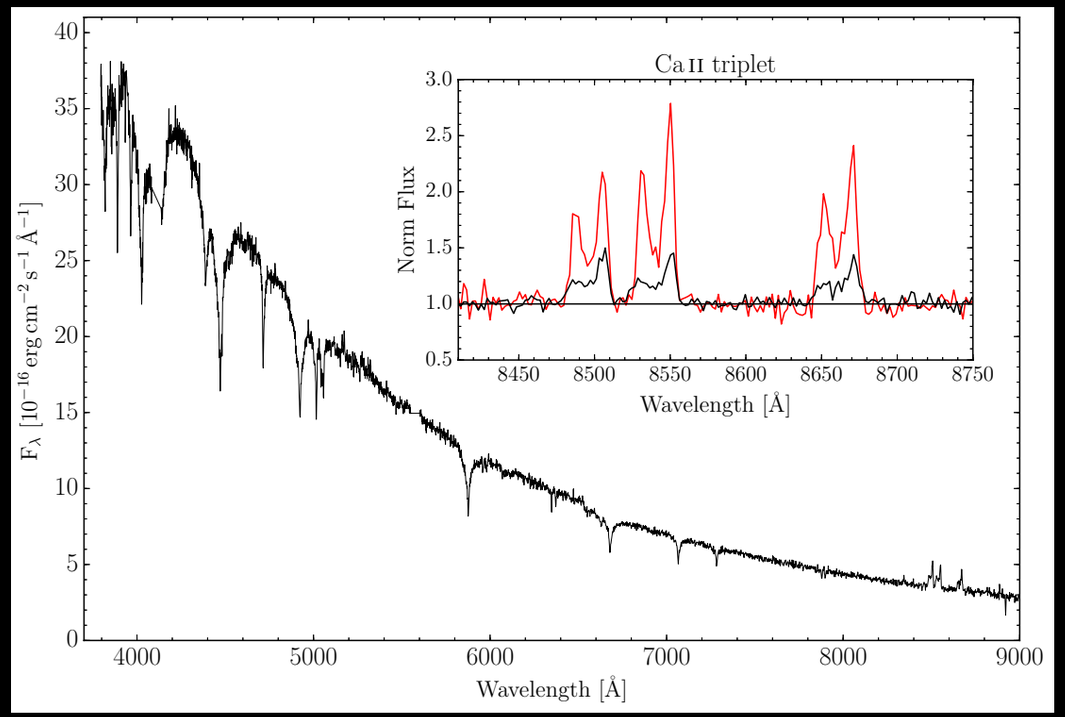


Frequency of observable gaseous debris discs at white dwarfs

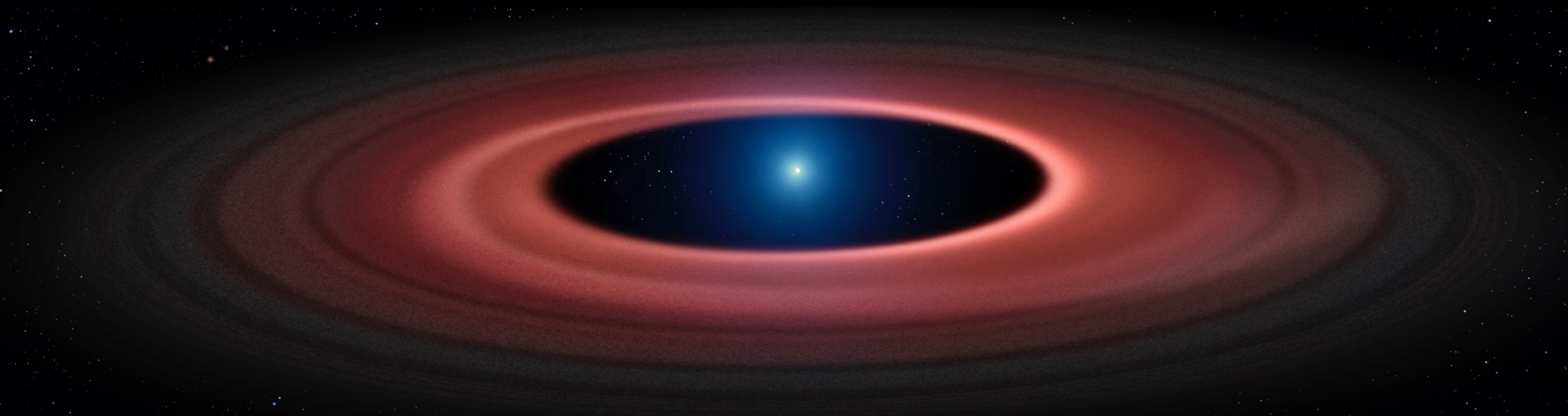
$0.07^{+0.03}_{-0.02}$ %

Detected Remnant Planetary System statistics

Metal pollution Koester et. al. 2014 25 - 50 %

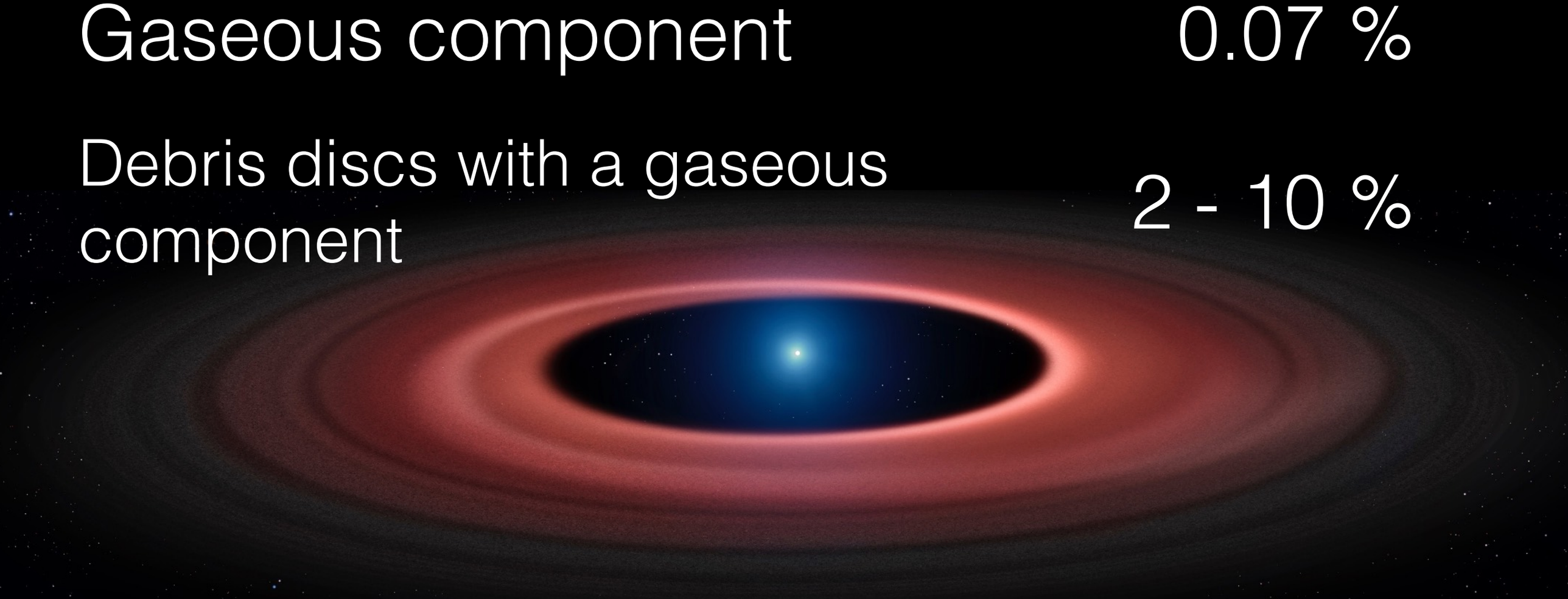
Dusty disc Farihi et al. 2009 Rocchetto et al. 2015 1 - 3 %

Gaseous component 0.07 %



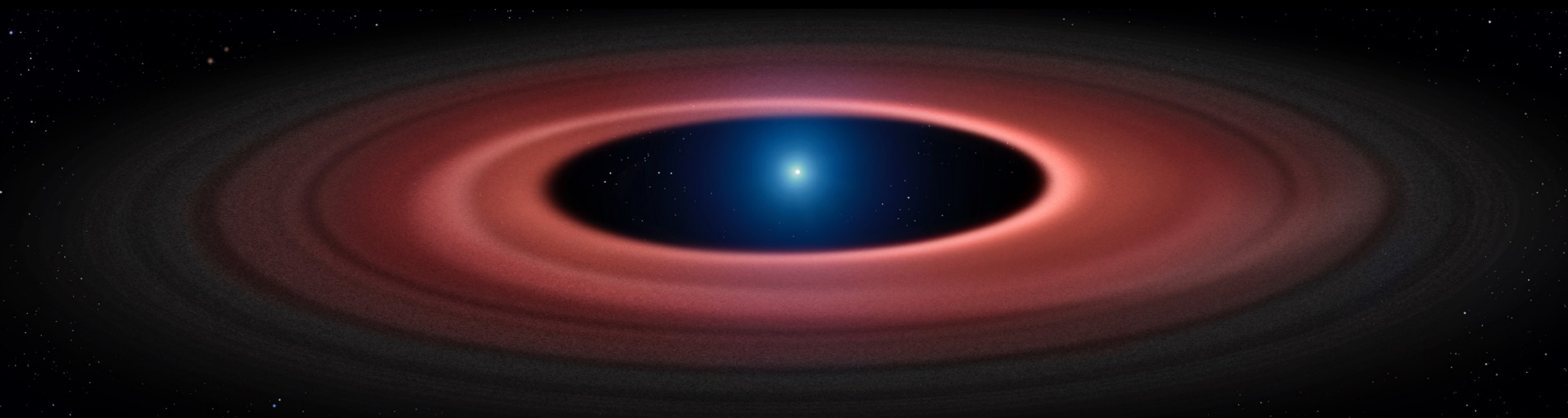
Detected Remnant Planetary System statistics

Metal pollution Koester et. al. 2014	25 - 50 %
Dusty disc Farihi et al. 2009 Rocchetto et al. 2015	1 - 3 %
Gaseous component	0.07 %
Debris discs with a gaseous component	2 - 10 %



Summary

- SDSS J1228+1040 is well studied, but still many unanswered questions.
- An observable gaseous component appears to be linked with variability
- Determined the frequency of a gaseous component to a debris disc at a white dwarf.



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Thanks for listening!

C.Manser@Warwick.ac.uk