



J/ApJS/225/29 NGC 5548 43 year-long monitoring in H $\beta$  (Bon+, 2016)

Evidence for periodicity in 43 year-long monitoring of NGC 5548.

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=[2016ApJS..225...29B](#) (SIMBAD/NED BibCode)

**ADC\_Keywords:** Galaxies, spectra ; Active gal. nuclei ; Spectroscopy

**Keywords:** accretion, accretion disks; galaxies: active; galaxies: nuclei; galaxies: Seyfert; quasars: individual: NGC 5548; quasars: supermassive black holes

**Abstract:**

We present an analysis of 43 years (1972 to 2015) of spectroscopic observations of the Seyfert 1 galaxy NGC 5548. This includes 12 years of new unpublished observations (2003 to 2015). We compiled about 1600 H $\beta$  spectra and analyzed the long-term spectral variations of the 5100 Å continuum and the H $\beta$  line. Our analysis is based on standard procedures, including the Lomb-Scargle method, which is known to be rather limited to such heterogeneous data sets, and a new method developed specifically for this project that is more robust and reveals a ~5700 day periodicity in the continuum light curve, the H $\beta$  light curve, and the radial velocity curve of the red wing of the H $\beta$  line. The data are consistent with orbital motion inside the broad emission line region of the source. We discuss several possible mechanisms that can explain this periodicity, including orbiting dusty and dust-free clouds, a binary black hole system, tidal disruption events, and the effect of an orbiting star periodically passing through an accretion disk.

**Description:**

We analyzed 1600 spectra of NGC 5548 in the H $\beta$  spectral interval, covering 43 years. We used:

(a) archival spectra obtained by K.K. Chuvaev from 1972–1988 (Sergeev+[2007ApJ...668..708S](#)) prior to the International AGN Watch (IAW) campaigns. These early spectra were recorded on photographic plates acquired with an image tube at the 2.6m Shajn Telescope of the Crimean Astrophysical Observatory.

(b) The 13 year study (from 1988 to 2002) of the IAW program (Peterson+[2002ApJ...581..197P](#)), which provided 1530 optical continuum measurements and 1248 H $\beta$  measurements.

(c) A spectral monitoring program with the 6 and 1m telescopes of the Special Astrophysical Observatory (SAO) in Russia from 1996 to 2002, and the 2.1m telescope of Guillermo Haro Observatory (GHO) in Cananea, Mexico, from 1996 to 2003 (S04; Shapovalova+ 2004, [J/A+A/422/925](#)).

(d) More recent, unpublished observations of the same program covering 2003–2013 observed at SAO (see Table 1), and a continuation of the monitoring campaign presented in S04.

(e) Spectra from the new IAW campaign obtained at Asiago observatory in 2012, 2013, and 2015.

(f) New unpublished observations from 2013 from the Asiago observatory (also given in Table 1).

See section 2 for further details.

**Objects:**

RA	(ICRS)	DE	Designation(s)
14 17 59.51	+25 08 12.5		NGC 5548 = Mrk 1509

**File Summary:**

FileName	Line1	Records	Explanations
ReadMe	80	.	This file
<a href="#">table1.dat</a>	51	86	Log of the new spectroscopical observations 2003–2015 from SAO, INOAE and Asiago
<a href="#">table2.dat</a>	96	1537	Spectral parameters obtained from the best fits

**See also:**

- [J/ApJ/821/56](#) : Space telescope RM project III. NGC5548 LCs (Fausnaugh+, 2016)
- [J/ApJS/222/25](#) : Long-term optical monitoring of E1821+643 (Shapovalova+, 2016)
- [J/MNRAS/453/1562](#) : CRTS close supermassive black hole binaries (Graham+, 2015)
- [J/ApJ/806/129](#) : Space telescope RM project. II. Swift data (Edelson+, 2015)
- [J/ApJ/806/128](#) : Space telescope RM project. I. NGC5548 (De Rosa+, 2015)
- [J/ApJ/806/22](#) : SEAMBHS IV. H $\beta$  time lags (Du+, 2015)
- [J/ApJ/779/109](#) : Long-term monitoring of NGC 5548 (Peterson+, 2013)
- [J/ApJS/201/23](#) : Spectroscopy of 88 z<0.7 SDSS QSOs (Eracleous+, 2012)
- [J/ApJS/189/15](#) : FeII emission in a sample of AGN spectra (Kovacevic+, 2010)
- [J/ApJ/683/L115](#) : Intermediate-line region in quasars (Hu+, 2008)
- [J/A+A/422/925](#) : Profile variability in lines of NGC 5548 (Shapovalova+ 2004)

[J/ApJ/599/886](#) : Emission lines of radio-loud AGN (Eracleous+, 2003)  
[J/A+A/371/79](#) : NGC5548 UVRI phot. and H $\alpha$ , H $\beta$  fluxes (Dietrich+, 2001)  
[J/ApJ/510/659](#) : Size and Structure of AGN in NGC 5548 (Peterson+, 1999)  
[J/AJ/116/102](#) : NGC 5548 BR photometry (Tyson+ 1998)  
<http://www.astronomy.ohio-state.edu/~agnwatch/data.html> :  
 International AGN Watch online data

**Byte-by-byte Description of file: [table1.dat](#)**

Bytes	Format	Units	Label	Explanations
1- 2	I2	---	Seq	Running sequence number of the observation
4- 13	A10	"D/M/Y"	Date	UT date of the observation
15- 23	F9.3	d	JD	Julian date; JD-2400000
25- 27	A3	---	Obs	A code assigned to the observatory ( <a href="#">(1)</a> )
29- 31	F3.1	arcsec	Ap1	Aperture used in the observations (Ap1xAp2)
32	A1	---	---	[x]
33- 37	F5.2	arcsec	Ap2	Aperture used in the observations (Ap1xAp2)
39- 42	I4	0.1nm	lambda1	[3250/5800] Observed lower range of spectral domain
43	A1	---	---	[-]
44- 47	I4	0.1nm	lambda2	[6950/8120] Observed upper range of spectral domain
49- 51	F3.1	arcsec	Seeing	[1.2/7.5] Seeing

**Note (1):** The code assigned to the observatory as follows:

SAO = Special Astrophysical Observatory of the Russian Academy of Science (Russia)  
 GHO = INOAE Guillermo Haro Observatory (Mexico)  
 ASG = Asiago Astrophysical Observatory (Italy)

**Byte-by-byte Description of file: [table2.dat](#)**

Bytes	Format	Units	Label	Explanations
1- 12	F12.6	d	JD	Julian Date; JD-2400000 ( <a href="#">(1)</a> )
14- 18	F5.2	10-15W/m2/nm	FHbeta	[0.6/17.5] H $\beta$ flux, in units of $10^{-13}$ erg/s/cm $^2$ /Å
20- 23	F4.2	10-15W/m2/nm	e_FHbeta	[0/7] FHbeta uncertainty
25- 29	F5.2	10-18W/m2	F5100	[1.2/16] Continuum flux measured at 510nm, in units of $10^{-15}$ erg/s/cm $^2$
31- 34	F4.2	10-18W/m2	e_F5100	[0/4] F5100 uncertainty
36- 42	F7.1	km/s	B25	[-9359/-2490] Width of the blue side of the broad line measured at 1/4 of intensity high
44- 49	F6.1	km/s	R25	[2393/9965] Width of the red side of the broad line measured at 1/4 of intensity high
51- 57	F7.1	km/s	B50	Width of the blue side of the broad line measured at 1/2 of intensity high
59- 64	F6.1	km/s	R50	Width of the red side of the broad line measured at 1/2 of intensity high
66- 72	F7.1	km/s	B75	Width of the blue side of the broad line measured at 3/4 of intensity high
74- 80	F7.1	km/s	R75	Width of the red side of the broad line measured at 3/4 of intensity high
82- 88	F7.1	km/s	B90	[-6123/1440] Width of the blue side of the broad line measured at 9/10 of intensity high
90- 96	F7.1	km/s	R90	[-3545/3885] Width of the red side of the broad line measured at 9/10 of intensity high

**Note (1):** Julian dates of IAW data in the form "\*.\*" are used to artificially make a difference between two different spectra under the same MJD on the International AGN Watch (IAW) web site (as for example, 48325. and 48325.1);  
<http://www.astronomy.ohio-state.edu/~agnwatch/data.html>

**History:**

From electronic version of the journal

(End) Prepared by [AAS], Emmanuelle Perret [CDS] 20-Oct-2016

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