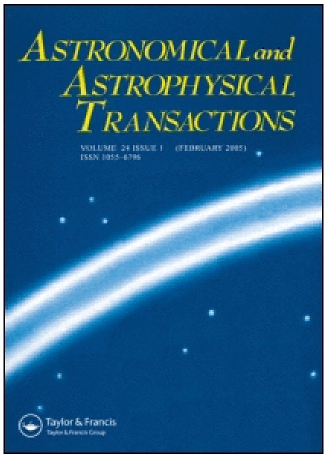

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EVIDENCE FOR A COSMOLOGICAL OSCILLATION OF THE NUCLEUS OF THE SEYFERT GALAXY NGC 4151

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Long-term observations of global oscillations of the Sun revealed the existence of the phasecoherent periodicity $P_0 = 160.0101 \pm 0.0001$ min seen in the Doppler shift of a photospheric spectral line. The true nature of the phenomenon is yet unknown. But the most intriguing aspect seems to be the recent discovery of the same periodicity in luminosity variations of several AGNs which makes the puzzle of the "ubiquitous" P_0-oscillation much more mysterious. The present analysis of all available data on the rapid variability of the nucleus of NGC 4151 fully confirms the AGN P_0-oscillation (with a mean amplitude ≈ 0.01 mag). It is argued that this oscillation must have a cosmological origin – due to, e.g., its independence of the AGN redshift. In terms of general relativity the P_0-oscillation is treated as a characteristic time scale of metric fluctuations of the Universe. The conclusion is made that this new astrophysical phenomenon severely contradicts today's cosmological model of the Universe based on the Big Bang paradigm.

KEY WORDS Seyfert galaxies, NGC 4151, observations, rapid variability, cosmology

1 INTRODUCTION

In the 1970s and 1980s several groups of astrophysicists reported the discovery of a global 160-min oscillation of the Sun (Brookes *et al.*, 1976; Severny *et al.*, 1976; Kotov *et al.*, 1978; Grec *et al.*, 1980; Scherrer and Wilcox, 1983). Later it was confirmed by a statistical analysis of the frequency distribution of onset times of $\approx$ 19 000 solar flares as observed on the Sun in 1947–1980 (Kotov and Levitsky, 1987); that latter work resulted in the most accurate determination of the period:

$$P_0 = 160.0101 \pm 0.0001 \,\text{min}.$$

Recently it was claimed (Kotov and Lyuty, 1988, 1990; Kotov *et al.*, 1994) that practically the same period, within the error limits, with surprisingly stable (over decades) initial phase, is present also in the optical and X-ray emission of several active galactic nuclei (AGNs; these are extragalactic, strongly variable sources for which the compact and supermassive – with typical mass $M \sim (10^6\text{–}10^{10}) \times M_\odot$ (usual notation) – object is normally thought to be a black hole).

The period appears to be independent of the distance and redshift z of the AGN, and this circumstance served as the main reason for a *cosmological* interpretation of the phenomenon. For a review of the P_0-problem – the P_0-oscillation seen in the Sun, the Solar system, short-period variable stars and also in distant AGNs – and for all other aspects associated with observations, data reduction procedures and all grounds for supposing a cosmological hypothesis, see Kotov (1985), Kotov *et al.* (1994) and references therein.

Since the publication by Kotov *et al.* (1994) the number of measurements of the luminosity of NGC 4151 has nearly doubled. This opens up the possibility of checking the previous results about the existence of the P_0-oscillation in this AGN and, therefore, to confirm or reject its cosmological significance.

2 THE OBSERVATIONAL DATA 1968–1994

To reveal a small-amplitude (≈ 0.01 mag) periodic effect, one must first filter out all slow trends which have much larger (usually by an order of magnitude) amplitudes. The detrending procedure we apply here is quite usual and was verified in a number of investigations in the field of helio- and asteroseismology (see, e.g., Koutchmy *et al.*, 1980; Scherrer and Wilcox, 1983; Kotov, 1985).

In our case slow trends for each separate data set (i.e. for observations during one night or during one observing season or a part of a season, or for measurements made over several hours in the case of X-ray (X) data from satellites) were approximated by linear regression lines or parabolae, then subtracted; sometimes – for data strings with lengths $L \approx 2$ to 3 hr – the mean values were subtracted from the original data points.

The residuals, with formal integration time interval ≈ 5 min, constitute the basic time sequence for further analysis. The time moment of each observation is determined as a rule with an accuracy ± 0.0005 d; the time moment of each observation was reduced to the Sun. The quoted errors everywhere are 1σ.

The power spectrum (PS) is computed using discrete Fourier transform code; the confidence level of the result (significance of the peak in the PS or that of the mean P_0-curve plotted with *a priori* known period P_0) is determined by methods described by Doroshenko *et al.* (1985), Kotov *et al.* (1994).

The first result of Kotov and Lyuty (1988) was based on only 290 separate measurements made by V. M. L. and collaborators in 1968–1986 (primarily using the 60-cm Zeiss reflector of the Sternberg Astronomical Institute (SAI)). These data were then much extended by the addition of all similar measurements (of the U-flux) performed at the SAI from 1987 to 1994. The total amount of these U-data (residuals) is now $N = 407$ (N is the number of residuals in a given data set), with rms-value $\Delta = 0.082$ mag.

Table 1. The V-observations of the nucleus of NGC 4151 in 1987–1994

No.	*Instrument*	*Date (UT)*	*L, hr*	*N*	Δ*, mag*
1	60-cm	4 February 1987	3.3	28	0.024
2	60-cm	23 March 1987	2.6	18	0.022
3	60-cm	20–21 April 1988	6.6	47	0.021
4	125-cm	17 March 1989	2.7	6	0.050
5	125-cm	28 April 1990	2.3	15	0.032
6	125-cm	16–17 January 1991	3.0	34	0.025
7	125-cm	11–12 February 1991	4.9	33	0.027
8	125-cm	11–12 March 1991	5.8	37	0.065
9	125-cm	15–16 February 1993	4.3	41	0.017
10	60-cm	26–27 April 1993	2.4	17	0.012
11	60-cm	27 April 1993	3.4	24	0.020
12	125-cm	10 January 1994	2.6	19	0.020
13	125-cm	6–7 February 1994	4.9	51	0.008
14	125-cm	6 May 1994	2.4	23	0.016
Total	–	1987–1994	51.2	393	0.028

The X-ray data 1975–1985 were collected by the Ariel-5 and *EXOSAT* satellites within the energy range 0.04–10 keV and were described earlier by Kotov *et al.* (1994): $N = 456$, with rms-value $\Delta = 0.199$ mag. Recently Yaqoob *et al.* (1993) published new X-ray data obtained in 1990–1991 by the Ginga satellite for energies 4–10 keV. We reduced all these data also, using parabola approximations for slow trends – separately for each of 11 records plotted by Yaqoob *et al.* (1993) – and derived $N = 97$ new X-residuals with $\Delta = 0.042$ mag. After merging these new data with the sample of old X-residuals ($N = 456$), we got the total sample of X-data 1975–1991: $N = 553$, with rms-value $\Delta_x = 0.182$ mag.

The ground-based differential (i.e. with respect to the reference star) measurements in the V-filter were performed in 1987–1994 at several telescopes (of the SAI and the Crimean Astrophysical Observatory (CrAO)); part of those data is given in Lyuty *et al.* (1989), the rest of the data will be published elsewhere.

During 1987–1994 the V-observations were carried out during 39 nights, with a total length of observations $L \approx 148$ hr (in all 1099 individual measurements of the V-flux). It was noted however that some nights did not show any appreciable (i.e. in excess of the sensitivity threshold of our records, $\sigma_0 \approx 0.01$ mag) fluctuations, relative to the slow trend.

(Indeed, it is well known that AGNs sometimes exhibit no significant rapid (intraday) variability at all (Massaro *et al.*, 1988). An addition of those data makes practically no sense: an increase of the number of data – by including "zeros" (observations with no appreciable variability) – by, e.g., three times will lead to a decrease of statistical significance of the result by about $\sqrt{3}$ times, so that an increase of measurements by nearly three times would be needed to get the previous level of confidence. Accordingly, to make a distinction between nights with and without variability, we introduced an empirical criterion $3\sigma_0 = 0.03$ mag: a

Table 2. The U-observations of NGC 4151 in 1989–1994

No.	*Instrument*	*Date (UT)*	*L, hr*	*N*	*Δ, mag*
1	125-cm	17 March 1989	2.7	6	0.057
2	125-cm	26–27 March 1990	5.0	27	0.013
3	125-cm	28 April 1990	2.3	15	0.045
4	125-cm	20 May 1990	2.9	25	0.014
5	125-cm	16–17 January 1991	3.0	35	0.023
6	125-cm	11–12 February 1991	4.9	33	0.029
7	125-cm	12 February 1991	2.1	15	0.025
8	125-cm	9–10 March 1991	7.6	30	0.016
9	125-cm	11–12 March 1991	5.8	37	0.066
10	125-cm	17–18 April 1991	2.6	16	0.020
11	125-cm	15–16 February 1993	4.3	44	0.024
12	60-cm	28–29 February 1993	2.9	29	0.013
13	60-cm	27 April 1993	3.4	24	0.020
14	125-cm	10 January 1994	2.6	19	0.019
15	125-cm	6 May 1994	2.4	23	0.017
Total	–	1989–1994	54.6	378	0.030

given record was supposed to show appreciable variability if some residual(s), by absolute magnitude, exceeded a $3\sigma_0$-threshold. Notice that this $3\sigma_0$-criterion was applied to the V-data without any *ad hoc* relation to the potential presence of periodicity; this means that the present analysis does satisfy the necessary condition of objectiveness.)

All 14 nights 1987–1994 with "appreciable" V-variability are listed in Table 1; the total number of individual measurement was $N = 393$, with rms-value $\Delta_V = 0.028$ mag and total length $L \approx 51.2$ hr.

Apart from the above-mentioned U-data 1968–1994 ($N = 407$; separate measurements, usually 1–2 measurements per night), other U-observations were performed at the Zeiss 60-cm telescope and at the CrAO reflector AZT-11 (with 125-cm diameter) in 1989–1994 during 27 nights (as a rule, simultaneously with the V-observations at the same telescope). In all, these observations were carried out during $L \approx 95.5$ hr, with $N = 712$ residuals and $\Delta = 0.023$ mag. The list of 15 nights with U-residuals which sometimes showed an excess of the $3\sigma_0$-threshold is contained in Table 2; the total number of those residuals is $N = 378$, with $\Delta = 0.030$ mag and $L \approx 54.6$ hr.

By merging the previous U-data set 1968–1994 ($N = 407$) with the new U-data 1989–1994 ($N = 378$), we get the summary U-data set 1968–1994: $N = 785$, with overall rms-value $\Delta_U = 0.063$ mag.

3 THE POWER SPECTRA OF NGC 4151

The first PS for NGC 4151 was computed by Kotov and Lyuty (1988) using only 290 U-residuals for the interval 1968–1986. Due to the scarcity of data that PS

Table 3. The data for NGC 3516, NGC 4151 and quasar 3C 273

Object	Interval	N	P, *min*	A_h,*mag*	φ	$\mathcal{P}$
NGC 3516	1968–1993	370	160.0101 ± 0.0005	0.006	0.78	4.2σ
NGC 4151	1968–1994	1731	160.0105 ± 0.0005	0.009	0.55	4.2σ
3C 273	1968–1986	372	160.0112 ± 0.0013	0.014	0.09	4.0σ
Three AGNs	1968–1994	2473	160.0104 ± 0.0006	–	–	$> 3.7\sigma$

Note. We give only the lowest limit for the confidence $\mathcal{P}$ of the P_0-peak on the average, for three AGNs, PS – due to gaps in real (unevenly spaced) data series (see Doroshenko *et al.*, 1985; Kotov *et al.*, 1994).

was plotted for a very narrow frequency range around the *a priori* frequency $\nu = P_0^{-1} \approx 104.160$ μHz (from 104.12 to 104.19 μHz); the significance of the P_0-peak was established at a confidence $\mathcal{P} \approx 3\sigma$. The harmonic amplitude A_h was found to be equal to 0.014 ± 0.004 mag, the phase of harmonic maximum of brightness $\varphi = 0.51 \pm 0.05$ (for the P_0-period; zero phase everywhere corresponds to the moment UT 00^h 00^m, 1 January 1974; for comparison see also Table 3).

Now we have nearly six times more data than those in Kotov and Lyuty's (1988) paper (and nearly twice more in comparison with the previous analysis by Kotov *et al.*, 1994) and therefore we may check the earlier conclusion of the significance of the P_0-periodicity. Also we may essentially widen the range of frequencies for the PS calculation. (Notice that due to the large number of gaps the probability of getting some peaks with amplitudes exceeding that of the a priori peak is growing with an increase in the number of independent frequencies tested.)

Firstly, the three data sets (U, V and X-data) were merged into a single time series, using well-known normalization procedures (Scherrer and Wilcox, 1983). Namely, the V and X-data were multiplied by factors $\Delta_U/\Delta_V \approx 2.25$ and $\Delta_U/\Delta_X \approx 0.35$, respectively (i.e., the rms-values of both series were reduced to the rms-value of the U-data). This procedure yielded the combined data set 1968–1994 with $N = 1731$ and $\Delta = 0.063$ mag.

The PS for the first portion of the data, the U-residuals 1968–1994, is shown in Figure 1(a) where a little might be claimed about confidence of the P_0-peak (with a period of $P = 160.0104 \pm 0.0005$ min); the result seems to be marginally significant since there are many other peaks with amplitudes much higher than that of the P_0-peak (notice that the frequency range here is about six times larger than in Kotov and Lyuty's (1988) work). Without a priori information – on the potential presence of the P_0-periodicity in the nucleus of NGC 4151 – certainly the claim of Kotov and Lyuty (1988) about its essential significance is impossible. (On the vertical axes of Figure 1 we plot A_h^2, in arbitrary units, representing the power spectral density at frequency ν, per unit frequency interval).

In Figure 1(b) we plot the PS computed for a larger amount of data: merged U and X-data with $N = 1338$ (the X-data were reduced to the rms-value of the U-data). The P_0-peak emerges now as one of the most dominant features (second by height, for the range of frequencies identical with Figure 1(a)).

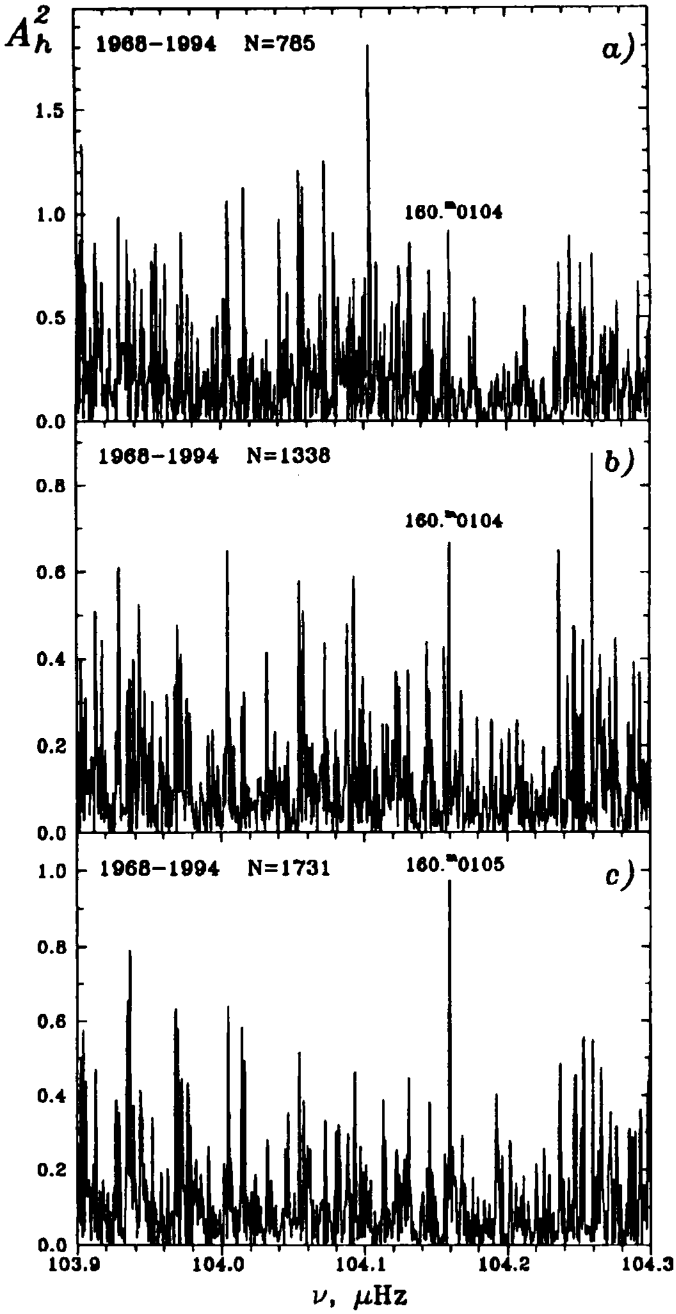

Figure 1 The PS computed for three portions of the NGC 4151 data 1968–1994: (*a*) U-residuals, $N = 785$, (*b*) U and X-residuals, $N = 1338$ and (*c*) U, X, V-residuals, $N = 1731$. The power A_h^2, in arbitrary units, is on the vertical axes; the step in frequency is $\Delta\nu = 0.1$ nHz (the same is in Figure 7).

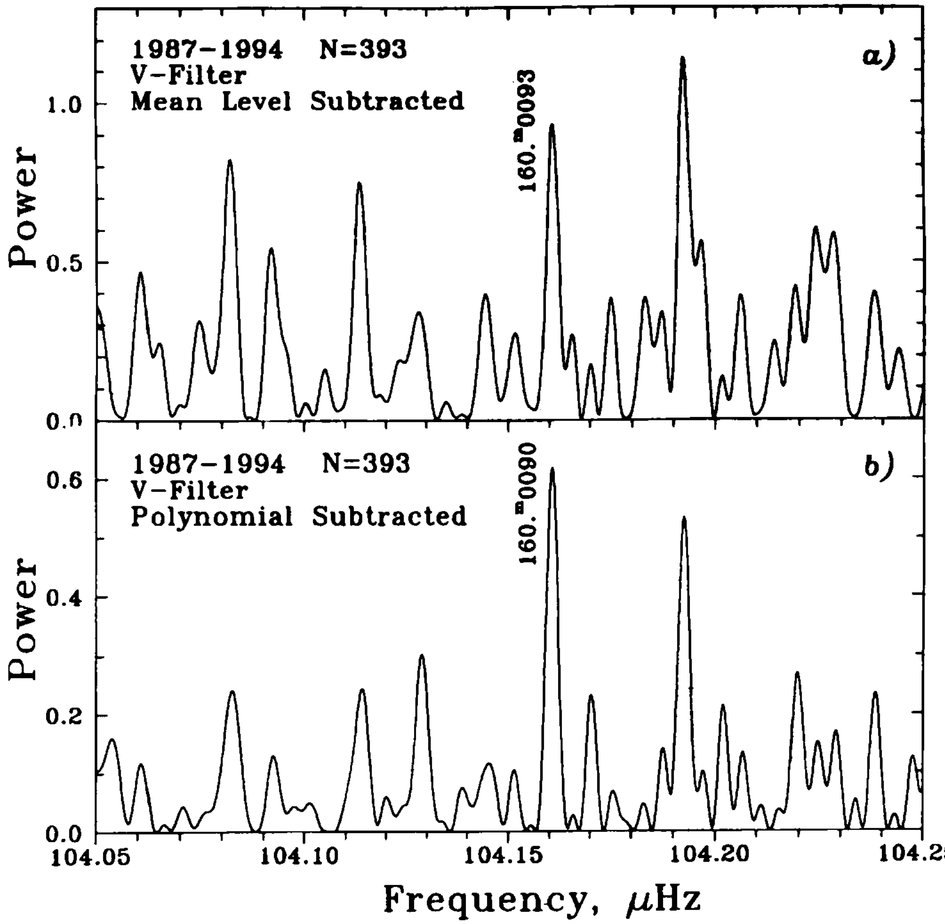

Figure 2 The power spectra of V-measurements of NGC 4151 performed in 1987–1994 (N = 393): (a) without the detrending procedure (but with nightly mean level subtracted), (b) for V-residuals after application of the standard detrending procedure. The power A_h^2, per unit frequency interval, is on the vertical axes (with A_h being expressed in units of 0.01 mag).

Finally, in Figure 1(c) we show the PS computed for the total U, V, X-observations (N = 1731). The P_0-feature is the highest one, with significance $\mathcal{P} > 3.7\sigma$. Figure 1 clearly demonstrates therefore the growth of significance of the P_0-periodicity with the increase of observational data.

4 ON THE DETRENDING PROCEDURE

The data reduction procedure is based on the use of a polynomial fit to eliminate quasi-systematic trends and random low-frequency noise (it was described in detail by Kotov and Lyuty, 1988, 1990). This low-frequency cutoff is a standard data reduction procedure which is necessary for (a) removing the noise power which increases steeply at lower frequencies and (b) to reduce the amplitude threshold for detection of the potential small-amplitude periodicity. (For a discussion of the detrending procedure and sampling effect (gaps) and their influences on the search for a periodic signal hidden in unevenly spaced (interrupted) time series, see, e.g., Dittmer, 1977; Koutchmy *et al.*, 1980; Kotov *et al.*, 1983.)

Some astrophysicists, however, ask: could the P_0-periodicity noticeable in the AGN time series not be subjected to a detrending procedure?

We attempted to answer this question using the V-observations of NGC 4151 carried out in 1987–1994 during 14 nights (see Table 1; those are the only data, for this AGN, which were obtained quasi-continuously during one night, with the observing length for each night $L \geq 2$ hr).

Firstly, the mean level of the V-flux was determined then subtracted for each of 14 nights separately (this procedure is similar to the calibration procedure usually applied to photometric data obtained with the use of different instruments and/or reduced in different photometric systems) to get an identical (zero) mean level and, analysing residuals, to study the rapid variability of the AGN. Then the PSa were computed for the two different data sets: (a) for these new V-residuals (with nightly mean values subtracted, $N = 393$), and (b) for the previous 393 V-residuals (obtained via application of the usual detrending procedure). From results shown in Figure 2 one may conclude that:

(a) both spectra exhibit a prominent peak with period $P_p \approx 160.009 \pm 0.002$ min which coincides well, within the limits of error, with the "canonical" value P_0;

(b) the harmonic amplitudes A_h of these two peaks agree with each other (if we take into account the formal statistical error of A_h, see below): 0.010 and 0.008 mag for the peak in the top and bottom panels, respectively;

(c) the detrending procedure substantially suppressed spurious peaks (with amplitudes comparable with that of the P_p-peak at the top PS), reduced the mean level of the PS and thus increased the confidence level of the P_p-peak.

In Figure 3 we plot two mean curves for the folding P_0-period obtained for those two different data sets: (a) for the V-data with nightly mean level subtracted, (b) for V-residuals obtained with the use of our standard detrending procedure. We see that there are no appreciable difference between these two mean curves:

(1) $A_h = 0.009 \pm 0.003$ mag, $\varphi = 0.66 \pm 0.05$, $\mathcal{P} \approx 3.7\sigma$, for non-detrended data (nightly means subtracted),

(2) $A_h = 0.008 \pm 0.003$ mag, $\varphi = 0.61 \pm 0.06$, $\mathcal{P} \approx 3.7\sigma$, for detrended data.

We arrive therefore at the conclusion that (a) the detrending procedure cannot result in the false appearance of the P_0-periodicity in the NGC 4151 data, (b) the P_0-periodic signal is clearly seen also in the data not subjected to the standard

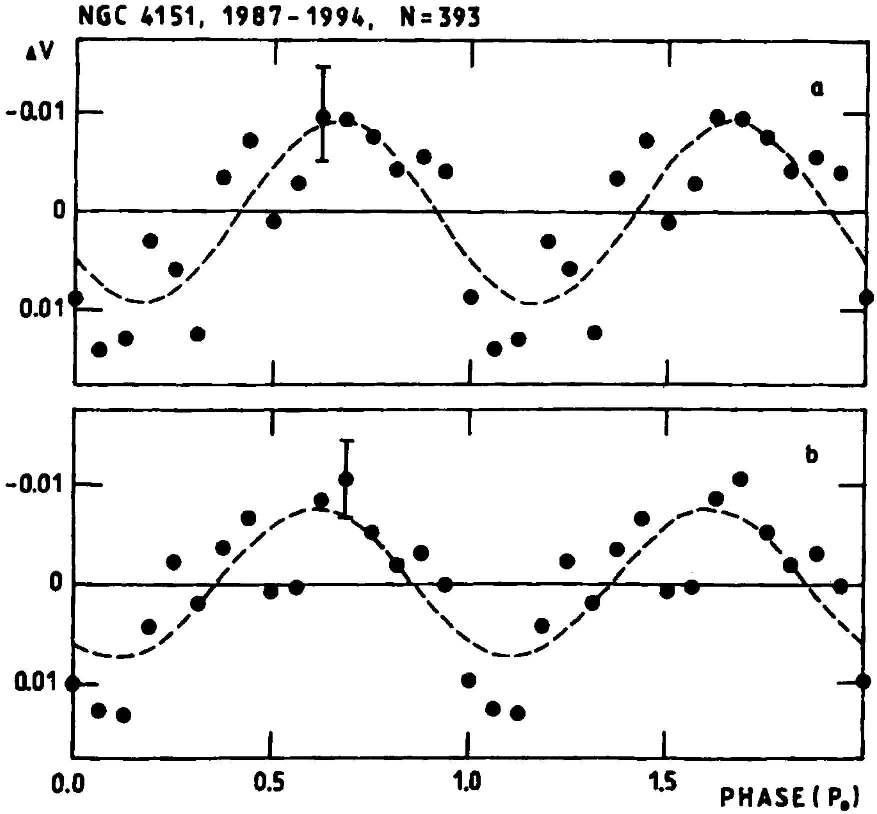

Figure 3 The P_0-mean curves obtained for two V-series of NGC 4151 (1987–1994, $N = 393$): (a) without the standard detrending procedure, and (b) after application of the standard detrending procedure. The dashed lines are best-fitted sinusoids. Each point represents the mean value of the residuals for the phase interval $\tau \approx 20$ min; zero phase corresponds to the moment UT $00^h\ 00^m$, 1 January 1974; the vertical bar indicates the typical $\pm 1\sigma$-error for each average point (the same is in Figure 4).

procedure of low-frequency filtering, and (c) detrending does not severely distort the P_0-signal (its amolitude and phase φ) but significantly suppresses spurious peaks and therefore increases the confidence level of the peak $P_p \approx P_0$ observed in the Fourier PS.

5 THE MEAN P_0-CURVES

Earlier it was shown that the phases φ of the mean curves constructed with the P_0-period for independent samples of NGC 4151 data (e.g., for U, V or X-data separately) are almost – within the error limits – identical (Kotov *et al.*, 1994). Therefore in Figure 4(a) we present the common mean P_0-curve for the merged

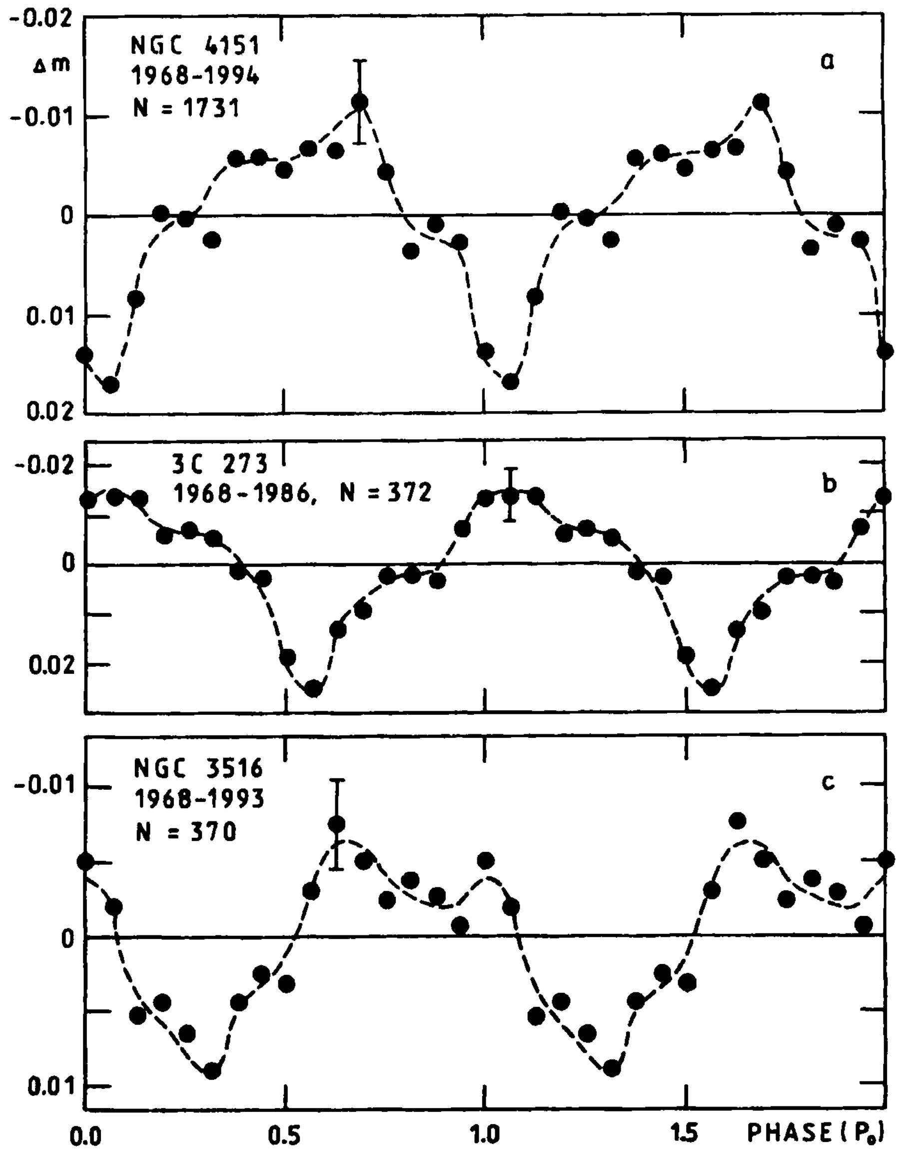

Figure 4 The mean P_0-curves for (*a*) NGC 4151 (optical and X-ray data 1968–1994, $N = 1731$), (*b*) quasar 3C 273 (optical and X-ray data 1968–1986, $N = 372$) and (*c*) NGC 3516 (optical data 1968–1993, $N = 370$). Dashed lines through average points are drawn "by hand".

NGC 4151 data 1968–1994 ($N = 1731$, $\Delta = 0.063$ mag): $A_h = 0.009 \pm 0.003$ mag, $\varphi = 0.55 \pm 0.05$, with confidence $\mathcal{P} \approx 4.2\sigma$.

For comparison, in Figure 4(*b*,*c*) we plot the P_0-curves for quasar 3C 273 (adopted from Kotov *et al.*, 1994) and for the Seyfert galaxy NGC 3516 (see below). The quasar's phase $\varphi = 0.09 \pm 0.04$ is almost opposite to that of the nucleus of

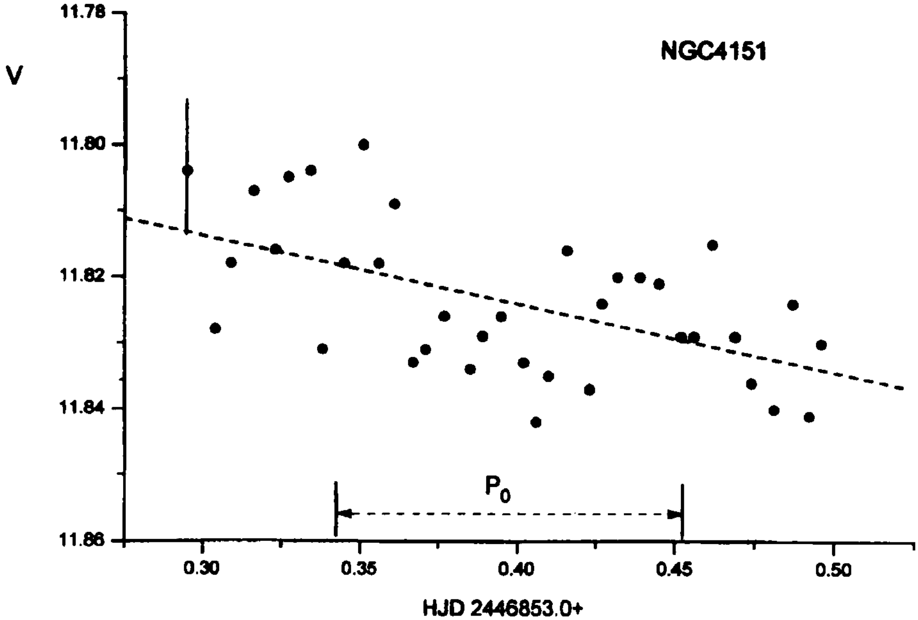

Figure 5 The V-observations of NGC 4151 (relative to a standard star) performed on 26 February 1987 at the SAI 60-cm reflector. The vertical bar indicates the typical error of an individual data point; the linear regression line is shown by a dashed line. The characteristic time scale ($\approx P_0$) of the V-flux variation is shown by an arrow. The maxima of the V-flux follow from all other V-observations 1987–1994 for the P_0-periodicity, correspond to the HJD moments $\approx$ ... 53.32 and ... 53.44.

the Seyfert galaxy NGC 4151, indicating that the periodic effect can in no way be attributed to errors or systematic artefacts of data reduction; or to the potential influence of the Sun or some unknown geophysical phenomenon (for discussion see Kotov and Lyuty, 1988, 1990; Kotov *et al.*, 1994).

The dashed lines in Figure 4 are drawn through average points "by hand", to emphasize significant deviations of the AGN mean curves from sinusoids. These deviations might be caused by random or systematic errors, or by incomplete subtraction of slow trends (especially in view of the closeness of the period to 1/9th of a day), and also by plausible non-harmonic forms of the real AGN curves; for discussion see Kotov *et al.* (1993, 1994).

For an illustration of the variability of NGC 4151 with a characteristic time scale of a few hours, in Figures 5 and 6 we plot the V-values obtained on 26 February 1987 (at the SAI 60-cm reflector) and on 6–7 February 1994 (at the CrAO 125-cm reflector, according to Table 1). One can see that deviations of residuals with respect to the linear regression lines more or less satisfactorily agree with epochs of the P_0-extrema predicted for these nights on the basis of all other observations and the NGC 4151 mean curve (shown, e.g., in Figure 4(*a*)). We may repeat (after, e.g., Kotov and Lyuty, 1988) that the presence of the P_0-periodicity might be *directly*

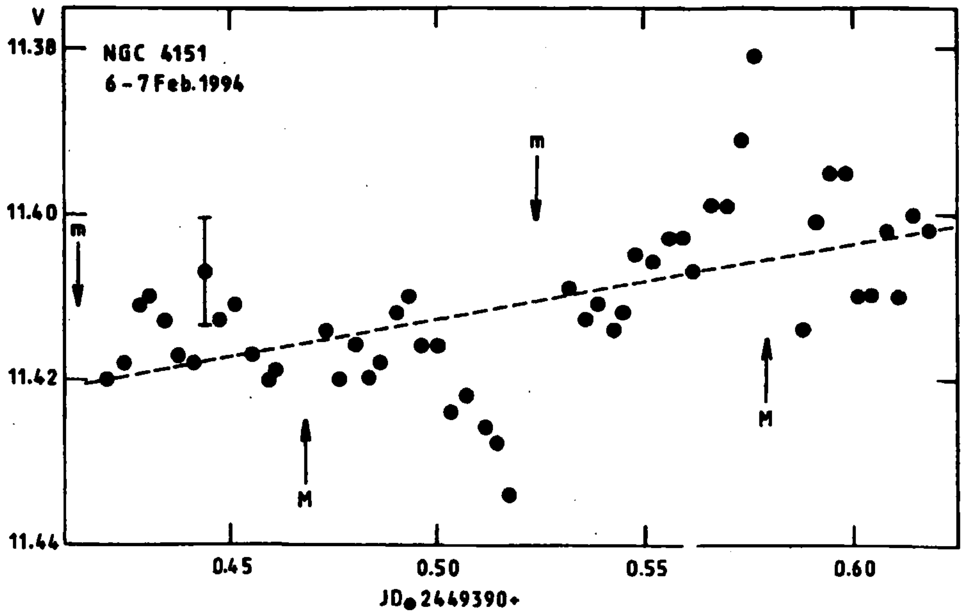

Figure 6 The same as in Figure 5 but for the night 6–7 February 1994 (the CrAO 125-cm reflector). The extrema of the mean P_0-curve which follow from all previous observations are shown by arrows and letters (m – minimum, M – maximum).

seen in the time behaviour of the NGC 4151 flux measurements, i.e. without any elaborate data reduction procedures.

6 AVERAGE POWER SPECTRUM FOR THREE AGNS

The PSa for two other AGNs, NGC 3516 and 3C 273, were published by Kotov *et al.* (1994); both exhibited significant (with nearly 4σ confidence) periodicity P_0.

In the present study, to the previous NGC 3516 data 1968–1990 ($N = 282$) made in the U, B, V-bands, we added 88 new U, B, V measurements made in 1990–1993 at the SAI 60-cm reflector. As a result we obtained the new NGC 3516 U, B, V-series 1968–1993 with $N = 370$ and $\Delta = 0.021$ (all data were reduced to the U-scale of residuals).

Then the PS was computed for each of the three AGNs (NGC 3516, NGC 4151 and 3C 273) separately, normalized (i.e. divided by its own mean value), then the three normalized PSa were averaged. The result is shown in Figure 7 where the primary peak corresponds to a period of 160.0104 ± 0.0006 min, with significance $\mathcal{P} > 3.7\sigma$.

Table 3 gives the values of the period, amplitudes A_h and other information about observations and results for these three AGNs.

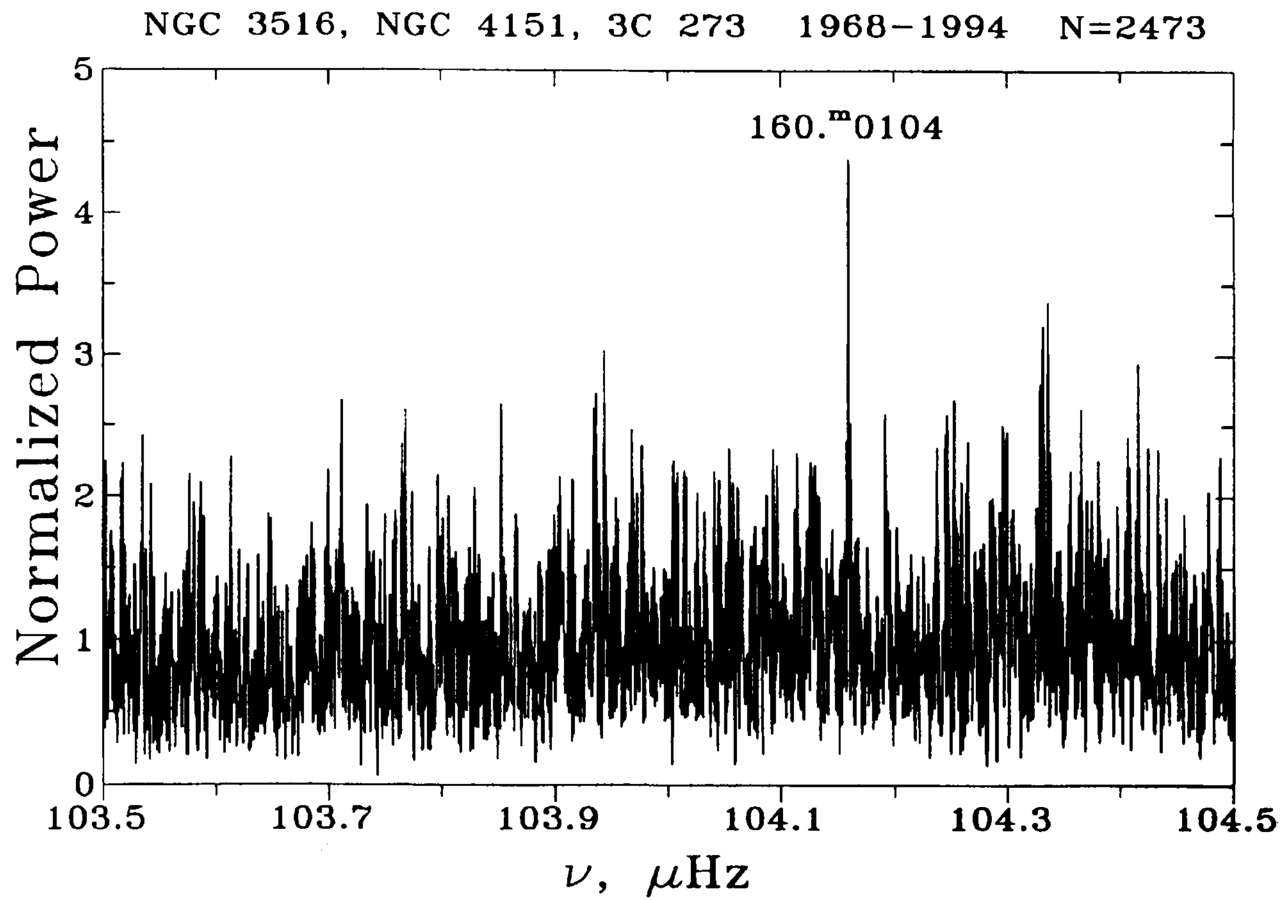

Figure 7 The average PS of three AGNs: NGC 3516, NGC 4151 and 3C 273 (1968–1994 data, total number of residuals $N = 2473$); the power is normalized.

7 INTERPRETATION

Astrophysicists believe that the regular periodicity being discovered in AGNs, would be fatal to many conventional models of AGNs (in particular, for those with a massive black hole as its principal "central engine").

We are convinced that the strong peak $\approx P_0 \approx 160.0101$ min in the AGN PS plotted in Figure 7 is related to some physical mechanism that operates in the two Seyfert nuclei and the quasar, and therefore might throw light on the true nature of AGNs, and must also bear on current cosmological theory.

It seems hard to believe that the observed periodicity results from, e.g., orbital motion of matter in the interior regions of an accretion disc as supposed in some models (see, e.g., Lyuty and Cherepashchuk, 1986) of AGN emission and its rapid variation (with gravitational focusing and Doppler beaming as basic mechanisms for light flux modulation, with superposition of a significant contribution from occultations and other geometric effects, see Fiore *et al.*, 1992). Also the recent model of Rees (1992) cannot explain the long-term periodicity P_0; the fact is that *one and the same period* is observed in various AGNs having different redshifts, and also in the Sun. (Rees (1992) suggested that stars might be captured in tight - perhaps even relativistic - orbits around the AGN central object, a massive black hole, and rotation of these stars could cause periodic fluctuations of the AGN emission with periods as short as ~ 1 hr.)

According to the cosmological hypothesis (Kotov and Lyuty, 1988, 1990; Kotov *et al.*, 1994) the P_0-oscillation represents "true periodic fluctuations of metrics of the Universe".

This "universal" P_0-oscillation poses a serious problem for the standard relativistic Big Bang cosmology. The hypothesis implies, e.g., that

(a) the P_0-period is a fundamental scale for a cosmic (Newtonian) time;

(b) the period P_0 of a cosmic oscillation is invariant (being independent of the motion of the reference frame) like a "universal clock";

(c) the redshift z of the P_0-period itself caused by the "expansion" of the Universe is compensated by an equivalent "deceleration" of time.

The authors of this hypothesis (Kotov and Lyuty, 1988, 1990) suppose that the perfect coincidence of the AGN period with that of the Sun is a natural consequence of a genuine cosmological origin of the P_0-effect. In the context of this supposition, an evolutional increase of the P_0-period fully compensates the Hubble redshift z of the period. Consequently, the conclusion was drawn that the observed P_0-period depends on neiher the redshift of an extragalactic object nor its distance from the Sun. This of course contradicts current cosmological theories based on general relativity and the idea of the Big Bang and thus may present a new astrophysical *paradox*.

One should note that contrary to popular belief, there is as yet no convincing evidence that the standard idea about the beginning of the Universe (hot relativistic Big Bang) is correct; see, e.g., Maddox (1989), Oldershaw (1990). Recently a new severe conflict – the "age conflict" – arose between observations and contemporary theorics of the Universe. Namely, the new observations of the Cepheid cyclic variations performed by the *Hubble Space Telescope* yielded a distance of 17.1 ± 1.8 Mpc to the Virgo cluster galaxy M100. This in turn leads to a high value of the Hubble parameter (the ratio of the recession velocity to the distance for a galaxy), $H_0 = 80 \pm 17$ km s^{-1} Mpc^{-1} (Freedman *et al.*, 1994) implying a very small expansion age of the Universe in the standard Big Bang model,

$$T \sim 2/(3H_0) \approx 8 \text{ Gyr}.$$

This severely contradicts the theoretical estimation of the ages of many globular clusters, $\approx$ 10–18 Gyr, inferred from stellar evolution theory. This result indicates an apparent paradox: the Universe is much yonger than the oldest stars and suggests therefore that the standard cosmological model based on the idea of Big Bang should be revised. (But there may of course be other possibilities: (a) the current theory of stellar and galactic evolution should perhaps be reexamined too and (b) an accelerating force could have existed in the early Universe.)

Our conclusion, on the necessity of a revision and possible rejection of the Big Bang paradigm and standard cosmology, consonant with the views of many other astrophysicists (see, e.g., Maddox, 1989; Arp *et al.*, 1990; Oldershaw, 1990; Hoyle *et al.*, 1993) who believe that, apart from being unacceptable philosophically, the Big Bang model – with the addition, in some theories, of one or even two stages of inflation – gives a too overcomplicated picture of the Universe's beginning and evolution.

It is clearly necessary that many other observations of the rapid (intraday) variability of AGNs should be made and analysed in such a way that it would be possible to get more crucial information on the presence and physical significance of the P_0-oscillation in various kinds of AGNs. Given the history of the "solar", and "universal", P_0-oscillation and its relevance to the standard Big Bang theory, more proof of the existence of the P_0-oscillation in various AGNs seems prudent.

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