A PHOTOMETRIC SYSTEM TO SEARCH FOR OPTICAL VARIABILITY ON TIME-SCALES OF 3×10^{-7} TO 300s: MAIN RESULTS.

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One of the basic astrophysical problems is to search for and investigate brightness fluctuations of celestial objects at times comparable with the mean time between registered photons. With that end in view, a special mathematical formalism has been developed in recent years (Shvartsman, 1977; Pimonov and Terebizh, 1981; Plakhotnichenko, 1980).

At the Special Astrophysical Observatory a photometric system has been produced which allows these ideas to be explored observationally and which also allows the study of light curves of astrophysical objects using classical methods. The system comprises the prime focus photometer of the 6m telescope (Neizvestnyi and Pimonov, 1978), a unit which registers the time of arrival at the telescope of each incoming photon (Pimonov, 1979), a CAMAC crate and an off-line computer (Type SM-4).

The equipment allows the photon arrival times to be determined with an accuracy of 5×10^{-8}s, the dead time being 3×10^{-7}s. The maximum intensity of the incoming photon flux is 2×10^{4} counts/s. All information on the photon arrival times is stored in the computer memory and subsequent mathematical processing allows detection of brightness fluctuations down to 3×10^{-7}s (Plakhotnichenko, 1980) .

Since 1978 we have carried out an observational program with this equipment on the 6m telescope, under the project title MANIA (Multichannel Analysis of Nanosecond Intensity Alteration). For a description of the MANIA experiment see Shvartsman (1977), Shvartsman and Tsarevskii (1977), Mansurov and Shvartsman (1977), Pimonov (1979) and Plakhotnichenko (1980).

The following astrophysical results have been obtained:

1. Sporadic optical variability (using a violet filter) of X-ray source Cyg X-2 has been detected on time scales of 10-100s; variability was absent on scales of 10^{-6}-1s in all of our

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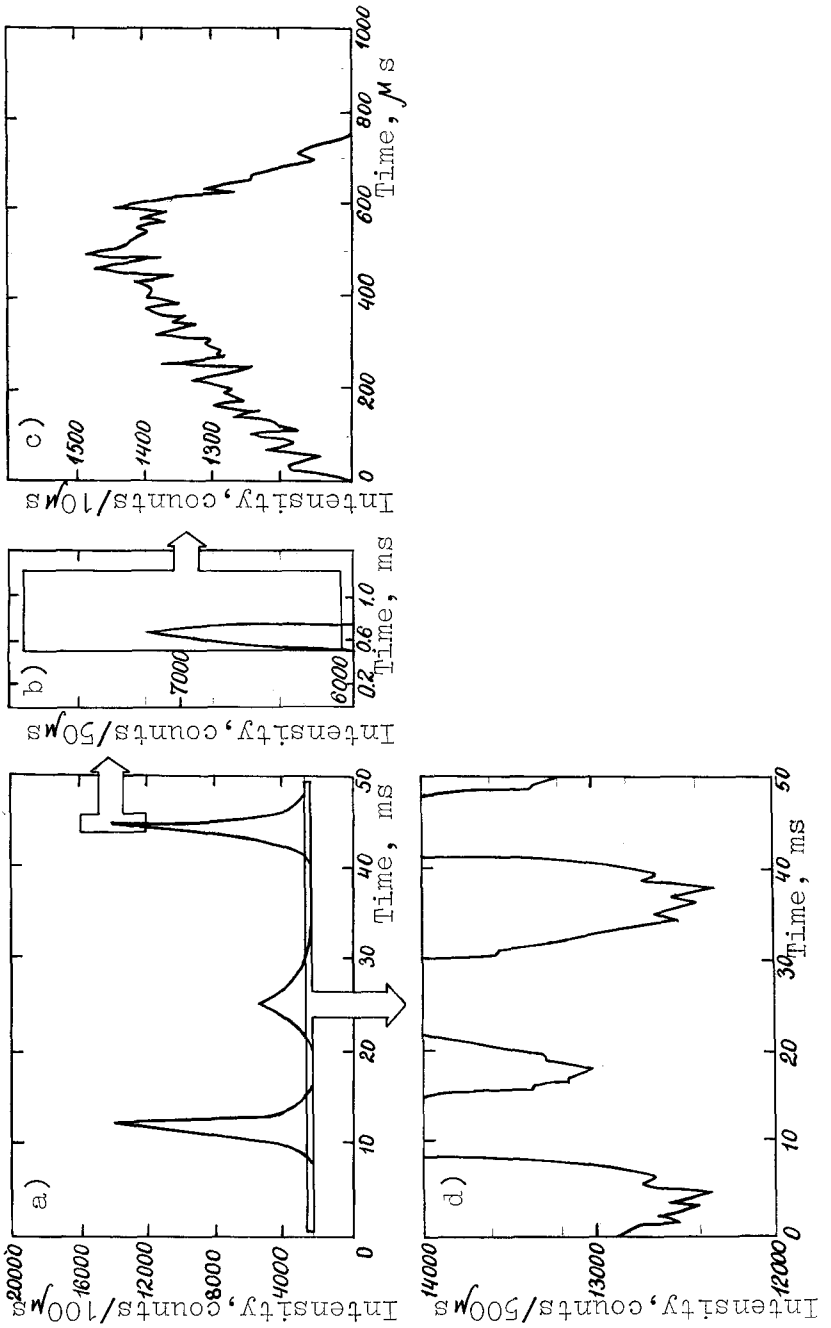

Figure 1. Light curve of pulsar NP 0532 averaged from 18000 periods (accumulation time 10 min, red filter)

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observations (Beskin et al., 1979a). The cutoff in optical variability on a time scale $t_{min} \sim 10\text{-}30$s implies that the size of the region where the X-ray flux is converted into optical radiation is $R \cong 10^{12}$ cm.

2. More than 20 objects which were considered candidates for black holes have been investigated (Beskin et al., 1980). All these objects have purely continuous optical spectra. Among them there are stellar-like radio sources 0G 180, 0E 400, 0I 090.4, OJ-131 at low galactic latitude; the stellar-like radio sources OJ 049, OJ 287, ON 325, OQ 530 varying their brightness during hours and days; and several DC white dwarfs with unusual colours or suspected variability. The analysis of our observational data has shown that the luminosity of these objects is constant on time scales of 10^{-6}-100s. The observed objects are therefore not galactic black holes (Shvartsman, 1971). The results we have obtained suggest that the number of black holes in the solar neighbourhood is considerably lower than that of the stars.

3. The investigation of the peculiar relativistic object SS 433 (rapidly rotating neutron star in a close binary system?) has shown that this object possesses no periodic pulsations nor fluctuations of luminosity on time scales of 3×10^{-7} to 40s (Beskin et al., 1979b; Lebedev and Pimonov, 1981).

4. The observations of supernova stars in the galaxies NGC 4647 and NGC 4321 have put an upper limit of 5×10^{39}erg/s for the optical luminosity of very young pulsars (Beskin et al., 1981).

5. Our observations of the pulsar in the Crab Nebula give some information about the mechanism of its optical emission (see Figures 1a - 1d, 2). No sporadic variations on time-scales of

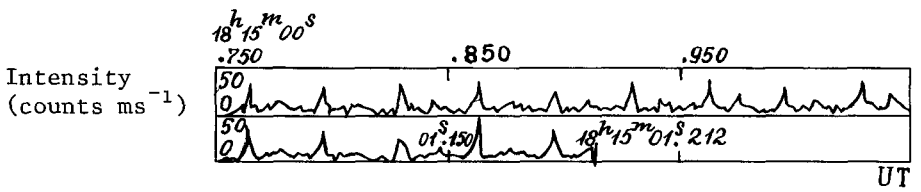

Figure 2. Light curve of NP 0532 in white light with 1ms resolution.

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3×10^{-7}s up to 1 year have been found. The results in Figs. 1 and 2 were obtained from observations with the 6m telescope on 18 February 1980.

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