NUMERICAL COMPUTATIONS ON CORRELATION FUNCTIONS OF ANISOTROPIC HEISENBERG CHAINS WITH INFINITE RADIUS OF INTERACTION

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New numerical data are presented graphically as well as some regularities for the correlation functions in anisotropic Heisenberg spin chains with infinite radius of interaction are deduced from the numerical data.

In the paper [1] we have considered some basic properties of spin chains with the Hamiltonian

$$\mathscr{H} = -J \sum_{n,j=1}^{\infty} \alpha_j (S_n^x S_{n+j}^x + S_n^y S_{n+j}^y + \gamma_j S_n^z S_{n+j}^z) - H \sum_{n=1}^{\infty} S_n^z, \quad S \geqslant \tfrac{1}{2}. \tag{1}$$

By the use of the two-time temperature Green-function formalism [2] we have performed analytical and numerical investigations of the correlation functions $\mathrm{Re}\,\varrho_1(l, t)$ and $\mathrm{Re}\,\varrho_2(l, t)$, where

$$\varrho_1(l, t) \equiv \langle S_{n-l}^-(0) S_n^+(t) \rangle, \qquad \varrho_2(l, t) \equiv \langle S_n^+(t) S_{n-l}^-(0) \rangle. \tag{2}$$

In the present work we give a graphical representation of a part of our further numerical investigations of functions (2) in the case $\alpha_j = p^j$. All the figures illustrate the case $T = \mathrm{Min}\,\varepsilon(k) = 0.01$, where $\varepsilon(k)$ is the energy of the elementary excitation in the system (1).

Using numerical data from this note, from paper [1], as well as from other unpublished results of ours, we mark the following correlations in the cases $\alpha_j = p^j$ and $\alpha_j = p^j/j!$, namely

I. At least $\mathrm{Re}\,\varrho_1(0)$ and $\mathrm{Re}\,\varrho_2(0)$, as well as the first maximum and the frequency of $\mathrm{Re}\,\varrho_2(t)$ increase, when S increases with $p = \mathrm{const}$.

II. When the convergence velocity of the infinite series decreases

— $\mathrm{Re}\,\varrho_1(t)$ and $\mathrm{Re}\varrho_2(0)$ decrease at $l = 1, 2$ but increase at $l = 10$,

— the first maximum and the frequency of $\mathrm{Re}\,\varrho_2(t)$, however, decrease for all $l = 1, 2$ and 10.

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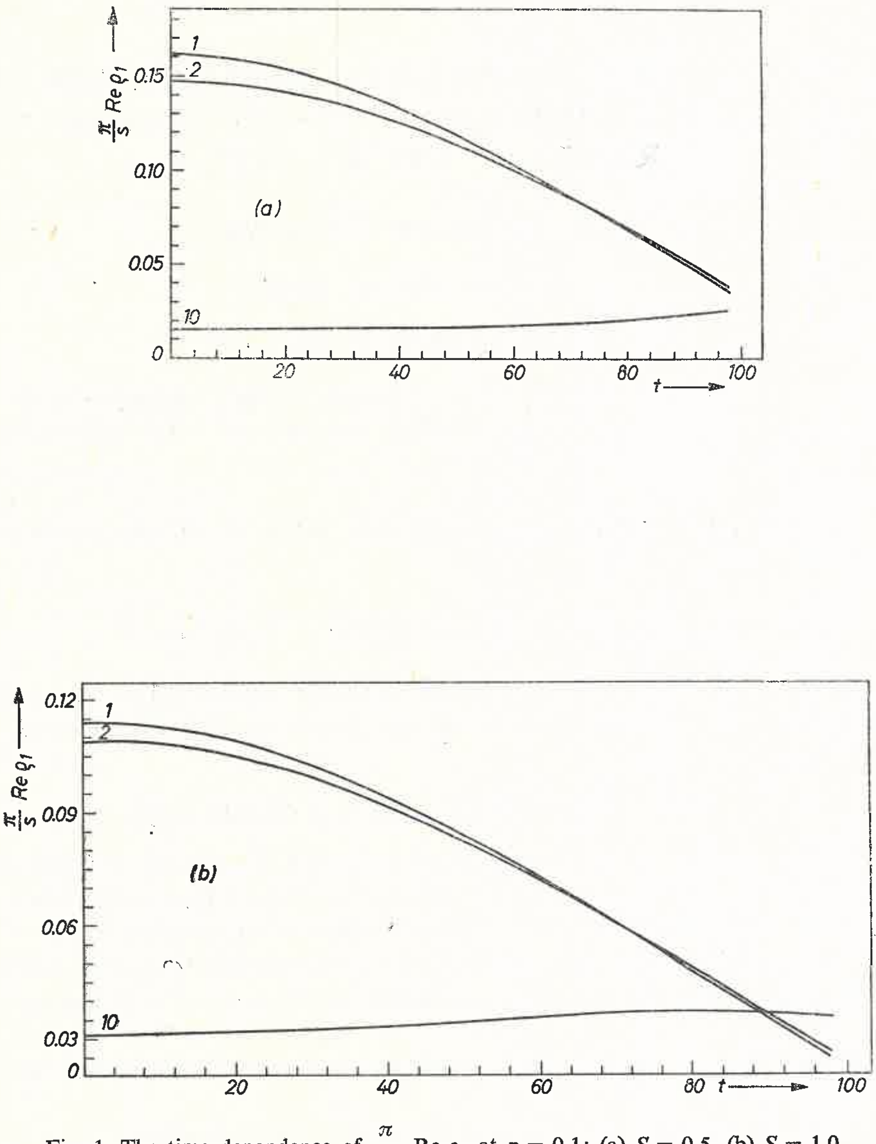


Fig. 1. The time dependence of $\frac{\pi}{S}$ Re ϱ_1 at $p = 0.1$: (a) $S = 0.5$, (b) $S = 1.0$

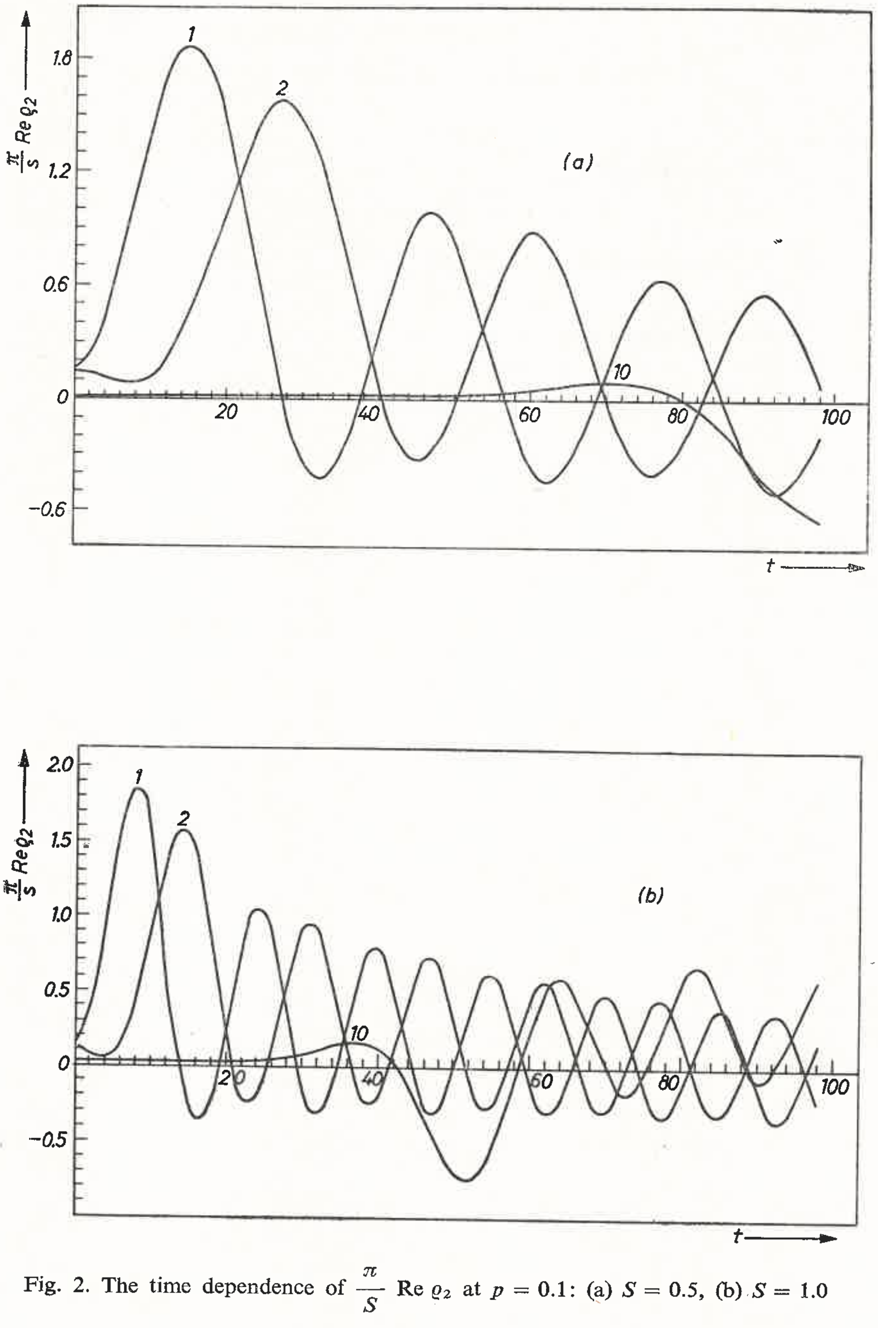
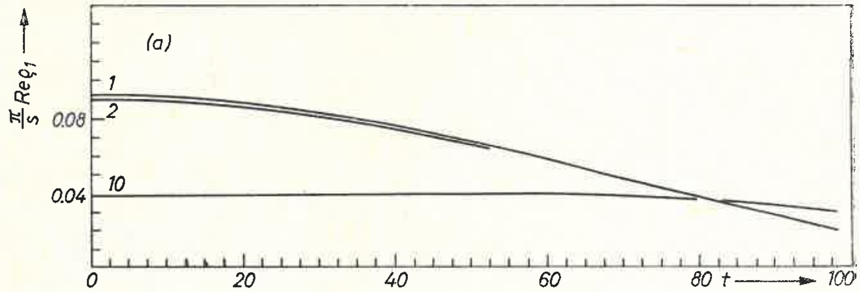


Fig. 2. The time dependence of $\frac{\pi}{S}$ Re ϱ_2 at $p = 0.1$: (a) $S = 0.5$, (b) $S = 1.0$



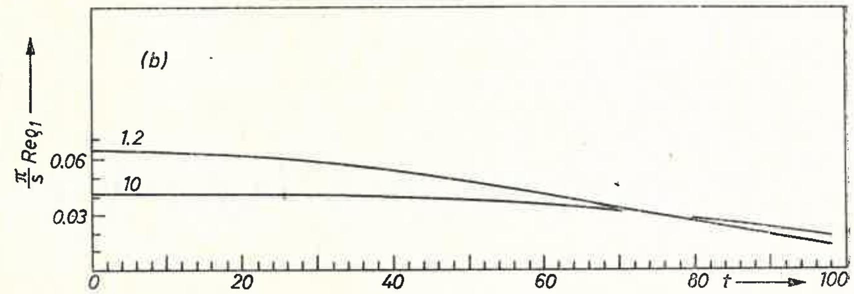


Fig. 3. The time dependence of $\frac{\pi}{S}$ Re ϱ_1 at $p = 0.2$: (a) $S = 0.5$, (b) $S = 1.0$

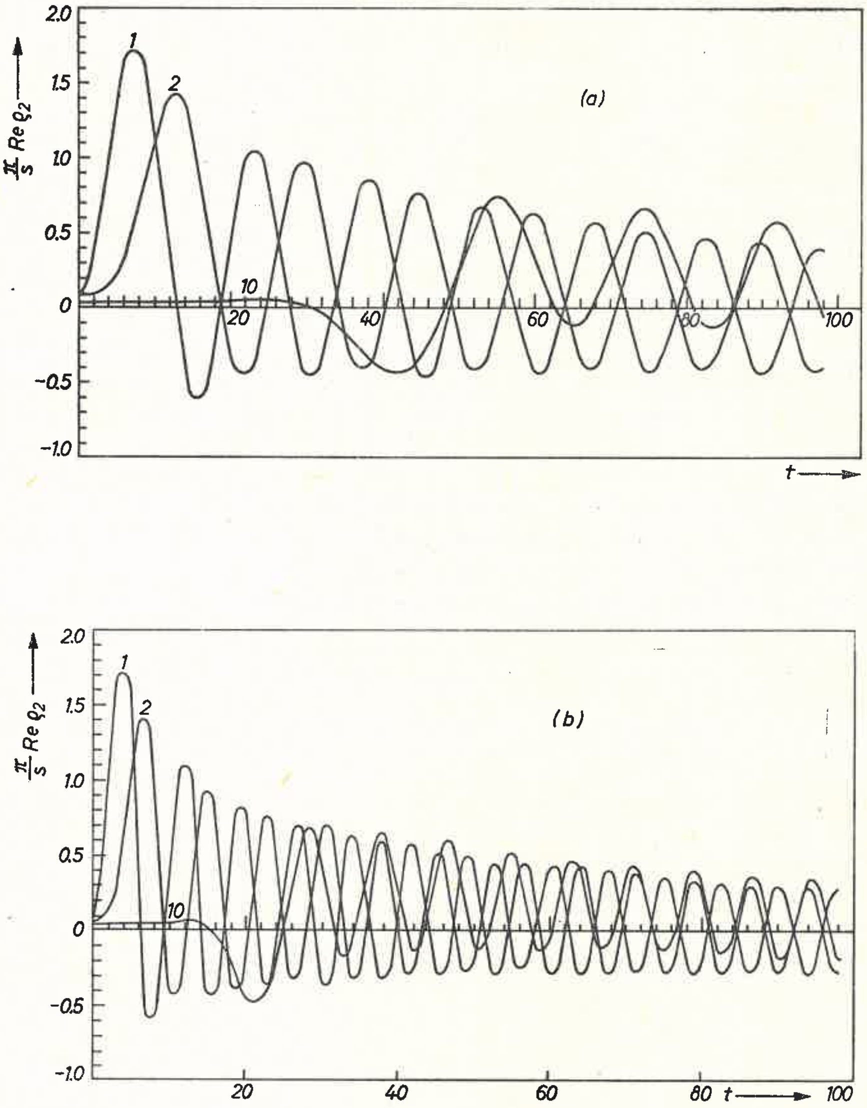


Fig. 4. The time dependence of $\frac{\pi}{S}$ Re ϱ_2 at $p = 0.2$: (a) $S = 0.5$, (b) $S = 1.0$

TABLE I

T	Min $\varepsilon(k)$	2π Re $\varrho_1(0) = 2\pi$ Re $\varrho_2(0)$ ($S = 0.5$)		
		$l = 1$	$l = 2$	$l = 10$
0.01	0.01	0.178	0.159	0.113
0.001	−0.01 −0.011 −0.012	−0.473 −0.423 −0.388	−0.423 −0.385 −0.361	0.140 0.106 0.987
0.002	−0.01 −0.011 −0.012	−0.556 −0.436 −0.347	−0.490 −0.400 −0.338	0.218 0.142 0.121
0.003	−0.01 −0.011 −0.012	−0.648 −0.457 −0.313	−0.567 −0.423 −0.323	0.306 0.189 0.156

In paper [1] we have given the limiting conditions for the accuracy of the method applied in calculating Green's functions. It should be mentioned that the values of the correlation functions (2) are substantially changed at small variations of the magnetic field strength H and the temperature T, especially in the case of Min $\varepsilon(k) < 0$ (Table I).

REFERENCES

[1] G. Georgiev, S. Gocheva, N. Milev, *Acta Phys. Pol.* **A50**, 55 (1976).
[2] S. V. Tyablicov, *Metodi Qvantovoj Teorii Magnetizma*, Nauka, Moskva 1965.