論文の内容の要旨

論文題目　Finite Size Effects on Phase Synchronization
(位相同期現象に対する有限サイズ効果)

氏名　西　川　　功

（本文）We investigate phase synchronization phenomena specific to the systems with large but finite system size, namely the phase synchronization phenomena caused by finite size effects. Resulting from the finite size effects, several rich dynamics, such as (A) nonvanishing fluctuations of an order parameter, and (B) switching phenomena among partial synchronization in some oscillators, can be expected. First, we deal with the problem (A). Here, for the simplicity of theoretical treatment, we mainly investigate this problem in coupled phase oscillators with global coupling. Although almost all the previous studies considered this problem only with special coupling function, sin (x), we reveal a feature that holds in general coupling functions for the first time. In addition, although almost all the previous studies neglected the chaotic fluctuations of the system, we study the problem (A) by using a new quantity defined here, denoted by D, to characterize the nonperiodicity of the system. Here, we always normalize values of quantities for fluctuations by considering N times or $\sqrt{N}$ times of those, where N represents the system size. This is because if the central limit theorem holds, those normalized quantities are scaled by O(1) for any large N. We reveal that D decreases with increase in N and D=0 in the limit of $N \to \infty$ when the system shows synchronization, although it takes a positive value for any large N when the system is not synchronized. Note the singularity of this phenomenon: In usual systems and usual quantities, fluctuations always take a positive value for any large N. However, D asymptotically goes to zero in the limit of $N \to \infty$ when

the system shows synchronization. In addition, the robustness of these results is also discussed. Next, we deal with the problem (B). Problem (B) has already been studied mathematically in coupled identical and non-identical oscillators systems. Both of these studies investigated the effect of higher-order terms in the coupling function. However, they did not focus on the intrinsic feature of each oscillator. Our study investigates the problem (B) by focusing on the fluctuations of both phase variables and chaotic amplitudes in each oscillator. In particular, we reveal an effect of the deterministic amplitude on the phase variables, although almost all the previous works recognized the chaotic amplitude effects as just a noise for phases.