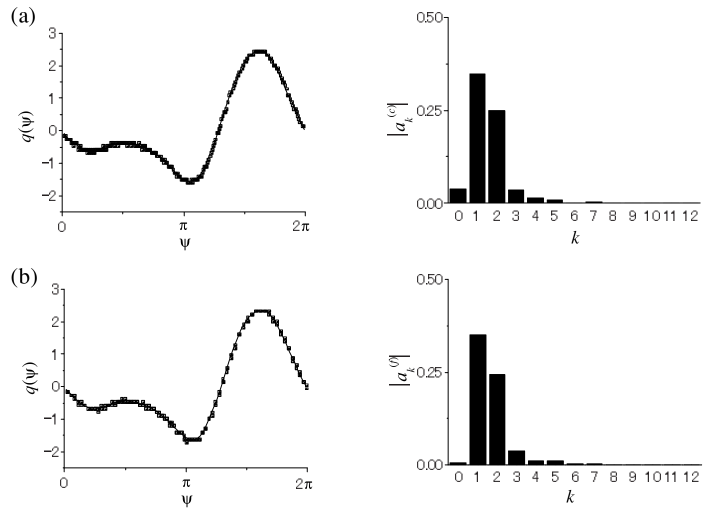

Fig. 2. Functional forms of (a) $q_c(\psi)$ and (b) $q_f(\psi)$ (left graphs). The data are obtained by using the method shown in Miyazaki and Kinoshita (2006a, b) (black dots), and they are fitted by a function $\gamma_0 + \sum_{k=1}^{12}(\beta_k \sin(k\psi) + \gamma_k \cos(k\psi))$ with the fitting parameters of β_k and γ_k (solid lines). In the right graphs, the absolute values of each Fourier coefficient, $|a_k^{(c)}|$ (or $|a_k^{(f)}|$) $= \sqrt{\beta_k^2 + \gamma_k^2}/2$ for $k \geq 1$ and γ_0 for $k = 0$, are shown.

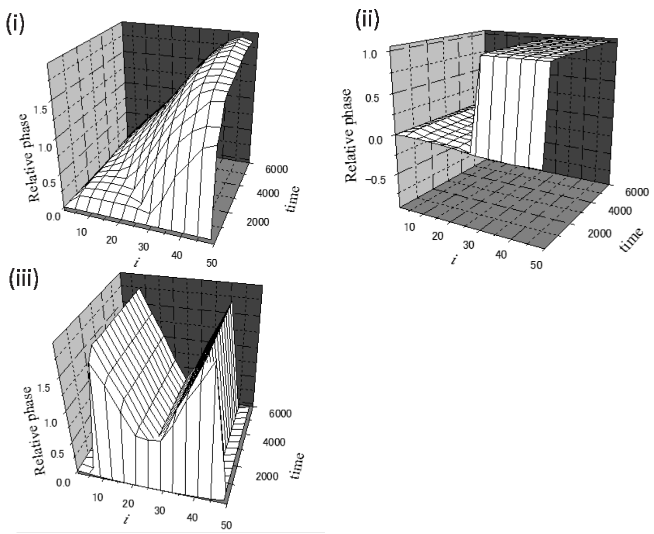

Fig. 3. Temporal evolutions of the phase difference between the ith and first oscillators obtained from the simulation of Eq. (8) when the target state is (i) unidirectional phase-shifted state, (ii) 2-cluster state, and (iii) "v-type" phase-shifted state. $\tilde{q}(\psi)$ and the positions of the nodes are given as shown in Figs. 4 and 5, respectively. The initial condition is set at $\phi_i = 0$ for all i. Since the relative phase is 2π-periodic, it is expressed within the range of (i), (iii) $[-0.05\pi, 1.95\pi]$ and (ii) $[-0.95\pi, 1.05\pi]$.

where

$$\sum_{j=1}^{N} \sigma_j^{(\gamma)} q_f(\phi_i(t) - \phi_j(t - \tau_m)) = \frac{1}{2\pi}\int_0^{2\pi} d\theta \mathbf{Z}(\phi_i(t) + \theta) \cdot \sum_{j=1}^{N} \sigma_j^{(\gamma)} p(\mathbf{x}_0(\phi_j(t - \tau_m) + \theta))\mathbf{r}. \tag{7}$$

The functional form of $q_f(\psi)$ can be derived in a similar manner as that of $q_c(\psi)$ (see details in Kano and Kinoshita (2008)). Let $q_f(\phi_i(t) - \phi_j(t))$ thus derived be expanded to Fourier series as $q_f(\phi_i(t) - \phi_j(t)) = \sum_k a_k^{(f)} \exp[\mathrm{i}k(\phi_i(t) - \phi_j(t))]$, where $a_{-k}^{(f)} = a_k^{(f)*}$ should be satisfied.

Suppose that Eq. (6) is consistent with the following equation:

$$\dot{\phi}_i = \bar{\omega} + \epsilon_d \omega_i + \frac{1}{N}\sum_{j=1}^{N} \epsilon_{ij} q_c(\phi_i(t) - \phi_j(t)) + \frac{1}{N}\sum_{\beta,\gamma} \epsilon'_{\beta\gamma} \rho_i^{(\beta)} \sum_{j=1}^{N} \sigma_j^{(\gamma)} \tilde{q}(\phi_i(t) - \phi_j(t)), \tag{8}$$

where $\tilde{q}(\psi)$ is the target coupling function. Note that the definition of this function is slightly different from that in our previous study (Kano and Kinoshita, 2008), where the natural coupling term is included into it (see equation (6) in Kano and Kinoshita (2008)). The functional form of $\tilde{q}(\psi)$ and the parameters related to the positions of the nodes, $\epsilon'_{\beta\gamma}$, $\rho_i^{(\beta)}$, and $\sigma_j^{(\gamma)}$, are explored through the simulation of