Plan of my research

Hironobu Kihara

I have interest in fundamental process of nature. The charm of investigations on the unification of all interactions attract me. Superstring theory and M-theory drive me to think how our nature is constructed. I have interest in the existence of extra dimensions very much.

I would like to investigate the possibility of embedding our four dimensional spacetime in higher dimensional physics and to make sure that the gravity effects are included in reduced matrix models. To confirm that idea, I would like to calculate the non-Abelian Berry phases with the fluctuation of the bosonic matrices from the background.

In our previous paper finite energy solitons in higher dimensional gauge theory are described in a quartic Yang-Mills theory. The quadratic term may vanish in an expansion of more fundamental theory in some background. I would like to make this argument clear. The Hamiltonian of the quartic Yang-Mills theory is positive semi-definite so we can consider that the energy is bound by topological charges. This discussion is based on the classical gauge theory. If one think the quantum effects of the model, difficulty of anomaly and non-renormalizability appear. SO(5) gauge theories with chiral fermions in six dimension are anomalous because seventh homotopy group of SO(5) is integer group, so non-Abelian chiral anomaly exists in general. One way to resolve these problem is that we derive the action from string theory or M-theory as a low energy effective action.

Further interest is to establish a duality between our soliton and octonionic instanton in eight dimension. Dualities between gauge theories in higher dimensions are discussed in some of the papers on generalization of instanton, monopole or sphaleron. I would like to show that the action of the quartic Yang-Mills is dual to an quadratic Yang-Mills theory in six dimensional spacetime. In this argument K-theory and Clifford algebra are crucial mathematical tools in treating topological effects like Ramond-Ramond charges in string theory or index theorem of gauge theories. Solutions which have topological charges greater than one are more complicated and interesting objects.

I am interested in solutions of four dimensional non-linear σ models with topological charges taking values in fourth homotopy group of target space. It is related to N=2 supergravity theories which contain scalar fields treated as coordinates of quaternionic spaces. There are few examples of quaternionic spaces which are mainly studied by Wolf. I would like to find topological solutions in the non-linear σ models on those spaces.