

## Results on research activity

I engaged mainly in studying knot theory and low dimensional manifolds of topology. In particular, I studied Alexander polynomial, topological imitation theory and surfaces in the 4-dimensional space, etc. Among earlier works, there is a solution of the non-invertibility problem on the knot  $8_{17}$  proposed by R. H. Fox, which has been the unsolved problem for 50 years. This result was done in the study of Alexander polynomial during the 2 academic year stay at the Institute for Advanced Study, Princeton. In recent years, I started a study of a model in psychology using a knot and a study of a spatial graph to apply to string-shaped materials, called soft matters (Macromolecule, DNA, etc.) as applications of knot theory and topology. As a result, the game "Region Select" applying knot theory (developed with colleagues) was shown at the world same time in the Android market. In 1983, I started a joint seminar "KOOK seminar" organized by the knot theorists of 4 universities in Kansai, Kobe University, Osaka University, Osaka City University, Kansei Gakuin University. This became a driving force of the development of the knot theory study in Kansai and later in Japan. In particular, "Knot Theory" (Springer Verlag Tokyo, 1990) was published in Japanese as the first book of the whole knot theory in Japan under co-operations with KOOK Seminar members. Later, the English version "A Survey of Knot Theory" (Birkhäuser, 1996) was published abroad and gave knot theorists in the world an impact. KOOK Seminar develops into "N-KOOK Seminar" joining Nara Women's University, which plays a central role of studying knot theory in Japan afterwards. From April 2003 to March 2008 I was a program leader of the 21<sup>st</sup> COE program "Constitution of wide-angle mathematical basis focused on knots". With this, I made an effort to establish Osaka City University Advanced Mathematical Institute (OCAMI). In the research area of education, I made an effort for introducing knot theory to school students and played a leading role in a study group of Osaka Kyoiku University. The result was settled as the text book "Teaching and learning of knot theory in school mathematics", the first book of English mathematics education. In the academic year 2014, I could publish a paper on the topological splitting problem of a certain definite 4-manifold with infinite cyclic fundamental group by developing the precedent year's splitting result, which is sufficient to confirm that every closed *smooth* 4-manifold with infinite cyclic fundamental group is always topologically split. The smooth unknotting conjecture for a ribbon surface-knot could be also confirmed by further combining a 2014 study "A chord diagram of ribbon surface-link", whose paper is submitted to a monograph. The paper "The Alexander polynomials of immersed concordant links" was published and the paper "Knot theory for spatial graphs attached to a surface" was accepted for publication. A Japanese monograph "Theory of Knots" was completed to publish until the next summer. A verification of an active effect of brain on an elderly version of the game "Region Select" applying knot theory was started.