AWARD OF MEDALS

The Eighty-fifth Annual Award of Medals was held on Monday, June 12, 1995, at 10:30 a.m., in the presence of Their Majesties the Emperor and Empress.

The function was opened with an address by the President, in which he made a brief statement of each award.

The Medals and Prizes were presented to the following recipients.

Imperial Prizes and Japan Academy Prizes to:

Toru MINEYA
  for *Ancient Chinese and Sino-Vietnamese*
Yoshio FUKAO
  for "Seismological Study on Mantle Dynamics"

Japan Academy Prizes to:

Akira HAYAMI
  for *Population, Economy and Society in Early Modern Japan: A Study of the Nobi Region*
Hiroshi SUGA
  for "Phase Transitions and Relaxation Processes in Condensed Phases"
Daiichiro SUGIMOTO and Ken'ichi NOMOTO
  for "Theory of Stellar Evolution and Supernovae"
Ryoji NOYORI
  for "Study on Asymmetric Synthesis"
Tomoya OGAWA
  for "Synthetic Studies on Cell Surface Glycoconjugates and Related Glycans"
Shun-ichi YAMADA and Kenji KOGA
  for "Novel Synthetic Methods of Optically Active Compounds Based on the Transcription of the Chirality of L-Amino Acids"
Shun-ichi AMARI
  for "Study of Fundamental Theories for Neural Information Processing"

After this, congratulatory addresses were given by the Prime Minister and the Minister of Education, Science and Culture.
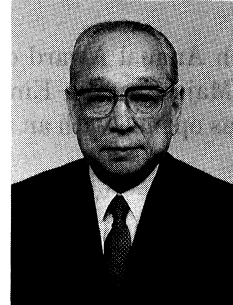
The function was closed at noon.

Imperial Prize and Japan Academy Prize to:

Toru MINEYA
Emeritus Professor,
University of Tokyo

for *Ancient Chinese and Sino-Vietnamese*

Outline of the Work:

Professor Mineya, the author of the work, is a distinguished linguist in the study of the Vietnamese language in present day Japan. The work is the result of his incessant research concerning the history of Sino-Vietnamese which is based upon his solid knowledge of Ancient Chinese.

The work is divided into two parts. The first part dealing with Ancient Chinese will be taken up later. The second part is dedicated to the study of Sino-Vietnamese, which realizes the main objective of his work. In the second part, he tried to clarify the phonetic history of Sino-Vietnamese. As in the case of Japanese and Korean, the early phase of the phonetic history of Vietnamese can be made clear by means of the readings of Chinese characters imported en bloc into Vietnam, i.e. Sino-Vietnamese. As to the Chinese phonology, the Western scholars, such as B. Karlgren and H. Maspero, already have introduced modern linguistic methods, so that the phonetic history of Chinese can be studied scientifically.

Based upon the Vietnamese (formerly called Annamese) sources, such as P.A. Rhodes' "Dictionarium Annamiticum Lusitanum et Latinum" (1651), the bilingual vocabulary of Hwa-yi-yi-yu (An-nam-yi-yu) and the Chu-nam characters (Chinese characters modified by Vietnamese), the author tried to compare the phonetic system of Sino-Vietnamese with that of Ancient Chinese. Having criticized the reconstruction of Ancient Chinese by the preceding scholars including Karlgren and Maspero, Professor Mineya has successfully established his own new reconstructions, which exemplifies his keen insights. From his comparison he has made clear that the system of the principal stratum of Sino-Vietnamese coincides well with the system of the Ch'ang-an dialect of T'ang Chinese, reflected in the fan-ch'ieh spellings of Hui-lin's "The Glosses to the Tripiṭaka", just like the Kan-on of Sino-Japanese as well as the dominant layer of Sino-Korean. Then he started to describe the development of Sino-Vietnamese and at the same time the phonetic history of the Vietnamese language itself.

In the first part of the work, numerous problems concerning Ancient Chinese are discussed. Especially the rime table Yun-ching of the Sung period is taken into consideration and the author's interpretation of the table surpasses the opinions of other scholars.

Imperial Prize and Japan Academy Prize to:

Yoshio FUKAO
Professor and Director,
Earthquake Research Institute,
University of Tokyo

for "Seismological Study on Mantle
Dynamics"

Outline of the Work:

The first-order information about the Earth's interior comes from observing and analyzing seismic waves propagating through it. Huge amount of seismic data can now be processed simultaneously with the aid of high-speed computer, using a technique of "seismic tomography". This technique has enabled us to explore the lateral heterogeneity of the Earth, a small perturbation from the spherically symmetric structure of our planet. In particular, the seismic tomography for the whole mantle has opened a new window in discussing the global dynamics of the mantle. Professor Yoshio Fukao, a world's famous seismologist from Japan, has made a great contribution to the development in this area.

A group led by Prof. Fukao developed a new method of analyzing the Earth's free oscillation to find a lateral distribution of seismic dissipation in the mantle transition zone, where they suggested intrusion of mantle upwelling from below. They further analyzed a set of free oscillation modes sensitive to the core-mantle boundary to obtain a structural model of the lowermost mantle, from which they suggested that the mantle upwelling has its origin near the thermal boundary layer at the bottom of the mantle.

Prof. Fukao and his colleagues were the first who did a whole mantle tomography of P wave velocity from worldwide data of first arrival times. They then introduced a technique of variable-scale parametrization into their whole mantle tomography to resolve the fine structure under the western Pacific. The better resolved image led them to propose an idea of "stagnant slab", a descending slab of lithospheric plate now being stagnant near the boundary between the upper and lower mantle. This new idea has been shown to be remarkably consistent with the recent high-pressure, high-temperature experiments on phase transition of mantle minerals and with the recent extensive computer simulations of mantle convection incorporated with such experimental data. "Stagnant slab" is now one of the basic concepts to understand mantle dynamics.

Prof. Fukao and others pointed out in their tomographic image the presence of high velocity anomaly at the bottom of the mantle under the region of stagnant slabs. This suggests that stagnant slabs eventually fall through the lower mantle to be piled up on the core-mantle boundary. This suggestion has been supported from the recent numerical simulations of mantle convection, in which the effects of phase transition are taken into account. Fall of stagnant slabs implies that mantle downwelling is far more intense and localized in time and space than previously thought. Prof. Fukao and others named this intense and localized current "cold plume" to emphasize its role in mantle dynamics. All these ideas, among others, were synthesized into "plume tectonics" by Prof. Maruyama as a working hypothesis towards the new view of the Earth after "plate tectonics".

Prof. Fukao made also a great contribution in the area of slab dynamics (dynamics on subducting slab of lithospheric plate). Plate subduction occurs at deep-sea trenches, where unusual earthquakes such as tsunami earthquakes and low-frequency earthquakes take place. By analyzing these earthquakes Prof. Fukao pointed out for the first time that their unusual characteristics are closely related to thick sediments near deep-sea trenches. He and his colleagues identified seismic waves trapped within a thin layer at the top of the subducted plate to show that the oceanic crust remains basaltic, upon subduction, down to a depth of 60 km without transforming eclogite. Seismic waves of this kind have now been found in many places along subduction zones to support the original idea of Prof. Fukao and his colleagues. Earthquakes occurring in a subducted slab at greater depths are called deep shocks. Prof. Fukao analyzed large deep shocks to show that they occur in a form of shear fault just as in the case of shallow earthquakes. This study has long been held up as a model study of deep shocks.

Prof. Fukao is a seismologist, but more fundamentally he is one of the best solid-earth scientists not remaining within the framework of seismology. In fact, his research extends over a wide area of solid-earth sciences, just for example, an experimental study of radiative heat transfer within the Earth's interior, gravity measurements in Japan Alps and the Andes to propose a mechanism of mountain uplifting, a series of studies on spherical shell tectonics, theoretical feasibility study for exploring radioactive elements in the Earth's interior using antineutrinos, experimental study to improve the ESR dating method for age measurement of fossil shells, tree-ring study of petrified woods for resolving volcanic activity of geologic age, theoretical and numerical study of two-immiscible phase convection with its application to core dynamics, and measurements of electric resistivity change upon fracturing of rocks to discuss its relevance to earthquake precursary phenomena. It should lastly be pointed out that many young scientists have grown up through these unique studies.

Japan Academy Prize to:

Akira HAYAMI
Professor, Reitaku University;
Emeritus Professor, Keio University;
Emeritus Professor, International
Research Center for Japanese Studies

for *Population, Economy and Society
in Early Modern Japan: A Study of
the Nobi Region*
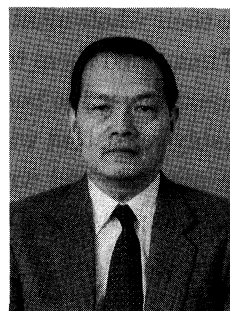
Outline of the Work:

In the first two chapters of Part 1, the author, Professor Hayami, has utilized quantitative surveys on population, land, agriculture and livestock conducted in every village at the end of the 17th century, by the local lord of Owari (Nagoya), along with those conducted on the same scale and in the same area by his vassal at the beginning of the 19th century. These surveys covered the whole domain of the Owari

territorial lord, which consisted of over 700 villages in the Owari Province and some 200 scattered villages throughout Mino Province.

During these two time periods, the population increased by about 30% overall, but the increase was much more significant in Mino. By dotting the changes by village on the map, the author discovered that the highest increase can be seen on the periphery of Owari and in the plain area of Mino. One of the most striking features of the comparison of these data is the decline of livestock. In spite of population growth and expansion of arable land, the livestock/population ratio decreased drastically from 1/20 to 1/50. Particularly in the rice-producing area, the ratio became 1/100. In the early 19th century, the agriculture of this area thus was driven not by livestock but by human power. In other words, agriculture obviously became labor intensive. What was definitively important is that this kind of hard labor was not seen as exploitation of the people but was accepted as a work ethic which was regarded as a virtue. We can call this phenomenom the "industrious revolution."

Chapter 3 deals with the changing rural population of the Mino Province through the use of several different kinds of sources. The population seems to increase in the 17th century, stagnate in the 18th century and grow again in the 19th century.

In Part 2, the author has utilized micro data, shumon-aratame-cho, of the Mino Province in the 18th and early 19th centuries, to examine marriage, fertility, and migration. The family reconstitution analysis is carried out for 4600 couples, and the indices on marriage and fertility are calculated. The age at first marrige, 28.0 for males and 20.5 for females, is higher than any other region ever examined.

In Part 3, the data of three villages, Kando-Shinden, Owari, a coastal village where new land reclamation techniques were advanced; Iinuma, Mino, a mountainous village where the availability of resources was very limited; and Nishijo, Mino, a village located in the Nobi Plain, from where the residents were able to gain access to other communities without trouble. Consequently, in Kando-Shinden, the population grew very quickly, almost 2.5 times between 1778 and 1871. The crude birth rate was as high as 32.6 per thousand and the total marital fertility rate was 6.3. In Iinuma, the populations stagnated with some ups and downs, but the crude birth rate did not exceed the death rate. It is very likely that population limitation was carried out. Nishijo has one of the best population records in Tokugawa Japan and the author has applied life history analysis to the 2000 inhabitants recorded on the data between 1773 and 1869. The residential population stagnated, however, with the result that the number of births was much larger than that for deaths. Consequently, there must have been a great deal of out-migration. In fact, about 50 per cent of males who reached the age of 11 experienced working outside of the village at least once; and about a half of them did not come back to the rural area. This percentage becomes much higher in the case of females, that is, it reached 62 per cent. Around two thirds of this kind of out-migration for work outside of the village was directed to the urban area, and most of those who migrated came from the lowest class.

In Chapter 11 of Part 4, the succession and inheritance of Nishijo inhabitants is examined. In the upper class, since the age at marriage in both sexes was relatively lower, the number of children born in this class resulted in an excess. The upper classes thus established a branch family in a lower class. In the lowest class, because of a large proportion of out-migration, the age at marriage was much later than that found in the higher class and sometimes there were no heirs to succeed when the household head died. Therefore the family became extinct. Thus the geographical mobility and inter-class mobility were combined and functioned as a population balancing mechanism. This is the reason for the regional stagnation of population, even when high economic development and urbanization was achieved in the Tokugawa period. At the same time, the rural areas were able to escape population pressure in spite of high fertility.

Japan Academy Prize to:

Hiroshi SUGA
Professor, Research Institute
for Science and Technology,
Kinki University;
Emeritus Professor, Osaka University

for "Phase Transitions and Relaxation
Processes in Condensed Phases"

Outline of the Work:

Study of phase transitions and relaxation phenomena in condensed phases is undoubtedly one of the current important topics in physical chemistry since these processes disclose the nature of the interactions between the constituents (ions or molecules) of a system. Professor Suga has developed various types of adiabatic calorimeters since 1965 in order to detect these processes and to clarify their energetic as well as entropic aspects for a wide variety of pure substances such as molecular crystals, ionic crystals and metal complexes. He and his collaborators have identified different types of phase transitions in these compounds and discussed the possible mechanisms in terms of the associated entropy changes through the Boltzmann equation. One of the unique results is the discovery of the freezing process in highly disordered systems such as mesophases that have an intermediate nature of disorder between ordered crystals and disordered liquids. Freezing occurs because of the prolonged relaxation times for the motion of the constituents on lowering the temperature. Thermodynamic behaviour associated with this freezing was essentially the same as that observed for a liquid below its glass transition temperature. Thus the glass transition turned out to be of wide occurrence in condensed phases irrespective of the periodicity of the centre-of-mass of the constituents. This observation required a new assessment of glass transition which had long been regarded as a characteristic property of liquids.

Prof. Suga also succeeded in characterizing non-crystalline solids prepared in many ways other than conventional quenching from liquid state. The adiabatic calorimeters have been greatly improved and can now be used as ultra-low frequency spectrometers suitable for the study of slow dynamics of the constituents of a system. Dielectric and nuclear magnetic resonance spectrometers with different time windows were used complementarily. Comparison of the relaxation rates between traditional and exotic non-crystalline solids was made to quantify successfully the energetic hierarchy of various states of non-crystallinity. Realization of non-crystalline solids of simple systems such as water, methanol, and propane is of particular importance.

These studies on transition phenomena in condensed phases have culminated in the discovery of the proton-ordered ice. Since the experimental observation of residual entropy in ordinary ice Ih by Giauque and Stout in 1936, heated discussions have continued concerning the origin of the relevant disorder and particularly the reason for the absence of any ordering transitions that should remove the associated entropy. Prof. Suga and his collaborators have found a weak glass transition in ordinary ice at around 100 K and ascribed it to the freezing out of reorientational motion of water molecules on cooling before the crystal reaches a hypothetical ordering transition. They tried to accelerate the mobility of molecules by introducing

a particular defect in the lattice. Lastly, a phase transition was induced at 72 K for a sample doped with a minute amount of alkali hydroxide. The structure of the ordered phase of ice Ih was determined by neutron diffraction and designated as ice XI. The phase diagram of water provided a space for accommodating this new orthorhombic modification of ice which obeys the third law of thermodynamics.

Thus the development of highly sophisticated calorimeters that sensitively differentiate stable equilibrium, metastable equilibrium, and nonequilibrium states have led to the opening of new realm of interplay between phase transitions and glass transitions in condensed phases. For his outstanding achievements, Prof. Suga has received the Physico-chemical Division Award of the Chemical Society of Japan, the Huffman Award of the US Calorimetry Conference, and the Kurnakov Medal of the Russian Academy of Sciences. His international reputation is evidenced by many invited lecturers delivered at Universities, Institutes, and Conferences in various countries. To conclude, Prof. Suga has made many original and important contributions to the development of physical chemistry worthy of the highest recognition.

Japan Academy Prize to:

Daiichiro SUGIMOTO   and   Ken'ichi NOMOTO
Professor, College of   Professor, Graduate
Arts and Sciences,   School of Science,
University of Tokyo   University of Tokyo
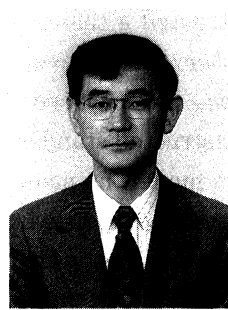
for "Theory of Stellar Evolution and Supernovae"

Outline of the Work:

At the center of the present Sun, nuclear fusion of hydrogen to helium (H-burning) is going on. In the future, all the hydrogen of the central region will be converted into helium and, further, He-burning begins at the center to lead to the formation of a C·O-core. Since 1960 it has been considered that, in the case of masssive stars, further C-burning begins to form an O·Ne·Mg-core and, succeedingly, a Si-core and an Fe-core are formed at the center. At the last stages of such evolution, the stars are expected to explode as supernovae being a billion times brighter than the Sun. Before 1970, however, it was very difficult to calculate the evolution to the last stages for the stars which have very complicated structures.

In 1970, Dr. Sugimoto first discovered that the main difficulty lies in the great difference of the time scale of heat flow between the stellar center and the surface, and he invented a very powerful method of

computation. In the next year, Dr. Sugimoto began the study of stellar evolution with Dr. Nomoto who was then a graduate student. This collaboration continued for about ten years and produced many successful resultes, as described below.

First, Drs. Sugimoto and Nomoto generalized their computation method to include the explosions and the nuclear reaction rates so as to be able to compute the evolution until the stage of supernova explosion. Next, they introduced a new system of coordinates to describe the regions where chemical compositions are rapidly changing. As a result, they could avoid a computational instability and also could treat the evolution in a case where mass is accreting onto the stellar surface.

Using the above computation method, they clarified many features of stellar evolution. The first is the theory of so-called type I supernovae due to the runaway of C-burning in the C·O-core. They found that the runaway is a defragration process instead of a detonation. The second outcome is the discovery of a type of supernovae which is triggered by the electron capture of Mg at stages when the O·Ne·Mg-core has been formed. They found that such an explosion occurs for stars with mass between 8 and 12 solar masses. Further, Dr. Sugimoto discovered that, when mass is accreting onto the surfaces of white dwarf stars and neutron stars, unstable He-burning and its repetition occur and this accounts for the phenomena of novae and X-ray bursts. Such mass accretion is possible if the star is a member of a close binary system and mass exchange occurs between the two members. Dr. Sugimoto also made clear the evolution of the two stars in the close binary SV Centauri.

The collaborative study of Drs. Sugimoto and Nomoto was almost finished in 1980 and afterwards they developed their own researches. Dr. Sugimoto constructed a general thermodynamical theory of evolution of self-gravitational systems and applied the theory to a globular cluster to clarify the features of its evolution. On the other hand, Dr. Nomoto continued the computation of stellar evolution until the formation of the Fe-core and constructed a theory which explains all the supernovae observed. Especially, after a supernova 1987A was observed, he developed greatly the theory of supernova explosion by comparing the theory with observations, as described below.

Dr. Nomoto first constructed standard models of stellar structure at stages just before the supernova explosion and using these models he made clear the process of nuclear synthesis in stellar interiors. When the supernova 1987A appeared in the Large Magellanic cloud, he computed its explosion processes in details. By comparing his results with the observations of visible lights, infra-red rays, X-rays and gamma-rays, he discovered that, in the course of explosion, chemical elements are well mixed throughout the interior and that the main energy source of the luminosity is the decay of ^{56}Ni, produced in the deep interior and transported to the surface by mixing, to ^{56}Fe with a half-life of 77 days. Further, taking into account the possibility of mass exchange in binary systems, he constructed a general theory of supernova which explains all the types of supernovae so far observed.

Japan Academy Prize to:

Ryoji NOYORI
Professor,
Faculty of Science,
Nagoya University

for "Study on Asymmetric Synthesis"

Outline of the Work:

Dr. Ryoji Noyori has many outstanding accomplishments in modern organic and organometallic chemistry. In particular, applications of his original and versatile asymmetric syntheses based on chiral molecular catalysts have allowed him and other scientists to realize truly efficient synthesis of chiral organic molecules of theoretical and practical importance.

Dr. Noyori devised a number of transition metal catalysts containing a new atropisomeric chiral diphosphine, BINAP, providing a major breakthrough in asymmetric organic synthesis. His discovery of BINAP-Ru (II) complex catalysts led to the stereoselective hydrogenation of a wide range of olefinic and ketonic substrates. The scope of this method is far reaching. Both antipodal products can be synthesized efficiently with equal ease by choosing the handedness of the catalysts. This transition metal catalysis is clean, operationally simple, economical, and hence is capable of conducting the reaction on any scale with a very high substrate concentration in organic solvents. A variety of terpenes, vitamins, β-lactam antibiotics, α- and β-amino acids, alkaloids, prostaglandins, and other compounds of biological interest are accessible using this homogeneous asymmetric hydrogenation. The Ru catalyzed asymmetric hydrogenation of a functionalized ketone has been applied to the large-scale production of the synthetic intermediates of antibiotic carbapenem and antibacterial levofloxacin. BINAP-Rh (I) complexes catalyze highly enantioselective isomerization of allylic amines to enamines of high enantiomeric purity. The reaction of geranyldiethylamine is currently playing a key role in industrial production of ($-$)-menthol and other optically active terpenes.

Dr. Noyori succeeded in achieving the first highly enantioselective addition of dialkylzincs to aldehydes using a catalytic quantity of a chiral amino alcohol, where the alkylation products possessing high enantiomeric excesses are accessible with the partially resolved chiral ancillary. The mechanism of this striking chirality amplification was elucidated at the molecular structure level. In addition, chiral binaphthol-modified lithium aluminum hydride reducing agents, elaborated by Dr. Noyori, exhibit extremely high enantioselection in the reduction of a wide variety of prochiral carbonyl compounds. The reagent is remarkably effective in generating the 15S configuration of the prostaglandin series, greatly facilitating its current industrial synthesis.

Dr. Noyori's scientific accomplishment, comprising over 300 articles, has exerted paramount influence on the advancement of organic chemistry. The efficiency of asymmetric catalysts discovered by Dr. Noyori rivals or in certain cases even exceeds that of natural enzymes. His synthetic methods are not only useful for laboratory synthesis of optically active compounds, but also powerful on industrial levels in the fields of

pharmaceuticals, agrochemicals, flavors, and fragrances. Technical refinements of his original chemistry have resulted in the practical synthesis of both natural and unnatural chiral substances.

Japan Academy Prize to:

Tomoya OGAWA
Professor,
Faculty of Agriculture,
University of Tokyo;
Chief Scientist, RIKEN
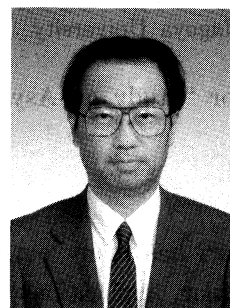
for "Synthetic Studies on Cell Surface Glycoconjugates and Related Glycans"

Outline of the Work:

Glycan chains of glycoconjugates on cell surface are oriented towards extracellular space and play important biological roles in cell-cell and cell-molecule interactions. In order to elucidate the biological functions of these glycan chains at molecular level, Dr. Ogawa developed novel methods and strategies which eventually established versatile synthetic routes to important classes of complex glycans. His achievements may be classified into two parts.

1) Exploitation of new methods and strategies

Highly regioselective and efficient acylation as well as alkylation were disclosed in 1976 by employing Tin (IV) mediated enhancement of the nucleophilicity of hydroxyl groups. Based on this disclosure, synthetic strategies for the regioselective extension of glycan chains at the branching points of complex glycans were eventually developed around 1984.

In addition, new methods for the activation of thioglycosides were developed by use of thiophilic reagents to give O-glycosides in a highly stereocontrolled manner.

In the case of alcohols with low reactivity such as ceramide derivatives, major side reactions ended up with the formation of orthoesters instead of 1, 2-trans glycosides. To amend this undesired outcome, either pivaloyl or trimethybenzoyl group was introduced as an O-2a auxiliary in the glycosyl donor which improved the coupling efficiency dramatically.

As for a new strategy for the glycosylation by sialic acid, a β-equatorially oriented phenylthio and phenylseleno groups were designed as a stereocontrolling auxiliary at C-3. Eventually introduction of an α-D-NeuAc residue into carbohydrate sequences was implemented in the first total synthesis of disialosyl gangliosides, GD_3 in 1989.

2) Total synthesis of complex glycoconjugates

a) *Plant Cell Wall*: Some of the plant cell wall fragments have been chemically and physiologically characterized as oligosaccharins. In 1984, a series of synthetic studies on pectin fragments, β-glucan hexasaccharides, and xyloglucan nona saccharides were initiated aiming at the confirmation of their plant physiological functions. Biotesting of the samples successfully synthesized revealed the physiological

equivalency to the natural sample in their plant hormon activities.

b) *Glycolipids*: In the field of glycosphingolipids, by use of the new strategy employing a novel sialosyl donor, first total syntheses of complex gangliosides were achieved. In addition, total syntheses of other glycolipids of biological importance including Forssman antigen, dimeric Le^x antigen, human natural killer cell antigen-1 (HNK-1), GPI anchor, sialyl dimeric Le^x antigen, neolacto series poly-N-acetyl-lactosamine-type glycolipids were successfully achieved for the first time.

c) *Cycloglycans*: A first *non enzymatic* "cycloglycosylation" by use of glucohexaosyl fluoride gave a cyclic product, that was further converted into α-cyclodextrin in 1985. Thus the total synthesis was accomplished after 70 years since Schardinger described its properties in reliable detail in 1920. After completing the synthesis of γ-cyclodextrin in 1987, stereocontrolled synthesis of α-(1→4) linked cyclomannohexaose and trigonally shaped cyclooligolactose were also achieved. Unique functions of artificial cycloglycans are expected to be disclosed.

d) *Glycoproteins*: Glycans of glycoproteins are classified into two groups, N- and O-linked type. In 1986, a crucial experiment using a glycotetraosyl trichloracetimidate as a glycosyl donor completed a first total synthesis of the most typical biantennary complex type N-glycan of glycoprotein. Glycophorin A is one of the popular glycoproteins embedded in the plasma membrane of human red blood cells and has a cluster of O-linked glycans. Based on the novel strategy for the α-stereoselective introduction of sialic acid as well as the conventional Fmoc strategy for the peptide chain elongation, a tetrasaccharide-serine block was designed and synthesized in highly stereocontrolled manner. Peptide chain elongations by repeated use of this unit was carried out successfully. This achievement established a versatile approach to the synthesis of a mucin type glycopeptides.

e) *Proteoglycans*: Early in 1990th, unambiguous synthesis of linkage region of chondroitin sulfate to peptide back-bone as well as a dermatan sulfate hexasacchaide sequence having high affinity toward heparin cofactor II, were achieved to give supporting evidences for their chemical structures and biological functions.

As introduced above, Dr. Ogawa has developed efficient and stereoselective synthetic strategies toward physiologically important glycoconjugates with complex carbohydrate sequences. These achievements made a breakthrough in the field of glycoconjugate research and eventually contributed to initiate a novel interdisciplinary science and technology now called glycobiology and glycotechnology.

Japan Academy Prize to:

Shun-ichi YAMADA   and   Kenji KOGA
Emeritus Professor,   Professor and Dean,
University of Tokyo   Faculty of Pharmaceutical
                                       Sciences, University of Tokyo
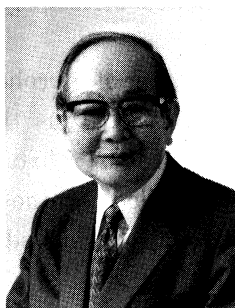
for "Novel Synthetic Methods of Optically Active Compounds
Based on the Transcription of the Chirality of L-Amino Acids"

Outline of the Work:

Dr. Yamada started in 1960 asymmetric synthesis of chiral organic compounds using L-amino acids as the source of chirarity, and then advanced his work to the diastereoselective asymmetric synthesis. This line of works was developed by Dr. Koga using newly designed chiral lithium amides, and highly enantioselective reactions were accomplished. Afterwards, those reactions have been improved more efficiently by using the chiral amines catalytically.

1. Asymmetric alkylation of optically active amino acid enamine (Fixation of conformation of the chiral center by inducing a chelate structure):

A chiral enamine formed from a carbonyl compound and L-proline derivative was alkylated, producing optially active α-substituted carbonyl compound, and L-proline derivative was recovered for recycling use. Fixation of comformation of the chiral center by introducing lithium remarkably increased the enantiomeric purity of the product (>95% ee). This reaction can be applied to the asymmetric syntheses of biologically active alkaloids, terpenoids and steroids.

2. Designing of new chiral bases derived from optically active amino acids and its application to asymmetric syntheses:

Dr. Koga designed several new chiral lithium amides possessing fixed conformations and applied them catalytically to the asymmetric synthesis of chiral enolate ions with a high enantioselectivity.

Prochiral ketones were efficiently deprotonated by the chiral lithium amide, producing highly optically active silyl enol ethers. This reaction was successfully applied to the regioselective enolization of optically active 3-ketosteroids and the kinetic resolution of racemic 2-substituted cyclohexanones. This chiral deprotonation was applied to a combination of chiral amine and achiral lithium amide. By lithium-hydrogen exchange, chiral lithium amide was repeatedly regenerated for catalytic use.

Enantioselective alkylation at the α-position of cyclic ketones was also achieved in high enantiomeric efficiency (95% ee) using a chiral lithium amide in the presence of lithium bromide. This asymmetric alkylation was performed by the catalytic action of chiral amine under the presence of achiral amine in excess.

3. Catalytic asymmetric epoxidation and Diels-Alder reaction

In addition to the above mentioned chiral syntheses, epoxyalcohol synthesis by enantioselective epoxidation of allylic alcohols using a chiral molybdenum chelated complex was reported by Dr. Yamada, and asymmetric Diels-Alder reaction catalyzed by the chiral Lewis acid was reported by Dr. Koga.

This series of works are based on the original idea of Dr. Shun-ichi Yamada to create small molecular compounds catalytically reacting as the high molecular enzymes with characteristic conformational structures. This idea has been materialized by the collaboration of Dr. Koga using L-amino acids, chiral synthetic amines and the chelated lithium amides to regulate enantioselective reactions. Asymmetric synthesis of organic compounds is important especially for the preparation of therapeutic agents which react at the site of enzymes or biological receptors in the body, which are enantiomerically composed. In this respect, the works of Dr. Yamada and Dr. Koga, which have developed several efficient reactions of enantioselective synthesis of organic compounds, are highly evaluated.

Japan Academy Prize to:

Shun-ichi AMARI
Professor,
Faculty of Engineering,
University of Tokyo

for "Study of Fundamental Theories
for Neural Information Processing"
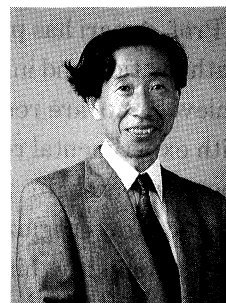
Outline of the Work:

The brain is a system composed of a large number of neurons, and its functions are realized by the complex network of neurons.

Professor Shun-ichi Amari has studied neural networks for many years, based on the belief that the theoretical approach to neural networks is significant and effective for elucidation of the principles of the brain functioning.

He had studied the computational principles of neural networks for fifteen years from 1965 to 1980, and proposed a new learning algorithm different from perceptron learning which was intensively studied in the early sixties. The algorithm is based on the stochastic descent method and is applicable to three-layer neural networks having a modifiable hidden layer. This network has far higher classification ability than the simple perceptron. His theory has been recognized to have established the principle of backpropagation, which was proposed fifteen years later by D. Runmelhart et al. and is now regarded as one of the most important principles of neurocomputers.

Prof. Amari further initiated statistical neurodynamics in order to analyze the behaviors of an ensemble of neurons, and obtained remarkable results: He analyzed the dynamics of recurrently connected neural networks and showed that its daynamics can be categorized into three types, monostable, oscillatory

and bistable behaviors depending on the strength of the inner connections and stimuli from the outside. The multistability emerges by connecting such networks. He further developed dynamics of nerve fields by using the macroscopic state equation.

An input stimulus pattern is transformed dynamically in a network with recurrent connections to reach invariant patterns which can be regarded as patterns memorized and consolidated in the network. Amari's theory is successful in analyzing the dynamical process of recalling and is now recognized as the standard theory of associative memory. The theory also predicts the memory capacity of a network, and shows that sparse encoding is effective for memory. This is also confirmed by experimental studies of the actual brain. Amari's theory also elucidates the formation of topographic maps by self-organization of nerve fields with lateral inhibitory connections. The theory is successful in explaining the mechanism of formation of patch and column structures in the cerebral cortex.

Prof. Amari has also devoted himself to construction of a new research field called information geometry, which is a fundamental method of information sciences applicable not only to neural networks but also to mathematical statistics, systems theory and information theory. This is a geometrical theory of the manifold of probability distributions and new differential geometrical notions are introduced in the manifold. Now information geometry is recognized as a fundamental method of neural networks, statistical physics, statistical inference, information theory, time series analysis and so on.

To summarize, Prof. Amari has proposed a number of new basic theories, models and their analyses by using his original mathematical and information-scientific methods of elucidating the fundamental principles of the brain. His achievements are remarkable in the sense that he has elaborated theoretical neuroscience to be comparable with experimental results of the brain, thus having prepared a solid foundation to the rise of computational neuroscience. In particular, his stochastic descent method of neural learning and statistical neurodynamics are recognized as most basic theories in this field. Moreover, it is remarkable that information geometry initiated by himself has had strong influences not only on neuroscience but also on mathematics, information sciences and statistical sciences.

PROCEEDINGS AT THE 890TH GENERAL MEETING

The 890th General Meeting of the Academy was held on Tuesday, June 13, 1995, at 1:00 p.m., Dr. Yoshio FUJITA, President, taking the chair. Eighty-nine members were present, and the following communications were made:

War and scholars . . . . Yoshitaro WAKIMURA, M. J. A.

The third ionization potentials of lanthanides and major orientations of 4f orbital clouds . . . . . .
. . . . Akimasa MASUDA

Acid character of Archean ocean waters revealed by 3.3 Ga-old ferruginous chert compositions, Western Australia . . . .
. . . . Ryuichi SUGISAKI, Yoshikuni HORIUCHI, Kenichiro SUGITANI, and Mamoru ADACHI

Characterization of monomeric green and polymeric orange forms of a Schiff base-oxovanadium (IV) complex and interconversion between these species . . . . Masaaki KOJIMA, Kiyohiko NAKAJIMA, Masanobu TSUCHIMOTO, Paul M. TREICHEL, Setsuo KASHINO, and Yuzo YOSHIKAWA
Above three, communicated by Kazuo YAMASAKI, M. J. A.

Role of novel microsomal cysteine proteases . . . . Makoto KITO and Reiko URADE
Communicated by Hisateru MITSUDA, M. J. A.

In vitro demonstration of hydration-induced calcium release in cells of *Nitella flexilis* . . . . . .
. . . . Munehiro KIKUYAMA, Kiyo SHIMADA, Kaoru KATOH, and Masashi TAZAWA
Communicated by Noburô KAMIYA, M. J. A.

Spiral vector theory of synchronous machine . . . . Sakae YAMAMURA, M. J. A.

A decomposition of R-polynomials and Kazhdan-Lusztig polynomials . . . . . Hiroyuki TAGAWA

The Diophantine equation $a^x + b^y = c^z$. II . . . . Nobuhiro TERAI

Seminear-rings characterized by their $\mathcal{S}$-ideals. II. . . . . Javed AHSAN
Above three, communicated by Shokichi IYANAGA, M. J. A.

On poles of twisted tensor L-functions . . . . Yuval Z. FLICKER and Dmitrii ZINOVIEV

Warped products with critical Riemannian metric . . . . Byung Hak KIM

Integrability of infinitesimal automorphisms of linear Poisson manifolds . . . Nobutada NAKANISHI

Relations of the Weyl groups of extended affine root systems $A_l^{(1,1)}, B_l^{(1,1)}, C_l^{(1,1)}, D_l^{(1,1)}$ . . . . .
. . . . Tadayoshi TAKEBAYASHI
Above four, communicated by Heisuke HIRONAKA, M. J. A.

Prediction of the three dimensional structure of the DNA-binding domain of the LysR family . . .
. . . . Yoshinori NITTA and Masashi SUZUKI

Methylation dependent functional switch mechanism of the *Escherichia coli* Ada protein . . . . .
. . . . Hitoshi SAKASHITA, Takahiko SAKUMA, Yoshiko AKI-
TOMO, Tadayasu OHKUBO, Masatsune KAINOSHO, Mutsuo SEKIGUCHI, and Kosuke MORIKAWA
Above two, communicated by Setsuro EBASHI, M. J. A.

Experimental study of the slab-mantle interaction and implications for the formation of titanoclino-humite at deep subduction zone . . . . Yoshiyuki IIZUKA and Eizo NAKAMURA
Communicated by Syun-iti AKIMOTO, M. J. A.

A three-manifold invariant derived from the universal Vassiliev-Kontsevich invariant . . . . . .
. . . . Thang Q. T. LE, Hitoshi MURAKAMI, Jun MURAKAMI, and Tomotada OHTSUKI

Extremal Kähler metrics and the Calabi energy. . . . . Andrew D. HWANG
Above two, communicated by Kiyosi ITÔ, M. J. A.

After a recess during which the members present met in their respect Sections, the General Meeting was resumed for business transactions.

First, the President announced that Dr. Toshio FUKUYAMA, M. J. A., had passed away on May 20, 1995; Dr. Takeo HIRAOKA, M. J. A., had passed away on May 31, 1995. The members rose from their seats in silence, expressing profound sense of grief.

Next, Dr. Kôichi TSUJIMURA, M. J. A., and Dr. Kazuhiko NISHIJIMA, M. J. A., paid a tribute of admiration to the late Dr. Hisayuki OMODAKA's and the late Dr. Ryogo KUBO's meritorious services to academic circles.

Then, the chairmen of both Sections made reports of the matters deal with at the respective Sectional Meetings.

Then, the President reported that the Twenty-second meeting of the Japan Academy Public lectures was opened to the public in the Academy Auditorium at 2:00 p.m. on Saturday, May 27, 1995, with Dr. Masanao MATSUI, M. J. A., and Dr. Takao FUSAYAMA, M.J.A., as speakers, whose respective subjects were:

Natural Substances and Synthetic Materials—Especially Some Compounds Controlling the Number of Insects Harmful to the Agriculture—.

Principle of Coexistence= "Sharing Life" (Medico-biological Social Phylosophy).

After that, it was reported on the result of election of half the members of the Administrative Committee, which had taken place at the Sectional Meetings. The Committee members elected are: Tatsuro YAMAMOTO, Shigemitsu DANDO, Keiichiro NAKAGAWA, Yoshihide KOZAI, Ryukiti HASIGUTI, Yoshiaki ISHIZUKA, Setsuro EBASHI.

The Meeting adjourned at 5:07 p.m.

PROCEEDINGS OF THE JAPAN ACADEMY

SERIES A
MATHEMATICAL SCIENCES

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CONTENTS

Papers Communicated:—