Professor Shin Sato, 
Physical Chemist and 
my Teacher for 50 Years

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Introduction

• I am thankful and excited to humbly present a little of the life and work of Professor Shin Sato.
• I had the privilege to meet professor Sato while spending a research year in his Tokyo Institute of Technology Radiation Chemistry Laboratory.
• I hold an M.Sc. in chemistry from the Hebrew University of Jerusalem, and a UNESCO and Japanese Government fellowship for chemistry and chemical engineering course (1972-73).
• In 1979 I received doctor of philosophy (Ph.D.) in chemistry from the Weizmann Institute of Science in Rehovot, Israel.

• My presentation is based on our many years of scientific friendship: long-distance correspondence and occasional visits to T.I.T., today's named Tokyo Tech.
Shin Sato Family

- Shin Sato was born in Yokohama, Japan, in 1928.
- He lived there most of his life, except for two periods of research in Ottawa, Canada.
- Sato had two brothers and a sister.
- He married Fusako, a pianist and piano teacher of many children.
- In her youth she played with the Yokohama Orchestra piano concert no. 2 by Grieg. So in one of their travels abroad they visited Grieg’s House in Bergen. Fusako took good care of family relatives and friends.
- They had two daughters, Atsuko and Mitsuko, a granddaughter Mika, and a great-granddaughter Reina (令奈).
佐藤 伸  Shin Sato
Professional CV

1956 Aug.- 1960 Dec. Assistant professor, Department of Chemistry, Tokyo Institute of Technology

1961 Jan. - 1963 Mar. Associate professor, Department of Chemistry, Tokyo Institute of Technology

1964 Apr. - 1981 Oct. Associate professor, Department of Applied Physics, Tokyo Institute of Technology

1981 Nov. - 1988 Mar. Professor, Research Laboratory for Nuclear Reactor, Tokyo Institute of Technology

1989 Apr. - Professor Emeritus, Tokyo Institute of Technology

1993 Teaching chemistry in a private university


Shin Sato’s main research topics (1)

- **LEPS Method**


**Early scientific recognition**


- Johnston wrote:

  “This equation is based purely on intuition...... Thus Sato's potential-energy surface for H₃ is a complete potential-energy surface that appears to be qualitatively correct.”

- “....This Semiempirical method does not predict activation energy. Its evaluation of other properties of the saddle point will be compared with other methods in a later section, where it will be referred to as the LEPS (London-Polanyi-Eyring-Sato) method. (Johnston p. 179).”

- Johnston: “...The Semiempirical method of London-Polanyi-Eyring-Sato, however, does give a complete potential energy surface.”
Shin Sato’s main research topics (2).

Photochemistry (1)


• **Phase-shift studies**


Shin Sato’s main research topics. (3)  

Photochemistry (2)

• **Amino acids formations**

  - **Abstract**: The photolysis of hydrogen azide was studied in liquid acetic acid, propionic acid, and isobutyric acid at room temperature. The formation of amino acids was confirmed by the color reactions with ninhydrin and with chromatographic acid and by the NMR spectra. The results are explained by the insertion reaction of NH(a^1Δ) into the C-H bonds of carboxylic acids.

  • **Table 2. The quantum yields of amino acids formation**
    - Reactant | α-amino acid | β-amino acid | Total |
    - CH₃COOH | 0.52 | - | 0.52 |
    - CH₃CH₂ COOH | 0.29 | 0.43 | 0.72 |
    - (CH₃)₂CHCOOH | 0.13 | 0.67 | 0.60 |

Shin Sato’s main research topics (4)

**Radiation Chemistry**

- **G-Values**

- **ESR Studies**
Shin Sato’s main research topics (5).

**Radiation Chemistry (2)**

- **Rate Constants, Arrhenius Equation**
  
  **Abstract:** Using the techniques of pulse radiolysis and of absorption of Lyman-alfa radiation by hydrogen atoms. The rate constants of reactions of hydrogen atoms with several olefins have been measured in room temperature.

  
  **Abstract:** The Arrhenius equation has been modified so as to express rate constants obtained at low temperatures: \( k = A \exp\left[-E_0/R(T_0^2+T^2)^{1/2}\right] \) ... \( k \) is the rate constant...The application and implication of this modified equation are discussed.

  
  **Abstract:** The rate constants for the reactions of H+Br\(_2\) and D+Br\(_2\) were measured by employing a pulse radiolysis–resonance absorption technique. The rate constants could be expressed by the following Arrhenius equations between 214 and 295 K:

  \[
  k(\text{H}+\text{Br}_2) = 6.7 \times 10^{-10} \exp\left(-680/T\right), \quad k(\text{D}+\text{Br}_2) = 6.0 \times 10^{-10} \exp\left(-720/T\right), \text{in units of cm}^3 \text{s}^{-1}.
  \]

  Sudden transition state theoretical calculations were performed on the basis of modified LEPS surfaces. The calculated results were compared with the experimental ones.
Shin Sato’s main research topics (6)

After retirement Sato continued research alone


  Abstract: An empirical rate equation \( k(T) = B[1 - \exp(E_b/RT)] \), where \( B \) and \( E_b \) are parameters, is proposed to express the rate constants of association reactions. By combining this empirical rate equation with the Arrhenius equation, the temperature dependence of the rate constants of oxygen atoms with several olefins from 20K to 500K can be properly demonstrated.


- His last publication:
  - 186. S. Sato: *Several considerations on the empirical rate formula for ion-molecule reactions and low-temperature-high-speed radical reactions*. Chemical Physics, Volume 525, 1 September (2019), 110358.
Shin Sato’s Books (not inclusive)

- 量子化学 Quantum Chemistry, published in 1974 謹呈著者
- Co-authored another book "Introduction to Modern Chemistry" 現代化学入門ー21世紀の化学 was published in 1992 by Kodansha 講談社.
- Translated into Japanese the book on "Chemical Kinetics and Dynamics" by Steinfeld, Francisco and Hase (1989)
Shin Sato scientific ideas and approach –
Quotes (1)

• “If we divide the world of physical chemistry into three fields: structure, physical properties, and reactions, the field I have been involved in belongs to the reactions category.”

• “Since that time [in Canada], I had wanted to work on reactions involving nitrogen atoms.”

• “At that time, (1954-1955), I proposed a new method for drawing potential energy surface, now known as the LEPS (London-Eyring-Polanyi-Sato) method. It was widely used in the kinetics and dynamics of chemical reactions and still often appears in papers.

• In the 38 years since then, there are more than 200 articles including books and commentaries, but not one paper has been cited by overseas researchers to the same extent as this letter.”
Shin Sato’s scientific ideas and approach - Quotes (2)

• “I have been engaged in research in both the fields of photochemistry and radiation chemistry.”

  “My subsequent papers have been almost equally divided between photochemistry and radiation chemistry.”

• “The next 10 years (1970s) will be the most productive time for me. The lab was poor, but the ideas were plentiful.”

• 『どの論文にも夢があった。実験とは毎日毎日が創造である。学生の創造に負けないように想像力を逞しくした。』

• “Experimentation is creation every day. I strengthened my imagination so as not to lose to the creativity of the students.”

• “The theoretical calculation were done by Mr. Okazaki's calculation of the G value, and Mr. Takayanagi's trajectory calculation and my long-standing thought have come to fruition.”
Shin Sato's attitude to students and co-authors

• I counted 99 names of students and colleagues who were co-authors in Sato’s articles during 1954-1991.
• Sato had a sensitive human approach to his students and colleagues. Concerning a colleague who had just left the room when I arrived Sato told me: “He came to discuss his scientific and personal problems.”
• Sato attended Okazaki’s wedding.
• Students’ group holiday week was in Ibaraki fishermen village, including his daughters Atsuko and Mitsuko.
• Saturdays’ afternoon were dedicated to Mahajan game. Other afternoons Sato played Go with colleagues at the South Building.
• In 2017 Sato wrote me that Tsunashima passed away of a heart attack; that they had worked together for more than 50 years.
Left: Shin Sato teaching Yona Siderer Japanese Chess – Shogi, Ms. Yumiko Sato, UNESCO course coordinator is watching.

Sato’s mentoring my studies (1)

- My research work concentrated on light-driven reactions.
- I studied the mechanism of oxygen evolution in plant photosynthesis during my Ph.D. studies at the Weizmann Institute of Science in Rehovot, Israel (1974-1979), by observing light induced room temperature changes of manganese ESR signals in chloroplasts.

- When I wrote Sato that I was offered a post-doc position at Princeton University he answered:
  “I would take it if I were you.”

- Research at Princeton University in the laboratory of Dr. G. C. Dismukes; We published articles on cryogenic ESR signal of Manganese-Protein complex in chloroplasts. Manganese participation in the 4 steps cycle to release oxygen molecule from water molecules.
- This work is continuously cited since our 1981 publications.
Sato’s mentoring my studies(2)
Returning to Japan

- In 2008 I arrived again to T.I.T. holding a Japan Foundation Fellowship, to study “the history of chemistry in Japan” in Professor Masanori Kaji laboratory; together with Prof. Kazuhiko Shibuya they encouraged me to teach a course on this topic to T.I.T. M.Sc. chemistry students.

- Prof. Sato attended my lecture on "Chaim Weizmann, a Chemist and a Statesman“ that I presented at the Annual Meeting of the Japanese Society for the History of Chemistry at T.I.T. Since 2008, I am a member of this society.


- My interest in Japanese science, language, history and culture deepened.
Sato’ mentoring my studies (3)

• In 2019, while I was studying from home Udagawa Youan’s chemistry research on *Kousa Seimika*, and *Seimi Kaiso*, Sato helped me to correct spelling of Japanese names of chemicals, hot springs, people's names and more.

• E.g., hot springs names:
  - 湯河原: Yugawara.
  - 鳴子: Naruko.
  - 陸前: Rikuzen.
  - 松本: Matsumoto.
  - 硫黄島: Ioujima.
  - 山代: Yamashiro.
  - 山中: Yamanaka.

• “... From the internet, I (Sato) have found how to read the following words:

  河渡 has three ways to read: Kawawatari, Kodo and Godo. They depend on where they are.”

Shin Sato passed away in April 2022, aged 94.
In front of the Centennial Hall, Tokyo Tech 2015
Kazuhiko Shibuya, Shin Sato, Yona Siderer, Yumiko Shibuya
Shin Sato last Greeting Card for 2022
and
Yona Siderer’s poem, Translated by Shuntaro Tanikawa

The rainy season is over
Summer clouds will appear
Let a thousand years pass –
You I shall know
Your people – a mystery
Acknowledgments and Thanks

Mrs. Yumiko Shibuya. Prof. Kazutaka Nakamura
Mrs. Mitsuko Nakamura. Prof. Kazuhiko Shibuya

Thank You for Your Attention!

ありがとうございました!

Toda Raba  תודה רבה