

Norimichi Kojima

Emeritus Professor, The University of Tokyo

[Present Position]

Fellow at Toyota Physical and Chemical Research Institute

[Research Field]

Physics and Chemistry of Transition-Metal Complexes, Molecular Magnetism

[Date of Birth]

October 01, 1949 [Sex] Male [Nationality] Japan

[Academic Qualifications]

03/1972 Bachelor of Science, Kyoto University

03/1974 Master of Science, Kyoto University

03/1978 Doctor of Science, Kyoto University

Thesis: Spectroscopic Study on Two-dimensional Antiferromagnets

[Professional Career]

- 12/1977 - 11/1978 Post Doctoral Research Fellow in Broadcasting Science Research Laboratory, Japan Broadcasting Corporation (NHK)
- 04/1979 – 03/1981 Part-time Lecturer, College of General Education, Kyoto University
- 04/1981 – 03/1984 Lecturer, Kobe-Tokiwa College
- 04/1984 – 02/1992 Research Associate, Faculty of Science, Kyoto University
- 03/1992 – 04/1994 Associate Professor, Faculty of Science, Kyoto University
- 05/1994 – 03/1996 Professor, Faculty of Arts and Sciences, The University of Tokyo
- 04/1996 – 03/2015 Professor, Graduate School of Arts and Sciences, The University of Tokyo
- 04/2005 – 02/2007 Vice-Dean, Graduate School of Arts and Sciences/College of Arts and Sciences, The University of Tokyo
- 02/2007 – 02/2009 Dean, Graduate School of Arts and Sciences/College of Arts and Sciences, The University of Tokyo
- 04/2009 – 03/2010 Executive Managing Director, The University of Tokyo
- 04/2009 – 03/2011 Vice-President, The University of Tokyo
- 04/2011 – 03/2012 Director-General, Division of Environmental, Health and Safety (EHS), The University of Tokyo
- 04/2015 - Fellow, Toyota Physical and Chemical Research Institute

[Membership]

Chemical Society of Japan, Physical Society of Japan, Japan Society for Molecular Science, Japan Society of Coordination Chemistry, Japan Mössbauer Spectroscopy Forum, Society of Muon and Meson Science of Japan

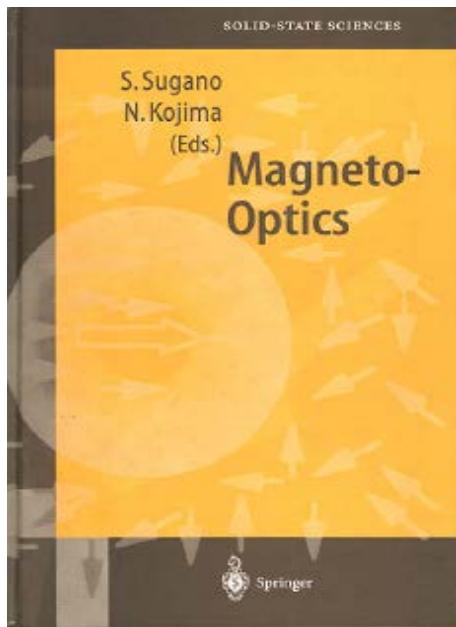
Research Overview

Norimichi Kojima

One of the most attractive research in the field of molecular solids is the investigation of multi-functionality induced by the synergetic effect between magnetic, optical or transport properties. Among various multifunctional materials, assembled transition-metal complexes are the leading candidates as field-responsive multifunctional materials. From these viewpoints, we have developed various kinds of assembled transition-metal complexes and investigated their multifunctional phenomena.

[Study on the magneto-optics of transition-metal compounds](1976-1995)

In magnetic compounds, various types of elementary excitations (excitons, magnons, phonons, domain-solitons, etc.) exist. The interaction between these elementary excitations enables them to combine with one another, forming new and more complex excitations such as exciton-magnon transition (magnon sideband). This interaction has an effect on the propagation, energy position and shape of the complex excitations. The most dramatic effect is the existence of the bound states below or above the two-particle continuum under certain circumstances. We have investigated the behavior of these elementary excitations in the optical 3d-3d or 4f-4f transition for various magnetic insulators, which has been reviewed in “Magneto-Optics” ed. S. Sugano and N. Kojima (Springer, 2000).



[Study on the optical properties of platinum mixed-valence complexes](1986-1996)

The inter-valence charge-transfer absorption spectra in the mixed-valence complexes $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ and $[\text{Au}_x\text{Pt}_{1-x}\text{I}(\text{en})_2]\text{SO}_4 \cdot 3\text{H}_2\text{O}$ ($x = 0.03$) have been investigated at 4.2 K. In these complexes, below the charge transfer absorption edge, a weak absorption band (A band) has been observed for the light polarized parallel to the chain axis. When these complexes were irradiated with the light in the region of the charge transfer transition from Pt^{II} to Pt^{IV} , the absorption coefficient of the A band remarkably increased, which implies that the A band is a photo-induced absorption band. The photo-induced effect for the A-band in $[\text{Au}_x\text{Pt}_{1-x}\text{I}(\text{en})_2]\text{SO}_4 \cdot 3\text{H}_2\text{O}$ ($x = 0.03$) is more intense than that in $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. The A-band suggests the existence of new excitations such as a soliton-like excitation in the electronic state of the platinum chains.

Discovery of photo-induced soliton for halogen-bridged one-dimensional mixed-valence Pt complex system.

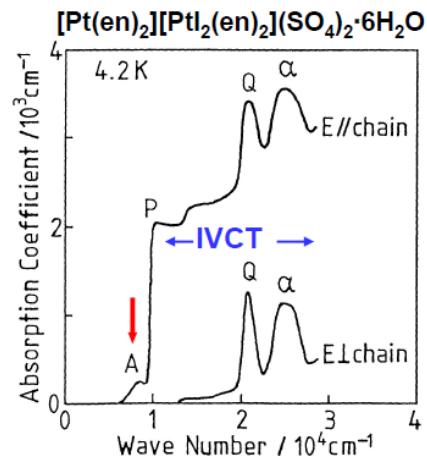
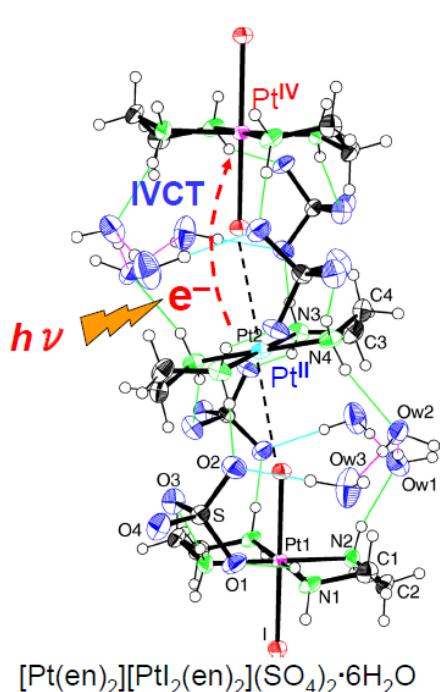


Fig. 2. Absorption spectra at 4.2 K in $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. E denotes the electric vector of the incident light.

IVCT: Inter-valence charge transfer from Pt^{II} to Pt^{IV} .

N. Matsushita, N. Kojima, T. Ban, I. Tsujikawa, *J. Phys. Soc. Jpn.* **56**, 3808 (1987).

Discovery of photo-induced effect on the A band due to soliton

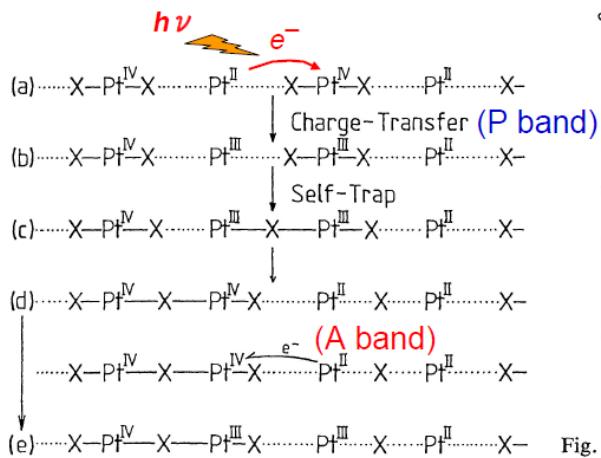


Fig. 5. A possible mechanism for the origin of the *A*-band in $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. (a) ground state, (b) intervalence charge-transfer exciton, (c) self-trapped exciton, (d) a mismatch of the Pt valence alternation, (e) another charge-transfer exciton.

Soliton: the mismatch of valence alternation

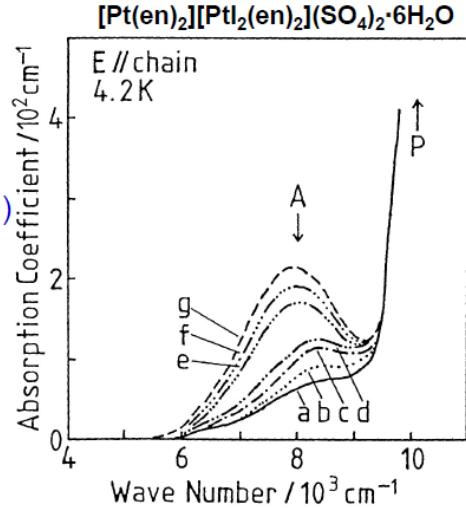


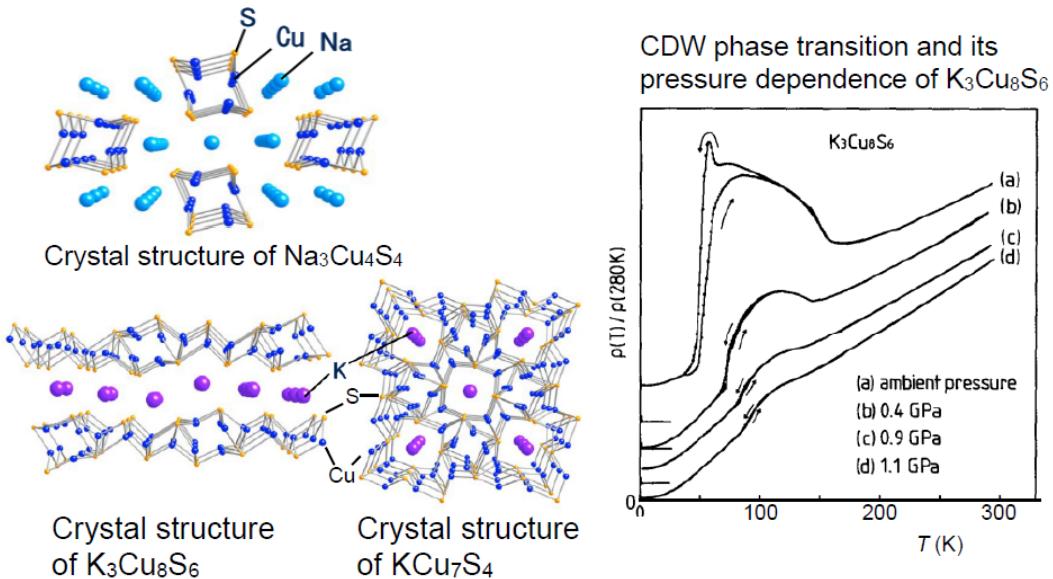
Fig. 3. Absorption spectra below the charge-transfer absorption edge for E/chain at 4.2 K by various measuring methods in $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$. (a) —: method 1, (b) - - -: method 2 (irradiated with the light above 8000 Å by filter IRD80B), (c) - - -: method 2 (above 6800 Å by R68), (d) - - -: method 2 (above 6300 Å by R63), (e) - - -: method 2 (above 5000 Å by Y50), (f) - · - -: method 2 (above 4600 Å by Y46), (g) - - -: method 3.

N. Matsushita, N. Kojima, T. Ban, I. Tsujikawa, *J. Phys. Soc. Jpn.* **56**, 3808 (1987).

[Study on the crystal structure and transport phenomena for ternary copper chalcogenide, A-Cu-X (A = Na, K, Rb, Cs; X = S, Se)](1988-1994)

We have systematically investigated the crystal structure and transport phenomena for ternary copper chalcogenides such as $\text{K}_3\text{Cu}_8\text{S}_6$, KCu_4S_3 , $\text{Na}_3\text{Cu}_4\text{S}_4$, which have various kinds of low-dimensional structures and mixed valent compositional ratios. $\text{K}_3\text{Cu}_8\text{S}_6$, which is one of such mixed valent low-dimensional copper sulfides, has a layered structure composed of Cu_8S_6 sheets separated by potassium ions. Each Cu_8S_6 sheet is composed of the Cu_4S_4 chains seen in $\text{Na}_3\text{Cu}_4\text{S}_4$ and the networks of edge-shared CuS_4 tetrahedrons seen in KCu_4S_3 , etc. In the case of $\text{K}_3\text{Cu}_8\text{S}_6$, two phase transitions are observed at T_1 (153 K) and at T_2 (55 K). The resistivity is metallic above T_1 , while non-metallic between T_1 and T_2 , in which an incommensurate superstructure (0, $(1-\delta)/2$, 0) appears. The behavior of resistivity between T_1 and T_2 is a typical CDW system, while the intensity of superstructure shows an anomalous oscillation as a function of temperature. On further cooling, the resistivity decreases drastically at T_2 . Below T_2 , the resistivity becomes metallic again, and the incommensurate superstructure disappears but another commensurate superstructure ($1/2$, $1/2$, 0) instead appears. A possible explanation of the T_2 transition is a lock-in transition of the CDW.

Study on the crystal structure and transport phenomena for the ternary copper chalcogenide, A-Cu-X

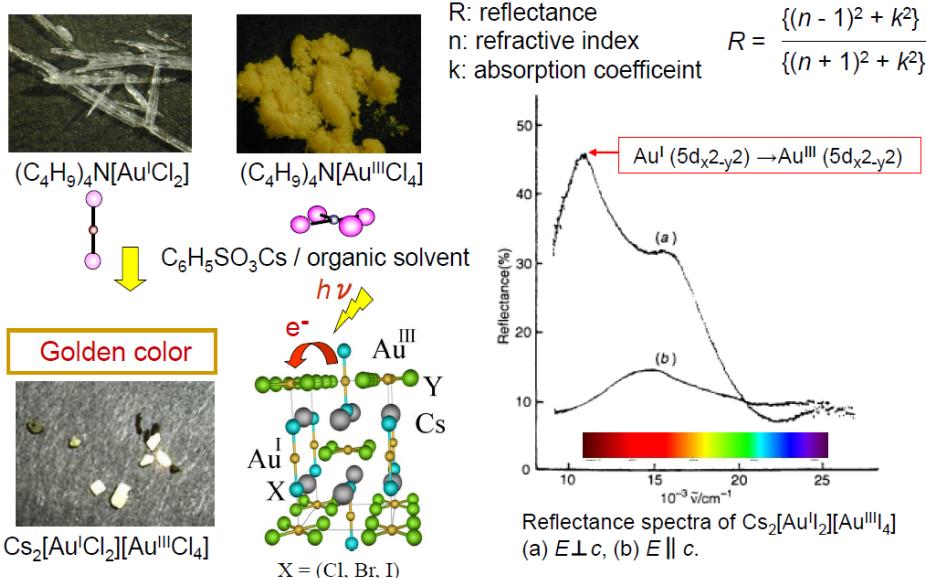


H. Sato, E. Igaki, T. Nakamura, T. Ban, N. Kojima, *Solid State Commun.* **71**, 793 (1989), H. Sato, N. Kojima, K. Suzuki, T. Enoki, *J. Phys. Soc. Jpn.* **62**, 647 (1993), H. Sato, N. Kojima, S. Kagoshima, *J. Phys. Soc. Jpn.* **62**, 2051 (1993).

[Study on the pressure-induced and photo-induced Au valence transition of gold mixed-valence complexes, $\text{M}_2\text{Au}^{\text{I}}\text{Au}^{\text{III}}\text{X}_6$] (1995-2012)

Halogen-bridged gold mixed-valence complexes, $\text{M}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{X}_4]$ ($\text{M} = \text{K}, \text{Rb}, \text{Cs}; \text{X} = \text{Cl}, \text{Br}, \text{and I}$) are typical examples for the mixed-valence complexes belonging to the class II, in which strong inter-valence charge transfer (IVCT) bands appear in visible region. Their characteristic properties of crystal structure and mixed valence state are quite similar to those of BaBiO_3 , which is the parent compound of the superconductors, $\text{Ba}_{1-x}\text{KBiO}_3$ and $\text{BaBi}_{1-x}\text{PbO}_3$. $\text{M}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{X}_4]$ ($\text{M} = \text{K}, \text{Rb}, \text{Cs}; \text{X} = \text{Cl}, \text{Br}, \text{and I}$) undergo the pressure induced valence transition from the mixed valence state of $\text{Au}^{\text{I,III}}$ to the single valence state of Au^{II} , which is coupled with a structural phase transition. In the case of $\text{Cs}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{X}_4]$ ($\text{X} = \text{Cl}, \text{Br}, \text{and I}$), the Au valence transition takes place at 11-12, 9, and 5.5 GPa, respectively. In the pressure region below the Au valence transition, these complexes show a metallic behavior due to the valence fluctuation of the Au^{I} and Au^{III} states. The metallic cubic phase appearing commonly for these complexes under high pressure and high temperature can be obtained as a metastable state even at ambient pressure and room temperature. Moreover, we have discovered a photo-induced Au valence transition for $\text{Cs}_2[\text{Au}^{\text{I}}\text{Br}_2][\text{Au}^{\text{III}}\text{Br}_4]$.

Optical properties of $\text{Cs}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{Y}_4]$ (X = Cl, Br, I): origin of golden color



We have succeeded in synthesizing nine kinds of hetero-halogen bridged gold mixed-valence complexes having perovskite-type structure, $\text{Cs}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{Y}_4]$ (X, Y = Cl, Br, and I; X ≠ Y), in organic solvent, and obtained their single crystals. Metallic golden color is attributed to the IVCT transition from the Au^{I} site to the Au^{III} site.

N. Kojima, H. Kitagawa, *J. Chem. Soc. Dalton Trans.*, 327 (1994), N. Kojima, *Bull. Chem. Soc. Jpn.*, **73**, 1445 (2000), N. Kojima, K. Ikeda, Y. Kobayashi, M. Seto, *Mössbauer Effect Reference and Data Journal*, **36**, 57 (2013).

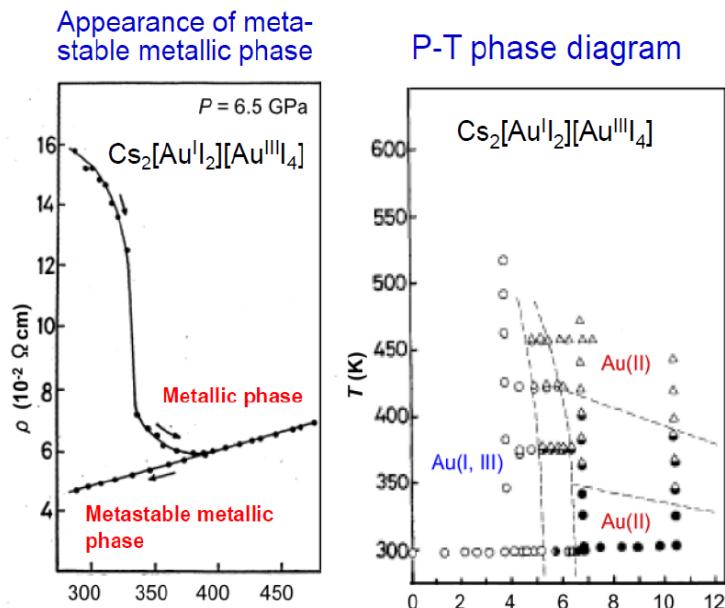
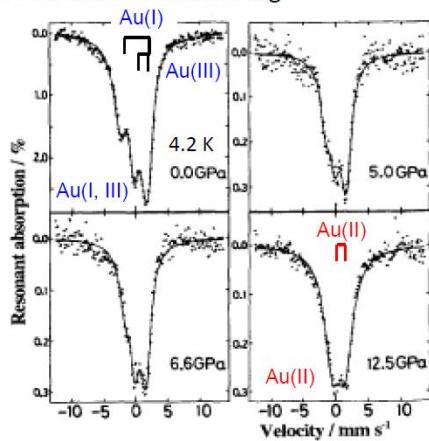


Figure: Pressure and temperature induced metallic phase and the existence of metastable metallic phase of $\text{Cs}_2[\text{Au}^{\text{I}}\text{I}_2]\text{[Au}^{\text{III}}\text{I}_4]$. P-T phase diagram of $\text{Cs}_2[\text{Au}^{\text{I}}\text{I}_2]\text{[Au}^{\text{III}}\text{I}_4]$.

N. Kojima, H. Kitagawa, T. Ban, F. Amita, M. Nakahara, *Solid State Commun.* **73**, 743 (1990), N. Kojima, M. Hasegawa, H. Kitagawa, T. Kikegawa, O. Shimomura, *J. Am. Chem. Soc.* **116**, 11368 (1994).

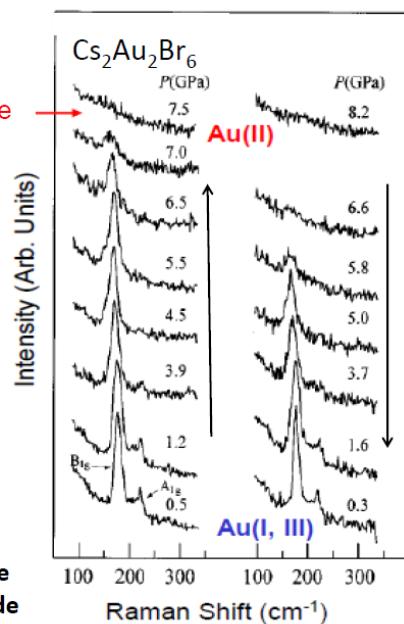
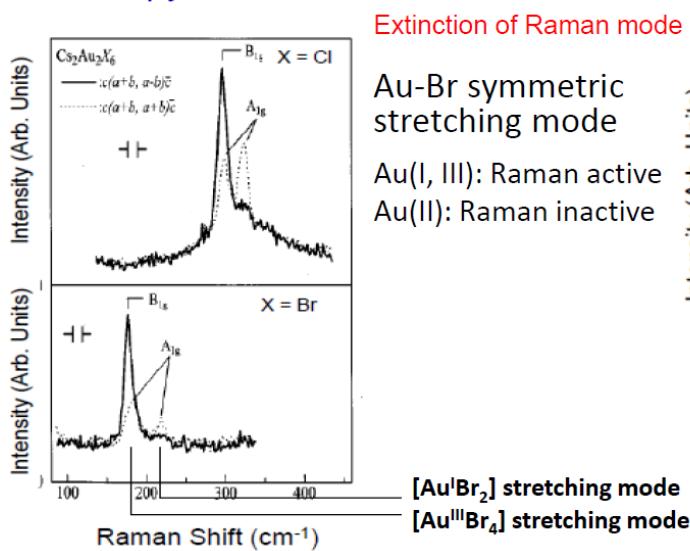
Pressure induced valence transition of $\text{Cs}_2[\text{Au}^{\text{I}}\text{I}_2]\text{[Au}^{\text{III}}\text{I}_4]$ by means of ^{197}Au Mössbauer spectroscopy at Marburg

^{197}Au γ -ray source produced in Berlin was transferred to Marburg.



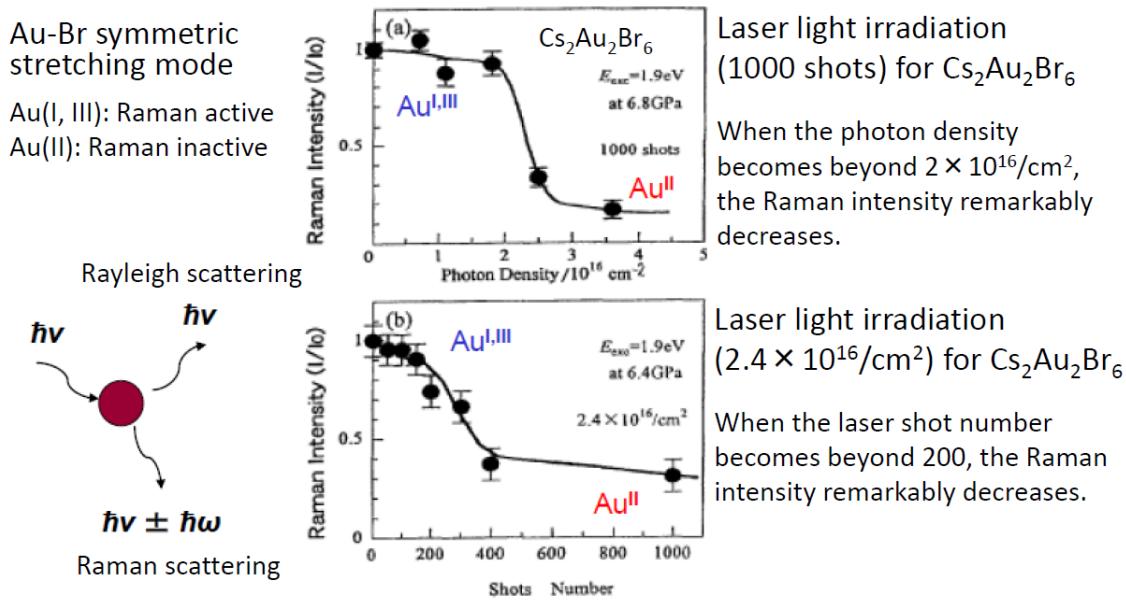
S.S. Hafner, N. Kojima, J. Stanek, Li Zhang, *Phys. Lett. A*, **192**, 384 (1994).

Pressure induced Au valence transition of $\text{Cs}_2[\text{Au}^{\text{I}}\text{Br}_2]\text{[Au}^{\text{III}}\text{Br}_4]$ by means of Raman spectroscopy



X.J. Liu, Y. Moritomo, A. Nakamura, N. Kojima, *J. Chem. Phys.*, **110**, 9174 (1999).

We have found a photo-induced phase transition (PIPT) for $\text{Cs}_2\text{Au}_2\text{Br}_6$ from the mixed-valence state of $\text{Au}^{\text{I},\text{III}}$ to the single-valence state of Au^{II} in the pressure region from 6.4 to 6.8 GPa. The PIPT shows a distinct threshold behavior against the photon density as well as the shots number, which has been interpreted in terms of the critical nucleation of the photo-injected Au^{II} clusters.



X.J. Liu, Y. Moritomo, M. Ichida, A. Nakamura, N. Kojima, *Phys. Rev. B* **61**, 20 (2000), N. Kojima, *Bull. Chem. Soc. Jpn.*, **73**, 1445 (2000).

[Study on the charge transfer phase transition and ferromagnetism for Mixed-Valence Iron Complexes](2000-2018)

Assembled organic-inorganic hybrid system has a possibility to exhibit multifunctional properties as a whole system through the interaction between individual components. From this viewpoint, we have developed a ferromagnetic organic-inorganic hybrid system, $\text{A}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]$ ($\text{A} = (\text{n-C}_n\text{H}_{2n+1})_4\text{N}$, spiropyran; $\text{dto} = \text{C}_2\text{O}_2\text{S}_2$), and investigated their multifunctional properties coupled with spin, charge and photon. In $(\text{n-C}_n\text{H}_{2n+1})_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]$, a charge transfer phase transition (CTPT) takes place at 122.4 K and 142.8 K for $n = 3$ and 4, respectively, where a thermally induced charge transfer occurs reversibly between the Fe^{II} and Fe^{III} sites. The CTPT and the ferromagnetic phase transition strongly depend on the honeycomb ring size in $[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]_\infty$. The increase of cation size expands the honeycomb ring, which stabilizes and destabilizes the HTP with $\text{Fe}^{\text{II}} (t_{2g}^4 e_g^2: S = 2)$ and $\text{Fe}^{\text{III}} (t_{2g}^5: S = 1/2)$ and LTP with $\text{Fe}^{\text{II}} (t_{2g}^6: S = 0)$ and $\text{Fe}^{\text{III}} (t_{2g}^3 e_g^2: S = 5/2)$, respectively. In order to control the ferromagnetic properties and the

CTPT by means of photo-irradiation, we synthesized a photo-responsive organic-inorganic hybrid system, (SP-R)[Fe^{II}Fe^{III}(dto)₃] (SP = spiropyran; R = CH₃ (Me), C₂H₅ (Et), C₃H₇ (Pr)), and found that this system undergoes the photo-isomerization of SP-R reversibly in solid state, and the photo-isomerization of SP-Me by UV light irradiation partially induces the CTPT from LTP to HTP on the two-dimensional [Fe^{II}Fe^{III}(dto)₃] layer and the change of T_C from 5 K to 22 K.

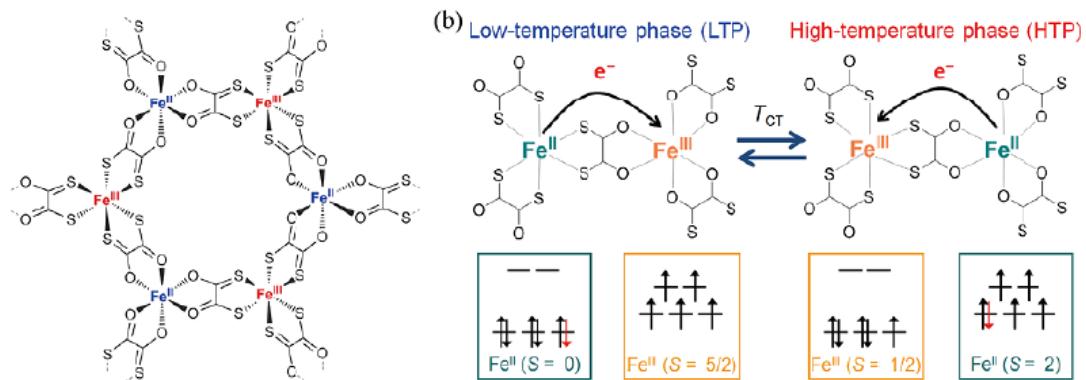


Figure: Haneycomb structure of [Fe^{II}Fe^{III}(dto)₃]_∞ and the schematic representation of charge transfer phase transition for (C_nH_{2n+1})₄N[Fe^{II}Fe^{III}(dto)₃] (dto = C₂O₂S₂)

N. Kojima, W. Aoki, M. Itoi, Y. Ono, M. Seto, Y. Kobayashi and Yu. Maeda, *Solid State Commun.*, **120**, 165-170 (2001), T. Nakamoto, Y. Miyazaki, M. Itoi, Y. Ono, N. Kojima, M. Sorai, *Angew. Chem. Int. Ed.*, **40**, 4716-4719 (2001).

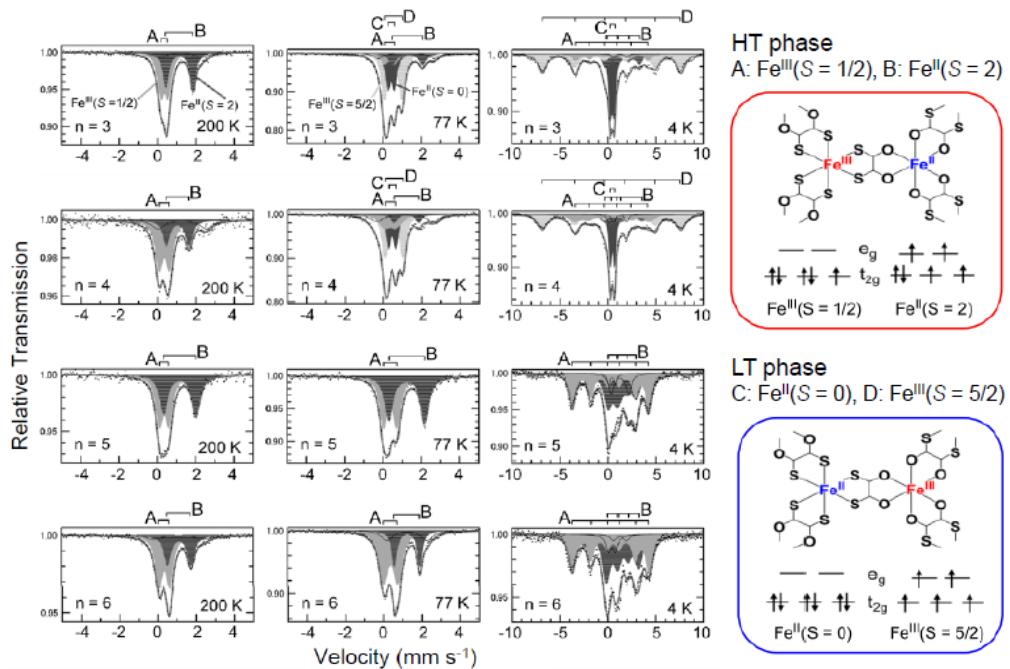
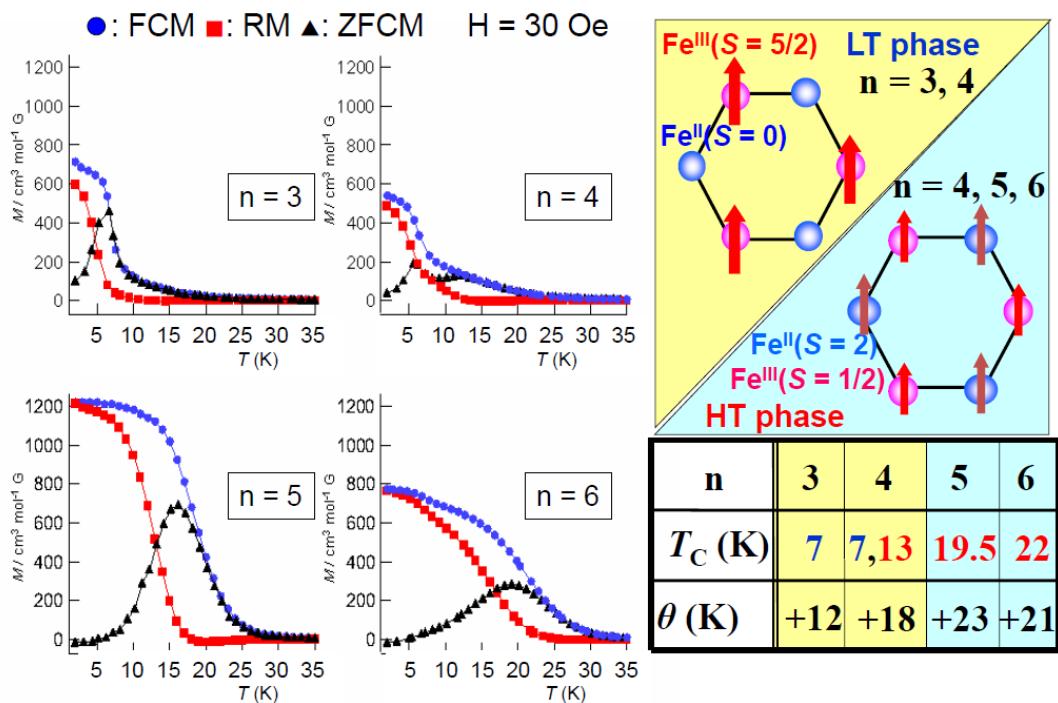


Figure: ^{57}Fe Mössbauer spectra for $(n\text{-C}_n\text{H}_{2n+1})_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dta})_3]$ ($n = 3\text{-}6$) at 200 K, 77 K and 4 K.

The assignment of the ^{57}Fe Mössbauer spectra were confirmed by the measurements for ^{57}Fe -enriched samples, $(n\text{-C}_3\text{H}_7)_4\text{N}[^{57}\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dta})_3]$ and $(n\text{-C}_3\text{H}_7)_4\text{N}[\text{Fe}^{\text{II}}{}^{57}\text{Fe}^{\text{III}}(\text{dta})_3]$. At 200 K, the line profiles of all the complexes are quite similar to each other, where two quadrupole doublets (A and B) mainly exist. The wider doublet (B) and the narrower doublet (A) are assigned to the Fe^{II} ($S = 2$) site coordinated by six O atoms, and the Fe^{III} site coordinated by six S atoms. In the cases of $n = 3$ and 4, with decreasing temperature from 200 K to 77 K, the ^{57}Fe Mössbauer spectra corresponding to the HTP decrease by about 80%. Instead of these spectra, two doublets (C and D) appear. At 4 K, a central strong doublet (C) and a sextet (D) divided from -8 to $+8 \text{ mm s}^{-1}$ with a large hyperfine field ($H_{\text{int}} = \sim 450 \text{ kOe}$) are observed. The former can be assigned to the diamagnetic state of Fe^{II} ($S = 0$) and the latter is typical of the magnetically ordered state of Fe^{III} ($S = 5/2$). From the analysis of ^{57}Fe Mössbauer spectra for $(n\text{-C}_n\text{H}_{2n+1})_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dta})_3]$, it is obvious that the charge transfer between the Fe^{II} and Fe^{III} sites takes place between 200 K and 77 K for $n = 3$ and 4. The ^{57}Fe Mössbauer spectra in the ferromagnetic phases for $n = 5$ and 6 are completely different from those for $n = 3$ and 4. In the cases of $n = 5$ and 6, the CTPT does not take place, so that the spectra at 4 K can be assigned to the Fe^{II} ($S = 2$) and Fe^{III} ($S = 1/2$) sites in the magnetically ordered phase.

N. Kojima, N. Kida, A. Okazawa, M. Enomoto, *Mössbauer Effect Reference and Data Journal*, **35**, 154 (2012), N. Kojima, M. Itoi, Y. Miyazaki, *Current Inorg. Chem.*, **4**, 85 (2014).

Ferromagnetism of $(n\text{-C}_n\text{H}_{2n+1})_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]$



M. Itoi, Y. Ono, N. Kojima, K. Kato, K. Osaka, M. Takata, *Eur. J. Inorg. Chem.*, 1198 (2006).

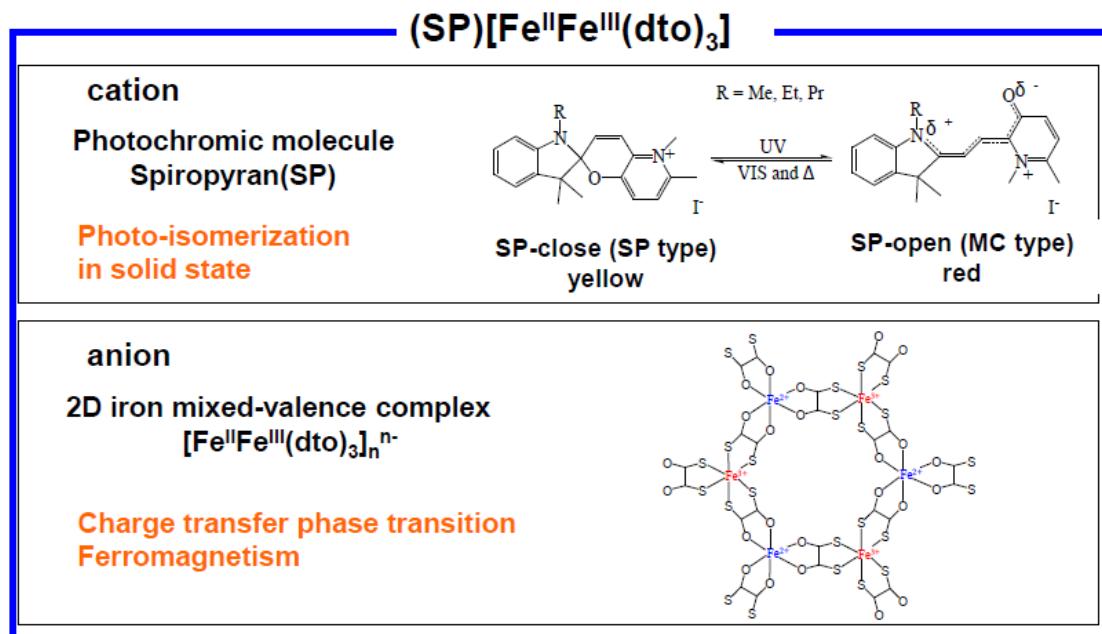


Figure: Molecular design of (SP)[Fe^{II}Fe^{III}(dto)₃] (SP = spiropyran) toward photo-induced charge transfer phase transition by means of photo-isomerization of photochromic molecule.

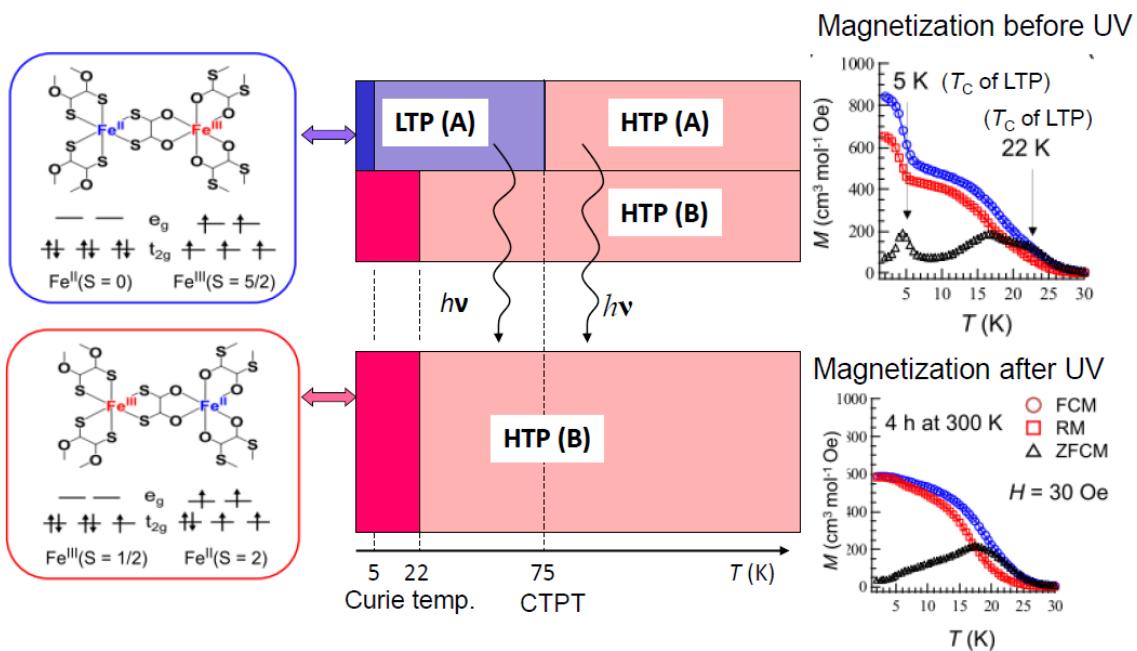


Figure: Temperature dependence of the magnetization for (SP-Me)[Fe^{II}Fe^{III}(dto)₃] before and after the UV light irradiation (350 nm with half width of 10 nm, 40 mW cm⁻²) for 4 h at room temperature. FCM: field cooled magnetization, RM: remnant magnetization, ZFCM: zero-field cooled magnetization.

N. Kida, M. Hikita, I. Kashima, M. Okubo, M. Itoi, M. Enomoto, K. Kato, M. Takata, N. Kojima, *J. Am. Chem. Soc.*, **131**, 212 (2009).

Disappearance of LTP under UV irradiation

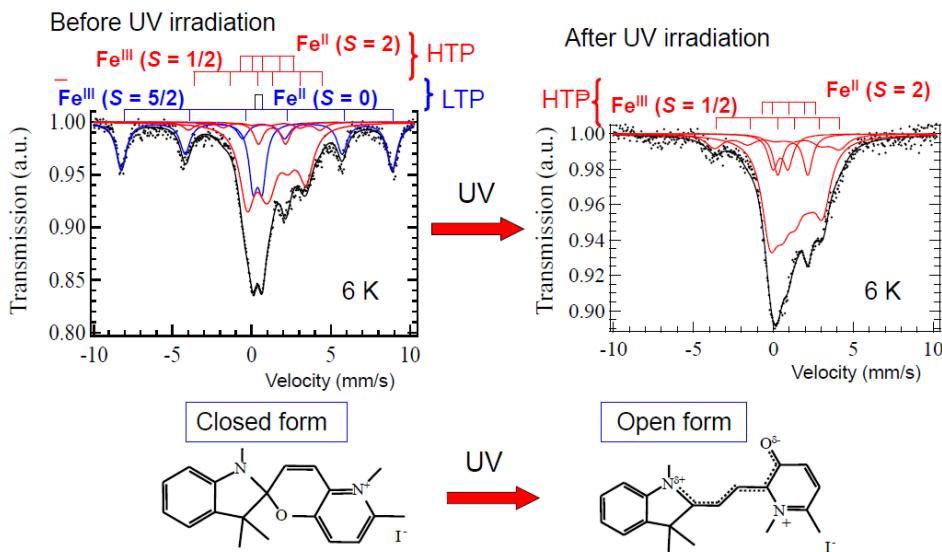
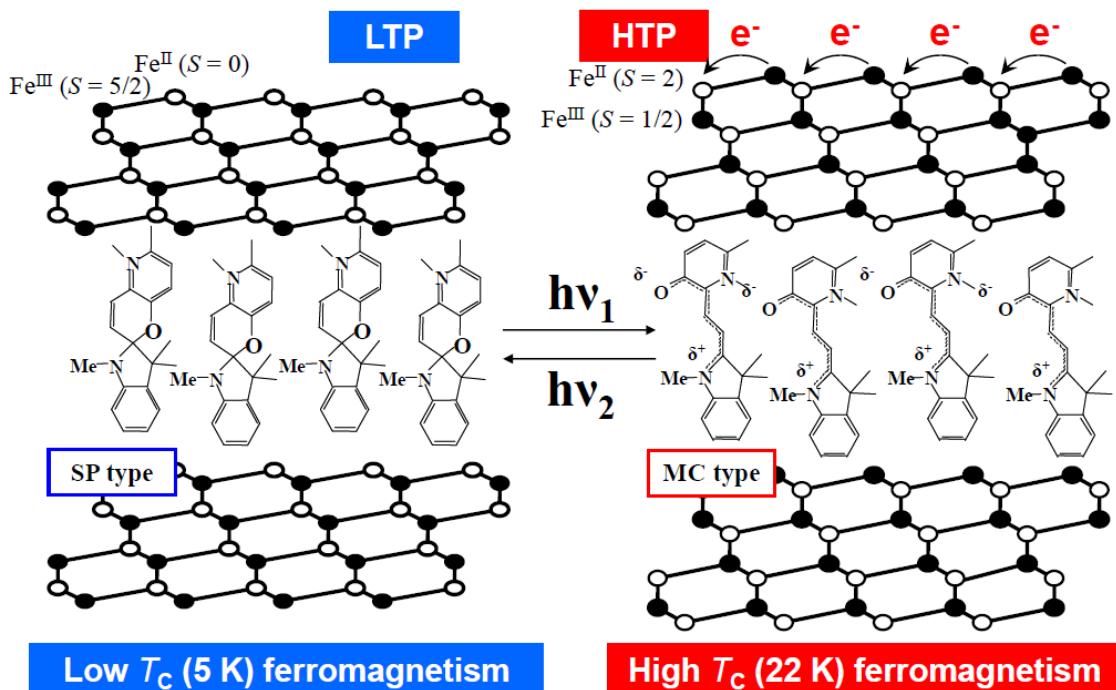


Figure: ⁵⁷Fe Mössbauer spectra of (SP-Me)[Fe^{II}Fe^{III}(dto)₃] at 6 K before and after UV light Irradiation (350 nm with half width of 10 nm, 40 mW cm⁻²) for 3 h at 300 K.

N. Kida, M. Hikita, I. Kashima, M. Enomoto, M. Itoi, N. Kojima, *Polyhedron*, **28**, 1694 (2009).

Photo-isomerization induced CT phase transition at 70 K



N. Kida, M. Hikita, I. Kashima, M. Okubo, M. Itoi, M. Enomoto, K. Kato, M. Takata, N. Kojima, *J. Am. Chem. Soc.*, **131**, 212-220 (2009).

[Dynamical Behavior of the Charge Transfer Phase Transition by means of muon spin spectroscopy](2007-2010)

Muon is a very useful elemental particle for sensing the magnitude, distribution and fluctuation of internal field. Therefore, the muon spin spectroscopy (μ SR) has been applied to the study of magnetic phase transitions, various kinds of spin frustrations, superconducting phenomena and so forth. We have applied the μ SR technique to an iron mixed-valence system, $(n\text{-C}_n\text{H}_{2n+1})_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]$ in order to investigate the dynamical behavior of the charge transfer phase transition (CTPT), and the hopping rate of electrons between Fe^{II} and Fe^{III} sites at the CTPT was revealed for the first time by the analysis of μ SR under longitudinal magnetic field.

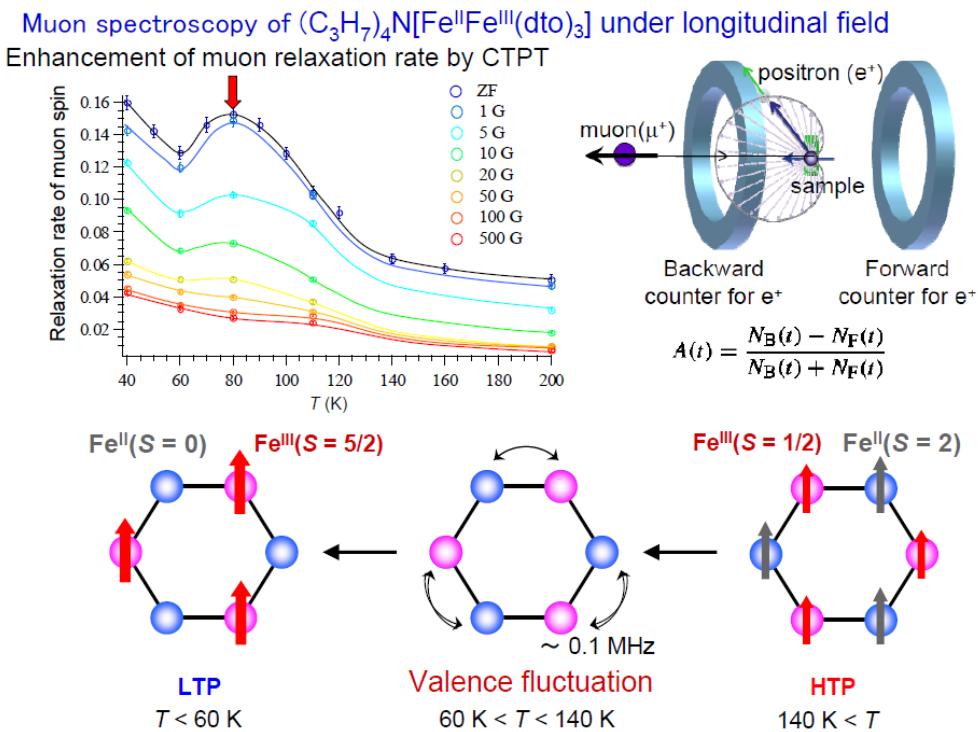


Figure: Schematic representation of muon spectroscopy. $N_F(t)$ and $N_B(t)$ are the total muon events of the forward and backward counters aligned in the beam line, respectively. Temperature and longitudinal-field dependence of the dynamic muon spin depolarization rate, λ_0 , at around CTPT for $(n\text{-C}_3\text{H}_7)_4\text{N}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{dto})_3]$. Schematic representation of the valence fluctuation between the Fe^{II} and Fe^{III} sites at the CTPT.

N. Kida, M. Enomoton, I. Watanabe, T. Suzuki and N. Kojima, *Phys. Rev. B* **77**, 144427 (2008), M. Enomoto, I. Watanabe, N. Kojima, *Current Inorg. Chem.*, **6**, 49 (2016).

[Control of ferromagnetism of $\text{Co}_4(\text{OH})_7(\text{DAE})_{0.5} \cdot 3\text{H}_2\text{O}$ by means of photo-isomerization of intercalated diaryletnene] (2005-2016)

Novel cobalt-based organic-inorganic compounds were prepared by anion exchange reaction, using the photochromic diarylethene anion (DAE). From the magnetic susceptibility measurements, the ferromagnetic transition temperature of $\text{Co}_4(\text{OH})_7(\text{DAE})_{0.5} \cdot 3\text{H}_2\text{O}$ changes from 9 K to 20 K with substitution of the intercalated anion from the open-form of DAE (**1a**) to the closed-form of DAE (**1b**). Therefore, the change of the Curie temperatures between $\text{Co}_4(\text{OH})_7(\text{DAE-open form})_{0.5} \cdot 3\text{H}_2\text{O}$ (**2a**) and $\text{Co}_4(\text{OH})_7(\text{DAE-closed form})_{0.5} \cdot 3\text{H}_2\text{O}$ (**2b**) can be attributed to the change of the π electron system in the DAE molecule. Moreover, the appearance of shoulder in the AC

magnetic susceptibility for $\text{Co}_4(\text{OH})_7(\text{DAE-open form})_{0.5} \cdot 3\text{H}_2\text{O}$ after the irradiation of UV implies that the ferromagnetism of this system can be controlled by photo-irradiation. In the temperature range between 9 K and 20 K, **2a** is placed above the ferromagnetic transition temperature, while **2b** is in below the ferromagnetic temperature, when the photoisomerization occurs in this temperature region, we can select the magnetism as the paramagnetic phase with **2a** or the ferromagnetic phase with **2b** by selecting the wavelength of irradiated light. This compound may be developed to realize a novel optical writing medium at low temperature.

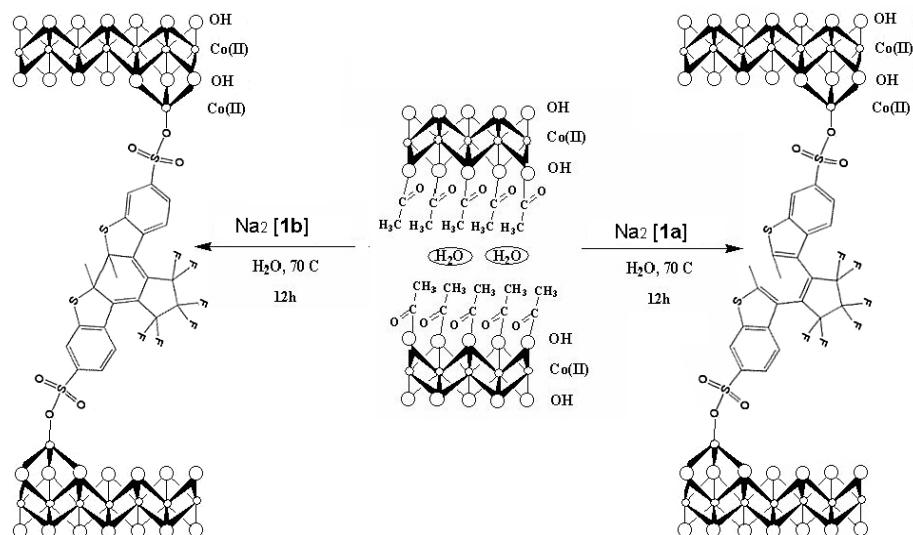
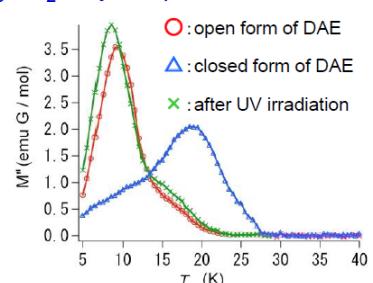
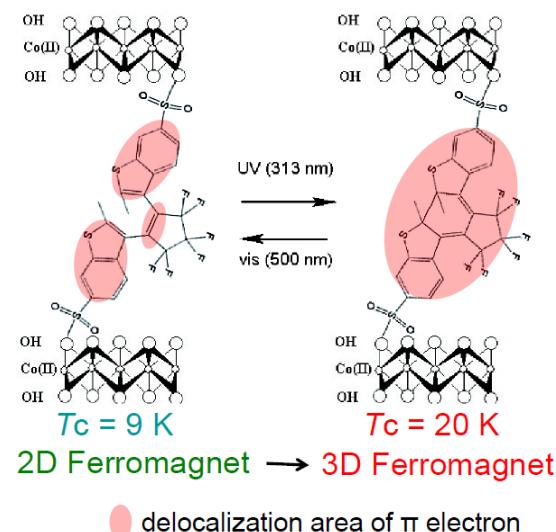


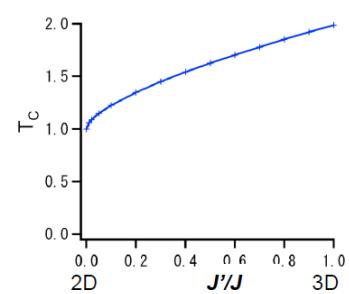
Figure: Synthesis of $\text{Co}_4(\text{OH})_7(\text{DAE})_{0.5} \cdot 3\text{H}_2\text{O}$ by means of anion exchange

Control of ferromagnetism of $\text{Co}_4(\text{OH})_7(\text{DAE})_{0.5} \cdot 3\text{H}_2\text{O}$ by the photo-isomerization of diarylethene (DAE)

DAE behaves as a photomagnetic coupler



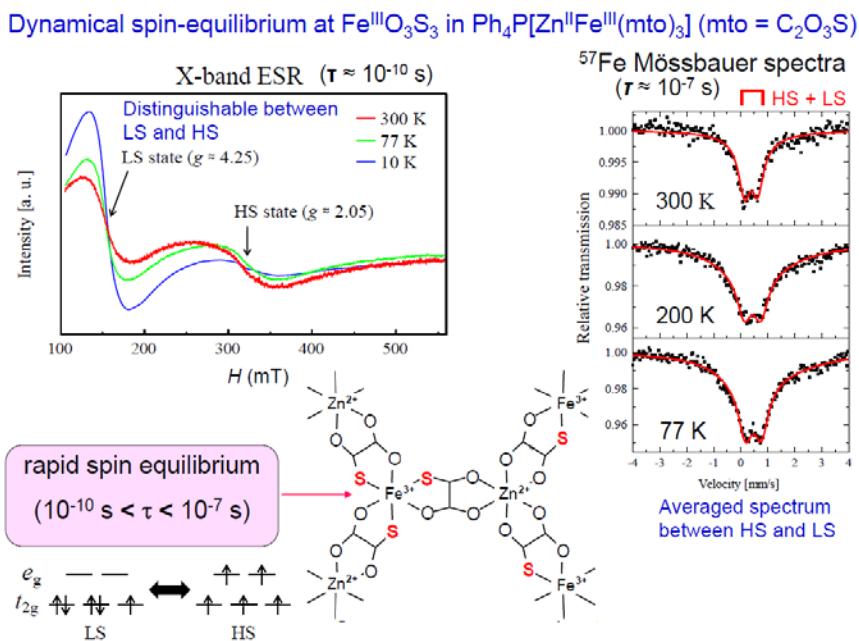
$$H = -J \sum_{\text{intralayer}} S_i^z S_j^z - J' \sum_{\text{interlayer}} S_i^z S_j^z$$



M. Okubo, M. Enomoto, N. Kojima, *Solid State Commun.*, **134**, 777 (2005), H. Shimizu, M. Okubo, A. Nakamoto, M. Enomoto, N. Kojima, *Inorg. Chem.*, **45**, 10240 (2006).

[Study on the dynamical spin equilibrium and its induced successive magnetic phase transition](2010-2018)

In general, the Fe^{III} site coordinated by six S atoms is in the low-spin (LS) state, while the Fe^{III} site coordinated by six O atoms is in the high-spin (HS) state. Therefore, it is expected that the spin state of Fe^{III} coordinated by three S atoms and three O atoms is situated in the spin-crossover region. Actually, the spin equilibrium in which the high-spin (HS) state and the low-spin (LS) state exchange have been confirmed for mononuclear Fe^{III} complexes consisting of Fe^{III}O₃S₃. However, the rapid spin equilibrium phenomenon has not yet been observed for assembled metal complex systems. From this viewpoint, in order to build an assembled metal complex system including Fe^{III}O₃S₃ site, we have synthesized Ph₄P[Zn^{II}Fe^{III}(mto)₃] (mto = monothiooxalato) consisting of Fe^{III}O₃S₃ and Zn^{II}O₆ octahedra and investigated the spin state of the Fe^{III}O₃S₃ site. Ph₄P[Zn^{II}Fe^{III}(mto)₃] has a two-dimensional honeycomb network structure. The ESR and ⁵⁷Fe Mössbauer spectra revealed that the rapid spin equilibrium in which the high-spin (HS) state and the low-spin (LS) state exchange in the time scale of $10^{-10} < \tau < 10^{-7}$ s occurs at the Fe^{III}O₃S₃ site, which is the first report for an assembled metal complex system.



K. Kagesawa, A. Okazawa, M. Enomoto, N. Kojima, *Chem. Lett.* **39**, 872 (2010).

In the case of assembled transition metal complexes whose spin states are situated in the spin-crossover region, concerted phenomena coupled with spin-crossover phenomenon and magnetic phase transitions are expected. From this viewpoint, we have synthesized a mto (= $\text{C}_2\text{O}_3\text{S}$) bridged hetero-metal complex system, $(\text{C}_6\text{H}_5)_4\text{P}[\text{Mn}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3]$ consisting of $\text{Fe}^{\text{III}}\text{O}_3\text{S}_3$ and $\text{Mn}^{\text{II}}\text{O}_6$ octahedra. The molar magnetic susceptibility (χ_M) as a function of temperature has a broad maximum, typical character of 2D Heisenberg-type antiferromagnet, around 50 K, and shows a steep increase below 30 K with a hump around 23 K, where both of the real (χ') and imaginary (χ'') parts in AC magnetic susceptibility exhibit steep peaks indicating a magnetic phase transition. The field cooled magnetization shows a rapid increase below 30 K, and almost saturates below 23 K. At 30 K, the remnant magnetization and the magnetic hysteresis loop disappear. Therefore, it is obvious that $(\text{C}_6\text{H}_5)_4\text{P}[\text{Mn}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3]$ undergoes two successive magnetic phase transitions at 30 K and 23 K. The ^{57}Fe Mössbauer spectroscopy for $(\text{C}_6\text{H}_5)_4\text{P}[\text{Mn}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3]$ implies that the spin state at the Fe^{III} site is still paramagnetic even at 24 K. At 23 K, both of the Mn^{II} and Fe^{III} spins are eventually ordered. It is considered that the successive magnetic phase transitions in $(\text{C}_6\text{H}_5)_4\text{P}[\text{Mn}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3]$ are induced by the rapid spin equilibrium at the Fe^{III} site.

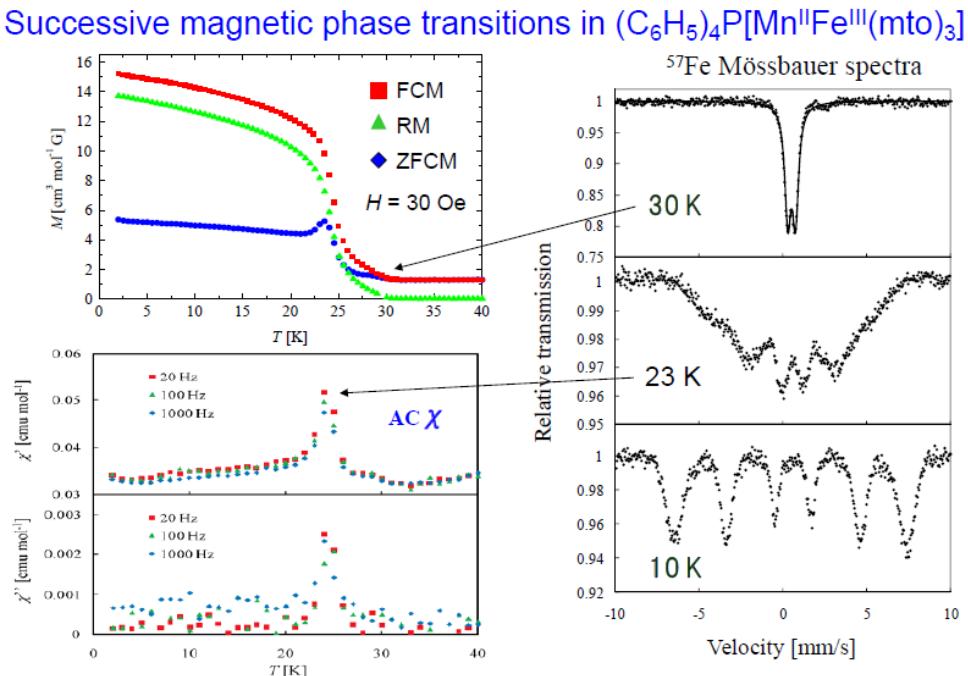


Figure: Successive magnetic phase transitions induced by the rapid spin equilibrium of $\text{Fe}^{\text{III}}\text{O}_3\text{S}_3$ site for $(\text{C}_6\text{H}_5)_4\text{P}[\text{Mn}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3]$.

[Control of spin crossover phenomena by means of functional counter ions](2005-2018)

The spin-crossover (SCO) phenomenon between a high-spin and a low-spin state has attracted much attention in the field of materials science. Among the various kinds of SCO complexes, the triazole-bridged iron(II) polymeric chain system, $[\text{Fe}(\text{II})(\text{R-trz})_3]\text{X}_2 \cdot x\text{H}_2\text{O}$ (where trz is triazole and X is the anion), exhibiting the SCO phenomenon with thermal hysteresis around room temperature, has been extensively studied from the viewpoint of molecular memory and molecular devices. In connection with this system, we have controlled the SCO phenomenon according to the characteristic properties of counter ions. In the case of $\text{X} = \text{C}_n\text{H}_{2n+1}\text{SO}_3^-$, the spin transition temperature ($T_{1/2}$) increases with increasing the length (n) of the alkyl chain of the counter ion and saturates above $n = 5$, which is attributed to the increase in the intermolecular interaction of the alkyl chains of $\text{C}_n\text{H}_{2n+1}\text{SO}_3^-$, called the fastener effect. The hysteresis width of $T_{1/2}$ decreases with increasing n , showing the even-odd effect. In the cases where X is toluenesulfonate (tos: $\text{CH}_3\text{C}_6\text{H}_4\text{SO}_3^-$) and aminobenzenesulfonate (abs: $\text{NH}_2\text{C}_6\text{H}_4\text{SO}_3^-$), $T_{1/2}$ and its hysteresis width vary drastically with the positional isomersism (*ortho*-, *meta*- and *para*-substitution) of counter ions, which implies the possibility of photoinduced spin transition by means of the photoisomerization of counter ions.

Fastener effect of counter ions on SCO for $[\text{Fe}(\text{II})(\text{R-trz})_3](\text{C}_n\text{H}_{2n+1}\text{SO}_3)_2$ system

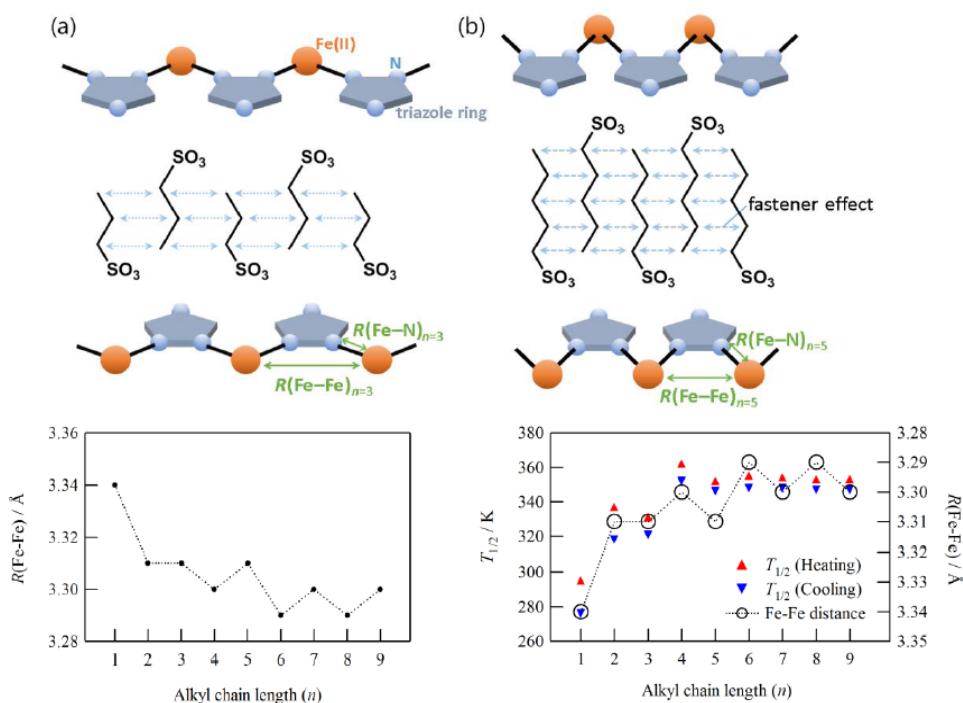


Figure: Nearest-neighbor Fe–Fe distance as a function of the alkyl chain length (n) at 35 K, and the correlation between SCO temperature ($T_{1/2}$) and the nearest neighbor Fe–Fe for $[\text{Fe}^{\text{II}}(\text{NH}_2\text{-trz})_3](\text{C}_n\text{H}_{2n+1}\text{SO}_3)_2 \cdot x\text{H}_2\text{O}$. Schematic representation of the fastener effect on $R(\text{Fe–Fe})$ and $R(\text{Fe–N})$ for $[\text{Fe}^{\text{II}}(\text{NH}_2\text{-trz})_3](\text{C}_n\text{H}_{2n+1}\text{SO}_3)_2 \cdot x\text{H}_2\text{O}$;

H. Kamebuchi, A. Nakamoto, T. Yokoyama, N. Kojima, *Bull. Chem. Soc. Jpn.*, **88**, 419 (2015).
A. Sugahara, H. Kamebuchi, A. Okazawa, M. Enomoto, N. Kojima, *Inorganics*, **5**, 50 (2017).

The Effect of Structural Isomerism of Counter Ions on SCO for the $[\text{Fe}(\text{II})(\text{R-trz})_3]$ System

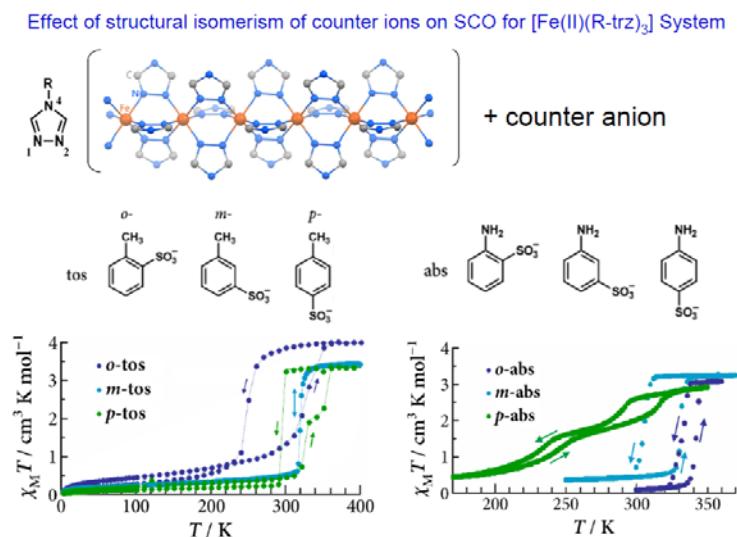


Figure: Temperature dependence of the magnetic susceptibility multiplied by temperature ($\chi_M T$) for $[\text{Fe}(\text{II})(\text{NH}_2\text{-trz})_3](o\text{-}, m\text{-}, \text{and } p\text{-tos})_2 \cdot x\text{H}_2\text{O}$ and $[\text{Fe}(\text{II})(\text{NH}_2\text{-trz})_3](\text{abs})_2 \cdot 2\text{H}_2\text{O}$. The arrows represent the sweeping directions of temperature.

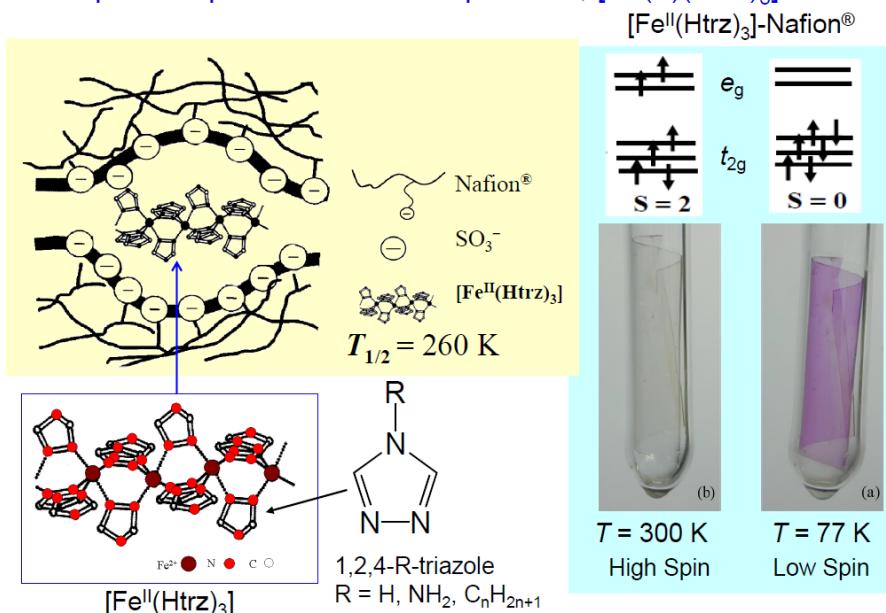
A. Sugahara, H. Kamebuchi, A. Okazawa, M. Enomoto, N. Kojima, *Inorganics*, **5**, 50 (2017).

[Development of multifunctional spin crossover complex film] (2003-2018)

Transition metal complexes with $3d^4$ – $3d^7$ configurations in octahedral surroundings have a possibility of spin-crossover transition between low-spin (LS) and high-spin (HS) states. The spin-crossover phenomenon has attracted much attention since the discovery of the photo-induced spin transition (light induced excited spin state trapping (LIESST)) for $[\text{Fe}(\text{II})(\text{ptz})_6](\text{BF}_4)_2$ (ptz = 1-propyltetrazole), and the thermally-induced spin transition with large thermal hysteresis around room temperature for 1,2,4-triazole (= trz) bridged Fe(II) complexes, $[\text{Fe}(\text{II})(\text{R-trz})_3]\text{A}_2 \cdot n\text{H}_2\text{O}$ (A = anion). In particular, the triazole

bridged polymeric Fe(II) chain system has a possibility of molecular device such as display and memory at room temperature. In order to realize photo-responsive molecular devices, the development of transparent spin-crossover film has been desired. From this viewpoint, we have succeeded in synthesizing a transparent complex film, $[\text{Fe}(\text{H-trz})_3]\text{-Nafion}$, exhibiting the spin crossover phenomenon around room temperature, in which Nafion membrane behaves as counter anion as well as transparent substrate. From the analysis of Fe K-edge EXAFS spectra, we have proved the existence of one-dimensional Fe chain structure, $[\text{Fe}(\text{H-trz})_3]_n$, in Nafion film, and the LIESST effect at 4.2 K.

Transparent spin-crossover complex film, $[\text{Fe}(\text{H-trz})_3]\text{-Nafion}$

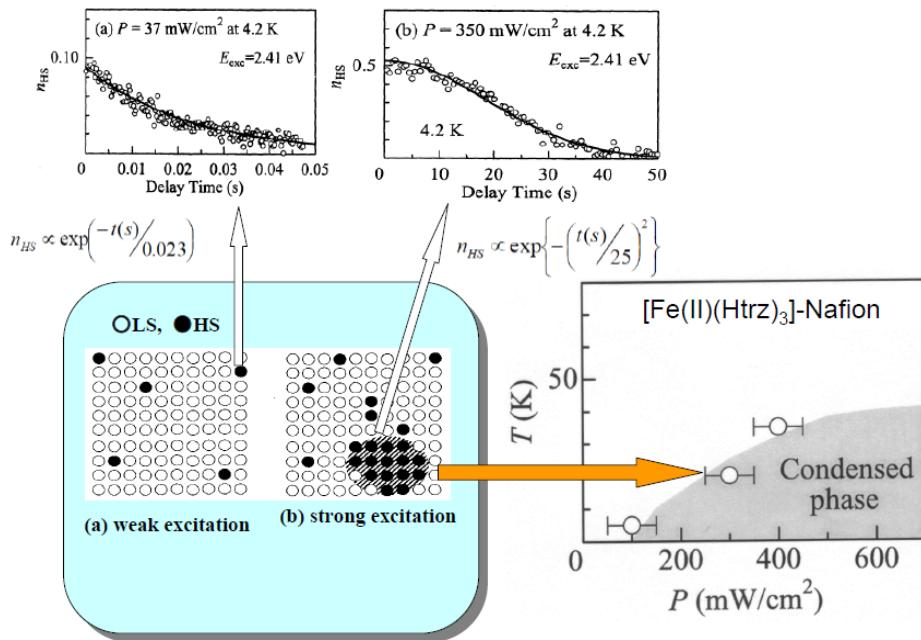


A. Nakamoto, Y. Ono, N. Kojima, D. Matsumura, T. Yokoyama, *Chem. Lett.*, **32**, 336 (2003),
 A. Nakamoto, N. Kojima, X.J. Liu, Y. Moritomo, A. Nakamura, *Polyhedron*, **24**, 2909 (2005).

LIESST effect of the spin crossover complex film, $[\text{Fe}^{\text{II}}(\text{H-trz})_3]\text{-Nafion}$,

We have investigated the LIESST effect for the transparent spin crossover complex film, $[\text{Fe}^{\text{II}}(\text{H-trz})_3]\text{-Nafion}$, and observed the condensed phase of photo-generated HS molecules below 35 K. The life time of the photo-generated HS state strongly depends on the intensity of irradiated light and temperature. Figure shows the relaxation dynamics of the photo-generated HS molecules for $[\text{Fe}^{\text{II}}(\text{H-trz})_3]\text{-Nafion}$ at 4.2K after turning off the excitation light: (a) $P = 37 \text{ mW/cm}^2$ and (b) $P = 350 \text{ mW/cm}^2$. Solid curves are least-squares-fitting results. Phase diagram of the $\text{Fe}^{\text{II}}(\text{H-trz})_3\text{-Nafion}$ against excitation power density (P) and temperature (T). The hatched region represents the condensed phase of the photo-excited HS molecules.

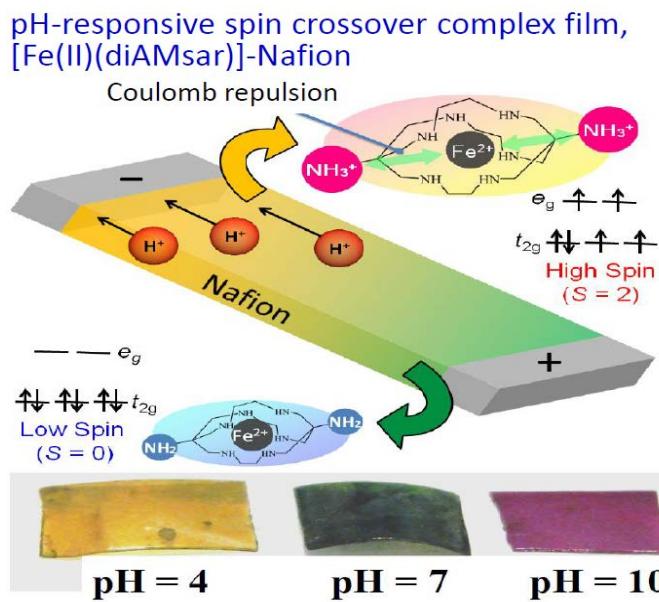
Condensed phase of photo-generated HS state for $[\text{Fe}(\text{II})(\text{Htrz})_3]\text{-Nafion}$



X.J. Liu, Y. Moritomo, T. Kawamoto, A. Nakamoto, N. Kojima, *Phys. Rev. B*, **67**, 012102 (2003),
J. Phys. Soc. Jpn., **72**, 1615 (2003).

pH-responsive spin-crossover complex film, $[\text{Fe}^{\text{II}}(\text{diAMsar})]\text{-Nafion}$

We have developed pH-responsive spin-crossover Fe^{II} complex films, by using diAMsar (1,8-diaminosarcophagine) as a ligand. Sarcophagine (sar) and its derivatives are hexadentate cage-type ligands, whose coordination compounds with Fe^{II} exhibit the spin-crossover phenomenon between the high spin state with $t_{2g}^4e_g^2$ ($S = 2$) and the low spin state with t_{2g}^6 ($S = 0$). The spin-transition temperature and the color of $[\text{Fe}^{\text{II}}(\text{diAMsar})]$ in the solution depend on pH ($T_{1/2} = 290 \text{ K}$ for pH = 4.5; $T_{1/2} = 370 \text{ K}$ for pH = 8.5) due to the protonation/deprotonation of the terminal amino groups in diAMsar. $[\text{Fe}^{\text{II}}(\text{diAMsar})]\text{-Nafion}$ also has different colors depending on the proton concentration controlled by buffer solution (pH = 4, 7 and 10), which indicates the spin state of $[\text{Fe}^{\text{II}}(\text{diAMsar})]\text{-Nafion}$ is spatiotemporally manipulated by the gradient of proton concentration derived from applied voltage. In this way, we can visualize the proton flow in Nafion membrane by using the pH-responsive spin-crossover complex as a color indicator. The development of field responsive spin-crossover complex films will open a large field of multifunctional molecular devices based on Nafion membrane.

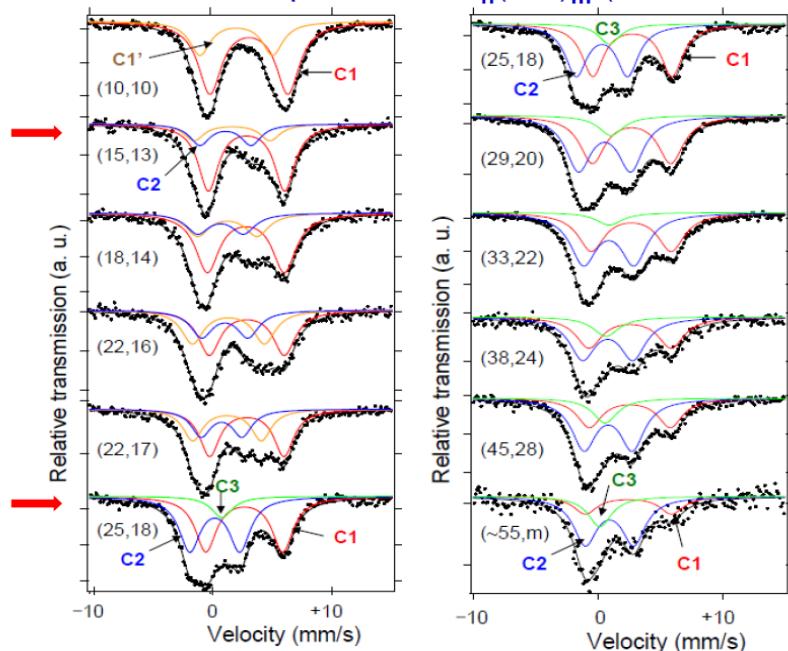


H. Kamebuchi, T. Jo, H. Shimizu, A. Okazawa, M. Enomoto, N. Kojima, *Chem. Lett.*, **40**, 888 (2011), H. Kamebuchi, M. Enomoto, N. Kojima, “Nafion: Properties, Structure and Applications,” Ch. 6, (Nova Science Publishers, Inc., 2016),

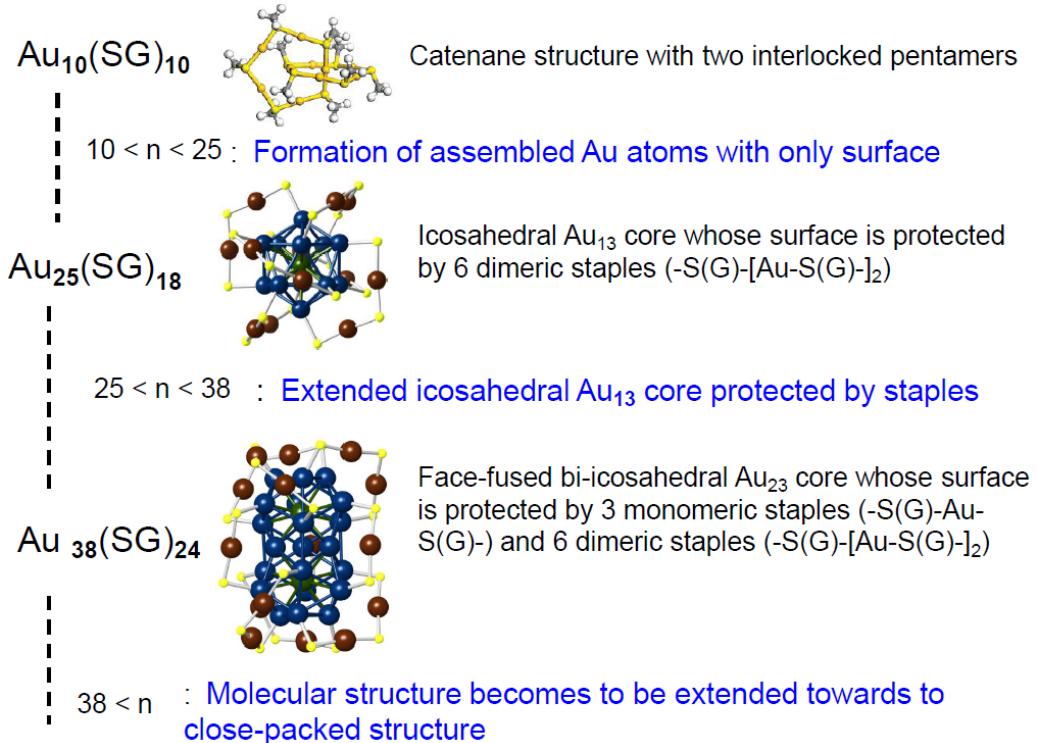
[Study on thiolate-protected Au clusters by means of ^{197}Au Mössbauer spectroscopy] (2006-2018)

The evolution of geometrical structures of thiolate (SR)-protected gold clusters, $\text{Aun}(\text{SR})_m$, in a $n = 10 - 55$ size range, was studied by means of ^{197}Au Mössbauer spectroscopy. Successful analysis of the $\text{Au}_{25}(\text{SR})_{18}$ spectrum, based on the crystallographically determined structure, enabled us to estimate quantitatively the numbers of gold atoms coordinated by different numbers (0, 1, and 2) of SR ligands for all the $\text{Aun}(\text{SR})_m$ clusters. In $\text{Au}_{10}(\text{SR})_{10}$, all the gold atoms are bonded to SR ligands, indicating $-\text{Au}-\text{S}(\text{R})-$ cyclic structures. A catenane structure was proposed for $\text{Au}_{10}(\text{SR})_{10}$. At $n = 15$, gold atoms bonded to a single SR ligand appeared, suggesting the formation of small clusters. At $n = 25$, a single Au atom without the SR ligation appeared, consistent with the formation of an icosahedral Au_{13} core protected by six staples, $-\text{S}(\text{R})-\text{[Au-S(R)-]}_2$. At $n = 39$, the number of Au atoms without the SR ligation increases from one to two, and the ^{197}Au Mössbauer spectrum is consistent with the face-fused bi-icosahedral Au_{23} core. These results demonstrate that ^{197}Au Mössbauer spectroscopy will provide detailed information on the structures of thiolate-protected gold clusters whose single crystals are difficult to make.

^{197}Au Mössbauer spectra of $\text{Au}_n(\text{SG})_m$ ($n = 10 - 55$)



Structure of $\text{Au}_n(\text{SG})_m$ by means of ^{197}Au Mössbauer spectra



K. Ikeda, Y. Kobayashi, Y. Negishi, M. Seto, T. Iwasa, K. Nobusada, T. Tsukuda, N. Kojima, *J. Am. Chem. Soc.*, **129**, 7230 (2007), T. Tsukuda, Y. Negishi, Y. Kobayashi, N. Kojima, *Chem. Lett.*, **40**, 1292 (2011), N. Kojima, Y. Kobayashi, Y. Negishi, M. Seto, T. Tsukuda, *Hyper. Interact.*, **217**, 91 (2013),

[Study on molecular magnetism and single molecule magnet]
 (2005-2018)

Study on the 4f–3d magnetic interaction of $[\text{Ln}_2\text{Cu}_2]$ (Ln = lanthanide)

The magnetization measurements and HF-EPR spectroscopy are complementary methods for the elucidation of the spin structures and energy diagrams for 4f–3d heteronuclear systems. By using HF-EPR spectroscopy, We have demonstrated the significant chemical trend in the plot of J_{4f-3d} against Z for the 4f–3d heteronuclear system, $[\text{Ln}_2\text{Cu}_2]_n$ (Ln = Pr, Nd, Sm, Eu, Gd, Tb, Ho, Er). The ferro- and antiferromagnetic 4f–3d couplings were characterized for the light and heavy lanthanoid derivatives, respectively. The J_{4f-3d} magnitude monotonically decreases with a decrease of the number of the 4f spins, and the strongest coupling was observed for the Gd^{3+} ($4f^7$) derivative.

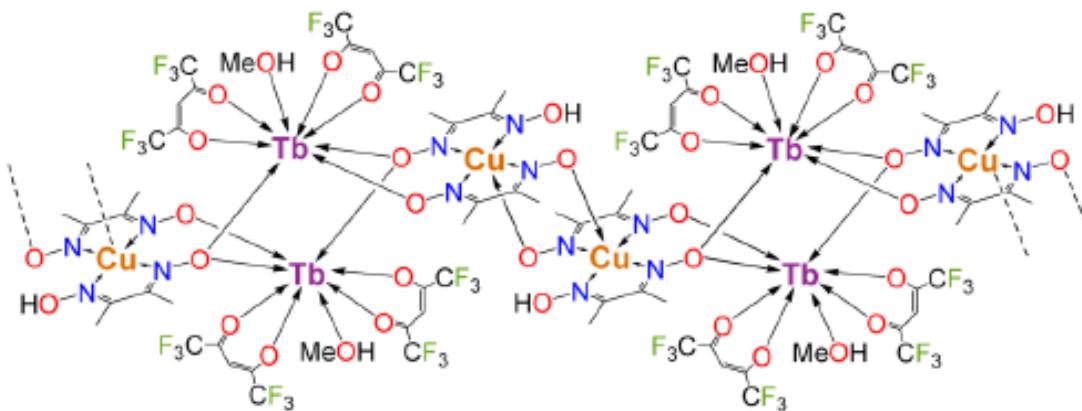


Figure: Crystal structure of $[\{\text{Tb}(\text{hfac})_2(\text{MeOH})\}_2\{\text{Cu}(\text{dmg})(\text{Hdmg})\}_2]_n$ ($\text{Hhfac} = 1,1,1,5,5\text{-hexafluoropentane-2,4-dione}$; $\text{H2dmg} = \text{dimethylglyoxime}$).

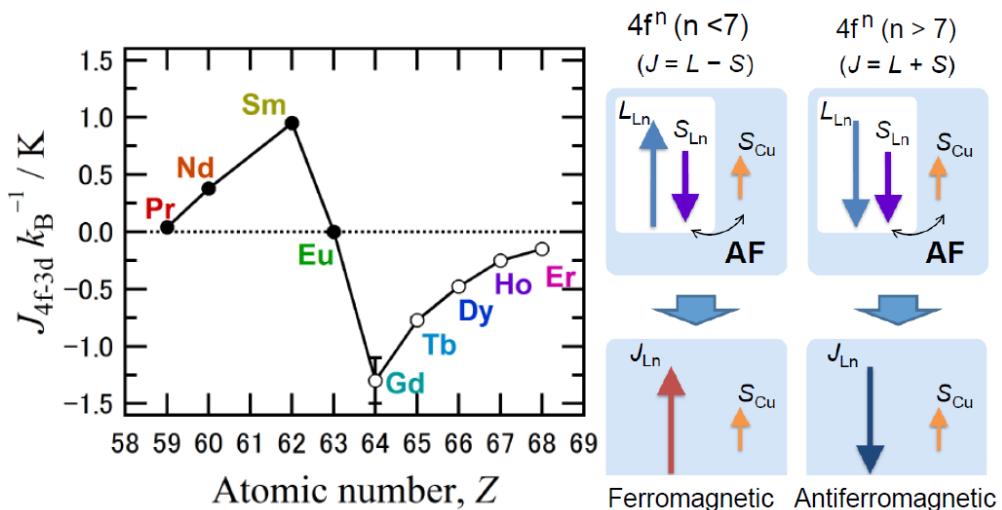


Figure: J_{4f-3d} parameters of $[\text{Ln}_2\text{Cu}_2]$ in $[\{\text{Tb}(\text{hfac})_2(\text{MeOH})\}_2\{\text{Cu}(\text{dmg})(\text{Hdmg})\}_2]_n$ as a function of the atomic number of Ln ions.

A. Okazawa, K. Fujiwara, R. Watanabe, N. Kojima, S. Yoshii, H. Nojiri, T. Ishida, *Polyhedron*, **30**, 3121 (2011).

Study on the single molecular chain magnet of mixed-valence Fe complex,

We have investigated the single molecular chain magnet of mixed-valence Fe complex, $[\text{Fe}^{\text{II}}(\text{ClO}_4)_2\{\text{Fe}^{\text{III}}(\text{bpca})_2\}]\text{ClO}_4$ (Hbpca = bis(2-pyridylcarbonyl)amine) by means of AC magnetic susceptibility, ^{57}Fe Mössbauer spectroscopy and muon spin spectroscopy. The relaxation times $\tau(T)$ extracted from the AC susceptibility and $^{57}\text{Mössbauer}$ spectra were used to construct an Arrhenius plot giving an estimated activation energy of 27 K. Extrapolating the Arrhenius plot, the blocking temperature ($\tau(T_B)$) 100 s was estimated as $T_B = 1.3$ K.

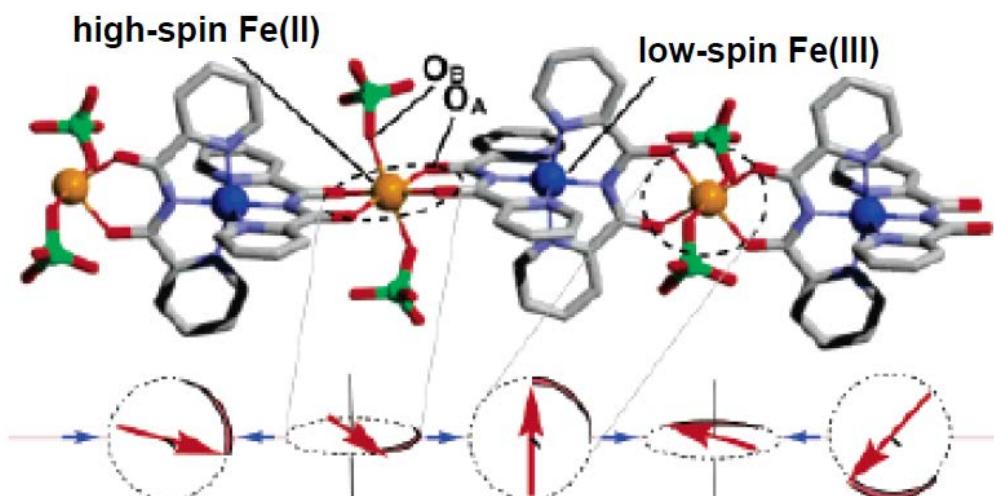


Figure: Crystal structure of $[\text{Fe}^{\text{II}}(\text{ClO}_4)_2\{\text{Fe}^{\text{III}}(\text{bpca})_2\}]\text{ClO}_4$ (Hbpca = bis(2-pyridylcarbonyl)amine) and the spin alignment of Fe^{II} ($S = 2$)– Fe^{III} ($S = 1/2$).

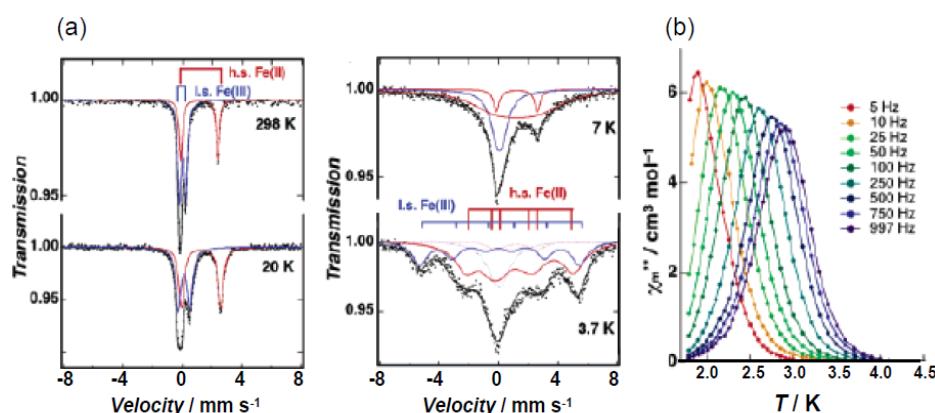


Figure: Temperature dependence of ^{57}Fe Mössbauer spectra between 200 K and 3.7 K, (b) AC magnetic susceptibility ($\chi''/\text{cm}^3 \text{ mol}^{-1}$) as a function of temperature for $[\text{Fe}^{\text{II}}(\text{ClO}_4)_2\{\text{Fe}^{\text{III}}(\text{bpca})_2\}]\text{ClO}_4$.

T. Kajiwara, M. Nakano, Y. Kaneko, S. Takaishi, T. Ito, M. Yamashita, H. Nojiri, N. Kojima, et al, *J. Am. Chem. Soc.*, **127**, 10150 (2005), T. Kajiwara, I. Watanabe, Y. Kaneko, S. Takaishi, M. Enomoto, N. Kojima, M. Yamashita, *J. Am. Chem. Soc.*, **129**, 12360 (2007).

3) Study on the single molecule magnet of linear two-coordinate Fe^{II} complex

We have investigated the behavior of single molecule magnet of linear two-coordinate Fe^{II} complexes bearing fused-ring bulky Rind groups, Fe^{II}(Rind)₂, by means of AC magnetic susceptibility and ⁵⁷Fe Mössbauer spectroscopy. All of these Fe(II) complexes adopt an almost linear C–Fe–C arrangement in the crystals (C–Fe–C angles of ca. 174–178°). For Fe(Eind)₂, a significant orbital contribution due to the linear two-coordination of the Fe(II) ion has been determined by the high effective magnetic moment ($\mu_{\text{eff}} = 5.82 \mu_B$) and the extraordinarily large internal hyperfine field ($H_n = \text{ca. } 140 \text{ T}$) in the ⁵⁷Fe Mössbauer spectrum. Variable frequency out-of-phase ac susceptibility data for Fe(Eind)₂ demonstrate an effective spin-reversal barrier of $U_{\text{eff}} = 51.2 \text{ cm}^{-1}$ associated with the single-ion magnet behavior.

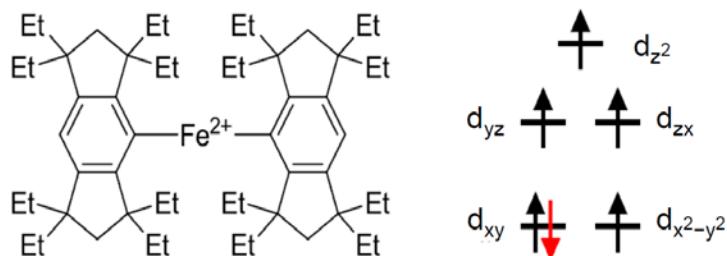


Figure: 3d electron configuration of Fe^{II} and the Molecular structure of Fe^{II}(Eind)₂.

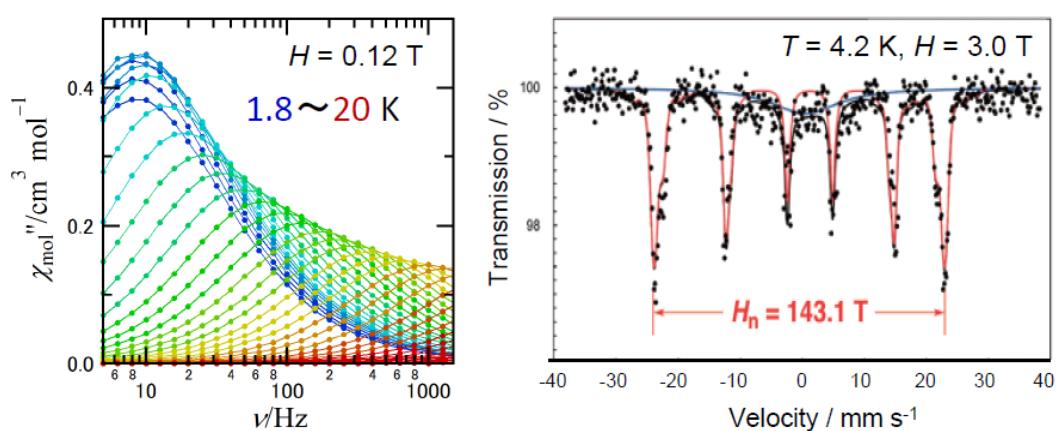


Figure: AC magnetic susceptibility (χ'') as a function of AC frequency, and ⁵⁷Fe Mössbauer spectra at $T = 4.2 \text{ K}$ and $H = 3.0 \text{ T}$ for Fe^{II}(Eind)₂.

S. Goda, M. Nikai, M. Ito, D. Hashizume, K. Tamao, A. Okazawa, N. Kojima, H. Fueno, K. Tanaka, Y. Kobayashi, T. Matsuo, *Chem. Lett.*, **45**, 634–636 (2016).

Publication list (2018)

Norimichi Kojima

Original papers

- 1) N. Kojima, T. Ban and I. Tsujikawa, "Magnon Sideband in the Quasi Two-Dimensional Antiferromagnet $(C_2H_5NH_3)_2MnCl_4$." *J. Phys. Soc. Jpn.* **41**, 1809-1810 (1976).
- 2) N. Kojima, T. Ban and I. Tsujikawa, "Temperature Dependence of the Absorption Spectra $^6A_{1g} \rightarrow ^4A_{1g}$ (4G), 4E_g (4G) in the Quasi Two-Dimensional Antiferromagnet $(C_nH_{2n+1}NH_3)_2MnCl_4$ ($n=2, 3$)."*J. Phys. Soc. Jpn.* **44**, 919-922 (1978).
- 3) N. Kojima, T. Ban and I. Tsujikawa, "Magnon Sideband of the $^4T_{2g}$ (4D) State in the Quasi Two-Dimensional Antiferromagnet $(C_2H_5NH_3)_2MnCl_4$."*J. Phys. Soc. Jpn.* **44**, 923-929 (1978).
- 4) N. Kojima, T. Tsushima and I. Tsujikawa, "Optical Investigations of $YbCrO_3$. I. Optical Absorption Spectra of Yb^{3+} Ion."*J. Phys. Soc. Jpn.* **49**, 1449-1455 (1980).
- 5) N. Kojima, K. Tsushima, S. Kurita and I. Tsujikawa, "Optical Investigations of $YbCrO_3$. II. Metamagnetic Transition in $YbCrO_3$.*J. Phys. Soc. Jpn.* **49**, 1456-1462 (1980).
- 6) N. Kojima, K. Aoyagi, K. Tsushima, I. Tsujikawa and S. Sugano, "Optical Investigations of in $YbCrO_3$. III. Cr^{3+} Exciton – Yb^{3+} Spin Flip Simultaneous Absorption."*J. Phys. Soc. Jpn.* **49**, 1463-1468 (1980).
- 7) N. Kojima, I. Tsujikawa and K. Tsushima, "Field Induced Spin Reorientation in $HoCrO_3$."*Ferrites*, 769-773 (1980).
- 8) N. Kojima, T. Ban and I. Tsujikawa, "Exciton Transfer in the Two-Dimensional Antiferromagnet $(C_2H_5NH_3)_2MnCl_4$."*Int. J. Quantum Chemistry* **18**, 619-623 (1980).
- 9) N. Kojima, K. Tsushima, K. Aoyagi and I. Tsujikawa, " Cr^{3+} Exciton Accompanied with R^{3+} Spin Flip in Rare-Earth Orthochromite $RCrO_3$.*J. Mag. Mag. Materials* **31-34**, 560-562 (1982).
- 10) N. Kojima, I. Tsujikawa, H. Hori, H. Nishimura and M. Date, "Optical Absorption Spectrum in $YbCrO_3$ under High Magnetic Field."*J. Phys. Soc. Jpn.* **53**, 2875-2878 (1984).
- 11) N. Kojima, I. Tsujikawa and K. Tsushima, "Optical Investigations of Rare-Earth Orthochromites. I. $TmCrO_3$.*J. Phys. Soc. Jpn.* **54**, 4794-4803 (1985).
- 12) N. Kojima, I. Tsujikawa, K. Aoyagi and K. Tsushima, "Optical Investigations of Rare-Earth Orthochromites. II. $RCrO_3$ ($R=Er, Ho, Dy$ and Tb)."*J. Phys. Soc. Jpn.* **54**, 4804-4820 (1985).
- 13) N. Kojima, I. Tsujikawa and K. Tsushima, "Optical Investigations of Rare-Earth Orthochromites. III. $GdCrO_3$ and Summary of the R'Band in $RCrO_3$.*J. Phys. Soc. Jpn.* **54**, 4821-4827 (1985).
- 14) H. Hori, N. Kojima, H. Nishimura, I. Tsujikawa and M. Date, "Optical Spectrum of R'-Band in Spin Reorientated $YbCrO_3$ under High Magnetic Field."*J. Phys. Soc. Jpn.* **55**, 1380-1383 (1986).
- 15) I. Mogi, T. Okamoto, N. Kojima, T. Ban and I. Tsujikawa, "Exciton-Magnon Transition in the Linear Chain Compound $CsCoCl_3 \cdot 2H_2O$.*J. Phys. Soc. Jpn.* **55**, 987-992 (1986).
- 16) I. Mogi, N. Kojima, T. Ban and I. Tsujikawa, "Exciton Transition in the One-Dimensional Antiferromagnet $CsCoCl_3 \cdot 2H_2O$.*J. Phys. Soc. Jpn.* **55**, 3664-3670 (1986).
- 17) M. Tanaka, N. Kojima, Y. Ajiro, T. Ban and I. Tsujikawa, "Synthesis and Electrical Conductivity of a New Family of Pt Mixed Valence Complexes: $Pt_6(NH_3)_{14}Cl_{10}X_4$ ($X=ClO_4, BF_4$ and PF_6)."*Synthetic Metals* **19**, 967-970 (1987).
- 18) K. Suzuki, N. Kojima, T. Ban and I. Tsujikawa, "Synthesis, Transport and Superconducting

Properties of Rare Earth Metal Intercalated Tantalum Disulfide Re_xTaS_2 ($\text{RE}=\text{La, Ce}$).” *Synthetic Metals* **19**, 893-896 (1987).

- 19) S. Kutsuzizu, N. Kojima, T. Ban and I. Tsujikawa, “Study of One-Dimensional Metal Complexes: $\text{K}[\text{Ni}(\text{mnt})_2]\text{H}_2\text{O}$ and $\text{K}[\text{Pt}(\text{mnt})_2]\cdot\text{H}_2\text{O}$.” *Bull. Chem. Soc. Jpn.* **60**, 2547-2552 (1987).
- 20) N. Matsushita, N. Kojima, T. Ban and I. Tsujikawa, “Photo-Induced Absorption Band in One-Dimensional Halogen-Bridged Mixed-Valence Platinum Complex: $[\text{Pt}(\text{en})_2][\text{PtI}_2(\text{en})_2](\text{SO}_4)_2\cdot 6\text{H}_2\text{O}$ and $[\text{Au}_x\text{Pt}_{1-x}\text{I}(\text{en})_2]\text{SO}_4\cdot 3\text{H}_2\text{O}$.” *J. Phys. Soc. Jpn.* **56**, 3808-3811 (1987).
- 21) I. Mogi, N. Kojima, Y. Ajiro, H. Kikuchi, T. Ban and I. Tsujikawa, “Optical Investigation of Soliton in One-Dimensional Ising-Like Antiferromagnet CsCoCl_3 .” *J. Phys. Soc. Jpn.* **56**, 4592-4597 (1987).
- 22) K. Kojima, J. Matsuda, N. Kojima, T. Ban and I. Tsujikawa, “Optical and ESR Spectra for High-Spin Tetrahedral Complexes of Co (III) and Co (II) in Keggin-Structure Heteropolytungstate.” *Bull. Chem. Soc. Jpn.* **60**, 3213-3217 (1987).
- 23) I. Mogi, N. Kojima, T. Ban, I. Tsujikawa and S. Kurita, “Magnon Sideband in the One-Dimensional Antiferromagnet $\text{CsCoCl}_3\cdot 2\text{H}_2\text{O}$ under Magnetic Field I.” *Solid State Commun.* **61**, 327-330 (1987).
- 24) I. Mogi, N. Kojima, I. Tsujikawa, Y. Kanamori, K. Kindo, K. Hazumi and M. Date, “High Field Magnetization of the One-Dimensional Ising Antiferromagnet $\text{CsCoCl}_3\cdot 2\text{H}_2\text{O}$.” *J. Phys. Soc. Jpn.* **56**, 2227-2228 (1987).
- 25) N. Kojima and I. Tsujikawa, “ Cr^{3+} Exciton Motion in Rare Earth Orthochromite RCrO_3 .” *J. Mag. Soc. Jpn.* **11-S1**, 45-50 (1987).
- 26) M. Takeda, G. Kido, Y. Nakagawa, H. Okada, N. Kojima, T. Ban and I. Tsujikawa, “Magneto-Absorption Spectra of $\text{CsFeCl}_3\cdot 2\text{H}_2\text{O}$ up to 220 kOe.” *J. Mag. Soc. Jpn.* **11-S1**, 65-68 (1987).
- 27) H. Togashi, N. Kojima, T. Ban and I. Tsujikawa, “Field Induced Davydov Splitting in Quasi One-Dimensional Antiferromagnets $\text{CsMnCl}_3\cdot 2\text{H}_2\text{O}$ and $(\text{CH}_3)_2\text{NH}_2\text{MnCl}_3\cdot 2\text{H}_2\text{O}$.” *J. Mag. Soc. Jpn.* **11-S1**, 69-72 (1987).
- 28) N. Watanabe, N. Kojima, T. Ban and I. Tsujikawa, “Classification of Optical Absorption Spectra in 2D Antiferromagnet $[\text{NH}_3(\text{CH}_2)_n\text{NH}_3]\text{MnCl}_4$ ($n=2, \dots, 5$).” *J. Mag. Soc. Jpn.* **11-S1**, 73-76 (1987).
- 29) H. Okada, N. Kojima, T. Ban and I. Tsujikawa, “Optical Absorption Spectra of One-Dimensional Antiferromagnet $\text{CsFeCl}_3\cdot 2\text{H}_2\text{O}$.” *J. Mag. Soc. Jpn.* **11-S1**, 77-80 (1987).
- 30) H. Hori, Y. Yamamoto, N. Kojima, I. Tsujikawa, K. Tsushima and M. Date, “High Magnetic Field Effects on R- and R'-Spectra in YbCrO_3 .” *J. Mag. Soc. Jpn.* **11-S1**, 141-143 (1987).
- 31) I. Mogi, N. Kojima, T. Ban, I. Tsujikawa, G. Kido, M. Takeda and Y. Nakagawa, “Exciton and Magnon Sideband in the One-Dimensional Antiferromagnet $\text{CsCoCl}_3\cdot 2\text{H}_2\text{O}$ under High Magnetic Field.” *J. Mag. Soc. Jpn.* **11-S1**, 145-148 (1987).
- 32) K. Suzuki, N. Kojima, T. Ban and I. Tsujikawa, “Magnetic and Transport Properties of Ce_xTaS_2 and $(\text{Ce}_2\text{S}_3)_x\text{TaS}_2$.” *Jpn. J. Appl. Phys.* **26-S3**, 1299-1300 (1987).
- 33) H. Togashi, N. Kojima, T. Ban and I. Tsujikawa, “Field-Induced Davydov Splitting of Excitons in Quasi-One-Dimensional Antiferromagnet $\text{CsMnCl}_3\cdot 2\text{H}_2\text{O}$.” *J. Phys. Soc. Jpn.* **57**, 353-360 (1988).
- 34) I. Mogi, H. Togashi, N. Kojima, T. Ban and I. Tsujikawa, “Exciton Transfer in the Random Antiferromagnet $\text{CsMn}_{1-x}\text{Co}_x\text{Cl}_3\cdot 2\text{H}_2\text{O}$.” *J. Phys. Soc. Jpn.* **57**, 2219-2220 (1988).

- 35) H. Togashi, N. Kojima, T. Ban and I. Tsujikawa, "Optical Absorption by Mn²⁺ Ions in MnM (edta)·6H₂O (M=Zn, Cu, Ni, and Co)." *Bull. Chem. Soc. Jpn.* **61**, 1903-1909 (1988).
- 36) N. Watanabe, N. Kojima, T. Ban and I. Tsujikawa, "Optical Absorption Spectra in the Quasi-Two-Dimensional Antiferromagnets [NH₃(CH₂)_nNH₃]MnCl₄ (n=2,3,4,5):I. Experimental." *J. Phys. C: Solid State Phys.* **21**, 4795-4808 (1988).
- 37) N. Watanabe, N. Kojima, T. Ban and I. Tsujikawa, "Optical Absorption Spectra in the Quasi-Two-Dimensional Antiferromagnets [NH₃(CH₂)_nNH₃]MnCl₄ (n=2,3,4, 5): II. Theoretical." *J. Phys. C: Solid State Phys.* **21**, 4809-4825 (1988).
- 38) N. Kojima and I. Tsujikawa, "Field Dependence of the Bound State of Cr³⁺ Exciton Accompanied with Yb³⁺ Spin Flip in YbCrO₃." *J. de Phys.* **49-C8**, 897-898 (1988).
- 39) M. Takeda, G. Kido, Y. Nakagawa, H. Okada, N. Kojima and I. Tsujikawa, "Spin Phase Transition in CsFeCl₃·2H₂O Induced by the Intense Magnetic Field." *J. de Phys.* **49-C8**, 1461-1462 (1988).
- 40) M. Takeda, G. Kido, I. Mogi, Y. Nakagawa, H. Okada and N. Kojima, "New Electronic Excitation at the Boundary of Ferromagnetic and Antiferromagnetic Phases in the One-Dimensional Ising Antiferromagnet CsFeCl₃·2H₂O." *J. Phys. Soc. Jpn.* **58**, 3418-3423 (1988).
- 41) N. Matsushita, N. Kojima, T. Ban and I. Tsujikawa, "Comparison between Optical Properties of Sulfates and Hydrogen-sulfates in Halogen-Bridged Mixed-Valence Platinum (II, IV) Complexes." *Bull. Chem. Soc. Jpn.* **62**, 1785-1790 (1989).
- 42) S. Kutsumizu, N. Kojima and T. Ban, "XPS Study of Au Bis (mnt) Complexes." *Chem. Lett.*, 345-348 (1989).
- 43) N. Matsushita, N. Kojima, N. Watanabe and T. Ban, "Three Photo Induced Absorption Bands of One-Dimensional Halogen-Bridged Mixed-Valence Complex, [Pt(en)₂][PtBr₂(en)₂](SO₄)₂ ·6H₂O." *Solid State Commun.* **71**, 253-258 (1989).
- 44) H. Sato, E. Igaki, T. Nakamura, T. Ban and N. Kojima, "Hydrostatic Pressure Effect on the Charge-Density Wave Transition in the Low-Dimensional Metal K₃Cu₈S₆." *Solid State Commun.* **71**, 793-795 (1989).
- 45) N. Matsushita, N. Kojima, T. Ban and I. Tsujikawa, "Study of Mixed-Valence State in Halogen-Bridged Mixed-Valence Platinum (II, IV) Complexes by Temperature Dependence of Intervalence Charge-Transfer Spectra." *Bull. Chem. Soc. Jpn.* **62**, 3906-3910 (1989).
- 46) K. Suzuki, N. Kojima, T. Ban and I. Tsujikawa, "Magnetic and Transport Properties of Ce-Ta-S Ternary System." *J. Phys. Soc. Jpn.* **59**, 266-272 (1990).
- 47) N. Kojima, H. Kitagawa, T. Ban, F. Amita and M. Nakahara, "Semiconductor-to-Metal and Metal-to-Metal Transitions in the Three-Dimensional Mixed-Valence Compound Cs₂Au₂I₆ under High Pressures." *Solid State Commun.* **73**, 743-745 (1990).
- 48) H. Okada, N. Kojima, T. Ban and I. Tsujikawa, "Optical Absorption Spectra of CsFeCl₃·2H₂O. I. Temperature Dependence." *Phys. Rev. B* **42**, 11610-11618 (1990).
- 49) H. Okada, N. Kojima, T. Ban and I. Tsujikawa, "Optical Absorption Spectra of CsFeCl₃·2H₂O. II. Magnetic Field Dependence." *Phys. Rev. B* **42**, 11619-11626 (1990).
- 50) S. Kutsumizu, N. Kojima, N. Watanabe and T. Ban, "Optical and Magnetic Properties of K[M{S₂C₂(CN)₂}₂]·H₂O (Where M is Ni, Pt, or Au)." *J. Chem. Soc. Dalton Trans.*, 2287-2292 (1990).
- 51) M. Takeda, I. Mogi, G. Kido, Y. Nakagawa, H. Okada and N. Kojima, "Suppression of Soliton Excitation by External Field in Quasi-One-Dimensional Ising Antiferromagnet RbFeCl₃·2H₂O."

J. Mag. Mag. Materials **90-91**, 244-246 (1990).

- 52) N. Kojima, H. Kitagawa, T. Ban, F. Amita and M. Nakahara, "Behavior of the Electrical Conductivity of the Three-Dimensional Mixed-Valence Compounds $Cs_2Au_2X_6$ ($X=Cl, Br, I$) under High Pressures." *Synthetic Metals* **42**, 2347-2350 (1991).
- 53) H. Kitagawa, H. Sato, N. Kojima, T. Kikegawa and O. Shimomura, "Structure Analysis of High-Pressure Metallic State of the Three-Dimensional Mixed-Valence Compound $Cs_2Au^I Au^{III} I_6$ by X-ray Diffraction Using SR." *Synthetic Metals* **42**, 1953-1956 (1991).
- 54) S. Kutsuzizu, N. Kojima and I. Tsujikawa, "Electrical Conduction and Electron Spin Resonance Studies on the Mixed Crystals of $K[Pt_{1-x}Au_x(mnt)_2] \cdot H_2O$." *J. Chem. Soc. Dalton Trans.*, 169-172 (1991).
- 55) H. Kitagawa, H. Sato, N. Kojima, T. Kikegawa and O. Shimomura, "Metallization and Phase Transitions of the Three-Dimensional Halogen-Bridged Mixed-Valence Complex $Cs_2Au_2I_6$ under High Pressure." *Solid State Commun.* **78**, 989-995 (1991).
- 56) H. Kitagawa, N. Kojima, N. Matsushita, T. Ban and I. Tsujikawa, "Studies of the Mixed-Valence States in Three-Dimensional Halogen-Bridged Mixed-Valence Gold Compounds, $Cs_2Au^I Au^{III} I_6$ ($X=Cl, Br, and I$). Part 1. Synthesis, X-Ray, and ESR Studies of $CrAu_{0.6}Br_{2.6}$." *J. Chem. Soc. Dalton Trans.*, 3115-3119 (1991).
- 57) H. Kitagawa, N. Kojima and T. Nakajima, "Studies of the Mixed-Valence States in Three-Dimensional Halogen-Bridged Mixed-Valence Gold Compounds, $Cs_2Au^I Au^{III} I_6$ ($X=Cl, Br, and I$). Part 2. X-Ray Photoelectron Spectroscopic Study of Au Compounds." *J. Chem. Soc. Dalton Trans.*, 3121-3125 (1991).
- 58) H. Kitagawa, N. Kojima and H. Sakai, "Studies of the Mixed-Valence States in Three-Dimensional Halogen-Bridged Mixed-Valence Gold Compounds, $Cs_2Au^I Au^{III} I_6$ ($X=Cl, Br, and I$). Part 3. ^{197}Au Mössbauer Spectroscopic Study." *J. Chem. Soc. Dalton Trans.*, 3211-3215 (1991).
- 59) K. Fukui, N. Kojima, H. Ohya-Nishiguchi and N. Hirota, "Metal-Thiolate Boning Properties: Single-Crystal ESR, Susceptibility, and Polarized Absorption: Evidence for Strong Interaction in Tetrakis(thiophenolato)cobaltate (II)." *Inorg. Chem.* **31**, 1338-1344 (1992).
- 60) I. Mogi, N. Takeda, G. Kido, Y. Nakagawa, H. Okada and N. Kojima, "Magnetic Franck-Condon Effect in the Magneto-Absorption Spectra of $CsFeCl_3 \cdot 2H_2O$." *J. Mag. Mag. Mater.* **104-107**, 1061-1062 (1992).
- 61) T. Terashima and N. Kojima, "Synthesis, Transport, and Magnetic Properties of Misfit Layer Compounds $(RES)_xNbS_2$ ($Re = rare\ earth\ metal$)." *Materials Science Forum* **91-93**, 195-200 (1992).
- 62) N. Kojima, "High Field Magneto-Optics in Rare Earth Orthochromite $RCrO_3$ -Two Types of Bound States of Cr^{3+} Exciton." *Low Temp. Phys.*, **18**, 59-64 (1992).
- 63) K. Ito and N. Kojima, "Optical Investigation of Two-Dimensional Triangular Lattice Antiferromagnets VX_2 ($X=Cl, Br\ and\ I$)." *Low Temp. Phys.*, **18**, 141-144 (1992).
- 64) N. Kojima, S. Maeda, N. Tanaka and N. Matsushita, "Midgap Absorption spectra in Various Kinds of Halogen-Bridged Mixed-Valence Pt Complexes." *Mol. Cryst. Liq. Cryst.* **216**, 163-168 (1992).
- 65) N. Matsushita, K. Toriumi and N. Kojima, "Design of Hydrogen Bond Network in Halogen-Bridged Mixed-Valence Platinum Complexes by Substitution of Counter Ion." *Mol. Cryst. Liq. Cryst.* **216**, 196-201 (1992).
- 66) H. Sato and N. Kojima, "Electronic Properties of Low-Dimensional Ternary Copper Chalcogenides A-Cu-X ($A=Na, K, Rb, Cs; X = S, Se$)." *Phosphorus, Sulfur, and Silicon* **67**, 361-366 (1992).

- 67) T. Terashima and N. Kojima, "Magnetic Properties of $(CeS)_{1.2}NbS_2$ and $(CeS)_{0.6}NbS_2$." *J. Phys. Soc. Jpn.* **61**, 3303-3312 (1992).
- 68) H. Sato and N. Kojima, "Study on Carriers and Charge-Density Wave Transitions of Two-Dimensional Metals $(K_{1-x}Rb_x)_3Cu_8S_6$, $K_3Cu_8(S_{1-x}Se_x)_6$ and $Rb_3Cu_8(S_{1-x}Se_x)_6$." *Synthetic Metals* **56**, 2731-2736 (1993).
- 69) H. Kitagawa, N. Kojima, H. Takahashi and N. Mori, "Electrical Conductivity and its Anisotropy of the Mixed-Valence Compound $Cs_2Au_2I_6$ under High Pressure and Low Temperature." *Synthetic Metals* **56**, 1726-1729 (1993).
- 70) N. Kojima, A. Tanaka, H. Sato, H. Kitagawa, T. Kikegawa and O. Shimomura, "Phase Diagram of the Three-Dimensional Halogen-Bridged Mixed-Valence Compounds $M_2Au_2X_6$ ($M=Rb$, Cs ; $X=Cl$, Br , I) under High Pressure." *Jpn. J. Appl. Phys.* **32-1**, 51-53 (1993).
- 71) N. Kojima, H. Kitagawa, H. Sakai and Yu. Maeda, " ^{197}Au Mossbauer Spectroscopy of the Cubic Phase in the Halogen-Bridged Mixed-Valence Complex $Cs_2Au_2I_6$." *Nuclear Instruments and Methods in Physics Research B* **76**, 321-322 (1993).
- 72) N. Kojima, A. Tanaka, H. Sakai and Yu. Maeda, " ^{197}Au Mossbauer Spectroscopic Study on the Three Dimensional Halogen-Bridged Mixed-Valence Complexes $M_2Au_2X_6$ ($M=Rb$, Cs ; $X=Br$, I)."
Nuclear Instruments and Methods in Physics Research B **76**, 366-367 (1993).
- 73) N. Kojima, M. Kawarazaki, I. Mogi, M. Takeda, G. Kido and Y. Nakagawa, "Bound State of an Exciton-Magnon System under High Magnetic Fields I. MnF_2 ." *Phys. Rev. B* **47**, 15086-15090 (1993).
- 74) N. Kojima, "Bound State of an Exciton-Magnon System under High Magnetic Fields II. $YbCrO_3$." *Phys. Rev. B* **47**, 15091-15096 (1993).
- 75) T. Terashima, N. Kojima, K. Suzuki and T. Enoki, "Magnetic Specific Heat of the Incommensurate Layer Compound $(CeS)_{1.2}NbS_2$." *Solid State Commun.* **84**, 963-966 (1993).
- 76) H. Sato, N. Kojima, K. Suzuki and T. Enoki, "Effects of Alkali Substitution and Pressure on the Charge-Density Wave Transitions of Two-Dimensional Metals $K_3Cu_8S_6$ and $Rb_3Cu_8S_6$." *J. Phys. Soc. Jpn.* **62**, 647-658 (1993).
- 77) H. Sato, N. Kojima and S. Kagoshima, "Structural Phase Transitions of the Quasi Two-Dimensional Metal $(K_{1-x}Rb_x)_3Cu_8S_6$: X-ray Scattering Studies." *J. Phys. Soc. Jpn.* **62**, 2051-2061 (1993).
- 78) T. Terashima, N. Kojima, H. Kitagawa, H. Okamoto and T. Mitani, "Optical Reflectivity Spectra of Incommensurate Layer Compounds $(CeS)_{1.2}NbS_2$ and $(CeS)_{0.6}NbS_2$." *J. Phys. Soc. Jpn.* **62**, 2166-2173 (1993).
- 79) N. Kojima, K. Ito, I. Mogi, M. Takeda, G. Kido, Y. Nakagawa, M. Sakai, N. Kuroda and Y. Nishina, "Optical Investigation of the Magnetic Excitation in Two-Dimensional Triangular Lattice Antiferromagnets." *J. Phys. Soc. Jpn.* **62**, 4137-4145 (1993).
- 80) M. Hangyo, T. Nishio, S. Nakashima, Y. Ohno, T. Terashima and N. Kojima, "Raman and Infrared Spectra of Misfit Layer Compounds $MNbS_3$ ($M=Sn$, Pb , La , Ce)."
Jpn. J. Appl. Phys. **32-3**, 581-583 (1993).
- 81) T. Terashima and N. Kojima, "Electrical Transport Properties of Incommensurate Layer Compounds $(RE)_xNbS_2$ (RE = Rare-Earth Metals; $x = 1.2$, 0.6)."
J. Phys. Soc. Jpn. **63**, 658-673 (1994).
- 82) N. Kojima and H. Kitagawa, "Optical Investigation of the Intervalence Charge-Transfer Interaction in the Three-Dimensional Au Mixed-Valence Compounds $Cs_2Au_2X_6$ ($X=Cl$, Br and I)."
J. Chem. Soc. Dalton Trans., 327-331 (1994).

- 83) N. Kojima, M. Hasegawa, H. Kitagawa, T. Kikegawa and O. Shimomura, "P-T Phase Diagram and Gold Valence State of the Perovskite-Type Mixed-Valence Compounds $\text{Cs}_2\text{Au}_2\text{X}_6$ (X=Cl, Br, and I) under High Pressures." *J. Am. Chem. Soc.* **116**, 11368-11374 (1994).
- 84) S. S. Hafner, N. Kojima, J. Stanek and Li Zhang, "Divalent Gold in Perovskite Type CsAuI_3 ." *Phys. Lett. A* **192**, 385-388 (1994).
- 85) M. Hangyo, K. Kisoda, T. Nishio, S. Nakashima, T. Terashima and N. Kojima, "Staging and Interlayer Interaction in the Misfit-Layer Compounds $(\text{RS})_n\text{NbS}_2$ (R=La, Ce; n=0.6, 1.2) Studied by Raman and Infrared Spectroscopies." *Phys. Rev. B* **50**, 12033-12043 (1994).
- 86) H. Ito, M. Kubota, Y. V. Sushko, N. Kojima, G. Saito and T. Ishiguro, "Temperature-Pressure Phase Diagrams of Hydrogenated and Deuterated κ -(BEDT-TTF)₂Cu[N(CN)₂]Cl." *Synthetic Metals* **70**, 925-926 (1995).
- 87) G. Saito, K. Yoshida, M. Shibata, H. Yamochi, N. Kojima, M. Kusunoki and K. Sakaguchi, "Structural and Physical Properties of Charge Transfer Complexes with [M(dto)₂] Anions (M=Ni, Pt, Cu, Pd. dto: Dithiooxalate)." *Synthetic Metals* **70**, 1205-1208 (1995).
- 88) N. Kojima, H. Okada, M. Kawarazaki, I. Mogi, M. Takeda, G. Kido, Y. Nakagawa and K. Tsushima, "Optical Investigations of YbCrO_3 under High Magnetic Fields I. Yb^{3+} Absorption Spectra." *J. Phys. Soc. Jpn.* **64**, 3082-3089 (1995).
- 89) N. Kojima, H. Okada, M. Kawarazaki, I. Mogi, M. Takeda, G. Kido, Y. Nakagawa and K. Tsushima, "Optical Investigations of YbCrO_3 under High Magnetic Fields II. Cr^{3+} - Yb^{3+} Two-Exciton Absorption." *J. Phys. Soc. Jpn.* **64**, 3090-3096 (1995).
- 90) N. Kojima, I. Mogi and G. Kido, "High-Field Magneto-Optics of MnF_2 and YbCrO_3 ." *Physica B* **216**, 336-337 (1996).
- 91) K. Kisoda, M. Hangyo, S. Nakashima, T. Terashima and N. Kojima, "Charge Transfer and Phonons in Misfit Layer Compounds $(\text{RS})_x \text{NbS}_2$ (R = rare earth; x=1.2)." *Physica B* **219&220**, 565-567 (1996).
- 92) M. Kubota, G. Saito, H. Ito, T. Ishiguro and N. Kojima, "Magnetism of the Organic Superconductor κ -(BEDT-TTF)₂Cu[N(CN)₂]Cl." *Mol. Cryst. Liq. Cryst.* **284**, 367-377 (1996).
- 93) N. Kojima, H. Sakai, M. Seto, S. Kitao and Yu. Maeda, "¹²⁹I Mossbauer Spectroscopy of Gold Mixed-Valence Compound $\text{Cs}_2\text{Au}_2\text{I}_6$." *Societa Italiana di Fisica* **50**, 47-50 (1996).
- 94) N. Kojima, M. Seto and Yu. Maeda, "Single Crystal ¹⁹⁷Au Mossbauer Spectroscopy of Gold Mixed-Valence Compound $\text{Cs}_2\text{Au}_2\text{I}_6$." *Societa Italiana di Fisica* **50**, 43-46 (1996).
- 95) N. Matsushita, A. Takano and N. Kojima, "Phase Transition and Generation Efficiency of Mismatch of Valence-Alteration in the Neutral MX Chain System. $[\text{PtX}_2(\text{en})][\text{PtX}_4(\text{en})]$ (X=Cl, Br, I)." *Mol. Cryst. Liq. Cryst.*, **285**, 317-322 (1996).
- 96) N. Kojima, "Structural Phase Transition and Au Valence State of the Perovskite-type Au Mixed-Valence Compounds $\text{M}_2\text{Au}_2\text{X}_6$ (M=Rb, Cs; X=Cl, Br, I) under High Pressure." *Mol. Cryst. Liq. Cryst.*, **285**, 295-302 (1996).
- 97) T. Komatsu, N. Kojima and G. Saito, "Magnetic Properties of an Organic Spin-Ladder Compound (BEDT-TTF)Zn(SCN)₃." *Solid State Commun.*, **10**, 519-523 (1997).
- 98) N. Matsushita, H. Kitagawa and N. Kojima, "Three-Dimensional Iodo-Bridged Mixed-Valence Gold(I,III) Compound, $\text{Cs}_2\text{Au}^{\text{I}}\text{Au}^{\text{III}}\text{I}_6$." *Acta Cryst.C*, **53**, 663-666 (1997).
- 99) T. Komatsu, N. Kojima and G. Saito, "Ambient-Pressure Superconductivity of κ' -(BEDT-TTF)₂ $\text{Cu}_2(\text{CN})_3$ Realized by a Carrier- Doping into a Mott-Insulating State." *Synthetic Metals*, **85**, 1519-

1520 (1997).

- 100) N. Kojima, F. Fukuhara, H. Kitagawa, H. Takahashi and N. Mori, "Metallic Bipolaron Phase and Its Pre-entrant Phenomenon in the Au Mixed-Valence Compounds $\text{Cs}_2\text{Au}_2\text{X}_6$ (X=Cl, I) under High Pressure." *Synthetic Metals.* **86**, 2175-2176 (1997).
- 101) A. Gohsh, N. Kimura, S. Ishimaru, R. Ikeda, A. Takano and N. Kojima, "Solid State ^1H NMR in One Dimensional Neutral Complex: $[\text{PtCl}_2(\text{en})][\text{PtCl}_4(\text{en})]$." *Solid State Commun.*, **104**, 469-472 (1997).
- 102) A. Ishikawa, M. Kurasawa, S. Kitahara, A. Sasane, N. Kojima and R. Ikeda, " ^{35}Cl NQR Study on $\text{Cs}_2[\text{Au}^{\text{I}}\text{Cl}_2][\text{Au}^{\text{III}}\text{Cl}_4]$." *Z. Naturforsch.*, **53a**, 590-594 (1998).
- 103) T. Hashimoto, N. Matsushita, Y. Murakami, N. Kojima, K. Yoshida, H. Tagawa, M. Dokiya and T. Kikegawa, "Pressure-induced Structural Phase Transition of LaCrO_3 ." *Solid State Commun.*, **108**, 691-694 (1998).
- 104) N. Matsushita, H. Ahsbahs, S.S. Hafner and N. Kojima, "Crystal Structure of Mixed-Valence Gold Compound, $\text{Cs}_2\text{Au}^{\text{I}}\text{Au}^{\text{III}}\text{Cl}_6$ up to 18 GPa." *Rev. High Pressure Sci. Technol.*, **17**, 329-331 (1998).
- 105) T. Yokoyama, Y. Murakami, M. Kiguchi, T. Komatsu and N. Kojima, "Spin-crossover Phase Transition of a Chain Fe(II) Complex Studied by X-Ray-Absorption Fine-Structure Spectroscopy." *Phys. Rev. B* **58**, 14238-14244 (1998).
- 106) X.J. Liu, K. Matsuda, Y. Moritomo, A. Nakamura and N. Kojima, "Electronic Structure of the Gold Complexes $\text{Cs}_2\text{Au}_2\text{X}_6$ (X=I, Br, and Cl)." *Phys. Rev. B* **59**, 7925-7930 (1999).
- 107) X.J. Liu, Y. Moritomo, A. Nakamura and N. Kojima, "Pressure Induced Phase Transition in Mixed-Valence Gold Complexes $\text{Cs}_2\text{Au}_2\text{X}_6$ (X=Cl and Br)." *J. Chem. Phys.*, **110**, 9174-9178 (1999).
- 108) T. Komatsu, N. Kojima and G. Saito, "A Weakly Coupled Molecular Spin-Ladder (BEDT-TTF) $\text{Zn}(\text{SCN})_3$." *Synth. Metals*, **103**, 1923-1924 (1999).
- 109) N. Kojima, Y. Murakami, T. Komatsu and T. Yokoyama, "EXAFS Study on the Spin-Crossover System, $[\text{Fe}(4-\text{NH}_2\text{trz})_3](\text{R}-\text{SO}_3)_2$." *Synth. Metals*, **103**, 2154 (1999).
- 110) Y. Murakami, T. Komatsu and N. Kojima, "Control of Tc and Spin Bistability in the Spin-Crossover System, $[\text{Fe}(4-\text{NH}_2\text{trz})_3](\text{R}-\text{SO}_3)_2$." *Synth. Metals*, **103**, 2157-2158 (1999).
- 111) A. Takano, T. Komatsu, N. Matsushita and N. Kojima, "Photo-Induced and Doping Effects on the Non-linear Excitation in $[\text{PtX}_2(\text{en})][\text{PtX}_4(\text{en})]$ (X=Cl, Br, I)." *Synth. Metals*, **103**, 153 (1999).
- 112) X.J. Liu, Y. Moritomo, A. Nakamura and N. Kojima, "Broad Raman Band in the Single-Valence State of $\text{Cs}_2\text{Au}_2\text{X}_6$ (X= Cl and Br)." *J. Phys. Soc. Jpn.*, **68**, 3134-3137 (1999).
- 113) N. Kojima, "Gold Valence Transition and Phase Diagram in the Mixed-Valence Complexes, $\text{M}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{X}_4]$ ($\text{M}=\text{Rb}, \text{Cs}; \text{X}=\text{Cl}, \text{Br}, \text{and I}$)." *Bull. Chem. Soc. Jpn.*, **73**, 1445-1460 (2000).
- 114) N. Kojima and N. Matsushita, "P-T Phase Diagram and Au Valence State of the Perovskite-type Au Mixed-Valence Complexes, $\text{M}_2[\text{Au}^{\text{I}}\text{X}_2][\text{Au}^{\text{III}}\text{X}_4]$ ($\text{M}=\text{K}, \text{Rb}, \text{Cs}; \text{X}=\text{Cl}, \text{Br}, \text{I}$)." *Coord. Chem. Rev.*, **198**, 251-263 (2000).
- 115) X.J. Liu, Y. Moritomo, A. Nakamura, S. Matsuba and N. Kojima, "Pressure-Induced Phase Transition in Quasi-1D Mixed-Valence Gold Complexes." *J. Phys. Soc. Jpn.*, **67**, 3158-3161 (2000).
- 116) N. Matsuba, N. Kojima, T. Komatsu, M. Seto, Y. Kobayashi and Yu. Maeda, "Studies of Mixed-Valence States in One-Dimensional Halogen-Bridged Gold Compounds $[\text{Au}^{\text{I}}\text{X}(\text{DBS})][\text{Au}^{\text{III}}\text{X}_3(\text{DBS})]$ (X= Cl, Br, I; DBS=dibenzylsulfide)." *Mol. Cryst. Liq. Cryst.*, **343**, 169-174 (2000).
- 117) S. Toyazaki, Y. Murakami, T. Komatsu, N. Kojima and T. Yokoyama, "Study on the Spin-Crossover

System for $[Fe(4-NH_2trz)_3](p-CH_3C_6H_4SO_3)_2$ nH₂O.” *Mol. Cryst. Liq. Cryst.*, **343**, 175-180 (2000).

- 118) T. Komatsu and N. Kojima, “Molecular Orbital Calculation on the Neutral Mixed-Valent Platinum Complex, $[Pt^{II}Cl_2(en)][Pt^{IV}Cl_4(en)]$.” *Mol. Cryst. Liq. Cryst.*, **34**, 139-144 (2000).
- 119) X.J. Liu, Y. Moritomo, M. Ichida, A. Nakamura and N. Kojima, “Photoinduced Phase Transition in a Mixed-Valence Gold Complex.” *Phys. Rev. B* **61**, 20-23 (2000).
- 120) X.J. Liu, Y. Moritomo, M. Ichida, A. Nakamura and N. Kojima, “Critical Nucleation in the Phototransferred Metastable Phase of $Cs_2Au_2Br_6$.” *J. Phys. Soc. Jpn.*, **69**, 1267-1270 (2000).
- 121) G. Saito, H. Izukashi, M. Shibata, K. Yoshida, L.A. Kushch, T. Kondo, H. Yamochi, O.O. Drozdova, K. Matsumoto, M. Kusunoki, K. Sakaguchi, N. Kojima and E.B. Yagubskii, “Formation of 2:1 Insulating Complexes of $D^+D^+A^{2-}$ Alternating Stack and a 4:1 Semimetallic Complex Using M(dto)₂ Dianions, (M= Ni, Pd or Pt and dto = dithiooxalate).” *J. Mater. Chem.*, **10**, 893-910 (2000).
- 122) X.J. Liu, Y. Moritomo, M. Ichida, A. Nakamura and N. Kojima, “Pressure- and Photo-induced Phase Transition in Gold Complex.” *J. Luminescence*, **87-89**, 649-651 (2000).
- 123) N. Kojima, W. Aoki, M. Itoi, Y. Ono, M. Seto, Y. Kobayashi and Yu. Maeda, “Charge transfer Phase Transition and Ferromagnetism in a Mixed-Valence Iron Complex, $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3](dto=C_2O_2S_2)$.” *Solid State Commun.*, **120**, 165-170 (2001).
- 124) X.J. Liu, Y. Moritomo, A. Nakamura, T. Hirao, S. Toyazaki and N. Kojima, “Photoinduced Phase Transition and Relaxation Behaviour in a Spin-Crossover Fe(II) Complex nafion-[Fe(Hrrz)₃] Film.” *J. Phys. Soc. Jpn.*, **70**, 2521-2524 (2001).
- 125) X.J. Liu, Y. Moritomo, A. Nakamura and N. Kojima, “Pressure- and Photo-induced Phase Transition in Mixed-Valence Gold Complexes.” *Phase Transitions*, **74**, 51-92 (2001).
- 126) X.J. Liu, Y. Moritomo, A. Nakamura and N. Kojima, “Dynamical Process of Photo-induced Phase Transition in a Mixed-Valence Gold Complex.” *J. Luminescence*, **94-95**, 541-544 (2001).
- 127) T. Nakamoto, Y. Miyazaki, M. Itoi, Y. Ono, N. Kojima and M. Sorai, “Heat Capacity of the Mixed-Valence Complex, $\{(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3]\}_n$ (dto: dithiooxalato) and Phase Transition due to Electron Transfer and Change in Spin-State of the Whole System.” *Angew. Chem. Int. Ed.*, **40**, 4716-4719 (2001).
- 128) S. Toyazaki, M. Nakanishi, T. Komatsu, N. Kojima, D. Matsumura and T. Yokoyama, “Control of Tc by Isomerization of Counter Anion in Fe(II) Spin Crossover Complexes, $[Fe(4-NH_2trz)_3](R-SO_3)_2$.” *Synthetic Metals*, **121**, 1794-1795 (2001).
- 129) N. Kojima, W. Aoki, M. Seto, Y. Kobayashi and Yu. Maeda, “Reversible Charge-Transfer Phase Transition in $[(n-C_3H_7)_4N][Fe^{II}Fe^{III}(dto)_3]$ (dto = $C_2O_2S_2$).” *Synthetic Metals*, **121**, 1796-1797 (2001).
- 130) Ishikawa, M. Kurashawa, K. Kurashawa, A. Sasane, R. Ikeda and N. Kojima, “³⁵Cl Quadrupole Relaxation Study on $Cs_2[Au(I)Cl_2][Au(III)Cl_4]$ and $Cs_2[Ag(I)Cl_2][Au(III)Cl_4]$.” *Z. Naturforsch.*, **57a**, 348-352 (2002).
- 131) N. Kojima and K. Tsushima, “Recent Progress in magneto-Optics and Research on Its Application.” *Low Temp. Phys.*, **28**, 677-690 (2002).
- 132) Y. Moritomo, K. Kato, A. Nakamoto, N. Kojima, E. Nishibori, M. Takata and M. Sakata, “Low-Temperature Structure of $[Fe(ptz)_6](BF_4)_2$ – Determination by Synchrotron-Radiation X-ray Powder Study –.” *J. Phys. Soc. Jpn.*, **71**, 1015-1018 (2002).

- 133) N. Kojima, S. Toyazaki, M. Itoi, Y. Ono, W. Aoki, Y. Kobayashi, M. Seto and T. Yokoyama, "Search on Multi-Functional Properties of Spin-Crossover System." *Mol. Cryst. Liq. Cryst.*, **376**, 567-574 (2002).
- 134) M. Ohkubo, T. Komatsu, N. Matsushita, N. Kojima and G. Saito, "Crystal Structure and Physical Properties of BEDT-TTF (bis(ethylenedithio)tetrathiafulvalene) Salt Coupled with a Photo-Sensitive Transition Metal Complex." *Mol. Cryst. Liq. Cryst.*, **376**, 147-152 (2002).
- 135) N. Kojima, M. Itoi, Y. Ono, M. Ohkubo, Y. Kobayashi and M. Seto, "New-type Phase Transition Coupled with Spin and Charge in Iron Mixed-Valence System." *Mol. Cryst. Liq. Cryst.*, **379**, 349-356 (2002).
- 136) Y. Ono and N. Kojima, "Study on the Molecular Magnetism in Mixed-Valence Iron Complexes, $M[Fe^{II}Fe^{III}(mto)_3]$ ($M = (n-C_nH_{2n+1})_4N$, mto = monothiooxalato (C_2O_3S))." *Mol. Cryst. Liq. Cryst.*, **379**, 349-356 (2002).
- 137) M. Itoi, N. Kojima, Y. Kobayashi and K. Asai, "Pressure Effect on Ferromagnetic Transition and Charge transfer Phase Transition in a Mixed-Valence Iron Complex, $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3](dto = C_2O_2S_2)$." *Mol. Cryst. Liq. Cryst.*, **379**, 377-382 (2002).
- 138) X.J. Liu, Y. Moritomo, A. Nakamura, S. Matsuba and N. Kojima, "Pressure Effects on Quasi-One-Dimensional Mixed-Valence Gold Complex, $[AuCl(DBS)][AuCl_3(DBS)]$ (DBS = dibenzylsulfide)." *Mol. Cryst. Liq. Cryst.*, **379**, 291-296 (2002).
- 139) Y. Moritomo, K. Kato, A. Kuriki, N. Nakamoto, N. Kojima, M. Takata and M. Sakata, "Structural Analysis of $[Fe(ptz)_6](BF_4)_2$ under Photo-Excitation – Condensation of Photo-Excited High-Spin Ions -." *J. Phys. Soc. Jpn.*, **71**, 2609-2612 (2002).
- 140) Y. Kobayashi, M. Itoi, N. Kojima and K. Asai, "Pressure Effect on Charge transfer Phase Transition in a Mixed-Valence Iron Complex, $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3](dto = C_2O_2S_2)$." *J. Phys. Soc. Jpn.*, **71**, 3016-3020 (2002).
- 141) X.J. Liu, Y. Moritomo, A. Nakamura, S. Matsuba and N. Kojima, "Pressure-induced Phase Transition in Mixed-Valence Complexes: Comparison of Quasi-1D System with 3D System." *Phys. Stat. Sol. (b)*, **223**, 183-187 (2002).
- 142) X.J. Liu, Y. Moritomo, T. Kawamoto, A. Nakamoto and N. Kojima, "Optical Hysteresis in a Spin-Crossover Complex." *Phys. Rev. B*, **67**, 012102-1-3 (2003).
- 143) X.J. Liu, Y. Moritomo, T. Kawamoto, A. Nakamoto and N. Kojima, "Dynamical Phase Transition in a Spin-Crossover Complex." *J. Phys. Soc. Jpn.*, **72**, 1615-1618 (2003).
- 144) M. Tozawa, S. Ohkoshi, N. Kojima and K. Hashimoto, "Ion-exchange Synthesis and Magneto-optical Spectra of Colored Magnetic Thin Films Composed of Metal(II) Hexacyanochromate(III)." *Chem. Commun.*, 1204-1205 (2003).
- 145) Y. Ono, M. Okubo and N. Kojima, "Crystal Structure and Ferromagnetism of $(n-C_3H_7)_4N[Co^{II}Fe^{III}(dto)_3](dto = C_2O_2S_2)$." *Solid State Commun.*, **126**, 291-296 (2003).
- 146) S. Miyashita and N. Kojima, "Generalized Wajnflasz Model for Charge Transfer Spin-Crossover Phenomena." *Progress Theor. Phys.*, **109**, 729-739 (2003).
- 147) A. Nakamoto, Y. Ono, N. Kojima, D. Matsumura, T. Yokoyama, X.J. Liu and Y. Moritomo, "Spin Transition and Its Photo-induced Effect in Spin Crossover Complex Film Based on $[Fe(II)(trz)_3]$." *Synth. Metals*, **137**, 1219-1220 (2003).
- 148) M. Enomoto, M. Itoi, Y. Ono, M. Okubo and N. Kojima, "Origin of Charge Transfer Phase Transition and Ferromagnetism in of $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3]$ ($dto = C_2O_2S_2$)" *Synth. Metals*, **137**, 1231-1232 (2003).

- 149) N. Kojima, M. Itoi, Y. Ono, M. Okubo and M. Enomoto, "Spin-Entropy Driven Charge-Transfer Phase Transition in Iron Mixed-Valence System." *Materials Science*, **21**, 181-189 (2003).
- 150) N. Kojima, K. Ikeda, Y. Ono, Y. Kobayashi, M. Seto, X.J. Liu and Y. Moritomo, "Control of Chemical Bond and Electronic State for Gold Mixed-Valence Complexes, $Cs_2[Au^I X_2][Au^{III} Y_4]$ X, Y = Halogen)." *Progress in Coord. Bioinorg. Chem.*, **6**, 115-120 (2003).
- 151) A. Nakamoto, Y. Ono, N. Kojima, D. Matsumura and T. Yokoyama, "Spin Crossover Complex Film, $[Fe^{II}(H-trz)_3]-Nafion$, with a Spin Transition around Room Temperature." *Chem. Lett.*, **32**, 336-337 (2003).
- 152) Y. Moritomo, Y. Isobe, X.J. Liu, T. Kawamoto, A. Nakamoto, N. Kojima, K. Kato and M. Tanaka, "Dynamical Phase Transition under Photo-excitation in a Spin-crossover Complex." *J. Luminescence*, **108**, 229-232 (2004).
- 153) M. Itoi, A. Taira, M. Enomoto, N. Matsushita, N. Kojima, Y. Kobayashi, K. Asai, K. Koyama, T. Nakano, Y. Uwatoko and J. Yamaura, "Crystal Structure and Structural Transition Caused by Charge-transfer Phase Transition for Iron Mixed-valence Complex, $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3]$ (dto = $C_2O_2S_2$)."*Solid State Commun.*, **130**, 415-420 (2004).
- 154) M. Itoi, M. Enomoto and N. Kojima, "Ferromagnetism of Iron Mixed-valence Complex, $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(dto)_3]$ (dithiooxalato: dto = $C_2O_2S_2$)."*J. Mag. Mag. Mater.* **272-276**, 1093-1094 (2004).
- 155) Y. Kobayashi, M. Itoi, N. Kojima and K. Asai, "Pressure-induced Charge-transfer Phase Transition in a Mixed-valence Iron Complex." *J. Mag. Mag. Mater.* **272-276**, 1091-1092 (2004).
- 156) N. Kojima, Y. Ono, Y. Kobayashi and M. Seto, "Control of Charge Transfer Phase Transition in Iron Mixed-valence System, $(n-C_nH_{2n+1})_4N[Fe^{II}Fe^{III}(dto)_3](n = 3-6; dto = C_2O_2S_2)$."*Hyperfine Interactions*, **156-157**, 175-179 (2004).
- 157) K. Ikeda, N. Kojima, Y. Ono, Y. Kobayashi, M. Seto, X.J. Liu and Y. Moritomo, "Study on Chemical Bond and Electronic State of New Gold Mixed-Valence Complexes, $Cs_2[Au^I X_2][Au^{III} Y_4](X, Y = Cl, Br, I, etc.)$."*Hyperfine Interactions*, **156-157**, 311-314 (2004).
- 158) M. Sakata, T. Itsubo, E. Nishibori, Y. Moritomo, N. Kojima, Y. Ohishi and M. Takata, "Charge Density Study under High Pressure." *J. Phys. Chem. Solids*, **65**, 1973-1976 (2004).
- 159) K. Ikeda, Y. Ono, M. Enomoto, N. Kojima, Y. Kobayashi, M. Seto, K. Koyama and Y. Uwatoko, "P-T Phase Diagram and Gold Valence State of New Gold Mixed-Valence Complexes, $Cs_2[Au^I X_2][Au^{III} Y_4](X, Y = Cl, Br, I; X \neq Y)$."*Ceramics-Silik*, **48**, 159-164 (2004).
- 160) X.J. Liu, Y. Moritomo and N. Kojima, "Electronic Phase Diagram of Mixed-Valence Gold Chloride." *Chinese Phys. Lett.*, **21**, 183-186 (2004)
- 161) I. Kashima, M. Okubo, Y. Ono, M. Itoi, N. Kida, M. Hikita, M. Enomoto and N. Kojima, "Ferromagnetism and Its Photo-induced Effect in 2D Iron Mixed-Valence Complex Coupled with Photochromic Spropyran." *Synth. Metals*, **153**, 473-476 (2005).
- 162) M. Enomoto and N. Kojima, "Charge Transfer Phase Transition and Ferromagnetism in a Novel Iron Mixed-Valence Complex $(n-C_3H_7)_4N[Fe^{II}Fe^{III}(tto)_3]$ (tto = C_2OS_3)."*Synth. Metals*, **152**, 457-460 (2005).
- 163) M. Okubo, M. Enomoto and N. Kojima, "Study on Photomagnetism of 2D Magnetic Compounds Coupled with Photochromic Diarylethene Cations." *Synth. Metals*, **152**, 461-464 (2005).
- 164) A. Nakamoto, N. Kojima, X.J. Liu, Y. Moritomo and A. Nakamura, "Demonstration of the Thermally Induced High-Spin – Low-Spin Transition for a Transparent Spin-Crossover Complex Film, $[Fe(II)(Htrz)_3]-Nafion$ (trz = triazole)."*Polyhedron*, **24**, 2909-2912 (2005).

- 165) M. Okubo, M. Enomoto and N. Kojima, "Reversible Photomagnetism in a Cobalt Layered Compound Coupled with Photochromic Diarylethene." *Solid State Commun.*, **134**, 777-782 (2005).
- 166) M. Okubo, M. Enomoto, K. Koyama, Y. Uwatoko and N. Kojima, "Hybrid Organic-Inorganic Conductor Coupled with BEDT-TTF and Photochromic Nitrosyl Ruthenium Complex." *Bull. Chem. Soc. Jpn.*, **78**, 1054-1060 (2005).
- 167) M. Tada, N. Kojima, Y. Izumi, T. Taniike and Y. Iwasawa, "Chiral Self-Dimerization of Vanadium Complexes on a SiO₂ Surface for Asymmetric Catalytic Coupling of 2-Naphthol: Structure, Performance, and Mechanism." *J. Phys. Chem. B* **109**, 9905-9916 (2005).
- 168) N. Matsushita, F. Fukuhara and N. Kojima, "A Three-dimensional Bromo-bridged Mixed-valence Gold(I,III) Compound, Cs₂Au^IAu^{III}Br₆." *Acta Cryst. E* **61**, i123-i125 (2005).
- 169) N. Matsushita, A. Tanaka and N. Kojima, "A Three-dimensional Iodo-bridged Mixed-valence Gold(I,III) Compound, Rb₂[Au^II₂] [Au^{III}I₄]." *Acta Cryst. E* **61**, i201-i203 (2005).
- 170) T. Kajiwara, M. Nakano, Y. Kaneko, S. Takaishi, T. Ito, M. Yamashita, A. Igashira-Kamiyama, H. Nojiri, Y. Ono and N. Kojima, "A Single-Chain Magnet Formed by a Twisted Arrangement of Ions with Easy-Plane Magnetic Anisotropy." *J. Am. Chem. Soc.*, **127**, 10150-10151 (2005).
- 171) J.Y. Son, T. Mizokawa, J.W. Quilty, K. Takubo, K. Ikeda and N. Kojima, "Photoinduced Valence Transition in Gold Complexes Cs₂Au₂X₆ (X = Cl and Br) Probed by X-ray Photoemission Spectroscopy." *Phys. Rev. B* **72**, 235105-1-4 (2005).
- 172) Y. Moritomo, M. Kamiya, A. Nakamura, A. Nakamoto and N. Kojima, "Cooperative Formation of High-spin Species in a Photoexcited Spin-Crossover Complex," *Phys. Rev. B* **73**, 012103-1-4 (2006).
- 173) M. Itoi, Y. Ono, N. Kojima, K. Kato, K. Osaka and M. Takata, "Charge Transfer Phase Transition and Ferromagnetism of Iron Mixed Valence Complexes, (n-C_nH_{2n+1})₄N [Fe^{II}Fe^{III}(dto)₃] (n = 3-6, dto = C₂O₂S₂)," *Eur. J. Inorg. Chem.*, 1198-1207 (2006).
- 174) H. Shimizu, M. Okubo, A. Nakamoto, M. Enomoto and N. Kojima, "Enhancement of the Curie Temperature by Isomerization of Diarylethene (DAE) for an Organic-Inorganic Hybrid System, Co₄(OH)₇(DAE)_{0.5}·3H₂O," *Inorg. Chem.*, **45**, 10240-10247 (2006).
- 175) M. Ferbinteanu, T. Kajiwara, K.Y. Choi, H. Nojiri, A. Nakamoto, N. Kojima, F. Cimpoes, Y. Fujiwara, S. Takaishi and M. Yamashita, "Binuclear Fe(III)-Dy(III) Single Molecular Magnet. Quantum Effects and Models," *J. Am. Chem. Soc.*, **128**, 9008-9009 (2006).
- 176) K. Ikeda, N. Kojima, Y. Kobayashi and M. Seto, "Study on Charge Transfer Interaction and Valence State of Layered Perovskite-type Mixed-Valence Complex, [NH₃(CH₂)_nNH₃][(Au^II₂) (Au^{III}I₄)(I₃)₂](n = 7, 8), by Means of ¹⁹⁷Au Mössbauer Spectroscopy," *Hyperfine Interactions*, **165**, 403-407 (2006).
- 177) M. Okubo, E. Hosono, J. Kim, M. Enomoto, N. Kojima, T. Kudo, H. Zhou and I. Honma, "Nanosize Effect on High-Rate Li-Ion Intercalation in LiCoO₂ Electrode." *J. Am. Chem. Soc.*, **129**, 7444-7452 (2007).
- 178) K. Ikeda, Y. Kobayashi, Y. Negishi, M. Seto, T. Iwasa, K. Nobusada, T. Tsukuda and N. Kojima, "Thiolate-Induced Structural Reconstruction of Gold Clusters Probed by ¹⁹⁷Au Mössbauer Spectroscopy." *J. Am. Chem. Soc.*, **129**, 7230-7231 (2007).
- 179) N. Matsushita, H. Ahsbahs, S.S. Hafner and N. Kojima, "Single Crystal X-ray Diffraction Study of a Mixed-Valence Gold Compound, Cs₂Au^IAu^{III}Cl₆ under High Pressures up to 18 GPa: Pressure-induced Phase Transition Coupled with Gold Valence Transition." *J. Solid State Chem.* **180**, 1353-1364 (2007).

- 180) M. Itoi, N. Kida, C. Lin, M. Koeda, N. Kojima, M. Hedo, Y. Uwatoko, Y. Kobayashi, K. Asai, Y. Ohishi and M. Takata, "Structural Analysis of Iron Mixed-Valence Complex, (*n*-C₃H₇)₄N[Fe^{II}Fe^{III}(dto)₃](dto = C₂O₂S₂), under High Pressure." *J. Phys. Soc. Jpn.*, **76**, Suppl. A 190-191 (2007).
- 181) T. Kajiwara, I. Watanabe, Y. Kaneko, S. Takaishi, M. Enomoto, N. Kojima and M. Yamashita, "Direct Observation of the Ground-Spin Alignment of Fe(II)-Fe(III) Single-Chain Magnet by Muon-Spin Relaxation." *J. Am. Chem. Soc.*, **129**, 12360-12361 (2007).
- 182) J.Y. Son, K. Takubo, D. Asakura, J.W. Quilty, T. Mizokawa, A. Nakamoto and N. Kojima, "Photoemission Study of Temperature Induced and Photoinduced Spin-State Transitions in Spin-Crossover Complex [Fe(ptz)₆](BF₄)₂." *J. Phys. Soc. Jpn.*, **76**, 084703-1-6 (2007).
- 183) K. Kato, M. Takada, Y. Moritomo, A. Nakamoto and N. Kojima, "On-Off Optical Switching of the Magnetic and Structural Properties in a Spin-Crossover Complex." *Appl. Phys. Lett.*, **90**, 201902-1-3 (2007).
- 184) N. Kojima, M. Okubo, H. Shimizu and M. Enomoto, "Control of Magnetism by Isomerization of Intercalated Molecules in Organic-Inorganic Hybrid Systems." *Coord. Chem. Rev.*, **251**, 2665-2673 (2007).
- 185) N. Kojima, M. Enomoto, N. Kida, I. Watanabe and T. Suzuki, "Ferromagnetic and Charge Transfer Phase Transitions in [Fe^{II}Fe^{III}(dto)₃](dto = C₂O₂S₂) Complexes Examined by Muon Spectroscopy." *RIKEN Accel. Prog. Rep.*, **40**, v (2007).
- 186) N. Kida, M. Enomoto, I. Watanabe, T. Suzuki and N. Kojima, "Spin dynamics of the charge-transfer phase transition of an iron mixed-valence complex observed using muon spin relaxation spectroscopy." *Phys. Rev. B* **77**, 144427-1-5 (2008).
- 187) M. Enomoto, N. Kida, I. Watanabe, T. Suzuki and N. Kojima, "Spin Dynamics of the Ferromagnetic Transition in Iron Mixed-Valence Complexes, (n-C_nH_{2n+1})₄N[Fe^{II}Fe^{III}(dto)₃] (dto = C₂O₂S₂, n = 3-5) by μSR." *Physica. B* **404**, 642-644 (2009).
- 188) N. Kida, M. Hikita, I. Kashima, M. Okubo, M. Itoi, M. Enomoto, K. Kato, M. Takata and N. Kojima, "Control of Charge Transfer Phase Transition and Ferromagnetism by Photoisomerization of Spiropyran for an Organic-Inorganic Hybrid System, (SP)[Fe^{II}Fe^{III}(dto)₃] (SP = spiropyran, dto = C₂O₂S₂)."*J. Am. Chem. Soc.*, **131** 212-220 (2009).
- 189) N. Kida, M. Hikita, I. Kashima, M. Enomoto, M. Itoi and N. Kojima, "Mössbauer Spectroscopic Study of Photo-Sensitive Organic-Inorganic Hybrid System, (SP) [Fe^{II}Fe^{III}(dto)₃] (dto = C₂O₂S₂ SP = spiropyran)." *Polyhedron*, **28**, 1694-1697 (2009).
- 190) M. Enomoto and N. Kojima, "Magnetic Dilution Effect on the Charge Transfer Phase Transition and the Ferromagnetic Transition for an Iron Mixed-Valence Complex, (n-C₃H₇)₄N[Fe^{II}_{1-x}Zn^{II}_xFe^{III}(dto)₃] (dto = C₂O₂S₂)."*Polyhedron*, **28**, 1826-1829 (2009).
- 191) K. Kagesawa, Y. Ono, M. Enomoto and N. Kojima, "Study on the Valence Fluctuation and the Magnetism of an Iron Mixed-Valence Complex, (n-C₄H₉)₄N[Fe^{II}Fe^{III}(mto)₃] (mto = C₂O₃S)." *Polyhedron*, **28**, 1822-1825 (2009).
- 192) N. Kojima, M. Enomoto, N. Kida and K. Kagesawa, "Progress of Multi Functional Properties of Organic-Inorganic Hybrid System, A[Fe^{II}Fe^{III}X₃] (A = (n-C_nH_{2n+1})₄N, spiropyran; X = C₂O₂S₂, C₂OS₃, C₂O₃S)." *Materials* **3**, 3141-3187 (2010).
- 193) K. Kagesawa, A. Okazawa, M. Enomoto and N. Kojima, "Study on the Rapid Spin Equilibrium in Ph₄P[Zn^{II}Fe^{III}(mto)₃] (mto = monothiooxalato)." *Chem. Lett.* **39**, 872-873 (2010).
- 194) E. Hosono, Y. Wang, N. Kida, M. Enomoto, N. Kojima, M. Okubo, H. Matsuda, Y. Saito, T. Kudo,

- I. Honma and H. Zhou, "Synthesis of Triaxial LiFePO₄ Nanowire with a VGCF Core Column and a Carbon Shell through the Electrospinning Method." *Appl. Mater. Interfaces*, **2**, 212-218 (2010).
- 195) K. Kagesawa, N. Kida, Y. Ono, M. Enomoto and N. Kojima, "Linkage-isomerization and Charge-transfer in the Formation of Iron Mixed-Valence Complexes, (*n*-C₃H₇)₄N [Fe^{II}Fe^{III}(dto)₃](dto = C₂O₂S₂) and (*n*-C₄H₉)₄N[Fe^{II}Fe^{III}(mto)₃] (mto = C₂O₃S)." *J. Phys.: Conf. Ser.*, **217**, 012034-012037 (2010).
- 196) A. Sugahara, M. Enomoto and N. Kojima, "Isomerization Effect on Counter Anion on the Spin Crossover Transition in [Fe(4-NH₂trz)₃](CH₃C₆H₄SO₃)₂·nH₂O." *J. Phys.: Conf. Ser.*, **217**, 012128-012131 (2010).
- 197) Z.Z. He, C.S. Lin, W.D. Cheng, A. Okazawa, N. Kojima, J. Yamaura and Y. Ueda, "Unusually Large Magnetic Anisotropy in a CuO-Based Semiconductor Cu₅V₂O₁₀." *J. Am. Chem. Soc.* **133**, 1298-1300 (2011).
- 198) M. Okubo, D. Asakura, Y. Mizuno, T. Kudo, H. S. Zhou, A. Okazawa, N. Kojima, K. Ikeda, T. Mizokawa and I. Honma, "Ion-Induced Transformation of Magnetism in a Bimetallic CuFe Prussian Blue Analogue." *Angew. Chem. Int. Ed.*, **50**, 6269-6273 (2011).
- 199) T. Shimada, A. Okazawa, N. Kojima, S. Yoshii, H. Nojiri and T. Ishida, "Ferromagnetic Exchange Couplings Showing a Chemical Trend in Cu-Ln-Cu Complexes (Ln = Gd, Tb, Dy, Ho, Er)." *Inorg. Chem.*, **50**, 10555-10557 (2011).
- 200) T. Tsukuda, Y. Negishi, Y. Kobayashi and N. Kojima, "¹⁹⁷Au Mössbauer Spectroscopy of Au₂₅(SG)₁₈ Revisited." *Chem. Lett.*, **40**, 1292-1293 (2011).
- 201) H. Kamebuchi, T. Jo, H. Shimizu, A. Okazawa, M. Enomoto and N. Kojima, "Development of pH-Sensitive Spin-crossover Iron(II) Complex Films, [Fe^{II}(diAMsar)]-Nafion: Manipulation of the Spin State by Proton Concentration." *Chem. Lett.*, **40**, 888-889 (2011).
- 202) A. Okazawa, H. Nojiri, T. Ishida and N. Kojima, "Single-Molecule Magnet Behavior Enhanced by Magnetic Coupling between 4f-3d Spins." *Polyhedron*, **30**, 3140-3144 (2011).
- 203) A. Okazawa, K. Fujiwara, R. Watanabe, N. Kojima, S. Yoshii, H. Nojiri and T. Ishida, "Exchange Couplings in One-dimensionally Arrayed 4f-3d Heterometallic [Ln₂Cu₂]_n Compounds. A Chemical Trend of the Coupling Parameter." *Polyhedron*, **30**, 3121-3126 (2011).
- 204) A. Sugahara, K. Moriya, M. Enomoto, A. Okazawa and N. Kojima, "Study on the Spin-Crossover Transition in [Fe(cis-/trans-stpy)₄(X)₂] (stpy: styrlypyridine, X: NCS, NCBH₃) under High Pressure toward Ligand-Driven Light-Induced Spin Change." *Polyhedron*, **30**, 3127-3130 (2011).
- 205) M. Enomoto, N. Kida, N. Kojima, I. Watanabe, T. Suzuki and T., Ishii, "Study on the Pressure Induced Charge Transfer Phase Transition in (C₅H₁₁)₄N [Fe^{II}Fe^{III}(C₂O₂S₂)₃] by Means of μSR Spectroscopy." *Polyhedron* **30**, 3137-3139 (2011).
- 206) N. Kojima, K. Kagesawa, A. Okazawa and I. Watanabe, "Study on the Spin-Equilibrium and the Succeeding Magnetic Phase Transitions in the Iron(III) Complex by Means of μSR Spectroscopy." *RIKEN Accel. Prog. Rep.*, **45**, 194 (2011).
- 207) K. Fujiwara, A. Okazawa, N. Kojima, G. Tanaka, S. Yoshii and H. Nojiri, "Oximate-Bridged Light-Lanthanide Ln₄Cu Complexes Showing Ferromagnetic Ln-Cu Exchange Coupling," *Chem. Phys. Lett.*, **530**, 49-54 (2012).
- 208) Y. Ono, A. Okazawa, N. Kida, M. Enomoto and N. Kojima, "Study on the Ferromagnetic State in Iron Mixed-Valence Complexes, A[Fe^{II}Fe^{III}(dto)₃](A = (*n*-C_nH_{2n+1})₄N, spiropyran; dto =

- $C_2O_2S_2$) by Means of Mössbauer Spectroscopy.” *Hyperfine Interactions*, **207**, 139-143 (2012).
- 209) A. Nakamoto, H. Kamebuchi, M. Enomoto and N. Kojima, “Study on the Spin Crossover Transition and Glass Transition for Fe(II) Complex Film, [Fe(II)(H-triazole)₃]@Nafion, by Means of Mössbauer Spectroscopy.” *Hyperfine Interactions*, **205**, 41-45 (2012).
- 210) N. Kojima, K. Ikeda, Y. Kobayashi, T. Tsukuda, Y. Negishi, G. Harada, T. Sugawara and M. Seto, “Study on the Structure and Electronic State of Thiolate-Protected Gold Clusters by Means of ¹⁹⁷Au Mössbauer Spectroscopy.” *Hyperfine Interactions*, **207**, 127-131 (2012).
- 211) D. Asakura, M. Okubo, Y. Mizuno, T. Kudo, H. S. Zhou, K. Ikeda, T. Mizokawa, A. Okazawa and N. Kojima, “Fabrication of Defectless Cyanide Bridged Perovskite Framework for Enhanced Electrochemical Ion Storage Ability.” *J. Phys. Chem. C* **116**, 8364-8369 (2012).
- 212) N. Kojima, N. Kida, A. Okazawa and M. Enomoto, “Size Effect of Intercalated Cation on the Charge Transfer Phase Transition and Ferromagnetism for Iron Mixed-Valence System, A[Fe^{II}Fe^{III}(C₂O₂S₂)₃] (A = (C_nH_{2n+1})₄N, (C_mH_{2m+1})₃ (C_nH_{2n+1})N).” *Mössbauer Effect Reference and Data Journal*, **35**, 154-165 (2012).
- 213) Y. Mizuno, M. Okubo, K. Kagesawa, D. Asakura, T. Kudo, H.S. Zhou, K. Ohishi, A. Okazawa and N. Kojima, “Precise Electrochemical Control of Ferromagnetism in a Cyanide-Bridged Bimetallic Coordination Polymer.” *Inorg. Chem.*, **51**, 10311-10316 (2012).
- 214) H. Ida, A. Okazawa, N. Kojima, R. Shimizu, Y. Yamada and M. Enomoto, “Effect of Nonmagnetic Substitution on the Magnetic Properties and Charge-Transfer Phase Transition of an Iron Mixed-Valence Complex, (n-C₃H₇)₄N[Fe^{II}Fe^{III}(dto)₃] (dto = C₂O₂S₂).” *Inorg. Chem.*, **51**, 8989-8996 (2012).
- 215) Z. Z. He, W. L. Zhang, W. D. Cheng, A. Okazawa and N. Kojima, “K₄Fe₄P₅O₂₀: A New Mixed Valence Microporous Compound with Elliptical Eight-Ring Channels.” *Inorg. Chem.*, **51**, 7469-7471 (2012).
- 216) T. Ishida, R. Watanabe, K. Fujiwara, A. Okazawa, N. Kojima, G. Tanaka, S. Yoshii and H. Nojiri, “Exchange coupling in TbCu and DyCu single-molecule magnets and related lanthanide and vanadium analogs.” *Dalton Trans.*, **41**, 13609-13609, (2012).
- 217) N. Kano, N. Yoshinari, Y. Shibata, M.Miyachi, T.Kawashima, M. Enomoto,, A.Okazawa, N. Kojima, J.D.Guo and S. Nagase, “Anionic Iron Complexes with a Bond between an Ate-Type Pentacoordinated Germanium and an Iron Atom.” *Organometallics*, **31**, 8059-8062 (2012).
- 218) N. Kojima, Y. Kobayashi, Y. Negishi, M. Seto and T. Tsukuda, “Structural evolution of glutathionate-protected gold clusters studied by means of ¹⁹⁷Au Mössbauer Spectroscopy.” *Hyperfine Interactions*, **217**, 91-98 (2013).
- 219) M. Okubo, K. Kagesawa, Y. Mizuno, D. Asakura, E. Hosono, T. Kudo, H. Zhou, K. Fujii, H. Uekusa, S. Nishimura, A. Yamada, A. Okazawa and N. Kojima, “Reversible Solid State Redox of an Octacyanometallate-bridged Coordination Polymer by Electrochemical Ion Insertion/extraction.” *Inorg. Chem.* **52**, 3772-3779 (2013).
- 220) N. Kojima, K. Ikeda, Y. Kobayashi and M. Seto, “Study on the electronic state of gold mixed-valence complexes, Cs₂[Au(I)X₂][Au(III)Y₄](X, Y = Cl, Br, I) by means of ¹⁹⁷Au Mössbauer spectroscopy.” *Mössbauer Effect Reference and Data Journal*, **36**, 57-72 (2013).
- 221) Y. Seki, A. Okazawa, M. Enomoto, J. Harada, K. Ogawa and N. Kojima, “Alternating Ferro- and Antiferromagnetic Couplings in One-dimensional Chain Hexachlorodicuprate(II), (MV)[CuCl₃]₂ (MV = methyl viologen).” *Current Inorg. Chem.* **3**, 94-100 (2013).
- 222) J. Yoshida, N. Kida, A. Okazawa and N. Kojima, “Cation Size Effect on Photomagnetism and

Charge Transfer Phase Transition of Iron Mixed-valence Complexes with Spiropyrans.” *Polyhedron*, **66**, 100-107 (2013).

- 223) Z. He, W. Zhang, W. Cheng, A. Okazawa and N. Kojima, “Long-range and Short-range Orderings in $K_4Fe_4P_5O_{20}$ with a Natrolite-like Framework.” *Dalton Transactions*, **42**, 5860-5865 (2013).
- 224) A. Okazawa, T. Shimada, N. Kojima, S. Yoshii, H. Nojiri and T. Ishida, “Exchange Coupling and Its Chemical Trend Studied by High-Frequency EPR on Heterometallic $[Ln_2Ni]$ Complexes.” *Inorg. Chem.* **52**, 13351-13355 (2013).
- 225) Y. Mizuno, M. Okubo, E. Hosono, T. Kudo, K. Ohishi, A. Okazawa, N. Kojima, R. Kurono, S. Nishimura and A. Yamada, “Electrochemical Mg^{2+} Intercalation into a Bimetallic CuFe Prussian Blue Analog with Aqueous Electrolytes.” *J. Materials Chemistry A* **1**, 13055-13059 (2013).
- 226) Y. Negishi, W. Kurashige, Y. Kobayashi, S. Yamazoe, N. Kojima, M. Seto and T. Tsukuda, “ $Au_{24}Pd_1(SC_{12}H_{25})_{18}$ Probed by ^{197}Au Mössbauer and Pd K-edge EXAFS Spectroscopy.” *J. Phys. Chem. Lett.* **4**, 3579-3583 (2013).
- 227) N. Kojima, H. Kobayashi, A. Okazawa, I. Kawasaki, I. Watanabe, “Study on the static and dynamic spin crossover phenomena in tripyrazolylmethane iron(II) complexes by means of mSR spectroscopy,” *RIKEN Accel. Prog. Rep.*, **47**, 258 (2014).
- 228) K. Nomura, S. Taya, A. Okazawa and N. Kojima, “Sol-gel synthesis and dilute magnetism of nano MgO powder doped with Fe.” *Hyperfine Interactions*, **226**, 161-169 (2014).
- 229) A. Okazawa, J. Yoshida, N. Kida, I. Kashima, W. Murata, M. Enomoto and N. Kojima, “Study on spin configuration in photoresponsive iron mixed-valence complexes by Mössbauer spectroscopy.” *Hyperfine Interactions*, **226**, 351-357 (2014).
- 230) T. Fujinami, M. Koike, N. Matsumoto, Y. Sunatsuki, A. Okazawa and N. Kojima, “Abrupt Spin transition and thermal hysteresis of iron(III) complex $[Fe^{III}(Him)_2(hapen)]AsF_6$ (Him = imidazole, H_2hapen = N,N' -bis(2-hydroxyacetophenylidene)ethylenediamine).” *Inorg. Chem.*, **53**, 2254-2259 (2014).
- 231) H. Kamebuchi, M. Okubo, A. Okazawa, M. Enomoto, J. Harada, K. Ogawa, G. Maruta, S. Takeda, N. Kojima, C. Train and M. Verdaguer, “A Tricky Water Molecule Coordinated to a Verdazyl Radical-Iron(II) Complex: a Multitechnique Approach.” *Phys. Chem. Chem. Phys.* **16**, 9086 - 9095 (2014).
- 232) N. Kojima, M. Itoi and Y. Miyazaki, “Phase Transitions due to Charge Transfer in Mixed-Valence Assembled Metal Complexes, $A[Fe^{II}Fe^{III}(dto)_3]$ ($A = (n-C_nH_{2n+1})_4N$, spiropyran; $dto = C_2O_2S_2$)”, *Current Inorg. Chem.*, **4**, 85-99 (2014).
- 233) A. Sugahara, N. Tanaka, A. Okazawa, N. Matsushita and N. Kojima, “Photochromic Property of Anionic Spiropyran Having Sulfonate-substituted Indoline Moiety.” *Chem. Lett.*, **43**, 281-283 (2014).
- 234) H. Kamebuchi, A. Nakamoto, T. Yokoyama and N. Kojima, “Fastener Effect on Uniaxial Chemical Pressure for One-Dimensional Spin-Crossover System, $[Fe^{II}(NH_2-trz)_3] (C_nH_{2n+1}SO_3)_2 \cdot xH_2O$: Magnetostructural Correlation and Ligand Field Analysis,” *Bull. Chem. Soc. Jpn.*, **88**, 419-430 (2015).
- 235) K. Nomura, P. de Souza, S. Hirai and N. Kojima, “Mössbauer Analysis of Iron Ore and Rapidly Reduced Iron Ore Treated by Micro-discharge Using Carbon Felf.” *J. Radioanal. Nucl. Chem.*, **303**, 1259-1263 (2015).
- 236) A. Taufiq, Sunaryono, E.G.R. Putra, A. Okazawa, I. Watanabe, N. Kojima, S. Pratapa, Darminto, “Nanoscale Clustering and Magnetic Properties of $Mn_xFe_{3-x}O_4$ Particles Prepared from Natural

Magnetite," *J. Superconductivity and Novel Magnetism*, **28**, 2855- 2863 (2015).

- 237) N. Tanaka, A. Okazawa, A. Sugahara, N. Kojima, "Development of a Photoresponsive Organic-Inorganic Hybrid Magnet: Layered Cobalt Hydroxides Intercalated with Spiropyran Anion," *Bull. Chem. Soc. Jpn.*, **88**, 1150-1155 (2015).
- 238) Sunaryono, A. Taufiq, E. G. R. Putra, A. Okazawa, I. Watanabe, N. Kojima, S. Rugmai, S. Soontaranon, M. Zainuri, Triwikantoro, S. Pratapa, Darminto, "Small-Angle X-Ray Scattering Study on PVA/Fe₃O₄ Magnetic Hydrogels," *Nano, World Scientific*, **11**, 1650027-1-12 (2016).
- 239) M. Enomoto, I. Watanabe, N. Kojima, "Dynamical Behavior of the Charge Transfer Phase Transition in Dithiooxalato-Bridged Iron Mixed-Valence System," *Current Inorg. Chem.*, **6**, 49-60 (2016).
- 240) S. Goda, M. Nikai, M. Ito, D. Hashizume, K. Tamao, A. Okazawa, N. Kojima, H. Fueno, K. Tanaka, Y. Kobayashi, T. Matsuo, "Synthesis and Magnetic Properties of Linear Two-coordinate Monomeric Diaryliron(II) Complexes Bearing Fused-ring Bulky "Rind" Groups," *Chem. Lett.* **45**, 634-636 (2016).
- 241) K. Nomura, S. Suzuki, Y. Koike, H. Li, A. Okazawa, N. Kojima, "Magnetic property and Mossbauer analysis of SrSn_{1-x}Fe_xO₃ prepared by a sol-gel method," *Hyperfine Interactions*, **237**, 26-1-10 (2016).
- 242) A. Sugahara, H. Kamebuchi, A. Okazawa, M. Enomoto, N. Kojima, "Control of Spin-Crossover Phenomena in One-Dimensional Triazole-Coordinated Iron(II) Complexes by Means of Functional Counter Ions." *Inorganics*, **5**, 50-1-23 (2017).
- 243) A. Taufiq, A.T. Sunaryono, N. Hidayat, A. Hidayat, E. Giri, R. Putra, A. Okazawa, I. Watanabe, N. Kojima, S. Pratapa, Darminto, "Studies on Nanostructure and Magnetic Behaviors of Mn-Doped Black Iron Oxide Magnetic Fluids Synthesized from Iron Sand" *Nano, World Scientific*, **12** (09), 1750110-1-11 (2017).
- 244) N. Shida, Y. Suzawa, M. Inaba, A. Okazawa, N. Kojima, M. Enomoto, "Magnetic Properties of V-substitution Effect an Iron Mixed-Valence Complex," *Polyhedron*, **136**, 143-148 (2017).
- 245) R. Tanaka, A. Okazawa, H. Konaka, A. Sasaki, N. Kojima and N. Matsushita, " Unique Hydration/Dehydration-Induced Vapochromic Behavior of a Charge-Transfer Salt Comprising Viologen and Hexacyanidoferate(II)," *Inorg. Chem.* **57**, 2209-2217 (2018).
- 246) R. Tanaka, A. Okazawa, N. Kojima and N. Matsushita, "Ionic Crystal Containing Protons (H⁺) as Counter Cations: Preparation and Crystal Structure of a Salt of 4,4'-Bipiperidine-1,1'-diium and Hexacyanidoferate(II)," *Chem. Lett.*, **47**, 697-699 (2018).

60 Review, Bulletin, Report, etc.

Representative bulletins, etc.

- 1) N. Kojima, "¹⁹⁷Au and ¹²⁹I Mössbauer Spectroscopy of the Perovskite-type Mixed-Valence Compound Cs₂Au₂I₆," *Proceedings of XXX Zakopane School of Physics* (Zakopane, Poland, 1995), pp. 326-338.
- 2) N. Kojima, S. Matsuba, M. Seto, Y. Kobayashi and Yu. Maeda, "¹⁹⁷Au Mössbauer Spectra of One Dimensional Au Mixed-Valence Complex [AuCl(dbs)][AuCl₃(dbs)]," *KURRI Progress Report*, 42 (1998).
- 3) N. Kojima, W. Aoki, M. Seto, Y. Kobayashi and Yu. Maeda, "Reversible Charge Transfer Phase Transition and Ferromagnetism in Mixed-Valence Complex, (n-C₃H₇)₄N[Fe^{II}Fe^{III}(dto)₃] (dto =

$\text{C}_2\text{O}_2\text{S}_2$)," *KURRI Progress Report*, 56 (1999).

- 4) S. Toyazaki, D. Matsumura, T. Yokoyama and N. Kojima, "Control of Tc by Isomerization of Anion in Fe(II) Spin-Crossover Complexes, $[\text{Fe}(4-\text{NH}_2\text{trz})_3](o-, m-, p-\text{NH}_2\text{C}_6\text{H}_4\text{SO}_3)_2 \bullet 2\text{H}_2\text{O}$," *Photon Factory Activity Report*, 103 (2000).
- 5) Y. Ono, N. Kojima, M. Seto and Y. Kobayashi, "Study on the Molecular Magnetism in Mixed-Valence Iron Complexes, $\text{M}[\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}(\text{mto})_3](\text{M} = (n-\text{C}_n\text{H}_{2n+1})_4\text{N}$, mto = monothiooxalato ($\text{C}_2\text{O}_3\text{S}$))," *KURRI Progress Report*, 16 (2001).
- 6) K. Ikeda, N. Kojima, Y. Ono, Y. Kobayashi and M. Seto, "Mössbauer Spectroscopy of New-Type Gold Mixed-Valence Complexes $\text{Cs}_2[\text{Au}(\text{I})\text{X}_2][\text{Au}(\text{III})\text{Y}_4](\text{X}, \text{Y} = \text{Cl}, \text{Br}, \text{I}, \text{etc.})$ with Bridging Hetero-Halogen," *KURRI Progress Report*, 59 (2002).
- 7) Y. Kobayashi, S. Kitao, M. Kurokuzu, Y. Negishi, T. Tsukuda, N. Kojima and M. Seto, " ^{197}Au Mössbauer Study of Au Nanoparticles," *KURRI Progress Report*, PR2-7 (2013).
- 8) N. Kojima, Y. Kobayashi and M. Seto, "Determination of the Structure and Electronic State of Thiolate-Protected Hetero-Metal Cluster, $\text{Au}_{24}\text{Pd}_1(\text{SC}_{12}\text{H}_{25})_{18}$, by Means of ^{197}Au Mössbauer Spectroscopy," *KURRI Progress Report*, PR2-8 (2013).

28 Monographs

Representative monographs

- 1) S. Sugano and N. Kojima (ed.) "Magneto-Optics," (Springer, 2000).
- 2) N. Kojima and K. Ikeda, "Magnetochromism of Inorganic Materials." in "Inorganic Chromotropism" ed. Y. Fukuda (Kodansha/Springer, 2007), pp. 355-367.
- 3) N. Kojima, "Photo-induced Spin Crossover Phenomena." in "Inorganic Chromotropism" ed. Y. Fukuda (Kodansha/Springer, 2007), pp. 258-273.
- 4) N. Kojima and A. Sugahara, "Spin-Crossover and Related Phenomena Coupled with Spin, Photon and Charge." in "Mössbauer Spectroscopy: Applications in Chemistry, Biology and Nanotechnology", ed. V.K. Sharma, C. Klingelhöfer, T. Nishida (Wiley Inc., 2013), pp. 152-176.
- 5) M. Okubo and N. Kojima, "Photomagnetic Organic-inorganic Hybrid Materials." in "Research Advances in Magnetic Materials.", ed. C. Toulson, D. Marwick, (Nova Science Publishers, Inc. 2013), pp. 55-76.
- 6) H. Kamebuchi, M. Enomoto and N. Kojima, "Progress of Multifunctional Spin Crossover Complex Film Based on Nafion," in "Nafion: Properties, Structure and Applications", ed. A. Sutton, (Nova Science Publishers, Inc., 2016), pp. 119-140.