


# SPRING-8/SACLA Research Frontiers 2017

## CONTENTS

<b>Preface</b>	<b>5</b>
<b>Editor's Note</b>	<b>6</b>
<b>Scientific Frontiers</b>	<b>7</b>
<b>Reviews</b>	
 <b>The Engine of Life Driven by Light – Structure of Photosystem II and the Mechanism of Water-splitting</b>	<b>8</b>
<i>J.-R. Shen</i>	
<b>Evolution of Nuclear Resonant Scattering Research at SPRING-8</b>	<b>12</b>
<i>M. Seto</i>	
<b>Life Science</b>	
 <b>Time-resolved crystallography: A molecular movie of structural changes in the light-driven proton pump bacteriorhodopsin</b>	<b>16</b>
<i>E. Nango and S. Iwata</i>	
 <b>Time-resolved crystallography: Nanosecond time-resolved XFEL structure analyses of bovine cytochrome c oxidase reveals the timing of proton-pump channel closure</b>	<b>18</b>
<i>T. Tsukihara, H. Ago and S. Yoshikawa</i>	
<b>Protein crystallography: Protein-phospholipid interplay in a Ca<sup>2+</sup>-pump revealed by X-ray solvent contrast modulation</b>	<b>20</b>
<i>C. Toyoshima and Y. Norimatsu</i>	
<b>Protein crystallography: Structural biology study of human cannabinoid receptor CB1</b>	<b>22</b>
<i>T. Hua and Z. Liu</i>	
<b>Protein crystallography: Crystal structure of overlapping dinucleosome reconstituted with human histones</b>	<b>24</b>
<i>H. Kurumizaka, D. Kato and A. Osakabe</i>	
<b>Protein crystallography: Crystal structures of the NAD<sup>+</sup>-reducing soluble [NiFe]-hydrogenase</b>	<b>26</b>
<i>Y. Shomura and Y. Higuchi</i>	
 <b>Crystallography technique: Multi-wavelength anomalous diffraction <i>de novo</i> phasing of serial femtosecond crystallography data using two-color pulses at SACLA</b>	<b>28</b>
<i>A. Gorel and I. Schlichting</i>	
<b>Neonatology: A vagal reflex mediates the lung aeration-induced increase in pulmonary blood flow at birth</b>	<b>30</b>
<i>J. A. R. Lang, J. T. Pearson, M. J. Kitchen and S. B. Hooper</i>	
<b>Cell biology: Imaging of Br-labeled fatty acids in mammalian cells by scanning X-ray fluorescence microscopy</b>	<b>32</b>
<i>M. Shimura</i>	

## Physical Science

- Charge density analysis:** Direct observation of molecular orbital distribution by synchrotron X-ray diffraction 34  
*S. Kitou and H. Sawa*
- Electromechanical response:** *In situ* observation of crystal structure dynamics in ferroelectric films under application of an electric field 36  
*H. Funakubo, T. Shimizu and O. Sakata*
- Charge glass formation:** Crystallization and vitrification of strongly correlated electrons on a geometrically frustrated triangular lattice 38  
*K. Hashimoto and T. Sasaki*
- Li-ion battery:** Probing the energy storage in Li ion batteries with hard X-ray Compton scattering 40  
*B. Barbiellini, A. Bansil and Y. Sakurai*
- Magnetism:** X-ray magnetic circular dichroism spectroscopy for voltage-controlled magnetic anisotropy in FePt/MgO multilayer system 42  
*S. Miwa*
- Magnetism:** Gigantic spin waves induced by ultrashort laser pulses 44  
*T. Ohkochi*
- Hydrogen science:** Hydride complex with ninefold H-coordination 46  
*S. Takagi*
- Atomic physics:** Charge transfer to ground-state ions in Ne-Kr mixed clusters producing slow electrons 48  
*D. You, H. Fukuzawa and K. Ueda*
-  **Nuclear scattering:** Multi-photon superradiance from a nuclear ensemble 50  
*A. Q. R. Baron and A. I. Chumakov*
- Inelastic scattering:** Water molecules in action, in real space and time 52  
*T. Egami*
- Coherent diffraction imaging:** Use of Kramers–Kronig relation in phase retrieval calculation in X-ray spectro-ptychography 54  
*Y. Takahashi and M. Hirose*
- Fracture imaging:** Damage micromechanisms in dual-phase steel investigated by combined phase- and absorption-contrast tomography 56  
*K. Hirayama, H. Toda and M. Kobayashi*

## Chemical Science

- Supramolecule:** Mathematical design of molecular self-assembly 58  
*D. Fujita and M. Fujita*
- XMCD:** Magnetic circular dichroism in X-ray emission 60  
*T. Inami*

<b>Mössbauer spectroscopy:</b> Crystal-site-selective spectrum of Fe <sub>3</sub> O <sub>4</sub> obtained by synchrotron Mössbauer diffraction <i>S. Nakamura, T. Mitsui and S. Shimomura</i>	62
<b>RMC modeling:</b> Formation of metallic cation-oxygen network in binary phosphate glass with anomalous thermal expansion coefficients <i>H. Masai, Y. Onodera and S. Kohara</i>	64
<b>Energy science:</b> Structural characterization of nanoparticulate GaN-ZnO electrode for artificial photosynthesis <i>Y. Imanaka and N. Awaji</i>	66
<b>Surface science:</b> Dehydration processes of metal cations during electrodeposition <i>M. Nakamura, O. Endo and O. Sakata</i>	68
<b>Photoresponsive crystal:</b> Photochromic hollow crystals showing scattering of crystals and dispersal of included objects mimicking <i>Impatiens</i> <i>K. Uchida, E. Hatano and M. Morimoto</i>	70
<b>XPS technique:</b> X-ray photoelectron spectroscopy under ambient pressure conditions <i>Y. Takagi, T. Yokoyama and Y. Iwasawa</i>	72
<b>Fuel cell research:</b> <i>Operando</i> three-dimensional XAFS imaging of the degradation of a polymer electrolyte fuel cell Pt/C cathode electrocatalyst <i>H. Matsui, N. Ishiguro and M. Tada</i>	74
<b>Physical chemistry:</b> Platonic micelles: A new concept of micelles since their discovery 100 years ago <i>S. Fujii, R. Takahashi and K. Sakurai</i>	76
<b>Waste processing:</b> <i>In situ</i> analysis of Cs species in an alkali-activated solid waste incineration fly ash and pyrophyllite-based system <i>K. Shiota and M. Takaoka</i>	78

## Earth & Planetary Science

<b>Mantle dynamics:</b> The pyrite-type high-pressure form of FeOOH <i>M. Nishi</i>	80
<b>Mantle dynamics:</b> Intermediate-depth earthquakes triggered by localized heating in peridotites <i>T. Ohuchi</i>	82
<b>Mantle dynamics:</b> Effect of ferrous iron on elasticity of bridgmanite: Possible origin of anticorrelated seismic velocity anomaly observed in the lower mantle <i>H. Fukui, S. Kamada and A. Yoneda</i>	84
<b>Core dynamics:</b> Melting experiments on Fe-Fe <sub>3</sub> S system to 254 GPa <i>K. Hirose</i>	86

## Archaeology

- X-ray fluorescence analysis:** Ancient glassware that traveled the Silk Road 88  
*Y. Abe*

## Industrial Applications

- Body soap:** Disruption of human stratum corneum lipid structure by sodium dodecyl sulfate 90  
*K. Yanase and I. Hatta*
- Automotive tires:** HAXPES for a better tire performance: Chemical state analysis of adhesive interface between rubber and steel cords 92  
*K. Ozawa, T. Kakubo and N. Amino*
- Synthetic fibers:** Effects of spinning speed and draw ratio on the fibril structure development of poly(ethylene terephthalate) fiber after neck-drawing 94  
*Y. Ohkoshi, R. Tomisawa and K. H. Kim*

## Accelerators & Beamlines Frontiers 96

### SPring-8

- Beam Performance** 97

#### New Apparatus, Upgrades & Methodology

- A new high-resolution X-ray spectrometer for studying electronic dynamics 98  
*D. Ishikawa and A. Q. R. Baron*
- Fresnel zone plate with apodized aperture for hard X-ray Gaussian beam optics 100  
*A. Takeuchi, K. Uesugi and Y. Suzuki*

### SACLA

- Beam Performance** 102

## Facility Frontiers 103

### SPring-8 Facility Status 104

- Introduction 104
- Machine Operation 104
- Beamlines 105
- User Program and Statistics 109
- Research Outcome 112
- Budget and Personnel 112
- Research Complex 113
- SPring-8 Users Community (SPRUC) 114
- Outreach Activities 115

### SACLA Facility Status 116

**Note:** The principal publication(s) concerning each article is indicated with all author's names in italics in the list of references.