

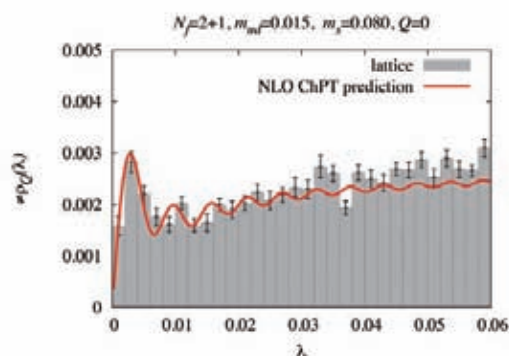
## Determination of the Chiral Condensate from QCD Dirac Spectrum on the Lattice

**Fukaya, H.**; Aoki, S.; Chiu, T.W.; Hashimoto, S.; Kaneko, T.; Noaki, J.; **Onogi, T.**; Yamada, N.  
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*PHYSICAL REVIEW D* **83**, 074501 (2011)

“What is the origin of mass?” Already at early 1960s, Dr. Nambu answered to this question by his Nobel Prize winning work on the dynamical chiral symmetry breaking. However, it has been a challenging target to directly confirm his idea from the 1st principle calculation of Quantum Chromodynamics (QCD). Using a latest supercomputer, we achieved, for the first time, the large-scale simulation of QCD keeping the chiral symmetry exact. Our result strongly suggests the existence of the chiral condensate, the source of the spontaneous symmetry

breaking:  $[234(04)(17) \text{ MeV}]^3$  (the errors are statistical and systematic, respectively).



## Antisense-Induced Guanine Quadruplexes Inhibit Reverse Transcription by HIV-1 Reverse Transcriptase

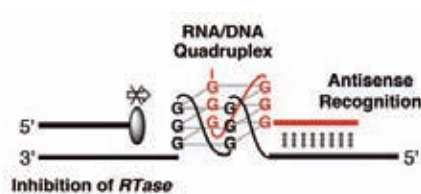
**Hagihara, M.**; **Yamauchi, L.**; **Seo, A.**; **Yoneda, K.**; **Senda, M.**; **Nakatani, K.**  
(The Institute of Scientific and Industrial Research)

*Journal of the American Chemical Society*, **132**, 11171-11178 (2010)

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We report a novel antisense strategy using guanine-tethered antisense oligonucleotides (g-ASSs). The g-ASSs can introduce an RNA–DNA heteroquadruplex structure on RNA templates in a predictable and sequence-specific manner, which in practice effectively inhibited reverse transcription on a variety of RNA sequences, including the HIV-1 RNA genome. Detailed binding properties of g-ASSs to target RNA sequences were certified by spectroscopic analyses and our developed reverse transcriptase-mediated enzymatic analyses (*RTase* stop assay). The remarkable inhibiting ability of reverse

transcription by guanine-tethered antisenses could make possible the development of novel antiretroviral gene therapies based on blocking the replication of RNA genomes that is a critical step for integration into the host’s genome.



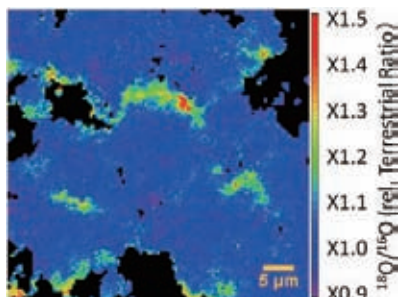
## Extreme Oxygen Isotope Anomaly with a Solar Origin Detected in Meteoritic Organics

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*Nature Geoscience*, **4**, 165-168 (2011)

Materials that characterize the surface of Earth, atmosphere, ocean and life, are considered to have derived from organics and water included in primitive meteorites. These volatile compounds are conceived to have originated from a cold space medium, although the exact origins remain unknown. We were able to identify the origin of the meteoritic organics by the detection of characteristic isotope anomalies of oxygen and carbon using an isotope imaging microscope. The enrichments in  $^{17}\text{O}$ ,  $^{18}\text{O}$  and  $^{13}\text{C}$  found in micron-sized organic grains suggest that they were formed at the envelope of the solar nebula illuminated by the sun-light, triggered by a photochemical reaction. The

figure demonstrates the composition image for the  $^{18}\text{O}/^{16}\text{O}$  ratio of the organics, where the part pasted in warm colors represents the detected organic grains.



## Pressure-induced Superconductivity and Large Upper Critical Field in the Noncentrosymmetric Antiferromagnet CeIrGe<sub>3</sub>

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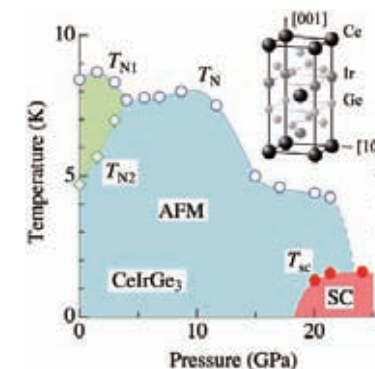
<sup>\*1</sup>(Graduate School of Science)

<sup>\*2</sup>(Center for Quantum Science and Technology under Extreme Conditions)

*PHYSICAL REVIEW B*, **81**, 140507(R) 1-4 (2010)

The interplay of magnetism and superconductivity has attracted a great interest in strongly correlated electron systems. An antiferromagnet CeIrGe<sub>3</sub> crystallizes in the tetragonal structure without inversion symmetry along the [001] direction. Our electrical resistivity measurements under high pressures revealed that CeIrGe<sub>3</sub> becomes superconductive above 20 GPa. The superconducting (SC) state coexists with the antiferromagnetic (AFM) state at around 20 GPa, and only a superconducting transition occurs at 24 GPa, as shown in the deduced *P-T* phase diagram. Note that the superconducting state has a huge upper critical field  $H_{c2} > 15 \text{ T}$  at 24 GPa, for the magnetic field along the [001] direction, which is

based on the non-centrosymmetric structure and heavy fermion state.



## Common Architecture of the Flagellar Type III Protein Export Apparatus and F- and V-type ATPases

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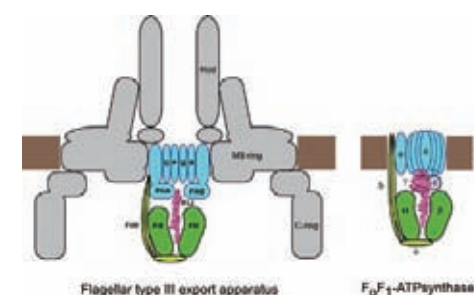
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<sup>\*2</sup>(Graduate School of Science)

*Nature Structural & Molecular Biology*, **18**, 277-282 (2011)

For construction of the bacterial flagellum, which is a filamentous organelle for motility, most of the component proteins require a specific protein export apparatus to be exported from the cytoplasm into the central channel of the growing flagellum. FliI and FliJ are soluble components of the export apparatus. We determined the crystal structure of FliJ at 2.1 Å resolution, and analyzed the FliI<sub>6</sub>-FliJ ring complex structure by electron cryo-microscopy. These studies clearly show significant structural similarities between the flagellar protein export apparatus and F<sub>0</sub>F<sub>1</sub>-ATPsynthase, suggesting a common

functional mechanism and an unexpected evolutionary relationship between the two systems.



## Nature of Electron Transport by Pyridine-Based Tripodal Anchors: Potential for Robust and Conductive Single-Molecule Junctions with Gold Electrodes

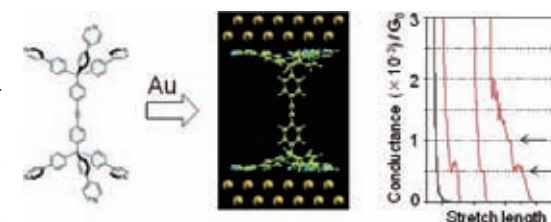
**Ie, Y.**; Hirose, T.; Nakamura, H.; Kiguchi, M.; Takagi, N.; Kawai, M.; **Aso, Y.**  
(Institute of Scientific and Industrial Research)

*Journal of the American Chemical Society*, **133**, 3014-3022 (2011)

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We have designed and synthesized a pyridine-based tripodal anchor unit to construct a single-molecule junction with a gold electrode. The advantage of tripodal anchoring to a gold surface was unambiguously demonstrated by cyclic voltammetry measurements. X-ray photoelectron spectroscopy measurements indicated that the  $\pi$  orbital of pyridine contributes to the physical adsorption of the tripodal anchor unit to the gold surface. The conductance of a single-molecule junction that

consists of the tripodal anchor and diphenyl acetylene was measured by modified scanning tunneling microscope techniques. Finally, by analyzing the transport mechanism based on ab initio calculations, the participation of the  $\pi$  orbital of the anchor moieties and  $\pi$ -channel electric transport were predicted.



## A New Idea to Search for Charged Lepton Flavor Violation Using a Muonic Atom

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(Graduate School of Science)

*Physical Review Letters*, **105**, 121601 (2010)

A new process of  $\mu^+e^- \rightarrow e^+e^-$  in a muonic atom for a quest of charged lepton flavor violation, which has not been discussed before, is proposed. Charged lepton flavor is known to be one of the important process to search for new phenomena beyond the standard model of elementary particle physics. In this newly proposed process, the Coulomb attraction from the nucleus in a heavy muonic atom leads to significant enhancement in its rate by  $Z^3$ , where  $Z$  is an atomic number of the nucleus of the muonic atom, compared to  $\mu^+e^- \rightarrow e^+e^-$ . The upper limit of the branching ratio is estimated to be of the orders of  $O(10^{-17})$ ,

and will become feasible in future experiments. This process could serve potentially promising opportunity to find new physics phenomena.

