

# Shigeru Yoshida, Dr.Sci.

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## Personal Data

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## Education

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March 1994 Ph.D., Tokyo Institute of Technology/The University of Tokyo  
(1991-1994)  
March 1991 M. Sc., Tokyo Institute of Technology  
(1989-1998)  
March 1989 B.S., Tokyo Institute of Technology  
(1984-1988)

## Award

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2014 Totsuka Prize  
Heisei Foundation for Basic Science  
1999 Distinguished Young Researchers Award  
Inamori Foundation  
1997 Fellowship for Distinguished Researchers  
The Ministry of Education and Culture  
1991 Scholar of Excellence  
Tejima Foundation

## Membership

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1994 – present: American Physical Society  
1988 – present: Physical Society of Japan

## Professional Appointment

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2012 –Present Professor, Chiba University, Japan  
2002 –2012 Associate Professor, Chiba University, Japan  
1997–2000 Visiting Scholar, University of Utah  
1997 Monbu-Sho Fellow, University of Tokyo, Japan  
1995–2002 Assistant Professor, Institute for Cosmic Ray Research, University of Tokyo

## Executive Summary of My Present and Past Involvement in Research

Sep. 12, 2016

### **Research Activity: IceCube (2002-present)**

- Analysis of the 7 year IceCube data to provide the most stringent constraint in the ultra-high energy cosmic ray rigins by neutrino observations(submitted to PRL, arXiv:1607:05886).
- Analysis of the 2009-2012 IceCube data to provide the most stringent constraint in the energy range from 10 PeV to 10 EeV (Physical Review D **88** 112008, 2013).
- Supervised the IceCube data analysis in ultra-high energy region above PeV, leading to the first discovery of the PeV neutrino events (Physical Review Letters **111** 021103, 2013).
- Co-worked to achieve the world's best sensitivity on the neutrino fluxes above  $\sim 1$  PeV (Physical Review D **83**, 092003, 2011)
- Initiated search for cosmogenic (GZK) neutrinos by IceCube (Physical Review D **82**, 072003, 2010)
- Calibrations of the first string IceCube data (Astroparticle Phys., **26**, 155, 2006).
- Developed core simulation programs for cosmogenic (GZK) neutrino searches with IceCube with JAVA (Physical Review D **69** 103004, 2004).
- Developed analysis and simulation chain with C++ for the ultra-high energy cosmic neutrino searches by IceCube.
- Energy scale calibrations of the IceCube optical modules using the in-situ laser sources.
- Development, calibration, and modeling of the IceCube photo-multiplier tubes (Nucl.Instrum.Meth. A **618** 139-152, 2010)

### **Research Activity: ARA (2010-present)**

- Supervising the ARA activities in Japan.
- The wireless data transfer system R&D for the ARA neutrino telescope.

### **Research Activity: Phenomenological Studies on Cosmic rays and Neutrinos (1993-present)**

- Bounds on the origin of extragalactic cosmic rays by the IceCube observations (Physical Review D **90**, 123012, 2014).
- Constrained the highest energy cosmic-ray sources by analytical formula to relate neutrino intensities and cosmological evolution of the sources (Physical Review D **85**, 063002, 2012).
- Constrained particle physics models beyond the standard model by bounding the neutrino-nucleon interaction cross section with the IceCube observation. (Physical Review D **82**, 103012, 2010).
- Proposed a neutrino model to explain the cosmic rays with energies beyond the predicted cutoff due to the collisions with CMBs (Physical Review Letters **81** 5505, 1998).
- Calculation of the ultra-high energy cosmic ray, gamma ray and neutrino fluxes originating from the topological defects (Physical Review D **59** 04350, 1999).
- Calculation of the cosmogenic neutrino fluxes and their detection sensitivity by air fluorescence detectors (Astrophysical Journal **522** 225-237, 1999).
- Study on the propagation of ultra-high energy neutrinos in the sea of cosmological relic

neutrinos (Astroparticle Physics **2** 187, 1994).

- Calculation of the propagation of ultra-high energy cosmic rays in extragalactic space, and the fluxes of the resultant secondary cosmogenic neutrinos and photons (Prog. Theor. Phys. **89** 833, 1993).

#### **Research Activity: Telescope Array (1995-2006)**

- Designed the air fluorescence detector array for realizing an order of magnitude larger aperture than the present generation experiments to detect ultra-high energy cosmic rays.
- Developed the Monte Carlo simulations programs and event reconstruction programs for the air fluorescence detector (1995-2000). It provides the core libraries in the current analysis software employed in the Telescope Array's offline computer programs.
- Simulation study on the energy and Xmax resolutions for events measured by fluorescence detectors (C. R. Physique **5**, 483-493 2004).
- Simulation study on the hybrid event reconstruction applicable to the Pierre Auger experiment (Astroparticle Physics **5** 239 1996).
- In charge for the site selection for building the fluorescence detector array. Two of the present detector sites were located from this work.
- Designed the fADC front-end electronics and determined the specification.
- Developed the DAQ and the wireless data link system for the surface detector array.

#### **Research Activity: Akeno Giant Air Shower Array - AGASA (1989-2002)**

- Found and analyzed the trans-GZK ultra-high energy cosmic ray event whose energy was estimated to be  $2 \times 10^{20}$  eV (Physical Review Letters, **73**, 3491 1994).
- The primary work for the energy spectrum of cosmic rays published from the AGASA experiment for the first time (Astropart. Phys. **3** 105 1995).
- Pioneered the search for ultra-high energy cosmic neutrinos with looking for young horizontal air showers with the scintillator detector array (Proc. 27th ICRC, 1142-1145 2001)
- In charge for designing, developing and constructing the online data acquisition system for the surface detector array (Nucl. Inst. Meth. **A311**, 338 1992).
- In charge for PMT gain calibration using MIPs for the scintillation detector.
- Analysis of the lateral distribution of extensive air showers measured by the surface detector. It provided the foundation to estimate the primary energy of cosmic rays measured by air showers (J. Phys. G: Nucl. Part. Phys. **20**, 651 1994).

#### **Coordination and Review Activity**

- Convener (leader) of the IceCube extremely-high energy neutrino physics working group (2006 ~ 2010).
- Rapporteur of 29th International Cosmic Ray Conference (2005).
- Rapporteur of 26th International Cosmic Ray Conference (1999).

## List of Publications and Presentations

Sep. 12, 2016

### List of Books and Review Articles (including the Japanese articles)

- 1 Ultra-high-energy cosmic neutrinos: at  $10^{15}$  eV energies and above  
Comptes Rendus Physique **15** 309-317 (2014).  
S. Yoshida
- 2 First Observation of PeV-Energy Neutrinos  
with IceCube  
日本物理学会誌 **68**, (2013)  
A. Ishihara and S. Yoshida
- 3 宇宙の観測 III  
高エネルギー天文学  
シリーズ 現代の天文学 **17**, 日本評論社 (2008)  
S. Yoshida (共著)
- 4 The IceCube Neutrino Observatory using the Antarctic Ice  
Began Its Operation  
日本物理学会誌 **59**, 358-361 (2004)  
S. Yoshida
- 5 Energy Determination of Trans-EeV Cosmic Rays  
C. R. Physique **5** 483-493 (2004)  
S. Yoshida
- 6 Ultra-High Energy Particle Astrophysics  
Nova Science Publishers, New York, (January 2003)  
S. Yoshida
- 7 Physics and Astrophysics of Ultrahigh Energy Cosmic Rays  
Lecture notes in Physics, Springer, (2001)  
S. Yoshida (part.cont.)
- 8 Telescope Array Project for  
Extremely High Energy Cosmic Rays  
日本物理学会誌 **55**, 924 (2000)  
M. Fukushima and S. Yoshida
- 9 The Extremely High Energy Cosmic Rays  
Journal of Physics G **24**, 905 (1998)  
S. Yoshida and H. Dai
- 10 The Highest Energy Cosmic Rays  
Physics Today, (Jan. 1998)  
w. T. O'Halloran and P.Sokolsky
- 11 The Highest Energy Cosmic Rays  
Parity, Maruzen, (Oct. 1998)  
S. Yoshida
- 12 Search for Ultrahigh Energy Cosmic Rays  
Parity, Maruzen, (July 1997)  
S. Yoshida

## List of Publications in Refereed Journals

◦ marks indicate publications as corresponding author.

★ marks indicate selected important papers to which Shigeru Yoshida made a central contribution.

† indicates the papers based on my thesis research.

1. ◦ “**Constraints on ultra-high-energy cosmic ray sources from a search for neutrinos above 10 PeV with IceCube**”, by **IceCube Collaboration (M. G. Aartsen et al)**, submitted to **Physical Review Letters**, **arXiv:1607.05886 (2016)**.
2. “Neutrino Oscillation Studies with IceCube-DeepCore”, by IceCube Collaboration (M. G. Aartsen et al), *Nuclear Physics B* **908**, 161-177 (2016).
3. “An All-Sky Search for Three Flavors of Neutrinos from Gamma-Ray Bursts with the IceCube Neutrino Observatory”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal* **824** 115, (2016).
4. “High-Energy Neutrino Follow-Up Search of Gravitational Wave Event GW150914 with ANTARES and IceCube”, by Antares Collaboration, IceCube Collaboration, LIGO Scientific Collaboration, and Virgo Collaboration (S. Adrian-Martinez et al), *Physical Review D* **93**, 122010, (2016).
5. “Lowering IceCube’s Energy Threshold for Point Source Searches in the Southern Sky”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal Letters* **824**,L28, (2016).
6. “Characterization of the Atmospheric Muon Flux in IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *Astroparticle Physics*, **78**, 1-17 (2016).
7. “First Combined Search for Neutrino Point-Sources in the Southern Hemisphere with the ANTARES and IceCube Neutrino Telescopes”, by ANTARES and IceCube Collaborations, *Astrophysical Journal* **823**,65 (2016).
8. “Improved Limits on Dark Matter Annihilation in the Sun with the 79-string IceCube Detector and Implications for Supersymmetry”, by IceCube Collaboration (M. G. Aartsen et al), *Journal of Cosmology and Astroparticle Physics*, **04**, 022 (2016).
9. “Performance of two Askaryan Radio Array stations and first results in the search for ultrahigh energy neutrinos”, by ARA Collaboration (P. Allison et al), *Physical Review D* **93**, 082003, (2016).
10. “Searches for Relativistic Magnetic Monopoles in IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *European Physical Journal C* **76**,133, (2016).
11. “Search for Astrophysical Tau Neutrinos in Three Years of IceCube Data”, by IceCube Collaboration (M. G. Aartsen et al), *Physical Review D* **93**, 022001, (2016).
12. “Search for Correlations Between the Arrival Directions of IceCube Neutrino Events and Ultrahigh-Energy Cosmic Rays Detected by the Pierre Auger Observatory and the Telescope Array”, by IceCube, Pierre Auger and Telescope Array Collaborations,(M. G. Aartsen et al) *Journal of Cosmology and Astroparticle Physics* **01**,037, (2016).
13. “Search for Transient Astrophysical Neutrino Emission with IceCube-DeepCore”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal* **816**,75, (2016).
14. “Search for Dark Matter Annihilation in the Galactic Center with IceCube-79”, by IceCube Collaboration (M. G. Aartsen et al), *European Physical Journal C* **75**, 492, (2015)
15. “Detection of a Type II<sub>n</sub> Supernova in Optical Follow-up Observations of IceCube Neutrino Events”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal*, **811**, 52, (2015).

16. “A Combined Maximum-Likelihood Analysis of the High-Energy Astrophysical Neutrino Flux Measured with IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal* **809**, 98, (2015).
17. “Evidence for Astrophysical Muon Neutrinos from the Northern Sky with IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *Physical Review Letters*, **115**, 081102, (2015).
18. “Searches for Time Dependent Neutrino Sources with IceCube Data from 2008 to 2012”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal*, **807**, 46, (2015).
19. “Measurement of the Atmospheric  $\nu_e$  Spectrum with IceCube” , by IceCube Collaboration (M. G. Aartsen et al), *Physical Review D* **91**, 122004, (2015).
20. “Searches for Small-Scale Anisotropies from Neutrino Point Sources with Three Years of IceCube Data”, by IceCube Collaboration (M. G. Aartsen et al), *Astroparticle Physics* **66**, 39-52, (2015).
21. “Search for Prompt Neutrino Emission from Gamma-Ray Bursts with IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophysical Journal Letters* **805**, L5, (2015).
22. “Determining Neutrino Oscillation Parameters from Atmospheric Muon Neutrino Disappearance with Three Years of IceCube DeepCore Data”, by IceCube Collaboration (M. G. Aartsen et al), *Physical Review D* **91**, 072004, (2015).
23. “Flavor Ratio of Astrophysical Neutrinos above 35 TeV in IceCube” , by IceCube Collaboration (M. G. Aartsen et al), *Physical Review Letters* **114**, 171102, (2015).
24. “First Constraints on the Ultra-High Energy Neutrino Flux from a Prototype Station of the Askaryan Radio Array” , by ARA Collaboration (P. Allison et al), *Astroparticle Physics* **70**, 62-80, (2015).
25. “Development of a General Analysis and Unfolding Scheme and its Application to Measure the Energy Spectrum of Atmospheric Neutrinos with IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *European Physical Journal C* **75**, 116, (2015).
26. “Atmospheric and Astrophysical Neutrinos above 1 TeV Interacting in IceCube”, by IceCube Collaboration (M. G. Aartsen et al), *Physical Review, D* **91**, 022001 (2015).
27. “Multipole Analysis of IceCube Data to Search for Dark Matter Accumulated in the Galactic Halo”, by IceCube Collaboration (M. G. Aartsen et al), *European Physical Journal C*, **75** 20, (2015),
28. ◦ **“Bounds on the origin of extragalactic ultrahigh energy cosmic rays from the IceCube neutrino observations”**  
**S. Yoshida and H. Takami, Phys. Rev. D 90 123012 (2014).**
29. “Multimessenger search for sources of gravitational waves and high-energy neutrinos: Initial results for LIGO-Virgo and IceCube” , *Physical Review D* **90**, 102002 (2014).
30. “Searches for Extended and Point-like Neutrino Sources with Four Years of IceCube Data”, by IceCube Collaboration (M. G. Aartsen et al), *Astrophys.Journal* **796** 109, (2014).
31. “Observation of High-Energy Astrophysical Neutrinos in Three Years of IceCube Data” , by IceCube Collaboration (M. G. Aartsen et al), *Physical Review Letters* **113**, 101101 (2014).
32. “Search for non-relativistic magnetic monopoles with IceCube” , by IceCube Collaboration (M. G. Aartsen et al), *The European Physical Journal C*, **74**, 2938, (2014)
33. “Search for neutrino-induced particle showers with IceCube-40” , by IceCube Collaboration (M. G. Aartsen et al), *Physical Review D* **89**, 102001, (2014).
34. “Search for a diffuse flux of astrophysical muon neutrinos with the IceCube 59-string configuration”, by IceCube Collaboration (M. G. Aartsen et al), *Physical Review D* **89**,

062007, (2014) .

35. “Energy reconstruction methods in the IceCube neutrino telescope”, by IceCube Collaboration (M. G. Aartsen et al), JINST **9**, P03009, (2014).
36. “Improvement in fast particle track reconstruction with robust statistics”, by IceCube Collaboration (M. G. Aartsen et al), Nuclear Instruments and Methods in Physics Research A: **736**, (2014).
37. ★ “Evidence for High-Energy Extraterrestrial Neutrinos at the IceCube Detector”, by IceCube Collaboration (M. G. Aartsen et al), Science **342**, 1242856 (2013).
38. “Measurement of Atmospheric Neutrino Oscillations with IceCube”, by IceCube Collaboration (M. G. Aartsen et al), Physical Review Letters, **111**, 081801, (2013).
39. “Measurement of the Cosmic Ray Energy Spectrum with IceTop-73”, by IceCube Collaboration (M. G. Aartsen et al), Physical Review D **88**, 042004, (2013).
40. ○ **“Probing the origin of cosmic-rays with extremely high energy neutrinos using the IceCube Observatory”**  
by IceCube Collaboration (M. G. Aartsen et al),  
e-Print: arXiv:1310.5477 [astro-ph.HE], Phys. Rev. D **88** 112008 (2013).
41. ★ **“First observation of PeV-energy neutrinos with IceCube”**  
by IceCube Collaboration (M. G. Aartsen et al),  
Phys. Rev. Letters **111** 021103 (2013).
42. “Measurement of Atmospheric Neutrino Oscillations with IceCube” by IceCube Collaboration (M. G. Aartsen et al), Phys.Rev.Letters **111**, 081801 (2013).
43. “Correlations of the Arrival Directions of Ultra-high Energy Cosmic Rays with Extragalactic Objects as Observed by the Telescope Array Experiment” by Telescope Array Collaboration (T. Abu-Zayyad et al), Astrophys.J. **777**, 88 (2013).
44. “The Energy Spectrum of Ultra-High-Energy Cosmic Rays Measured by the Telescope Array FADC Fluorescence Detectors in Monocular Mode” by Telescope Array Collaboration (T. Abu-Zayyad et al), Astropart.Phys. **48**, 16-24 (2013).
45. “Measurement of South Pole ice transparency with the IceCube LED calibration system” by IceCube Collaboration (M. G. Aartsen et al), Nucl. Instrum. Mth. **A711** 73-89 (2013).
46. “Measurement of the Atmospheric  $\nu_e$  flux in IceCube”, by IceCube Collaboration (M. G. Aartsen et al), Phys. Rev. Letters **110** 151105 (2013).
47. “Search for dark matter annihilations in the Sun with the 79-string IceCube detector”, by IceCube Collaboration (M. G. Aartsen et al), Phys. Rev. Letters **110** 131302 (2013).
48. “Search for Galactic PeV Gamma Rays with the IceCube Neutrino Observatory”, by IceCube Collaboration (M. G. Aartsen et al), Phys. Rev. D **87** 062002 (2013).
49. “Observation of Cosmic Ray Anisotropy with the IceTop Air Shower Array”, by IceCube Collaboration (M. G. Aartsen et al), Astrophys. Journal **765** 55 (2013).
50. “Searches for high-energy neutrino emission in the Galaxy with the combined IceCube-AMANDA detector” by IceCube Collaboration (R. Abbasi et al), Astrophys. Journal **763** 33 (2013).
51. “Search for Relativistic Magnetic Monopoles with IceCube” by IceCube Collaboration (R. Abbasi et al), Phys. Rev. D **87**, 022001 (2013);
52. “An improved method for measuring muon energy using the truncated mean of  $dE/dx$ ” by IceCube Collaboration (R. Abbasi et al), Nucl. Instrum. Mth. **A703** 190-198 (2013).
53. “IceTop: The surface component of IceCube” by IceCube Collaboration (R. Abbasi et al), Nucl. Instrum. Mth. **A700** 188-220 (2013).

54. “Cosmic Ray Composition and Energy Spectrum from 1-30 PeV Using the 40-String Configuration of IceTop and IceCube” by IceCube Collaboration (R. Abbasi et al), *Astropart. Physics* **42** 15-32 (2013).
55. “The Cosmic Ray Energy Spectrum Observed with the Surface Detector of the Telescope Array Experiment” by Telescope Array Collaboration (T. Abu-Zayyad et al), *Astrophys. Journal* **768** L1 (2013).
56. “Search for Anisotropy of Ultra-High Energy Cosmic Rays with the Telescope Array Experiment” by Telescope Array Collaboration (T. Abu-Zayyad et al), *Astrophys. Journal* **757** 26 (2012).
57. “An Absence of Neutrinos Associated with Cosmic-Ray Acceleration in Gamma-Ray Bursts” by IceCube Collaboration (R. Abbasi et al), *Nature* 484, 351-354 (2012).
58. “Background Studies for Acoustic Neutrino Detection at the South Pole” by IceCube Collaboration (R. Abbasi et al), *Astroparticle Physics* 35, 312-324 (2012).
59. “Cosmic Ray Composition and Energy Spectrum from 1-30 PeV Using the 40-String Configuration of IceTop and IceCube” by IceCube Collaboration (R. Abbasi et al), *Astroparticle Physics*, 42 115-32 (2013).
60. “IceTop: The Surface Component of IceCube” by IceCube Collaboration (R. Abbasi et al), *Nuclear Instruments and Methods A*700 188-220(2013).
61. “Lateral Distribution of Muons in IceCube Cosmic Ray Events” by IceCube Collaboration (R. Abbasi et al), *Phys. Rev. D*87 (2013) 012005;
62. “Multiyear Search for Dark Matter Annihilations in the Sun with the AMANDA-II and IceCube Detectors” by IceCube Collaboration (R. Abbasi et al), *Physical Review D*85, 042002 (2012).
63. ◦ **“Constraints on the origin of the ultra-high energy cosmic-rays using cosmic diffuse neutrino flux limits: An analytical approach”**  
by Shigeru Yoshida and Aya Ishihara,  
**Phys. Rev. D 85, 063002 (2012).**
64. “Neutrino Analysis of the 2010 September Crab Nebula Flare and Time-Integrated Constraints on Neutrino Emission from the Crab using IceCube” by IceCube Collaboration (R. Abbasi et al), *Astrophysical Journal* 745, 45 (2012).
65. “Observation of Anisotropy in the Galactic Cosmic-Ray Arrival Directions at 400 TeV with IceCube” by IceCube Collaboration (R. Abbasi et al), *Astrophysical Journal* 746, 33 (2012).
66. “Search for Ultrahigh-energy Tau Neutrinos with IceCube” by IceCube Collaboration (R. Abbasi et al), *Physical Review D*86, 022005 (2012).
67. “Searches for High-Energy Neutrino Emission in the Galaxy with the Combined IceCube-AMANDA Detector” by IceCube Collaboration (R. Abbasi et al), *Astrophysical Journal* 763 (2013) 33; e-print archive arXiv:1210.3273.
68. “Searches for Periodic Neutrino Emission from Binary Systems with 22 and 40 Strings of IceCube” by IceCube Collaboration (R. Abbasi et al), *Astrophysical Journal* 748, 118 (2012).
69. ★ **“Design and Initial Performance of the Askaryan Radio Array Prototype EeV Neutrino Detector at the South Pole”**  
by ARA Collaboration (P. Allison et al.),  
**Astropart. Phys., 35, 457477, (2012).**
70. “Observation of Anisotropy in the Arrival Directions of Galactic Cosmic Rays at Multiple Angular Scales with IceCube” by IceCube Collaboration (R. Abbasi et al.), *Astrophys. J.*



740, 16 (2011).

71. “Time-Integrated Searches for Point-like Sources of Neutrinos with the 40-String IceCube Detector” by IceCube Collaboration (R. Abbasi et al.), *Astrophys. J.* 732, 18 (2011).
72. “Limits on Neutrino Emission from Gamma-Ray Bursts with the 40 String IceCube Detector” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. Lett.* 106, 141101 (2011).
73. “Search for neutrino-induced cascades with five years of AMANDA data” by IceCube Collaboration (R. Abbasi et al.), *Astropart. Phys.* 34, 420 (2011).
74. “Constraints on high-energy neutrino emission from SN 2008D” by IceCube Collaboration (R. Abbasi et al.), *Astronomy & Astrophysics* 527, A28 (2011).
75. ★ **“Constraints on the Extremely-high Energy Cosmic Neutrino Flux with the IceCube 2008-2009 Data”**  
by IceCube Collaboration (R. Abbasi et al.),  
**Phys. Rev. D 83, 092003 (2011).**
76. “Measurement of the atmospheric neutrino energy spectrum from 100 GeV to 400 TeV with IceCube” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. D* 83, 012001 (2011).
77. “Search for a Lorentz-violating sidereal signal with atmospheric neutrinos in IceCube” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. D* 82, 112003 (2010).
78. “The Energy Spectrum of Atmospheric Neutrinos between 2 and 200 TeV with the AMANDA-II Detector” by IceCube Collaboration (R. Abbasi et al.), *Astropart. Phys.* 34, 48 (2010).
79. “Measurement of the Anisotropy of Cosmic Ray Arrival Directions with IceCube” by IceCube Collaboration (R. Abbasi et al.), *Astrophys. J.* 718:L194 (2010).
80. ○ **“Constraints on neutrino-nucleon interactions at energies of 1 EeV with the IceCube Neutrino Observatory”**  
Shigeru Yoshida,  
**Phys. Rev. D 82 103012 (2010).**
81. ○ **“The first search for extremely-high energy cosmogenic neutrinos with the IceCube Neutrino Observatory”**  
by IceCube Collaboration (R. Abbasi et al.),  
**Phys. Rev. D 82, 072003 (2010).**
82. “Search for Muon Neutrinos from Gamma-Ray Bursts with the IceCube Neutrino Telescope” by IceCube Collaboration (R. Abbasi et al.), *Astrophysical Journal* 710 346 (2010).
83. “Limits on a Muon Flux from Kaluza-Klein Dark Matter Annihilations in the Sun from the IceCube 22-string Detector” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. D* 81, 057101 (2010).
84. “Measurement of Sound Speed vs Depth in South Pole Ice for Neutrino Astronomy” by IceCube Collaboration (R. Abbasi et al.), *Astropart. Phys.* 33, 277-286 (2010)
85. ○ **“Calibration and Characterization of the IceCube Photomultiplier Tube”**  
by IceCube Collaboration (R. Abbasi et al.),  
**Nuclear Instruments and Methods A, 618, 139-152 (2010).**
86. “Extending the Search for Neutrino Point Sources with IceCube above the Horizon” by IceCube Collaboration (R. Abbasi et al.), *Physical Review Letters* 103 (2009) 221102.
87. “First Neutrino Point-Source Results From the 22 String IceCube Detector” by IceCube Collaboration (R. Abbasi et al.), *Astrophysical Journal Letters* 701 47 (2009).
88. “Limits on a muon flux from neutralino annihilations in the Sun with the IceCube 22-string detector” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. Lett.* 102, 201302 (2009).

89. “Determination of the Atmospheric Neutrino Flux and Searches for New Physics with AMANDA-II” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. D* **79**, 102005 (2009).
90. “The IceCube Data Acquisition System: Signal Capture, Digitization, and Timestamping” by IceCube Collaboration (R. Abbasi et al.), *NIM A* **601** 294 (2009).
91. “Search for Point Sources of High Energy Neutrinos with Final Data from AMANDA-II” by IceCube Collaboration (R. Abbasi et al.), *Phys. Rev. D* **79** 062001 (2009).
92. ★ **“Search for Ultra High Energy Neutrinos with AMANDA-II”, by IceCube Collaboration (M. Ackermann et al.), *Astrophysical Journal* **675**, 1014 (2008).**
93. “The Search for Muon Neutrinos from Northern Hemisphere Gamma-Ray Bursts with AMANDA”, by IceCube Collaboration (A. Achterberg et al.), *Astrophysical Journal* **674**, 357 (2008).
94. “Detection of atmospheric muon neutrinos with the IceCube 9-string detector”, by IceCube Collaboration (A. Achterberg et al.), *Phys. Rev. D* **76**, 027101 (2007).
95. “Multi-year search for a diffuse flux of muon neutrinos with AMANDA-II”, by IceCube Collaboration (A. Achterberg et al.), *Phys. Rev. D* **76**, 042008 (2007).
96. “Five years of searches for point sources of astrophysical neutrinos with the AMANDA-II neutrino telescope”, by IceCube Collaboration (A. Achterberg et al.), *Phys. Rev. D* **75**, 102001 (2007).
97. “Limits on the muon flux from neutralino annihilations at the center of the Earth with AMANDA”, by IceCube Collaboration, (A. Achterberg et al.), *Astropart. Phys.*, **26**, 129 (2006).
98. “On the selection of AGN neutrino source candidates for a source stacking analysis with neutrino telescopes”, by IceCube Collaboration, (A. Achterberg et al.), *Astropart. Phys.*, **26**, 282 (2006).
99. “Limits on the high-energy gamma and neutrino fluxes from the SGR 1806-20 giant flare of December 27th, 2004 with the AMANDA-II detector”, by IceCube Collaboration (A. Achterberg et al.), *Phys. Rev. Lett.*, **97**, 221101 (2006).
100. ★ **“First Year Performance of the IceCube Neutrino Telescope”, by IceCube Collaboration (A. Achterberg et al.), *Astropart. Phys.*, **26**, 155-173 (2006).**
101. ○ **“Propagation of Extremely High Energy Leptons in Earth : Implications for Their Detection by the IceCube Neutrino Telescope” S.Yoshida, R.Ishibashi, and H Miyamoto, *Phys. Rev. D* **69**, 103004 (2004).**
102. “Sensitivity of the IceCube Detector to Astrophysical Sources of High Energy Muon Neutrinos”, by IceCube Collaboration (J. Ahrens et al.), *Astropart. Phys.* **20**, 507 (2004).
103. “Energy Determination in the Akeno Giant Air Shower Experiment” by AGASA Collaboration (M. Takeda et al.), *Astropart. Phys.* **19**, 447 (2003).
104. “Upper Limit of  $\gamma$ -ray Flux above  $10^{19}$  eV Estimated by the Akeno Giant Air Shower Array Experiment”, by AGASA Collaboration (K. Shinozaki et al.), *Astrophys. J.* **571**, L117 (2002).
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  109. “The Anisotropy of Cosmic Ray Arrival Directions around  $10^{18}$ eV”, by AGASA Collaboration (N. Hayashida et al.), *Astropart. Phys.* **10**, 303 (1999).
  110. ○ **“Probing Grand Unified Theories with Cosmic-ray, Gamma-ray, and Neutrino Astrophysics”**  
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  117. “Muons ( $\geq 1$  GeV) in Large Extensive Air Showers of Energies between  $10^{16.5}$  eV and  $10^{19.5}$  eV Observed at Akeno” by AGASA Collaboration (N. Hayashida et al.), *J. Phys. G: Nucl. Part. Phys.* **21**, 1101 (1995).
  118. † **“The Cosmic Ray Energy Spectrum above  $3 \times 10^{18}$  eV measured by the Akeno Giant Air Shower Array”**,  
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121. ○ **“Lateral Distribution of Charged Particles in Giant Air Showers above EeV observed by AGASA”**  
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**J. Phys. G: Nucl. Part. Phys.** **20**, 651 (1994).
122. ○ **“Energy Spectrum of Ultra-high Energy Cosmic Rays with Extra-Galactic Origin”**  
S. Yoshida and M. Teshima,  
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126. ○ **“Akeno giant air shower array (AGASA) covering 100-km<sup>2</sup> area”**  
by AGASA Collaboration (N. Chiba et al.),  
**Nucl.Instrum.Meth.** **A311**, 338-349 (1992).

## Conference Proceedings

Ultra-high energy neutrino online alert system  
for GRB and transient astronomical source

Proc. of the 33rd ICRC, Rio De Janeiro, **id** 0409 (2013)

Search for ultra-high energy cosmic neutrinos  
with the IceCube neutrino observatory

AIP Conf. Proc. **1535** 245-151 (2013)

Constraints on the origins of the ultra-high energy cosmic-rays  
using the IceCube diffuse neutrino limits : An analytical approach

Proc. of the 32nd ICRC, Beijing, **id** 0954 (2011)

The Extremely-high energy neutrino search with IceCube

Proc. of the 31st ICRC, Lodz, **HE 1.4** (2009)

The IceCube Neutrino Telescope and its Capability to  
Search for the EHE Neutrinos

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The IceCube Neutrino Telescope

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Ultra-high Energy Neutrino Astronomy

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Universal Academy Press pp.61-68 (2004)

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Proc. of the 28th ICRC, Tsukuba, **H.E 2.3** 1369 (2003)

Propagation of Extremely High Energy Leptons in the Earth

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The Air Fluorescence Method to Measure the Extremely High Energy Cosmic Rays

Proc. of the International School on

Physics and Astrophysics of Ultra High Energy Cosmic Rays

(UHECR2000)

Springer Lecture Notes in Physics, to be published (2002)

Neutrino Cascades: The Byproducts of Propagation of Ultra High Energy Neutrinos  
Proc. of the International School on  
Physics and Astrophysics of Ultra High Energy Cosmic Rays  
(UHECR2000)  
Springer Lecture Notes in Physics, to be published (2002)

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Muons in Giant Air Showers Observed by AGASA and Its Implications  
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Proc. of the 25th ICRC, Durban, 5 217 (1997)

The Cosmic Ray Energy Spectrum above  $10^{19}$  eV Determined by AGASA  
(with N. Hayashida et al.)  
Proc. of the 25th ICRC, Durban, 4 145 (1997)

Arrival Direction Distribution of Extremely High Energy  
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(with N. Hayashida et al.)  
Proc. of the 25th ICRC, Durban, 4 177 (1997)

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Future Air Fluorescence Detectors  
Proc. of Int. Symposium on Extremely High Energy Cosmic Rays,  
University of Tokyo, Tokyo, 205 (1997)

#### Recent Results of AGASA Experiments

Proc. of Int. Symposium on Extremely High Energy Cosmic Rays,  
(with N. Hayashida et al.)  
University of Tokyo, Tokyo, 50 (1997)

#### The Telescope Array Project

Proc. of Int. Symposium on Extremely High Energy Cosmic Rays,  
(with N. Hayashida et al.)  
University of Tokyo, Tokyo, 205 (1997)

#### Arrival Direction Distribution of EHECR from AGASA Data

Proc. of Int. Symposium on Extremely High Energy Cosmic Rays,  
(with N. Hayashida et al.)  
University of Tokyo, Tokyo, 398 (1997)

#### Composition of Cosmic Rays Between $10^{16.5}$ eV and $10^{19.5}$ eV observed by Akeno (with T. Doi et al.)

Proc. of the 24th ICRC, Rome, **2** 685 (1995)

#### The Cosmic Ray Energy Spectrum above $1 \times 10^{19}$ eV determined by AGASA (with T. Doi et al.)

Proc. of the 24th ICRC, Rome, **2** 740 (1995)

#### Characteristics of Giant Air Showers of Energies around 50 EeV

Observed by AGASA

(with T. Doi et al.)

Proc. of the 24th ICRC, Rome, **2** 764 (1995)

#### Point Source Search for Cosmic Rays above $3 \times 10^{17}$ eV by AGASA

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#### Advanced Studies of Cosmic Rays with Extremely High Energies with the Telescope Array

Proc. of the Tokyo Workshop on the Techniques for the Study of  
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#### Energy Spectrum of Cosmic Rays and Neutrinos with Extremely High Energies

Proc. of the Tokyo Workshop on the Techniques for the Study of  
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Energy Spectrum of Primary Energy Cosmic Rays above  $10^{18}$  eV  
Determined by Akeno Giant Air Shower Array (AGASA)  
(with N. Chiba et al.)  
Proc. of the 23rd ICRC, Calgary, **2** 42 (1993)

A Study of Arrival Direction Distribution of Cosmic Rays above  $10^{17}$  eV  
(with N. Chiba et al.)  
Proc. of the 23rd ICRC, Calgary, **2** 59 (1993)

Telescope Array Project  
(with J. Elbert et al.)  
Proc. of the 23rd ICRC, Calgary, **2** 470 (1993)

Lateral Distribution of the Charged Particles in Giant Air Showers above EeV  
(with N. Chiba et al.)  
Proc. of the 23rd ICRC, Calgary, **4** 315 (1993)

Propagation of Ultrahigh Energy Neutrinos in  
the Black-Body Neutrino Field  
Proc. of the 23rd ICRC, Calgary, **4** 442 (1993)

Characteristics of Giant Air Showers above  $10^{17}$  eV  
(with N. Hayashida et al.)  
Proc. of the 22nd ICRC, Dublin, **4** 331 (1991)

Akeno Giant Air Shower Array (AGASA) Covering 100 km<sup>2</sup> Area  
(with N. Chiba et al.)  
Proc. of the 22nd ICRC, Dublin, **2** 700 (1991)

Energy Spectrum of Primary Cosmic Rays between  $10^{17}$  eV and  $10^{20}$  eV observed at Akeno  
(with M. Nagano et al.)  
Proc. of the 22nd ICRC, Dublin, **2** 89 (1991)

Arrival Direction of Cosmic Rays above  $10^{17}$  eV (with N. Hayashida et al.)  
Proc. of the 22nd ICRC, Dublin, **2** 117 (1991)



Calculation of the Propagation of Ultra High Energy Cosmic Rays

S. Yoshida and M. Teshima

Proc. of Astrophysical Aspects of the Most Energetic Cosmic Rays,  
Kofu, (World Scientific) 106 (1991)

Experimental Results Obtained from the Akeno Giant Air Shower Array

(with M. Teshima et al.)

Proc. of Astrophysical Aspects of the Most Energetic Cosmic Rays,  
Kofu, (World Scientific) 49 (1991)

A New 100km<sup>2</sup> Air Shower Array at Akeno (AGASA)

(with M. Nagano et al.)

Proc. of Astrophysical Aspects of the Most Energetic Cosmic Rays,  
Kofu, (World Scientific) 335 (1991)

A Search for Point Sources above 10<sup>17</sup> eV using Data from  
the Akeno Giant Air Shower Arrays

(with N. Hayashida et al.)

Proc. of the 22nd ICRC, Dublin, **1** 309 (1991)

Propagation of the Highest Energy Cosmic Rays I

S. Yoshida and M. Teshima

Proc. of the 21st ICRC, Adelaide, **3** 165 (1990)

Propagation of the Highest Energy Cosmic Rays II

S. Yoshida and M. Teshima

Proc. of the 21st ICRC, Adelaide, **2** 403 (1990)

AGASA Optical Fiber Network System (GAS-II)

(with H. Ohoka et al.)

Proc. of the 21st ICRC, Adelaide, **4** 290 (1990)

A New 100 km<sup>2</sup> Array at Akeno (AGASA)

(with S. Kawaguchi et al.)

Proc. of the 21st ICRC, Adelaide, **4** 294 (1990)

## Selected Seminars, Colloquium, and Invited talks

1	August 2013	Invited talk	PPP 2013 Kyoto University Japan	On Detection of ultra-high energy cosmic neutrinos with the IceCube neutrino observatory and its implications to the origin of ultra-high energy cosmic rays
2	August 2013	Invited talk	TeVPA 2013 University of California Irvine USA	What can we learn about ultra-high energy cosmic-ray origin with IceCube?
3	March 2013	Invited Talk	JPS Hiroshima University Japan	On Detection of ultra-high energy cosmic neutrinos with the IceCube neutrino observatory and its implications to the origin of ultra-high energy cosmic rays
4	November 2012	Colloq.	Department of Physics Ohio State University USA	The New Messengers From The Universe “First Light” of the High Energy Neutrino Astronomy
5	November 2012	Seminar	Department of Physics New York University USA	On Detection of ultra-high energy cosmic neutrinos with the IceCube neutrino observatory and its implications to the origin of ultra-high energy cosmic rays
6	November 2012	Colloq.	Department of Physics New York University USA	The New Messengers From The Universe “First Light” of the High Energy Neutrino Astronomy
7	June 2012	Invited Talk	ARENA 2012 Erlangen Germany	Search for Ultra-high Energy Cosmic Neutrinos with IceCube
8	June 2012	Seminar	APC Paris France	Search for Ultra-high Energy Cosmic Neutrinos with IceCube
9	June 2012	Seminar	DESY Hamburg Germany	Search for Ultra-high Energy Cosmic Neutrinos with IceCube
10	November 2011	Invited Talk	HEAP 2011 KEK Japan	Neutrino Astrophysics with IceCube

11	December 2010	Invited Talk	UHECR 2010 Nagoya Japan	Neutrino Astrophysics
12	May 2009	Invited Talk	Fujihara Seminar Shonan Japan	Explore High Energy Universe with the IceCube Observatory
13	November 2006	Colloq.	Department of Physics University of California Berkeley California, USA	Extremely High Energy Universe: Astrophysics in the Highest Energy End
14	August 2006	Invited Talk	2nd Workshop on TeV Particle Astrophysics (TeV II) Wisconsin, USA	Are There EHE Signals?
15	June 2006	Invited Talk	Int. Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY 06) California, USA	The IceCube Neutrino Telescope and Its Capability to Search for the Extremely High Energy Neutrinos
16	August 2005	Rapporteur Talk	30th ICRC Pune India	Cosmic Ray Measurements in Extremely High Energy region
17	November 2003	Invited Talk	Frontier in Astroparticle Physics and Cosmology (6th Resceu) Tokyo, Japan	Ultra-high Energy Neutrino Astronomy
18	November 2003	Invited Talk	Int. Symposium on Cosmology and Particle Astrophysics (CosPa 2003) Taipei, Taiwan	The IceCube Neutrino Telescope
19	October 2003	Invited Talk	New Direction of Particle Physics (TEA03) Kyoto, Japan	Ultra-high Energy Neutrino Astronomy
20	September 2003	Invited Talk	Int. Workshop on Topics in Astroparticle and Underground Physics (TAUP 2003) Seattle, USA	The IceCube Neutrino Telescope

21	March 2001	Invited Talk	Int. Workshop on Extremely High Energy Cosmic Rays, ICRR, Chiba	A search for HAS induced by EHE cosmic neutrinos observed by AGASA
22	January 2001	Invited Talk	Moriond Meeting on High Energy Phenomena in the Universe Les Arcs, France	Propagation of Photons and Neutrinos (GeV- $\geq$ ZeV)
23	June 2000	Invited Talk	Intrenational School on "Physics and Astrophysics of "Ultra High Energy Cosmic Rays", Observatoire de Paris, France	Propagation of UHE neutrinos
24	June 2000	Invited Lecture	Intrenational School on "Physics and Astrophysics of "Ultra High Energy Cosmic Rays", Observatoire de Paris, France	Optical Detectors
25	October 1999	Colloq.	Department of Physics University of Utah Salt Lake City, Utah, USA	Mysterious Cosmic Rays: The Elite of and the Universe
26	August 1999	Rapporteur Talk	26th ICRC Salt Lake City Utah, USA	Cosmic Ray Measurements above 1 TeV
27	February 1999	Seminar	Department of Physics UCLA Calif. USA	Detection of Ultra High Energy Cosmic Rays and Neutrinos
28	December 1998	Invited Talk	Workshop on "Very High Energy Astronomical Objects", Kawaguchi-Lake, Japan	Measurements of the Highest Energy Cosmic Rays
29	October 1998	Colloq.	Department of Physics Tokyo Inst. Tech Tokyo, Japan	EHE Neutrinos, Neutrino Dark Matter, and the Highest Energy Cosmic Rays
30	September 1998	Colloq.	Department of Physics University of Utah Salt Lake City, Utah, USA	EHE Neutrinos, Neutrino Dark Matter, and the Highest Energy Cosmic Rays

31	June 1998	Colloq.	Department of Physics Tokyo Inst. Tech Tokyo, Japan	The Telescope Array Project
32	November 1997	Invited Talk	Workshop on “Observing Giant Cosmic Ray Airshowers for $\geq 10^{20}$ eV Particles from Space”, U. of Maryland College Park, Maryland	Propagation of Cosmic Rays and Neutrinos through Space
33	May 1997	Invited Talk	Annual Auger Collaboration Meeting, Park City Utah, USA	The Telescope Array R & D
34	May 1997	Seminar	Department of Physics University of California Irvine, Calif.	The Highest Energy Cosmic Rays
35	January 1997	Invited Talk	Moriond Meeting on High Energy Phenomena in the Universe Les Arcs, France	The AGASA Results on the Highest Energy Cosmic Rays
36	November 1996	Colloq.	Department of Physics University of Utah Salt Lake City, Utah, USA	The Physics of the Highest Energy Cosmic Rays Measured by the AGASA Experiment
37	October 1996	Seminar	KEK Tsukuba, Japan	The Highest Energy Cosmic Rays
38	September 1996	Invited Talk	Int. Symposium on Extremely High Energy Cosmic Rays, Tokyo	EHE Neutrinos and Their Detection by Future Air Fluorescence Detectors
39	December 1995	Invited Highlight Talk	Workshop on “Very High Energy Astronomical Objects”, Kawaguchi-Lake, Japan	The Highest Energy Cosmic Rays

## Committees, Media Appearances and Grants (the Japan's domestic ones are described in Japanese)

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Sep. 12, 2016

### Committees

- 1998 : 書評委員会 日本物理学会
- 1999 : Advisory Committee, Seiwa Scholars Society
- 2004-2007 : 実行委員, 宇宙線研究者会議
- 2005-2006 : 東京大学宇宙線研究所共同利用経費査定委員会 委員
- 2006-2008 : 宇宙線・宇宙物理領域運営委員、日本物理学会
- 2007-2008 : 東京大学宇宙線研究所共同利用研究実施専門委員会 委員長
- 2007 : 東京大学宇宙線研究所将来計画検討委員会 委員
- 2008-2009 : 日本学術振興会特別研究員等審査会 委員
- 2010-2011 : 日本学術振興会科研費審査委員会 委員
- 2011 : 東京大学宇宙線研究所人事委員会 外部委員
- 2011-2013 : 文部科学省サイエンスインカレ審査委員会 委員
- 2016 : 東京大学宇宙線研究所共同利用運営委員会
  
- 2003 : Chair - Int. Workshop on Neutrino Telescope, Chiba, Japan
- 2005 : Co-Chair - Particles and Radiation from Cosmic Accelerators, Chiba, Japan
- 2006 : International Organazing Committee - SUSY 2006, USA
- 2011 : International Organazing Committee - Neutrino 2012, Kyoto, Japan
- 2015 : International Organazing Committee - TeVPA 2015, Kashiwa, Japan
- 2016 : Scientific Advisory Committee - CRIS 2016, Ischia, Italy

### List of Media Appearances (Japanese Only)

- 2006 : 日本経済新聞夕刊
- : 朝日新聞朝刊
- : 毎日新聞朝刊
- : 産経新聞朝刊
- : Newton
- 2007 : R25
- : 赤旗
- 2008 : 日本経済新聞夕刊
- : 日経サイエンス
- 2012 : 朝日新聞朝刊
- : 毎日新聞朝刊
- : 読売新聞朝刊
- : 千葉日報朝刊
- 2013 : 日経サイエンス

## List of Extramural Research Grants (Japanese Only)

平成 7 - 11 年度	科研費重点領域「超高エネルギー天体」計画研究 A (分担)
平成 11 年度	稲盛財団研究助成金 (代表)
平成 11 - 12 年度	科研費 国際学術研究 (分担)
平成 12 - 14 年度	科研費 基盤 A (分担)

Blow are the list of grants after moving to the Chiba University

平成 14 年度	科研費奨励研究 (代表) 「自立型最高エネルギー宇宙線検出器の開発」	1,400 千円
平成 15 - 16 年度	科研費若手 B (代表) 「高エネルギー宇宙ニュートリノ探索用高効率光電子像倍管の開発」	2,800 千円
平成 15 - 18 年度	科研費基盤 B 海外 (分担) 「南極氷河標的 ICECUBE 観測実験による 高エネルギー宇宙ニュートリノの探索」 (注) この基盤 B は若手 B との重複申請制限のために、 同僚助教授を代表にして申請。 南極・グループ会議への旅費として使用。	5,800 千円
平成 15 - 17 年度	井上科学振興財団 (代表) 「南極氷河標的 ICECUBE 観測実験による 高エネルギー宇宙ニュートリノの探索」	8,400 千円
平成 16 - 20 年度	特定領域 (計画研究 B02 代表) 「最高エネルギー宇宙線の起源」	145,800 千円
平成 17 - 18 年度	日本学術振興会二国間交流事業 (日米 - NSF) 「ギガトン容量光検出器 IceCube による 高エネルギーニュートリノ天文学の開拓」	4,515 千円
平成 19 - 21 年度	科研費基盤 B (代表) 「IceCube ニュートリノ望遠鏡による 極高エネルギー宇宙線放射機構の解明」	11,700 千円
平成 22 - 23 年度	日本学術振興会二国間交流事業 (日ベルギー) 「南極点直下チェレンコフ電波アレイ建設による 超高エネルギーニュートリノ深宇宙探査」	4,800 千円
平成 22 - 24 年度	科研費基盤 B (代表) 「IceCube ニュートリノ望遠鏡による 極限宇宙物理の新たな展開」	14,200 千円
平成 25 - 29 年度	科研費基盤 S (代表) 「南極点複合ニュートリノ望遠鏡で探る深宇宙一 高エネルギーニュートリノ天文学の始動」	160,900 千円
平成 25 - 29 年度	科研費新学術領域 (領域 A04 代表) 「ニュートリノで探る深宇宙」	139,800 千円