Reason for selection

<Scientific achievement>

As for academic contribution made by Mr. Ryuya Aoki, he performed experimental study on electrical transport properties of monoaxial chiral magnetic crystals of $CrNb_3S_6$ and $YbNi_3Al_9$ and obtained the following four major scientific achievements.

1. He demonstrated the existence of a chiral soliton lattice (CSL) in $YbNi_3Al_9$ compounds by identifying stepwise behavior of magnetoresistance taken in a fine interval of the applied magnetic field. Only soft X-ray data were available to identify Cu-doped $YbNi_3Al_9$ until that time. [cp-2,pr-3]

Details: He fabricated micrometer-sized samples of chiral magnet in f-electron systems $YbNi_3Al_9$ and performed precise measurement of magneto-resistance (MR) to find evidence for CSL. He discussed similarity (step wise behavior) and difference (magnitude of discontinuity, lock-in of MR) in CSL between the two materials $CrNb_3S_6$ and $YbNi_3Al_9$. Those findings will open a new field of CSL physics in heavy fermion systems.

2. He made important contribution to understanding of origin of large hysteresis observed in micrometer-sized samples of $CrNb_3S_6$ [cp-3]

Details: Since Togawa et al (2015) revealed large hysteresis in MR in micrometer-sized samples, the origin of this phenomenon has been an unsolved issue. Mr. Aoki performed precise measurements of MR in micrometer-sized samples in the demagnetization-free configuration, where a quantitative comparison between theory and experiments becomes possible. His measurements showed that large jump in field-decreasing process is highly reproducible and has endorsed that this jump is due to soliton penetration through an intrinsic process in chiral magnets.

3. He made important contribution to understanding of phase diagram of chiral magnet $CrNb_3S_6$ under tilted magnetic field. [cp-4]

Details: Since Laliena et al (2016) and Yonemura et al. (2017) studied thermodynamic properties and metastability, the understanding of phase diagram under tilted magnetic field becomes an important issue in chiral magnet; Change of the direction of magnetic field can control existence/absence of chiral soliton and interaction property (repulsion/attraction) between solitons as well as the types of phase transition. His precise measurement of dependence of MR on direction of magnetic field allows quantitative agreement between theory and experiments. His achievement to establish understanding of phase diagram and properties of solitons under tilted magnetic field

can be a starting point of further study to control of chiral solitons.

4. He measured non-reciprocal electric transport in mono-axial chiral magnets.[cp-1,pr-1,pr-2,pr-4]
Detail: In systems where the spatial inversion symmetry is broken, the particle/wave propagation in certain direction is not always equivalent to that in opposite direction. This non-equivalency is called non-reciprocity of propagation. This phenomenon has been recently studied in propagation of electromagnetic wave in magnets and vortex transport in superconductors with inversion symmetry broken. However, there has been no reports in monoaxial chiral magnets so far. Mr. Aoki has successfully observed appreciable magnitude of this effect in electric transport in chiral magnet $CrNb_3S_6$. His achievement will stimulate study of non-reciprocity of various type of waves and particles in monoaxial chiral magnets.

<Attitude to research>
He worked intensively to measure precisely MR data with a short period. This data allows us to compare our theory with his data. Mr. Aoki really supports two phD candidates of theory of condensed matter in our group last year through collaboration from experimental side.

In conclusion, Mr. Aoki deserves this award in terms of his work and his attitude towards scientific research.

Selection Committee if Chiral Science Award

List of papers and presentations

[cp-1]-PRL, resubmitted
Ryuya Aoki, Yusuke Kousaka, and Yoshihiko Togawa
Anomalous nonreciprocal electrical transport on chiral magnetic order
Phys. Rev. Lett. resubmitted.
Note that it will be accepted shortly based on the comments given by referees in the first round.

[cp-2]--PRB
Ryuya Aoki, Yoshihiko Togawa, and Shigeo Ohara

Electrical transport properties of micrometer-sized samples of the rare-earth chiral magnet $YbNi_3Al_9$
Phys. Rev. B 97, 214414 (2018) - Published 13 June 2018

[cp-3]--PRB, Editors' Suggestion
Misako Shinozaki, Yusuke Masaki, Ryuya Aoki, Yoshihiko Togawa, and Yusuke Kato
Intrinsic hysteresis due to the surface barrier for chiral solitons in monoaxial chiral helimagnets
Phys. Rev. B 97, 214413 (2018) - Published 13 June 2018

[cp-4]--PRB, Rapid Communication
Yusuke Masaki, Ryuya Aoki, Yoshihiko Togawa, and Yusuke Kato
Chiral solitons in monoaxial chiral magnets in tilted magnetic field
Phys. Rev. B 98, 100402(R) (2018) - Published 10 September 2018

Presentation(Selected)
[pr-1]---低温工学・超電導学会 関西支部 特別講演会
"Non-reciprocal electric transport phenomena in chiral magnets $CrNb_3S_6$" (in Japanese)
Ryuya Aoki, Yoshihiko Togawa,
Quansei gakuin Univ. Umeda campus, Osaka 018/11/30 Oral presentation
Note: Oral presentation in Japanese. He won "the award for young scientists in low temperature engineering and superconductivity" by this presentation.

[pr-2]---International Conference on Magnetism (ICM) 2018
"Nonreciprocal electrical transport on chiral magnetic order"
Ryuya Aoki and Yoshihiko Togawa
San Francisco, USA, July 15-20, poster presentation on July 17.

[pr-3]---JPS meeting in 2017
"Transport property of micrometer-sized samples of a rare-earth chiral magnet $YbNi_3Al_9$" (in Japanese)
Ryuya Aoki, Yoshihiko Togawa, and Shigeo Ohara
Iwate Univ. 9/21-9/24, 2017 Poster presentation on Sep. 22

[pr-4]---JPS meeting in 2018
"Nonreciprocal electrical conduction in a chiral magnet $CrNb_3S_6$" (in Japanese)

R. Aoki, Y. Togawa,

Doshisha Univ.　Kyotanabe, Kyoto, 9/9-12, 2018 Oral presentantion on Sep. 9.

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