X-ray imaging of the Cr and Fe lines from Cassiopeia A


Publication date
2014

Document Version
Final published version

Published in
Proceedings of Suzaku-MAXI 2014: Expanding the Frontiers of the X-ray Universe: February 19-22, 2014, Ehime University, Japan

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
X-ray imaging of the Cr and Fe lines from Cassiopeia A

Yoshitomo Maeda¹, Toshiki Sato¹, Hiroshi Tsunemi³, Aya Bamba⁴, Jacco Vink⁵, Yukikatsu Terada⁶, Takafumi Takeda⁴, Makoto Sawada⁴, Poshak Gandhi⁷, Hironori Matsumoto⁸, Yasunobu Uchiyama⁹, Eveline A. Helder¹⁰, Junko Hiraga¹¹, John P. Hughes¹², Motohide Kokubun¹, Toru Tamagawa¹³, Yohko Tsuboi¹⁴

¹ Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), 3-1-1 Yoshinodai, Sagamihara, 229-8510, Japan
² Tokyo Metropolitan University, 1-1 Minami-Osawa, Hachioji, Tokyo 192-0397
³ Department of Earth and Space Science, Osaka University, 1-1 Machikaneyama-cho, Toyonaka, Osaka 560-0043, Japan
⁴ Aoyama Gakuin University, 5-10-1 Fuchinobe, Sagamihara 252-5258, Japan
⁵ Anton Pannekoek Institute/GRAPPA, University of Amsterdam, PO Box 94249, 1090 GE Amsterdam, The Netherlands
⁶ Saitama University, Shimo-Okubo 255, Sakura, Saitama 338-8570, Japan
⁷ Department of Physics, Durham University, Durham DH1-3LE, UK
⁸ Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-8602
⁹ College of Science Department of Physics, Rikkyo University, Nishi-Ikebucksuro 3-34-1, Nerima-ku, Tokyo
¹⁰ Department of Astronomy and Astrophysics, The Pennsylvania State University, 525 Davey Laboratory, University Park, PA 16802, USA
¹¹ Research Center for the Early Universe Graduate School of Science, The University of Tokyo
¹² Department of Physics and Astronomy, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854-8019, USA
¹³ Cosmic Radiation Laboratory, RIKEN, 2-1 Hirosawa, Wako, Saitama 351-0198
¹⁴ Chuo University, 1-13-27 Kasuga, Bunkyo-ku, Tokyo 112-8551

E-mail(TS): toshiki@astro.isas.jaxa.jp

Abstract
Follow-up Suzaku X-ray observations of a young supernova remnant Cassiopeia A carried out with a long exposure of ~165 ksec in 2012. Owing to the high statistics of the data, the map of Cr-K line is made. The map of Cr-K line is similar to that of Fe-K. The similarity indicates that the reverse shock is currently heating the ejecta layer that the Fe and Cr elements co-exists in.

Key words: supernova remnants – X-rays: individual(Cassiopeia A)

1. Introduction
Cassiopeia A is a young supernova remnant accompanied with a rich X-ray emission lines from various elements such as Fe (e.g., Serlemitsos et al. 1973, Holt et al. 1994). Yang et al. (2008) and Maeda et al. (2009) found an emission line from a minor element Cr. The Cr is theoretically predicted to be effectively produced in an incomplete silicon burning layer at the supernova explosion. We then investigated the layer by making a map of the Cr line. We present here preliminary results of these lines using the Suzaku XIS.

2. Observation and Data Reduction
The long exposure observation of Suzaku satellite has carried out in 2012 December. The XIS data were processed with the Suzaku pipe-line software (version 2.8). During our observation, Cassiopeia A has experienced no occultation due to the earth. In order to earn photon statistics, a loose screening was then made with the following standard criteria: (a) only GRADE 0,2,3,46 events are selected, (b) the standard time interval after passage through the South Atlantic Anomaly. and (c) the object is at least 1 degrees above the rim of the Earth. Finally, the total net exposure time after this filtering is about 165 ksec for XIS.

2.1. Results
Figure 2 shows the energy-resolved images with the XIS in 6-7 band. It is confirmed that the Fe-K line is bright in the three region in north, west, and south east. Figure 2 shows the spectra of the four typical region of Cassiopeia A including the three regions. The flux ratio of Cr-K to Fe-K is constant with being constant at any region within
the errors.

The Cr and Fe K-lines appears at the similar band between 5 and 7 keV. Therefore, the emissivity is less dependent on the temperature of the plasma, but is uniquely dependent on the abundance of the elements. This results likely suggest the co-location of the iron and chromium elements in ejecta that were heated with the reverse shock.

We also thank all members of the Suzaku team. This work is partly supported by a Grant-in-Aid for Scientific Research by the Ministry of Education, Culture, Sports, Science and Technology (25105516).

References

Fig. 1. Fluxes of Cr-K and Fe-K lines. Numbers correspond to those of the spectral region given in Figure 2.

Fig. 2. XIS-0 image in the 6–7 keV band (top). XIS-0 Spectra of the four regions given in top panel are also plotted.