Report of Committee to Evaluate Research and Academic Activities of the Division of Solar and Plasma Astrophysics of the National Observatory of Japan

February 20, 2008

Summary

This is the report by an external committee which examined self evaluations of the three projects of the Division of Solar and Plasma Astrophysics of the National Observatory of Japan. The committee is pleased to report that we fully endorse the self evaluations. The committee commends the Division for its outstanding, world-leading accomplishments, especially under conditions of restricted resources. In particular, the success of the Hinode project should be a source of pride for NAOJ and the nation of Japan. It is the premier facility for study of small-scale details about the Sun and has opened a new chapter of astrophysical research. We are pleased to note strong efforts by the senior staff of DSPA to cultivate and encourage young researchers and to welcome international collaborations as ways of maximizing the scientific output of the DSPA investments.

Introduction

The sun enables and sustains life on earth. It regulates our daily lives and governs our natural environment. Arguably the most important astronomical object to humans, it has long been a subject of intense scientific study. The major research topics today include:

- Understanding causes of solar activity and resulting effects on our environment.
- Advancing our understanding of astrophysics in general by study of the one star that can be observed in great detail.
- Making contributions to particle and plasma physics by study of phenomena in conditions that cannot be duplicated on earth.

Modern solar research addresses these and other topics using observations from space and ground combined with advanced numerical modeling and theoretical insight to interpret the observations. The vast range of solar phenomena requires wide ranges of spatial, temporal and spectral observational capabilities operated collaboratively to gain better physical understanding. Such community cooperation is a noteworthy and vital aspect of modern solar research.

This report is a critical evaluation of material (self evaluations) submitted to the evaluation committee (EC) by the Division of Solar and Plasma Astrophysics (DSPA). This is a step in assessing the record of the DSPA at a point midway in a six-year plan that started in 2004. The

charge to the EC requested comments in a specific format, which we follow in the main part of this report. The EC understands that this mid-term evaluation of the DSPA will be integrated into a summary report for the entire National Astronomical Observatory of Japan (NAOJ).

The EC was provided with a charge and written self-evaluations on December 30, 2007. The EC chair visited the Hinode Operations Center at ISAS on January 15, 2008 and the DSPA on January 16, 2008. During these visits, he talked informally with senior and junior staff members. The formal committee meeting was held with members of the DSPA at NAOJ on January 17, 2008. Oral presentations were given and ample time was available for questions and answers. The EC met in closed session on January 18, and also held one follow-up interview with a program head, and interviewed several young staff members. We also met with the NAOJ Director-General. This final report was prepared by e-mail exchange among the EC members.

The external EC members were Tim Bastian (National Radio Astronomy Observatory, Charlottesville, VA, USA), Len Culhane (Mullard Space Science Laboratory, University College London, UK), Ryoichi Fujii (Solar-Terrestrial Environment Laboratory, Nagoya University), John Harvey (National Solar Observatory, Tucson, AZ USA), and Zensho Yoshida (Graduate School of Frontier Sciences, University of Tokyo). The Chair was J. Harvey. The EC members heartily thank members of the DSPA and NAOJ for excellent support and outstanding hospitality.

Evaluation

The DSPA consists of three projects, Hinode Science Center (HSC), Solar Observatory (SO) and Nobeyama Solar Radio Observatory (NoSRO). The written material the committee evaluated was prepared separately by each project. We have combined the three programs into one overall evaluation in this report. There were some differences in how the three programs presented their self evaluations, which slightly complicates our report.

The self assessments involve ranking of research outputs in two categories, SS (distinguished) and S (commendable). The EC has interpreted the superior SS rating to indicate a significant research breakthrough or making an important new discovery. This ranking scheme is applied to both project achievements and individual selected research papers. One result is that two projects are ranked as SS but no papers are so ranked. The EC notes this apparent contradiction but explains it as follows. First, the selected papers do not represent the entire research output of a project. Excluded are papers that are not exclusively or collaboratively authored by members of the DSPA staff. The enlightened policy of open access to DSPA data has led to outstanding

papers based on DSPA data but sometimes without strong authorship roles by DSPA staff members. Although several of these papers are strong candidates for SS ranking, the EC did not have time to carefully assess them in the same way as the submitted material. Second, the EC feels that the DSPA was overly, but understandably, modest in ranking very recent papers since their impacts are just beginning to emerge. The EC was tempted to increase the ranking of some papers but resisted.

1. Evaluation of Status of Research Activities, and Inter-University User Support and Collaborative Research Activities

1.1 On Research activities

(a) outstanding research outputs

HSC

1. Development of SOT/OTA on board the Hinode mission (SS)

We confirm SS self evaluation. The high-resolution optical telescope assembled on Hinode satellite is a very powerful instrument that has enabled investigations of detailed structures dominating multi-scale nonlinear phenomena in the sun. It has already produced interesting data showing Alfven wave propagation, micro-flare reconnections, etc. The ADS bibliographic system currently lists 196 publications involving Hinode. Of these, more than 64 are based on data from the SOT. This is an outstanding level of scientific productivity from a new facility little over a year old.

2. Development of the Hinode spacecraft (SS)

We confirm SS self evaluation. Development, launch and successful operation of the Hinode spacecraft constitute a world-leading accomplishment. In terms of solar science achievement it is highly likely to outstrip both of its illustrious predecessors - Yohkoh launched 1991 and SOHO launched 1995. This observational capability has been a goal of solar observers for decades. Its outstanding realization as Hinode is a dream come true.

3. Scientific Operation of the Hinode Mission (S)

We confirm S self evaluation. The Hinode mission is operationally relatively young. Its success will ultimately be measured against the scientific research based on observations by its instruments. However, it is certainly the case that instrument performance, reliability, and accessibility will play a significant role in enabling scientific research with Hinode. In this regard, the scientific operation of Hinode has been exemplary. We explored the resources available to scientific users of Hinode, the ease of their use, the accessibility of the data, and the transparency

of the documentation, and find that it is outstanding. The appearance of nearly 200 publications in little over a year from launch is a testament to careful and smooth operation of Hinode.

4. Proposing of Next Japanese Solar Physics Mission (S)

We confirm S self evaluation. Two possible solar missions - a helioseismology and magnetic field observatory that will orbit well above the ecliptic plane and an advanced version of Hinode, are now being considered with one to be selected for launch in 2015. The former project offers the particularly exciting prospect of sub-surface flow observations in the polar regions; results from this admittedly ambitious mission could finally solve the difficult question of solar dynamo origin. The second builds on the success of Hinode. Both are well conceived, welcome international collaboration, and either would provide important new information about the sun.

5. Ichimoto, K., Suematsu, Y., Tsuneta, S., et al., 2007, Twisting Motions of Sunspot Penumbral Filaments, Science 318 (5856), 1597-1599. (S)

We confirm S self evaluation. This paper reports the discovery of twisting motions in sunspot penumbral filaments by the Hinode SOT. An analysis of their properties, using the latest models, surprisingly reveals that the twisting motions are likely apparent, rather than real. The discovery highlights the outstanding performance characteristics of the SOT. No citations yet as the paper is only two months old.

6. Katsukawa, Y., Berger, T. E., Ichimoto, K., et al., 2007, Small-Scale Jet-like Features in Penumbral Chromospheres, Science 318 (5856), 1594-1597. (S)

We confirm S self evaluation. A succinct paper that describes a newly observed phenomenon in the complex penumbra of sunspots. It offers two possible physical explanations and clearly indicates what observations are needed to distinguish between them. Recent unpublished observations have confirmed the discovery and indicate that the jets are low lying. No citations yet as the paper is only two months old.

7. Okamoto, T., Tsuneta, S., Berger, T., et al., 2007, Coronal Transverse Magneto-hydrodynamic Waves in a Solar Prominence, Science 318 (5856), 1577-1580. (S)

We confirm S self evaluation. Hinode has made the first observation of waves - probably Alfven waves, in prominence fine structures. This is a major result with high significance for understanding of the heating mechanism of the corona, which has been a long-standing central problem of solar physics. The Alfven-wave heating is one of the most promising mechanisms, while there had been no direct observational proof. The high-resolution optical telescope of Hinode brought about a very clear evidence of the excitation of Alfven waves, in support of the Alfven-wave heating of solar corona. The paper has one citation even though it is only two months old.

SO

1. Hagino, M. and Sakurai, T., 2005, Solar-Cycle Variation of Magnetic Helicity in Active Regions, PASJ, 57, 481-485. (S)

We confirm S self evaluation. This work extends that of Hagino & Sakurai (2004). Data obtained over 19 yrs (1983-2001) by the SFT at Mitaka and the 65 cm telescope at Okayama were used to analyze the solar-cycle variation in the magnetic helicity in active regions. Invoking the notion of "helicity", that is, a topological index characterizing twists of field lines, the long-term evolution of the large-sale structure of magnetic fields has been related with the solar cycle. The authors find that while the magnetic helicity "sign rule" is satisfied during solar maximum, it may not be during solar minimum. Significant yearly variations in the measured magnetic helicity were also found. This result gives important input for theoretical and simulations studies of solar plasma dynamics. The physical origin of magnetic helicity and its distribution remains controversial. The paper has seven citations. It appears to have stimulated follow-up studies (e.g., Zhang 2006) and has caught the attention of modelers (e.g., Sokoloff et al. 2006).

2. Hanaoka, Y., 2005, H-alpha Stokes V/I Features Observed in a Solar Active Region, PASJ, 57, 235-244. (S)

We confirm S self evaluation. A careful piece of work showing the difficulty and pitfalls of measuring chromospheric magnetic fields – especially in sunspots. Measurements of the chromospheric magnetic field are an important new frontier for solar research. This paper has stimulated a new instrument and confirming observations in India (Nagaraju et al. 2008). We note four citations for this paper.

NoSRO

1. Long and steady operation of NoRH and high quality data supply (S)

We confirm S self evaluation. The operation of the instruments at the NoSRO has been a model of reliability and accessibility. Certainly, in the solar radio community, the NoSRO has pioneered the means of making the necessary data archive and software tools available through the web, thus ensuring their use by an international community of scientists. In this sense, NoSRO operations have enabled scientific productivity. Nobeyama Radioheliograph is playing an important role in the study of high-energy phenomena. Combinations of the radiograph with other measurements, such as Hinode SOT and X-ray telescope, will provide very interesting data.

2. Organized an International Symposium focused on NoRH to summarize scientific results and they are published as a proceedings book and special issue of PASJ. (not self rated as S or SS)

We assign an evaluation of S. The NoSRO has run a series of highly successful international workshops since 1990. The 2004 Kiyosato workshop was particularly distinguished by the broad international attendance. While mainly focused on radio observations, the range of

multiwavelength topics covered dealt with most of the major topics in solar atmosphere physics.

(b) levels of the research outputs and its rationales

HSC

We confirm distinguished self evaluation. The Hinode project is a world leader in advancing solar research. It provides unique and important capabilities long needed by the research community. Innovative and high-level achievement.

SO

We confirm distinguished self evaluation. In the top rank of ground-based solar observatories. Solid and steady efforts to develop innovative instruments, as well as new methods and models of data analysis.

NoSRO

We confirm commendable self evaluation. Plays a unique role in radio astronomy.

(c) quality improvement

HSC

Although we easily confirm the "improving adequately" self evaluation, we feel that the HSC project was excessively modest. The highest rating would be justified based on improvements compared to the previous Yohkoh mission. Experience from Yohkoh has been most effectively applied to Hinode. The Japanese team is still burdened with the brunt of operations activities. This can only distract and detract from the ability of the group to focus on science. But this situation is a significant improvement compared to Yohkoh.

SO

We confirm the self evaluation of "keeping high quality". Steady efforts to improve accuracy and diversity of data. We are very impressed by the productivity of this group and its drive to develop new instrumentation and techniques. The closure of Norikura is unfortunate but may motivate development of and/or participation in next-generation ground-based facilities.

NoSRO

Although no self evaluation was provided, the committee assigns a rating of "keeping high quality" based on submitted materials. Steady efforts to produce high-quality long-term data.

NoSRO is being maintained in a steady state; short of a significant infusion of people and resources, the best that it can do is to continue operating in a reliable fashion. It is regrettable that a modest instrument development program and a larger core group of scientists could not be sustained on site.

1.2 On User Support and Collaborative Research Activities
(a) outstanding research outputs

HSC

1. Sakao, T., Kano, R., Narukage, N., et al., 2007, Continuous Plasma Outflows from the Edge of a Solar Active Region as a Possible Source of Solar Wind, Science 318 (5856), 1585-1588. (S)

We confirm S self evaluation. Outflows are detected at the edge of an active region by a time series of high resolution images obtained by the Hinode XRT and by spectroscopy by the Hinode EIS. These outflows may contribute to the solar wind mass budget. Again, the result highlights Hinode's outstanding new capabilities, which have opened up new discovery space. No citations yet due to its recent publication.

2. Shibata, K., Nakamura, T., Matsumoto, T., et al., 2007, Chromospheric Anemone Jets as Evidence of Ubiquitous Reconnection, Science 318 (5856), 1591-1594. (S)

We confirm S self evaluation. An exceptional Hinode/SOT observation based on previous Yohkoh experience that has unveiled a new solar phenomenon - reconnection jets in the chromosphere. The high-resolution optical telescope of Hinode enabled this new trophy to Shibata and his collaborators, the founders of the reconnection model. Magnetic reconnection is now widely accepted as the most essential elementary process in magnetized plasmas. This result may have major importance for solar atmosphere heating. No citations yet as the paper is only two months old.

SO

1. Hori, K., Ichimoto, K., Sakurai, T., et al., 2005, Flare-Induced Coronal Disturbances Observed with Norikura "NOGIS" Coronagraph I: A CME Onset, ApJ, 618, 1001-1011. (S)

We confirm S self evaluation. This is a rare and unusual observation of the CME launch process by the Norikura NOGIS instrument along with the SOHO and TRACE spacecraft. It provides the first evidence for the operation of both magnetic tether-cutting and breakout action in a CME launch. The paper has earned six citations including being highlighted in the review "Astrophysics in 2005".

2. Singh, J., Sakurai, T., and Ichimoto, K., 2006, Do the Line-Widths of Coronal Emission Lines Increase with Height above the Limb?, ApJ, 639, 475-483. (S)

We confirm S self evaluation. This is an important observational paper that severely constrains models of heating and solar wind acceleration in the solar corona. By a careful analysis of the line-emission data, the authors found interesting distribution of line widths, which probably implies multi-temperature (non-equilibrium) nature of coronal plasma cased by connections of different sub-regions of coronal loops through magnetic field lines. This paper criticizes prevailing model of waves and rouses renewed interest in coronal loops. It has one citation. It has stimulated one committee member who has related data to start a similar study.

3. Hara, H., Nishino, Y., Ichimoto, K., et al., 2006, A Spectroscopic Observation of Magnetic Reconnection Site in a Small Flaring Event, ApJ, 648, 712-721. (S)

We confirm S self evaluation. Using Norikura and Nobeyama observations along with space data from Yohkoh, SOHO and TRACE, this paper reports the first spectroscopic detection of the plasma inflow associated with the flare reconnection process. It has provided important lessons for future Hinode work. This paper was cited in the review "Astrophysics in 2006".

4. Maeshiro, T., Kusano, K., Yokoyama, T., et al., 2005, A Statistical Study of the Correlation between Magnetic Helicity Injection and Soft X-ray Activity in Solar Active Regions, ApJ, 620, 1069-1084.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This paper presents a careful and comprehensive analysis of the magnetic and X-ray data of seven solar active regions. Among the findings is that the SXR flux from active regions is proportional to the product of the absolute helicity flux and the length of the shear inversion layer. The authors suggest that coronal heating could be "activated" by helicity injection. Their result provides us with a very clear understanding of the evolution of twisted complex structures of the magnetic fields and their role in coronal heating. The work has garnered 11 citations including one in "Astrophysics in 2005".

5. Yamamoto,T.T., Kusano, K., Maeshiro, T., et al., 2005, Magnetic Helicity Injection and Sigmoidal Coronal Loops, ApJ, 624, 1072-1079.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This is an important contribution to the growing study of helicity in solar activity. It makes the best use of limited observational data and claims that emergence rather than shear is the main mechanism of helicity injection into active regions. It also shows that local injection is far more important than throughout the entire active region. This paper has been cited 10 times including being highlighted in "Astrophysics in 2005".

NoSRO

1. Promotion of solar radio astronomy by providing high quality continuous data (S)

We confirm S self evaluation. The NoSRO is distinguished both for the excellence of its scientific output and for the high level of its availability to both Japanese and international observers. Fully automatic operation, ability for remote monitoring by the internet and careful annual maintenance are among the factors that contribute to an overall average availability of better than 98%. This level of operation is exceptionally high and has been sustained from mid-1992 to the present time.

2. Melnikov, V. F., Reznikova, V. E., Shibasaki, K., et al., 2005, Spatially resolved microwave pulsations of a flare loop, A&A, 439, 727-736.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. The study of coronal wave phenomena has recently assumed considerable importance. This classic microwave observation of spatially resolved periodicities in a flaring loop has allowed the identification of the two wave modes involved and has led to an estimate of the magnetic field strength in the emitting structure. Thus the authors have pioneered an important new tool in the very difficult field of coronal magnetic field estimation. This paper has an appreciable impact on the development of MHD related physics. The paper has been cited seven times including a highlight in the review "Astrophysics in 2005".

3. Asai, A., Nakajima, H., Shimojo, M., et al., 2006, Preflare Nonthermal Emission Observed in Microwaves and Hard X-Rays, PASJ, 58, L1-L5.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This paper combined observations with the Nobeyama radio heliograph at two wavelengths and RHESSI high energy images to study the non-thermal acceleration of particles prior to the main phase of a large flare. Crucial was the ability to construct radio spectral hardness maps with rapid time cadence and good spatial resolution. It is shown that some localized, non-thermal physical process is at work before the main flare. This is an important fact for the theory of solar flares. The paper has been cited twice.

4. Shimojo, M., Yokoyama, T., Asai, A., et al., 2006, One Solar-Cycle Observations of Prominence Activities Using the Nobeyama Radioheliograph 1992-2004, PASJ, 58, 1-10.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. A data pipeline was developed to automatically detect and characterize solar prominence activity over one solar cycle (1992-2004). This is a solid piece of observational work that extends and complements previous studies of H-alpha filaments and prominences, and the relationship of CMEs to prominence eruptions. The work has received one citation since appearing two years ago.

5. Kundu, M. R., Schmahl, E. J., Grigis, P. C., et al., 2006, Nobeyama radio heliograph observations of RHESSI microflares, A&A, 451, 691-707.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This study compared the HXR and microwave properties of a sample of 30 microflares observed by RHESSI and the NoRH. This is one of the few studies that compares the relative spatial positions of the X-ray and radio sources. It extends earlier observations that did not have the benefit of the unique microwave imaging capability of NoRH. The authors conclude that microflares behave like scaled down "normal" flares, showing both thermal and nonthermal emissions. The work has received four citations since its publication in mid-2006 including the review "Astrophysics in 2006".

6. Asai, A., Nakajima, H., Oka, M., et al., 2007, Loop top nonthermal emission sources associated with an over-the-limb flare observed with NoRH and RHESSI, Adv. Sp. Res., 39, 1398-1401.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This short paper presents an analysis of joint RHESSI/NoRH observations of a looptop source in an over-the-limb flare whose footpoints have been occulted. The radio source is clearly non-thermal, yet the HXR source, which coincides in projection with the radio source, appears to be "thermal-like". The accompanying microwave observations by the NoRH are essential for clarifying the source physics and show the continuing importance of the radio heliograph for solar flare studies. No citations yet, but it's a very recent publication.

7. Bastian, T. S., Fleishman, G. D., Gary, D. E., 2007, Radio Spectral Evolution of an X-Ray-poor Impulsive Solar Flare: Implications for Plasma Heating and Electron Acceleration, ApJ., 666, 1234-1241.

This paper was not self evaluated but included on list of outstanding papers and the committee rates it as S. This paper proves the importance and uniqueness of the radio measurements of astronomical phenomena. It is an excellent demonstration of the necessity of observations over wide spectral range to help diagnose the physics of flares. It also points to the importance of studying unusual (rare) events to test theoretical paradigms. The careful analysis of spatially resolved radio and X-ray data provides us with important information to develop understanding of plasma heating and electron acceleration in solar flare. The findings call into question some of the assumptions of the standard picture of flares. This paper may have played a role in stimulating a new emerging paradigm of energy transport in flares by Fletcher and Hudson (2008). The paper has one citation since it appeared a few months ago.

(b) overall level of the user support and collaborative research

HSC

We confirm A self evaluation. Intensive collaborations with universities from the design phase. The level of support for all users, and the opportunities for collaboration are indeed exceptional.

SO

We confirm A self evaluation. Accepts as many as possible proposals of collaborations from universities. Collaborations with simulation researchers produced important results. While on a different scale from Hinode, the SO group has made very strong efforts in cultivating "intra-university user support and collaborative research", as well as collaborative work on instrument development.

NoSRO

Not self rated. We assign an evaluation of A. Excellent. High-quality data have been opened to worldwide scientists. We rate NoSRO's efforts at "User Support and Collaborative Research Activities" as exceptional. They have a strong visitors program and have taken pains to make the data archive and supporting tools widely available. They have organized several workshops highlighting NoSRO results.

(c) quality improvement

HSC

The self-evaluation of “improving adequately” is too modest. The degree of collaboration and the support of the wider community are exceptional. One might argue that engagement of the "local" Japanese university community could be improved, but given the size of the community and the amount they're already doing, it would be unfair to do so. This new project is based on rich experience from Yohkoh.

SO

We confirm “keeping high quality” rating. Continuous efforts to develop new instruments.

NoSRO

Not self rated. We assign “keeping high quality” rating. There have been successful, strong efforts to maintain high quality and continuity of the data.

1.3 Overall Evaluation

HSC

The committee is pleased to commend NAOJ and DSPA for their major contributions to the highly successful Hinode project. This mission is the most significant observational advance in solar research in many years. As demonstrated above, it is already changing our ideas about how the sun works. The project is run efficiently. Excellent national and international collaborations are underway thanks to an enlightened data policy. This is a very challenging new project that has just started to produce plenty of interesting data. The high-resolution observations may reveal unknown effects, leading to new understanding of solar physics, as well as stimulating general physics.

SO

A long record of regular measurements of solar activity is essential to the study of long-duration phenomena such as the solar cycle. The SO has a large and unique collection of good vector magnetograms, the only such collection freely available for research. These data have led to new discoveries about the important role of helicity in solar activity. Careful and detailed analyses of solar MHD phenomena have made essential contributions for the understandings of solar phenomenology (such as solar activity cycle), as well as basic plasma physics (such as helicity and reconnection).The committee notes that several important discoveries about the corona have been made with Norikura facility and is concerned about the planned closure of this coronal research capability. The facility had strong connection with the international and university communities. Our concern is mitigated by the opportunities that this closure will afford to explore the development of next generation ground based instruments in Japan and to engage with other major international ground based projects.

NoSRO

The NoSRO provides sustained high-resolution microwave imaging of the sun. This unique capability has enabled science to have a comprehensive view of solar activity that would otherwise be impossible. The value comes in providing observations of emissions from non-thermal electrons, observations that complement those provided by hard X-ray observations. These bring additional constraints to bear on models of solar activity as demonstrated by the research output listed earlier. As noted at the end of this report, the committee is concerned about a possible loss of such a capability for several years. The high-quality long-term data produced by NoSRO have a unique scientific value—combinations with other new measurements will open up a new regime of interest.

2. Evaluation of Achievement of the Mid-Term Objectives

2.1 Research Activities

HSC

We confirm A rating. Successfully achieved the planned projects, produced excellent data and more than 90 research papers in little more than a year. A resounding success.

SO

We confirm A rating. Successfully achieved the planned projects, and produced excellent data. Though much smaller in scale, the SO group has effectively exploited available resources to advance a strong research and instrument development programs.

NoSRO

We confirm B rating. The NoSRO continues to support an international research community with unique, reliable, and readily accessible data.

2.2 User Support and Collaborative Research Activities

HSC

We confirm A rating. Excellent support of users and strong level of collaboration. Exemplary.

SO

We confirm A rating. Strong outreach and support programs, including encouragement of local and international investigators. Making current and archival observations openly available serves the entire world community of researchers studying solar activity. Currently provides the only readily accessible long-term archive of vector magnetograms.

NoSRO

We confirm A rating. Outstanding level of user support. The research papers demonstrate strong collaborations. Excellent engagement with, and support of, the wider solar radio community.

2.3 Graduate School Education

We confirm the C self evaluations of all three programs while noting the expressed wish of all of the programs to become more strongly involved in the education of young solar astronomers. The programs appear to have used every available opportunity to build vigorous educational components. We anticipate a number of PhD theses to result from Hinode observations and note

that data from SO and NoSRO have supported previous PhD theses not only in Japan but also elsewhere.

2.4 On the Collaborations with general public and the international exchange

HSC

We confirm A rating. Outstanding international science exchanges. Organizing many meetings and symposiums, excellent data of Hinode have been effectively disseminated to the world science community. HSC is clearly successful, both in terms of scientific research and international visibility.

SO

We confirm C rating. Some international collaborations were productive. Good attempts to support emerging programs (Peru, Nigeria).

NoSRO

We confirm A rating. Excellent international exchanges and collaborations. The NoSRO has been highly successful in cultivating and supporting an international user community. This has been achieved through high reliability, open data access, ease of use, and periodic workshops.

2.5 Overall Evaluation of the achievement of the Mid-Term Objectives

HSC

Highest level of achievement. All objectives were met or exceeded. An outstanding success in the progress of world solar research. Our only concern is if enough people around the world will be able to fully harvest the wealth of data produced by Hinode. Efforts to extract science results from Hinode should continue at a high level even while studying the next solar mission. It is time to more aggressively share the exciting results from Hinode with the general public, in the spirit of what was done with Yohkoh.

SO

The committee confirms impressive progress by the Solar Observatory in achieving its plans, especially considering the size of the group. We regret the imminent loss of the Norikura station and its observing capabilities. We strongly support the project's plans to invite proposals from the world research community to use these unique facilities before they become unavailable.

NoSRO

The committee is impressed with the high levels of quality and availability of unique data from NoSRO. The NoSRO is a "mature" facility but a unique one. It continues to operate with exceptional reliability, producing high quality data for use by a wide community. It has met or exceeded expectations in all areas. We discuss below the serious scientific impact of early closure of the NoRH.

3. Future Plans

HSC

We endorse the 1-3 year plan. Well-defined plans of measurements will produce hoped-for data that will contribute refined understanding of various solar phenomena significantly. They are planning to conduct extensive collaborations with worldwide solar physics community. Disseminating information to a wider science community (such as plasma physics and space physics) will also be important. For the near-term, the HSC envisages the systematic Hinode study of the rising phase of solar cycle 24. The plan involves extensive collaboration with Japanese and international facilities - both ground- and space-based. The very successful public outreach activities based at NAOJ will also be maintained. As a most valuable byproduct, studies of Japan's next solar space mission will also be undertaken. These plans are carefully thought through and rely for their successful execution on the continued support of the Hinode Science Center.

We endorse the 3-10 year plan. For the mid- to longer-term, Hinode will pursue magnetic field observations in particular and their consequences in the rest of the Sun's atmosphere. This will require a deeper interaction with the Japanese and international communities along with continued joint use of assets. As the mission matures, the fundamentally important new results that will emerge will require more careful attention to the public outreach program. In addition careful attention must be paid to staff management so that the future of the next Japanese solar mission can be secured. All of these issues are addressed in the plan but rely on the continuation of appropriate resources through a ten year period. For development of the next solar mission, it is important that consideration be given to a greater involvement of specialist project management and engineering staff. Towards the end of this time, increasing effort will be devoted to the creation of Hinode data archive so that the scientific legacy of this unique mission can be secured.

SO

We endorse the 1-3 yr plan. Understanding the solar activity cycle is indeed an ambitious goal. However the proposed methodology is sound. In particular the goal of developing advanced vector magnetograph instruments is an important one to pursue. Given the uncertainty in the post-Norikura era, it is clear that continued instrument development at Mitaka, while seeking involvement in major advanced solar ground-based telescopes in Japan, US or elsewhere is a potentially productive path to follow. We hope that funds made available by the closure of Norikura will allow a rapid completion of the new magnetograph development. In addition to pursuit of solar cycle understanding, Japan has pioneered in the area of digitizing historic photographic records from solar observatories around the world. Such archival data are invaluable for studies of long-term solar variability.

We support the 3-10 year plan. The plan continues the 1-3 year goals, which is appropriate for long-term studies of solar variability. We suggest that the SO should prepare a roadmap of ground-based optical solar research in Japan with emphasis on new developments that would enhance the scientific return of the future Solar-C.

NoSRO

We endorse the 1-3 year plan. Current plans call for the NoRH and the NoRP to continue operating through 2010. The panel strongly endorses this plan. With the launch of Hinode, STEREO, and soon, the Solar Dynamics Observatory, and the continuing operation of RHESSI, the NoSRO is the only facility currently providing high-resolution microwave imaging, and well-calibrated fixed frequency microwave light curves, in support of these mission data. Collaborations with theory and simulation groups are strongly encouraged, because the data provides important information about heating and acceleration mechanism. Given the possibility of early closure of NoRH, strong efforts are required to ensure that its unique capabilities are exploited by the national and international research communities as the level of solar activity increases.

We support the 3-10 year plan. The NoSRO proposes to continue operations beyond 2010, to 2015. This would allow the facility to continue to provide unique microwave imaging data in support of new missions through the solar maximum period. Extending operations until 2015 would also provide a critical bridge to next-generation facilities: FASR and the SSRT upgrade. Recognizing that extended operations come at a cost, the panel nevertheless endorses the NoSRO proposal for an extended operations phase.

4. Others

The committee has no basis to make comments about academic-industry and cooperative research.

Additional Comments

Scientific consequences of termination of NoSRO program.

If the NoSRO is closed in 2010 there will be a number of negative scientific consequences.

1- The next maximum of solar activity will occur in 2012 or so. Scrutiny of the sun is particular intense during the years surrounding solar maximum. With the new generation of instruments flying, and the uniqueness of the NoSRO facilities, there is always the potential for breakthrough science. The NoSRO should contribute to, and be part of, the numerous observational opportunities available during the solar maximum period.

2- Microwave observations probe energetic populations of electrons that are otherwise only accessible through hard X-ray and gamma-ray observations. However, microwaves are also sensitive to the (vector) magnetic field and therefore bring additional and complementary insights to bear on the problems of magnetic energy release, plasma heating, electron acceleration and transport, mass ejecta, and so on. While the RHESSI hard X-ray imager is currently flying, it is unknown how much longer it will be active. It is conceivable that the NoRH will be the only dedicated instrument capable of imaging emissions from nonthermal electrons during the next solar maximum on a regular basis.

3- There are well-known plans to construct and operate a next-generation radioheliograph in the United States: the Frequency Agile Solar Radiotelescope (FASR). This instrument would presumably supersede the NoRH as an international facility. The FASR project is not yet assured. It is possible that the project will receive funding by the beginning of 2009. If so, it is expected that FASR observations could commence in 2013. Recently, Russia has initiated plans for a significant upgrade of the Siberian Solar Radio Telescope (SSRT). It is expected that this project, too, will commence operations on a time frame similar to FASR's. Therefore, the most obvious consequence of closing the NoRH in 2010 is the loss of dedicated, high-resolution imaging at centimeter wavelengths for a period of several years.

4- Another important instrument operated by the NoSRO is the NoRP. The NoRP provides important information on the long-term variation of solar radiation and the data are considered to be a good indicator of solar activity. It is getting more important for the

study of solar influence on climate, a field in which solar physicists and geophysicists have been collaborating more closely particularly since the CAWSES (Climate And Weather of the Sun-Earth System) run by SCOSTEP under ICSU started in 2004. It is important to note that for this purpose continuous, very well calibrated, and very long term observations of the total radio instensity at several frequencies are needed (more than 5 solar cycles to exclude the effects of the 11 year solar cycle and to obtain the longer-term trend of the solar activity). These kinds of observations are necessary not only for solar physics but also for geoscience. Future spectral observations with FASR will be of course useful, but FASR may have difficulty providing the absolute intensity of the radio emissions, as NoRP currently does provide. While the costs of operating the NoRP are modest, it would be difficult to continue such operations at the Nobeyama site beyond 2010 if the NoRH was closed. Hence, an even wider community of scientists would be affected by such a closure. One possibility would be to move the NoRP to another site, a possibility that should be given consideration regardless of whether the NoRH closes in 2010 or 2015.

Young staff development.

The panel members interviewed individually a group of research students and postdocs. The topics discussed clearly differed somewhat between these categories though there was one interesting common point.

The students appreciated that they were in a competitive situation but were highly motivated to succeed and enter the field. All emphasized the importance of mentor choice. They spoke of a roughly 80-20 time division between research and operations/observing – they were happy with this and recognized their need to acquire observational data. All felt that their working environment was well resourced. Several felt that although they were committed to the solar discipline, opportunities in Japan outside e.g. NAOJ, Kyoto and Tokyo, were somewhat limited. They wished for greater opportunities to hear of work in progress in other divisions of NAOJ. Overall they described a very positive experience as research students and are clearly high caliber people.

The postdocs were also concerned by the need for exposure e.g. through seminars, to a broader range of the work in progress at NAOJ. They also noted a lack of diversity in future career opportunities; they felt that this situation could be enhanced by greater interaction by NAOJ with a broader range of Japanese universities. Some felt that their three year appointment terms were short compared to the scientifically productive lives of missions and facilities. Those

involved with Hinode felt that, following its successful launch and operation, their ability to assign personal time to research had been much improved. One felt that the NAOJ organizational structure was somewhat weighted in favor of Projects – this is of course an essential ingredient of success, and that some strengthening of the role of Divisions would benefit research productivity. All spoke positively and very highly of their work experience in the NAOJ environment.

Critical mass concerns.

We shared the concern expressed in the self-evaluations of insufficient numbers of researchers to take full advantage of the impressive facilities of the DSPA.

Interactions within and without NAOJ.

Solar physicists of NAOJ have rather strong interactions with scientists of related areas. For example, annual joint meetings with plasma physicists and space physicists have created interdisciplinary discussions/collaborations. Young scientists are strongly encouraged to participate in these activities. Collaborations, for example, with theory and simulation groups inside/outside NAOJ are very important to construct physical models of various phenomena found by new instruments. Nevertheless, young researchers expressed some feelings of isolation from other activities in NAOJ. We hope that interactions can be strengthened.

Citation analysis.

In addition to the self evaluations, the EC on its own undertook a citation analysis of the staff of the DSPA and compared it with other international organizations having similar missions and sizes. We used the Web of Science database provided by Thomson Scientific in December 2007. Such comparisons are problematic in many ways but do provide one way of assessing international research standing, if used with caution. For example, the first results from Hinode are just now appearing in refereed journals and it will take several years for their undoubtedly major impact to be properly assessed. One criterion we used is the so-called meta Hirsch index which is the number of members of a research group who have individual Hirsch indexes larger than or equal to the number. For example, 10 members of the staff of the US National Solar Observatory have individual Hirsch indexes of 10 or more. The individual Hirsch index, H, is the number of papers published by a researcher with that number or more citations each. It obviously favors older, senior researchers. We are happy to report that the DSPA meta H index of 10 is comparable with other world-class solar groups, especially considering the ages of the staffs. The other organizations we examined are the High Altitude Observatory (12), the National Solar Observatory (10), Lockheed Martin Solar and Astrophysics Lab (9) and the

Stanford Solar Group (11).

Appendix

List of materials provided to the committee.

1. Charge to committee.
2. “Documents and Materials for External Evaluation” (English and Japanese versions).
3. Meeting agenda.
4. Copies of oral presentation materials.
    a. An Overview of NAOJ (Sakurai)
    b. Introduction to NAOJ/DSPAP (Watanabe)
    c. Solar Physics from Space at NAOJ (Tsuneta)
    d. Solar Observatory (Suematsu)
    e. Nobeyama Solar Radio Observatory (Shibasaki)
    f. Self-Evaluation Summary (Watanabe)
    g. Selected Papers using Nobeyama Radioheliograph Data (2004-2007) (Shibasaki)
5. NAOJ Annual Report 2004 (Japanese).
6. Lists of papers published.
7. Summary of NoRH&NoRP data use.
8. List of Post Docs, Students and PhD staff.
9. Reprints of research papers.