Hinode 7:
Conference Summary and Future Suggestions

Eric Priest
Mathematics Institute, St Andrews University, St Andrews KY16 8QR, UK
erp@st-andrews.ac.uk

(Received ; accepted )

Abstract

This conclusion to the meeting attempts to summarise what we have learnt during the conference (mainly from the review talks) about new observations from Hinode and about theories stimulated by them. Suggestions for future study are also offered.

Key words: Sun:photosphere, Sun:activity, Sun:chromosphere, Sun:corona, Sun:coronal heating, Sun:solar flares, Sun:Hinode satellite

1. Introduction

We have been treated to an outstanding set of review talks here, and so it is a real pleasure to summarise the main points from them. What have we learnt from the invited reviews about the big questions in solar physics, and where should we go next? But first an advert and a look back.

For the past 10 years, I have been writing a replacement for the book Solar MHD. Three days ago, I finally finished the page proofs, and so it will hopefully appear next spring, published by Cambridge University Press (Priest, 2014). The “baby” is a completely new rewrite, not just a new edition, so I had to decide on a new name for the new baby. In the end, I came up with Magnetohydrodynamics of the Sun, so as to indicate that the subject matter is the same as before, but the book is very different.

My first visit to Japan was over 30 years ago in 1982 to the Hinotori symposium in Tokyo, and many key figures in our field can be seen in the conference photograph as rather younger people (Fig. 1). Near the centre of the photograph there is Uchida-san, whom I admired greatly as a highly creative MHD theorist, as well as Watanabe-san and two young graduate students, Sakurai-san (hiding on the back row) and Shibata-san (behind my shoulder), who at the time thought that reconnection has no role in solar flares! How one’s ideas can change over time! On the left side of the photograph on the second or third row stands Ichimoto-san
between Suematsu-san and a serious bespectacled Tsuneta-san. Finally, on the right, you can see Hirayama-san and Hiei-san on the front row, with Doschek, Acton, Svestka and Tandberg-Hanssen a little further back.

A few days ago, Ichimoto-san and Shibata-san took me on October 28th to Kwasan observatory, where they and Mai Kamobe kindly laid on a special treat – my first X-class flare seen alive in real time.

Hinode of course continues to make major contributions to fundamental understanding, thanks to teams of selfless scientists working under the brilliant PI’s with the instruments and the data, both on SOT, EIS and XRT. We have over the past few days been treated to an excellent set of talks, so what have we learnt about the big questions and where should we go next? The individual talks referred to here can be found in these proceedings, and related work that has been published elsewhere is listed at the end of this article.
2. The Structure of the Convection Zone

Hideyuki Hotta, a research student with a bright future, described how helioseismology has shown us several features:

(i) the equator is accelerated due to the transport of angular momentum by the Reynolds stress $\langle v_r v_\phi \rangle$;

(ii) the internal velocity in the convection zone is constant on cones, due to a subtle balance including the effects of an entropy gradient and of meridional flow;

(iii) a strong shear layer (the tachocline) is located at the base of the convection zone;

(iv) and a near-surface shear layer, which is not understood at all but may be due to small-scale (granular) convection.

Hotta (2014) has come up with a brilliant new idea for global computations of the convection zone, namely, to replace the usual anelastic approximation by a \textit{reduced sound-speed} technique, in which the continuity equation is written as

$$\frac{\partial \rho}{\partial t} = - \frac{1}{\xi(r)^2} \nabla \cdot (\rho_0 \mathbf{v}).$$

An example of one of his numerical experiments is shown in Fig. 3.

We also heard interesting talks about oscillatory dynamos without an omega-effect from Masada-san (2013), the effect of turbulent pumping on the solar cycle from Dibyendu Nandy (2013), and stellar dynamos in which buoyant loops are generated by a spot dynamo from Sacha Brun (2013).
3. The Photosphere and Chromosphere

Hiroko Watanabe (2012) gave an interesting review of the properties of umbral dots. As the magnetic field increases, their size and rise speed decreases but their lifetime remains the same. They tend to cluster at the edges of the strongest umbral field, and it is possible in future that comparison with models may indicate properties of the subsurface field.

Shin Toriumi, another rising star, reviewed flux emergence (Toriumi 2013, 2014). He first described observations and simulations of emergence from the deep interior, and then suggested that resistive processes are important in the birth of active regions. Finally, he gave a recent example of the formation of a flaring active region in which he inferred from sunspot motions that there may well have been a single flux tube below the photosphere which split into two parts (Fig.4).

In future, since simulations have shown the difficulty of encouraging flux to emerge completely through the photosphere, it would be good to try and estimate from observations and theory just how much flux is likely to pile up below the photosphere, both in the quiet Sun and in active regions. The presence of such flux may affect and interact with the near-surface shear layer, and it may also provide a background seed on which convection can operate and generate granular magnetic loops.

Alan Title (2013) presented some stunning UV slit jaw images and spectra from the new mission IRIS (Fig.5). These show that the chromosphere is incredibly dynamic, with rapid fine-scale brightenings and motions everywhere. Ted Tarbell (2013) described coordinated observations from IRIS, SST and Hinode, while Tiago Pereira (2013) focussed on spicules, Viggo Hansteen compared the presence of a multitude of cool loops with models, and Mark Cheung showed examples of recurrent helical jets. Clearly in future it is important to try and determine the causes of such fine-scale dynamics.

We also heard a variety of other talks about the photosphere. For example, Luis Bellot Rubio (2012) described the latest results about the ubiquitous horizontal magnetic fields dis-
Fig. 5. Images of fine-scale structuring of the solar atmosphere from IRIS (a) from above and (b) from the side.

Fig. 6. A numerical experiment by Shimojo and Shibata (2000) on jets produced by 2D reconnection.

covered with Hinode with typical fields of 140 Gauss. Daiko Shiota (2012) presented details of the reversal of polar magnetic fields, while Ada Ortiz Carbonell (2014) described an example of granular flux emergence in the form of a magnetic bubble. Andreas Lagg showed us the properties of granules in a light bridge, while Yukio Katsukawa (2012) presented details of photospheric power spectra. Finally, two more future stars to watch out for in our field, Sanja Danilovic (2013) and David Buehler (2013), discussed the complex properties of 2D magnetic inversions for internetwork Hinode/SP data and for plage flux tubes.
**Fig. 7.** A numerical experiment by Archontis (2013a, 2013b) on jets produced by 3D reconnection, showing (a) the temperature, (b) the magnetic fields, (c) a twisted jet and (d) the density.

### 4. Coronal Structure and Heating

Etienne Pariat (2012) gave a masterly review of coronal jets, splitting them into *standard jets* and *blowout jets*, which are more complex, arise from multipolar magnetic fields and often have a cool part. Often (anemone) jets occur at 3D null points by spine-fan reconnection, and helical structure is common. He described the basic 2D mechanism first suggested by Heyvaerts, Priest and Rust (1977) and subsequently developed by Forbes and Priest (1984) as well as Shibata (1992), Yokoyama (1996) and their colleagues (Fig.6). These suggested a hot fast jet produced by reconnection together with a cooler jet produced by evaporation.

In three dimensions, the process is more complex and has new features, such as untwisting jets, according to experiments by Pariat (2010) and Archontis (2013a,b), and it is still uncertain whether the cooler chromospheric jets are produced by slow-mode shocks or pressure build-up.

In future, we need more observations and numerical experiments on the 3D aspects of jets produced by reconnection, which could shed light on several fronts. For example, what is the role of time-dependent jets in generating waves? What is the role of magnetic helicity?
How much of the twist is releasing stored up twist and how much is due to the conversion of mutual magnetic helicity into self helicity by the reconnection process? Furthermore, what is the effect of the jets on both coronal heating (converting kinetic energy into heat and spreading out the energy of hot jets) and on accelerating the solar wind?

Harry Warren (2013) gave an innovative talk about active-region coronal heating, stressing a promising technique (sparse Bayesian inference) to balance uncertainty and complexity in models. He also showed a comparison of an observed SDO active region with a nonlinear force-free model, in which the temperature and density on 1000 field lines were calculated. These suggest that the heating ($H$) has the following scaling

$$H \sim \frac{B}{L}$$

with magnetic field ($B$) and loop length ($L$). They also imply that the heating events occur on time-scales more rapid than the cooling time.

In future, there is room for much more comparison between theory and observation in order to determine the likely heating mechanisms at work.

Ineke De Moortel reviewed wave heating of the corona (see De Moortel, 2012; Parnell and De Moortel, 2012), first of all describing observations of Alfvénic waves in spicules and in the corona (with COMP and SDO), which imply that 100 W m$^{-2}$ is required in the quiet Sun and 2000 W m$^{-2}$ in active regions. She then pointed out that they could be generated directly from photospheric vortices or by mode coupling from kink modes, in which the waves become localised in a flux tube boundary (Fig.8). Their observational signature is at present unclear, since they could produce an impulsive or turbulent emission.

Waves are likely to be important in heating part of the corona, but there is a need to develop the basic theory beyond the current paradigm of simple flux tubes and to deduce observational signatures in more realistic geometry.

We also heard excellent talks on a variety of other topics. Marc de Rosa described the effect of spatial resolution on nonlinear force-free extrapolation. On prominences, two more future stars are David Orozco Suarez (2014), who discussed the inferred magnetic field of prominence threads, and Andrew Hillier (2014), who showed how observations of rising plumes can be used to infer the plasma beta in a prominence. In addition, Elena Dzifcakova (2014) gave interesting insights on the nature of the prominence transition region.

Regarding jets and flux emergence, Irina Kitiashvili (2013) described ejection by a photospheric vortex tube, while Vasyl Yurchyshyn (2013) suggested that spicules are accelerated by reconnection (Uchida-san would be pleased), and Len Culhane (2012) talked about the properties of solar wind outflow from active regions using EIS. Shinsuke Takasao (2013) discussed jets accelerated by reconnection and shocks, and Peter Young (2014) introduced the idea of “dark jets” in coronal holes.

Finally, there were several talks on coronal heating in general. Three other future stars
were: Philippe Bourdin (2013), who presented a 3D model of an active region being heated in response to photospheric motions; Jiansen He, who talked about slow-mode waves and outflows from reconnection; and Hwanhee Lee, who discussed a variety of different magnetic configurations. In addition, observations from the Hi-C rocket flight were shown by Sabrina Savage of active-region dynamics and by Paola Testa (2013) of moss variations due to nanoflares.

5. Flares and CME’s

Helen Mason gave a masterly review of evaporation in small flares using imaging and spectroscopy from Hinode/EIS. In the 90’s, Doschek had observed blue shifts during flares with BCS, but at the time he had no idea about their location. Now with EIS, Del Zanna and Mason (2013, 2014) have shown how EIS blue shifts are located in kernels at the ends of hot coronal loops (Fig. 9). They occur only in lines at 2–3 MK and represent evaporation from the chromosphere. The upflowing plasma is located at a height of 200 km with a density of \(10^{11} \text{ cm}^{-3}\) and its properties agree with those from a conduction-driven 1D simulation. SDO/EVE has produced more examples of upflows at 100–200 km s\(^{-1}\).

In future, it would be interesting to study such evaporation processes in large more-complex flares and to try and determine the heating and particle acceleration mechanisms.

The subject of reconnection and particle acceleration in eruptive flares was reviewed by Naoto Nishizuka (2013) (also a rising star). He showed how brightenings start below an erupting prominence, and suggested that the eruption drives impulsive reconnection in a current
Fig. 9. Observations by Del Zanna (2014) of a coronal loop with EIS, showing (a) Doppler shifts and (b) 10 MK plasma.

Fig. 10. 3D simulations by Nishida et al (2013) of a current sheet below and erupting prominence, showing (a) a snapshot of the current density and (b) the electric field as a function of time.
sheet. The fragmentation and ejection of plasmoids in the sheet has been demonstrated in 3D simulations (Fig.10), and test-particle orbits have found Fermi acceleration at a fast-mode shock as well as stochastic acceleration at multiple separators.

In future, it would be good to compare with observations of SAD’s (supra-arcade downflows) and also to develop self-consistent plasma physics of the process.

Then Jun Lin discussed large-scale current sheets in CME’s, showing how they have been observed in LASCO images, with plasmoids and typical thicknesses of $10^3$ km, lengths of $10^5$ km and Alfvén Mach numbers of 0.01. Numerical experiments reveal fragmentation and the properties of plasmoids with upflow and downflow velocities of 150–250 km s$^{-1}$ and 90–160 km s$^{-1}$, respectively. At a magnetic Reynolds number of $10^5$, there are typically 15 plasmoids and the turbulence enhances reconnection.

In future, determining the nature and properties of the turbulence will be helpful, as well as determining the formation mechanism for the the blobs (such as perhaps secondary tearing).
Other interesting talks that we heard were about: the location of non-thermal velocities from EIS (by Louise Harra, 2013); an MHD eruption (by Ed De Luca, 2013); flare ribbons and current ribbons by (Miho Janvier, 2013, 2014, another rising star); shear flow with SOT along a polarity inversion line (by Toshi Shimizu, 2013); a flare observed with FISS/NST (by Hyungmin Park, 2013); the way in which SAD’s indicate fragmentation of a turbulent flare current sheet (by David McKenzie, 2013, and Kathy Reeves, 2013); reconnection outflows in an X-flare (by Hirohisa Hara, 2011); supersonic outflows in a prominence eruption (by David Williams, 2013); the magnetic field deduced from EIT waves (by David Long, 2013); and hard X-rays from FOXSI by Shin Ishikawa (see Krucker et al, 2011).

6. Superflares on Solar-Type Stars

Karel Schrijver (2012) and Hiroyuki Maehara (2012) reviewed the concept of superflares. On the Sun, the flare energy is mostly in white light and so is hard to measure. From Kepler, the frequency of stellar flares fits a power law and increases with rotation. The flare energy is independent of rotation but depends on spot area and so a superflare needs superspots. On the Sun, one flare at $10^{34}$ erg is expected every 800 years and one at $10^{35}$ erg every 5000 years, so space weather can become much worse.

We also heard how Hinode helps understand stellar flares (from Petr Heinzel), details of stellar winds from young solar-type stars (from Takeru Suzuki, 2013), how a magnetic storm twice as large as the Carrington event is possible (from Bruce Tsurutani, 2014) and about rapid events in tree rings (from Fusa Miyake, 2013).

7. In Future

Brian Welsh (2014) raised three questions about the nature of photospheric magnetic fields and flows. First of all, do photospheric flows drive Alfvénic turbulence to heat the atmosphere? He does find flows that are faster and shorter-lived at smaller scales, but the
observed flows do not agree with the Van Ballegooijen (2014) model. Secondly, is flux emergence ideal or is reconnection necessary? He often finds that flux loss, cancellations and the deduced electric fields suggest reconnection is indeed important. Thirdly, what is the cause of the changes in photospheric magnetic field during flares? Perhaps a change in magnetic tension or a relation to sunquakes is involved.

In order to solve these questions properly, higher-resolution observations from Solar C and ATST are needed, together with new ideas and computational experiments.

Valentin Martinez Pillet (2014) raised the question: do you need continuous magnetogram observations for days with very high resolution and a small field of view? He suggested that the answer is yes, but that you also need full-disc observations to provide the context. He discussed an example of the puzzling nature of orphan penumbrae when sunspots have an unusual appearance (Fig. 12a). He suggested that large field of view observations enable an understanding of such localised behaviour. Thus, orphan penumbra occur when a strong horizontal magnetic field in the photosphere inhibits convection. This may occur either during the emergence of active regions or when the axis of a twisted flux rope dips down to the photosphere (Fig. 12b).

We also heard about coronal loop strands from EIS, AIA and Hi-C (from David Brooks, 2013), about the plans for CLASP (from Ryohko Ishikawa, 2014), and about NST observations (from Sasha Kosovichev, 2013).

8. Conclusion

Several amusing or memorable comments were made during the conference. George Doschek asked “Should we think out of the box or drink out of the box?” But thankfully
Helen beat sense into him (Fig. 13). Shibata-san impressed us with dramatic Kitaro music accompanying flares. Watanabe-san told us about Kyoto’s Galileo, called Mr Suzuki. Ada Ortiz Carbonell talked about “the most awaited romance”. Andreas Lagg daringly put the word “naked” into his talk title. Andrew Hillier had his father as a co-author. Louise Harra admitted to stopping us from going for our beer. Miho Janvier said “If you don’t follow my talk, blame the conference dinner alcohol”.

We all agreed this had been a memorable conference in a beautiful location and were most grateful to the members of the SOC for their hard work, led by Shibata-san (Fig. 14), and also to the LOC led by Ichimoto-san and especially to Shin’ichi Nagata. But, as we parted we remembered to enjoy the beauty of the solar corona (Fig. 15).

9. Acknowledgement

I am extremely grateful to Hirohisa Hara and Kazunari Shibata for hosting my visits to Tokyo and Kyoto, respectively, and for looking after me so well. It was a real delight to meet old friends and make new ones. I am also grateful to the University of Tokyo and to the Leverhulme Trust for financial support.

References

Archontis, V. and Hood, A. W. (2013). A numerical model of standard to blowout jets. Astrophys. J. Letts. 769, L21.
Archontis, V., Hood, A. W., and Tsinganos, K. (2013). The emergence of weakly twisted magnetic fields in the Sun. *Astrophys. J.* **778**, 42.

Bellot Rubio, L. R. and Orozco Suárez, D. (2012). Pervasive linear polarization signals in the quiet Sun. *Astrophys. J.* **757**, 19.

Bourdin, P.-A., Bingert, S., and Peter, H. (2013). Observationally driven 3D magnetohydrodynamics model of the solar corona above an active region. *Astron. Astrophys.* **555**, A123.

Brooks, D. H., Warren, H. P., Ugarte-Urra, I., and Winebarger, A. R. (2013). High spatial resolution observations of loops in the solar corona. *Astrophys. J. Letts.* **772**, L19.

Brun, A. S., Browning, M. K., Dikpati, M., Hotta, H., and Strugarek, A. (2013). Recent Advances on Solar Global Magnetism and Variability. *Space Sci. Rev.*

Buehler, D., Lagg, A., and Solanki, S. K. (2013). Quiet Sun magnetic fields observed by Hinode: Support for a local dynamo. *Astron. Astrophys.* **555**, A33.

Culhane, J. L., Brooks, D., Zurbuchen, T., van Driel-Gesztelyi, L., Fazakerley, A. N., and DeRosa, M. L. (2012). Tracking solar active region outflow plasma from its source to the near-earth environment. *AGU Fall Meeting Abstracts*, A2255.

Danilovic, S., Röhrbein, D., Cameron, R. H., and Schüssler, M. (2013). On the relation between continuum brightness and magnetic field in solar active regions. *Astron. Astrophys.* **550**, A118.

De Moortel, I. and Nakariakov, V. M. (2012). Magnetohydrodynamic waves and coronal seismology: an overview of recent results. *Phil. Trans. Roy. Soc. Ser. A* **370**, 3193–3216.

Del Zanna, G. (2013). The multi-thermal emission in solar active regions. *Astron. Astrophys.* **558**, A73.
Del Zanna, G. and Mason, H. E. (2014). Elemental abundances and temperatures of quiescent solar active region cores from X-ray observations. *Astron. Astrophys.* **565**, A14.

DeLuca, E. E., Su, Y., Kliem, B., and Van Ballegooijen, A. A. (2013). An MHD model of a solar eruption starting from NLFFF initial conditions. In *AAS Solar Physics Division Meeting*. AAS Solar Physics Division Meeting, vol. 44). 103.01.

Dzifčáková, E., Mackovjak, Š., and Heinzel, P. (2014). Kappa-distributions and temperature structure of the prominence-corona transition region. In *IAU Symposium*. IAU Symposium, vol. 300). 408–409.

Forbes, T. G. and Priest, E. R. (1984). Numerical simulation of reconnection in an emerging magnetic flux region. *Solar Phys.* **94**, 315–340.

Hara, H., Watanabe, T., Harra, L. K., Culhane, J. L., and Young, P. R. (2011). Plasma motions and heating by magnetic reconnection in a 2007 May 19 flare. *Astrophys. J.* **741**, 107.

Harra, L. K., Matthews, S., Culhane, J. L., Cheung, M. C. M., Kontar, E. P., and Hara, H. (2013). The location of non-thermal velocity in the early phases of large flares revealing pre-eruption flux ropes. *Astrophys. J.* **774**, 122.

Heyvaerts, J., Priest, E. R., and Rust, D. M. (1977). An emerging flux model for the solar flare phenomenon. *Astrophys. J.* **216**, 123–137.

Hillier, A., Hillier, R., and Tripathi, D. (2014). Determination of prominence plasma $\beta$ from the dynamics of rising plumes. In *IAU Symposium*. IAU Symposium, vol. 300). 94–97.

Hotta, H., Rempel, M., and Yokoyama, T. (2014). High-resolution calculations of the solar global convection with the reduced speed of sound technique. I. The structure of the convection and the magnetic field without the rotation. *Astrophys. J.* **786**, 24.

Ishikawa, R., Asensio Ramos, A., Belluzzi, L., Manso Sainz, R., Stepan, J., Trujillo Bueno, J., Goto, M., and Tsuneta, S. (2014). On the inversion of the scattering polarization and the Hanle effect signals in the hydrogen Lyman-alpha line. *ArXiv e-prints*.

Janvier, M., Aulanier, G., Bommier, V., Schmieder, B., Démoülin, P., and Pariat, E. (2014). Electric current in flares ribbons: observations and 3D standard model. *ArXiv e-prints*.

Janvier, M., Aulanier, G., Pariat, E., and Démoulin, P. (2013). The standard flare model in three dimensions. III. Slip-running reconnection properties. *Astron. Astrophys.* **555**, A77.

Katsukawa, Y. and Orozco Suárez, D. (2012). Power spectra of velocities and magnetic fields on the solar surface and their dependence on the unsigned magnetic flux density. *Astrophys. J.* **758**, 139.

Kitiashvili, I. N., Kosovichev, A. G., Lele, S. K., Mansour, N. N., and Wray, A. A. (2013). Ubiquitous solar eruptions driven by magnetized vortex tubes. *Astrophys. J.* **770**, 37.

Kosovichev, A. (2013). Astrophysical processes on the Sun. *Geophys. Astrophys. Fluid Dyn. 107*, 717–719.

Krucker, S., Christie, S., Glesener, L., Ishikawa, S.-N., McBride, S., Glaser, D., Turin, P., Lin, R. P., Gubarev, M., Ramsey, B., Saito, S., Tanaka, Y., Takahashi, T., Watanabe, S., Tanaka, T., Tajima, H., and Masuda, S. (2011). The Focusing Optics X-ray Solar Imager (FOXSI). In *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*. Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, vol. 8147).
Lin, J. (2012). Impact of magnetic reconnection on energetics of mass ejections from the Sun. In 39th COSPAR Scientific Assembly. COSPAR Meeting, vol. 39). 1086.

Long, D. M., Williams, D. R., Régnier, S., and Harra, L. K. (2013). Measuring the magnetic-field strength of the quiet solar corona using “EIT Waves”. Solar Phys. 288, 567–583.

Maehara, H., Shibayama, T., Notsu, S., Notsu, Y., Nagao, T., Kusaba, S., Honda, S., Nogami, D., and Shibata, K. (2012). Superflares on solar-type stars. Nature 485, 478–481.

Martínez Pillet, V. (2013). Solar surface and atmospheric dynamics. The photosphere. Space Sci. Rev. 178, 141–162.

Martínez Pillet, V. (2014). Solar Surface and Atmospheric Dynamics). 65.

Masada, Y., Yamada, K., and Kageyama, A. (2013). Effects of penetrative convection on solar dynamo. Astrophys. J. 778, 11.

McKenzie, D. E. (2013). Turbulent dynamics in solar flare sheet structures measured with local correlation tracking. Astrophys. J. 766, 39.

Mei, Z., Shen, C., Wu, N., Lin, J., Murphy, N. A., and Roussev, I. I. (2012). Numerical experiments on magnetic reconnection in solar flare and coronal mass ejection current sheets. Mon. Not. Roy. Astron. Soc. 425, 2824–2839.

Miyake, F., Masuda, K., and Nakamura, T. (2013). Lengths of Schwabe cycles in the seventh and eighth centuries indicated by precise measurement of carbon-14 content in tree rings. J. Geophys. Res. 118, 7483–7487.

Nandy, D. and Karak, B. B. (2013). Forecasting the solar activity cycle: new insights. In IAU Symposium, A. G. Kosovichev, E. de Gouveia Dal Pino, and Y. Yan, eds. IAU Symposium, vol. 294). 439–444.

Nishida, K., Nishizuka, N., and Shibata, K. (2013). The role of a flux rope ejection in a three-dimensional magnetohydrodynamic simulation of a solar flare. Astrophys. J. Letts. 775, L39.

Nishizuka, N. and Shibata, K. (2013). Fermi acceleration in plasmoids interacting with fast shocks of reconnection via fractal reconnection. Phys. Rev. Let. 110, 5 (Feb.), 051101.

Orozco Suárez, D., Asensio Ramos, A., and Trujillo Bueno, J. (2014). A first look into the magnetic field configuration of prominence threads using spectropolarimetric data. In IAU Symposium. IAU Symposium, vol. 300). 112–116.

Ortiz, A., Bellot Rubio, L. R., Hansteen, V. H., de la Cruz Rodríguez, J., and Rouppe van der Voort, L. (2014). Emergence of granular-sized magnetic bubbles through the solar atmosphere. I. Spectropolarimetric observations and simulations. Astrophys. J. 781, 126.

Pariat, E., Antiochos, S., and DeVore, C. R. (2012). Generation of plasma flows and waves during the development of coronal jets. In 39th COSPAR Scientific Assembly. COSPAR Meeting, vol. 39). 1449.

Pariat, E., Antiochos, S. K., and DeVore, C. R. (2010). Three-dimensional modeling of quasi-homologous solar jets. Astrophys. J. 714, 1762–1778.

Park, H., Chae, J., Song, D., Mauery, R. A., Yang, H., Park, Y.-D., Jang, B.-H., Nah, J., Cho, K.-S., Kim, Y.-H., Ahn, K., Cao, W., and Goode, P. R. (2013). Temperature of Solar Prominences Obtained with the Fast Imaging Solar Spectrograph on the 1.6 m New Solar Telescope at the Big Bear Solar Observatory. Solar Phys. 288, 105–116.
Parnell, C. E. and De Moortel, I. (2012). A contemporary view of coronal heating. Phil. Trans. Roy. Soc. Ser. A 370, 3217–3240.
Pereira, T. M. D., De Pontieu, B., and Carlsson, M. (2013). The effects of spatio-temporal resolution on deduced spicule properties.Astrophys. J. 764, 69.
Priest, E. R. (2014). Magnetohydrodynamics of the Sun. (Cambridge University Press, Cambridge, UK).
Reeves, K., Hanneman, W., and McKenzie, D. E. (2013). Thermal Structure of Supra-arcade Downflows and Flare Plasma Sheets. In AAS Solar Physics Division Meeting. AAS Solar Physics Division Meeting, vol. 44). 304.04.
Schrijver, C. J., Beer, J., Baltensperger, U., Cliver, E. W., Güdel, M., Hudson, H. S., McCracken, K. G., Osten, R. A., Peter, T., Soderblom, D. R., Usoskin, I. G., and Wolff, E. W. (2012). Estimating the frequency of extremely energetic solar events, based on solar, stellar, lunar, and terrestrial records. Journal of Geophysical Research (Space Physics) 117, 8103.
Shibata, K., Ishido, Y., Acton, L. W., Strong, K., Hirayama, T., Uchida, Y., McAllister, A., Matsumoto, R., Tsuneta, S., Shimizu, T., Hara, H., Sakurai, T., Ichimoto, K., Nishino, Y., and Ogawara, Y. (1992). Observations of x-ray jets with the Yohkoh Soft X-ray Telescope. Publ. Astron. Soc. Japan 44, L173–L179.
Shimizu, T. (2013). Hinode observations of flares and active region emergence. J. Phys. Conf. Ser. 440, 1 (June), 012002.
Shimojo, M. and Shibata, K. (2000). Physical parameters of solar X-ray jets. Astrophys. J. 542, 1100–1108.
Shiota, D., Tsuneta, S., Shimojo, M., Sako, N., Orozco Suárez, D., and Ishikawa, R. (2012). Polar field reversal observations with Hinode. Astrophys. J. 753, 157.
Suzuki, T. K., Imada, S., Kataoka, R., Kato, Y., Matsumoto, T., Miyahara, H., and Tsuneta, S. (2013). Saturation of stellar winds from young suns. Publ. Astron. Soc. Japan 65, 98.
Takasao, S., Isebe, H., and Shibata, K. (2013). Numerical simulations of solar chromospheric jets associated with emerging flux. Publ. Astron. Soc. Japan 65, 62.
Tarbell, T. D., Title, A. M., De Pontieu, B., Lemen, J. R., Wuelser, J., Wolfson, C. J., Hurlburt, N. E., Schrijver, C. J., Golub, L., DeLuca, E. E., Kankelborg, C. C., Hansteen, V. H., Carlsson, M., Bush, R. I., Sainz Dalda, A., and Kleint, L. (2013). First results from coordinated observing with IRIS, Hinode, and ground-based observatories (Invited). AGU Fall Meeting Abstracts, A3.
Testa, P., De Pontieu, B., Martínez-Sykora, J., DeLuca, E., Hansteen, V., Curtain, J., Winebarger, A., Golub, L., Kobayashi, K., Korreck, K., Kuzin, S., Walsh, R., DeForest, C., Title, A., and Weber, M. (2013). Observing coronal nanoflares in active region moss. Astrophys. J. Letts. 770, L1.
Title, A. M. (2013). First results from the IRIS observatory (Invited). AGU Fall Meeting Abstracts, A1.
Toriumi, S., Iida, Y., Kusano, K., Bamba, Y., and Imada, S. (2014). Formation of a flare-productive active region: Observation and numerical simulation of NOAA AR 11158. Solar Phys.
Toriumi, S., Ilonidis, S., Sekii, T., and Yokoyama, T. (2013). Probing the shallow convection zone: Rising motion of subsurface magnetic fields in the solar active region. Astrophys. J. Letts. 770, L11.
Tsurutani, B. T. and Lakhina, G. S. (2014). An extreme coronal mass ejection and consequences for the magnetosphere and Earth. *Geophys. Res. Lett.* **41**, 287–292.

van Ballegooijen, A. A., Asgari-Targhi, M., Cranmer, S. R., and DeLuca, E. E. (2011). Heating of the solar chromosphere and corona by Alfvén wave turbulence. *Astrophys. J.* **736**, 3.

Warren, H. P., Winebarger, A. R., and Brooks, D. H. (2012). A systematic survey of high-temperature emission in solar active regions. *Astrophys. J.* **759**, 141.

Watanabe, H., Bellot Rubio, L. R., de la Cruz Rodríguez, J., and Rouppe van der Voort, L. (2012). Temporal Evolution of Velocity and Magnetic Field in and around Umbral Dots. *Astrophys. J.* **757**, 49.

Welsch, B. T. (2014). The photospheric Poynting flux and coronal heating. *ArXiv e-prints.*

Williams, D. R., Baker, D., and van Driel-Gesztelyi, L. (2013). Estimates of rapidly moving prominence material from high-cadence EUV images. *Astrophys. J.* **764**, 165.

Yokoyama, T. and Shibata, K. (1996). Numerical Simulation of Solar Coronal X-Ray Jets Based on the Magnetic Reconnection Model. *Pub. Astron. Soc Japan* **48**, 353–376.

Young, P. R. and Muglach, K. (2014). Solar Dynamics Observatory and Hinode observations of a blowout jet in a coronal hole. *Solar Phys.*

Yurchyshyn, V., Abramenko, V., and Goode, P. (2013). Dynamics of chromospheric upflows and underlying magnetic fields. *Astrophys. J.* **767**, 17.