CD-I10 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

What is the role of magnetic reconnection in solar flare particle acceleration?

Thomas Neukirch[1]
[1] School of Mathematics and Statistics, University of St Andrews, UK
e-mail (speaker): tn3@st-andrews.ac.uk

During solar flares, previously stored magnetic energy is released and converted into kinetic energy in the form plasma flows, thermal energy in the form of plasma heating, and non-thermal energy in the form of high-energy particle populations. The consequences of this energy release can be observed across the electromagnetic spectrum,[1] and especially the radio and high-energy parts of the observed flare-related radiation are closely linked to the acceleration of charged particles during solar flares.[1,2]

The large-scale dynamics of flares is described well by magnetohydrodynamics (MHD), and magnetic reconnection is thought to play a key role in the release of magnetic energy during solar flares.[3,4,5] Magnetic reconnection is thought to contribute either directly or indirectly to the generation of the non-thermal particle population.[6,7,8] Acceleration via the generic reconnection electric field parallel to the magnetic field[9,10] would be classified as direct, whereas other acceleration mechanisms associated with reconnection, such as stochastic acceleration in turbulent reconnection outflows,[11,12,13] collapsing magnetic traps[14,15] or termination shocks,[16,17] would be classified as indirect.

The main tool generally used in current investigations of particle acceleration is still test particle calculations in given electromagnetic fields. These fields can be either analytically prescribed[15,18] or are generated by numerical MHD simulations.[19,20,21]

There is, however, a growing body of work that uses kinetic theory to investigate particle acceleration in the context of collisionless magnetic reconnection,[22,23,24] along with recent attempts to couple the microscopic and macroscopic scales self-consistently.[25,26,27]

In this talk, I plan to give an overview of some aspects of the link between magnetic reconnection and particle acceleration during solar flares and discuss some of the open questions associated with our theoretical understanding of these acceleration processes.

References

[1] A. Benz, Liv. Rev. Sol. Phys. **14**, 2 (2017)
[2] A. Pick & N. Vilmer, Astron. Astrophys. Rev. **16**, 1 (2008)
[3] E. R. Priest & T. G. Forbes, Astron. Astrophys. Rev. **10**, 313 (2002)
[4] K. Shibata & T. Magara, Liv. Rev. Sol. Phys. **8**, 6, (2011)
[5] M. Janvier, J. Plasma Phys. **83**, 535830101 (2017)
[6] M. Aschwanden, Space Sci. Rev. **101**, 1 (2002)
[7] T. Neukirch *et al.*, in *Reconnection of Magnetic Fields*, eds. J. Birn & E. R. Priest, Cambridge University Press, 281 (2007)
[8] P. J. Cargill *et al.*, Space Sci. Rev. **173**, 223 (2012)
[9] K. Schindler *et al.*, J. Geophys. Res. **93**, 5547 (1988)
[10] M. Hesse & K. Schindler, J. Geophys. Res. **93**, 5553 (1988)
[11] W. Liu *et al.*, Astrophys. J. **676**, 704 (2008)
[12] E. Kontar *et al.*, Phys. Rev. Lett. **118**, 155101 (2017)
[13] L. Vlahos & H. Isliker, Plasma Phys. Contr. Fusion **61**, 014020 (2019)
[14] B. V. Somov & T. Kosugi, Astrophys. J. **485**, 859 (1997)
[15] A. Borissov *et al.*, Sol. Physics **291**, 1385 (2016)
[16] G. Mann *et al.*, Astron. Astrophys. **494**, 669 (2009)
[17] B. Chen *et al.*, Astrophys. J. **884**, 63 (2019)
[18] J. T. Threlfall *et al.*, Sol. Physics **292**, 45 (2017)
[19] J. T. Threlfall *et al.*, Astron. Astrophys. **585**, A95 (2016)
[20] J. Birn *et al.*, Astrophys. J. **848**, 116 (2017)
[21] A. Borissov *et al.*, Astron. Astrophys. **635**, A63 (2020)
[22] M. Hoshino *et al.*, J. Geophys. Res. **106**, 25979 (2001)
[23] J. Dahlin *et al.*, Phys. Plasmas **24**, 092110 (2017)
[24] P. A. Muñoz & J. Büchner, Astrophys. J. **864**, 92 (2018)
[25] J. F. Drake *et al.*, Phys. Plasmas **26**, 012901 (2019)
[26] M. Gordovskyy *et al.*, Adv. Space Res. **63**, 1453 (2019)
[27] H. Bakke *et al.*, Astron. Astrophys. **620**, L5 (2018)