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Observations of magnetic reconnection in the partially ionized lower solar atmosphere

Hui Tian[1]
[1] School of Earth and Space Sciences, Peking University
e-mail (speaker): huitian@pku.edu.cn

In the light of the proposal that the solar atmosphere is powered by prevalent small-scale magnetic reconnection (Parker et al. 1988), efforts have been made to search for evidence of small-scale reconnection events in the solar atmosphere in the past 30 years. With recent high-resolution observations by NASA's IRIS mission, BBSO's 1.6-m solar telescope GST and the Chinese 1-m solar telescope NVST, we have discovered several types of bursty events that are most likely related to magnetic reconnection in the partially ionized chromosphere or even deep in the photosphere. For instance, in emerging active regions IRIS has revealed pockets of hot gas (~80,000 K) resulting from magnetic reconnection in the lower atmosphere (IRIS bombs) [1, 2]. Using joint observations between IRIS and NVST, we find that some of these IRIS bombs are connected to the previously identified Ellerman bombs formed in the photosphere. Our finding demonstrates that Ellerman bombs may be heated much more efficiently than what we thought before [3]. In the quiet Sun and coronal hole regions, IRIS has detected prevalent and intermittent jet-like features with apparent speed of 80-250 km/s from the network lanes [4]. These prevalent jets reach a temperature of at least ~80,000 K, and they are likely an important source for the energy and mass supply to the solar wind. The observations highly resemble the magnetic furnace model of the solar wind, suggesting that magnetic reconnection might be involved in the generation of these high-speed network jets. Solid evidence of magnetic reconnection is rarely reported within sunspots, the darkest regions with the strongest magnetic fields and lowest temperatures in the solar atmosphere. With GST observations, we have recently detected prevalent reconnection through frequently occurring fine-scale jets in the Hα line wings at sunspot light bridges [5]. Many jets have an inverted Y-shape, shown by models to be typical of reconnection in a unipolar field environment. Simultaneous spectral imaging data from IRIS show that the reconnection drives bidirectional flows up to 200 km/s, and that the weakly ionized plasma is heated by at least an order of magnitude up to ~80,000 K. Such highly dynamic reconnection jets and efficient heating should be properly accounted for in future modeling efforts of sunspots.

References

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Figure 1. Prevalent reconnection jets from sunspot light bridges [5].