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Dynamics of Sunspot Light Bridges

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Light bridges (LBs) are among the most prominent sub-structures in sunspots with magnetic field and convection conditions greatly deviating from the ambient sunspot background. Such divergences provide a favorable environment for various dynamic activities, which in turn make LBs ideal for studying different physical processes in astronomical environments with extremely strong magnetic field and partially ionized plasma, typified by the sunspots.

Recent high spatial, temporal, and spectral resolution observations have revealed various activities above sunspot LBs, e.g., brightenings in ultraviolet (UV), G-band, and Ca II H channels[1-4]; and jets or surges in Hα passband[5-8]. In addition, recent observations from the Interface Region Imaging Spectrograph (IRIS) revealed another type of bright wall-shaped structure above sunspot LBs. Their most prominent feature is the coherently oscillating bright front in the IRIS 1400/1330Å channel[9-12]. These structures are called light walls (LWs) and are interpreted to be the result of upward-shocked p-mode waves leaked from the sub-photosphere[13-15]. These activities display a wide variety of physical properties and expose a highly dynamical scenario of sunspot LBs.

Although part of the various activities above sunspot LBs have been deeply investigated, due to the limitation of previous observation conditions and the lack of comparative studies, several open questions still remain: How many types of activities could appear above sunspot LBs? What are the differences between these activities? How is one type of activity linked to another one? What is the frequency distribution of these different activities? Insights into these questions are necessary to understand the essential physical processes shaping the sunspot LB dynamics and call for a comprehensive and comparative investigation into the different types of activities above sunspot LBs.

In this talk, we first give an overview of various activities detected in sunspot LBs and their possible connections to different physical processes. Then we classify them into four distinct categories: transient brightening (TB), intermittent jet (IJ), type-I LW (LW-I), and type-II LW (LW-II) (see details in Table 1). The comparison of these activities are also discussed, including the relations between different activities detected recently by the IRIS and that between the activities with different names reported in previous and recent works. Finally, we discuss existing problems and future perspectives for the dynamics of sunspot LBs.

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Activities	Size	Lifetime	Period	Velocity	Driving Mechanism	References
TB	Spot: 1–2 Mm Elongated: 3–4 Mm	Several minutes	/	/	Magnetic reconnection	Toriumi et al. (2015b) Hou et al. (2020)
IJ	Height: $\gtrsim$10 Mm Width: 1–2 Mm	Several minutes —several hours	/	>50 km s^{-1}	Magnetic reconnection	Toriumi et al. (2015b) Hou et al. (2017, 2020) Tian et al. (2018)
LW-I	Height: 2–5 Mm Width: entire LB	Several hours —several days	4–5 minutes	~10 km s^{-1}	Leakage of waves	Yang et al. (2015, 2017) Bharti (2015) Hou et al. (2016a, 2017) Zhang et al. (2017) Tian et al. (2018)
LW-II	Height: ~10 Mm Width: entire LB	several hours	/	>50 km s^{-1}	Magnetic reconnection	The present work

Table 1. Various Activities above Sunspot Light Bridges in IRIS Observations[15].