ADVANCING THE UNDERSTANDING OF SUBSURFACE SURUCTURE AND DYNAMICS OF SOLAR ACTIVE REGIONS: AN OPPORTUNITY WITH NGGONG

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National Solar Observatory (NSO) is promoting the design of a new global ground-based network for solar observations as there is a strong interest for an advanced solar synoptic network within the solar physics community both in the US and within the broader international solar community. The science objectives discussed in various scientific forums call for a new type of routine observations, which are not available from the existing facilities. In this context, NSO and the High Altitude Observatory (HAO) have jointly prepared a proposal to the NSF to design the next generation ground-based network (ngGONG), which will replace the existing Global Oscillation Network Group (GONG) and the Synoptic Optical Long-term Investigations of the Sun (SOLIS) instrument suite. Once operational ngGONG will provide key measurements of the solar atmosphere that drive the heliosphere and space weather as a single system.

There are a number of additional scientific research areas that ngGONG can address and support. One of such goals would be to study the effect of inclined magnetic field on the seismology of active regions to interpret the helioseismic signals in sunspots and active regions. This has not been widely undertaken due to the lack of simultaneous observations at different heights in the solar atmosphere. Theoretical studies indicate that inclined magnetic fields in the solar atmosphere convert the acoustic waves into various types of MHD modes and change the apparent phase of the waves [1]. This produces incorrect inferences of the subsurface structure below active regions [2] since local helioseismic techniques do not account for these effects. Theory of linear wave propagation in strong and inclined magnetic field regions [3] further suggests that the incident fast acoustic wave from below the surface couples partially to a fast magnetic wave where the Alfvén velocity equals the local sound speed (see Figure 1). The key to understand these effects lies in multi-wavelength measurements to provide observations of wave propagation and the vector magnetic field as a function of height in the solar atmosphere [4]. Simultaneous helioseismic and magnetic observations would improve the understanding of acoustic wave propagation in the presence of magnetic fields and would bring us closer to comprehend subsurface structure and associated dynamics beneath the active regions. This may enable forecasting the emergence of active regions and a better interpretation of sub-photospheric properties of magnetic fields. Our understanding of the generation, transport, and evolution of the solar magnetic fields would progress significantly with the availability of continuous long-term multi-wavelength observations.

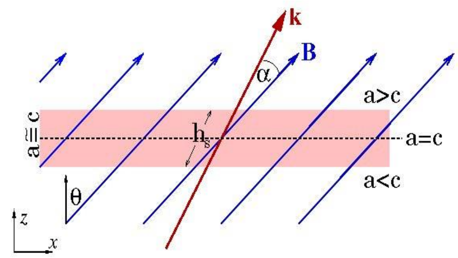

*Figure 1: Schematic diagram of wave propagation in an active region. This illustrates the scenario of a wave with wave vector **k** approaching a magnetic region from below. Here a is the Alfven velocity, c is the sound speed, k makes an angle α to the magnetic field B, which itself makes an angle θ to the vertical at a=c layer. Adapted from [5].*

References:

[1] Schunker H. and Cally P. (2006) MNRAS, 372, 551-564.

[2] Gizon L. et al. (2009) Space Sci. Rev., 144, 249-273.

[3] Moradi, H. et al. (2015) MNRAS, 449, 3074-3081.

[4] Tripathy S. C. et al. (2018) Adv. Space Res., 61, 691-704.

[5] Cally P. S. (2007) Astron. Nachr., 319, 286-291.