Magnetic Energy Coupling Across Broad Solar Atmospheric Plasma Conditions and Temperature Scales

N. Brice Orange *[orangewaveno@gmail.com], David L. Chesny, and Ruel Mitchel;*
OrangeWave Innovative Science, LLC and University of the Virgin Islands

Investigations of solar variability and its magnetic energy coupling are paramount to solving many key solar and stellar physics problems. Particularly, understanding the temporal variability of magnetic energy redistribution and heating processes. Using observations covering a portion of Cycle 24, from the Solar Dynamics Observatory's Atmospheric Imagining Assembly and Helioseismic Magnetic Imager, radiative and magnetic fluxes, respectively, were measured from coronal hole (CH), quiet Sun (QS), active regions (ARs), active region cores (ARCs), and at full-disk (FD) scales. Radiative flux modulations and magnetic energy couplings reveal a self-similarity throughout CH, QS, ARs, and FD features; consistent with notions of a similar central engine. A mathematical formula describing temporal thermal variability of our feature set is suggestive to a coupling of such to the solar atmospheric activity cycle. We also present, and mathematically describe, the coupling of radiative fluxes, across broad regimes of the electromagnetic spectrum (covering photospheric through coronal plasmas), to the available magnetic energy. A comparison of the typical approach describing solar atmospheric radiative to magnetic coupling (i.e., strictly linearly and confined to small energy ranges of the electromagnetic spectrum) is performed against our extended description, which utilizes a broken power-law, and reveals an entanglement of thermodynamic and magnetic energy contributions in previous literature. Additionally, our work suggests that stellar X-ray observations could populate radiation distributions in spectral ranges that are currently undetectable.