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# Shock Heating Energy in an umbra of a sunspot

Tetsu Anan, Tom Schad, and Sarah Jaeggli
AURA, National Solar Observatory, United States (tanan@nso.edu)

In December 7, 2014, umbral flashes, which are periodic brightness increases in chromospheric spectral lines of the umbrae due to shocks, were observed in near infrared He I triplet with an integral-field-unit spectrometer, SPIES (SpectroPolarimetric Imager for the Energetic Sun) on the Dunn Solar Telescope with a cadence of 14 seconds. The SPIES is a prototype instruments of a facility instrument of the Daniel K. Inouye Solar Telescope. In order to determine Mach number at upstream of shock waves, we fit the measured spectral profiles in the He I 1083 nm triplet with theoretical profiles computed with a radiative transfer equation using an atmospheric model based on two constant property slabs, of which temperatures and macroscopic velocities are constrained by the Rankine-Hugoniot relations. From the Mach number and the temperature, shock heating energy per unit mass of plasma is derived as 2.0 x 10 ^ {10} erg/g. Finding a positive correlation between a spatial variation of the chromospheric temperature and shock speed, we concluded that prominent heating mechanism can be related with the shock, although estimated shock heating energy rate is less than the required amount of energy to maintain the umbral chromosphere.