The Magnetic Field of Solar Chromospheric Spicules

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Abstract. A suitable diagnostic tool for investigating the magnetism of the solar chromosphere is the observation and theoretical modeling of the Hanle and Zeeman effects in solar spicules. In our presentation we highlighted the great scientific interest of this new diagnostic window by showing how the magnetic field vector can be inferred from spectropolarimetric observations of solar chromospheric spicules in several spectral lines, such as those of the 10830 Å and 5876 Å multiplets of neutral helium. Our off-limb spectropolarimetric observations of the He I 10830 Å multiplet were obtained with the Tenerife Infrared Polarimeter (TIP) attached to the Vacuum Tower Telescope at the Observatorio del Teide (Tenerife), while those of the 5876 Å multiplet resulted from observations with the Zurich Imaging Polarimeter (ZIMPOL) at the Gregory Coudé Telescope of the Istituto Ricerche Solari Locarno. The application of a Stokes profiles inversion technique led to the following conclusion. In quiet Sun spicules the magnetic field vector at a height of about 2000 km above the solar visible “surface” has a typical strength of the order to 10 G and is inclined by approximately 35° with respect to the solar local vertical direction. In spicules observed close to active regions the strength of the magnetic field was of the order of 50 G. The two figures below show the off-limb Stokes profiles of the He I 5876 Å multiplet observed in a quiet region (upper figure) and close to an active region (lower figure). Note that in both cases Stokes U is non-zero, which is the observational signature of the Hanle effect of an inclined magnetic field. The change of sign in Stokes U along the spatial direction of the spectrograph’s slit can be explained by variations in the azimuth of the magnetic field vector. Interestingly, while the Stokes V profiles corresponding to the observed quiet region are caused by the alignment-to-orientation transfer mechanism (see, e.g., page 607 of Landi Degl’Innocenti & Landolfi 2004), that observed in the spicules close to the active region is dominated by the longitudinal Zeeman effect. The interested reader will find more information in the papers by Trujillo Bueno et al. (2005) and by Ramelli et al. (2006).

References

Figure 1. Illustrative examples of the off-limb Stokes profiles of the He I 5876 Å multiplet observed in a quiet region (upper four panels) and close to an active region (lower four panels). The slit was parallel to the solar limb, at 2.5 arcsec from the visible limb (as seen in the slit-jaw image). Note the fine structure along the slit. The reference direction for Stokes $Q$ is the parallel to the solar limb.