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# On the multithermal nature of spicular downflows

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Spectroscopic observations of the emission lines formed in the transition region (TR) commonly show persistent downflows of the order of 10–15 $\mathrm{kms}^{-1}$. Their cause, however, is still not fully clear and has remained a matter of debate.

Using two sets of coordinated data from SST, IRIS, and SDO, we aim to understand the cause of such downflows by studying the coronal and TR responses to the recently reported chromospheric downflowing rapid redshifted excursions (RREs), and their impact on solar atmospheric heating. To provide theoretical support, we use an already existing 2.5D magnetohydrodynamic simulation of spicules performed with the Bifrost code.

We show several examples of the spatio-temporal evolution of downflowing RREs across multiple channels, ranging from the cooler chromosphere to the hotter corona. Our analysis suggests that they are likely the returning components of the previously heated spicular plasma. Furthermore, the TR Doppler shifts associated with them are close to the average redshifts observed in this region, which implies that they could (partly) be responsible for the persistent downflows observed in the TR. We also propose two mechanisms (an upflow followed by a downflow and downflows along a loop), from the numerical simulation, that could explain the ubiquity of such downflows. A detailed comparison between the synthetic and observed spectra, reveals a distinctive match, and further suggests an impact on the heating of the solar atmosphere.

We present compelling evidence that suggests that many of the downflowing RREs are the chromospheric counterparts of the TR and lower coronal downflows.



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