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Spinning spicule bunches and their connection to solar corona - An insight by means of 3D simulations and solar observations

Spicules are one of the most intriguing phenomena of the lower solar atmosphere. In spite of decades of research, they remain mysterious. From our initial work on how solar p-modes may generate spicules (Nat. 2004), through showing the formation of a forest of them using radial MHD simulations (Nat. Phys. 2022), finally we are able to report a more unified theory of spicular physics, underpinned with solar observational confirmation. First, bringing together SDO and IRIS observations, numerical simulations of the Sun (from convective zone to low corona) and laboratory fluid dynamics experiments we unveil insights into the mechanism underlying the ubiquity of jets: the nonlinear focusing of quasi-periodic waves in anisotropic media of magnetized plasma as well as polymeric fluids under gravity is sufficient to generate a forest of spicules on the Sun.

Next, using Hinode BFI data together with 3D rMHD simulations, we successfully capture the observed rotation amongst clusters of spicules. We show how this occasional swirly spicular motion is linked to hot rotating plasma columns – that we label as coronal swirling conduits (CoSCo). The spicules themselves appear as folds of drapery made of dense and cool plasma, in the upper solar atmosphere. A particular class of tall CoSCos seen in our simulations can potentially form by feeding on spicules and channeling this energy to the upper reaches of the solar atmosphere.

Finally, we propose, how with DKIST data the next step may be made in this context.

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