2-FLUID NUMERICAL SIMULATIONS OF SOLAR SPICULES

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Abstract

With the use of newly developed JOANNA code, we numerically solve 2-fluid (for ions + electrons and neutrals) equations in 2D Cartesian geometry. We follow the evolution of a spicule triggered by an initial pulse in vertical components of ion and neutral velocity launched from the upper chromosphere. Our numerical results reveal that this pulse steepens into a shock that propagates upward into the corona. The chromospheric cold and dense plasma lags behind this shock and rises into the corona with the mean speed of 20-25 km/s. The formed spicule exhibits the upflow/downfall of plasma during its total life-time of around 3-4 minutes, and it follows the typical characteristics of a classical spicule which is modeled by magnetohydrodynamics. The simulated spicule consists of a dense and cold core that is dominated by neutrals. The general dynamics of ion and neutral spicules are essentially similar to each other; some differences are seen in structures of both spicules, Rayleigh-Taylor instabilities seen in neutral plasma, and growing in time rarefaction of the ion spicule. We show that the spicule contributes to solar wind generation.