M16a Alfvén Resonances on UV Spicules

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We consider the propagation of small-amplitude torsional Alfvén waves on spicule-like structures seen at UV and EUV wavelengths. We assume that such UV spicules have densities an order-of-magnitude lower than chromospheric spicules. Extending the analysis of Sterling & Hollweg (1984), we find that UV spicules can act as resonance cavities, whereby Alfvén waves of preferred frequencies have strong transmission into the structures. The resonance cavity forms because of the sharp changes in Alfvén velocity between the photosphere/chromosphere and the UV spicule at the UV spicule's base, and between the UV spicule and the corona at the top of the UV spicule. For a canonical UV spicule residing on a magnetic flux tube of strength $B_0 = 40$ G with length $L = 10{,}000$ km and density $\rho = 1.0 \times 10^{-14}$ g cm^{-2}, we predict a fundamental resonance period of about 35 s, some 3 times shorter than for a corresponding chromospheric spicule. Velocities along the length of the UV spicule vary from about 30—150 km s^{-2}, increasing with height along the structure. Longer UV spicules have longer resonance periods and lower rotational velocities, and stronger magnetic fields result in shorter resonance periods and higher velocities. The same qualitative parameter dependencies also hold for chromospheric spicules. Damping flattens out the velocity amplitude's profile along the structure and reduces the maximum velocity, but does not appreciably change the periods of the resonances.