THE FARLEY-BUNEMAN INSTABILITY IN THE SOLAR CHROMOSPHERE

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Models of the solar chromosphere show intense electron heating immediately above its temperature minimum. Mechanisms such as resistive dissipation and shock waves appear insufficient to account for the persistence and uniformity of this heating as inferred from both UV lines and continuum measurements. This paper develops the theory of the Farley-Buneman Instability (FBI) applicable to the solar chromosphere that could contribute substantially to this heating. It expands upon the single ion theory presented by Fontenla (2005) by developing a multiple ion species approach that accurately models the diverse, metal-dominated ion plasma of the solar chromosphere. This analysis generates a linear dispersion relationship that predicts the critical electron drift velocity needed to trigger the instability. Using careful estimates of collision frequencies and a one-dimensional, semi-empirical model of the chromosphere, this new theory predicts that the instability may be triggered by velocities as low as 4 km/s, well below the neutral acoustic speed. In the Earth's ionosphere, the FBI occurs frequently in situations where the instability trigger speed significantly exceeds the neutral acoustic speed. From this, we expect neutral flows rising from the photosphere to have enough energy to easily create electric fields and electron Hall drifts with sufficient amplitude to make the FBI common in the chromosphere. If so, this process will provide a mechanism to convert neutral flow and turbulence energy into electron thermal energy in the quiet Sun.