HIGH ION ENERGIES IN Z PINCHES: POTENTIAL FOR ^{3}He FUSION?*

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Doppler-broadened lines with large widths, indicative of ion energies much higher than the thermal electron energies, are sometimes observed in Z pinches [1-4]. In some Z-pinch experiments, these large energies are likely due to a high ion temperature [3], but turbulence may dominate in others [4]. The rate of the aneutronic fusion reaction ^{3}He+D→^{4}He+H+18.4 MeV, is near its maximum at ion temperatures of 200 keV, similar to those measured on the Z facility in experiments described in Ref. 3. Viscous heating of the ions due to the dynamics of the m=0 instability is an attractive candidate to generate high ion temperatures. The important parameters at stagnation determining whether ion viscous heating is dominant are the ratio of the ion-electron equilibration time to the radial Alfven transit time, and the magnetic Prandtl number. Both should be larger than one. Importantly, for Z pinches in which this viscous process is not expected to be significant, ion heating was not observed [5]. When integrated over the pinch volume, the viscous heating can be expressed in terms of an effective additional nonlinear resistance, as in the magnetic bubble model proposed in [6]. Employing a 1D Lagrangian RMHD model with ion viscous heating, we investigate the scaling of ^{3}He-bearing Z-pinch parameters up to currents of 60 MA, and evaluate their favorability for the ^{3}He+D reaction.

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