# HEATING IN THE STAGNATION PHASE OF THE DYNAMIC DENSE Z-PINCH

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It is well known that the energy radiated at the stagnation phase of a dynamic Z-pinch can be 3 or 4 times the kinetic energy of the imploding plasma.[1,2] On the other hand some experiments do not show this effect.[3] This can be resolved by considering the various regimes of MHD behaviour, particularly for the m=0 instability at short wavelengths. High or low values of the Reynolds' number, the magnetic Reynolds' number, and particularly the magnetic Prandtl number $P_m$ delineate the behaviour. It is clear that for this effect to be present the viscous dissipation must dominate over resistive dissipation. Another important parameter is the ratio of the equipartition time to the radial Alfvén transit time. When this is greater than one, and $P_m>1$, the ion temperature arising from thermalisation of the kinetic energy persists in being much greater than the electron temperature and indeed can rise during the stagnation phase to 300keV[4]. On the other hand when equipartition is fast but a high Z plasma is employed it is the electron viscosity which is dominant and will convert magnetic energy via saturated MHD modes directly into electron thermal energy and thence to radiation. Unfortunately current resistive MHD simulations do not include real viscosity, but only an artificial viscosity of larger magnitude. Nevertheless in simulations about 70% of the energy radiated is found to arise from this numerical heating[5]. But it does lead to an artificially enhanced $P_m$, and the modes involved will have longer wavelength and larger amplitude. This fast heating via fast growing short wavelength instabilities is an excellent feature of Z-pinches for both ICF and K-alpha sources. It also removes the so-called limiting current proposed by Pease[6] and Braginskii[7] above which radiative collapse would occur. Furthermore it can lead to enhanced ion heating in deuterium gas-puff Z-pinches[8] and a neutron yield of $3\times10^{13}$.

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