Doctoral Thesis Abstract (The University of Sydney): Observations of Alfven Waves in a Tokamak Plasma

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In order to heat a tokamak plasma to the temperatures required for thermonuclear fusion to occur, a source of energy additional to the ohmic heating due to the current flowing through the plasma will almost certainly be required. Radiofrequency heating through the excitation of Alfven waves is a possible means of providing this power.

The thesis is predominately concerned with an experimental investigation of the excitation and propagation of Alfven waves in a tokamak plasma and in particular the potential application of Alfven waves to the heating of a fusion plasma.

A general introduction to the Alfven wave heating scheme and its theoretical basis is given. A detailed discussion of the effect of a low density edge plasma (which is normally present in a tokamak) on the compressional Alfven wave dispersion relation is presented.

The TORTUS tokamak, and the radiofrequency apparatus and procedures employed in the experiments, are described in detail. The construction of the antennas used, and their properties in the absence of a plasma, are discussed.

Experimental investigations of the plasma loading of a large number of antenna configurations are presented. It is demonstrated that the anomalously large resistive and inductive loading of some antenna configurations is due to the connection of extra current paths by the plasma. The dependence of antenna loading on antenna configuration and excitation frequency, and plasma parameters, is discussed.

Measurements of the poloidal and radial distribution of the magnetic fields associated with the waves excited by a Faraday shielded antenna, oriented in a poloidal plane of the tokamak, are presented. It is shown that the antenna directly couples to the torsional Alfven wave, which propagates along magnetic field lines in the edge plasma. The antenna excitation frequency and plasma electron density dependence of this undesirable coupling is investigated. Means of minimizing the coupling are suggested.

Coupling of energy from the antenna to Alfven resonance surfaces well inside the central plasma (as required for Alfven wave heating) is also observed, through significant wave field enhancement at the theoretically predicted radii. Experiments utilizing a phased array of three toroidally spaced antennas indicate that energy is coupled to the Alfven resonance surfaces through excitation of the surface branch of the compressional Alfven wave. A significant proportion of the total wave energy is shown to be coupled to surfaces well inside the central plasma, which is a result favourable to the prospects of the Alfven wave heating scheme.
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